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Transition to Energy Secure Future:

Policies Enabling Energy Transition in India

Nandakumar Janardhanan[1] **February 2012**

Abstract

India's fossil fuel dominated energy mix poses various challenges to the country. First, the over-reliance on the imported fuel makes the country vulnerable to supply challenges due to geopolitical turbulence in the energy producing regions, second, use of hydrocarbon sources has been adversely affecting the environment and human health, third, the growing dependency on import adds significant burden to the economy, and fourth, growing energy related emissions is adding to the concerns of global climate change. In this context, to ensure energy security and meet the long term economic goals, transition to a cleaner fuel mix with higher share of domestically supplied alternative sources evolves to be a strategic necessity. Coordinated and precise policy tools, implementation in mission mode and right policy catalyst are important to ensure mainstreaming of the transition process. While there are various factors that function as policy catalysts towards energy transition, climate mitigation efforts can potentially evolve to be the most effective pathways. This paper explores various policy efforts that contribute to energy transition in the country and argues that under the climate mitigation agenda the previously fragmented efforts are getting consolidated and help smoother transition to low carbon economy and to achieve and energy-secure future.

Key words:

Energy Transition, energy security, climate mitigation, market mechanisms, Perform Achieve and Trade (PAT), Renewable Energy Certificate.

[1] Policy Researcher, Climate Change Group, Institute for Global Environmental Strategies, Japan

Table of Contents

Abbreviations

NDC	National Development Council
Mt	Million Metric Tons
CCS	Carbon Capture and Sequestration
Mtoe	Million Tons of Oil Equivalents
MW	Mega Watt
CNG	Compressed Natural Gas
LPG	Liquefied Natural Gas
BEE	Bureau of Energy Efficiency
NAPCC	National Action Plan for Climate Change
PAT	Perform Achieve and Trade
BLY	Bachat Lamp Yojana
REC	Renewable Energy Certificate

1. Introduction

Events of Politico-strategic importance and economic development have always been significant catalysts for changes in the energy policy of countries across the world. Incidents such as the oil crisis in 1970s and 80s, subsequent political volatilities in Persian Gulf, oil price fluctuations, global economic downturn etc contributed to various changes in the energy policies. The surge in nuclear power in the 1970s among the major economies, *Pró-Álcool* policy[2] of Brazil for developing bio fuels, promotion of solar, wind and hydro power etc have all been important milestones in the energy policy changes worldwide. However, the energy security perception among many economies continued to be largely oriented towards petroleum supply security; primarily due to two key reasons. There were; first, despite various pressure factors, the technological feasibility and economic viability of shifting away from conventional fossil fuel sources were perceived with great level of scepticism; and second, the prevailing fear-psychosis that any sudden and significant shift to non-conventional sources would dampen the planned domestic economic targets. To some extent a change in perception of the conventional link between fossil fuel and energy security was catalysed by factors such as continuous political volatilities in the Persian Gulf region, oil price volatility, surging fuel demand in developing economies and above all the need to effectively address the concerns on GHG emission and climate change.

A truly global and integrated energy technology revolution is essential to address the intertwined challenges of energy security and climate change while also meeting the growing energy needs of the developing world.[1] Hence a transition from conventional fuel dependency to a new, low carbon energy mix is important for a country like India. Though moving away from a fossil fuel based economy is still perceived as challenge to the domestic targets, climate change mitigation efforts especially the market mechanisms can positively contribute to the transition process through development of non-conventional energy sources and greater reliance on low carbon energy technologies. Strong policies at the domestic front towards energy efficiency improvement and promoting electricity generation from non-conventional sources are also able to overcome the decades-old concerns about technology lock-ins. The co-benefits of the new market mechanisms being promoted in India as part of the climate strategies also continue to be the main drivers for energy transitions and have the potential to address both supply-side as well as demand-side energy concerns in India.

Various factors contribute to energy transition in a country, depending upon their respective socio-political, economic conditions. In the case of India various socio-political, economic, environmental and geopolitical factors have been critical catalysts to energy transition. As ensuring long term energy security has been major policy driver in the country, hydrocarbon sources have gained significant attention in the past. Though the development of other fuel types have only received little importance in the past, last decade witnessed considerable importance being attributed towards development of renewable energy, building legal and administrative institutions that contribute to the development of cleaner energy development and usage, and demand side energy management efforts. However, energy transition as a policy mechanism was only seen as fragmented components until the recent years especially because of various challenges which made energy transition as difficult policy process. A possible change to this scenario emerged in the last decade following the increased attention paid to importance of addressing energy and environmental concerns. The importance of ensuring long term energy security and environmental health need to be seen as pivotal components that helped bring the need for energy transition in the policy thinking. During the later years of last decade, with the formation of the National Action Plan for Climate Change which consolidated the climate mitigation agenda of the country the policy measures contributing energy transition increasingly gained

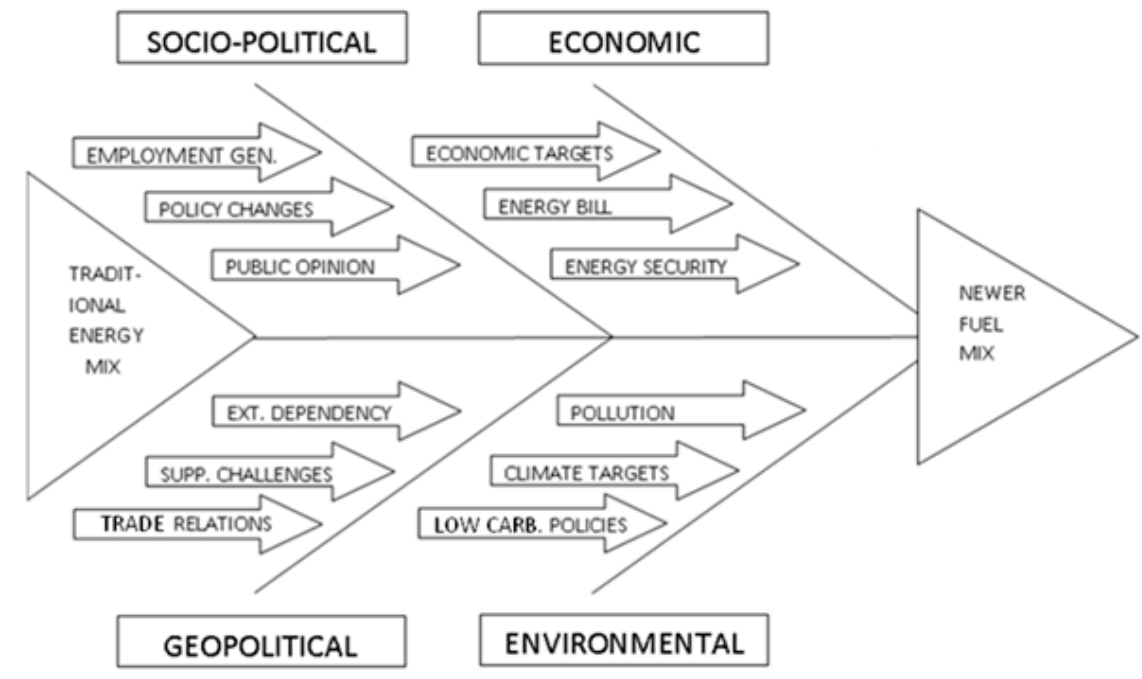
[2] Brazil, which is currently the largest producer of ethanol, began a nationwide program financed by the government to promote the production of ethanol, called the National Alcohol Program -Pró-Álcool- (Programa Nacional do Álcohol) in 1975. The increase in ethanol production was aimed at reducing the dependency imported petroleum fuels.

attention. These fragmented policy tools, though got only limited attention in the past, have been critical in promoting energy transition. With the target of reducing emission intensity and meeting the economic goals, transition to cleaner fuels emerged as natural choice which offer various socio-political as well as economic benefits. The climate agenda not only brought in various key governmental institutions for this common target but also helped raise awareness among the national as well as sub-national government machineries. While the policy mechanisms prescribed action plans in mission mode various legal tools that already existed in the country paved way for better implementation of the transition efforts. It is also important to note that various market mechanisms that emerged as part of the climate mechanism also contribute to energy transition, by promoting various alternative sources and demand-side energy management measures. This paper argues that climate mitigation agenda in India has immense potential in promoting energy transition process.

2. Energy Transition: Conceptual Outlook

Energy transition is a political decision, primarily driven by social, economic, geopolitical and environmental objectives of a country. The process of transition includes both supply side as well as demand side energy management measures aimed at achieving a newer mix of cleaner sources and technologies. The schematic diagram below highlights some of the key factors that contribute to energy transition in a country.

Figure 1. Key Factors Influencing Energy Transition



The schematic diagram is developed based on the factors commonly understood as influencing energy transition.

