Conclusion and Findings

Energy security has emerged as a catch phrase in years, both in political discussions and scientific arena. It has been traditionally associated with the securing access to oil supplies and with impending fossil fuel depletion. Especially after the oil crisis of the 1970s made the dependence of oil exporting countries in the Middle East evident. Now it is a fact that energy security is strongly related to other policy issues which concern the energy system such as affordable energy; climate change and environmental policy; implies that it is important to consider the energy security consequences of different pathways. Energy being directly linked to the development and security of nation gained importance at the level of policy making of the government. The issue has become more important and clear that India is not energy secure and its vulnerability will not only have domestic effects but also impacts on foreign policy.

First of all, an effort has been made to define energy security in Indian perspective in the introductory part of the research work. There is an urgent need to clearly define the constituents and to clearly demarcate the much needed diversification in the overall energy mix. It is now clear that an uninterrupted supply of energy is critical for smooth functioning of Indian economy. Availability of energy with required quality of supply is not only the key to sustainable development, but also commercial energy has a direct impact and influence on quality of service in the fields of education, health and food security of people. Therefore, when it comes to subject of energy in India, there has been criticism on the implementation part of planning. There is a need for clear vision and overall energy strategy in India. The first solution lies in hydrocarbons i.e. oil and natural gas. Efforts should be made to acquire more oversea assets, private participation may be increased, conduct of oil diplomacy and participation in projects like transnational pipelines to gain access. India should reduce its dependence on oil by turning to coal, since its coal reserves are abundant. Further India needs to decrease dependence on fossil fuels in general and emphasize on renewable i.e. nuclear, hydro or solar energy and other alternative sources of commercial energy over the long term. Self-
sufficiency is the key theme in Indian discourse. The energy independence with total freedom from oil, gas and coal imports is possible, although it will take a lot of hard work to achieve this target. A major breakthrough in nuclear or solar technology can prove to be of great help in sustaining the energy demand.

Since her independence India has been making efforts in developing nuclear energy for civilian purposes. In context of depletion of fossil fuels and continuous increase in global warming, nuclear power is highly solicited as an alternative by World Energy Congress for solving energy crisis forever. Nuclear power is a clean energy source that produces electricity without emitting any of the pollutants associated with fossil fuels, including greenhouse gases like carbon dioxide and methane, deadly particulates, nitrogen oxide, and sulfur dioxide. Reductions in these pollutants would alleviate global warming, mitigate environmental hazards like acid rain, and tackle the thousands of deaths a year caused by the combustion of fossil fuels. Moreover, nuclear power is only responsible for five percent of hazardous waste, while it contributes nearly 20 percent of our energy and new designs for nuclear plants could eliminate the issue entirely.

Since India is an emerging economic power with 1.22 billion people behind only to China and being the fourth largest energy consumer in the world after USA, China and Russia, India’s energy demand continues to rise. Aspirations of common people are on the rise, either it the case of increasing vehicle ownership or the demand of household items and comforts everything is energy driven. While India’s domestic energy resource base is substantial, the country relies on imports for a considerable amount of its energy use. India needs urgent energy security for domestic and foreign policy reasons. For this India needs an intelligent energy mix of oil, coal, gas, nuclear, hydro, solar, wind and other forms of energy. In the past few decades, oil has played an important role for energy sector in India but after liberalization of the domestic market it started to grow with the purchasing power of people becoming more and stronger. Demand for electricity, water and other amenities increased as people tried to uplift their standard of living. This has laid down a challenge to the Government of India to ensure an ever-expanding energy requirement of her people.
India did not concentrate on energy security prior to 1991 as it did not face any major difficulty in fulfilling its earlier energy demands. Through domestic production and a little import of hydrocarbons from the gulf regions it was able to fulfill its demand. But due to liberalization and foreign capital flow the domestic market grew robust and the demand for energy increased. In the year 2000 the government of India came out with a policy document titled *India Hydrocarbon Vision-2025* which outlined its understanding, future requirements and the roadmap for immediate and long term fulfillment of energy security. The document envisioned to assure energy security of achieving self-sufficiency through increased indigenous production and investment in equity oil abroad. An effort was made to develop hydrocarbon sector as a global competitive industry which could be could be a remarkable effort against the best in the world through technology up gradation and capacity building in all facets of industry. Further it was resolve to ensure oil security for the country keeping in view strategic and defence considerations. In this way the hydrocarbon vision document clearly stated India’s objectives for energy security. The important attached documents towards oil and gas security points towards India’s vulnerability and the strategic and defence weakness.

