नीति आयोग

Draft National Energy Policy

NITI Aayog, Government of India

Version as on 27.06.2017

CONTENTS		

List of Tables:

List of Figures:

List of Abbreviations

AC	Air Conditioners
ACS	Average Cost of Supply
AD	Accelerated Depreciation
BAU	Business As Usual
BCM	Billion Cubic Metres
BEE	Bureau of Energy Efficiency
CAGR	Compounded Annual Growth Rate
CBET	Cross Border Electricity Trade
CBM	Coal Bed Methane
CCS	Carbon Capture and Storage
CEA	Central Electricity Authority
CGD	City Gas Distribution
CIL	Coal India Limited
CMPDI	Central Mine Planning and Design Institute
CO2	Carbon Dioxide
CSP	Concentrated Solar Power
CTL	Coal to Liquid
CTO	Chief Technical Officer
DBT	Direct Benefit Transfer
DBT-L	Direct Benefit Transfer – Liquefied Petroleum Gas
DDG	Decentralized Distributed Generation
DDUGJY	Deen Dayal Upadhyaya Grameen Jyoti Yojana
DELP	Domestic Efficient Lighting Programme
DME	Dimethyl Ether
DSR	Demand Side Reduction
DST	Department of Science and Technology
E&P	Exploration and Production
EESL	Energy Efficiency Services Limited
ESCO	Energy Service Company
EV	Electric Vehicles
FBR	Fast Breeder Reactor

FSA	Fuel Supply Agreement
GAIL	Gas Authority of India Limited
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSI	Geological Survey of India
HDI	Human Development Index
HDV	Heavy Duty Vehicle
HELE	High Efficiency Low Emission
HRD	Human Resource Development
IAEA	International Atomic Energy Agency
IBM	Indian Bureau of Mines
IEA	International Energy Agency
IESS	India Energy Security Scenarios
IGCC	Integrated Gas Combined Cycle
IREDA	Indian Renewable Energy Development Agency Limited
Kgoe	Kilogram of Oil Equivalent
kWh	Kilo Watt Hours
LCOE	Levelized Cost of Electricity
LDV	Light Duty Vehicle
LED	Light Emitting Diode
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LWR	Light Water Reactor
Mboe	Million Barrel of Oil Equivalent
MDO	Mine Developer cum Operator
MoEF&CC	Ministry of Environment, Forests and Climate Change
MoPNG	Ministry of Petroleum and Natural Gas
MoSPI	Ministry of Statistics and Program Implementation
Mtce	Million Tons of Coal Equivalent
Mtoe	Million Tons of Oil Equivalent
MW	Mega Watts
NAPCC	National Action Plan on Climate Change
NDCs	Nationally Determining Contributions

NELP	New Exploration Licensing Policy
NEP	National Energy Policy
NGO	Non-Governmental Organization
NISE	National Institute of Solar Energy
NIWE	National Institute of Wind Energy
NMCC	National Mission on Clean Cooking
NMEEE	National Mission on Enhanced Energy Agency
NMT	Non-motorized transport
NOC	National Oil Company
NPCIL	Nuclear Power Corporation of Indian Ltd.
NRDC	National Research Development Corporation
NSS	National Sample Survey
NTPC	National Thermal Power Corporation
OALP	Open Acreage Licensing Policy
OECD	Organization for Economic Cooperation and Development
OIDB	Oil Industry Development Board
OMC	Oil Marketing Companies
ONGC	Oil and Natural Gas Corporation
PAT	Perform, Achieve and Trade
PCRA	Petroleum Conservation Research Association
PGCIL	Power Grid Corporation of India
PHWR	Pressurized Heavy Water Reactor
PLF	Plant Load Factor
PMUY	Prime Minister Ujjwala Yojana
PNG	Piped Natural Gas
PNGRB	Petroleum and Natural Gas Regulatory Board
PPA	Power Purchase Agreements
PPP	Public Private Partnership
PSU	Public Sector Undertaking
PWD	Public Works Department
R&D	Research and Development
R&R	Resettlement & Rehabilitation
RE	Renewable Energy

RESCO	Renewable Energy Service Company
RPO	Renewable Purchase Obligation
SAARC	South Asian Association for Regional Cooperation
SDA	State Nodal Agency
SECI	Solar Energy Corporation of India
SERC	State Electricity Regulatory Commission
SUVs	Sport Utility Vehicles
T&D	Transmission and Distribution
TEC	Telecommunication Engineering Centre
TWh	Terwatt Hour
UDAY	Ujwal Discom Assurance Yojana
ULB	Urban Local Bodies
UMPP	Ultra Mega Power Project
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
VGF	Viability Gap Funding

Chapter 1

Preamble

1.1 Energy is acknowledged as a key input towards raising the standard of living of citizens of any country, as is evident from the correlation between per capita electricity (a proxy for all energy forms) consumption and Human Development Index (HDI). Accordingly, energy policies of India have over the years directly aimed to raise per capita energy (and electricity) consumption, even while the main focus of the country's development agenda has been on eradication of poverty. With nearly 304 million Indians without access to electricity, and about 500 million people, still dependent on solid bio-mass for cooking, it may be acknowledged that the country has to still go a long way on securing its energy security objective. While India strives to achieve a double digit growth rate in its national income, making clean energy available to all of its citizens, ought to be included as a key component of the poverty alleviation programmes.

1.2 The National Energy Policy (NEP) aims to chart the way forward to meet the Government's recent bold announcements in the energy domain. All the Census villages are planned to be electrified by 2018, and universal electrification is to be achieved, with 24x7 electricity by 2022. The share of manufacturing in our GDP is to go up to 25% from the present level of 16%, while the Ministry of Petroleum is targeting reduction of oil imports by 10% from 2014-15 levels, both by 2022. Our NDCs target at reduction of emissions intensity by 33%-35% by 2030 over 2005, achieving a 175 GW renewable energy capacity by 2022, and share of non-fossil fuel based capacity in the electricity mix is aimed at above 40% by 2030. In view of the fact, that energy is handled by different Ministries that have the primary responsibility of setting their own sectoral agenda, an omnibus policy is required to achieve the goal of energy security through coordination between these sources. This is also expected to mainstream emerging energy technologies, and provide consumer energy choices. The NEP builds on the achievements of the earlier omnibus energy policy – the Integrated Energy Policy (IEP), and sets the new agenda consistent with the redefined role of emerging developments in the energy world.

1.3 A number of far-reaching developments have taken place in the local and global energy space which have to be reflected in our own policy framework. There is a need to support the trends which usher in efficiency by a pro-active policy. While steps have already been taken by the Government to embed many such developments in the sectoral energy policies, however, it is desirable to develop a clear roadmap so that there is clarity amongst all the stakeholders on the Government's long-term energy agenda. Long term investors, both on supply and demand sides, need clarity on stable energy policy outlook. The following global developments call for policy clarity:

1.3.1 **Changes in the energy mix**

The world is moving away from overwhelming dependence on fossil fuel, and within the fossil fuels, away from coal and oil in favour of gas. Against an 88% total share of fossil fuels globally in the primary energy mix in the year 2005, the same fell to 86% in the year 2015. The share of oil has in particular fallen from 36% to 33%, while that of natural gas has increased from 23% to 24%, and that of Renewable Energy (including nuclear and large hydro) has gone up from 12.5% to14% in the period 2005-15. The above trends, principally owing to climate change concerns, are expected to be maintained over the medium term.

1.3.2 **Abundance in supply of natural gas**

The success of horizontal drilling combined with the technology of hydraulic fracture, has come to be established in the US where the production of natural gas went up from 511 BCM in 2005 to 767 BCM in 2015. This has boosted the already rising production of natural gas in the world from 2791 BCM in 2005 to 3539 BCM in the year 2015. As the price of gas is lower than that of oil, and is also one-third lesser as carbon emitting than oil, the ascendency of gas vis-a-vis oil is likely to continue in the near foreseeable future.

1.3.3 **Over supplied oil and gas markets**

Due to multiple reasons including the two factors listed above, along with other commodity prices, oil and gas prices have softened, and this is triggering energy policy reforms across the world. The prices of oil and gas have fallen by 50% and 70%, respectively over 2014. Many oil importing countries including India have been able to attempt bold petroleum pricing reforms, and are in a sound fiscal position to attempt larger energy policy reforms.

1.3.4 **Maturity of renewable energy technologies**

The sharp decline in the prices of wind and solar technologies in the recent years by about 60% and 52% respectively between 2010 and 2015 (in kWh terms), has led to a change in the relative importance of energy sources. Tropical countries, including India, are richly endowed with the above resources, and can harness them in an innovative manner to meet energy requirements at decentralised locations. In the recent auctions, solar and wind energy prices have achieved bus bar grid parity at the generation end.

1.3.5 **Climate change concerns**

The adverse effects of climate change are much more discernible than ever before, with a better understanding of the relationship between energy use and poor environmental outcomes. While the global agenda is of common concern, there is a heightened consciousness of the need to fix poor air quality standards in Indian cities, which is being reflected in tough administrative actions and court mandated orders.

1.4 All the above developments offer a challenge to the existing energy pathways, and also offer an opportunity to respond by building in sustainability in the new energy infrastructure. There is a raging debate as to whether the latter could be developed in a more decentralised manner. Whether or not the past global practice of large generation plants with capital intensive evacuation/transmission infrastructures, can now be better done with low cost decentralised solutions, the new energy pathways must be enabled to accept decentralised solutions. As per the energy modelling exercise undertaken by the NITI Aayog — India Energy Security Scenarios (IESS), 2047, the energy demand of India is likely to go up by 2.7-3.2 times between 2012 and 2040, with the electricity component itself rising 4.5 fold (Annex 1). India has an opportunity to incorporate emerging technologies in the new infrastructure, to be able to exploit these technologies as they mature and costs falls.

1.5 In the light of the energy challenges faced by the country, and the global energy related developments, the NEP proposes to set out the national energy objectives and the strategy to meet them. The overall objectives have been discussed in the succeeding chapter, which is then followed by a detailed discussion, on how the NEP integrates different sources of energy with interventions on demand side, as well as in areas such as infrastructure, regulation, technology, etc. While India strives to attain energy consumption levels equivalent to those of the developed countries, we are also conscious of the present small base. It is proposed that the present policy may be framed for the medium term to be able to guide the investors and the other stakeholders, who are likely to play a major role in the energy sector. During the medium term, we may strengthen the energy infrastructure and aim at scaling up over the longer period. Therefore, the medium term time span of the NEP (2017-2040) will provide clarity to the energy sector actors, and help lay the foundation for India to match the energy consumption parameters of developed countries over the longer period.

The IESS has been used to generate multiple scenarios of the likely energy demand for the country up to the year 2040 on a 5 yearly basis. These have been developed keeping in mind energy efficiency, behavioural changes and elasticity of energy demand to GDP. The above exercise has revealed that in 2040, energy demand could be brought down over the default scenario by 17% by suitable interventions. It has also revealed that even if efforts were stepped up to enhance domestic energy supply, coupled with heroic effort to reduce energy demand, India's overall primary energy import dependence could still rise to 36-55% by 2040 from 31% in 2012. The following chapters propose policy action which could help India raise its per capita energy consumption from nearly 521 kgoe (2014) to 1055-1184 kgoe in the year 2040. The above parameters, would lead us to meet the NDC goals of renewable energy capacity, emission intensity and non-fossil fuel share in the electricity mix of India in the year 2030.

Chapter 2

Four key objectives

2.1 There are four key objectives of our energy policy: **Access at affordable prices, Improved security and Independence, Greater Sustainability and Economic Growth**.

2.2 Considering poverty and deprivation in India, access to energy for all at affordable prices is of utmost importance. We are yet to provide electricity to nearly 304 million people, and clean cooking fuel to nearly 500 million people, which still depend on Biomass. The policy aims to ensure that electricity reaches every household by 2022 as promised in the Budget 2015-16 and proposes to provide clean cooking fuel to all within a reasonable time. While it is envisaged that financial support will be extended to ensure merit consumption to the vulnerable sections, competitive prices will drive affordability to meet the above aims.

2.3 Improved energy security, normally associated with reduced import dependence, is also an important goal of the policy. Today, India is heavily dependent on oil and gas imports while also importing coal. In so far as imports may be disrupted, they undermine energy security of the country. Energy security may be enhanced through both diversification of the sources of imports and increased domestic production and reduced requirement of energy. Given the availability of domestic reserves of oil, coal and gas and the prospects of their exploitation at competitive prices, there is a strong case for reduced dependence on imports. In due course, we may also consider building strategic reserves as insurance against imported supplies.

2.4 The goal of sustainability acquires added importance and urgency in view of the threat of catastrophic effects of climate change as well as the detrimental effects of fossil fuel usage on local air quality. In India, sustainability is also closely linked with energy security. Our fossil fuel requirements, which comprise nearly 90% of our commercial primary energy supply, are increasingly being met by imports. This means that cutting fossil fuel consumption would promote the twin goals of sustainability and security. Hence the policy lays heavy emphasis on de-carbonisation through the twin interventions of energy efficiency and renewable energy.

2.5 Finally, the energy policy must also support the goal of rapid economic growth. Efficient energy supplies promote growth in two ways. First, energy is the lifeblood of the economy. It is an important enabling factor of growth and its availability at competitive prices is critical to the competitiveness of energy-intensive sectors. Second, being a vast sector in itself, its growth can directly influence the overall growth in the economy. For example, petroleum products have been an important

direct contributor to our growth in recent years by attracting large investments in refining/distribution, and also fuelling economic activity.

2.6 In general, these four goals may or may not move in harmony with one another. We noted above that energy security and sustainability are mutually reinforcing in our case since our energy imports are predominantly fossil fuel based. Reduction in imports and in emissions can both be achieved through an expansion of renewable energy consumption. On the other hand, as long as fossil fuels remain the cheapest source of energy, the goal of energy accessibility at affordable prices would come in conflict with the goal of sustainability and possibly energy security as well. Until such time as the costs of generating, transmitting and distributing renewable energy drop sufficiently to allow its delivery to the customer at lower cost than energy from fossil fuel sources, a conflict is likely to exist among the above three objectives. Energy efficiency is, however, one goal that reinforces all the four objectives. Hence, we identify it as a common area of intervention across all demand sectors in the Strategy.

2.7 Having identified the four broad objectives of our energy policy, we need to link them to propose actions on the ground. Figure 1a and 1b provide a schematic division of possible areas of intervention. The areas are classified according to the source (coal, oil gas or renewable) or form (electricity) of energy and the stage of value chain. Stages of value chain are divided into upstream, midstream and downstream. For example, upstream stage of electricity is generation while midstream and downstream stages are transmission and distribution. Likewise, exploration and production define the upstream stage of oil while refining and distribution are midstream and downstream stages of it. Final consumption is analysed according to four major consumption sectors: businesses, households, transportation, and agriculture.

2.8 Our schematic division allows us to identify seven areas of intervention:

(i) Energy Consumption by businesses, households, transportation and agriculture
(ii) Energy Efficiency/de-carbonisation measures on the demand side
(iii) Production and distribution of coal
(iv) Electricity generation, transmission and distribution
(v) Augmenting supply of oil and gas, both by domestic E&P, and through acquisition of overseas acreages
(vi) Refining and distribution of oil and gas.
(vii) Installation, generation and distribution of renewable energy

2.9 Our discussion of the policy in the following chapters heavily relies on the above areas of intervention.

2.9.1. An important aspect of interventions in virtually all areas we have identified concerns governance, particularly as it relates to pricing and regulatory policies.

In the past, insufficient attention has been paid to robust institutions, optimal pricing and regulation issues in India. The present policy focuses more centrally on this aspect. There are important gains to be had from the introduction of well-functioning institutions to enable efficient decision-making, pragmatic pricing and regulatory reforms at various stages of value addition in the chains associated with different energy sources.

2.9.2. Energy efficiency, which entails using less energy for the same service, is an important element in energy policy. For example, the recent campaign by the government to replace regular bulbs by LED bulbs has the potential to reduce energy load by 20 GW and save nearly 100 billion kWh worth of energy each year after replacement of all incandescent bulbs. The urgency of action on the enhancement of energy efficiency stems from the fact that our CO_2 emissions and energy imports could go up substantially in the 'do-nothing' scenario. Improved energy efficiency alone can reduce our energy demand over BAU (business as usual) scenario by 17% in 2040. These projections by India Energy Security Scenario (IESS) 2047 also indicate that demand reduction through energy efficiency could be further supplemented by actions on domestic supply. Recognizing the importance of energy efficiency, the policy addresses energy efficiency in detail in a separate chapter.

2.9.3. There also remains the issue of time horizon of the policy. The policy focuses on two horizons: a short term horizon going up to 2022 and a medium term going all the way up to 2040. The time frame upto 2022 is short enough that it allows us to discuss interventions that are required right away while the period upto 2040 is long enough to contemplate bolder interventions that are required to fully modernize India's energy sector.

2.9.4. The objectives of the energy strategy are inextricably linked with those of the economic policy of the Government. Hence, the complexity of the energy sector is no less than the national challenges of development and growth. The economic transformation of India has to be supported by transformation of the energy sector, too. While striving for competitiveness of manufacturing in India, even the welfare objectives have to be expeditiously met. In the past, the challenge of meeting both objectives resulted in sacrificing one for the other. Global experience tells us that the two are actually two sides of the same coin, and the two are complementary. The NEP aims at efficiently delivering intended benefits to vulnerable sections of the society as has been eminently displayed in the energy sector itself (DBT-L), while not making our industries un-competitive. Towards the above objective, the NEP draws heavily from the country's economic strategy.

2.9.5. The NEP proposes actions to meet the objectives in such a way that India's economy is 'energy ready' in the year 2040. Technological advancements and global energy markets are rapidly changing. Our own bold economic reforms, which are likely to lead to robust economic growth at double-digit annual rates over the next decade, promise to transform the way energy is consumed and supplied. All four major energy-consuming sectors—industry, household, transport, and agriculture—will undergo dramatic changes in the coming decades. On the energy front, they should be able to internalise volatility in energy prices, which is often the case when markets get integrated globally. Urbanization is expected to go up to 47%, while current share of manufacturing in the GDP will double to 30% by the year 2040. The population of India is predicted to go up to 1.6 billion by 2040. All these developments will result in the energy demand increasing by 2.7-3.2 times between years 2012 and 2040. The NEP must deliver the energy demanded at all times to support the desired economic outcomes.

Figure 1a: Areas of Supply Sector Intervention

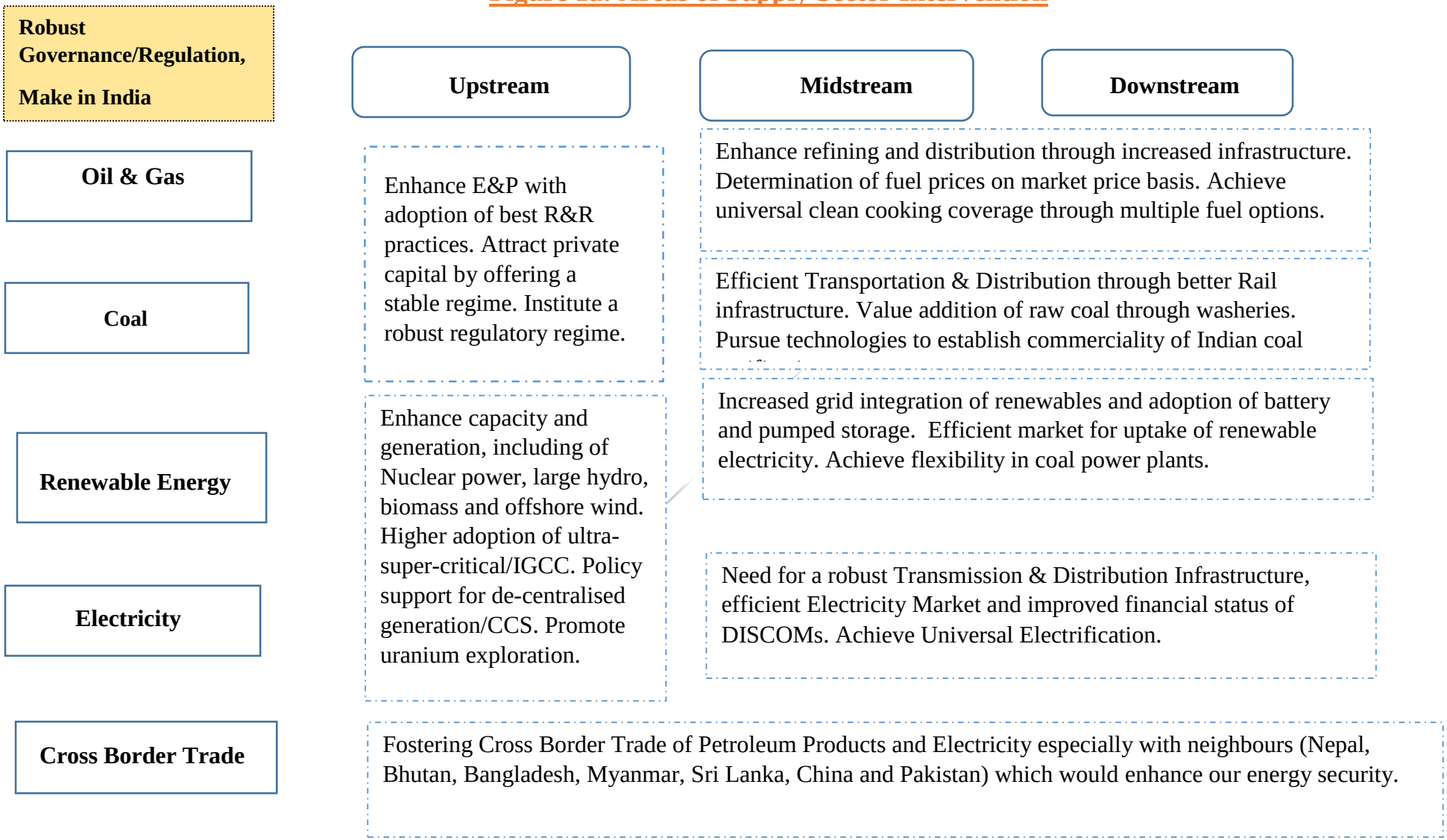
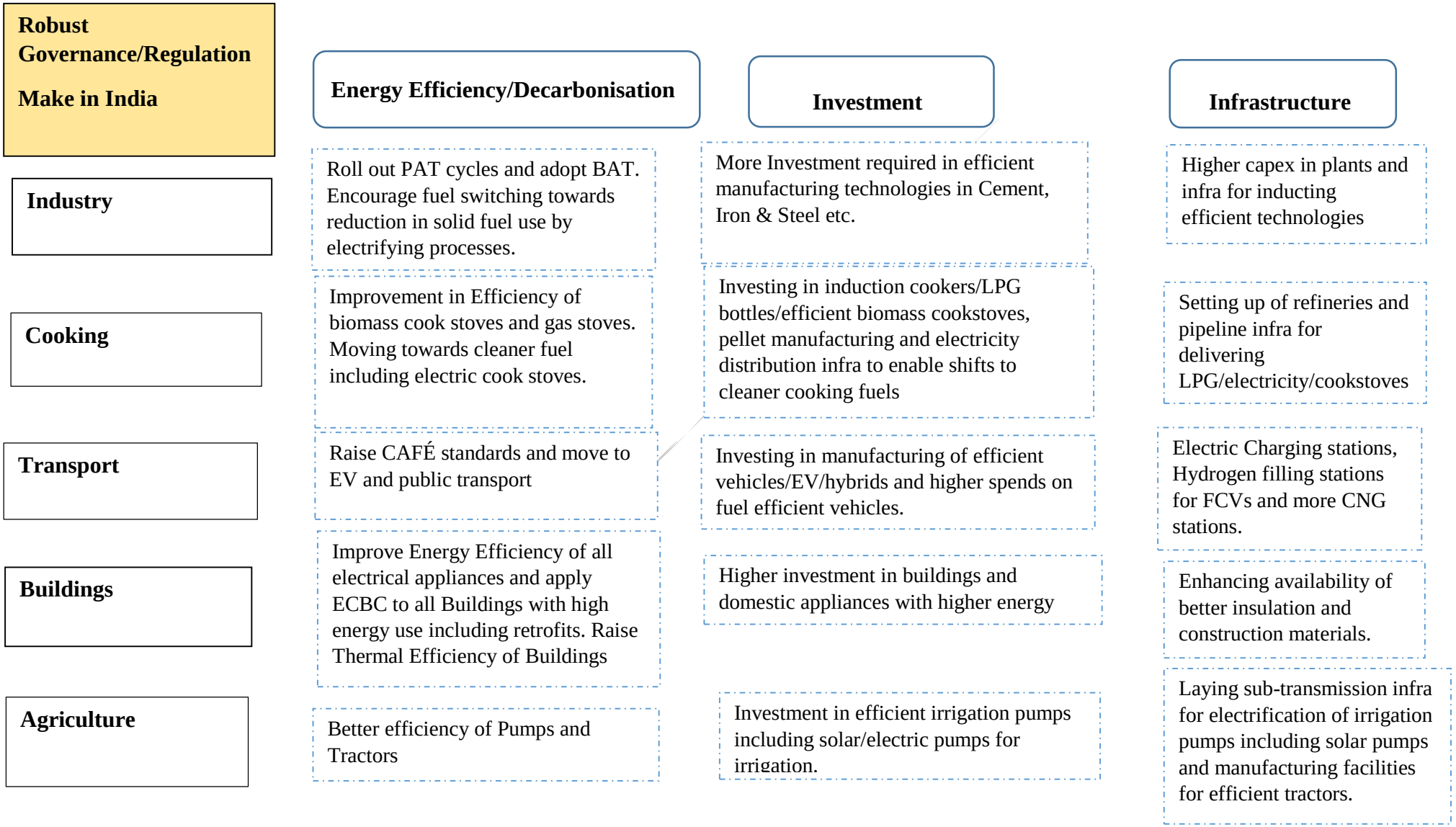


Figure 1b: Areas of Demand Sector Intervention



Chapter 3

Energy Demand: Efficiency and Conservation

3.1. In relation to its population, India is poorly endowed with energy resources. Its share in the world population is 17% but the shares in the world gas, oil and coal reserves are only 0.6%, 0.4% and 7%, respectively. This has meant heavy dependence on imports even at a rather low level of energy consumption. It is surprising that despite this severe supply constraint, only recently have we begun to pay serious attention to demand-side interventions that would help economize on the use of energy. There are at least two demand-side interventions that can help cut energy usage: behavioural change that results in reducing the demand for energy-based service and the introduction of alternatives that maintain the level of service but reduce the energy required for its provision. The former is called energy conservation and the latter greater energy efficiency. An example of energy conservation is the shift to fan from air-conditioning, which cuts the need for energy by lowering the level of service received. Similarly, an example of improved energy efficiency is the shift to LED bulbs from regular bulb, which maintains the service but cuts energy consumption. Often conservation and efficiency effects come jointly. For example, when houses are designed to allow better flow of air and the use of air-conditioning is foregone, there is partial decline in service (comfort level) indicating both conservation and efficiency.