2.1. Socio-Political Factors

The decision to shift away from a certain energy mix can be due changes in the political stance of the respective governments. However, such changes in the policies are not stand alone. They are closely interlinked with various domestic factors. One recent example to cite is from Japan. The post 3/11 efforts by the government of Japan to change the fuel mix of the country and make a newer one with more renewable energy components is triggered by the Fukushima nuclear accident. According to experts, 'nuclear power has lost credibility[3] in Japan not only among the general public but also among the policy makers in Japan. Anti-nuclear sentiments have reached to a level that it can potentially affect any nuclear sector development.[4] With such level of anti-nuclear public sentiments significant level of attention has been given for promoting renewable sources in the energy mix. It is expected that a greater level of renewable energy technology penetration is important for the country to improve its energy self-sufficiency.

Promoting fuel shift can also be a result of the government decision to explore the employment generation potential. The employment generation due to the spur in alternative energy industry, associated manufacturing sectors and service sectors can potentially be considered as long term benefits of promoting transition. According to the Ministry of New and Renewable Energy of India, various renewable energy programs are significantly contributing to employment generation. For example, biomass power generation in India attracts investments of over Rs.600 crores (~ 120 million USD) every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas. [2] The progress made in other renewable energy sectors such as solar and wind also have similar co-benefits of employment generation.

2.2. Economic Factors

The economic target of a country is one of the main drivers of growth in its energy consumption. While the conventional energy sources play a major role in the energy mix in many countries, it is important to explore possible alternative sources that can meet demand of various sectors. This perception acts as a catalyst for transition. With regard to India, the country targets to meet close to double digit annual GDP growth for the coming years. 'The National Development Council (NDC), in approving the Approach to the Eleventh Five Year Plan (2007 to 2011), endorsed a target of 9% GDP growth for the country. But the envisaged growth of the economy at 9% in the Eleventh Plan cannot be achieved without a commensurate increase in the availability of energy.'[3] This necessitates an increased energy generation from alternative sources in the country.

The energy import bill is another key factor. It is often an indicator of the burden on economy due to fossil fuel import. Reducing the energy bill is hence seen as one of the important targets for any government. In this regard policy attention is given to diversify the fuel sources and improving domestic supply capabilities for which alternative sources gets the priority. For a country like India which has 68 percentage of its total population living in rural area[5] and has vast and varied geography, making supply lines –electricity transmission or fossil fuel transportation facilities – to meet the growing energy demand is a critical concern. Moreover, it is also seen that making adequate energy supply provisions to the rural population with petroleum fuels would significantly add to the energy bill of the country, which is already estimated to be highest among all the G20[4] countries. In this context, meeting economic targets of various sectors and sections of population necessitates increasing the share of alternative sources which in turn targets to the need for transition.

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[3] The perception of 'credibility' of nuclear power may be attributed to the long persisting nuclear allergy of the Japanese society that originated since the atomic weapon attack in Hiroshima and Nagasaki.

[4] Author's interview with Ambassador Tetsuya Endo, former Vice Chairman, Atomic Energy Commission of Japan on 19th October, 2011

[5] As per the latest estimate of the Census of India in 2011 the rural population is 833, 087, 662 against the urban population of 377, 105, 760. Accessed: http://censusindia.gov.in/2011census/censusinfodashboard/index.html, 26/12/2011

2.3. Geopolitical Factors

Geopolitical challenges play a significant role in the energy transition policies of countries. In the 1970's after the Arab oil embargo that caused severe shortage of crude oil supplies from the Persian Gulf region stimulated various policy changes in many countries. One of the most noticeable examples is the *Pró-Álcool* policy of Brazil, where the country has started promoting ethanol production to address potential crude oil supply disruption in future. According to IEA, Brazil has made it mandatory that Gasoline must contain a minimum of 22% of ethanol.[5] Today Brazil is one of the largest ethanol producers in the world. Similarly, the bio fuel production in US also increased in the immediate following years of the first oil shock and the domestic concern of subsequent supply cuts. Another major policy development evinced across the world in the immediate following years of the 1970s oil shock was widespread promotion of nuclear power as one of the major supply alternatives in many countries. Nuclear energy development in Asia, especially Japan and South Korea, Europe and even in US, which followed the concerns on geopolitical volatility in the Persian Gulf region had positive impacts on efforts to reduce dependence on fossil fuel. A similar trend was also visible in the renewable energy front, though the flurry of policy attention faded in the later years of 1970s when the crude oil price fell back to normal levels. Firmer efforts to reduce the dependency on fossil fuel sources began in the following decades. The continued geopolitical volatility in the Persian Gulf region following 'Gulf War I & II'[6] has culminated into many countries giving significant policy attention towards developing domestic supply sources. In the case of India the last decade witnessed an array of government initiatives to address the long term energy security which promoted plans for the development of various alternative energy sources. The formation of Energy Conservation Act 2001, Electricity Act 2003, Integrated Energy Policy, Draft Renewable Energy Policy etc has been some of the major initiatives that catalyse the energy transition in the country.

2.4. Environmental Factors

Often the decision to shift away from carbon intensive fossil fuel consumption to greater use of environmentally friendly low carbon energy sources such as renewable sources are due to the concerns on energy related emission. As the economic consequences of environmental and air pollution have long term adverse impacts on the economy, shifting away from conventional fuel types is prioritised by many countries. Low carbon development policies and climate mitigation targets have also notable influence in developing policies towards energy transition.

The carbon emission level in India has been on the rise for the past many years. The energy related carbon emission increased from 1009.75 Million metric tons (Mt) in 2002 to 1494.88 in 2008. The growing dependency on the conventional fossil fuels is one of the prime causes of energy related emissions. This concern will escalate in the future along with the growth in energy consumption as the country keeps annual GDP growth target closer to 10 percent. While the government points out that, the economic growth at such a scale is necessary for poverty alleviation energy consumption would continue to grow, with fossil fuel continuing to have a major share in the energy mix. The consumption pattern in the country is also in tune with the developmental agenda which focuses on the need for rapid economic growth as an essential precondition for poverty alleviation. Meeting this agenda, which will also reduce climate -related vulnerability, requires large scale investment in infrastructure, technology and access to energy.[6] Due to the overarching importance given to climate mitigation the energy related measures increasingly gaining greater policy attention.

[6] The terms Gulf War I & II refers to military incidents such as 1) Saddam Husain's invasion of Kuwait in 1991 and the subsequent Military movement carried out by Allied Forces and 2) The military invasion of Iraq done by the Allied Forces in 2003 which finally overthrew the Saddam Government.

The above mentioned four factors play pivotal role in setting the energy transition agenda in India. However, environmental factors can be the most prominent catalyst in today's context as it necessitates various policy measures that ensure tangible output in terms of meeting the emission intensity reduction goal the country has committed to. According to India's official communication to the UNFCCC during the 15th Conference of Parties held at Copenhagen, *India will endeavour to reduce the emissions intensity of its GDP by 20-25% by 2020 in comparison to the 2005 level*[7]. This highlights the fact that significant measures have to be taken to develop alternative energy sources apart from adopting a number of demand side energy saving measures in order to ensure that economic targets are met while cutting down energy related emissions.

3. Energy Scenario in India

While an average person usually sees energy only in the form of electricity for household use, cooking gas and petrol for his car or two-wheeler, much larger, by a factor of many hundred times, is the quantity of energy directly or indirectly required to maintain our standard of living such as in agriculture, infrastructure and industry.[7] The economic targets of developing economies hence require uninterrupted supply of various fuel sources to meet the surging domestic demand from various key sectors. In turn this dependency on conventional fossil fuel sources is equally burdening the domestic economy and environment.

India is one of the largest energy consumers in the Asia Pacific region with the total consumption of commercially traded fuel reaching 500.9 million tons of oil equivalents (Mtoe) in 2010.[8] The current energy mix shows that fossil fuels constitute more than 90 percent of the commercially traded primary energy mix. Hydrocarbon fuel consumption has been increasing steadily which also contributes to the significant level of anthropogenic emission. Total fossil fuel consumption in the country grew from 274.1 Mtoe to 410.34 Mtoe during the period 2000-2010.[9] One of the biggest concerns regarding energy and climate change in India is about how to balance the climate mitigation targets with developmental goals. Energy consumption will significantly increase in India in the comings years as the demand will grow to meet the targets primarily for reducing poverty and having a sustained economic growth close to double digit. As two thirds of the population in the country currently lives in rural regions, a potential increase in demand for various types of energy sources are inevitable. Since the consumption of such a scale could potentially burden the energy bill of the country and could pose major challenge to the environment, long term policies towards planning low carbon development is necessary for the country.

The energy consumption grew significantly in the post 1990 period as the country began to implement economic reforms focusing on faster GDP growth. Industrial, transportation and household consumption of energy increased substantially during this period. However, larger share of the commercial energy consumption was mostly limited to the urban region or urban oriented activities while the majority of the Indian population live in the rural regions continued to rely on conventional biomass sources for fuel needs. A significant portion of the rural population still does not have access to the modern forms of energy and their energy needs, mostly residential energy consumption in rural areas is largely met by conventional biomass fuels. About 27.5% of India's population lived below the poverty line in 2004-05 and 44% are still without access to electricity.[10] This indicates a potential rise in energy consumption in the coming years as the economy aspires to grow closer to 10 percent growth rate. This also highlights that securing adequate energy supply from all possible sources for meeting this growing demand would be a strategic necessity for the country.