In 2005, the Petroleum & Natural Gas Minister, Mani Shanker Aiyer at the *Round Table conference of Asian Energy Ministers* at New Delhi had said that the three were two aspects of energy security. Firstly there should be security against of supplies and secondly there should be assurance of markets for producers and assurance of supply to the consumers. For India energy security is not merely a matter of policy decision but goes beyond the parameter of conventional governance. The availability of energy with required quality of supply is not only key to sustainable development but also the commercial energy has a direct impact on the quality of service in the field of education, health and various other sectors.

The report of expert committee on *Integrated Energy Policy* of India’s Planning commission, 2006, mentioned that India is energy secure when lifeline energy is supplied to the citizens without considering the ability to pay at all times despite shocks and disruptions in supply. TanviMadan of Brooking Institution in Washington D.C. an expert on energy issues of this region has similar views as the above stated report of the expert
committee on integrated policy says that India’s energy security has slightly different connotations. Energy security has become vital for the economic growth of India because energy is a life line for the all sectors of the Indian economy and India is unable to overcome its energy crisis.

India does not have the domestic conventional i.e. oil gas and high grade coal energy resources to sustain its rapidly growing economy. Consequently she is compelled to meet its requirements through foreign energy resources. India’s rapidly expanding economy requires increasing energy consumption by an annual rate of 4-4.5 percent in order to maintain growth rate of 7-8 percent. Today it is estimated that the demand for oil will increase 100 percent in the next ten to fifteen years. As India consumes more energy from world’s static supply, the cost of energy for ordinary citizens will increase significantly. Civilian nuclear cooperation has emerged as a viable option for India as the share of nuclear energy in the overall energy mix must increase so as to meet the ever increasing demand of energy. Currently nuclear energy contribution is less than three percent of India’s energy consumption and this number must increase substantially.

An important aspect about energy security is confirmation from the energy importing countries of regular imports of energy to the country. A sound foreign policy can help sustain this as well as finding new partners for trade and friendship to enhance new resources of energy resources supply and trade that can enhance India’s position to stay in the race. So India needs a well-conceived, comprehensive and sustainable energy policy that could deal with the energy security holistically, from political, diplomatic, economic and strategic perspectives.

Therefore, India needs to adhere to some principles to streamline energy security. It must promote diversification of energy supply, both in terms of locations and sources. The resilience of energy systems must be maintained to facilitate security margins to contain setbacks and offer viable means of recovery after disruptions. As a result of prevailing trends a more comprehensive framework of Energy Security should be taken into account. There is an urgent need to enhance the strategic reserve storage capacity. Government should pay special attention towards the conceptual aspects as has been described above.
Flexibility approach can leverage in spare production capacity, strategic reserves, backup supplies of equipment, adequate storage capacity along the supply chain and stockpiling of critical parts for electric power production and distribution. Diversification of supply in terms of location and source is one of the essential prerequisites of energy security. If a country can enlarge the number of supplier’s base from which it imports energy, it is relatively less open to the risks and consequential vulnerabilities. All countries are pushed into very tight and very sophisticated international energy market. To realize comprehensive energy security the stability of this market for all parties’ suppliers and recipients is necessary rather than the narrowly marked motive of any one country. Concerns on the part of suppliers or recipients can accelerate tensions and distrustful mind set not only undermine the mutuality of relationship between the involved trading parties but also cast deleterious impact to the entire domain, range and scope of energy security.

**Role of Nuclear Energy in India’s Energy Security**

India has announced its ambitious plans to expand its nuclear energy program nearly fifteen fold in the next twenty years from the current 4780 MWe to about 62,000 MWe by 2032. By 2020 *Department of Atomic Energy* (DAE) plans to install 20,000 MWe of nuclear power generation capacity and that would make India fifth largest producer of nuclear energy in the world. The Department has further plans that India will have capacity to produce 275 GWe of nuclear power by 2052.

These above figures show that India has ambitious plans in the field of nuclear power expansion. It is evident that without sufficient quantities of energy India cannot hope to become a global power of reckoning. The dream of eight to nine per cent economic growth per annum will be only fulfilled when it increases the share of nuclear power in overall energy mix along with renewable sources of energy. If the current projections are to be realized, the share of nuclear energy in the total energy output will still be 20 per cent. These statics are far below the present day energy mix of developed country like France where contribution of nuclear energy is 74 percent. At present nuclear energy contributes 20 percent in the US energy mix.
Successive governments since independence have fully supported DAE’s plans in the peaceful development of nuclear energy. The Support is likely to continue in future. After the Indo-US civil nuclear deal and Nuclear Suppliers Group (NSG) waiver in 2008, the mood of India has turned upbeat. India is now getting integrated into global nuclear regime even though it had not signed Nuclear-Non Proliferation Treaty (NNPT). After the NSG waiver France was the first country to enter into civilian nuclear cooperation with India. As of September 2014, Australia having largest number of uranium reserves accounting for 31 per cent of total worlds uranium reserves is the tenth country to enter into civilian nuclear trade and cooperation with India.