3.2. The recently adopted Nationally Determined Contributions (NDCs) as signatory to the United Nations Framework Convention on Climate Change (UNFCCC) emphasize the importance of demand side factors. In its submission, India gave particular importance to behavioural change leading to energy conservation, something that has received insufficient attention in the developed countries. The NEP aims to internalize this shift in our energy policy.

3.3. Energy consumption in India is characterized by low per capita level and a large disparity between urban and rural areas. In 2015-16, our per capita energy and electricity consumption at 670 kgoe and at 1075 KWh/year, respectively, are just one-third of the world average. Nearly 25% of our population today is without access to electricity and 40% without access to clean cooking fuel. In 2014, the share of electricity in final energy demand was only 17% compared with 23% in the member countries of Organization for Economic Cooperation and Development (OECD). This low share means that a large proportion of energy consumption takes the form of solid and liquid fuels, exacerbating the air quality at the demand centres. Because electricity has the virtue of delinking emission from the point of consumption, for many uses, it is a preferred form of energy.

3.4. **India Energy Security Scenarios**

3.4.1. India Energy Security Scenarios or IESS 2047 allows us to predict energy consumption in the final year of the policy, 2040, under alternative scenarios with respect to efforts towards achieving greater energy efficiency. In Table 1, we show these estimates under a range of two sets of assumptions: a baseline effort and a significantly more ambitious effort towards achieving energy efficiency and conservation. The baseline scenario (BAU) generates the higher demand bound and the ambitious scenario is represented by the lower bound.

3.4.2. In the ambitious scenario, energy consumption ends up being 17% below that in the baseline case illustrating the power of energy conservation and efficiency. In this scenario, the share of electricity in the final energy demand at 26% is also significantly higher than the 23% share in the baseline case suggesting an environmentally cleaner outcome at the point of consumption. In per capita terms, annual energy consumption rises from 670 kgoe in 2015-16 to 1055-1184 kgoe in 2040. Correspondingly, per-capita annual electricity consumption increases from 1075 KWh in 2015-16 to 2911-2924 kWh in 2040. At the above levels, our economy would still be much more efficient than many developed countries while meeting satisfactory levels of energy demand of our citizens.

3.4.3. With the GDP composition across different sectors changing with growth, energy shares of different consuming sectors shift. Buildings, industry and transport sectors together are the main gainers in both scenarios. But the gains of individual sectors vary considerably in the two scenarios. The maximum efficiency gains accrue in transportation sector whose share in the total energy consumption in 2040 turns out to be 23% under the ambitious scenario compared with 25% in the baseline scenario.

3.4.4. The most dramatic shift occurs in the cooking sector. Here we see environmentally cleaner energy replacing the current biomass fuels. Energy share of cooking drops from 22% in 2012 to just 3.3% in 2040 in the baseline case and 3.5% in the ambitious scenario. From health perspective, this is a most valuable shift.

Table 1: Actual energy consumption in 2012 and projected consumption under alternative scenarios in major sectors in 2022 and 2040

Sectors	2012	2022		2040	
TWh		BAU	Ambitious	BAU	Ambitious
Buildings	238	568	525	1769	1460
Industry	2367	4010	3600	8764	7266
Transport	929	1736	1628	3828	3243
Pumps& Tractors	237	423	388	728	592
Telecom	83	131	124	207	164
Cooking	1072	829	684	524	467
Total	4926	7697	6949	15820	13192
% reduction in energy demand in 2040	17%				

Table 1

3.5. The following considerations underline the importance of demand side factors in formulating the NEP:

3.5.1. Different combinations of sectoral shares are possible for any given level of growth. Each combination of shares would imply a different energy basket. Additionally, it is expected that dramatic shifts would take place in the primary energy mix of India with the shares of biomass and fossil fuels dropping sharply and that of renewable sources rising correspondingly.

3.5.2. The energy basket would shift with increase in income. For example, networked devices will exert a large pressure on electricity share. Likewise, per capita transport demand would rise. The NEP must take into account behavioural shifts that would accompany increases in income.

3.5.3. So far rural areas have lagged in availability of efficient energy solutions. The NEP should pay greater attention to the provision of basic infrastructure in rural areas.

3.5.4. The above factors when combined with increase in urbanization will put added pressure on the energy system and bring adverse air-quality effects in a large number of towns. City plans must respond to the needs of an efficient energy system in cooking, transport and electricity segments.

3.5.5. Appropriate price signals help in getting demand side response (DSR). This is vital both from shifting demand (smoothening demand curve) and also achieving energy efficiency and conservations gains.

3.5.6. Because of accelerating growth trajectory of India in the years to come, an efficient energy demand side management system will be a useful, and more economical intervention, giving India an opportunity to 'lock-in' savings while building a major section of its energy consumption ecosystem.

3.6. **Towards Energy Efficiency and Conservation Policy**

3.6.1. The National Mission for Enhanced Energy Efficiency (NMEEE), launched under the National Action Plan on Climate Change (NAPCC) has not been able to achieve its intended goals due to poor inter-sectoral linkages. Energy efficiency programmes cannot be run on a stand-alone basis and require close coordination between energy supplying and consuming sectors, as well as with technology development, management apparatus and finance streams. A revamped National Mission would be launched which would have stronger linkage than before between the related sectors, and provide for a robust supervisory and review mechanism.

3.6.2. The adoption of efficient practices across all energy consuming sectors calls for a well-planned strategy with four specific components:

- First, the policy objectives need to be clearly identified which would lead to the right implementation strategy.
- Second, the regulatory and statutory mechanisms need to be made robust so that along with consumer preferences, even the manufacturing and trade sectors conform to state of the art technology and energy practices.
- Third, choosing the right intervention tools and programmes will be an important component of this strategy.
- Finally, a robust institutional mechanism ought to be created which can evaluate, monitor and promote a nation-wide energy efficiency programme.

3.7. **Setting Objectives**

3.7.1. Energy efficiency programmes ought to be evaluated against set targets which requires a robust data base. In order to develop a baseline status of energy efficiency in different demand sectors, the Bureau of Energy Efficiency (BEE) would conduct a study directly or by an out-sourced agency. The scope of the study would include all energy demand sectors of the economy, and extend to existing processes and technologies, level of energy efficiency, readiness to move to more energy efficient technologies, current cost considerations, current level of skillsets and whether they would require upgradation/change when new technologies are introduced.

3.7.2. The BEE would specifically look at convergence with existing national programmes and plan appropriate interventions: **100 Smart Cities, Housing for All by 2022, Power for All by 2022, 175 GW of renewable energy by 2022** etc. to achieve synergy. The initiatives such as Smart Cities and solar pumps should mandate using only the most efficient appliances.

3.7.3. The goals will be commensurately set with the cost-effective potential. The following guidance will inform the setting of goals:

- Making the globally most cost effective technology the norm in India in the next five to seven years.
- The goal criteria should include key co-benefits.
- Decision on whether goals would be mandatory or voluntary.
- A focus on constructing measurable goals that can be easily monitored in the specified timeframes.
- Goals should identify stakeholders/agencies that would be held liable in case the target is not met. Introduction of a penalty mechanism would be incorporated into the goal setting criteria.

3.7.4. Specific goals will be set for the following major energy consuming sectors:

- DELP program for AC, pump, and fans
- Revision of AC standards

- National buildings program for residential and commercial buildings
- Expansion of the PAT program and adoption of BAT to reduce the industrial energy consumption.
- Expansion of fuel efficiency standards to other modes of transport like Trucks and
- Standards for HDVs and periodic revision of LDV standards.

3.8. Addressing Existing Regulatory and Legal Barriers

3.8.1. There is a need to analyse the present ecosystem governing energy efficiency such as policies, laws, institutions and arrangements. On the policy front, there is no overarching energy efficiency policy. This has hampered the adoption of efficient practices across energy consuming sectors. It is envisaged that an omnibus policy will be announced to cover all the energy producing and consuming sectors.

3.8.2. The current energy efficiency statutory framework, which is primarily defined by the Energy Conservation Act of 2001, has provided a robust initial framework for facilitating energy conservation and adoption of efficient technologies and practices. There is a need to empower BEE so as to enable it to implement the Act more effectively across all energy consuming sectors.

3.8.3. The National Mission for Enhanced Energy Efficiency had proposed to put in place new initiatives in order to enhance energy efficiency such as tradable energy saving certificates, innovative financing mechanisms that capture future energy savings and introduction of fiscal instruments. The above proposals have not been translated into effective instruments. There is a need to mandate energy efficiency measures with tighter provisions and introduce fiscal measures to incentivize the adoption of efficient measures.

3.9. Launch of Appropriate Tools

3.9.1. Awareness creation will be an essential component of the renewed energy efficiency programme. As there is an upfront cost in adopting energy efficiency, unless there is a reasonable degree of confidence of the long term benefits, which can be enforced through credible mass public campaigns, there will be slow adoption.

3.9.2. Financial interventions varying according to the type of consumer will be framed. A focused financing initiative such as offering line of credit to EESL or other agencies, loan guarantees, grants, making energy efficiency as a priority lending sector, partial risk sharing of Energy Efficiency programs etc. would be taken up.

3.9.3. Energy Services Companies (ESCO) are crucial in creating the Energy Efficiency value chain. However, for the ESCO business model to take off, enforcement of the existing codes is crucial as a driver for actions by consumers. EESL or other agencies ought to provide partial loan guarantees to ESCOs for de-risking their performance based contracts.

3.9.4. Clear policies need to be made regarding end of life with respect to major energy consuming equipment in industrial, automobiles and buildings sectors. Very old and extremely inefficient equipment and appliances and vehicles, can undo the efficiency gains of any aggressive energy efficiency policies.

3.9.5. Mandatory energy use disclosure programs, such as energy use reporting by commercial and large residential buildings at the time of real estate transactions and/or property filing, could be helpful in making energy consumption as one of the decision variables in such transactions.

3.9.6. All key appliances, equipment, and vehicles should be covered by mandatory standards and labelling programs by 2020.

3.9.7. Over the next five years, DELP type programs should be implemented for 10 most electricity intensive appliances and equipment with a target of super-efficient technology to be 50% of all new purchases.

3.9.8. On Building codes, it will be simplified and code compliance strengthened while clear division of responsibilities across central, state and ULB departments will be delineated. Residential buildings will also be brought under the fold of ECBCs.

3.9.9. As regards Industrial energy efficiency, clear targets will be fixed for deepening and widening of the PAT program; PAT must cover 80% of all industrial consumption, including the unorganised sector, by 2020. The efficiency targets for ensuing PAT cycles will be raised in tune with technological advancements in processes.

3.9.10. Awards and tax rebates for facility and enterprise energy efficiency are an effective way to create awareness and promote competition between consumers. The existing Award scheme will be extended across sectors and States.

3.9.11. Grid interactive demand response by smart appliances, buildings/industrial consumers, or EV chargers can provide critical services to the grid, especially for Renewable Energy grid integration or during peak demand periods. Such programs can capture significant co-benefits of efficiency policies and technology upgradation.

3.10. Institutional Arrangements

3.10.1. The role of State Governments in achieving efficiency in energy generation and consumption is recognized. The Government will endeavour to create and strengthen robust State Nodal Agencies (SNAs), and strive to achieve an active cooperation in implementing energy efficiency programmes, which has not been the case so far.

3.10.2. In order that energy efficiency becomes a major instrument of the NEP, there will be a need to raise the resource allocations for key energy efficiency agencies both at the central (such as BEE, EESL) as well as state (SDAs) level – both in terms of staff as well as program funds.

3.10.3. Institutional capacity building to run these programmes will need to be raised manifold. There are multiple agencies in charge for overseeing/implementing energy efficiency programs especially in the buildings sector, for example, BEE, PWD, SDA and ULB; greater inter-agency coordination is called for. Coordination is needed with agencies across energy sectors, such as PCRA, too.

3.10.4. Data acquisition, monitoring, and load/consumer surveys are critical for goal setting as well as effective implementation. The energy efficiency related institutions must have expert manpower capabilities for such technical jobs.

3.10.5. A technical institute /research body focused on energy efficiency (similar to the National Institute for Wind Energy) will be created for providing technical and analytical expertise for policy and regulation making.

3.10.6. Energy efficiency sector is a technical one wherein the role of R&D is very significant. There ought to be support for Research, Development and Deployment through public funding, both to private and public sectors.

3.10.7. In order to capture the levels of energy efficiency in the states and also motivate them to perform better by challenging them, NITI Aayog would establish an index of States by rating them across a range of energy efficency related parameters.

3.11 Price Signals

DSR is best achieved through pricing cues. It has to be ensured that movements in wholesale prices are passed on to the retail market. This will happen only if robust electricity markets are ushered in and regulators support such practices. While subsidising the vulnerable section of consumers, it will be ensured that the objective of attaining energy efficiency is met through appropriate tools including sharing the gains with the consumers. This will also ensure that additional capacity is avoided to meet peaking needs by shaving off peak demand.

Box 1: Rural Electrification

India is paying great developmental costs due to its energy poverty. Lack of access to electricity in homes marks a failure of the country's energy policies and impacts education, health and economic development, especially in rural India. The NEP aims at achieving 100% electrification by 2022, and will take this to be the main plank of the overall energy strategy. As per the results of the 68th Round of NSS Survey (2011-12), only 4% of the urban households did not use electricity as the primary source of lighting. But, more than 26% of the rural households are in this hapless state which shows an inclination towards kerosene based lighting solutions. A total of near 304 million people in the country are without access to electricity. The Government has launched the DDUGJY as its principal vehicle to achieve the above goal by 2022, by first achieving 100% village electrification by 2019. Studies have revealed that in spite of major strides made by the earlier schemes in providing connections and now, DDUGJY, the problem of electricity 'access' did not improve appreciably. An inherent challenge in the process is ensuring the coverage of households as opposed to only villages. Several states with high electrification rates still have poor household electrification, and certain hamlets, not covered in the national sample surveys and the DDUGJY, housing a considerable section of the populace, are also without access to energy. Government schemes may deploy public apparatus to create the necessary infrastructure, but sustaining supply is a dynamic challenge.

Electrification can be viewed to be a combination of a set of facets: Setting up of electricity infrastructure, providing connectivity to households, adequate supply of desired quality of power, supply of electricity at affordable rates, and proving clean, and sustainable power in an efficient fashion. But, universal electrification and sustained access has faced the following challenges, some real and other assumed ones:

- The capex requirement is prohibitive
- The rural consumer is indifferent towards electrification
- There is a large affordability issue
- Rural supply is reckoned as a welfare activity, and not a commercial one
- Solar lighting is an effective solution for household electrification, but not cost effective in many cases, especially if battery back-up is also provided
- Differential resource endowments and economic growth patterns of states.

The above challenges have to be de-mystified as they have harmed the cause of rural electrification by creating a false impression of a large perceived challenge. Some of the above beliefs, especially those pertaining to poor commerciality are erroneous. Rural consumer values electricity as much as anyone else, and are perfectly willing to pay reasonable tariffs. Studies show that the willingness to pay for reliable electricity services in rural areas is high, and exceeds the long-run marginal cost of supply. Energy related expenses incurred by poorly served consumers, both in rural and urban settings, are suggestive that formal energy supply would in fact be an income-saver for them. However, there are several other challenges, which are not usually acknowledged, and are listed below:

- Connection is not the only factor — even duration, quality and reliability are important. This may require dovetailing grid supply with off-grid one

- Many rural consumers are unable to pay bills in one go, especially as their earnings accrue in a staggered manner. Hence, the divide between BPL and APL in electrification schemes may not work.
- Rural consumers also need flexibility in supply to be able to avail more supply should they add appliances or deploy power for productive use.
- Lack of an efficient maintenance mechanism is a major dampener.
- Solar lanterns tend to be more cost effective than the outgo on kerosene subsidy.

Keeping all the challenges in mind, it is envisaged that the Government will first endeavor to provide grid based supply to all households, and renewable based supply will be resorted only in exceptional circumstances. There is also a need to redefine the concept of 'Electrification', as occurs in the DDUGJY, to include stages of electrification in a village, with the village being deemed completely electrified if and only if ALL households of a village have an electricity connection, which witnesses reliable supply of electricity atleast for a set number of hours. Although rural consumers may be extended capital subsidy for initial connectivity, as is being done through DDUGJY, the same should be equitable, well targeted and have an exit strategy, with the consumer being reckoned as a revenue generating variable thereafter. The non-BPL households may also be offered support, albeit at a different level. Innovative billing and metering practices will be offered to them to be able to pay in a staggered manner. Adoption of DBT will meet the twin goals of curbing wasteful consumption and also deliver subsidy to the meritorious efficiently.

At the Centre, an 'Energy Access Fund' can be established to address the urgent need to convert capital subsidies into operational incentives. This could serve as a motivator for sustained performance of energy systems. It could enable a transition towards an incentive linked mechanism for better delivery of energy services.

Rural consumers have as much a right to receive efficient service as anyone else, and discoms ought to buttress their manpower towards this challenge. In areas where the reach of the grid is limited due to geographical constraints, incentivizing the sector of micro-grids in areas where the same makes economic sense, by identifying a business model/ policy framework to encourage independent developers, NGOs, and social businesses to scale up their efforts is also a key area of intervention. Micro-grids may play another role, even in electrified villages. They offer a value proposition in meeting peak electricity requirement in electrified villages, and may be in business until the supply quality aspect is resolved.

Box 2: Clean Cooking Access

Clean cooking refers to efficient and affordable fuel, the combustion of which does not harm family health due to indoor air pollution, and is also not onerous on women in its collection and use. In India, household electrification and provision of clean cooking fuel have been twin challenges, with the former having received priority over the latter. This has led to poor redressal of this issue, resulting in near 40% of our population without access to clean cooking fuel. The situation in rural areas, with a significant section of the populace below poverty line, is grim, and is changing quite slowly. The PM Ujjwala Yojana is expected to overcome this. Our end aim should be fuel substitution of sources of energy like firewood/chips, dung cake, kerosene, coke/coal etc. to cleaner sources of energy like LPG, PNG and Electricity. Even where biomass is being used, the cookstoves are inefficient. A programme to improve the efficiency of biomass cookstoves is of vital importance. As per NSS Report 567 (68^{th} Round, 2011-12), between 1999-2000 and 2011-12, the drop in use of solid biomass in cooking in rural households was only 8.2 percentage points to 67.3%, while the uptake of LPG went up from 5.4% to 15% (roughly 1% per year). In urban areas, the substitution has been faster with only 14% of the households still using solid biomass. In addition to availability, the adoption of cleaner sources of energy and improved cookstoves is hindered by behavioral patterns like differentiated cooking practices, and local preferences with regard to preparation. An interesting revelation in the NSS Report is, that kerosene serves as cooking fuel only for 1% and 6% of the total rural and urban households, respectively. The grim picture above points to the necessity of the National Energy Policy taking on this agenda as one of its most significant ambitions, and suggesting a robust strategy forward for provision of clean cooking fuel for all in the quickest timeframe in a mission mode. The launch of the 'PM Ujjwala Yojana' (PMUY) has come as a shot in the arm towards meeting the target of achieving universal clean cooking coverage. The NEP recognizes LPG as a major component of the clean cooking solution. However, looking to the historical cooking practices and abundance of agri-and forest-based biomass, there is a need to devise a strategy for its deployment in a clean and efficient manner. Biomass offers several advantages over fossil fuels such as LPG and PNG in the cooking space.

Clean cooking fuel has been the biggest casualty of lack of coordination between different energy Ministries. The clean cooking fuel policy option for rural areas has been virtually none, with a poor LPG component (1% growth per year). As if biomass is going to remain as the staple fuel, the major focus has been only on efficient cook-stoves through MNRE schemes, which owing to several reasons, did not reach the rural populace in a significant manner. On the other hand, for urban areas, LPG has been the fuel of choice. Moreover, there has been no national programme for clean cooking fuel, and no administrative Ministry responsible for this vital aspect! The announcement in the Union Budgets (2016-17 and 2017-18) of separate allocation of money for subsidy towards LPG connections in the name of rural women is a right step (PMUY).

The challenges faced by this sector are as follows:

- Clean cooking fuel was not high on national priority until the launch of PMUY. This has led to persistence of solid biomass as the preferred fuel for over 40% of the country's population, combined with inefficient cookstoves. The above is responsible for a huge health implication, largely on women and infants.

- There is a clear rural-urban divide in the use of modern cooking fuels. Rural households do not have a choice (or multiple) of cooking fuel solutions the way urban households have been provided. The former need stacking of cooking fuels just like the latter.
- As nearly 50% of country's LPG consumption is imported, absence of an assured market keeps the market of non-subsidised bottles under-supplied. Import infrastructure and supply chain, will pose a challenge for LPG imports to be ramped up significantly under the PMUY.
- Inspite of 3 decades of Government intervention, less than 1% of the rural households use improved cookstoves. Additionally, despite the large market potential, there are a limited number of manufacturers of clean cookstoves in the market (many lack design/ testing/ standard protocols) and none of them have received the scale and profitability. Along with the same, issues of R&D, fiscal support to manufacturing and after sales services deter expansion of the market.
- The subsidised cookstove with natural draft has poor emission specifications, while the one with forced draft is not acceptable to the consumers due to poor design and non-availability of biomass pellets. There is a higher budgetary allocation for the former as it is cheaper even though it does not address the objective.
- Electricity, natural gas (PNG in urban areas) and biogas have so far not been considered as serious cooking fuel options, while kerosene is rightly discouraged.
- Information asymmetry about the long-term benefits of clean cooking fuels, and the negative impacts of traditional fuels and cookstoves.
- Market-based clean cooking solutions have not evolved due to a poor eco-system. The same needs to be kick-started with a comprehensive strategy.

It is evident that the problem is of a large magnitude, and there is no clear strategy. Instead of promoting clean fuels, we have been concentrating on a half-hearted efficient cookstove programme. The import implications of LPG as the primary clean cooking solution will also mean energy insecurity, along with other things. However, sorting out a large anomaly in LPG distribution (that will hopefully be corrected by DBT and de-duplication), could help. As per OMCs, there were 201 million active domestic LPG connections as of 1.04.2017 which amount to around 80% of the total households. But, as per NSS Report, only approximately 71% households in Urban areas and 21% households in Rural areas in the country were found to be regularly using LPG. Hence, there is a large volume of LPG, which could be rationalized and offered to rural consumers without a significant import implication and un-authorised use of subsidised supplies.