[7] India's Official Communication of Domestic Mitigation actions made to the (Executive Secretary) UNFCCC, at CoP 15, Copenhagen.

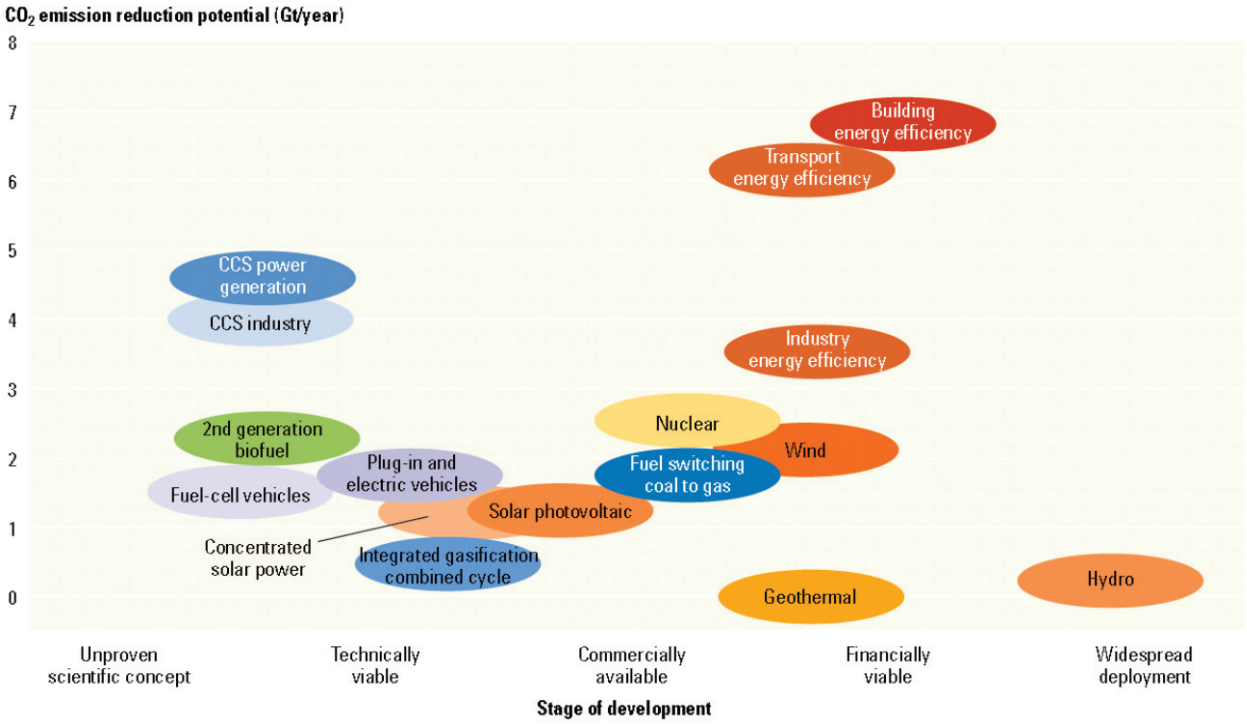
4. Potential Avenues for Energy Transition

Being a developing country India faces these twin challenges of meeting the surging energy demand to satisfy the economic needs on one side and addressing the concerns of energy related emissions on the other. In order to balance the long term economic goals and the emission reduction targets as part of the climate agenda the country needs to mainstream energy transition as a key policy. Energy transition as a policy measure needs to be promoted at supply side as well as demand side. The supply side transition can include measures for fuel shifting from fossil fuel to other low carbon sources. Promotion of new and renewable energy sources for electricity production, increasing the share of nuclear power, carbon dioxide capture and sequestration are important options. As part of demand side management, use of advanced energy technologies, improving energy efficiency and energy conservation measures etc will be the key options for the country.

Energy transition involves various supply side and demand side measures. While there are various energy technologies that help promote energy efficiency and energy conservation, alternative and renewable energy technologies help meet the energy demand. The development of low carbon energy technologies and rigorous implementation of energy efficiency plans are critical to the reduction of energy related emissions. Clear-cut short term and long term policies towards low carbon energy are required to meet these goals. However, the level of policy implementation and scale of growth of technologies are adversely affected by various challenges. Most of the low carbon energy options or technologies are lacking economic feasibility.

The figure below details the economic feasibility of various technologies against their respective CO2 emission potential. Technologies such as carbon capture and sequestration (CCS), fuel cells, plug in electric vehicles and integrated gasification combined cycle are some of the technologies which have the least economic feasibility. Technologies such as nuclear and fuel switching has more commercial viability than solar.

Figure 2. Economic Feasibility of Energy Technologies



Source: World Development Report 2010, World Bank.

Among the renewable technologies wind and geothermal are viable financially and the hydro power generation has the cheapest power generation options. Despite the importance given to most of the energy technologies it is important to note that many of them do lack economic feasibility in the current socio political and economic scenario in the world. The figure also presents the view that while considering a series of technologies for low carbon energy development; the most important option is to invest in energy efficiency projects which is financially and commercially feasible and also ensures lesser GHG emission per unit of GDP.

5. Transition from Where to Where?

Energy transition as a concept indicates shifting away from depending heavily on high carbon emitting energy sources to fuel types and technologies that limit the quantity of carbon emitted per use of unit of energy consumption. Hence the key aspect of energy transition process is the change in the quantity of carbon emission per unit of energy consumption. While a conventional thinking would suggest completely shifting from fossil fuels to zero carbon emitting sources, it is wise to understand that the process of transition can gradually move from high carbon emitting to lower emission. However, it is difficult to achieve a complete decarbonisation of energy systems across the world, especially because of the uneven distribution of technological, socio-political and economic status of countries. With regard to India, energy transition as a concept is closely linked to the long term energy security perception as well. While the concerns on long term demand and supply situation, need for poverty alleviation, environmental and climatic concerns and the socio-political factors significantly influence the energy security strategy of the country, transition as a key measure promotes a policy thinking for shifting away from hydrocarbon fuels of which majority is imported from overseas sources. However it is important to note that energy transition is not formally incorporated as a mainstream policy measure in the country; rather it is largely fragmented though certainly emerging as a key ingredient of policies that deal with long term economic targets.

The demand growth projection of commercial energy sources, as discussed in the Integrated Energy Policy, is one of the major catalysts for promoting energy transition. According to estimates, about 58 to 67 percentage of total primary energy demand will be met by imports, by 2031-32 with an estimated GDP growth of 9 percent.[11] This poses two major concerns to the country. First, the increased use of fossil fuels will have a direct impact on the emission profile of the country and second, the increasing import of fossil fuel will add significant burden to the economy.

Table 1. Range of Commercial Energy Requirement

Fuel	Energy Use in 2003-04	Range of Requirement in Scenarios	Assumed Domestic Production	Range for Imports	Import (Percent)
Oil (Mt)	119	397-555	35	362-520	91-94
Natural Gas (Mtoe)	29	125-235	100	25-135	20-57
Coal (Mtoe)	167	860-1296	560	300-736	35-57
TCPES (Mtoe)	329	1667-2077	-	972-1382	5867

Source: Interim Report on Low Carbon Strategies for Inclusive Growth, Planning Commission, Government of India, 2011, p-11

A similar perception of the need to invest in cleaner technologies is discussed in the World Energy Outlook 2009. This is also in tune to the need for energy transition in the country. According to the estimate to meet the 450 scenario[8] India needs to invest in advanced energy technologies to offset the carbon emission that may happen due to increased dependence on the fossil fuel.

Table 2. India- Energy Related CO2 Abatement

	Abatement (Mt CO2)		Investment ($2008 Billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	170	601	74	301
Renewable	76	400	48	312
Bio fuels	1	5	1	11
Nuclear	0	131	0	59
CCS	2	30	1	11

Source: World Energy Outlook 2009, International Energy Agency, p-360

It is estimated that the country requires about $ 124 billion for clean energy investment during the period 2011-2020 and about $ 694 billion during the period 2021-2030 to abate total of carbon dioxide emission of 249 Mt CO2, and 1167 Mt CO2 respectively.[12] According to estimates the possible energy technology development options are with energy efficiency improvement, Renewable sources, Bio fuels, Nuclear and carbon capture and sequestration. This points to the fact that significant level of transitioning to alternative energy sources and technologies will be a strategic necessity for the country in the coming years.