Furthermore, the success in realizing its nuclear energy program will contribute to India’s rise as a global power. This ambitious program will solve twin purposes for India. On the one hand it will provide the much needed nuclear power for an energy hungry India, on the other will create capacities in the nuclear industry which will provide hi-tech jobs to Indian youth. The private sector in India is also getting ready to participate in the yet nascent nuclear engineering sector. Several Indian companies are manufacturing critical components and sub-assemblies for Nuclear Power Corporation of India Limited (NPCIL) as various nuclear power reactors.

From the very beginning nuclear energy has been not only technical and financial issue but also it has been intensely political issue as well. India refused to sign NNPT which came into force in 1970 and conducted nuclear tests in 1974 and 1998 it was treated by international community as an outlier and put under several technological sanctions. The sanctions implied that India could not enter into nuclear cooperation with other countries after its ‘Peaceful Nuclear Experiment’ in 1974. This turned into virtue for India. Since it had no access to nuclear technologies, after 1974 it sought to develop a broad based indigenous program.

India continuously inched towards attaining self-sufficiency in its nuclear program. Since then it has set up a wide array of nuclear facilities including twenty indigenous nuclear reactors, reprocessing facilities, uranium mining and fuel fabrication, waste management, isotope manufacturing facilities, uranium recovery units and a range
of nuclear science research apart from a number of specialized institutions that has been set up in last few decades.

Nevertheless, human resource has been trained by Bhabha Atomic Research Centre (BARC) set up in 1957. The work of BARC is to do the basic research in the field of atomic energy development. The NPCIL was given charge of building and operating nuclear reactors. The NPCIL has clocked 332 reactor years of operation. BHAVINI, another public sector undertaking of DAE, is building fast breeder reactors which will provide much of the nuclear power in future. Atomic Energy Regulatory Board (AERB) is mandated with to enforce the safety norms for the nuclear power plants.

**Nuclear Policy with Regards to Strategic Dimension of India's Nuclear Program and Its Impact on Nuclear Power Generation Capacity of India:**

Obduracy of nuclear powers (haves) of the world compelled India to go nuclear in 1998 keeping in view the deteriorating regional security environment. Further, the legitimization of nuclear weapons by the international community also contributed towards India going nuclear. Rising trend of intervention by the industrialized nations in the domestic affairs of developing nations, among which India is also one, also compelled India to divert its nuclear resources towards nuclear weapons. It was necessary for India to protect the autonomy of decision-making in the developmental process and in strategic matters which are inalienable democratic rights of one sixth of the global population residing in India despite its unambiguous resolve of using nuclear technology for peaceful purposes and other fields like health and agriculture.

Keeping in view the realities of a nuclear zed world it is believed that in recent year’s nuclear weapons have played major roles in the strategic considerations of both major and regional powers. The frequency with which nuclear weapons have been brought into play to manage strategic interests is a pointer to a dangerous and disturbing trend. South-East Asia has witnessed a military crisis since 1999. The Kargil conflict occurred within months of the two countries going overtly nuclear. India’s strategy was to limit its operation to recapture it which Pakistan had occupied and India’s restrain in the scale of its military operations obtained international support and put Pakistan on notice about taking recourse to military means against India. According to some defense
analysts Pakistani leadership assessed that nuclear weapons had deterred India from widening the Kargil conflict.

After the December 13, 2001, terrorist futile attack on India’s Parliament, India lunched ‘Operation Pakistan’ and moved the army to the borders with Pakistan. The air force and navy were also moved into a state of operational readiness. There were statements from the military leadership of Pakistan indicating their readiness to use nuclear weapons if necessary. The threat of war from India made the major powers to pressurize Pakistan to end its terrorism policy against India. It is believed that threat of nuclear war was the main reason behind the involvement of the major powers. But India’s stand on the role of nuclear weapons is quite clear. India has emphasized at the conference of disarmament that Pakistan has been involved in nuclear blackmail and the South Asian region is confronted with aggressive nuclear positioning and irresponsible threat of use of nuclear weapons by irresponsible military leadership. It is evident that India is not in race with any other nuclear power. India has exercised its nuclear option without violating any international obligations in order to mitigate the threats to the world and the region has compromised to its national security.

India has its own nuclear doctrine which affirms its commitment to no-first-use of nuclear weapons and not using these weapons against non-nuclear weapon states. The defensive nuclear doctrine has a command and control system under certain political authority. Land marks of India’s nuclear doctrine are-

- Building and maintaining a credible minimum deterrent.

- A posture of no-first-use: nuclear weapons will only be used in retaliation against a nuclear attack on Indian Territory or on Indian forces elsewhere.