And, what about the rural consumer's preference? Studies have revealed that LPG is in great demand, even at a commercial price. However, just like billed electricity, many rural consumers cannot pay for the 14.2 kg LPG refill at one go. The distribution of the LPG cookstove and related initial infra through Union Budget subsidy has successfully bridged the initial reluctance of the rural poor. Here lies the opportunity for us to develop a successful market based clean cooking programme, wherein costs can be shared. The Government will anyway have to dispense equitably with the rural areas, and subsidise just as it does the urban consumer. The National Energy Policy proposes the following:

- A National Mission on Clean Cooking (NMCC) will be launched which will coordinate efforts on cooking fuels, efficient cookstove and related R&D with an aim to achieve full clean cooking fuel coverage by 2022. This will be housed in the NITI Aayog. Energy Ministries, State Governments and industry will be taken on board.
- Rural households form bulk of the problem, and need a specialized strategy as their cooking needs are varied, including water heating and fodder preparation. Stacking of fuels is the norm, and is acknowledged. Hence, every home will have more than one cooking fuel.
- With Universal Electrification aimed for 2022, electricity cannot be overlooked as a clean cooking fuel, with admissibility to cooking subsidy. Also, keeping in mind the additional capacity of electricity required, if fuel substitution were to take place in favor of electricity, the efforts of other initiatives of the Government like the renewable energy targets, should be dovetailed into this to ensure clean energy at the source and the end.
- Appropriate appliances including induction cookers will be encouraged. The specifications of electricity connections under the DDUGJY would be altered to be able to support the same.
- Efficient biomass cookstoves will be an important component of the strategy of multiple cooking fuels. As electricity reaches homes, forced draft version will be the norm and there will be no need for solar power to run the fan in such cookstoves (biomass based cooking). Normal draft will be discouraged. Solar powered forced draft cookstoves, suitably developed to meet cooking practices in villages being electrified with off grid solutions, will be deployed.
- Studies have revealed that in many areas even biomass is being bought, and it is not that it is accessible for free everywhere. Expenditure incurred (wage opportunity lost) in collecting/buying biomass is not significantly higher than cost of clean fuels. Hence, there is an appetite to pay for the latter.
- The Government is committed to make subsidy available evenly for urban and rural citizens, especially if they are poor. Subsidy will be extended for a slew of measures, including a variety of fuels, efficient cookstoves and for provision of supply chain linkages. However, this subsidy will be tailored according to the different needs of remote and rural regions, allowing high flexibility and efficiency.
- An ecosystem of mass market for cookstoves, electric cooking appliances, bottled LPG in various refill sizes, setting up of fuel distributorships across the country and strengthening city gas networks in urban areas will be encouraged. Clean cooking is a vast market, which will be tapped with its economic spin-offs.
- The problem of maintenance of the aforementioned clean cookstoves (biogas/ improved) would be addressed in rural areas, so as to maximize adoption. The on-going Skill India Mission will be synergized with it.
- Creation of a database driven intervention strategy, which includes the sales records, consumer database, and projects the benefits accrued in terms of reduced emissions and import dependence is essential for designing future interventions.
- Promotion of an enterprise based model for operating biogas plants in rural areas would increase usability and provide co-benefits of employment and livelihood opportunities.

The cooking sector is set for a sea-change during the time frame of the NEP, with solid biomass giving way almost entirely. With increasing population pressure and expansion of agriculture, firewood is no longer easily within reach everywhere. Adoption of modern

harvesting technologies is not yielding agri-waste for fuel like before. However, in the over two decade time-span of this Policy, biomass cannot be overlooked and efficient cookstoves have to be included in the basket of solutions. Rural consumers will also stack cooking fuels, that suggests that an array of cooking fuels should comprise the national cooking fuel strategy, with accompanying supports. This strategy will also have positive ripple effects on public health, gender, livelihoods and environmental aspects of the country.

Box 3: Grid Integration of Renewable Electricity and More Efficient Grid Operation

Challenge of Grid Integration

Grid integration means minimizing and/or managing the variability and uncertainty aspects of Renewable Energy. Unlike fossil fuel based electricity that can be generated steadily, renewable sources like wind and solar cannot be made to generate on demand (or be shut down for later exploitation). The renewable-based generation may actually rise or fall suddenly (e.g. solar), or over seasons more predictably (e.g. wind), causing inconvenience to grid managers. Technically, Renewable Energy is described as an intermittent source of electricity, where intermittency consists of two distinct aspects:

- "Predictability/Uncertainty" refers to the lack of accurate knowledge about future Renewable Energy generation (e.g. sudden drop in solar power).

- "Variability" is the known natural variation in Renewable Energy generation (e.g., wind peaking during monsoon and reduced availability in other seasons), just as exists on the demand side currently (e.g., low demand at mid- night and high demand during late afternoon).

An Expert Group constituted by NITI Aayog has determined that meeting the 175 GW renewable installed capacity target by 2022, would not be as much a financial challenge as a technical one. Internationally — where Renewable Energy accounts for increasingly large shares of power system generation — various changes to grid design, technology, and its operation have been implemented that allow successful utilization of renewable electricity. Many of these strategies are inherently useful for improving the overall efficiency of grid operations and reducing overall costs to consumers, whether Renewable Energy accounts for a large (more than 25%) share of the generation mix or not. Some of these changes are one-time changes while others would evolve over time as load shapes and the resource mix continue to change. Some of the key strategies are summarized in Table 2 below.

Table 2: Renewable Energy Grid Integration and Efficient Grid Operation Strategies

Strategy	**Impact on Uncertainty**	**Impact on Variability**
One-time		
Upgrade grid technology	Minimize	Manage
Upgrade grid operation protocols	Minimize	Manage
Expand "Balancing Areas"	Minimize	Minimize and manage

Upgrade grid planning practices	Minimize	Minimize
Ongoing		
Balancing resources — estimation, procurement, dispatch	Manage	Manage

Strategy

In India, it is expected that in 2022, renewable electricity would comprise more than 15% of electricity generated in the country. The share is expected to be much higher in eight states — TN, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Gujarat, Rajasthan and MP. The challenge imposed by such high Renewable Energy share on the power systems, unless managed, would put-off grid operators resulting in impact on Renewable Energy absorption by the grid, thus impacting investors. The Centre and States would collaborate to address this problem in close coordination. In this direction, NITI Aayog has already created a twin coordination mechanism under the Vice Chairman and CEO, NITI Aayog, respectively, in partnership with Union Ministries and State Governments to coordinate the multiple efforts already under-way. The following strategy will be adopted:

1. ***Upgrade grid technology:*** System operators at all levels (i.e. state, regional and national) should have visibility of all the Renewable Energy generation systems in their areas, and grid status in neighboring balancing areas as well, and also the ability to easily coordinate with them.
    i. The capabilities of the transmission companies (i.e. central and state transmission utilities) and Load Dispatch Centers (LDCs) (i.e. POSOCO and State LDCs) will be upgraded by deploying sensors for generating real-time high geographic resolution data on grid conditions.
    ii. These data generation sensors will be coupled with sophisticated analytical engines that provide the necessary information for grid operations.
    iii. Centralized Renewable Energy forecasting mechanisms will be tightly integrated with system operations.
    iv. Advanced decision-making and control systems will be implemented that enable system operators to respond significantly faster to changed grid conditions.

2. ***Upgrade grid operation protocols:*** Various aspects of system operations will be updated. The following steps will be taken:

i. *Grid Codes:* System operators will update their grid codes to ensure that Renewable Energy additions do not affect the grid adversely, and to explicitly acknowledge attributes unique to Renewable Energy generators and, consequently, build-in appropriate capabilities so that Renewable Energy generation is not adversely impacted.

ii. *Scheduling and Dispatch:* Scheduling and dispatch will be upgraded from the current 15-minute basis. System operations technologies and protocols will be updated to enable five-minute scheduling and dispatch of all resources connected to the grid and automated incorporation of Renewable Energy forecasts. This will lower consumer costs and also lower ancillary service requirements.

3. ***Expand Balancing Areas:*** Larger balancing areas can help reduce variability by offering more balancing resources/demand, making it easier to manage. However, due to jurisdictional issues, regulation and management is currently being done at state level. A single national-level load dispatch center that is nonprofit, independent, and regulated by CERC would be empowered for managing the entire national grid as one, with appropriate markets and regulatory frameworks in place.

4. ***Promote flexible demand and supply resources:*** Power systems, especially those with a high share of Renewable Energy, require access to sufficient flexible resources (e.g., demand response, gas turbines, flexible thermal generation, hydroelectricity, etc.) to ensure continued stability of the grid at each moment.

   i. The amount of balancing resources needed and how these can be procured and dispatched will be ascertained through regular studies. Grid simulations will be conducted routinely to identify resource pools (both built and un-built).
   ii. Procurement mechanisms will be implemented to ensure these resources are connected for use in assuring grid stability.
   iii. Finally, mechanisms for fair price discovery and compensation of flexible resource providers (e.g. ancillary services) will be established.

Process

The above strategy will require coordination between multiple agencies at the central level, and similarly a number of actors at the state level. It is expected that the mechanism created by NITI Aayog may address this requirement. Typically, MNRE is in-charge of creating renewable capacity and is a client of the Ministry of Power that owns the grid. Then, at the central level, the CERC works independently to issue regulations, which will enable the grid integration. A key challenge is that most of the action need to happen at the State level, where power is generated and has to be evacuated and consumed. Therefore, the apex agency will need to bring the states and centre together. The following process is contemplated:

- Suitable provisions in the National Electricity Policy and Tariff Policy will enjoin upon the CERC/SERCs to issue regulations to enable the policy related interventions.
- CTU/STU will upgrade the technologies and make necessary investments to handle the intermittency through appropriate technical interventions.
- R&D will be supported for storage solutions at macro- and micro-levels for the discoms and individual consumers to address the challenge of variability.

- Different kinds of reserves (spinning and capacity) will be created and the costs socialized to provide the back-up power to help manage the variability.

Conclusion

India's zeal to step up renewable capacity has to be matched with capability to manage intermittency. The problem is aggravated by differential resource potential across states, which cannot be easily overcome by RPOs. Policy enablement will play a key role in development of balancing supplies. The government's financial support to transmission — inter- and intra-statal — will help in catalyzing capacity growth as well as grid balancing. In addition, a number of other steps as listed above, will have to be simultaneously taken. Flexible operation of thermal power plants – both coal and gas based – is likely to create a synergy between the conventional and renewable sources, rather than hostility. Even the stranded gas-based capacity may find a market for their power. In addition, a close coordination between generation and transmission will be needed, especially if India has to succeed in raising the share of renewable electricity yet higher by the terminal year of NEP — 2040.

Energy Supply

Fossil Fuel Based Energy Supply

Chapter 4

Oil and Gas

4.1 Because oil and gas are generally found jointly, policy discussions often focus on them jointly. Due to a number of differentiators, including carbon content per unit of heat, more gas availability and lower cost in calorific terms, today gas is preferred to oil. From global shares of oil and gas of 33% and 24% in energy consumption in 2015 respectively, the IEA estimates the respective shares of oil and gas to converge at 25% each by 2035. In India, the shares of oil and gas in energy consumption in 2015-16 were 26% and 6.5%, respectively. It is expected that in the medium term while the share of oil may not come down, share of gas would rise. A supportive regime for gas has to be put in place for the same to rise to 8-9**%** by 2040, which will translate into a large supply in absolute numbers. Table 3 provides the production potential of different fuels in India based on the present extent of knowledge of the hydrocarbons potential. The NEP proposes specific actions for oil and gas to achieve the stated objectives herein.

Table 3: Domestic Production Potential of Different Fuels in India

	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Coal (Mtce)	582	904	1006	1190	1385
Oil (Mtoe)	38	44	46	54	61
Gas (BCM)	48	46	53	95	124

4.2 Continued expected importance of oil and gas to the Indian economy underscores the need for a robust strategy for assuring supply. Previous policy statements did aim at increasing domestic production and reducing import dependence. However, while consumption of each has registered sharp increase, production has increased only moderately. From 2005-06 to 2015-16, oil production increased by 15% while consumption of petroleum products increased by 62% and, gas production remained static, though there was an upswing in gas consumption between 2009-12 due to gas supplies from KG D6 after which the production has been constantly declining, whereas the consumption increased by 38%. Consequently, India's import dependence and vulnerability to external price and supply shocks in energy domain has increased. In keeping with the overall Objectives of the NEP, robust policy interventions have to be made which will arrest the trend and enhance domestic production. The above scenario also calls for demand side interventions discussed earlier.

4.3 **Upstream**

4.3.1 India has nearly 3.17 million square km of sedimentary area, out of which only 19% has been moderately-to well-explored. In order to quickly appraise the entire sedimentary area, there is a need to offer geological data to the prospective Exploration and Production (E&P) companies. The Director General of Hydrocarbon will complete this appraisal by applying Oil Industry Development Board (OIDB) funds expeditiously. The sponsored data acquisition will be supplemented by multi-client speculative surveys.

4.3.2 As the National Data Repository gets commissioned, it will become possible to launch Open Acreage Licensing Policy (OALP). The terms for bidding for acreage under OALP will be finalized by the end of this financial year (2017-18) so that exploration can be intensified and the entire area can be awarded for exploration by 2022. In order to encourage bids, the terms will favour the first bidder for the available acreage.

4.3.3 There is a potential for opening up the upstream data business to the private sector by easing controls on data sharing. Even proprietary data ought to come into public domain after specified timelines. This will also help in improved success rate in exploration of areas in close proximity to discovered areas. The Government will release all geological and other technical non-proprietary data to specialist data companies, for use by research agencies and oil and gas sector companies for existing exploration and promotion of acreage.

4.3.4 A number of NELP contracts are in existence. But, as of March, 2017 only 19 discoveries have come into production. Many blocks with discoveries and unfulfilled exploratory commitment have come under stress due to two reasons - sub-optimal size of discoveries and violation of prescribed timelines. There is a need to monetise discoveries and intensify exploration in the awarded acreages that have come under stress by resolving the above two issues.

4.3.5 Out of the 26 sedimentary basins, only 7 basins are producing ones while exploration has not been initiated in 15 of them. In order to attract risk capital in exploration activity to the latter, a more attractive regime including ‘uplift’ which allows a multiple of the exploratory spend in cost recovery, may need to be offered. Hence, a differential fiscal exploratory regime will be developed keeping in mind the risk profile of the basin.

4.3.6 The existing NELP contracts provide for cost recovery for which an elaborate approval process exists which has been found to be unwieldy and irksome. Greater empowerment for quicker decision making, more transparency and standardized norms can alone provide the necessary expediency. Steps will be taken to provide for an efficient decision making apparatus.

4.3.7 The upstream regulatory regime and contract administration need to be separated for an arms-length administration of upstream matters. The former

function will be distanced from the Government and placed in a statutory body while the latter will remain with the Government. However, the latter needs technically competent advice, for which a specialist wing may be created out of the existing DGH on the lines of Central Electricity Authority (CEA) and Telecommunication Engineering Centre (TEC) in the areas of electricity and telecom, respectively.

4.3.8 The role of markets in determining prices, consumer categories/consumers, pipeline alignment and efficiency in capital expenditure will be enhanced. The new upstream contracts are already providing for above freedoms. Regulatory oversight and audit mechanisms are expected to address public concerns.

4.3.9 There is a need to migrate the existing hydrocarbons regime (both Nomination and PSCs) to the emerging framework of market-determined prices and marketing freedom. However, this cannot be done overnight and needs to be achieved in gradual phases. This is expected to remove the anomalous situation of multiple gas prices with the attendant legacy of gas allocation. Releasing cash directly on lines of DBT can meet the government's aim of subsidising farmers in the purchase of gas-based urea.

4.3.10 Upstream infrastructure is often a challenge for E&P companies especially for smaller finds and for discoveries in offshore and difficult terrains. The Government will issue guidelines for mandatory sharing of surplus infra on the lines of 'common carrier' downstream infrastructure. This will help in quicker monetization of smaller discoveries and make infra investments financially viable, too. Nearly 200 discoveries exist under the nomination and PSC regimes, which have not been put to production. These discoveries must be monetized or surrendered for re-cycling under OALP in the next 2-3 years.

4.3.11 Production from NOCs needs to be given special attention as they are holding older acreages, many of which are depleting. Looking to the fact that such nominated acreages are producing 68.4% and 73.5% (2015), respectively of India's oil and gas production, there is an urgency to encourage this segment. At the same time, there exists a potential to fully appraise these properties for tapping of the balance resources. The Government will encourage closer association of NOCs with private sector to rejuvenate the mature fields, and extract full value from them, too. New forms of contractual arrangements on risk sharing basis will be considered to achieve the above objective.

4.3.12 Induction of latest technology, improvement in the skill set of industry personnel, adequate supply of technical manpower of related disciplines, availability of service industry and eco-system of supporting private sector supplies call for an integrated collaborative strategy from the industry and Government. The NOCs will be encouraged to evolve new forms of alliance to access these technologies.

4.4 **Downstream**

4.4.1 At the end of financial year 2016, domestic refining capacity was nearly 25% higher than the country's demand for petroleum products. This surplus capacity is a high foreign exchange earner and assures us energy security. In recent years, from 2010-11 to 2015-16, the pace of capacity expansion was at a CAGR of 3.5%, against a CAGR of 5.4% in demand for petroleum products. India may become a net importer of refined products in the near future. Hence, there is a need for the Government to encourage capacity expansion and setting up of Greenfield refineries, preferably at coastal locations, through measures, including facilitating market access for new refineries. Further, support can be given to investors in the refining sector by resolving issues related to land acquisition and infrastructure. However, this expansion will have to bear challenges to liquid fuel demand from new technologies, especially EVs in mind.

4.4.2 Petrochemical sector is closely linked to availability of feedstock from refineries. A revamped coordinated strategy for integrated refinery-cum-petrochemical development along the coastline will be separately launched with a view to exploit the logistical advantage of imported crude supplies. This will also sit well with the Government's emphasis on '*port-led'* development of coastal regions.

4.4.3 Storage of crude and petroleum products has not grown in India in keeping with global practice, to assure crude supplies at times of supply disruption. Strategic stocks are available only for 5.33 MT against annual consumption of 183.5 MT of products in 2015-16, which is expected to keep rising. Stocking of crude and products is the norm in countries where market norms are the prevalent practice. The Government will encourage setting-up of 90-day consumption requirement of strategic and commercial storages, both for crude and petroleum products through innovative private investment strategies as has been successfully witnessed recently with Gulf suppliers for the Mangalore storage.

4.4.4 With rising integration of South Asia, greater inter-dependence amongst the countries of the region will be a natural outcome. The recently concluded SAARC agreement in 2014 on South Asian electricity grid is an example. The surplus refining capacity in North India and North East holds the potential for supplying neighbouring countries, which will be actively promoted by the Government. The role of pipelines and regional product demand and supply will be important for tapping the above market.

4.5 **Marketing**

4.5.1 Development of a vibrant gas market is the key to raising the share of gas in primary commercial energy mix. The Government has already declared its intention of transitioning towards a gas economy. Availability of domestic gas supplies, which is likely to grow only over medium term, cannot be the lone

strategy. LNG and gas supplies via pipelines from West and Central Asia need to be assimilated in our energy system. The Oil Marketing Companies (OMCs), whose primary business so far has been liquid fuel, have to recognize the role of gas and enhance their uptake of the latter. The Government will come up with a comprehensive strategy to encourage gas as a substitute for oil.

4.5.2 A large gas-based power generation capacity lies stranded due to inability of the power sector to pass-on the variable cost of generating power from LNG. If these plants could become operational, it would raise the utilisation of gas pipelines and LNG terminals, thereby boosting the share of gas in our energy mix. This may also assist renewable electricity, which is in the need of a balancing power supply. A concerted effort of Petroleum, Power and Renewable Energy Ministries is called for to exploit these assets. If necessary, the Government may extend purchase support to gas-based power on the lines of what was done to develop the wind/solar sectors.

4.5.3 On the lines of a normative petroleum product storage infrastructure, even gas storage will be required if consumers have to be assured of un-interrupted supplies. Depleted oil/gas fields of NOCs will be offered on competitive basis to interested gas marketers, both for strategic and commercial storages. This calls for a policy statement.

4.5.4 OMCs have done a commendable job in maintaining petroleum supplies throughout the country. The next step in this direction is to encourage competition by entry of private sector in a big way, so as to raise efficiency and consumer satisfaction levels. Even the prices of non-sensitive petroleum products, including ATF will become more reflective of movements in the international crude prices. The policy framework regarding creation of '*common carriers'* and access to marketing infrastructure will be liberalized. This will pave the way for Petroleum and Natural Gas Regulatory Board (PNGRB) to issue consistent regulations.

4.5.5 With a view to promoting LNG uptake, the provisions of '*open access*' and '*regulated tariff*' in the PNGRB Act need to be extended to gas off-takers at the LNG terminals. The Government will issue necessary policy guidelines for the same.

4.5.6 In order to increase the penetration of natural gas, a National Gas Grid would have to be rolled out throughout the country and VGF support would be extended to the stranded gas pipelines towards achievement of the above goal. Further, the pace of award of City Gas Distribution (CGD) licenses will need to pick up to distribute piped natural gas throughout urban India. Looking to the long-term commitment of funds in creation of this infrastructure, attractive investment terms may be offered. In this direction, the Government will issue appropriate policy guidelines for compliance by the PNGRB. This will be done on a priority basis since substitution of liquid fuel by natural gas is the key to curbing emissions while sparing LPG for smaller markets in the rural areas.

4.5.7 Availability of petroleum products in rural areas needs to be enhanced for supply of clean cooking fuels on a sustained basis. The role of private traders in connecting these areas needs to be tapped by easing the licensing regime for petroleum trade. This is likely to lead to innovative marketing practices such as bottling of LPG in varying volumes, introduction of a variety of payment terms and retail practices, suited for such markets. This will give long-term stability to PMUY.

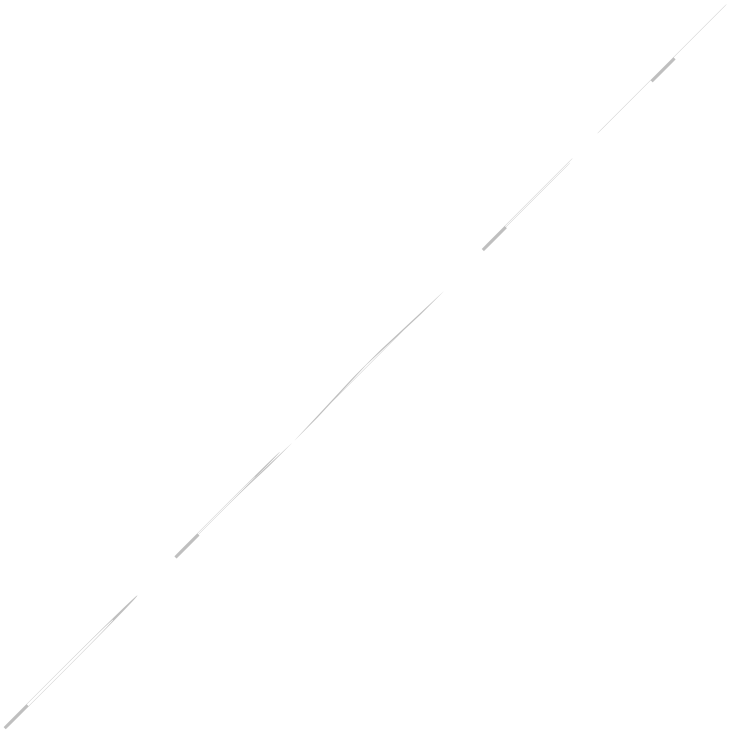
4.5.8 The appropriate use of kerosene in the energy system has to be appreciated. Its use as a cooking fuel is marginal as compared to lighting, especially in rural homes, which can easily be substituted by solar lamps. However, malpractices in its distribution, primarily due to price differential with other fuels, result in leakage of public finances and harm to transport sector. The Government will erect an efficient DBT based kerosene subsidy administration system, aimed at appropriate target—consuming sector and consumers, while restricting diversion.

4.5.9 Pricing plays a major role in petroleum sector. Having assured international prices of crude to upstream producers, consumer prices of both oil and gas must reflect market determined prices. At present, these fuels are unable to compete due to policy-induced price and tax distortions. One example of the latter is import duties on LNG, which discourages the use of a clean fuel vis-à-vis crude oil. Then, there are multiple prices in several commodities owing to duplicate channels of distribution, one through the subsidy route and second via free market channels as seen in LPG and natural gas. The above anomaly ought to be rationalised and DBT may be adopted to address the needs of subsidy disbursal, thereby doing away with the dual pricing regime. The Government will put in place a comprehensive pricing policy to encourage oil and gas production both from existing and new fields, and adequate returns along the value chain, by removing distortions both between petroleum products and with other fuels.