[8] According to IEA, 450 Scenario depicts a world in which collective policy action is taken to limit the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million of CO2-equivalent (ppm CO2-eq), an objective that is gaining widespread support around the world

Table 3. Energy Transition: Policy Actions and Targets

Category	Key Policies	Action Plans	Targets Planned
Supply Side Measures	Renewable Energy Certificates (REC)	• Aimed at boosting renewable energy production. • Incentive based program • REC as a policy instrument prescribed in NAPCC	• Renewable energy to constitute 15% of the electricity mix in India by 2020
	Jawaharlal Nehru National Solar Mission (JNNSM)	• Aimed at promoting solar energy generation	• Solar power generation is expected to reach 20 GW by 2022
	Nuclear Energy	• Increasing nuclear power generation, building more nuclear reactors for meeting electricity demand	• Currently 20 operational reactors • India expects to have 20,000 MWe nuclear capacity on line by 2020 and 63,000 MWe by 2032. • Aims to supply 25% of electricity from nuclear power by 2050.[13]
	Natural Gas	• Increasing natural gas utilisation	• No clear targets on planned increase, however, the usage has been growing significantly over past many years, indicating growing dependency • Plans to import natural gas through transnational pipelines such as TAPI (Turkmenistan-Afghanistan-Pakistan-India) and IPI (Iran-Pakistan-India)
Demand Side Measures	National Mission on Enhanced Energy Efficiency	• Enhance over all energy efficiency in the country	• The mission seeks to avoid capacity addition of 19,598 MW by 2020 and a total of 98.55 m tonCO2 emissions will be offset.
	Perform Achieve and Trade	• Improve energy efficiency in the industrial sector, target major energy consuming industry units	• PAT scheme to achieve energy saving of about 10 MMTOEby 2014
	Bachat Lamp Yojana	• Improve efficiency of household lighting with the use of advanced LED lamps	• The "Bachat Lamp Yojana" aims at the large scale replacement of incandescent bulbs in households by CFLs. • 400 million light points presently estimated on incandescent bulbs could reduce energy consumption upto10,000 MW by using CFL
	Energy Efficiency Labelling	• Labelling energy efficiency appliances	• Improve energy efficiency of high energy consuming appliances • Mandatory energy efficiency labelling for appliances

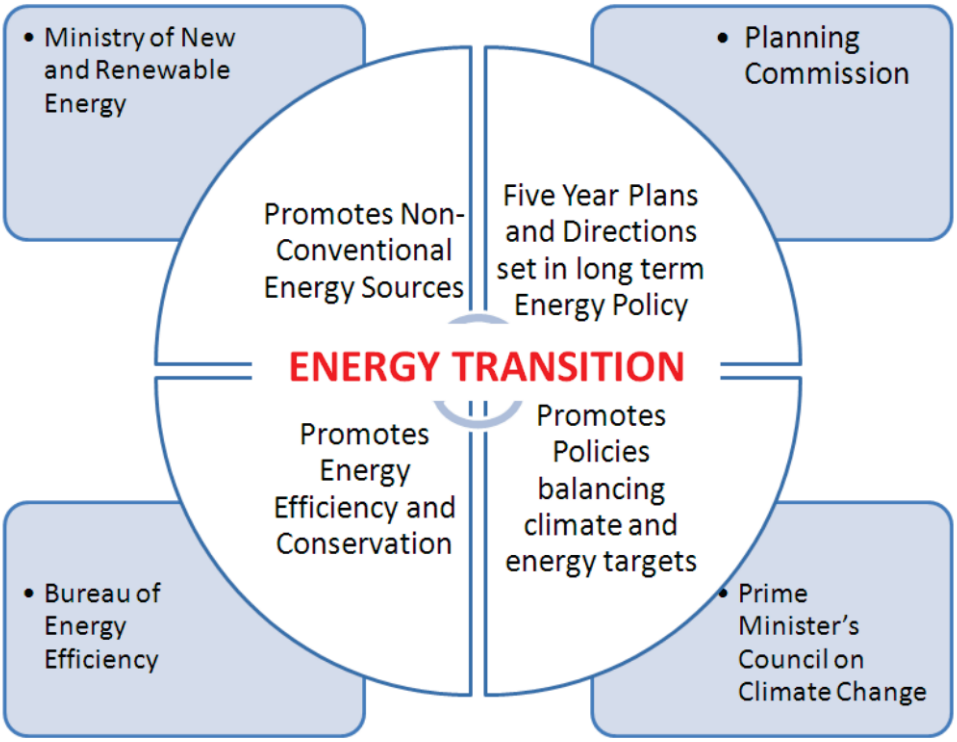
6. Energy Transition: Institutional and Legal Framework in India

The institutional mechanism that supports energy transition is highly fragmented in India. This is primarily due to the fact that strategies towards achieving energy security (prioritising uninterrupted supply of conventional fuel sources) is viewed as much more important and requires greater policy attention than a transition to newer energy sources which requires enormous financial and technological investment. In this context, the dependency on conventional fossil fuel sources have been seen important to meet the immediate and long term economic goals of the country, taking into consideration the lack of adequate technological as well as economic support required for the development of alternative sources. For developing country like India shifting away from conventional fuel dependency, changing consumption patterns or the use of advanced energy technology etc are time consuming as well as an economically intensive effort.

6.1. Energy Transition: Key Institutions

India has five governmental organs that are involved in governing the energy sector in the country. These are Ministry of Petroleum and Natural Gas, Ministry of Coal, Ministry of Power, Ministry of New and Renewable Energy Sources and Department of Atomic Energy. However with regard to the institutional framework pertaining to energy transitions four important institutions can be cited as those directly or indirectly instrumental in promoting policies towards transition in India. These are Prime Minister's Council on Climate Change, Ministry of New and Renewable Energy, Planning Commission and the Bureau of Energy Efficiency. Most of the policy efforts that can be counted in favour of transitioning to low carbon energy are closely linked to the climate mitigation efforts.

Figure 3. Key Institutions and their efforts instrumental in Energy Transition in India



The Planning Commission: The Planning Commission of the Government of India plays a significant role in setting long term directions of the energy sector in the country as part of the national planning. The Integrated Energy Policy released by Planning Commission in 2006 addresses long term energy security concerns and sets directions for ensuring energy security for the country.

Prime Minister's Council on Climate Change: As a governmental body which oversee climate mitigation actions, the Prime minister's council on climate change plays key role in promoting policy measures towards energy transition. Among the eight missions under the National Action Plan for Climate Change, National Solar Mission and National Mission on Enhanced Energy Efficiency sets supply side and demand side targets in mission mode. As an institutional structure, the Council assumes significant importance especially because of the involvement of Prime Minister as well representatives from various Ministries associated with Environment and climate mitigation policy making.

Bureau of Energy Efficiency: The Bureau of Energy Efficiency under the Ministry of Power was set up as per the provisions of the Energy Conservations Act, 2001. The Bureau, with the targets of improving energy efficiency and promoting energy conservation in the country, works with various government machineries in developing policies and strategies concerning energy sector.

Ministry of New and Renewable Energy: In order to promote renewable energy development and efficient energy usage the government established a Commission for Additional Sources of Energy which later integrated into the Department of Non-Renewable Energy Sources in the early 1980s. The formation of the Ministry of Non-Renewable Energy Sources in 1992 gave a boost to the renewable energy development in the country. Today, India is probably the only country which has a Ministry exclusively in charge of renewable energy sources. With regard to supply side efforts, Ministry of New and Renewable Energy is instrumental in promoting various alternative energy sources.

6.2. Energy Transition: Policy and Legal Framework

Though there is no specific framework that exclusively provides any mandatory legal direction for energy transition, various Policies, Acts and regulations pertaining to energy sector promote and positively contribute to transitioning to a low carbon energy mix in the future.

Electricity Act: The Act consolidates the laws relating to generation, transmission, distribution, and use of electricity and generally for taking measures conducive to development of electricity industry promoting competition therein, protecting interests of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent polices regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.[14] It covers details on areas such as National Electricity Policy, electricity generation, transmission & distribution, tariff and dispute resolution. The Electricity Act which came into force in 2003 was amended in January 2004 and in June 2007.

Energy Conservation Act: The energy conservation act stipulates provisions for conservation and efficient use of energy sources. As per the directions set under the energy conservation Act, the Bureau of Energy Efficiency was formed subsequently.

Integrated Energy Policy: India has five key governmental organs involved in setting directions to the energy sector. These institutions are, Ministry of Coal, Ministry of Power, Ministry of Petroleum and Natural Gas, Ministry of New and Renewable Energy, and the Department of Atomic Energy. Considering the importance

for India to meet its long term economic goals and energy demand, it has been observed critical that a policy integration at all levels is necessary and an integrated framework needs to be developed which encompasses the five different organs dealing with energy sector under the government of India. This has culminated into the preparation of Integrated Energy Policy document which was released in 2006. The key understanding behind the formation of Integrated Energy Policy was that, it is critical to ensure greater coordination among the key organs dealing with energy sector in ensuring long term energy security of the country. Considering the fact that 'to deliver a sustained growth rate of 8% through 2031-32 and to meet the lifeline energy needs of all citizens, India needs, at the very least, to increase its primary energy supply by 3 to 4 times and, its electricity generation capacity/supply by 5 to 6 times of their 2003-04 levels'[15] which requires greater participation of all the energy institutions under the union Government deemed necessary. Apart from examining the key energy security challenges for the country the policy document gives special focus on the energy supply and demand options, role of new and renewable energy in India's energy mix and the critical linkages between energy and environment and necessary policy options. However, with regard to energy transition, the policy document suggests that existing institutional structure of energy sector needs to be taken into consideration while designing strategies for long term transition.[16] Due to the continued importance given to the existing energy sector, which is dominated by conventional fossil fuels, policies for 'demand side management' evolved to be one of the major components of energy transition strategies.