- Nuclear retaliation to a first strike will be massive and designed to inflict unacceptable damage.

- Nuclear retaliatory attack can be authorized by a certain political leadership only through NCA.

- No-use of nuclear weapons against non-nuclear weapon state.
• In the event of a major attack against India or Indian forces anywhere by biological or chemical weapons. India will retain the option of retaliating with nuclear weapons.

• Continuance of strict control on export of nuclear and missile related materials and technology, participation in the fissile material cut off treaty negotiations and continued observance of the moratorium on nuclear tests.

• Continued commitment to the goal of a nuclear-free world through global verifiable and no discriminatory nuclear disarmament.

India’s Credible Minimum Deterrence and Nuclear Doctrine: There are three major pillars of India’s Nuclear Doctrine as under:

1. No-First–Use: The nuclear doctrine states that India is committed to a no-first-use of nuclear weapons. The theory of deterrence and no-first-use go together. The first aggressive use of a nuclear weapon will be a confession that deterrence has failed and use of nuclear weapons was the only recourse left. It is globally recognized that nuclear war between two nuclear powers would not lead to any meaningful military decision beyond appalling losses to both sides. In these circumstances no-first-use is the most appropriate policy.

2. Credible Minimum Deterrent: The concept of minimum nuclear deterrent will include sufficient survivable and operationally prepared nuclear forces, a robust command and control system, effective intelligence and early warning capability and comprehensive planning and training for operations in line with the strategy and the will to employ nuclear forces and weapons. The nuclear doctrine envisages a deterrent that has the capability of inflicting destruction and punishment to the aggressor. The principles of credibility, effectiveness and survivability will be central to India’s nuclear deterrent. The nuclear doctrine does not quantify the minimum deterrent. It calls for highly effective military capability. The nuclear doctrine stresses upon effective, enduring diverse forces which are based upon a nuclear tread of air-craft, mobile land-based missiles and sea-based assets.
3. Nuclear Command Authority (NCA): The fact is that on January 4, 2003 India revealed a three-tier Nuclear Command Authority (NCA) to manage its nuclear weapons. This board framework was approved in the nuclear doctrine prepared by the national security board set up after the May 1998 nuclear tests. The NCA comprises of (a) political council, (b) executive council and (c) strategic forces command. Political council is headed by the prime minister. It is the body which authorizes the use of nuclear weapons. Executive council is headed by the national security adviser to the prime minister. Its function is to provide inputs for decision making by the NCA and to execute the directives given to it by the political council. The executive council may comprise of the chiefs of defense services, the IIC chairman, the convener of the NSAB, the cabinet secretaries, heads of intelligence agencies and secretaries of ministers represented in the Cabinet Committee Of Security (CCS). The Strategic Force Command (SFC) would be responsible for the administration of the nuclear forces and will be actually tasked with the firing of nuclear weapons. SFC is the second tri-service command after the first one in Andaman and Nicobar Islands was established in 2001.

Furthermore, India's nuclear doctrine is the most responsible doctrine which aims at providing minimum credible deterrent. It is a consensus document which does not limit the country in any way in exercising its nuclear weapon options. It provides complete elasticity in deciding; the number of nuclear weapons India should possess and classifies the emphasis on the survivability of the deterrent. Establishment of the NCA will add credibility to India's nuclear posture. The NCA stands out in its firm commitment to deterrent stability through civilian control over nuclear weapons. Most significant aspect of India's nuclear doctrine is that it is intimately tied up with continued commitment to total nuclear disarmament. The five major nuclear powers are reluctant to give up their monopoly over production and deployment of nuclear weapons while denying a similar privilege to other countries.

In contrast with India's nuclear doctrine there are ambiguous, questions about nuclear capability, precise doctrine and delivery systems of Pakistan. There is a fundamental difference between the nuclear policies of India and Pakistan. Whereas no-first-use of nuclear weapons remains the key element of India's nuclear policy Pakistan
maintains the first strike option in its nuclear doctrine and has refused to sign an agreement no-first-use. With India's over-whelming superiority over Pakistan in conventional forces, Pakistan looks towards nuclear weapons as a safe bet to overcome its disadvantages in a conventional view. In its first ever meeting the nuclear command authority under the chairmanship of the prime minister reviewed the arrangements in place for the strategic forces program. In a significant departure from the earlier stand the government warned that India would retain the option of retaliating with nuclear weapons if attacked with chemical or biological weapons by even non-nuclear adversaries. It also said that WMD attack on Indian forces outside Indian Territory would result in a nuclear response.