4.5.10 Wider consumer choice, based on competitive prices is the goal of efficient markets. It is expected that electricity, gas, liquid fuels including LPG, will witness greater competition across consumption sectors than before. The two most significant consumer needs (after lighting), transportation and cooking, will be the first candidates for inter-play of market forces, which will be reinforced by technological advancements in areas of Electric Vehicles and induction cooking. The Government will encourage these developments by removing distortions in pricing and taxation, and encouraging trade and creation of related infrastructure.

4.6 Petroleum sector can play the role of a multiplier in many sectors of our economy. In this section we discussed those aspects of this sector, which have relevance to meeting the energy related objectives of our country. In the above process, there are several other impacts on our economy, which call for a balanced view in taking decisions. Oil sector taxation has a major role to play in bolstering up Union and State finances, including on sharing the rents. Fiscal levies also serve environmental objectives by serving as the proxy for congestion and air pollution in road transport. Our large

energy imports (mainly of oil and gas) have anchored our economic relations with many countries, including the two super-powers. Our NOCs contribute a large share of the value of our capital market, and their re-organisation decisions have large implication on stock exchanges. Looking to the above, a robust inter-ministerial co-ordination mechanism could go a long way in advising the Petroleum Ministry in decision-making and implementing them, too.



Chapter 5

Coal

5.1. Amongst fossil fuels, India is most well endowed with coal. Approximately 7% of the world's proven coal reserves are located in India, which enhances its stature amongst the basket of fuels. Additionally, coal is important to us for other reasons — large thermal power capacity, a large employer and negligible price volatility. The large power requirement and solid fuel demand in process industries brings to fore the need for efficient coal exploitation, investment in related infrastructure, and a forward-looking regime. The large planned new coal based thermal capacity is likely to put pressure on coal resources. Coal based power generation capacity of 125 GW in 2012 is likely to go up to more than 330-441 GW by 2040 (192 GW in FY 2017). The demand for these plants is likely to be first met by domestic coal, which will require quick exploitation of our reserves. As per assessment, at high rates of coal demand, domestic coal supplies may plateau by the year 2035. (Figure 2). All the above call for fuller coal resource assessment, optimum mining, efficient use, and appropriate reckoning of the role of coal in our energy mix.

Figure 2: Trend of domestic coal production in India

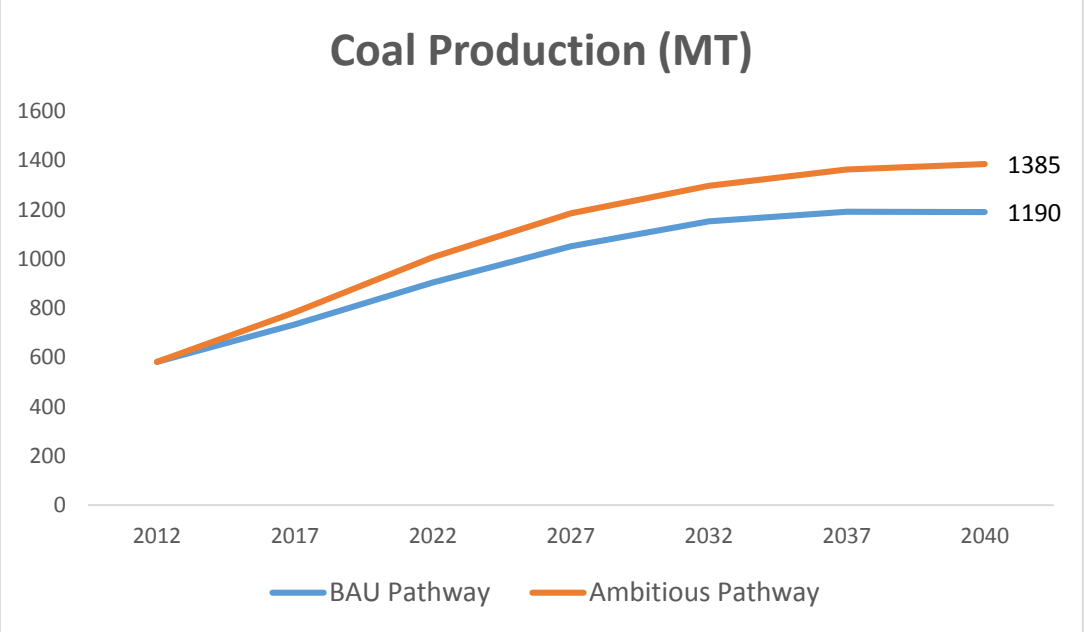


Figure 1

Source: Derived from IESS

5.2. The share of coal in India's commercial primary energy supply was 55% in 2015-16 and is expected to remain high at 48-54% in 2040. Imports contributed 25% of the supply in 2015-16, and could remain high unless domestic production grows rapidly. The thrust of the NEP will be on interventions required to optimally exploit our coal

resources, while addressing the overall environmental concerns related to coal mining. Sustained levels of high domestic production would greatly advance India's energy security. Coal gasification technology and methanol economy also hold value for India to commercially tap our coal resources. In the instant discussion here, we recommend measures, which directly relate to enhancing coal production, optimum use, and efficiency in use (high efficiency, low emission).

5.3. While the role of coal in India's energy future draws mainly from the long history of coal in India and abroad, the electricity markets of the world including India are being shaken by falling costs and rising efficiency of renewable technologies. Experts agree that once the costs of supporting technologies such as battery storage (already falling at the rate of 10% per year) make the cost of variable renewable power viable, coal based power will phase out. This makes the task of projecting the demand for coal difficult. In FY 2017, the addition of conventional power generation capacity in India was surpassed by addition in the renewable sector. The NEP proposes that different fuels are allowed to compete for market and administrative directions to invest or not invest are not given. At present, CIL is making a yearly investment of nearly $1 billion to augment capacity to meet the target of 1 billion tonnes of coal production by 2019. For this investment to be viable, coal-based power capacity must gradually rise to double from the present. It would be desirable that while facilitating the policy and fiscal regimes for coal production in India, we allow decisions to be made on the basis of market cues.

5.4. **Production**

5.4.1 Coal India Ltd (CIL) is expected to remain the principal vehicle of coal production in the country in the immediate future. It has to strive hard to achieve the target of 1 billion tonne production by 2019. However, with subdued demand for coal, we may not require the production level envisaged above. A careful assessment of demand for coal-based power is needed so that the over $1 billion annual investment being made by CIL, in raising its production capability is not left stranded. Looking to the fact that power demand is growing only at 5% per annum presently, the coal sector is allowed to respond autonomously rather than pursue a target-led strategy.

5.4.2 The issue of meeting full coal demand of the power plants with FSAs needs to be resolved so that these plants are able to receive their full coal demand, and raise their PLFs. CIL will prioritise its allocation to these power plants.

5.4.3 The concept of 'pass-through' of coal price in power sector whereby coal is supplied to power companies at subsidized rates compared to the market price so that they may sell electricity at subsidized prices

does not encourage efficient mining, and is also responsible for low productivity of coal in CIL. A change in present policy is required to move towards market pricing.

5.4.4 The pursuit of raising overall coal production will require an integrated strategy including for licensing commercial mining, appropriate pricing and attractive returns over investment. The above will have to be dovetailed with adequate transportation for evacuation of coal and setting up of coal washeries. The environmental guidelines on coal quality will keep tightening, calling for washing/blending of all coal to meet the ash content specifications. An appropriate commercial model alone can attract such investment, which is determined by a coal market.

5.4.5 The present coal regime in India continues to be a historical relic. While most other sectors of the economy have evolved to adopt free market principles, beyond the adoption of auctioning of mines, coal sector has remained untouched by liberalizing reforms. In 2015-16, the total supply of coal was 840 million tonnes. Of this, 540 million tonnes was supplied by the seven subsidiaries of CIL. Singareni Collieries Company Limited (SCCL), jointly owned by the Government of Telangana and the Government of India, supplied another 60 million tonnes. Of the remaining 240 million tonnes, imports accounted for nearly 200 million tonnes and private companies for 40 million tonnes.

5.4.6 On the demand side, coal users include generation companies that receive coal under old long standing Fuel Supply Agreements (FSA), generation companies that buy coal through reverse auction, independent power producers, captive power producers, other industrial coal users and some small retail consumers. Beyond a small e-auction market, our coal economy is run almost entirely through administrative allocation. There exist multiple prices associated with the allocations and the methodology of fixing coal prices is arbitrary. Coal India Limited charges prices that are significantly higher than the implicit cost of mining by the Independent Power Producers (IPPs). Given its monopoly on coal, CIL is able to pass higher costs to coal buyers and thus has no incentive to contain costs.

5.4.7 In the medium to long run, it is essential that we move away from this opaque coal economy and introduce greater competition in it. This requires two key steps. First, we must corporatize the seven subsidiaries of CIL into independent companies and allow them to compete against one another in an open coal market. Second, progressively fresh production from new mines ought to come from private sector. This will call for comprehensive reforms in allocating

coal blocks on commercial lines to independent companies specialized in coal mining. These two steps will replace the current system of administrative allocation of coal by a vibrant coal market with prices performing the function of allocation. The resulting competitive pressure will foster efficiency and bring about substantial reduction in coal price. It is entirely conceivable that our coal industry will emerge as an exporter of coal.

5.4.8 A possible downside of market-determined coal supply may be its potential adverse impact on electricity price paid by vulnerable customers through an increase in the price of coal paid by generation companies. Our assessment is that reductions in coal prices due to increased efficiency and competition are likely to lower rather than raise the price of coal for generation companies. But even in the unlikely event that the price of coal for generation companies rises thereby necessitating a temporary rise in their sale price of electricity, we must protect the vulnerable electricity customers through direct benefit transfer (DBT). Our ultimate objective is to provide electricity at low prices to vulnerable customers and this can be done more efficiently by giving the subsidy to the latter through DBT. Achieving the same goal indirectly through the provision of subsidized coal to generation companies creates unnecessary inefficiency in the production process.

5.4.9 The installed coal based generation capacity is expected to grow to 330- 441 GW by 2040. This is likely to translate into a coal demand of 1.1-1.4 billion tonnes. The known levels of proven coal reserves (138 billion tons as of 31.03.2016) may only be able to support an annual peak production of 1.2-1.3 billion tonnes till 2037, with a gradual decrease thereafter. This fact calls for intensifying exploration to enhance the proven coal reserves. Multiple institutions such as GSI, CMPDI and IBM are responsible for exploration of coal in India. There is a need to synergise the efforts of all these agencies to undertake 100% resource mapping of coal.

5.5 **Interim Measures to Achieve Transparency in Pricing**

5.5.1 The reforms to create a genuinely open and competitive coal market as described above will take some time. Therefore, in order to address the immediate concerns, there is need for determining the price of coal in a more transparent manner, the procedure of which would be in the public domain. Moreover, the practice of differential pricing by CIL, wherein different prices are charged to different category of consumers needs to be dropped with

buyers competing for coal. In the coming years, power demand of the country will be met by multiple energy sources and efficiency requires that market forces determine their shares. This calls for market discovery of coal price and pricing of electricity by generation companies based on genuine costs. Any fear of a rise in price to vulnerable customers should be addressed by subsidy on power use through Direct Benefit Transfer (DBT). Distribution companies should pay full market-determined price to generation companies and receive the same from customers with the latter compensated through DBT.

5.5.2 Allowing the market to determine the price of domestic coal will also help eliminate inefficiencies arising from administered prices of domestic coal vis-à-vis imported coal. As long as the delivered price of domestic coal is lower than that of imported coal, no imports would take place. Imports will only come up to the point that the delivered import price equals the delivered price of domestic coal. This will also ensure that at the margin the costs of electricity produced from using domestic and imported coal are equal.

5.5.3 In the immediate future, the issue of coal supply to 'stranded' power plants must be addressed on priority so as to gain benefits from the investment already incurred. The extant statute is being invoked to ensure coal linkages for stranded assets as the first recipients. In the case of power supplies under long-term agreements, the principle of 'pass through' of cost of coal from mines acquired through auction may be maintained. This is required as per the law. However, for sales of coal to other customers in electricity generation and other industries, coal may be sold at market prices.

5.5.4 The Government has already come out with a policy whereby mines have been allotted to state governments. The latter are to supply coal to non-regulated sectors through coal auctions. While this is an improvement over the current system of administrative allocation of coal at administered prices, it is important to remember that the state governments need not have the best expertise in coal mining. It is important that coalmines are auctioned at commercial terms so that we get the benefit of the most efficient mining technologies. In this respect, the proposals for the introduction of commercial mining are a welcome step.

5.5.5 The current practice of reverse bidding whereby generation companies offering to sell electricity at the lowest price are awarded coalmines at below competitive prices also undermines efficiency. This process once again results in subsidized price of coal for generation companies provided the latter pass on the subsidy to electricity customers. As already discussed, healthy development of the coal sector requires that we give the subsidy directly to intended beneficiaries instead of inputs along the production chain.

5.5.6 The UMPP policy calls for a tie-up between the coal and power sectors. In order to facilitate grant of multiple regulatory permissions, and provide essential inputs such as land, coal and water available to the proposed large coal based power plants, the Government has launched 'plug and play' policy. As already discussed, we must move away from the linkage and provide coal on the basis of market price instead of the reverse bidding process. This will also sit well with promoting coal production by offering attractive price to CIL.

5.5.7 The present policy of reverse bidding has the further drawback that it results in a loss of royalty income to coal bearing states. Realisation of market price by states would lead to a rise in power prices, but higher accruals to the state governments through royalty payments. The extra revenues so earned can contribute to DBT transfers to vulnerable electricity customers.

5.6 **Other Interventions**

5.6.1 The potentials of exploiting coal bed methane (CBM) and in-situ gasification of non-producible coal (Underground coal gasification or UCG for short) have not been exploited satisfactorily in India. The mandate for exploiting CBM should be placed fully within the domain of the Ministry of Coal, principally because the efficient concept of unified licensing policy demands that even CBM and coal ought to be commonly licensed. Due to the large volume of coal resources that cannot be exploited due to poor quality and other reasons, the prospect of tapping UCG is immense. Similarly, other value-added outputs such as methanol/DME can also be produced from coal. A Committee may be appointed under the chairmanship of Member (S&T), NITI Aayog to develop the technology roadmap for gasification of coal and tapping coal by products such as methanol and DME.

5.6.2 Third Party sampling has been introduced by the Government to test the quality and quantity of delivered CIL-supplied coal at the consumption end. But further improvements are required in this regard. In particular, Railways, which transport coal, need to be party to this arrangement.

5.6.3 Opening up the coal sector to encourage commercial mining and move towards market-determined prices, can only succeed if decision-making is at arm's length. This makes the need for an independent statutory Coal Regulator even more acute. The Government must appoint an independent Coal Regulator for healthy and comprehensive development of this sector at the earliest. At the appellate level, the responsibility may be given to the existing Electricity Tribunal.

5.6.4 The link between coal mining and adverse local environmental implication calls for efforts to mitigate the ill-effects. The Government has already announced a robust agenda for sharing of the sovereign income from the coal sector with the local bodies and communities for adequate safeguarding of the eco system. The Government's announcement in 2014 forbidding power plants situated beyond 500 Km from coalmines from using coal with more than 34% ash content is a step in the right direction. It is proposed to further raise this bar in the future so that the fallout from transport of ash is minimized and the subsequent problem of ash/slag handling at power plants is avoided.

5.6.5 Mine developers and operators (MDOs) are likely to play a critical role in coal mining, especially in the private sector. The MDO contract must be drawn up with care so that it does not lead to disputes and issues of interpretation, hampering the growth of coal mining. With the opening of the coal sector to private mining and trade, dedicated coal mining companies may also be expected to enter this business.

Non-Fossil Fuel Based Energy Supply

Chapter 6

Renewable Energy

6.1. With rising maturity of renewable energy technologies, aided by decline in their costs and upon environment considerations, the Government has already articulated its decision to boost Renewable Energy capacity. While a cumulative capacity target of 175 GW has been declared for the year 2022, by 2040 a likely capacity of 597-710 GW is expected to be achieved. However, no targets are proposed beyond 2022 as the growth is expected to take place autonomously. The above capacity will translate into 50%-56% and 29%-36% Renewable Energy (excluding large hydro) capacity in installed capacity and generation from all power generation sources by 2040, in place of 14% and 6.5%, respectively in 2015-16. The period 2017-2040 will, therefore, witness a transformation in the electricity sector of India, calling for policy action across the entire value chain of generation, transmission and distribution.

6.2. The Renewable Energy policy has to be a subset of the larger electricity sector policy. In the NEP, we are merely considering measures that are required to ensure that the large envisaged Renewable Energy capacity integrates well with the electricity system (See Box 3). In this regard, electricity markets are now expected to take over the role that Government subsidies have played so far. The sharp reduction in tariffs received in bids for solar and wind power points towards two aspects – exposing these technologies to market discipline, and also the need to now address other lagging renewable sources such as hydro and biomass. On markets, as renewable technologies mature, they ought to support transmission and balancing concerns on their own. Therefore, the NEP proposes gradual withdrawal of the provisions of 'must-run' status and other supports such as non-levy of inter-State transmission charges. It is envisaged that as consumers become agnostic to the source of power, renewable energy will soon blend with conventional power and markets will determine dispatch rather than policy levers.

6.3. Large Hydro-Power

6.3.1 While proposing policy action, the common issues of the two major Renewable Energy sources – solar and wind – are in primary focus. However, the importance of other Renewable Energy sources is also well recognized. Large hydro-power can play a key role in balancing variable electricity due to its ability to store water in comparison with small hydro power, which are essentially run-of-the-river projects. There is merit in supporting hydro capacities larger than 25 MW as well, which are presently not covered under the category of Small Hydro-power (SHP). As the issues of the hydro sector are different from wind/solar technologies, dedicated attention needs to be given to former. Despite India being endowed with a large potential, this sector has been rather slow in delivering power to the nation, and the share of large hydro in the electricity mix has fallen from 12% in 2002 (at the end of the

IXth Plan) to 10% in 2014-15. Arunachal Pradesh alone is touted to have a potential of 50,000 MW of hydro-power potential of which only 98 MW has been developed till March, 2016. Experience tells us that R&R are not the only reason, though a major one, for poor development of hydro resources.

6.3.2 This source of power has a large number of co-benefits including containment of flood, irrigation, fishery, ground water-charge to name a few. There are adverse consequences, too, which call for quality research at the stage of project development and provision of funds for implementation of safeguards. It is envisaged that the Central and State Governments will cooperate in reorienting the current hydro-power strategy for course correction. A salient part of the above will be financial rehabilitation of the on-going/stranded large hydro projects so that the funds already invested in them can be put to good use. The Government will consider a rehabilitation package for revival of the stranded hydel projects. The project life of hydro projects will be considered for a longer time frame (60 years instead of the present 35 years), which will enable them to access long term financing. Among other lessons, the successful implementation of Indian Government projects in Bhutan is a good example to emulate for the proposed new strategy.

6.4. The following measures will be initiated for a healthy growth and smooth integration of renewable sources of electricity in the Indian electricity system:

6.5. **Financial Measures:**

6.5.1. In the case of technologies that need financial support to compete with conventional power, Performance linked incentives that do not involve upfront payment but encourage generation, will be promoted. Incentives like deferral of tax (accelerated depreciation subject to provisions in the proposed GST) appear to be appropriate tools over other measures. Capital subsidy needs to be phased out and feed-in tariffs ought to drive growth of Renewable Energy. It is evident that in the short run, without RPO compliance, the growth of this sector will be slow. Over time as the cost of these technologies fall, there may be a balanced regional growth of these sources. Once markets drive renewable energy autonomously, there may be no need to enforce RPOs. This would also result in renewable energy shares differing across the States.

6.5.2. The level of tariff support, until necessary, will be determined on the basis of marginal cost of power, which has so far been imported coal based power. However, for off-grid solutions including stand-alone systems, the support level will be calculated on the basis of average cost of supply (ACS) from grid-based solutions. It has already been established that competitively derived prices (both for wind and solar) are ideal for determination of the level of support and also to drive them down.

6.5.3. It is recognized that due to inherent qualities of lower cost via economies of scale and ability to meet varying demand for power, grid based electricity is preferable to renewable solutions. Therefore, efforts will be made to first electrify villages by extension of grid. However, small size of habitations and remote locations, often render grid-based solutions unviable. The electrification of such habitations will not be postponed until grid reaches, and in the short run off-grid solutions will be provided.

6.5.4. Renewable Energy Service Companies (RESCOs) can provide capital, technology and maintenance support to the Renewable Energy sector, particularly, in the case of roof top segment. The Government will issue appropriate guidelines for ensuring satisfactory technical standards, model contracts and payment assurance for the RESCO business model.

6.5.5. The present financing models are placing all the cost of balancing the intermittent renewable supply on the DISCOMs. Tools such as RPO and REC impose a large burden on the latter. The Government will develop suitable financing mechanisms to support them, including building it into the prices of renewable energy, in meeting the difference in the true cost of supply between conventional and renewable supply.

6.5.6. With increasing deployment, while renewable generation technologies have become cheaper, but due to remoteness of sites, the cost of developing local infrastructure and evacuating power continues to be high. The Government will endeavor to support the non-generation segments of this business through facilitation and engagement with state agencies. Due to the long gestation period of Renewable Energy, financial support for the above segment may be needed in the short term. Ultimately it is expected that infrastructure development would be able to come up on its own.

6.6. **Renewable Energy for Energy Access**

In many situations, Renewable Energy based mini-grids and micro-grids offer viable, clean and efficient solutions. They have, however, been given residual role in our electricity programmes. In those habitations where grid-based solutions are found unviable, appropriate enabling environment for mini-grids/micro-grids needs to be created, especially to allay the fear of investments being rendered a waste when the grid reaches the habitation. It is also a reality that rural areas suffer the brunt of shortage of electricity at peak hours of consumption. Micro-grids supported by storage solutions can be handy, even in grid-connected villages, to meet the peak load demand, particularly of small businesses. Biomass-based power can serve multiple interests. They are flexible enough to provide back-up, can meet the local power need and also prevent air pollution by avoidance of stubble burning which has

assumed menacing proportions in North India. The NEP advocates framing of a Bio-energy Policy that encompasses all forms of biomass-based energy (solid fuel, first/second generation biofuels and gasifying biomass). The present strategy of promoting ethanol and biodiesel admixtures in liquid transport fuels will be continued, even while the Government's recent focus on augmenting the supply of ethanol through 2nd generation technologies will be pursued vigorously.

6.7. **Role of State Governments**

6.7.1. Renewable Energy has multiple downstream effects on different stakeholders. There is a need to address the technical, commercial and quality of power supply issues. The distribution companies need to be reassured that roof top solutions do not pose a commercial threat to them. The State Governments will be encouraged to set prices in net-metering solutions in a manner that balances the interests of consumers and discoms.

6.7.2. The State Governments have a major role in development of Renewable Energy as both local infrastructure and purchase support, can only be provided by States. As far as the Central Government is concerned, it will support the state agencies and not directly engage in generation element. The collaboration to promote transmission systems (Green Corridors) is a good example of the kind of support being given. The national agencies such as SECI, IREDA and government R&D institutions will continue to provide various kinds of support such as channelizing funds, providing project execution know-how, and power purchase/payment assurance.

6.7.3. So far, Renewable Energy sources have seen concentrated development in resource-rich regions. Consequently, sale of this energy to other parts of India has posed a problem. While falling costs will reduce the unattractiveness of this source of energy, however, the grid instability concerns will continue to pose a challenge for concentrated development of Renewable Energy. Therefore, efforts will be made to promote generation by ensuring compliance of RPOs. This also holds the clue to financing needs of this sector as RPOs can easily ensure growth of Renewable Energy by blending it with conventional power. It is also hoped that with steady reduction in prices of wind/solar, States will become agnostic towards renewable power and there will no longer be any need to pursue any targeted growth.

6.8. **New Technologies**

6.8.1. Smart grids have already been taken up on pilot basis in the country. Now, this technology will be rolled-out across the country so as to provide an efficient electricity distribution system, which also supports Renewable Energy. Appropriate technology solutions may be needed if RE has to drive

the electric vehicle agenda. Along with adequate equipment, even institutional and staffing arrangements will need an upgrade. There is a need to set up Renewable Energy Management Centres (REMCs) in all States to handle issues arising out of variable renewable electricity.

6.8.2. Renewable Energy can also be generated from off-shore locations for which a National Off-shore Wind Policy has already been announced in 2015. Similarly, floating solar panels on reservoirs, lands held by government institutions and public buildings (including government housing) may diversify generation, and ease stress on land. Islands, hilly areas and remote locations ought to be the prime candidates for application of off-grid renewable sources of electricity supply.