7. Efforts towards Energy Transition: Supply Side Measures

As supply side measures for energy transition, three key sectors have gained significant policy attention. These are renewable energy generation, expanding nuclear energy infrastructure, and increasing the use of natural gas.

7.1. Development of Renewable Energy in India

Though renewable energy will be critical in meeting the increasing power demand, not many substantial economic investments were done in the past. The perception of higher electricity generation costs has been one of the important challenges to the development of renewable sources. While increasing the share of renewable sources in India is accepted by and large, another school of thought, expecting a crash in oil prices and the chance of finding huge petroleum reserves, believes that a fall in oil prices would eventually make investments in renewable energy a big mistake. Scepticisms come from those who recall the the development in the following years of 1970s oil shocks where the alternative energy sources became less attractive due to the falling oil price. Back then, high oil prices and concerns over scarcity led many firms to bet heavily on alternative-energy technologies which turned out to be a loss when oil and gas prices fell in the late 1980s.[17] Higher cost of technology and its availability are two other factors which make renewable economically less competitive. Unlike the developed western economies which are much ahead in technological innovations and energy efficiency, India faces limitations in the availability of sufficient technologies to make the renewable development economically viable. In the case of electricity generation, though the country has huge potential, storage of power appears to be a cost intensive effort and requires advanced technology.

However, the changing petroleum price scenario in the global arena and its implications on countries indicates that the renewable energy development would not be as cost intensive as it appeared in the past. Since the post 2003 period, investment in renewable energy sector has been making noticeable progress mainly due to the oil price fluctuations. However the debate over the economic feasibility of various renewable energy technologies continues to prevail in the country. India has abundant renewable energy resources and has huge potential for electricity generation from sources such as large and small hydro power, wind power, solar power, biogas and

biomass. India has the potential for developing almost all types of major renewable sources. However in the past the explored level of renewable energy sources in the country is significantly less primarily due to the absence of any strict policy to ensure the development in mission mode.

Table 4. Renewable Energy Potential and Achievement

Renewable Energy Programme/ Systems	Target for 2011-12	Achievement during the month August, 2011	Total achievement during 2011-12	Cumulative achievement up to 31.08.2011
I.POWER FROM RENEWABLES:				
A. Grid-interactive Power (MW)				
Wind Power	2400	266	833	14989
Small Hydro Power	350	21	111.3	3153.93
Biomass Power	460	25	86.5	1083.6
Bagasse Cogeneration		12.5-	111.5	1779.03
Waste to Power: -Urban	25	1.2	1.2	20.2
Waste to Power: -Industrial		-	-	53.46
Solar Power (SPV)	200		8.5	46.16
Total	**3435**	**325.7**	**1152**	**21125.38**
B. Off-Grid/ Captive Power (MWeq)				
Waste to Energy :-Urban		-	-	3.5
Waste to Energy :-Industrial	15	0.75	10.18	72.3
Biomass (non-bagasse) Cogeneration	80	2.55	31.99	327.95
Biomass Gasifiers -Rural	3	0.72	1.2	15.55
Biomass Gasifiers - Industrial	10	2.96	4.5	125.88
Aero-Generators/Hybrid systems	0.5	-	0.12	1.24
SPV Systems (>1kW)	20	0.42	3.5	72.5
Water mills/micro hydel	400 Nos.	400 Nos.	400 Nos.	400 Nos.
Total	**128.5**	**7.4**	**51.49**	**618.92**
II. REMOTE VILLAGE ELECTRIFICATION				
No. of Remote Village/Hamlets provided with RE Systems	500	688	742	8846
III. OTHER RENEWABLE ENERGY SYSTEMS				
Family Biogas Plants (No. in 100,000s)	1.5	0.07	0.12	44.16
Solar Water Heating - Coll. Areas (Million m2)	0.6	0.04	0.2	4.67

Source: http://www.mnre.gov.in/achievements.htm, Accessed: 13 December 2011.

Currently renewable energy constitutes 0.9%[18] of the total commercially traded primary energy mix. The 11th Five Year Plan recommended that the country must have about 5 percent of the total grid connected power to be contributed by renewable sources by the end of the plan period, i.e. 2012. As per this plan the government set a target of total addition of 14,000 MW installed capacity for grid connected power generation with a total plan outlay amounting to about 10,460 crore ($2.3 billion).[19] The renewable energy development for the coming years is planned through measures such as (a) Grid-Interactive and Distributed Renewable Power, (b) Renewable Energy for Rural Applications, (c) Renewable Energy for Urban, Industrial & Commercial Applications, (d) Research, Design & Development for New & Renewable Energy and (e) Support Programs.

7.2. Nuclear Energy Development in India

Nuclear power sector has the potential to play a vital role in the energy security of countries which are conventionally depending heavily on fossil fuels. While nuclear power cannot be the panacea for the global energy security challenges, the main role it can play is in sharing the burden of meeting the growing energy demand along with other fuel types. Though nuclear power currently has relatively low share (amounting to less than 3 percent) in the total electricity mix, it is considered as a low carbon energy source with potential to expand. 'The total life cycle GHG emissions of nuclear are less than 40g or CO2 equivalent per 1 kWh electricity (40 g CO2-eq/kWh), (against the emission from fossil fuel estimated to be 400g CO2/kWh (e)[20]) which is similar to those of renewable energy sources.[21]

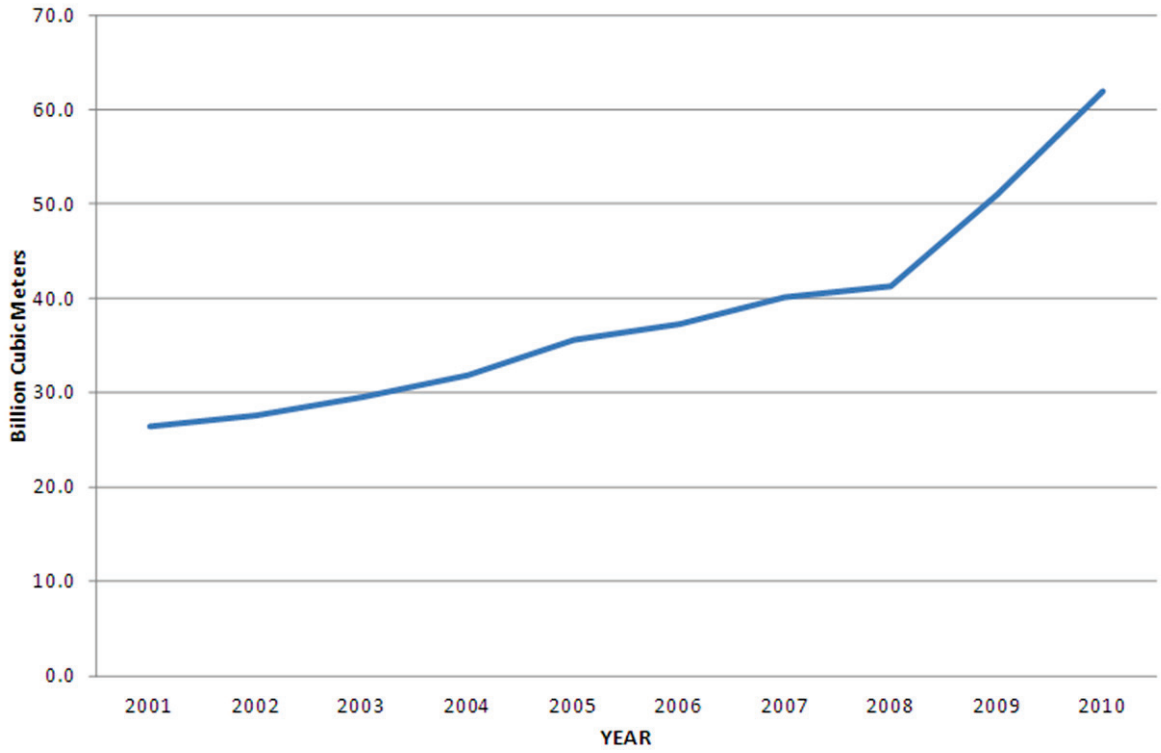
India has 20 operational reactors and 5 reactors under construction. The country also plans to build about 40 more nuclear reactors during the period up to 2030. According to the government, promotion of nuclear energy through enhancing nuclear capacity and adoption of fast breeder and thorium-based thermal reactor technology in nuclear power generation would bring significant benefits in terms of energy security and environmental benefits, including GHG mitigation.[22] Hence, nuclear will be a preferred energy source for India and has the potential to play a key role in India's transition to low carbon energy future.