**Nuclear Energy Development in India:** The fact is that it is a quest for independence and sustainable energy for developmental activities of our economy. Therefore, the demand for electricity started rising at a fast pace for sustaining economic growth. Naturally then, India would need energy on a large scale to support her growing economy and improve the human development Index to the best level possible. Given the scale of energy required for this purpose as stated in the beginning, India came to be seen as a large energy market that could have a major escalatory impact on prices of fossil energy. This was also the time of heightened sensitivity about the threat to global climate as a result of increased use of fossil energy. Exploiting Indian energy market through nuclear energy thus started appearing to be an attractive proposition since India in any way had graduated in nuclear technology terms and geo-politically was never a threat to major nuclear vendors rather this also presented an opportunity to develop greater strategic balance in the region and a lucrative market for multinational companies of those who are leaders in the nuclear technology.

In case of India shortage of natural uranium put a severe constraint on the nuclear program. On the other side India has an abundance of thorium reserves world’s highest, a naturally occurring non-fissile material which can be converted into uranium-233, which is a fissile material. Foundation of India’s nuclear energy program was laid on this usage of thorium instead of uranium as a fuel. It needed a program which minimized the use of natural uranium. Accordingly, India’s nuclear program is based on a three-stage
progression conceptualized by Homi Bhabha, the father of India’s nuclear program, way back in 1954. The main aim of the three-stage program is to utilize the abundant thorium reserves in the country in reactors especially designed to use U-233 manufacture from irradiated thorium(Th232). The DAE report 2009-10 presents an account of the status of three stages, as follows:

- **Stage I: Pressurized Heavy Water Reactors (PHWRs) and Light Water Reactors (LWRs):** India has currently 20 reactors including two boiling water reactors. Together they have an installed capacity of 5780 MWe including the one 1000 MWe of the Kudankulam unit that went critical in second half of 2013. Six projects are under construction.

- **Stage II: Fast Breeder Reactors (FBRs):** A 500 MWe FBR being constructed at Kalapakkam, is nearing completion. This will set a stage for the commercial installation of fast breeder reactors in India, the main stay of second stage. Two FBRs might be constructed in the next eight years. Pre-project activities have been approved. According to S. Banerjee the Chairman of the DAE, the 500 PFBR is at an advanced stage of construction.

- **Stage III: Thorium Based Reactors:** Thorium reactors are still at experimental stage. It will be a while that appropriate designs are evolved, tested and commercialized and it could take some more years to a few decades. A 300 MWe *Atomic Heavy Water Reactor* (AHWR) is being developed in Trombay.

This was the time when in technological terms, we had made important strides, the program was far short of meeting national expectations in energy terms which were becoming rather critical in the context of growing economy. While our reactors were creating new performance bench marks, they started suffering loss of capacity on account of uranium supply shortages. While work on several new mines was initiated, it would take a while before they produced results. At a time when despite heavy investments the new exploration such as TDEM survey instruments, electro-hydraulic drills etc are under way and are nearing yielding results. This however would take even longer time to deliver Uranium to our existing load capacity of our existing power plants. We were technologically ready and national expectations on electricity supply were high but non
availability of Uranium was letting us down. The best we could do was to reconfigure reactors to work at a lower power with much greater uranium use efficiency, so that NPCIL could sustain without making losses till uranium supply situation improved and simultaneously pursue various avenues to a lasting solution to the problem of assured uranium supply for our present and future nuclear reactors.

A long term assessment also revealed that about 25 percent gap would persist between electricity supply and demand despite the most optimistic performance of all electricity generation options including the domestic three stage nuclear power program. In terms of nuclear related resources, India had access to proven and potential nuclear fuel. It has poor natural uranium resources, with domestic supply able to fuel the production of 10,000 MWe by PHWRs running at a capacity of forty years. Indigenous ore is also of low grade at around 0.1 per cent uranium, which makes production two to three times more expensive than international sources. India does have almost one-third of world’s reserves of thorium, a fertile element that can be used to produce nuclear energy once it is converted into uranium-233 in a reactor. The three stage nuclear power development plan put on by Bhabha still guides the development of nuclear power industry to the present day, but only stage one of the three-stage plan - the establishment of PHWRs using natural uranium to produce electricity – has been mastered and put into operation. Rapid progress has been made in stage-two as the 500 MWe FBR being constructed at Kalapakkam, is nearing completion. This will set a stage for the commercial installation of fast breeder reactors in India, the mainstay of second stage. Two FBRs might be constructed in the next eight years in India. That is why the only way to bridge the ever increasing gap between the demand and supply of energy was possible only through import of it. Of all choices for the import of energy, import of uranium would have several advantages. As it is the quantity involved would be very small. More importantly, since we were to any way pursue uranium recycle in breeder reactors as a part of our domestic three stage strategy, import of a limited quantity initially could also address the long term energy needs through leveraging our fuel recycle capability without having to resort to any further imports of energy. It was with this background that opening of civil nuclear co-operation with United States was pursued.
Most of the studies have revealed that utmost care has been taken to ensure strategic autonomy in all aspects of domestic program and prevention of vulnerabilities arising as a result of a significant program being established through imports. One could be very firm in ensuring these, being aware of the strong motivation on both sides to move positively forward. Fortunately, we now have access to larger uranium supply potential both from within the country and outside the country. Further the capacity factors of our reactors is now at a high level, our industry is eagerly awaiting to play a crucial role in the supply chain for nuclear power plants based on both of domestic as well as foreign technology and in competitive terms nuclear power should be even better placed given the domestic coal supply constraints and higher price of coal in international market.