6.9. **Development of an Enabling Ecosystem**

6.9.1. Rooftop solar has vast potential across different categories of consumers, both for power generation and supply of heat. It has also been estimated that this technology is already viable for commercial and industrial consumers. Even in urban areas, rooftop solar has become cost effective especially in higher tariff slabs. However, subsidized tariff for domestic consumers creates a dis-incentive for adoption of roof-top solar and calls for subsidy support. A vibrant solar related eco-system needs to be developed to meet customer demand, and offer satisfactory services for these technologies to achieve a mass adoption. This is all the more essential if the target of achieving 40GW target by 2022 from non-grid connected solar is to be achieved.

6.9.2. The large Renewable Energy programme will require land, which is a scarce commodity in many States. It will, therefore, be essential to promote mega solar power plants only on wastelands and non-agricultural tracts. However, in order to achieve a wide dispersal of Renewable Energy and also to maintain grid stability, generation ought to be brought close to consumption centres, as far as possible. For this, small sized solar plants (up to 50 MWp) need to come up across the country in rural areas especially at the end of the transmission lines. This will reduce the size of plots, which ought to be purchased on commercial basis, and will not be dependent on state intervention in making land available. The co-benefit would be lesser challenge to grid integration.

6.9.3. Over and above the grid/off-grid power generation potential, multiple applications of Renewable Energy in domestic, commercial and industrial segments also need to be encouraged. These applications can address energy demand for water heating, air conditioning, cooking, lighting, pumping etc. and supplement energy supply. The deployment of such applications will require innovations in our own country. The Government will encourage the same through appropriate measures, including purchase support. As Heating

operations consume nearly 50% of the energy consumed in Industry, solar applications have a large opportunity.

6.10. Storage and Backup Solutions

In order to counter the intermittency in supply of renewable energy, there needs to be a push towards integrating the same with gas based power plants and the development of storage technologies. A healthy backup capacity will ease consumer anxiety and help renewable energy find a place in the market. Appropriate technology to introduce flexibility in coal-fired power plants will also be encouraged. However, looking to the stranded gas-based capacity, the Government will first endeavor to deploy these capacities. One option could be only to contract future renewable power blended with balancing capacity so as to provide steady supply. As the cost of wind/solar-based power has come down, blending the same with even LNG based balancing supply could be supported under the existing financial support schemes of SECI/State Governments. This will be in the fitness of things so as to de-risk the DISCOMS from having to arrange back-up/balancing supply. A scheme to give feed-in-tariff to the existing stranded gas based capacity will be launched to address the balancing issues of renewable power. The above measure can help in salvaging the existing gas based capacity and also reduce the challenges that come with variable renewable energy. Another related emerging technology is of Electric Vehicles that can also double up as a storage device. Suitable application of time-of-the-day tariff mechanisms will be applied to encourage EVs to store-up renewable energy when it is available in excess of demand.

6.11. The steep rise in the share of Renewable Energy in the electricity mix will call for a number of measures to adapt the grid. The measures listed above are expected to allow integration of this variable and seasonal electricity source, by addressing both commercial and technical challenges. Diversified geographical and distributed generation helps in addressing the above challenges in a cost effective manner. NITI Aayog will offer a platform to bring the Central Ministries and State Governments together to solve the inter-agency issues related to integration and growth of Renewable Energy in the country as per the Renewable Energy Integration Roadmap 2030.

Chapter 7

Nuclear

7.1. In order to meet the large energy demand of the country, India has rightly been consistent in its approach of promoting all sources of energy. On nuclear power, while several countries have recently had a rethink, India has steadfastly seen it as an important contributor to its energy basket. While India is richly endowed with clean sources of energy, the intermittent nature of renewable energy sources of solar and wind limits their share of energy mix. Nuclear energy, being the only base load power source offering green energy, needs to be promoted even if its share in the overall mix is not high enough now. Further, the development of Fast Breeder Technology enables exploitation of a large part of the fuel energy through closed fuel cycle, thus offering large sustainable energy sources for many centuries. We have had an enviable safety record in operating nuclear power plants for nearly five decades and in the light of recent experiences around the world, we have further upgraded our safety systems. In the recently concluded NDCs, India has indicated its intention to ramp up nuclear power capacity tenfold by 2030 to 63 GW. In the light of India's bold ambition, the National Energy Policy offers the strategy to achieve the target set for the country.

7.2. India has an installed nuclear power capacity of 6,780 MW (2016-17), which contributes to over 3% of total electricity generated. Construction of additional nine reactors is in progress, which will ramp up the nuclear capacity to 13,480 MWe of power. In addition, the government has approved an additional 10 PHWR reactors of 700 MWe each, which will give a boost to the domestic nuclear industry. Two more reactors of 1000 MWe each have also been approved for construction at Kudankulam, thus taking the total capacity to 22,480 MWe by 2030. Even though the nuclear contribution is not high at this stage, however this lays a solid foundation for the rapid expansion of nuclear power addition through fast breeder reactors. The collaborative projects to install LWRs with US and France are going slow due to various reasons, even after the India-US accord of 2008.

7.3. **Clarity is needed on the following fronts:**

7.3.1 Economic viability

Nuclear power plants are comparatively capital intensive and the focus on safety has further increased their cost. Imported Natural Uranium is cheaper than domestically mined Uranium because of rich concentration and availability at shallow depths abroad. Fuel cost is relatively small component of the overall LCOE and is only a small fraction of fossil fuel cost. Besides, nuclear reactors have substantially longer life compared to other power plants and are quite cost effective when viability is considered over the lifetime of projects. There is continuous increase in the fuel costs in the case of fossil fuels, whereas the effect of fuel costs remains insignificant in the case of nuclear power. Hence, while the nominal cost is initially higher on LCOE

basis, this source of electricity is able to compete with fossil sources. The older plants in India are providing some of the cheapest power to grids, which makes a strong case for this technology. However, large initial capex appears daunting, for which a stable and investor friendly regime with private capital involvement appears feasible, for which a change in statutory regime will be required.

7.3.2 **Technology**

India had publicly declared a three stage programme – with a combination of Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactor (FBR) and Thorium based one. The above strategy was a direct outcome of limited domestic Uranium availability. At some point of time, it was concluded, India has limited uranium reserves (which serves as the fuel for the first phase technology) but abundant reserves of thorium. However, with stepped up uranium exploration activity, the scenario is changing fast and NEP rightly proposes to expedite the exploration and mining of uranium reserves in India which will help in the growth of the first stage reactors. The PHWR technology has reached a level of maturity and the pace of expansion of the first phase sets the stage for quick growth of second stage reactors, which mainly depends on the reprocessed fuel from the discharged spent fuel of the first stage. Our ability to import uranium in the recent years has already boosted the PLF of power plants.

India is one of the few countries interested in the development of Fast Breeder Reactors, for multi-fold increase in capacity creation through uranium-plutonium route. The entire technology involving design, construction & operation of the FBR and all the associated technologies for closing the fuel cycle such as reprocessing, fabrication of fuel and waste management were developed indigenously. These technologies could be made possible with the experience gained in the operation of test reactor for over 30 years and generated the confidence to launch the first commercial breeder reactor of 500 MWe, which is likely to go critical in 2017. The second stage has a potential of over 500 GWe electrical power base, supplying energy for few centuries. LWR programme with foreign collaboration is being pursued for increase in nuclear capacity in the short term taking advantage of foreign credit.

As thorium is not a fissile material, it cannot be used in reactor for production of power. So, thorium will be deployed for power production only towards the end of 2nd stage of nuclear programme. Till then India; a lead country in thorium R&D; will pursue R&D in thorium technology and establish demonstration scale facilities.

7.3.3 **Liability**

The issue of civil nuclear liability has assumed significance after the Fukushima disaster in 2011, which resulted in large human and economic costs. Our plans of attracting investment in this sector call for a fair distribution of liability between the nuclear technology supplier, operator and the Government. This issue has recently been sorted out by the newly introduced provision of the operator taking out an INR 1500 crore (~$220 million @1=INR 68) insurance. Suppliers' insurance policy is also in place. It is expected that the above will allay the fears of the suppliers, as even in the coming years, the underlying principle of the operator taking care of a

threshold level of liability will continue. This is expected to strike a fine balance between all the stakeholders. India has deposited its instrument of ratification of the Convention on Supplementary Compensation for Nuclear Damage (CSC) for adoption to provide an international framework.

7.3.4 Public confidence

India has nearly five decades of operating experience with nuclear power plants (over 400 reactor operating years) with an enviable safety record. This has emboldened the Government, both at the Centre and in the States to pursue this source of power. However, so far, the Government has itself been the operator through public sector companies. If private sector is encouraged to set up these plants, there will be a need to assure the same level of public support and confidence building amongst the local communities. The establishment of Nuclear Safety Regulatory Authority will go a long way towards fostering such confidence.

7.4 Strategy

7.4.1 India needs to fast-track nuclear power to meet India's growing energy needs. Government of India has taken note of Department of Atomic Energy's action plan for accelerated growth of nuclear power. To start with, budgetary provision has been made for providing to the extent of INR 3000 crores/year. The Atomic Energy Act has been modified for forming joint ventures between non-DAE Indian PSUs and DAE PSUs like Nuclear Power Corporation of India Ltd. Presently, participation of private sector and foreign suppliers in nuclear arena is restricted to construction activity only and Atomic Energy Act will need major modification for them to be involved in operation/ownership of nuclear plants.

7.4.2 Present regulator, Atomic Energy Regulatory Board (AERB) functions independent of operator, Nuclear Power Corporation with Department of Atomic Energy as the administrative ministry. AERB, operating in a scientific atmosphere, has technical support from world's biggest pool of highly qualified scientific and technical manpower and has maintained highest safety standards in the world. Nuclear Safety Regulatory Authority Bill is under consideration of Government.

7.4.3 The designs of indigenous PHWRs, FBRs and imported LWRs are standardized, time tested and are the promising nuclear technology options in the long run.

7.4.4 With limited domestic uranium availability, India has already entered into fuel supply agreements with foreign suppliers, both for domestic and imported reactors. Adequate provisions in Power Purchase Agreements (PPAs) are expected to address this issue. India's multiple diplomatic engagements with nuclear fuel supplier nations are also expected to yield many positive results. FBR has the advantage that after the initial fuel loading, the reactor generates more fuel than it uses and is not dependent on external supplies.

7.4.5 The capacity growth programme will be determined by availability of convenient sites, and be largely driven by PHWRs, LWRs and FBRs. The Government's announcement of construction of 10 units (700 MWe each) of indigenously developed PHWRs and two more LWRs (1000 MWe each) at Kudankulam site are right steps towards rejuvenating Indian industry and capacity addition.

7.4.6 The large nuclear programme is expected to significantly contribute to the 'Make in India' campaign. NPCIL will support the nuclear industry for the manufacture of reactor components. As the growth of LWRs is highly prospective, we are encouraging joint ventures between foreign and domestic entities to manufacture equipment in India.

7.5 Nuclear power has a great potential in India to supplement and in the longer term even substitute coal based power as base load. However, the large capital requirements in setting up these plants, which also raises the cost of power due to a high interest burden in the initial period, has to be borne in mind. The long coastline offers the opportunity to locate these plants on the coasts in different power markets. The above peninsular region is deficit in electricity and could take advantage of proximity of nuclear power plants. A stable policy regime will internationalize this sector and attract the much-needed capital.

Chapter 8:

Electricity

8.1. Electricity is a key ingredient for economic growth and attainment of high quality of life. With electricity comprising only 17% of our final energy consumption in 2014 (against 23% in OECD), India ranks well below the global average in electricity consumption. In addition, it exhibits greater variance in electricity consumption across sectors with households lagging behind. During the 2001-2011 decade, household electrification grew only at 1% per annum. Consequently, a household electrification backlog of nearly 20% remains. It is in this context that the goal of universal electrification by 2022 offers a major challenge. The 2008 Integrated Energy Policy had aimed at achieving a minimum of 1 kWh/day per capita consumption by 2012. In a similar vein, the National Electricity Policy 2005 had aimed at 100% access by 2010. But both targets have been missed. The household consumption in rural areas stands at just above 1 kWh/day per capita in 2015.

8.2. In keeping with the global trend, NEP expects the share of electricity in energy consumption to rise in the coming years. This is likely to result partially from declining prices led by declining cost of electricity from renewable sources and from progressively greater use of electrical devices due to rising efficiency of them relative to appliances relying on other sources of energy. In the ambitious scenario, we envisage India's electricity supply rising by nearly five times to 4800 TWh (2012-2040). However, by adoption of efficiency, even at a per capita consumption of around 3000 kWh/year in 2040 against much higher levels in the developed world, we expect that electricity will comprise 26% of our final energy demand in the ambitious scenario.

8.3. By meeting the energy needs of a prosperous society with moderate energy consumption, India will be setting an example to the world of how energy ought to be produced and consumed. Other than houses, the potential for electrification of energy demand is immense, as is being seen in the developed world. This is particularly true of transportation (Electric Vehicles), cooking, agriculture and industries. Heat is estimated to account for 50% of all energy demand in Industry, and can easily be supplied efficiently by power (preferably through renewable sources) rather than burning solid or liquid fuels. Greater use of electricity can also be an important source of de-carbonisation. Hence, there is a strong case for a shift towards electricity across demand sectors.

8.4. The Electricity Act, 2003 brought far-reaching reforms in electricity sector including unpacking of erstwhile electricity boards into generation, transmission and distribution companies and the advent of electricity regulatory commissions at the centre as well as in states. The Act also set the stage for greater participation of

private sector though it has remained largely confined to generation. Distribution has been privatized in Delhi but has not spread much beyond it. The transmission and distribution segments have remained inefficient with large Transmission and Distribution (T&D) losses persisting in many states. Since the promulgation of the Act, the Government has had to bail out the distribution companies (discoms) thrice with the latest such bailout being the 2015 UDAY scheme. As electricity is a social good, it is quite understandable that when distribution companies are in distress, the Government feels obliged to respond. However, there is a legitimate concern that such interventions make discoms and state governments complacent. Under UDAY, the Government has negotiated with states a number of steps towards reducing the cost of supply, improving access and bridging the gap between the average cost of supply (ACS) and average revenue realized (ARR). The NEP takes the view that appropriate pricing can be an effective tool of achieving cost reduction.

8.5. Had we stayed course originally chartered by the Electricity Act 2003, significantly greater transformation of Indian electricity sector would have been accomplished. Fuel supply issues, bureaucratic attitude in state electricity companies and sub-optimal decision making of Regulators have robbed the sector of its potential gains. Looking to the vitality of the sector, and failure of repeated efforts, there needs to be a careful consideration of the strategy going forward. Power sector continues to face challenges of poor demand, low returns on investment, and stranded generation assets. As a result, capital is not coming to the sector with a likely medium term impact on power availability. The existence of a large number of captive generation plants based on diesel, one of the costliest fuels for electricity generation, is indicative of the absence of reliable supply of electricity through discoms.

8.6. **Reform of the Distribution Sector in the Medium Run**

8.6.1 Today, we face the paradoxical situation such that we have voluminous unsatisfied demand for electricity and yet our generation capacity is grossly underutilized. The phenomenon has arisen because of poor financial health of discoms. The role of discoms is to intermediate between supply of and demand for electricity. They buy electricity from generation companies and sell it to customers. Electricity purchases from discoms usually require long terms power purchase agreements (PPA). When discoms are in poor financial condition, generation companies fear that they would be unable to make good on their promised payments. In turn, generation companies refuse to enter into PPAs with the discoms. The result is that the latter are unable to provide electricity even when customers are able and willing to pay for it. Sooner or later, the government has to step in to bail out the discoms.

8.6.2 The fundamental cause of repeated episodes of discoms going bankrupt is the absence of commercial pressure on them. Political pressures to provide

electricity either free or highly subsidized prices to certain segments of the society have meant that revenues of discoms often fall well short of payments due to generation companies. Large volumes of transmission and distribution (T&D) losses due to theft and low efficiency of transmission and distribution reinforce this revenue shortfall. With rare exceptions, discoms are public sector entities and are not subject to the usual commercial pressures. Typically, they are able to borrow from public-sector banks with implicit guarantee by the state governments to cover the revenue shortfall and pay the generation companies for a few years. But over time, this leads to the accumulation of debt with interest payments becoming larger and larger. Eventually, they lose credibility as buyers of electricity forcing the government to come to their rescue.

8.6.3 The ultimate solution to this problem lies in ensuring that electricity distribution is subject to commercial pressure. This can be achieved by separating the distribution of electricity from ownership of the distribution grid. Discoms would continue to own the grid while actual distribution or sale of electricity would pass on to private agents. The latter would contract with generation companies to buy electricity for sale to final customers and haul electricity from the point of generation to the point of consumption on the transmission and distribution grids for charges determined by regulators. As in telecom sector, customers will have the freedom to choose their electricity distributor from among various private agents and go for the one who offers the best deal. Electricity distributors will thus compete for customers. Discoms will give open access to distributors to haul electricity on the grid for a charge.

8.6.4 A critical question under this arrangement concerns cross subsidy. Currently, industrial customers are charged a price well above the average cost of electricity generation. This excess helps finance below-cost prices charged to other customers. The same cross subsidy can be provided under the proposed system by taxing the purchases of electricity by industrial customers and using the tax proceeds to subsidize vulnerable customers. An advantage of this arrangement is that it is far more transparent than our current practice. Even more importantly, the proposed arrangement will enforce efficiency through competition among electricity distributors. It will also free up the government from having to periodically bail out discoms. Because private agents will insist on the transmission of electricity from generation company to the customer without undue losses along the transmission and distribution grid, the proposed system will also force entities owning transmission and distribution grids to operate efficiently as well. It may be noted that states such as Karnataka, which currently offer open access to electricity grid, already practice cross subsidization through taxation.

8.7 Complementary Reforms

8.7.1 The recent reform under the Ujjwal Discom Assurance Yojana (UDAY) has outlined a path to restoring the health of discoms in the immediate future. While transferring 75% of discom debt to the state government budgets, this reform also attempts to bring down AT&C losses. For the future, we need to work towards the separation of distribution grid and distribution of electricity as discussed above. This will help make the sector self-sustaining in the future.

8.7.2 To fructify the large investments necessary in electricity sector, we will need several additional reforms, however. The contemplation of private capital and management in the Distribution segment has not happened despite there being provisions for the same. The successful operation of this business by private operators in many cities ought to set an example for State Governments. It is now proposed that central Government utilities may be encouraged to partner with state utilities in the distribution business also with a view to forge forward integration. They could do so directly or partner with private sector.

8.7.3 We would also need to strengthen the State Electricity Regulatory Commission (SERC), which would regulate the charge on hauling electricity on the distribution grid and settle disputes arising between parties transacting at different points of the supply chain. As we move to a telecom-like competitive distribution system, during transition, the SERC may also need to set tariff for different demand segments (for example, households, farmers and businesses). The government concerned would pay electricity subsidies to chosen segments of the society (for example, farmers) through DBT, which is an efficient subsidy delivery mechanism. Our eventual goal should be to bring down the cross subsidy from industry, placing the burden directly on the budget. This would contribute to making electricity-intensive businesses more competitive.

8.7.4 Distribution segment needs nursing for it to become healthy. A number of Government's top priority programs such as 175 GW and "Power for All" depend on a healthy distribution segment. The NEP calls for constant monitoring of UDAY and pave the way for the major reform separating the wire and content as discussed above. Past experience tells us that unless comprehensive distribution reforms are undertaken, the electricity sector may relapse into difficulty. There are visible signs of distress, lack of robust demand for power and the threat of large renewable supply going unused. Falling PLFs and rising cost of supply due to rising RPO commitments and the fixed cost burden of conventional power plants are threatening the Government's power augmentation agenda. The NEP advocates that as has been experienced globally, the market be allowed to allocate resources, under

regulatory supervision. It may not be possible for the Government to manage by overt presence the transition of power market while simultaneously addressing multiple goals of universal access, clean energy, efficiency uptake of technology and security of supply.

8.8 The power sector of tomorrow

8.8.1 A question is often raised on the pathway India may adopt — a capex heavy centralised conventional electricity infrastructure, or a decentralized renewable energy based one. Unlike the West, where demand has largely stabilized, India's power system is likely to grow many times over, and has the choice to adopt its strategy. It is no doubt that renewable energy costs are falling, and further reductions in them are predicted. This offers an opportunity, especially if large transmission costs could be avoided by decentralized generation. However, the challenges that come with this infirm source—storage and intermittency—are still formidable. On the other hand, India has sizable coal reserves and with appropriate policy moves, could absorb natural gas-based power, too. It is generally agreed that the vast electricity demand of India cannot be met by decentralized solutions in a short time. Large power plants bring sizable supplies to the market in a more efficient manner. Solutions to the challenges facing India that renewable technologies bring are still work in progress and Indian consumer cannot wait for them. Therefore, India's immediate way forward has to be a mix of the large and small, central and distributed, and fossil and renewables. While developing the new infrastructure, it will be ensured that the grid can absorb and distribute renewable electricity in the long run.

8.8.2 The three main segments of power business — generation, transmission and distribution — have their own challenges and potential solutions but modern regulatory practices and commercial viability have to be at the centre of the latter. Power interfaces other sectors, too, especially when it comes to fuel supply, environmental clearance, land allocation and financing. The NEP underscores the role of regulation in addressing these linkages in a holistic manner. Renewable electricity, smart grids, DSM, energy efficiency and new business models are likely to impact the infrastructure and revenues of power sector operators in a major way. Unless they are able to de-risk their projects by a stable and forward-looking policy regime, investments may not be forthcoming. And even if investments are forthcoming, the system may fail to encourage the adoption of efficient technologies. Two examples bring out this point clearly.

- Micro-grids have not grown in rural areas out of the fear that the investments may be rendered waste once the grid reaches these areas. Grid based technologies, and micro grids must forge an alliance, with

regulation defining the role of micro-grids in the initial phase of universal access and coverage.

- Similarly, increasing share of renewables calls for integration of geographical regions beyond the conventional state-level boundaries of regulatory jurisdictions. The role of Regulators in adopting global best practices in resolving such challenges is manifest. The expertise and exposure of Central and State Regulators to such practices will have to be enhanced.

8.8.3 Recent technological advances are likely to have a large impact on the quality, cost and efficiency of electricity supply. The two-way communication ability of smart meters between the consumer and distributor has opened the possibility of new kinds of contracts. Precise data can be generated, maintenance can be made efficient, demand side responses can be recorded, and a lot many other non-consumer based interventions including mainstreaming of renewable power can now be undertaken. The role of technology in generation and transmission has already made rapid advances. It is integration of renewable energy, which is posing new challenge that is being addressed by multiple agencies, both at the central and state levels. It is, however, on the distribution side that recent developments are offering exciting options, as they allow innovative commercial tools such as differential pricing, choice of supplier and power purchase planning to be adopted. New business models, spurred by renewable energy such as micro-grids and rooftop solar, are changing the way electricity will be bought and sold. This is bringing efficiency to the power market and is helping finance the sector.

8.8.4 Technological advancement in mobility including hybrid vehicles, electric vehicles and fuel cell vehicles are likely to be inducted in the transportation system of the future. An enabling environment for charging, grid management, two-way communication system and cyber security will need to be provided by municipalities/discoms. An immediate urgency for the above interventions has arisen in the Hundred Smart Cities Programme of the Government, where the above protocols need to be addressed right away.

8.8.5 Financing will continue to pose a challenge to the Indian electricity sector. As per IEA, the Indian energy sector will require an investment upwards of $3.6 trillion between 2015 and 2040. With India's infrastructure poised for all-round growth, funds will be allocated to the sector that minimizes risk for the given return. Because we have not allowed various segments of the supply chain to operate on commercial basis, private investors have been hesitant to enter them. As the NEP proposes to change it along the lines described in the previous paragraphs, this would change. Attracted by commercial returns, private investors may be expected to enter the sector on substantial scale.

8.8.6 Separation of distribution grid from distribution of electricity can also allow captive generation to turn into an effective source of power. Under the Electricity act 2003, captive generation has been freed from all controls including the license requirement and techno economic clearance from the Central Electricity Authority (CEA). Therefore, once captive generation is offered smooth access to electricity grid, its potential can be fully exploited.