7.3. Natural Gas Consumption in India

Ever since the beginning of modernisation in late 1980s, great importance has been attributed to shifting away from the use of coal to petroleum fuels. This was primarily an effort to ensure that more efficient fuel types are used to meet the demand from various sectors. The fossil fuel based power generation units in India were predominantly coal fired, but started witnessing an increasing number of gas fired plans for past two decades. As of 2005, about 11 percentage of total electricity in the country was produced by gas fired plants.[23] The use of natural gas in the transportation also increased significantly in the recent years, especially since the government has approved the use of same in private as well as public vehicles in cities. Natural gas is used as the main fuel for public transport in Delhi, the capital of India, following a Supreme Court order of 1998. Currently, the city's public transport system under the *Delhi Transport Corporation* has the world's largest fleet of CNG (Compressed Natural Gas) based buses.[24] The increased use of natural gas evinced significant environmental advantages. According to reports, the conversion of diesel based vehicles to CNG based has substantially reduced the vehicular pollution in the capital.[9]

[9] Various studies have been conducted to examine the air quality differences after the implementation of compulsory natural gas usage for transportation vehicles. The study titled The Impact of Delhi's CNG Program on Air Quality (Urvashi Narain and Alan Krupnick,, Accessed: http://rff.org/rff/documents/rff-dp-07-06.pdf)shows various observations about the changes in the air quality in Delhi after the implementation of CNG for vehicles.

Figure 4. Trend in Natural Gas Consumption in India



Source: Statistical Survey of World Energy, British Petroleum, 2011.

While increasing natural gas consumption can be highlighted as an important step towards transitioning to less carbon emitting source, there are serious concerns exiting about increasing the reliance on natural gas. Majority of the domestically consumed natural gas is supplied from overseas regions and the continued reliance on the same will present energy security challenges and economic burden. This points to the fact that better policy tools need to be developed to ensure transition to cleaner fuels. Various demand side measures and newer alternative supply options emerge to be important to explore.

8. Demand Side measures

Energy demand management measures focus on the exiting energy sources and technologies with a target of improving efficiency and promoting energy conservation. These measures constitute a significant component of the energy transition process in any economy, primarily due to two reasons. First, these measures provide a 'transition support'[10] to the existing energy consuming system. It enables the transition less damaging to the economy. Second, the demand side measures set a higher efficiency and lower carbon emission targets which in turn promotes cleaner fuels in the energy mix.

8.1. Energy Efficiency Standards & Labelling

Energy labelling has been one of the most important measures adopted to improve the energy efficiency in the

[10] This support to the existing energy consuming system to ensure that the transition to a newer mix will not adversely affect the economic activities of the country.

country since last decade. The objectives of Standards & Labelling Program is to provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the marketed household and other equipment.[25] The standards and labelling procedures are managed by the Bureau of Energy Efficiency (BEE, a statutory body under the Ministry of Power).

The energy efficiency standards and labelling are currently implemented in the transportation sector and on some of the electrical and electronic appliances. All the new passenger cars need to fuel consumption standards which would provide a regulatory signal to manufacturers to improve the fuel efficiency. These cars are also to carry labels providing information on the fuel consumption compared to other models in the same weight class. These two instruments together provide a ceiling for fuel consumption of new cars that are sold in India, as well as provide a market pull for low fuel consumption models.[26]

With regard to electrical and electronic appliances the Bureau of Energy Efficiency has made it mandatory to label Frost free refrigerator, Tubular Florescent Lamps, Room Air Conditioners and Distribution Transformers. There are also other appliances which are currently under voluntary labelling scheme including induction motors, agricultural pump sets, ceiling fans, liquefied petroleum gas stoves, electric geysers, television sets, washing machine and computer. The voluntary labelling will help boost the market value of the equipments while also promoting efficient usage of electricity for equipments.

9. Challenges to Energy Transition in India

Energy transition as a process requires coordination of various policy and governance measures could face significant challenges in implementation. Some of the challenges that might adversely affect the energy transition efforts in a country include, role of pressure groups, policy hurdles, lack of a strong institutional structure, perception of economic feasibility of shifting away to newer fuel mix etc.

9.1. Dependence on Coal

Coal has been the mainstay of India's energy mix. Currently it constitutes about 52 percentage of the total commercially traded primary energy mix in the country.[27] The domestic availability of coal, concerns on potential supply fluctuations with regard to petroleum sources, lack of adequate alternate supply sources to replace coal usage and the traditional dependency of power plants on coal makes it important for the country to continue rely on the same. Coal meets majority of the energy needs in the power sector, iron and steel sector and cement sector. Coal is expected to remain India's most important energy source till 2031-32 and possibly beyond.[28] Hence coal as an energy sector would require great policy attention to ensure that the continued use of the same would use advanced technologies for checking carbon emission. There have been efforts by the Ministry of Coal and Coal India Limited, a state owned coal mining corporate, to promote advanced technologies such as coal liquefaction and gasification. Coal India Limited has proposed setting up a coal-to-liquid (CTL) project at Deocha Panchmi block in Birbhum district, West Bengal, with technological support from Sasol of South Africa or Lurgi of Germany.[29] However, large-scale commercial level implementation of the same has not been done in the country so far.

9.2. Role of Pressure groups and Policy Hurdles

Being conventionally dependent on the fossil fuel sources to meet energy requirements, the petroleum and coal sector have determining role in the energy transition process in the country. There have been instances where

fossil fuel lobbies influenced government decision in energy transition in many countries. There have been reports that fossil fuel companies spent a record $175 million in 2009 to defeat a climate bill in United States.[30]

However, an energy transition policy may not be initiated by the government though such a decision could be in the interest of environmental health as well as for the general public. It will face opposition from the conventional energy industries that dominate the supply market. A government which typically serves a four or five years term in power will be keen to invest their attention into policies that show quick economic or political results rather than long term energy transition policy which may run against the interest of certain industries sections who typically play major role.

9.3. Institutional Mechanism and Key Challenges

Coordinated policy efforts and institutional mechanism to implement and carry out necessary legal procedures are critical drivers for energy transition in any economy. First and foremost challenge to energy transition from the institutional point of view is the lack of specific administrative and legal mechanisms. In many countries energy transition as a policy measure can only be seen as fragmented initiatives without specific support of strong legal mechanisms. Various other challenges can also be pointed out with regard to the institutional mechanisms role in promoting energy transition. First, since transition is more of a reactive policy measure than a proactive one it often has to depend on exiting institutions for implementation and execution. Hence, conflicting interests of an existing institution such as protecting conventional energy industry against promoting transition will play a key hurdle to the process. Second, a newly built institution to govern a transition will also face conflicts with existing energy institutions that are conventionally supporting a specific energy sector. For example, a coal ministry would have objections to reduce coal consumption or to implement advanced clean coal technology as a mandatory measure, as that affects the coal sector and the government revenue. Lack of appropriate institutional framework had been a critical concern in India, until the climate change agenda took shape in the later years of last decade. However, there have been dramatic changes in the recent years following the increased attention given by policy makers towards energy and climate change link.

9.3. Economic Feasibility of Shifting Away[11]

Financial concerns of shifting away from a conventional fuel source adversely affect the policy process favouring transition. Huge investment for building new energy infrastructures and development of supply sources can often be seen as a difficult task for the government. The fossil fuel sector, especially petroleum sector is one of the major sources of tax revenue for any government. ‘As for political leaders, who are serving a four or five years term in power, it is natural that there would be more interest to invest their attention into policies that show quick economic and political results. Such a decision could possibly secure them another term in power rather than planning a long term energy transition policy which maybe against the immediate interest of various pressure groups such as conventional fuel industry.’[31] Moreover, the economic viability of developing alternative sources also adversely affects the energy transition. In many countries the where the governments ‘rely heavily on the tax revenue generated by the fossil fuel industry, as the economy switches from oil products to alternatives, governments will lose billions of dollars in taxes that are imposed on gasoline,

[11] Discussion points under this section are based on the author’s article, “Climate Change Policy and Energy Transition in India: Two divergent views” published in Climate Edge Newsletter, Accessed: http://www.iges.or.jp/jp/cp/newsletter009.html, June, 2011.

diesel, and other oil products. In many cases there are public concerns that alternative energy would not be economical.[32] According to a leading Economist Prof, AF Alhajji, while many of the alternatives might be "economic" because of the subsidies, they will not be economic once users have to pay the tax to compensate for government lost revenues.[12] For instance, in India about half of the retail price of transport fuel is collected by the government as tax, which points to the fact that conventional fuel sources are also a significant source for government revenue. Hence the efforts for energy transition bring into context a possible concern about cost vs. benefit which continues to pose a challenge to the policy makers.[33]

10. Climate Mitigation and Energy Transition Measures

India's voluntary commitment to reduce emission intensity by 2020 from that in the 2005 levels also play a major role as a cardinal factor and a key catalyst for domestic efforts towards energy transition. According to the government of India, the country needs to sustain an economic growth of 9 percent over the next 20 years to eradicate poverty and meet its human development goals and meeting the energy requirements for growth of this magnitude in a sustainable manner presents a major challenge.[34] The emission intensity reduction planned by the country and the huge demand growth that is expected for the coming years bring in focus the need for a pragmatic policy framework that works towards shifting the type and pattern of fuel usage.