**Role of Civilian Nuclear Deal in Development of India’s Nuclear Energy Security:** We know that the Indo-US nuclear deal concluded in 2008 after hectic parleys on both sides which was full of skepticism and mutual doubts is seen as the most significant and potent development in the perspective of energy augmentation, international diplomacy and international politics for India. After five years of its operation it has now started yielding results. The United States recognized India a ‘responsible nuclear state with advanced nuclear technology, obfuscating the reality that it cannot be recognized as a de jure nuclear weapon state’. The United States also pledged that India ‘should acquire the same benefits and advantages as other states’, for which US President will ‘seek agreement from the congress to adjust US laws and policies’, and will work with friends and allies to adjust international regimes’ to enable civil nuclear energy cooperation and trade with India, including uranium fuel supplies for the safeguarded light water reactors in Tarapur.

This agreement after six years has become basis for wide-ranging bilateral cooperation from basic applied research to full civil-nuclear cooperation, including import of reactors, nuclear safety, radiation environment protection and nuclear fuel cycle management. Under the agreement, India can use its own technology and under IAEA safeguards, reprocess used nuclear fuel imported after the conclusion of the deal with US and finally waiver by NSG. The United States continues to occupy the apex of global
power in the political, military, economic and technological dimensions, despite its current financial difficulties. The deal envisaged a large area of cooperation in civilian nuclear energy generation, high-tech development and other areas. The deal exempted India from operations of the international nuclear regime which had ostracized India since the first Pokhran test in 1974 and made it ineligible to receive nuclear technology, materials and equipment from abroad. The deal has enabled India desperately needed natural uranium for PHWRs; its available low-grade indigenous uranium ore reserves are insufficient to sustain an ambitious nuclear program, taking into account the estimates of nuclear power requirements projected by the atomic energy establishment in India. India has been hobbled by various technology control and restraint regimes like the NSG and MTCR, Warssenaar Arrangements and the Australian Group, that have prohibited India from acquiring high technology, goods and services to accelerate the economic growth. This relaxed dispensation would surely benefit India on many counts. The deal has been therefore the key to unlocking the door for receipt of high technology for India’s modernization program. The deal has been apparently motivated by the India’s growing energy needs as well as the US desire to forge into a new strategic partnership with India.

India is aggressively pursuing international cooperation to augment its nuclear energy program. India has concluded Memorandum of Understanding (MoU) and agreements with Argentina, Canada, France, Kazakhstan, Magnolia, Russia, the UK, the USA, South Korea and latest with Australia. Discussions are going on civil nuclear cooperation with Japan. India has signed a roadmap of cooperation in nuclear energy with Russia according to which it will built units 3,4,5 and 6 at Kudankulam where unit one has already started functioning and the unit two is under construction. Russia has also been offered a site in Haripur in West Bengal for two more units to be built during the 12th Five Year Plan.

India’s nuclear energy program is on the verge of taking off. Imported light water reactors will not only fulfill a part of India’s energy needs but also the future of India’s energy program will largely depend on success of second and third stage of the program. India’s nuclear energy program will come of age only when fast breeder reactors and
Thorium fuelled reactors are commercialized. Several countries which had experimented with fast breeder technology have abandoned their efforts. India is continuing with it. There are significant challenges which lie ahead but Indian scientists are optimistic. While progress up to 2020 remains reasonably sure, the future beyond 2020 is dependent on several technological and institutional challenges that have yet to be overcome. Let us see India’s capability to overcome these challenges.

Nuclear experts have concluded that the joint declaration announced on 18 July 2005 on a door note that a basic confusion in objectives and concealment of India’s nuclear energy program has created a parlous situation necessitating the current nuclear deal being reached with United States from a position of weakness. Right up to October 2008, more than three years later, in between, the US congress passed the Hyde Act in end of December 2006, giving a free pass to India. Later in March 2007, the 123 Agreement, named after the relevant sections of the US Atomic Energy Act. Three further hurdles needed to be crossed: India had to negotiate an India-specific Safeguards Agreement with International Atomic Energy Agency (IAEA); The United States had to persuade the Nuclear Suppliers Group (NSG) to amend its guidelines and make India an exception to its mandate, and finally, the US congress had to pass the 123 Agreement to incorporate the IAEA and NSG requirements.