8.8.7 To-date, market pricing has been the biggest challenge to the power sector. Cross subsidy from industry to other sources of demand and direct subsidies to certain segments have been widely deployed due to various pressures. The result has been poor performance of the sector with the quality of electricity supply being poor. While it is often agreed that all segments of this business need to be profitable, proper pricing of electricity has been a challenge. Surveys have revealed that those yet un-electrified desperately seek electricity not only for the quality life but also for its productive use to raise income levels. There is a high value attached to personal use as well as possible productive use of electricity and there is willingness to pay for it. The Tariff Policy and National Electricity Plans have successively highlighted the need to supply quality power at appropriate price. By not doing so, we have placed our industry at a great disadvantage. Sectors in which electricity cost is a significant proportion of the total cost are particularly disadvantaged. The Government is committed to closing the gap between ACS and ARR in the short run, and allowing markets to determine prices in the medium term.

8.8.8 The suggested reforms may result in the flight of large consumers through 'open access' options to cheaper sources including renewables. As the cross-subsidy contributions from industrial and commercial consumers dips, the subsidy bill for vulnerable sections of the society cannot be left at the doorstep of State Governments. While efficiency in coal markets and UDAY reforms, including reduction in AT&C losses, will bring down the revenue deficit, the Government could seek cross-subsidy contributions from large domestic consumers. Experience of evolved electricity markets reveals that with opening up of electricity markets there was a reduction in costs and retail prices. Therefore, the NEP proposes a new way forward for the electricity sector in tandem with reforms in the coal and renewable sectors, to take advantage of the emerging transformation, with the confidence that the twin objectives of reducing cost of power to the productive segments, can be achieved without forsaking the welfare agenda of the Government.

8.9 **Role of different stakeholders**

8.9.1 At the outset, it may be stated that the Electricity Act provides for a National Electricity Policy which is to be prepared in a cooperative process with State Governments. This provision needs to be used effectively to forge a national

consensus on the challenges confronting this sector. Electricity is in the Concurrent List with distribution being largely a state subject. The first principle being advocated by the National Energy Policy is that after near seven decades since Independence, it is time that the States take greater responsibility in the provision of power. A perception has been created that the Union has greater responsibility in this sector and this has resulted in the States leaning more heavily on it. The result has been repeated episodes of massive losses, accumulation of debt and bailout packages by the centre. States need to take more ownership in the electricity sector, however, the gap between the average cost of supply and average tariff, which was 76 paise per unit in 2011-12, has decreased to nearly 50 paise per unit presently. The State Governments and SERCs have not been able to ensure financial wellbeing of the electricity distributors. As the state companies do not have investible surplus, the role of Central Power Sector Utilities is also being invoked across the electricity sector, now even in the emerging renewable electricity. It is envisaged that in the future States would take greater responsibility in the management of power sector, with the Centre playing a complementary role. The alignment of Centre and States may be finalised through a revision of the National Electricity Policy.

8.9.2 It is also important to distinguish the roles of private sector vis-à-vis the Government. The Electricity Act has already provided clear guidance on policy, regulation and business segmentation. However, the reforms have remained incomplete in the sense, that some sectors, which could attract private players, continue to be dominated by Government companies. Transmission and distribution fall in this category. In some sectors, where government support could fast forward the reforms, there is poor momentum. Demand side management, smart meters, innovative pricing (by the time of the day), robust open access and movement away from cross-subsidies are some examples where reforms could offer handsome returns. The tragedy of electricity sector has been that after a robust start in the early 2000s, reforms stopped half way home. The role of private sector must be expanded to all investment areas, including supplying electricity to rural areas. The likely separation of wire from content is expected to throw up more investment opportunities in the distribution sector. Various models exist for participation of the private sector in Distribution. The Ministry of Power will assist the states in adoption of the model as per their choice by developing suitable protocols and model documents.

8.9.3 It is also recognised that owing to electricity being in the nature of social good, and presence of multiple distortions in the electricity markets - all of which cannot be eliminated in the medium term, Government cannot leave this sector to markets alone. The Regulators may have to continue to play an active role for protecting the consumers, while also supporting the power sector stake-

holders. Creation of adequate capacity is a strategic responsibility placed on the Regulators, especially in the light of poor offtake of power at present, and rising growth of renewable capacity. Markets alone may not be able to send the right signals for long-term security of supply. It is, however, emphasised that markets address these issues better than state intervention.

8.9.4 Policy, regulation, financial institutions, trained personnel, state governments and equipment manufacturers are all critical to building a robust electricity sector. While many of these diverse elements have been discussed in this chapter and others, there is an important role for a coordinating institutional mechanism. Power sector needs a dedicated effective coordinating mechanism that brings different power sector partner Ministries together. There is also need for a federal mechanism that has States on board. With the all India grid getting synchronized effectively, the true character of the 'Concurrent' jurisdiction will come into play. Universal electrification, 24x7 power and higher uptake of renewable call for a more effective mechanism. The inter-State power trade, forecasting and scheduling power (especially the renewable) on a regional rather than state basis, wheeling of renewable electricity from resource rich states to the others, coordination between Central Transmission Utility and State Transmission Utilities and human resource issues can be best addressed by a standing mechanism, which is jointly owned by the Centre and States. It is notable that while power business has been corporatized, there has been no effort to attract managerial talent to these companies, particularly in the state sector. The Ministry of Power will create an institution that jointly supervises and monitors the overall development of the country's power sector.

Facilitating Mechanisms

Chapter 9

Regulators

9.1. Introduction

NEP's aim of competitive markets cannot be achieved without effective independent oversight. It is proposed to complete the regulatory space by putting in place statutory Regulators for coal, oil and gas (upstream) on the same lines as in electricity. The growth in India's energy supply by a multiple of nearly more than three by 2040, has to be facilitated by assuring investors of competent, arms-length and effective decision-making. In a developing scenario, investors will not come forward unless they anticipate commerciality in the sector. On the other hand, consumer interests can also be addressed by the same strong watchdog mechanism. Simultaneously, Regulators must implement Government policy on current issues such as access, air quality, affordability etc. The other objectives, which the regulatory apparatus must meet, are:

- Internalize global cues in energy markets
- Integrate the sector with the country's macro-economic policy
- Translate the related statutes, NEP and sector policies into reality
- Adopt a national outlook on energy issues, while simultaneously addressing concerns of the states
- Engage effectively with all stakeholders.

9.2. Evolving Role

Internationally, the role of Regulators has evolved, from independence and promotion of free markets, to ushering in mandates of decarbonisation and protection of investments. In contrast with developed economies, Indian energy sector displays varying degree of maturity across different sub-sectors. As energy demand is diminishing in the former resulting in over-supply, Regulators are no longer engaged with consumer protection rather with ensuring commerciality in operations and security of supply. However, in India the demand for energy is rising, albeit at a varying rate across sources, and consumer prices are a vital concern. It is rising at a high rate in the oil and gas sectors, while it is subdued in coal and electricity segments presently. Within the latter, renewables is on the upswing and even electricity demand may go up in the years to come. Therefore, the regulatory situation calls for a mixed approach. One aspect of their role is clear – they have to incentivise investment so that the energy system of the country grows rapidly. Recognising that technology and markets are fast integrating energy into a commodity market, sub-sector energy Regulators will have to guide their energy sources into a common market. While in the immediate, the role of each Regulator may vary, several functions may be uniformly dispensed by all of them, such as that of HSE.

9.3. **New Regulators**

Coal and upstream petroleum sectors have lacked independent, statutory regulators. Due to several reasons, including strong presence of PSUs and limited number of private operators, it was so far not found useful to place the latter in position. But, now with increased private activity, the time is appropriate. Ideally, there ought to be a single Regulator to govern the energy market. But, in India, the market has not fully developed with a vast domestic potential remaining to be exploited. Hence, the Regulators need to devote considerable attention to development of supply. And, looking to the large inherent complexities in different fuel sources, it is pertinent that there ought to be sectoral Regulators. However, at the level of electricity, all fuels ultimately converge into a common product which is rightly governed by a single Regulator. In the petroleum sector, there is every merit in extending the remit of PNGRB over selected statutory aspects of the upstream business, including HSE, data collection, joint development of reservoirs in adjacent blocks, sharing of infrastructure and promotion of acreages. However, the contract administration role of PSCs will remain with the DGH. But for that, the former will have to be equipped with adequate and competent resources. On the other hand, an independent Coal Regulator, strengthened with full powers, is already under the Government's consideration and needs to be put in place immediately.

9.4. **Sovereign Powers**

Even while the Government delegates several of its powers to regulatory authorities, owing to several reasons including ownership over natural resources, it cannot divest all its responsibilities. It also needs to address the concerns of energy poverty through various subsidy mechanisms. Hence, the role of Government in the energy domain will remain manifest as listed below:

- Policy making which will guide the overall mandate and functioning of Regulators
- Statutory powers, to meet the objectives adopted in the policies
- Fiscal powers to raise revenue from the energy sector
- Award of exploitation rights to energy minerals and renewable resources
- Obligation to promote the interests of vulnerable sections of the society

9.5. **Areas of Regulation**

India's fast growing energy sector will undergo an evolution over time from a supply deficit state to competition between sources, also influenced by development of technology and falling costs. However, along the way under-utilisation issues will pose challenges as are being faced presently by power generators and gas pipeline operators. The new technologies are also encountering difficulties of lack of infrastructure, higher cost than older sources of energy and absence of regulatory support. There is also a fear that highly competitive bids in the renewable sector may result in poor returns leading to incomplete projects. Weak provisions for obligatory purchase of solar/wind power, and non-inclusion of marketing infra of liquid fuels in

the definition of 'common carriers', are some examples. In the long run, all Regulators will need to provide effective regulation in the following areas:

- Developmental (expansion of grids, pipelines, CGD networks etc.)
- Commerciality (attracting investment and adequate return on investment)
- Consumer protection (access, availability, supply assurance including quality of supply, profiteering etc.)
- Regulatory aspects (fulfillment of minimum service/exploratory commitments, RPOs, other conditions of grant of licenses etc.)
- HSE related provisions.

Unlike many mature energy markets elsewhere, Indian energy Regulators must undertake developmental role to help bring in more players, enhance availability, help reduce the entry costs and help different segments of the business integrate well.Several of the above areas are already included in the regulatory statutes with poor implementation. PNGRB is one example which has not been able to succeed in rapid roll-out of CGD networks. The Indian energy sector has higher expectations from Regulators as compared to the developed energy markets of the world where regulation is gradually giving way to open markets.

9.6. **Issues**

A number of common features are witnessed in well-developed energy markets. India also aims to achieve many such characteristics, namely, competition between fuel sources on calorific parity basis (provided non-fuel economics is also neutral), ease of entry and exit for players, free consumer choice of vendor, market determined prices etc. However, many of these features evolve over time when conditions ripen. Indian energy market is now ready for several new regulatory interventions as listed below:

- Separation of content and carriage in electricity, city gas, liquid fuels (at select locations)
- Sharing of energy infrastructure by inclusion in the definition of 'common carriers' (storages and marketing infra, ATF hydrants, offshore infra, LNG terminals, aviation fuel infra etc.)
- Grant of choice of service provider (LPG, kerosene, electricity etc.)
- Data sharing especially in the area of oil/gas exploration

9.7. Beside the above, the existing regulations need to be expanded to address the needs of our energy market to usher in strong market framework. The existing Regulators will provide for the following aspects, or clarify through Regulations:

- Unbundling between gas transporters and marketers
- Overlap between jurisdictions relating to competition issues
- Adequate returns to gas pipeline developers in the initial years when the throughput is miniscule
- Induction of latest technology
- Robust data collection and dissemination
- Health, safety and environment (HSE)

9.8. **Staff Issues**

The experience so far with many State Electricity Regulars has not been good as exhibited by poor decision making. The long intervals in raising electricity tariffs, poor enforcement of RPOs and weak regulatory oversight has often been blamed on political meddling. The lack of training has compounded poor quality of manpower in some cases. The above calls for improvement in quality of recruitment of Regulators and subordinate staff, and rigorous in-service training. As energy is a technical subject constantly evolving due to R&D, building top-class capabilities in the cadre which will update itself with latest advancements is a must. Energy sector has been witnessing vast technological advances which requires the staff working in regulatory organizations to be trained on a continuous basis. For this, cadres will be created in all Regulators, so that there is no overt influence of deputationists. Along with budgetary support, the Regulators will be allowed to collect fees from their sector, so that they ultimately obtain freedom from the former. The Government will provide for suitable provisions in sectoral policies to mandate achievement of its objectives. It will call for close review of performance of Regulators.

9.9. **Conclusion**

The Government-Regulator interface will be strengthened especially with regard to bringing upcoming sources of energy such as renewable electricity, value-added biomass, CBM, UCG among others. While the above fuels would statutorily come under the ambit of existing Regulators, what will be needed is pro-active regulations to support these young fuels. It will be ensured that Regulators do not end up in any stake-holder capture, be it the consumers or the investors. In order to achieve energy security, supply security is essential. The sooner are the regulations issued, swifter will be the response from industry. With regard to new Regulators (coal and upstream petroleum), the statutory provisions will be so made to provide for effective Regulators. India needs large doses of private capital, both domestic and international, and this will be forthcoming only if we erect world-class Regulators.

Chapter 10

Energy Infrastructure

10.1. Energy infrastructure needs a dedicated consideration because often the business environment for energy and infra are different, and separate policy frameworks are required. Here, we make a distinction between energy 'production' and 'transport' assets, with the latter being identified as infrastructure. The focus of energy Ministries being on energy supply, often results in overlooking of specific requirement of the latter. An omnibus infrastructure policy may not be able to address the infra needs of the diversified energy sector. For example, LNG terminals, charging station for E-vehicles, trunk gas pipelines and coal washeries cannot be supported merely as infra assets. Unless they are linked with the energy policy, they will not come up by merely an infra support policy. Hence, it is in fitness of things to discuss the specific policy requirements of energy infrastructure under the NEP. By definition, all infrastructural assets have long life, thereby needing a stable policy environment. They involve lumpy investments and usually serve as 'common carrier' or cater to more than one client, and may come up merely by a financial investor. Their monopoly status needs to be regulated by a regulatory framework, just as their own financial viability needs assurance of business over long tenures. The above are some of the wide-ranging issues that are addressed under the following policy mandate.

10.2. **Creating Local Interest**

With the jurisdiction of States and local bodies over energy infrastructure in matters such as land acquisition, environmental clearances, right of user in land and fixing of charges levied by local bodies, closer alignment of Central and local interests could fast forward these projects. Energy assets should not be seen as central Government's responsibility. Cross country gas pipelines and power transmission lines need local support which would be easier forthcoming, if a value proposition was also offered to the local energy consumers. This calls for creation of an economic interest of the local residents as partners in the venture and their ownership. For example, the states through which gas trunk pipelines pass, will be the first beneficiary of CGD projects and availability of gas should spur fertilizer and power units. The invocation of Central laws in acquiring the transit rights as well as engagement of central agencies (PGCIL, NTPC, GAIL etc.) should not in any way alienate the local communities. Adequate compensation and energy requirements of the region impacted by infrastructure development will be borne in mind. A shared interest ought to be created so that the States come forward to expedite the necessary approvals for energy infra projects.

10.3. Statutory Clearances

The Government will not distinguish between private and public sector projects in invoking its powers of acquisition of 'right of user/way' to facilitate creation of energy infrastructure. The requirements of speed and avoidance of cost overruns, calls for application of Central laws to acquire land related rights. The template of the recent UMPP model of 'plug and play' wherein different permissions are secured before the projects are bid out will be adopted, especially where private sector investment is to be attracted in the energy sector. The Government will, therefore, invite investments on transparent criteria, and not distinguish between public and private sectors. Wherever public sector has been given a differential treatment under statutory laws, the distinction will be phased out over time.

10.4. Evolution in Infrastructure type

By 2040, the energy mix of India is expected to become renewable intensive, with 46-52% of the power capacity being solar and wind dominated. This calls for a different kind of infrastructure. The infrastructure would be made flexible to respond to evolving technology and energy mix by issuing enabling policy. Even local (DDG) solutions will mushroom in the nature of micro- and mini-grids. The project implementation capacity and the eco-system for award/contract finalization of energy infra projects are different for small, decentralized solutions as compared to large conventional energy ones. The Regulators would factor in the above in structuring viability, and has been discussed under the Regulation chapter. Energy infra policy of different sources needs to factor in the interests of small and large infra providers. Micro grids will need encouragement and de-risking from advent of the conventional grid and be dovetailed in the latter. Supply chains for marketing petroleum products in rural areas may need a dedicated policy to deliver transport and cooking fuels in small markets.

10.5. Capital

Capital requirement in the energy domain is the biggest challenge before the country. This is aggravated by high interest rates as compared to developed economies. A near $150 billion capital investment is needed in energy sector on an annual basis until 2040 (IEA). This has to be met without impacting availability of capital in other sectors. The role of external commercial borrowing (ECB) is well recognized, for which suitable hedging mechanisms will be conceived. Deployment of overseas equity in financially viable, long duration infra projects may be an answer to the high hedging costs. Moreover, a number of financial tools exist to enhance returns to investors. The Government will encourage adoption of imaginative tools such as extended debt tenure, VGF, tolling, and dollar denominated returns to attract private capital to the energy infrastructure sector. The NITI Aayog will get a study undertaken to determine

the capital requirements sector-wise to deliver the targeted energy supply by 2040, and recommend the strategy to attract the required capital. Ministry of Finance would lead the initiative to promote the investment opportunities and attract investors, both in India and abroad.

10.6. Revenue Models

Power transmission lines and natural gas pipelines will deploy the largest share of energy infrastructure capital. While the power sector has an established revenue model which adequately remunerates investors of inter-state transmission lines, it is the last mile connectivity for renewable electricity which faces funding challenges. The Government will continue to provide financial budgetary support to the states for the above projects. As regards gas, a large capex requirement is needed for new LNG terminals, trunk gas pipelines, CGD networks and commercial storages. There is no commercial gas storage as of now, and if India is to be a major gas consumer, there needs to be assurance of supply in times of higher demand. As the gas market is under evolution, the capacity utilization risk is fully loaded on the infra investor which is holding them back, resulting in stranded assets. The Government will come out with a strategy to de-risk these projects, either through VGF support, or through an attractive revenue model. Strategic/commercial oil storages will also be essential for energy security. The above can come up without capital support from the Government, provided attractive contractual models and storage sites can be offered. The NITI Aayog-led study will estimate the capex requirement for the above, and devise a suitable methodology for the same. The role of Regulators will be vital in the above, and has been discussed separately. Similarly, coal washeries will be given a viable financial model to upgrade the high ash content Indian coal.

10.7. Civil Contractors

Energy sector is poised for a take-off and the complexity of infra projects on offer is likely to increase, for which global expertise will be encouraged. Trans-continental gas pipelines/power transmission lines, and large LNG terminals will need competent civil contractors. India has few local contractors who can implement high value projects of complex nature such as trunk gas pipelines, LNG terminals, oil/gas storages etc. This problem is expected to be overcome naturally once large global principals come up on their own or in joint ventures with local companies. They will be able to attract civil contractors from all over the world on their own, too. A speedy process for statutory clearances, as suggested earlier, would also send appropriate signals to globally reputed contractors to take up Indian projects, which will be followed up by development of local competencies. The working environment will be improved with attractive contractual arrangements including PPP, annuity models, EPC etc. and speedy dispute resolution mechanisms.

10.8. Infrastructure will play an important part in delivering energy to distant locations in the country. It is obvious that with an over three times expansion in energy supply, there will be a concomitant growth in infrastructure. As the energy mix evolves, the type of infra will also change, with its ensuing impact on investment, revenue model and technology. By nature, infra must precede energy supply, but will not be erected unless the latter is assured. Therefore, there is a symbiotic relationship between energy and infrastructure. The Government will ensure that the policy frameworks for energy supply and related infrastructure are harmonious.

Chapter 11

Human Resource Development

11.1. Energy sector is a fine example of integration between the interests of job creation and supply of a critical input. Unlike other economic sectors, a closer relationship can be forged between academia and energy sector, also due to the possibility of the latter to fund specialist institutions. India has a challenge to provide job opportunities to its vast young population. On the other hand, an array of specializations and skill sets are required for the many times over likely growth of the energy sector. For instance, solar and wind renewable energy is estimated to have created nearly 70,000 full time equivalent jobs in India so far (2016). A study has revealed that if India achieves its new target of 100 GW of installed solar energy by 2022, as many as 1 million full-time equivalent jobs could be created (NRDC, 2015). While energy is thematically one sector, but the kinds of expertise required across all sub-sectors are quite diverse. The petroleum sector requires specialists in geology, geo-physics, drilling and production, while the electricity sector requirements are in instrumentation, civil engineering, electrical and electronics/IT. Similarly, the requirements of coal, renewables and nuclear power are different, too. General management, including financial management in managing the utilities and energy businesses, has been an ignored area so far, which also calls for matching the skill set requirement with supply. The NEP proposes to address the vital aspects of HRD requirements of the energy sector.

11.2. On the other hand, the supply side has been equally unplanned. Only a handful of new, dedicated energy Universities have come up in the past 2-3 decades, with poor collaboration between the demanders (industry) and suppliers (academia). This needs to be corrected by a closer interaction so that the industry could fund education, seek expansion in the offered courses, buttress the curriculum, and also provide faculty to these institutions. There are successful examples of such collaboration, such as in Brazil, where the petroleum sector underwent a complete transformation supported by enhanced availability of relevant expertise over time. However, this requires integrated planning and communication between different actors, for which a dedicated apparatus may need to be erected. The corporatization of the power sector demands a careful consideration of the skill set required to lead the businesses as commercial entities. The gradual adoption of market framework in the entire energy domain will require a similar re-orientation in the management cadres. Both technical and managerial skills will be the focus of interventions in creation of a new HRD cadre for energy sector.

11.3. Various studies have revealed that the growth in the Indian energy sector is expected to generate millions of jobs in the coming decades. It is also acknowledged, that without the availability of relevant expertise, our energy sector may get tripped. Many of these new positions will be in the nature of energy

specialists, while at the other extreme, skilled technicians will be required for routine functions. A Skill India Mission is already at work, and the NEP must dovetail the opportunities in the energy sector with it. As regards specialists, an industry-academia collaboration is required to identify the niche areas and plan for their availability. In some sub-sectors, such as power, the government has already been an active player in providing trained manpower through its multiple institutions, many of them managed by public sector companies. The NEP may consolidate the opportunities, requirements and the strategy for supply of relevant manpower to the entire energy sector. The following measures are proposed to be taken up in this direction:

11.3.1. **Creation of a strengthened database**

India's energy sector is expected to keep growing at a fast pace for several decades, which will keep employing increased number of personnel. On the other hand, due to the changing profile of the energy mix, which may have a larger share of clean energy and energy efficiency, the desired skill set may also be shaped correspondingly. An exercise will be undertaken for analysis of the energy sector staffing needs, available institutions and the gaps in the above. The above analysis will take into account the common demand of other sectors from the technical institutions so that the net availability of manpower for the energy sector may be estimated.

11.3.2. **Industry-Academia collaboration**

The energy sector ought to acknowledge manpower as a vital input for which it may need to invest in their training and education. On the basis of the data to be generated from the above exercise, the energy sector companies would fund/sponsor/support educational institutions to set up colleges/Universities/ITIs/polytechnics in the specialized disciplines sought by them. In order to cater to the needs of integrated energy planning and management, existing specialized energy discipline Universities will be aided to become omnibus energy Universities. The role of Industry federations would be significant in this continuous engagement, especially in assuring the institutions and the student community of employment opportunities after the end of the courses. The number of positions of Interns/Trainees will also be significantly raised for a closer association between the industry and students, and early identification of talent.

11.3.3. **Institutional integration**

There are a plethora of institutions working in the domain of energy sector skills. Currently 40 Sector Skill Councils exist, while dedicated training

institutions set up by PSUs supplement the private academic institutions. Few State Governments have taken a lead in setting up energy related institutions of higher learning, which needs to be remedied as local Governments best appreciate the job opportunities existing in their energy installations. Convergence of the prevailing initiatives of the Ministries of Labour, Skill Development and Entrepreneurship with energy sector Ministries will be undertaken. A taskforce would be created with representatives from the aforementioned central ministries, industry bodies, sector skill councils, and State Governments to develop a strategy for the same.

11.3.4. **Quality and not just Quantity**

The large employment prospects in the energy sector must not be mis-construed as a mere supply of numbers. In order to ensure top quality of manpower, our HRD initiatives will be so deployed that they incubate the best in class professionals. For this, collaborations between our academic institutions and the globally best ones in selected domains will be forged. Energy sector is witnessing rapid change as technology evolves, and our manpower needs to be abreast with them. The same institutions are the source of researchers who will be a critical ingredient of our energy related R&D initiatives. In order to achieve the above ends, the quality of faculty, facilities and funding needs to be of a high order. It is expected that the support of Industry will much help to address the above requirements.