Though the climate mitigation efforts and reducing energy related emission often gets overshadowed by the conventional argument of developed country responsibility, India has made noticeable entry into the energy transition pathways. According to the Eleventh Five Year Plan the compulsions of moving to a rational energy policy are underlined by the emerging threat of climate change which presents special challenges over the longer term. The Plan suggests that the country should focus more on the clean technology areas such as: Clean coal technologies of carbon capture and sequestration, In-situ coal gasification, Solar photo-voltaic and solar thermal electricity, Cellulosic extraction of ethanol and butanol from agricultural waste and crop residues, improvement in the yield of Jatropha and other oilseeds for biodiesel.[35]

10.1. National Mission for Enhanced Energy Efficiency (NMEEE)

Energy efficiency improvement is one of the key elements in the climate mitigation strategies. Since fossil fuel burning has been one of the major sources of anthropogenic greenhouse gas emissions in India, the mission plan for enhancing energy efficiency will play a key role in the mitigation efforts. The key institution responsible for promoting energy efficiency standards in the country is the Bureau of Energy Efficiency (BEE). Various measures have been proposed under this mission which include: a) Perform Achieve and Trade (PAT) to address industrial energy efficiency, b) Market Transformation for Energy Efficiency (MTEE) for accelerating shift to energy efficient appliances, c) Energy Efficiency Financing Platform (EEFP) for creation of mechanisms that would help finance demand side management programmes in all sectors by capturing future energy savings and d) Framework for Energy Efficient Economic Development (FEEED) for developing fiscal instruments to promote energy efficiency.[36] It is estimated that the mission can to open huge market for energy efficiency services and products. More than 19000 MW of new capacity addition and about 98 million tons of CO2 emission can be offset by these efficiency measures. By promoting energy efficiency in all key sectors, the mission will play a critical role in transition to a low carbon economy.

10.2. Jawaharlal Nehru National Solar Mission (JNNSM)

[12] Author's discussions with Prof. AF Alhajji, Chief Economist, NGP Energy Capital Management, Irving, Texas

The national solar mission is aimed at promoting solar power generation in the country. Due to India's geographical position on the planet, the country receive about 5000 trillion kWh/year equivalent energy through solar radiation which can be utilised for developing efficient solar power generation facilities. The country keeps a target of having 20 Giga Watt of installed solar power generation facilities by the 2022. 'The mission plans include adopting a 3-phase approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3. At the end of each plan, and mid-term during the 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global.'[37] The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected. According to the government, Policy and Regulatory measures for promotion of solar technologies would also be enhanced as common to all renewable based technologies.[38]

Table 5. Jawaharlal Nehru National Solar Mission (JNNSM) – Implementation Phases

Application segment	Target for Phase I (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
Solar collectors	7 million sq meters	15 million sq meters	20 million sq Meters
Off grid solar applications	200 MW	1000 MW	2,000 MW
Utility grid power, including roof top	1,000-2000 MW	4000-10,000 MW	20,000 MW

Source: JNNSM, http://india.gov.in/allimpfrms/alldocs/15657.pdf

10.3. Role of Market Mechanisms

The three main market mechanisms that gained significant attention from policy makers as well as industry are 'Perform Achieve and Trade (PAT)' a mechanism aimed at improving the industrial energy efficiency, 'Renewable Energy Certificate (REC)' which is aimed at promoting renewable energy generation and the Bachat Lamp Yojana (BLY) aimed at improving the energy efficiency at residential lighting. These market mechanisms are expected to have significant influence among the industrial as well as household users to promote energy efficiency and use of renewable energy sources.

10.3.1. Perform Achieve and Trade: Improving Industrial Energy Efficiency

The PAT scheme is a market mechanism under the National Mission on Energy Efficiency Enhancement of NAPCC. This market-based mechanism aims to enhance energy efficiency of the major energy consumers in the industrial sector, termed as 'Designated Consumers' (DC). The designated consumers have a wide bandwidth of specific energy consumption which is indicative of large energy-savings potential among these units.[39] This is also a reflection of the differences in the energy-saving possibilities amongst plants. The current energy intensive units estimated to be about 700 are originally identified as DCs under the Energy Conservation Act 2001 belong to key energy consuming sectors such as Aluminium, Cement, Iron & Steel, Chlor Alkali, Thermal Power Plants, Fertilizer, Pulp & Paper, Textiles and Railways.

The PAT scheme is aimed at identifying the energy saving measures of the DCs. Each unit is to file their energy returns (estimate of energy consumption audit) to the designated agency. Based on the energy audit the energy conservation can be estimated at units of oil equivalent or coal equivalent by each unit during a given time frame. The government proposes to issue Energy Saving Certificates (ESCerts) to the units that are over achieving the energy efficiency targets and these ESCerts can be traded with those units which are unable to meet Specific Energy Consumption (SEC) targets. As an innovative measure to promote energy efficiency, the PAT is a self rewarding system which not only recognises the energy efficiency improvement in an industrial unit but also gives monitory benefit based on the trading of ESCerts. The PAT system has significant potential as an energy saving measure which can be promoted among various levels of industry units especially due to the tradability of the energy certificates. The tradability concept expected to promote energy efficiency which would help cut down about 5 per cent of the total energy consumption by 2015.

Table 6. Expected Energy Reduction and Energy Consumption through PAT

Sector	Energy Consumption (MMTOE)	Share of Consumption %	Apportioned Energy reduction (MMTOE)	No. of Probable DCs
Power Plant (Thermal)	160.3	69.24%	6.92	146
Iron & Steel	36.08	15.58%	1.56	101
Cement	14.47	6.25%	0.6	83
Fertilizers	11.95	5.16%	0.51	23
Textile (Approximated)	4.5	1.94%	0.2	128
Aluminium	2.42	1.05%	0.11	11
Pulp & paper	1.38	0.60%	0.06	51
Chlor-Alkali	0.43	0.19%	0.02	20
Total	231.6	100.00%	10	563

The above list of DCs does not include the Indian Railways
Source: Bureau of Energy Efficiency, Ministry of Power, Government of India.

One of the major reasons behind targeting the industries for energy efficiency improvement is due to its large scale consumption of commercially traded primary energy source. The DCs of these 8 sectors account for about 231 Mtoe (million metric tons of oil equivalent) of energy consumption annually as per 2007-08 data which is about 54% of the total energy consumed in the country.[40] PAT will be a one of the key mechanisms that would govern the energy consumption pattern in the industrial sector. Since the government of India has also been considering fungibility[13] of ESCerts with Renewable Energy Certificates (discussed below), many of the industrial energy consumers would find it meaningful to rely of renewable energy sources to meet certain percentage of their energy requirement.

10.3.2. Renewable Energy Certificate

In order to increase the renewable energy generation in India, the government has promoted policies of market

[13] The quality of being capable of exchanged or interchanged.

mechanisms that encourage greater participation of public as well as private investors in alternative energy development. Renewable Energy Certificate (REC) mechanism is a market-based instrument to promote renewable energy generation and facilitate renewable energy purchase obligations amongst various stakeholders.[41] As directed by the Electricity Act 2003, renewable energy generation needs to be promoted at national as well as state levels. As part of this, the State Electricity Regulatory Commissions (SERC) is obligated to purchase certain percentage of renewable energy to meet its Renewable Purchase Obligation target (RPO). Under the scheme a renewable power supplier may sell units of electricity fed to the grid and is eligible for certificates against each unit of electricity fed into the grid. These certificates can be sold to companies or SERCs to help them meet their RPO targets. The REC can help states which do not have sufficient renewable energy generation capacity but need to meet the RPO targets.