Now it is assumed that it would add to the cost of atomic power generation, but also contrary to the general policies of Indian government. This has now become a huge issue between India and United States centering only on the provisions of India’s Civil Nuclear Liability Act that are deemed inimical to nuclear commerce. India’s Civil Liability for Nuclear Damage Act has led to great concerns to Americans and even to Russia and France. To assuage this angst of all concerned, India affected a post-haste entry into the Convention of Supplementary Compensation for Nuclear Damage in Vienna before President Obama’s visit to India in November 2010, to give some sort of assurance to nuclear industry. It was really a herculean effort was needed by the Bush Administration to steer the Indo-US nuclear deal through the US congress. There was also hope that American nuclear industry would benefit from the lucrative contracts to supply nuclear reactors and related technology. After investing so much political capital
the US government felt that American Nuclear industry was entitled to a fair share of the Indian nuclear business. Voices were heard in New Delhi that since a general waiver has been obtained to import nuclear technology, materials and equipment, India might negotiate with Russia and France if US pre-conditions proved too onerous.

Safety and Security Aspects of India’s Nuclear Power Program: The civil nuclear liability law was intended to ally the suspicions but instead it had enhanced these concerns. The Civil Liability for Nuclear Damage Act (CLNDA) Act fixes the liability for compensating the victims of a possible nuclear accident on the operator of the nuclear facility, which has been capped around $ 10 billion. For damages exceeding this amount, up to 300 million Special Drawing Rights (SDRs) the Union Government in India accepts the responsibility. This provision is only applicable in practice to the Union Government, since Atomic Energy Commission is the only nuclear operator in India. The Problem arises with section 17 (B) of the impugned Act. It envisages that the operator has the right to recourse, i.e. obtain compensation from the suppliers or his employees, which includes the supply of defective equipment, material or substandard services. In marked contrast, the international law constrained in the Convention on Supplementary Compensation for Nuclear Damage fixes the responsibility on the operator and confers ‘no right to recourse’ (RoR).

Lessons Post-Fukushima & Its Impact on Nuclear Energy Development Program: The fact is that after four years of Fukushima disaster that occurred in March 2011, Japan’s new nuclear regulatory agency declared on September 10, 2014 that an atomic power plant was safe to operate, in a widely watched move that brings Japan a step closer to restarting its idled nuclear industry. The two reactors at the Sendai power plant on the southern island of Kyushu are the first to be certified as safe enough to restart by the Nuclear Regulation Authority since the agency was created two years ago to restore public confidence in nuclear oversight. All of Japan’s 48 operable commercial nuclear reactors were shut down after the 2011 triple meltdown at the Fukushima Daiichi Nuclear Power Station created serious public doubts about the safety of atomic power in earthquake-prone Japan. This has been one of the main the reason the Indo-Japan civilian
nuclear cooperation is not making headway. But the recent developments have rekindled hope for nuclear power.

**Future of Nuclear Energy Development Program in India:** There is not an iota of doubt that nuclear energy will decide the developmental profile of India in the coming decades. There are some of challenges that we need to keep in focus from a near and longer term perspective:

- Rapid increase in share of nuclear power in overall electricity supply in the country. Share of nuclear power would be a little more than around four and a half percent once both Kudankulam units are on stream. We should expect this to happen soon enough. Reaching the next target of 20,000MWe by the year 2020 would need a construction program of around 13,000MWe to be in place by the year 2024. At the moment only around 2800 MWe capacity is under construction. Considering that at a site a pair of reactors can be taken up at a time, commencement of work at a minimum of six sites would be necessary if the target is to be met. Given that there are several fronts like PHWRs, LWRs, FBRs and AHWRs, this should indeed be possible provided there are no further slippages and bottlenecks at decision making level. In past we have successfully undertaken this level of activity. A matching effort would be needed with regard to lining up the supply chain including nuclear fuel.

Along with PHWRs, further evolution of Indian FBRs and even LWRs should remain an ongoing activity to improve relative competitiveness even as one continues to use these technologies for large scale deployment. In the long term, we should aim at taking the share of nuclear power to around 25% with the remaining share coming from solar energy. As seen earlier, these two would necessarily to be the mainstay for sustainable energy supply in India.