11.4. **Role of State Governments**

As the Central Government alone cannot meet these large expectations, the role of State Governments in HRD is acknowledged and their support to this agenda will be taken in a big measure. The existing robust engagement of State Governments in higher education needs to be extended to specialized technical disciplines including the energy sector ones. Even the private sector institutions look upon the States to support their efforts to set up technical institutions. States will appreciate that their programmes of clean energy deployment, and other interventions related to the energy sector (e.g. Smart cities, Electric vehicle deployment, Decentralized renewable energy solutions in villages etc.) will need high quality energy professionals. The budgetary outlays in energy sector schemes meant for manpower training and deployment, will be aligned with the national skill development towards development of high quality energy specialists.

11.5. Unlike many other sectors, the Government within its overall HRD agenda cannot alone meet the manpower requirement of the energy sector. Not only are the needs of this sector highly technical for both the Government and educational community, the largely well capitalized energy sector is often looked upon as one

that ought to help itself. There is earnestness in the Industry as well, to engage with all stakeholders for a steady stream of supply of trained manpower. This calls for an active role for Industry in the HRD strategy for its own good, which can be well supported by the vast resources at its command. The global integration of the energy sector and its nature being such that R&D plays a significant role in cost cutting and enhancing the efficiency of operations, there is a vital role for a HRD policy within the NEP. A strong coordination and management apparatus for energy sector HRD, as proposed herein, is expected to fill this role.

Chapter 12

Technology and Research and Development

12.1 Technology can help in enhancing supply of energy at affordable price, and deliver it efficiently and sustainably. While India has been at the forefront of technology deployment but not of development. We have been cognizant of the importance of technology in energy as is evidenced by early adoption of initiatives on smart grids, LED, deepwater oil/gas exploration and a dedicated target for Concentrated Solar Power technology (CSP). It is a matter of pride that the private sector led the induction of many of these cutting-edge technologies, aided by the large Indian energy market. However, a lot more needs to be done. Recent disruptive technologies, such as hydraulic fracture of shales for oil/gas extraction, high efficiency low emission power generation (HELE), coal to liquid (CTL) and high efficiency solar photovoltaic (SPV) cells, have all been developed elsewhere. If India were to promote technology development domestically, it could direct the efforts towards our local problems, rather than wait for the solutions to be developed abroad. It is easier for us to induct new technology when creating new infrastructure, rather than retrofitting. Therefore, India has the opportunity of erecting a brand new, technologically advanced energy system. The NEP offers a perspective on the strategy to achieve the objective of faster uptake and development of technology, both from overseas and local sources.

12.2 Buy or develop

India needs technology, and if the relevant technology is not available anywhere, then we have to encourage R&D. That is why the NEP deals with the two topics of technology and R&D at the same place. India spends a fraction of the global expenditure on R&D. This suggests that we need an ecosystem for absorbing latest technology from abroad. In some sectors such as oil and gas, technology is developed either by industry players themselves or by service providers, and cannot be bought out. PSUs are dominant in several Indian energy sub-sectors, and need to adopt imaginative procurement processes. Conversely, in many cases, India's unique energy resource endowment and challenges, may require a dedicated R&D pursuit. Here, the role of Government assumes significance. In a nutshell, we will not be averse to procuring available technologies, and also be ready to pursue research and deployment, and even extend support to R&D where required. The India sponsored International Solar Alliance (ISA) is a good example of the latter. We have to provide for a pro-active policy approach for technology induction both by procurement and incubation.

12.3 Technology gaps

While energy technology is a vast area and it will require some effort to identify our own gaps and match them with globally available technologies, yet, we are aware of some broad areas. On the demand side, energy efficiency holds a large promise for technology

induction. It is also directly inked with India's NDCs as efficiency reduces energy intensity. Technological interventions in transport, industry, agriculture and household can save costs, and reduce energy demand. EVs are an area of huge interest to India as it holds the potential of reducing the demand for liquid fuel. On the supply side, which is the prime focus of the NEP, we need technology particularly in augmenting our energy sources in areas of exploration, evaluation, development and production. India is poorly explored for oil and gas, and has not been able to optimally exploit its other energy sources, too. New technologies such as gasifying coal at higher depths, tapping the heat value of solar energy, developing hydrogen as a source of energy, are highly relevant to India. The opportunities exist beyond new technology development, to deployment as well. Raising the efficiency of power plants by induction of ultra-critical/IGCC technologies, offshore wind energy, grid balancing under high renewable scenarios and micro-grid development are some examples of deploying technologies already in practice in the world. In order to proceed effectively, a detailed analysis will be needed.

12.4 Technology - Way Forward

The way forward in induction of technology is discussed as follows:

12.4.1 An industry-academia alliance is best suited for identifying areas for technology induction. This initiative will be led by BEE in the demand sectors, and by sector-specific energy ministries in supply sectors.

12.4.2 Energy access, exploration/evaluation, production, alternate technologies and energy efficiency will be the main areas of technology focus.

12.4.3 A technology roadmap will be laid out for different energy sub-sectors through the exercise of the alliance as stated above. This will guide the efforts over the medium term especially as results can only be achieved over time.

12.4.4 The Government will supplement private sector efforts in technology development through its dedicated agencies/PSUs in different energy Ministries, and Department of Science and Technology (DST) as well as Department of Bio-Technology.

12.4.5 The Government may place its fund with the technology developers and allow operational freedom by maintaining an arms-length relationship.

12.4.6 Diplomatic Missions abroad will be harnessed in tapping the Indian diaspora in providing guidance to the technology related efforts, especially from reputed technology centres at select locations.

12.4.7 Many technology providers are unwilling to part with technology, but offer partnerships on a variety of terms. In some cases, such procurement may not be amenable through established processes. Our PSUs will make imaginative

arrangements to access technologies, and be open to engaging with technology providers on risk-reward basis.

12.4.8 Technology related efforts will be dove-tailed with the Skill India Mission to have a symbiotic relationship between the two.

12.4.9 The energy Ministries require technical advice at top levels which is often missing. Therefore, a position of Chief Technology Officer (CTO) will be created in each energy Ministry for guidance, supervision and technology related initiatives.

12.5 R&D Strategy

As discussed earlier, technology development and R&D efforts go hand-in-hand. Many of our felt needs may not be a high priority area for the scientific community abroad. The strategy for developing technologies locally through R&D will be as follows:

12.5.1 The Government recognizes its role in supplementing commercial R&D. While technology may have many suitors, it is R&D which struggles due to investment risk. Therefore, Government will enhance its support to energy R&D.

12.5.2 The Ministries will deploy the new mechanism created for technology development herein to identify the areas of R&D pursuit.

12.5.3 A distinction, however, is needed to be made between fundamental research and R&D for applications. India offers a vast potential for research in energy sector deployment.

12.5.4 Many emerging sectors such as clean coal technologies, CCS, hydrogen as a source of energy are been actively pursued abroad. The Ministries will support joining international R&D where it is felt useful.

12.5.5 Policy research has a great relevance in deployment by suggesting practices to make new products/technologies financially viable. Hence, the Government will also support such research in technical centres.

12.5.6 Laboratories operated by CSIR and other scientific ministries will be mainstreamed with related energy Ministries to make their research productive. A linkage will be provided through the newly created position of CTO.

12.5.7 The research facilities operated by energy sector PSUs such as ONGC, NTPC, and CIL hold a vast potential for peer reviewed research. They will be made autonomous for greater independence and accountability on the lines of National Institute of Wind Energy (NIWE) and National Institute of Solar energy (NISE).

12.5.8 Financial incentives/tax reliefs will be offered to encourage energy related research in the private sector.

12.5.9 R&D cannot be incubated overnight. An ecosystem to support it will be created in due course, by forging a closer relationship between the industry and academia. Longer duration joint research projects will be initiated in consortium between government and companies.

12.6 Technology and R&D are critical inputs for the Indian energy sector. The value proposition of the above in improving the energy parameters of the country is recognized. Funds, relevant technical manpower, institutional support and an appropriate ecosystem are vital for technology to flourish. The NEP proposes to bring the above ingredients together. A quick resolution to harnessing India's energy resources, and delivering energy to its vast un-served citizens through low-cost options, can be fast-forwarded by technology supported by R&D.

Chapter 13

Overseas Engagements

13.1 Introduction

The NEP views energy security in terms of assured supply. Until domestic sources, particularly the renewable ones, become available in larger volumes, our import dependence for energy supply is set to increase. With high import dependence for commercial primary energy supplies, India has a vested interest in deep overseas engagement across stakeholders. While increased import dependence is an inevitability, it also offers an opportunity. Our galloping energy demand needs investors, both domestic and overseas, to create the infrastructure, our companies can tap opportunities abroad to bring the energy supplies. As import dependence rises sharply by 2040, there is every reason that Indian companies seize a large share of the overseas energy business. There are a number of other interests, too, as enumerated below that justify an effective overseas energy strategy:

- Accessing latest technology
- Overland energy supplies through pipelines and transmission lines
- Leveraging our large buying position to influence energy markets
- Playing a lead position in international energy organisations
- Climate policy diplomacy to protect our energy strategy
- Collaborating in large international consortia based research.

13.2 Due to a variety of overseas energy interests, the number of stakeholders and nature of engagement is also broad. We have developmental, commercial and strategic roles to play in the international arena, all of which call for a comprehensive strategy. The launch of the International Solar Alliance by India at COP21, is one example of the emerging role of India as a world leader in promoting clean energy solutions, while assisting the emerging nations meet their energy needs. On the other hand, we need to secure stable, long-term and attractive commercial contracts for supply of oil, LNG and electricity from renewable sources, especially in the northern Himalayan region. Then, with Indian energy demand likely to comprise nearly 40% of the additional global demand upto 2040, we have a vested interest in influencing global energy architecture by participating actively in international energy organisations. The energy sector Ministries and Ministry of External Affairs will pursue the overseas strategy set forth in the NEP. However, an overarching coordination mechanism will be created, particularly to engage across energy issues with institutions that handle omnibus energy issues at the global level.

13.3 Mixed Results

There has been a lack of clarity across the board on the objective of our overseas strategy, and success is usually measured merely on the parameter of acquisition of overseas assets. Our companies have been engaging internationally for over two decades, but no more than 5% of our domestic oil requirements are being produced from their overseas assets. However, in the recent past, there has been an overwhelming success in securing oil and gas assets by our companies, and this number is set to increase. There is some success also in accessing hydro-power from the Himalayan neighbours. The poor success of the past has often been viewed as a failure of our overseas energy strategy. While it is important to scale-up our equity oil production, what is lost sight is that our National Oil Companies have achieved laurels in many other ways. NEP offers clarity to our overseas agenda. We are the world's fourth largest energy consumer, and have to protect our energy interests in a number of areas. While we have to enhance our commercial engagement, we have to also advance a variety of other interests.

13.4 Challenges

It is useful to list the challenges faced in the past while engaging internationally. An appreciation of the same would help in drafting a suitable strategy. The following appear as the prominent ones:

- Lack of clarity on the objectives
- Slow decision making in acquisition proposals
- Geo-political disturbances, mainly in the Gulf
- Lack of coordination between diverse energy Ministries
- Poor utilization of the capability in our Missions
- Ineffective participation in international organisations

13.5 Strategy

It is proposed to address the above by adopting the following strategy:

13.5.1 The objective of our overseas energy strategy is to support domestic energy policy through international engagements. The aim is to reduce imports and diversify them, promote the interests of Indian energy companies, attract investment, and engage effectively with international energy organisations.

13.5.2 The increasing integration of the world reflected in rising trade of energy, offers an opportunity to India as well. We will diversify our energy imports by securing long-term supplies across all energy sources —oil, gas, electricity, nuclear fuels and coal — from all regions, including our immediate neighbourhood. The above strategy of bringing

energy supplies from our own overseas assets will fit in well with greater inter-play between market forces in domestic energy market.

13.5.3 The over-supplied energy markets offer an opportunity to India to leverage its large buying position for a number of energy sources. This will be effectively used to acquire assets and also seek beneficial energy supply contracts. Imaginative purchase contracts will be struck that give us price and volume flexibility.

13.5.4 There exists an opportunity to forge strong links through energy trade in our neighbourhood, including balancing our electricity grid by inter-connecting with the south Asian grid, as well as sourcing renewable energy from as far as central Asia, and as close as Sri Lanka and Bhutan.

13.5.5 Overland oil and gas supplies from central and West Asia will be secured by pursuing the existing and new opportunities. The TAPI and IPI gas pipeline projects must be pursued earnestly keeping in mind the evolving geo-political situation in the region.

13.5.6 The NOCs will be given greater freedom to take commercial decisions without the requirement of multiple clearances, consistent with devolution of financial powers. Necessary diplomatic assistance will be given to support our companies.

13.5.7 An effective diplomatic initiative will be undertaken with the international community to protect the engagements of our companies. Our companies can also benefit from a commercial orientation where required, without losing time for government-to-government deals which are usually time-consuming. This will also improve accountability and speed up decision making.

13.5.8 Unlike many large countries that have an omnibus energy Ministry, absence of a unified face to the overseas counterpart in India leads to a challenge. A separate coordination mechanism will be created in MEA to effectively promote India's energy strategy internationally. Moreover, there is a need to realize the benefits of the presence of Indian technical diaspora abroad. Indian Missions would seek their assistance for technology and manpower access.

13.5.9 When engaging internationally, energy security should take primacy over other considerations, especially as India's energy imports are expected to rise alarmingly in the medium term. Therefore, we will source energy to promote energy security on the basis of sound commercial decisions.

13.5.10 Our large energy programme will require high fossil fuel dependence even while we ramp up renewable energy supplies over the medium term. The energy supply and affordability agenda calls for greater involvement of energy experts in engagement with international climate change community. The line Ministries will play an active role in overseas engagements.

13.5.11 Energy technology and policy are evolving rapidly across the world. Adoption of the above offers opportunity to suppliers and consumers commonly. Our energy Ministries and private sector need to engage effectively with international community to access the above through joint programmes.

Chapter 14

Air Quality

14.1 In recent years, regulatory action and court mandates have been demanding technology upgrades and ameliorative action for this sector like never before. This has impacted the bottom lines of energy related companies as well as energy prices. The NEP clarifies the Government's stand on air quality concerns, with a view to convey its position so that the industry can take appropriate steps, while assuring the citizens of air quality concerns. Energy use and environment are closely linked. As per India's Biennial Update Report (BUR), nearly 75% of GHG emissions came from energy sector in 2010. The poor air quality in India particularly in urban centres where energy is used in concentrated areas, calls for bold action through energy policy as a part of the overall environment strategy. While climate change is a more complex issue of global dimension, but local air quality is a direct outcome of domestic actions. The NEP acknowledges sustainable use of energy as one of its overarching objectives, with sustainable habitats as a co-benefit from deployment of sustainable energy sources. This calls for action on the two components of clean energy space — energy efficiency and renewable energy — both of which have been discussed in detail elsewhere in the NEP. Often, the above interventions are looked upon merely as means to augment energy supply, without acknowledging the environmental co-benefit. The proposals herein address this precise issue by focusing on air quality concerns, through coordination between multiple agencies, while meeting energy needs of the country.

14.2 It is evident that air quality objectives cannot be achieved without the desired environment related investments in the energy sector, both in generation and consumption. The poor commerciality in energy business (including cost plus regime) led to cost-cutting with harmful effects on air quality. The new norms of water and air quality notified by the MoEF&CC desire course correction. The former are mindful of the cost implication being liberal towards older coal power plants, but do provide a roadmap for ultimate improvement in emissions. The power sector is likely to be impacted adversely and may need to retire some coal plants (over 25 years of age) on commerciality-cum-efficiency consideration, or seek moderate hike in tariffs or put them in reserve category. It would be prudent to take a long-term view and move towards efficient operations while conserving scarce water resources and also meeting air quality emission norms. Transport sector is already moving in the direction of compliance, aided by soft crude prices.

14.3 It has to be appreciated, that a number of sectoral policies have to work in unison to achieve clean habitats. The National Environment Policy mainstreams environmental concerns in all developmental activities, and is implemented through a slew of statutes and regulations. Indian energy sector is required to develop future energy sources consistently with the above Policy. On the other hand, the NEP assures that India's energy demand will be fully met in a cost effective manner, providing the roadmap both on energy demand and supply sides. The air quality objective demands that inputs related

to technology, behavioural change and demand reduction are integrated, mainly in the following energy consuming areas — transport, household and electricity sectors — and urban planning. Even the agricultural practices, particularly post-harvest ones, have to be mindful of air quality concerns. Within the above sectors, the national transport and urban policies are dedicated towards provision of effective transport facilities and sustainable habitats to the citizens. In order that air quality is not vitiated by energy pathways in all energy consuming sectors, following steps will be taken:

14.4 Transport Sector

14.4.1 Public transport

14.4.1.1 Public transport system could reduce energy requirement. For this to happen, a slew of measures need to be taken including promoting domestic capacity for manufacturing and deploying of buses and other public transport vehicles in the country.

14.4.1.2 There is a need to classify public transport and non-motorised transport (NMT) as essential service, and provide subsidies to public transport.

14.4.1.3 Technological innovation and other strategies will be promoted to bring down the cost of hybrid and electric public transport vehicles.

14.4.1.4 CNG vehicles need to be promoted by rolling out city gas distribution (CGD) projects and pricing liquid transport fuels on market driven principles. Diesel vehicles may be discouraged until clean diesel becomes available on a nation-wide basis.

14.4.1.5 Efficient implementation of fuel efficiency regulation and improving fuel quality need to move in tandem.

14.4.2 Private transport

14.4.2.1 An analysis of total emission over life of different modes of transport options is critical to decide about the appropriate mode of transport. The policy to promote electric and hybrid vehicles needs to be supported. Other policy options should be explored to arrive at optimal solutions and incentives to decide whether to support expensive technology; or to give subsidies. The success of efficiency in private transport depends on progress in mass transport system such as metro rail. Further widening taxation differential between cars (higher tax for big cars/ SUVs) will

promote adoption of more fuel-efficient cars.

14.4.3 **Non-motorised transport**

14.4.3.1 Energy consumption of transport, particularly urban transport, is directly proportional to the number of trips multiplied by the trip length; so the solution is to reduce the number of vehicular trips and check pollution. Building transit-oriented cities much help in reducing trip lengths. Further, promoting non-motorised transport is a key intervention, which is a behavioural aspect. Provision of footpaths, and encouraging cycling is strongly recommended.

14.5 Household Sector

14.5.1 Clean and affordable supplies must meet the household sector energy needs. The present distinction between well supplied urban centres, and poorly served rural areas has to give way to an even dispensation. The following interventions are a must in both urban and rural settings, which display different challenges of air quality arising out of different energy footprints.

14.5.2 Electricity is the most efficient source of energy for lighting, cooling/heating and cooking. The Government is committed to supplying all habitations with 24x7 electricity supply by 2022.

14.5.3 Until universal electrification is achieved, there will be a need to meet the lighting needs by clean non-electricity based solutions. As kerosene is a highly polluting fuel, off-grid solutions through renewable energy will be the preferred source.

14.5.4 LPG and natural gas best serve cooking needs, until electric cooking becomes acceptable as per behavioural choice. This is discussed elsewhere under this Policy. The role of efficient cook-stoves is manifest as long as solid biomass serves as the cooking fuel, especially in rural areas.

14.5.5 Cities need to adopt natural gas as the transport and cooking fuel for clean air. The displaced liquid fuels would ease petroleum imports, while LPG can be diverted to rural areas.

14.6 Power Sector

14.6.1 Electrification of energy demand

Electricity and hydrogen are carriers of energy and do not pollute the environment at the point of consumption. The share of electricity in energy demand was 17% in 2014, and needs to be stepped up to check air pollution in habitations. Efforts will be made to substitute solid and liquid fuels with

electricity across consuming sectors. This would help in demand of renewable power, too, whose capacity is being ramped up as a conscious policy.

14.6.2 **Phasing out old, inefficient coal fired power plants**

In the long term, India's power generation sector faces the challenge of adding capacity expeditiously. However, there needs to be environment consciousness in generation. Older plants that guzzle fuel and emit large volumes of fumes, especially close to cities, need to be phased out.

14.6.3 **Geographic concentration of power plants**

New power plants ought to be so sited that they do not damage air quality in human habitations. Water supply to power plants ought to be priced as per its scarcity value, so that concessional water tariffs do not spur growth of thermal plants in water stressed regions.

14.6.4 **Clean coal technologies**

India's dependence on coal is expected to remain high. But, the Indian coal is known to have high ash content and low calorific value, which aggravates the air quality via poor thermal efficiency. Two major technological solutions need to be worked on are (1) washing of coal with minimum or no water consumption and (2) gasification of coal for power generation, through IGCC. Both these technologies will bring down the particulates as well as gaseous pollutants. At present, India has not joined the global research for CCS technologies even though this technology has high relevance for us. India needs to join the international efforts underway through the consortia approach.

14.6.5 Energy from Biomass

The aggravation of urban air quality standards by stubble burning can be turned into an opportunity by promoting power plants based on agri-residues. A comprehensive Bio-energy Policy would lay the roadmap for promoting these plants which would also harness this resource, while addressing air quality concerns.

14.7 **Cross-border electricity trade (CBET)**

India's northern neighbours have a huge hydro-power potential — Nepal 83 GW and Bhutan 30 GW. Exploring cross border electricity trade among the South Asian nations by developing competitive market, will help India to optimize the utilization of its grid and also meet electricity need through clean sources. Balancing of the grid will be better due to varying peaking demand across in different time zones across the east-west expanse of the South Asian grid.

14.8 Urban Sector

14.8.1 Improving air quality cannot merely be a function of low emission technologies, and is also impacted by efficiency of transportation and uptake of clean energy. Smart city planning includes providing adequate transport spaces and transit orientation. Circular roads, Metro rail and MRTS facilities ought to be provided in city planning.

14.8.2 As land prices are generally high in India, it is important to provide for fuel stations and electric charging stations in city planning, and consider them to be public utilities in determining the land rates.

14.8.3 The municipal charges for laying natural gas pipelines in urban areas ought to be based on no-profit basis as substitution of liquid fuels by gas is environment friendly.

14.8.4 The building bye-laws must provide for laying of natural gas pipelines and provision of gas connections in homes on the lines of power and water connections.

14.8.5 The city plans must provide for storage (dumps) of fuels at safe locations away from human habitations while simultaneously, being well connected to transport facilities for receipt and evacuation of fuel.

14.9 Other Interventions

Beside focused action on above specified issues, an invigorative ecosystem is essential to drive clean energy deployment via investments in multiple areas. Global environmental concerns are spurring clean energy technologies and green growth. Our energy pathways must be ready to assimilate the emerging technologies which are likely to become affordable as they mature and scale-up. The cost of externalities will also need to be factored into costing so as to promote the viability of cleaner options. Urban administrations need to take note of the above, and harness such investments in economic growth. Additionally, there is a need to address the heating requirement of Industry through clean energy sources, as heat comprises the major share of Industry's energy requirement. This calls for a 'Heat Strategy' which will be drafted by NITI Aayog deploying clean energy sources. Similarly, space cooling is likely to emerge as a major energy guzzler and a dedicated strategy to provide efficient cooling solution needs to be devised for the country. Looking to the inter-sectorial issues in the wide area of clean energy as discussed above, an inter-ministerial empowered agency will be set up to oversee implementation of these provisions.

Chapter 15

Conclusion

India Vision 2040

15.1. The NEP aims at supporting the Indian ambition to emerge as a well-developed and resilient economy with high level of human development. Additionally, it helps prepare the nation to anticipate the technological and market related changes in the energy sector. What will India's energy sector look like in 2040? India Vision 2040 aims to answer the above precise question. Demand-driven provision of energy at affordable prices, high per capita consumption of electricity and access to clean cooking energy and electricity with universal coverage, low emission and security of supply will characterize the energy parameters of India in 2040. The energy mix will also undergo a transformation with preponderance of renewable technologies, storage solutions, smart grids and enlightened consumer behaviour becoming the order of the day. We attempt here to present the NITI Ambition Scenario (NAS) 2040 — energy in India in 2040 — the expected energy status of India, via the NEP. The NAS has been developed so as to provide a range of implications for the Indian energy sector (Annex 1). The range represents the outcome scenarios if India were to follow a business-as-usual path versus if it were to transition to an ambitious one — cleaner and more sustainable pathway. The policy mandate has to be linked to the latter.