Table 7. Renewable Purchase obligations fixed upon State Electricity Regulatory Commissions in difference States in India

State	Date of Issue of Order	Renewable Purchase Obligation per annum (% of total electricity)
Andhra Pradesh	27.09.2005	5
Gujarat	11.08-2006	2
Haryana	15.05.2007	3-10
Karnataka	11.02.2008	Minimum 10
Kerala	24.06.2006	5
Madhya Pradesh	11.06.2004	10
Maharashtra	16-08.2006	3
Orissa	23.4.2005 (initial)	450 MW
Rajasthan	21.11.2005	7.5
Tamil Nadu	15.05.2005	10
Utter Pradesh	12.01.2006	7.5
West Bengal	04.05.2006	3.8

Source: Ministry of New and Renewable Energy, Government of India, Accessed: http://www.mnre.gov.in/press-releases/press-release-28042008-2.pdf, 11 December, 2011

The renewable energy certificate is expected to boost the total share of renewable energy sources in India's energy mix up to a target of 15% as envisaged by the National Action Plan on Climate Change. As a key supply side measure, REC will play a key role in country's transition to low carbon energy mix. The mechanism has been designed in such a way that the responsibility of renewable energy generation is decentralised and vested in the State electricity authorities. This provides lesser administrative control from the central government in implementing the mechanisms and necessitates greater role from the State machineries. For a country like India which is diverse in geography, ethnicity, socio-political landscape and languages decentralisation is a key mantra for any successful policy efforts.

10.3.3. CDM Program of Activity - The Bachat Lamp Yojana (BLY)

The government of India has also initiated a plan to promote CFL lamps under the Bachat Lamp Yojana CDM PoA (CDM Program of Activity). The Bachat Lamp Yojana (BLY) conceived as CDM Programme of Activity (PoA) for mass distribution of Compact Fluorescent Lamps (CFLs) has been registered successfully by the CDM-Executive Board on 29 April 2010.42 Under the program, the state level electricity distribution companies will distribute high quality CFL lamps for Rs: 15 (~$ 0.35). This is primarily aimed at reducing the incandescent lamp usage which currently meets 80 percent of the total lighting in the country. The Programme would not only help the reduction of peak load in the country but also lead to a potential reduction of over 6,000 MW in electricity demand.[43] This program will have greater role in promoting energy efficient lighting among household users in the country.

The climate agenda have been playing a critical role in consolidating the policy efforts that help promote transition. Many of the previously fragmented policy measures and legal mechanisms which were formed over the past years have now found greater implementation possibilities under the climate agenda. Transition as an element is embedded in the climate policy efforts such as National Action Plan for Climate Change, which sets plans in mission mode to balance economic and environmental targets. The Integrated Energy Policy which was formed in last decade and sets directions for achieving long term energy security for the country too is given greater importance as it encourages diversification of supply sources. Apart from these measures, specific programs under the NAPCC such as renewable energy certificates (REC) to improve renewable energy production; Perform, Achieve and Trade (PAT) to address industrial energy efficiency concerns; and previously formed Acts and regulations on energy sector together play key an umbrella structure for energy transition.

10.4. Energy Transition: The Way Forward

Recognising the fact that energy transition requires various measures supported by economic and legal efforts, it is important for India to ensure appropriate policy tools for building long term energy transition strategy. Consolidating various policy measures that help increase the share of non-conventional energy sources and promoting demand side energy management deemed important in this context. Some of the long term measures that would be critical to energy transition are highlighted below:

- Appropriate policy mechanisms need to be developed to ensure that energy and climate mitigation targets are mutually complementary
- The impacts of climate change pose serious human security challenges. Eliminating energy poverty of various sections of society will help fight these threats to a considerable extent. Considering these socio-economic and environmental benefits, it is important to ensure that climate mitigation policies are given appropriate legal support in implementation.
- There are wide disparities in the urban and rural energy consumption pattern in the country. While the urban regions traditionally dependent on hydrocarbon sources many of the rural regions lack access to modern forms of energy. Considering the fact that the energy demand in rural areas will exponentially increase in the coming years, it is important to develop long term energy development targets specially focusing on catering to rural energy demand.
- Being a democratic set-up with a quasi-federal political system, market mechanisms can play effective role than top-to-bottom flow of polices which are mostly designed and decided by the central government.

- The political differences between central government and state governments appear to be major blockade for development and implementation policies. This indicates that greater participation of sub-national governments needs to be ensured in developing long term energy security, environmental and energy transition policies.
- Public-Private partnerships can play potential role in energy transition in the country. It is important to explore more opportunities to bring in the private players in areas such as renewable energy generation, energy efficiency improvement and energy conservation.
- Despite its enormous significance, often the role of education as a tool to build awareness is largely ignored by many governments. It is important to ensure that energy efficiency, energy conservation and the importance of environmentally friendly energy options are given adequate importance in the academic curricula.

11. Conclusion

Energy Transition is a strategic necessity for India from the perspectives of energy security, growing rural energy demand and increasing energy related emission. Being a net petroleum importing country, India is vulnerable to the fuel price fluctuations in the international market and the geopolitical volatilities in the petroleum producing regions. However, the dependency on the same will continue as various key sectors of the economy heavily rely on fossil fuel sources. To a great extent, India's approach towards ensuring energy security had been largely influenced by the conventional Anglo-Saxon[14] perception which considered imported petroleum as the chief source to meet the domestic energy needs. The dependency on Anglo-Saxon countries for technology and innovation in all major energy consuming sectors such as industry and transportation also made way for the developing economies to follow a similar energy consumption pattern and fuel types.

However, a difference in perception began to evolve among the developing economies in the recent decades as the US and its Allied forces demonstrated their willingness to use even military muscles to protect their energy interest from Persian Gulf. The use of force to intervene in the Persian Gulf politics during Kuwait-Iraq conflicts and the subsequent military measures taken against the Saddam regime need to be seen through the prism of 'use of power to secure energy security'. However, developing economies have never been in a position to use military force[15] to protect their energy supply unlike the Anglo-Saxon economies. This has emerged to be one of the major reasons to develop policy thinking, invest and develop domestic supply capabilities especially alternative sources. Concerns about burgeoning energy bill with the fluctuation in petroleum price in the international market and increasing dependency on the finite fossil fuel source have also catalysed the efforts towards transition to an energy mix that depends more on domestic supply capabilities.

Today, about 68 percentage of the total population in India lives in rural areas[16] and majority of them do not have access to modern forms of energy sources. In 2005, out of a rural population of 809 million, 364 million lacked access to electricity and 726 million to modern cooking fuels.[44] This poses a critical challenge to India's long term economic targets of having a near double digit GDP growth. Meeting the growing energy demand in

[14] The Anglo-Saxon countries have been conventionally dependent on the petroleum sources imported primarily from the Persian Gulf region. To a great extent these economies have traditionally given great importance to securing their crude oil supplies and often this approach reflected quite vividly in their policies towards Persian Gulf region. The major developing economies like China and India have also followed the Anglo-Saxon perception of energy security and hence significant importance has been given to securing fossil fuel supplies from the Middle Eastern regions.

[15] China's example of using military force against South East Asian States (Philippines) on the issue of the South China Sea energy reserves need to be seen differently. More than the importance attributed to the potential energy reserves in the region, Strategic importance in terms of controlling the sea lanes of supply to the rest of East Asia could be seen as a bigger reason for China's use of military force in the past decades.

[16] As per the estimate of the Census of India in 2011 the rural population is 833, 087, 662 against the urban population of 377, 105, 760. Accessed: http://censusindia.gov.in/2011census/censusinfodashboard/index.html, 26/12/2011

rural areas with conventional fossil fuel supplies will pose three critical challenges. First, the geographic location of most of the rural areas makes it difficult for having sufficient supply infrastructure, be it fossil fuel supply or electricity supply lines. Second, meeting the energy demand in the rural areas with conventional fossil fuels will add to the fuel import of the country, which will in turn add to the energy bill. Third, the increased fuel consumption in the rural areas will also significantly increase the energy related emission of the country. Due to these factors the transitioning to a newer mix of fuels that depends more on alternative sources emerges as a necessity for the country in the long term.

Though India's per capita emission has been one of the lowest among the major economies, total emissions from fuel burning have been increasing for the past many years. The total carbon dioxide emission from consumption of energy has increased from 1002.95 million metric tons in the year 2000 to 1591.12 million metric tons in 2009.[45] In this context, it is important for the country to increase the share of non-fossil fuel in its energy mix. India's pledges to reduce emission intensity will also instrumental in enabling the transition from conventional fossil fuel based economy to a cleaner energy mix in the future.

While a complete transition to non-fossil fuel energy consumption would not be feasible in any major economy with the currently available technological capabilities, energy transition indicates shifting away from a conventional energy mix with high share of fossil fuels to a low carbon fuel mix and technology options. However, in the present Indian context energy transition should be seen as minimising the incremental dependency on fossil fuels and meeting certain percentage of the demand by cleaner technologies and measures. Despite the fact that nergy transition has not evolved yet as the mainstream policy in India, climate mitigation agenda has been instrumental in consolidating the fragmented policies and measures towards transition. Considering the long term economic, socio-political, and environmental and energy security benefits, transition to clean-energy economy will evolve to be a necessary component in the domestic policies in India.

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CONTACT **Institute for Global Environmental Strategies**
2108-11 Kamiyamaguchi, Hayama, Kanagawa, Japan 240-0115
Tel: 81-46-855-3860 Fax: 81-46-855-3809
URL: http://www.iges.or.jp
janardhanan@iges.or.jp