- **New Technology Initiatives:** For realization of Thorium utilization objectives in full measure a number of new technologies have to be evolved and proven for successful competitive deployment. Many of them would require pursuing pathways different from most other countries since Thorium is unlikely to be a matter of high priority for them. Structured as well as unstructured programs
around research, development, demonstration and deployment chain to address all aspects of Thorium reactors and related fuel cycles would need to be pursued with a holistic approach without leaving any gaps in the Indian capability.

A related development domain that would need to be pursued to ensure large scale acceptability of nuclear energy would be to reduce radio-toxicity of long lived radio-active wastes to the level of Uranium mine in a reasonable time span of say a few hundred years. Similarly the safety of nuclear reactors should be taken to a level that precludes any serious impact in public domain and confidence. Then, a further development objective would be to build in robust proliferation resistance as well as facilitate deep burning of plutonium to extract energy and render it of no proliferation consequence. Thorium has special role here. AHWR 300-LEU has been designed with many of these objectives can serve as an important platform for pursuing further developments in this context.

Expanded role for Thorium to deliver safe and secure nuclear energy worldwide, while Thorium constitutes a large energy resource for us, it can also contribute to wider geographical spread in deployment of nuclear power with reduced proliferation, security and safety risks. In an era of heightened risks as a result of global climate change, Indian Thorium capability can make important contributions to meeting safe and carbon free energy needs worldwide. The concept energy security must be evolved which is a critical part of national security which would decrease India’s energy vulnerabilities. It would be a failure of nation if steps for enhancing energy security are timely not taken and for that complacency future generation might have to pay for this failure.
Findings of the Study:

There is shortage of natural resources like oil and gas, lack of reforms, poor infrastructure and inadequate hydrocarbon reserves and for these reasons India has been feeling increasingly insecure in the energy sector. Therefore the energy sector needs to be restructured and liberalized. Greater investment is needed that may be increased through private participation. There is need to increase the distribution infrastructure. India needs to move from being largely a fossil-fuel-driven energy economy, to one that is powered by energy from clean and renewable energy forms. For achieving that target it should adopt a strategy, with focus on following:

- Lessen reliance of imports and increase domestic production especially oil and natural gas. India should buy foreign assets including promoting regional cooperation with energy suppliers, transit countries and energy users for outsourcing of fossil fuels. In addition to that robust energy diplomacy is needed for checking the repeated episodes of insecurity of energy supply and disruption.

- India must strive to create strategic petrochemical reserves in oil, LNG, CNG including enhancing the storage capacities for emergency situations. It can be realized by diversification of sources of fuel supply and implementation of energy reforms across the board.

- India must increase refinery capacity to become a global refinery hub and must also upgrade energy infrastructure including pipelines, electricity grids etc.

- Nuclear Knowledge Management: Industry knowledge base needs to be strengthened to sustain the growth of nuclear industry. This will help in increasing nuclear power generation. There is a need to gain access to IVth generation nuclear reactor technology, nuclear fuel and nuclear fuel cycle technology before realizing the massive expansion of nuclear energy program.

- Aggressively pursue the development of nuclear energy while providing the essential emphasis on safety and addressing public perception issues.

- There is need to manage demand, improve efficiency to reduce energy intensity levels, from the policy level to grassroots.
• Increase shares in renewable in energy mix with relatively low gestation period but high returns, by designing the appropriate regulatory and incentive structures. While promoting clean technologies we should replace “dirty” fuels with ‘greener’, e.g. nuclear, gas. Various fuels are also being commercialized like shale gas, bio-fuels etc. should also be considered for the future energy requirements.

• Rapidly move to a high efficiency energy path, with relatively low gestation period but high returns, by designing the appropriate regulatory and incentive structures. Create a pool of technically qualified human resources to serve the domestic and international clean energy markets.

• The Indi-US civilian nuclear deal has emerged as India’s hope of integrating in the global nuclear framework and also enhance India’s energy security situation at least in the short term. To ensure energy security, projections, plans and supply arrangements should look beyond short-term demand as well.

• This calls for a paradigm shift. From supply domination to an integrated approach and judicious mix of improvements in operational and end-use efficiencies and renewable energy technologies.

Possibility of joint sector projects and private sector participation to mobilize additional financial resources should explored. Research & Development on specific development tasks in the field of nuclear power technology should be fully supported by the Government of India as a part of the national policy. There is a need for standardized system for annual revision of tariff. The problem of shortage of funds would be solved to a large extent when tariffs are fixed on an objective basis for power generation from different sources. Develop a long-term integrated mobility and freight movement strategy that is aligned with the overall objective of driving India’s energy economy through clean energy forms. India should move to a completely market-driven pricing mechanism for all energy forms under the regulatory oversight of preferably a single, energy regulatory commission. Thus, the above few findings and suggestions would certainly help India emerge as a energy secure leader in clean, green and environmental friendly energy policies, technologies, manufacturing, and other related services.
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