15.2. **Access and availability**

The Annex 1 offers an overview of the Indian energy sector as envisioned for 2040. The foremost objective of the NEP is to banish energy poverty from India and make energy available to all its citizens. In 2040, nearly a hundred years since Independence, every Indian must have access to all forms of energy as per choice, in desired volumes. The total energy supply in the country is expected to go up by a multiple of around 3 times over 2012. This will translate into 1055-1184 kgoe per capita energy consumption, (it was 500 kgoe in 2012), including 2911-2924 kWh per capita electricity consumption (887 kWh in 2012). A high level of efficiency ensures that even at a moderate level of per capita energy as well as electricity consumption, an average Indian is able to fulfill all his energy needs. The good news is that with fuel switching in favour of electricity, its share is higher in energy demand in 2040. The above supply at approximately 3.6%-4.3% CAGR over 2012-40, is expected to meet the energy requirement for a minimum quality of life of every Indian. Robust energy markets will enable the spread of infrastructure to make energy available across the country.

15.3. **Energy Security**

The energy mix of India will have a high share of renewable which will sustain the present self-dependence scenario. India had imported nearly 31% of its primary energy in 2012, with 77% and 22% of oil and gas imports, respectively. The share of renewables (excluding biomass) was 3%. In 2040, with renewables comprising 7%-10% of India's energy mix, the overall import of primary energy is expected to rise substantially. Oil and gas imports will be responsible for the rise in imports, and are estimated to rise to 81-88% and 35-51%, respectively. Therefore, while registering a 2.7-3.2 times growth in energy supply, the country's dependence on overseas supply is expected to increase. On the other dimension of energy security, namely supply assurance, with widespread expansion of energy infrastructure, storage solutions and inter-connectors with other countries in the region, it is hoped that there will be high levels of confidence, devoid of supply threats. Even technology is expected to play a major role, as the share of electricity in final energy will have risen to 23-26% in 2040 against 17% in 2014, with almost all demand sectors becoming amenable to its use. We are aware that power supply is inherently a more dependable source due to its inter-connectedness, and also due to local deployment of renewable electricity.

15.4. **Equity**

Increased urbanization and rural transformation will have by and large removed the developmental distance between the rural and urban settings. The modelling assumes similar levels of per capita energy consumption in rural and uraban areas by 2031-32. While their energy consumption parameters may be different, but rural areas would not lack commercial sources of energy. Solid biomass is expected to be replaced by liquid and gaseous fuels, and electric cooking will be a major practice across the country. Around 30% of the rural households will remain dependent on solid biomass for cooking. The Government's target of universal electrification by 2022 would have addressed the issue of clean energy source, much before the terminal year of the NEP. As mentioned earlier, electricity will be the major form of energy use, and the large off-grid renewable agenda will contribute significantly to its widespread availability. Market framework will address the issues of delivery mechanism, which are presently a major challenge for the public sector agencies.

15.5. **Affordability**

The pricing, subsidy and affordability aspects of energy supply will undergo the most dramatic change of all. The country will have transitioned to direct benefit transfer (DBT) to the meritorious, and also make it possible for the vulnerable sections to exercise choice in procuring their preferred source of energy. This will further promote markets and competition, which will have become the norm in the larger context. The IESS 2047 modelling exercise reveals that the transition to cleaner energy in the case of India Vision 2040, will be a cheaper pathway than the default one in terms of consumer spends, however, capital intensive. Without the

7%-11% share of commercial energy coming from renewable sources, Indian energy market would have become more dependent on global volatile energy markets (imports have the potential to reach 41-59**%** of primary commercial energy in 2040 from 36% in 2012, depending on the pathway that the economy follows). Hence, competitive markets, combined with higher share of cheaper renewable sources and efficient subsidy delivery mechanism, will make energy affordability a non-issue.

15.6. **Energy mix**

In an increased electricity share, while in the immediate run-up towards universal coverage of electricity it may not be viable to tap rooftop solar for homes, but by 2040 it would have become the norm. The share of solar and wind is expected to be 14-18**%** and 9-11**%** in electricity, and 3-5**%** and 2-3% in the primary commercial energy mix respectively. The advent of EVs will have helped curb a rise in share of oil and environment friendly gas would substitute oil in many uses. However, the share of oil and gas would have almost maintained their shares of 26% and 6.5% in 2015-16 to 25-27**%** and 8-9**%** in 2040, respectively. In spite of a more than three times increase in gas consumption, owing to large increase in total energy, the increase in gas would be less in percentage terms. While coal would have risen in absolute terms (nearly double), but in relative terms, it would have reduced its contribution from 58**%** in 2015 to 44-50**%** in 2040. The overall share of fossil fuels would have come down from 81**%** in 2012 to 78**%** in ambitious pathway in 2040.

15.7. **Energy markets**

In 2040, the Indian energy market will have fully evolved with supply rising to meet demand on the basis of competitive markets. The trend of rising private sector share in supplies of electricity, oil, gas, coal, and renewables — both in production and trade — will transform the market by 2040. The market size will be nearly 2.7-3.2 times the present, and public sector's contribution will have been much reduced, other than in coal production and nuclear power. The latter will be an outcome of the statutory provisions reserving the public sector's business, rather than of the economics of these sectors. As subsidies will be in cash rather than in kind, the private sector will also be able to deliver energy to the targeted sections of the society, and be an active participant of subsidy schemes. So far, subsidised energy delivery has in parts been reserved for the public sector. India will be integrated with global energy markets and be an active energy trader with its neighbours, including central and west Asian ones. Long term energy supply contracts will be the norm, and prices will be aligned with international ones.

15.8. **Structure of the Industry**

The present scenario of energy companies specializing in their sub-sectors is expected to undergo a change, with companies integrating both forward and backward. With increased globalisation, emergence of mega-super majors will

threaten national companies, leading to amalgamations in the latter space, too. As the share of electricity is likely to increase from 17% in 2014 of energy demand to near 23-26%, there will be a natural tendency of integration (both forward and backward) for energy producers (coal, oil and gas) to tap the power market and become generators, just as power producers are trending towards picking up coal mines. In later years, as generation/refining plateaus, there will be a tendency to move towards distribution as well. This will also lead to consolidation and emergence of large integrated energy players, reaping the economies of scale afforded by the large energy market. The role of markets having become manifest, energy will be freely traded and competition will achieve benefits for the customers. The local endowment of energy resources will influence the energy mix in nearby markets as will be witnessed in the north and north east, where hydel power may play an important role. The coastal south and west India, being close to the oil/gas rich West Asia, will witness a more significant role of LNG, including imported coal based plants. However, the emergence of a robust national electricity grid will ensure a single power market.

15.9. **Infrastructure**

Enhanced energy supply will require a large expansion in energy infrastructure along the entire value chain, and will have been created during the period up to 2040. Just as the country is going in for optic fibre backbone across the country, gas pipelines and electric transmission lines will have net-worked the entire country. LNG terminals, city gas distribution grids, strategic and commercial oil and gas storages, renewable energy projects (both grid connected and rooftop) will have sprung up to deliver energy to all parts of India. India has the advantage of offering a new market, for which latest technology will be the norm in infrastructure creation. It is acknowledged that it is more cost effective to adopt latest technology when building new rather than retrofitting, which is the case in the West. The advent of new technology and cost reduction in storage options (battery among others), will facilitate exploitation of the abundant renewable resource. The near 30-35% share of renewable energy in electricity mix will see a different kind of infrastructure — distributed and decentralized — than the capital intensive and centralized ones that exist in the West.

15.10. **Government as an animator of markets**

The Government will have gradually moved into the role of a facilitator rather than an active player. Energy will be sourced from wherever necessary, domestic or imported sources, and sold at market prices. The Government, directly and through its agents — PSUs and Regulators — will help create the conditions for suppliers and demanders to meet in the market. The role of Government as a welfare state will be carried out efficiently, by not loading the subsidies on businesses, but through its own coffers where necessary. It may even socialise costs. In some processes, such as technology development, R&D, HRD and infrastructure, Government may step in to reduce capital risks both by policy interventions and

providing seed capital, but will otherwise remain an animator rather than an active participant. The large capex of $3.6 trillion in the energy sector upto 2040 (IEA) will be a major target to strive for by the Indian policy makers. This translates into nearly $150 billion per year, mostly in the electricity sector, which is a quantum jump from the present. The above scenario will be realized by 2040 with energy being a major contributor to, and a recipient of support from, other economic sectors.

The NEP assumes a high GDP growth rate for India between now and 2040, and an equally high adoption rate of energy efficient measures. Hence, while there will be a significant growth in energy demand, but the energy intensity will be much lesser than now. This will be consistent with our NDCs. The large Indian energy market will drive competition between sources of energy and also within the same source. The role of markets in lowering the price of solar and wind energy and LED bulbs has already been witnessed, as has the role of markets in driving technology been recognized in the exploitation of shales in the US, through horizontal drilling and hydraulic fracture. Smart grids and storage solutions hold a great future for a country like India that wishes to achieve a large share of renewable electricity. Therefore, markets and technology are expected to define the energy scenario of India in 2040, called the NITI Ambition Scenario (NAS), 2040.

15.11 Monitoring and Coordination Mechanism

The NEP envisages interventions across multiple Ministries, over an extended period of time. This will call for a standing arrangement for overseeing its implementation. A twin mechanism will be created to monitor progress of the proposals contained in the NEP, and also coordinate the efforts of different Ministries. A Steering Committee comprising of Ministers of the relevant Ministries chaired by the Prime Minister will be created to review the progress of implementation. This would be serviced by the NITI Aayog. The second Committee to help in inter-ministerial coordination towards implementing the proposals would comprise Secretaries in the relevant Ministries, would be chaired by the CEO, NITI Aayog.

Annexure I

NITI Ambition Scenario (NAS)

The NEP aims at meeting the objectives as set out in Chapter 2. In order for India to realize the India Vision 2040, demand sectors ought to adopt efficiency, while domestic production of all sources will need to be stepped-up. The following discussion explains what results can be realized by adoption of policy prescription outlined in the NEP. The NITI Ambition Scenario (NAS) is a set of two bounds of energy demand and domestic production, sector and source wise, respectively. The higher demand and lower domestic supply comprise the BAU, while the ambitious scenario comprises lower energy demand and higher domestic production bounds. Understanding the potential scenarios that India's energy sector may witness in the years to come is essential both for planning, and policy formulation in the sector. Additionally, the building blocks of the energy sector have huge cost implications and relatively long lock-in periods. **The NITI Ambition Scenario aims to present a range of possible energy implications for the country till the year 2040**.

Basic Premise of the NAS

This analysis acknowledges the fact that the results of several national energy and climate modeling studies for the Indian energy sector may diverge widely, depending on the modeling approach utilized. Being cognizant of the same, this exercise does not propagate any particular pathway or numbers. The NITI Ambition Scenario uses the India Energy Security Scenarios, 2047 – an energy scenario building tool developed by NITI Aayog, to arrive at **a range of possible energy futures** for the Indian energy sector till the year 2040 (www.indiaenergy.gov.in). The main aim of this analysis is to give a possible direction to the planning process of the country, and aid the formulation of interventions in terms of policy measures, institutional mechanisms etc.

The range presents the scenarios which India may follow if it were to follow a **business-as-usual path versus if it were to transition to an ambitious pathway which is cleaner and more sustainable.** The assumptions entailing this scenario are presented in the following pages. The former is nevertheless ambitious, too, as it incorporates the Government's recent announcements on Renewable Energy target, emission intensity reduction, share of non-fossil fuel capacity in the electricity mix etc. However, the latter is yet more ambitious on adoption of energy efficiency and clean energy. The above would also result in higher self–reliance in energy. It may be noted that the IESS, 2047 is simply used as a platform for the determination of this scenario. As the assumptions, and the GDP growth rate etc. of the NITI Ambition Scenario differ from that which are pre-programmed in the IESS, 2047, suitable changes have been made in the IESS, 2047 to arrive at a scenario from which implications can then be derived. These changes are also discussed in the following sections.

Fixed Assumptions

The projections are based on certain assumptions relating to likely GDP growth, population, level of economic activity etc. which would impact the demand for energy. While short term

projections can be made using historical growth rates, however, medium term ones require a deeper analysis. The NAS was finalised after consulting multiple agencies, and those assumptions were adopted which appeared to be most reasonable. A majority of these assumptions are in line with India's internationally declared targets. The following discussion elaborates the same so that the stakeholders may note the assumptions, and the basis of their adoption.

1. **Assumptions around the Gross Domestic Product**

The GDP of the economy is assumed to grow at a CAGR of 8% between 2012 and 2040. The growth rate gradually picks up and after plateauing in the short term, then it descends. The growth rate of 8% is largely in line with India's Vision, Strategy and Action Agenda for 2031-32 and various other International commitments. The growth rate of India is assumed to increase to 8.3% in 2027-32 interval and then comes down to 8.1% in 2037-40. This growth rate is a deviation from the three scenarios pre-programmed in the IESS, 2047. Exercise to determine how the activity demand of sectors change with a higher level of GDP were undertaken to arrive at the level of service demand for each sector.

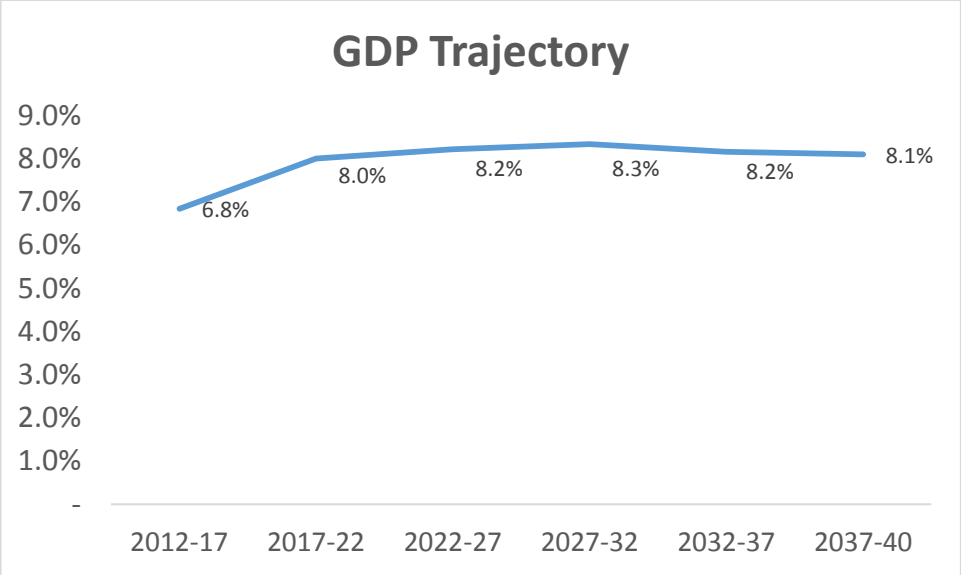


Figure 2

2. **Population and rate of urbanization**

The population of India is assumed to grow from 1.2 billion in 2014 to 1.6 Billion in 2040. (Population Foundation of India, Scenario B) The urbanization rate, in line with the patterns followed by many major economies, is assumed to increase to 47% in 2040. (United Nations World Urbanization Prospects 2014)

3. **Attainment of India's Developmental Ambitions**

The NAS assumes that all of India's recently declared developmental ambitions like Housing for All by 2022, Power for All by 2022 (All census villages to be electrified by 2019), 100

Smart Cities, and 175GW of Renewable Energy Capacity till 2022, will be met in their target years. The exercise aims to capture India's growth trajectory post-attainment of the targets.

Equal level of service demanded

The aim of this exercise is to show how efficiency and technological measures on the demand side could reduce the aggregate energy demand, thereby relaxing the amount of supply needed to fuel that particular level of energy demand in the economy. This generates two numbers for energy demand, one at lower level of efficiency (BAU), and another at heightened level. Therefore, the level of service demand in the analysis is constant, and the variations are due to efficiency and technological interventions. **The difference between the two levels of energy demand highlight the immense potential that interventions on the demand side of the economy can have on realizing the developmental goals of India in the years to come.**

Energy Demand:

The analysis captures the six major energy demand sector: Transport, Buildings, Agriculture, Cooking, Industry, and Telecom.

How the scenarios have been generated: The IESS, 2047 aims to capture 4 different levels of energy demand for each sector based on the adoption of energy efficiency and technology measures. Two pathways for the demand sectors, based on two different levels of efficiency and technology interventions are constructed, and the results are derived from the same. This analysis opts for the Business-As-Usual path and an Ambitious path in order to determine the energy demand for these two scenarios. In the latter path, energy demand falls due to adoption of energy efficiency and behavioural changes.

The major factors, among a variety of others, that have been considered on the demand side for this analysis are entailed below:

1. **Transport (Passenger and Freight Transport):** Transit oriented development, a shift towards Rail based mass transport systems, coupled with the development of the systems, and increasing investments to fuel the same, a shift towards Electric and Hybrid Vehicles, better logistical planning, assisted by information technology solutions to optimize route planning, concentrated economic activity in the form of logistical parks, industrial clusters etc., reducing the demand for Freight Transport, a modal shift towards rail freight, introduction of Dedicated Freight Corridors throughout the four legs of the Golden Quadrilateral, increasing electric traction in Railways etc.
2. **Buildings (Residential and Commercial):** A move towards using more energy efficient building materials for the construction of buildings (energy efficient building envelopes), strengthening of the Energy Conservation Building Code (ECBC) of the Bureau of Energy Efficiency, and periodic revisions of the same, coupled with increasing adoption of the same, better urban planning, adoption of high efficiency lighting technologies and appliances, market transformation to high efficiency appliances, and promotion and adoption of new financial models.
3. **Industry:** Increasing energy efficiency penetration in the Perform, Achieve, and Trade (PAT) scheme to move towards the best available technologies, energy

efficiency improvements in the processes of smaller units not under the PAT scheme, and a consideration of, and a move towards more disruptive technologies in the major energy guzzling Iron and Steel (Switch to electric furnace, Increased gas based direct reduced iron, Increased electricity from the grid, and Increased Scrap), and Cement sectors (Increased waste heat recovery, Increased electricity from the Grid, and Increased Alternate Fuels and Raw Materials). Since, the technology employed in ambitious pathway considers a shift from solid and liquid hydrocarbons to electricity, the electricity demand in ambitious pathway is higher than BAU in industry sector.

4. **Agriculture:** Increased efficiency of agricultural pump sets, a shift towards electric and solar powered pump sets, from diesel pump sets, and a reduction in energy demand from farm mechanization by introduction of fuel efficiency in tractors.
5. **Cooking:** A shift towards modern fuels for cooking (LPG, PNG and Electricity), and a continued improvement in the efficiency of LPG, PNG, Electricity, and improved Biomass cook stoves. This would lead to an increased demand for gaseous and liquid hydrocarbons and electricity in the ambitious pathway.
6. **Telecom:** A reduction in the specific fuel requirement of telecom towers by considering a shift away from Diesel, in favour of electricity and clean power solutions, and the deployment of green solutions to replace diesel.

The Potential:

Energy Demand:

TWh	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Buildings	238	568	525	1769	1460
Industry	2367	4010	3600	8764	7266
Transport	929	1736	1628	3828	3243
Pumps & Tractors	237	423	388	728	592
Telecom	83	131	124	207	164
Cooking	1072	829	684	524	467
Total	4926	7697	6949	15820	13192
% reduction in energy demand in 2040	17%				

Table 4

Segregation of Energy Demand by fuel:

Mtoe	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Solid Hydrocarbons	174	225	191	438	314
Liquid Hydrocarbons	150	244	224	492	415
Gaseous Hydrocarbons	30	66	62	115	104

Table 5

Electricity Demand (Final):

TWh	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Industry	336	492	457	1103	1278
Buildings	239	607	562	1819	1494
Transport	79	128	134	220	244
Agriculture	136	245	217	442	324
Others	14	38	50	94	99
Total	804	1511	1420	3678	3439
% reduction in electricity demand in 2040	6.5%				

Table 6

Share of Electricity in Energy Demand:

2012	2022		2040	
	BAU	Ambitious	BAU	Ambitious
16%	19.6%	20.4%	23.2%	26.1%

Table 7

Demand for Different Hydrocarbons:

Mtoe	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Solid Hydrocarbons	360	591	546	1041	783
Liquid Hydrocarbons	150	244	224	492	415
Gaseous Hydrocarbons	47	84	84	144	151

Table 8

Energy Supply:

The IESS offers options to generate the fuel mix on the basis of multiple factors — more domestically produced (fossil or non-fossil), cheaper, lesser carbon emitting and higher supplies from emerging technologies. The energy mix chosen to meet the chosen level of energy demand works on the principles of a reduction in import dependence, and a transition towards cleaner and sustainable supply options.

How the scenarios have been generated: Two pathways were mapped out in the IESS based on a transition towards cleaner sources of energy, and greater indigenous resource production. The scenarios on the supply side assume the meeting of the 175 GW of renewable energy target of the Government of India in 2022 and enhanced deployment thereafter. Two different paths, based on the development of a market ecosystem for these technologies have been assumed, and alterations in the trajectories of the IESS were done to achieve the same. Since, the ambitious pathway assumes a greater penetration of renewable and cleaner sources of energy, the energy supply from the same would be greater in ambitious pathway than BAU. Similarly, the energy supply from coal and oil would be lower in ambitious pathway in comparison with BAU. Suitable options in terms of providing for adequate storage capacities, and gas power plants, to balance the renewable energy, and dialing back of coal power plants when the large amount of renewable energy kicks in has been attempted. Newer source of fuel like Hydrogen for the Telecom and Transport sectors has also been considered. Although the IESS has been used as a platform for constructing this scenario, alterations have been done in order to keep pace with the India's developmental goals, and its international commitments.

The supply side of the analysis, among a variety of other factors, brings together:

1. **Higher domestic fossil fuel production**: Mechanisms to augment indigenous resource production, with an aim to reduce import dependence have been taken into consideration. This results in higher domestic coal, oil and gas production. Apart from conventional fuel supplies, unconventional resources such as CBM, UCG, and shale oil/gas would also contribute to the domestic production. .
2. **Thermal Power Generation**: Commercialization of newer, and cleaner technologies (e.g: Ultra Supercritical and IGCC technologies in Coal based generation etc.), would lead to their increased penetration. Enhanced Gas based power generation capacity is well acknowledged to encourage cleaner sources of power generation along with balancing requirement for renewable energy capacities. The potential for CCS in coal and gas based generation capacities in the medium to long term is also taken into account.
3. **Renewable Energy (Renewable Energy)**: Apart from attainment of 175 GW of Renewable energy capacity by 2022, the creation of a market and facilitating mechanism for renewable energy post the target year 2022 would lead to its increased adoption by autonomous growth. Solar CSP and offshore wind capacities would also contribute to the Renewable Energy generation capacities other than solar PV, Distributed SPV and onshore wind.

4. **Hydro and Nuclear Power Generation**: There has been dismal addition of around 2 GW of large hydro power generation capacity in the 12th five-year plan. However, this exercise seeks to exploit the hydro-power potential of the country. India's nuclear power generation capacity would further diversify the sources of electricity generation. The commercial operation for Kudankulam unit 2 is expected to commence in mid-2017, whereas new plants – Kakrapar, Kota and Kudankulam units 3 & 4 are also expected to bear fruit. The Government has also approved 10 new PWHR reactors of 700 MWe capacity each.
5. **Storage Capacities**: Increased storage capacities would be established to meet intermittencies due to a high supply of electricity from renewable sources.
6. **Biofuels:** Enhanced use of liquid biofuels (1st and 2nd generation, advanced biofuels) would curb the country's oil imports. And biogas could be used for cooking in rural areas.
7. **AT&C:** A reduction in AT&C losses, introduction of Smart Grids, and electricity imports and exports is considered while drawing the two scenarios.

The Potential:

Domestic Production

	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Coal (Mtce)	582	904	1006	1190	1385
Oil (Mtoe)	38	44	46	54	61
Gas (BCM)	48	46	53	95	124

Table 9

Electricity Capacity

GW	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Gas Power Stations	24	34	39	46	70
Coal power stations	125	266	251	441	330
Carbon Capture Storage (CCS)	0	1	1	26	26
Nuclear power	5	12	12	23	34
Hydro Power Generation	41	61	61	71	92
Solar PV	1	59	59	237	275
Solar CSP	0	4	5	28	48
Onshore Wind	17	62	62	168	181
Offshore Wind	0	2	2	19	29
Distributed Solar PV	0	36	36	102	120
Other Renewable Sources	8	18	20	43	56
Total	221	555	548	1204	1261

Table 10

Primary Energy Supply:

TWh	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Renewable & Clean Energy	266	797	823	2010	2602
Coal	3281	6021	5529	11320	8433
Oil	1936	3024	2762	6036	4883
Gas	570	1018	1016	1762	1788
Others	1060	1108	1152	1351	1626
Total	7113	11968	11282	22479	19332

Table 11

Electricity Generation:

TWh	2012	2022		2040	
		BAU	Ambitious	BAU	Ambitious
Gas Power Stations	115	128	154	181	302
Coal power stations	708	1526	1482	2606	1984
Carbon Capture Storage (CCS)	0	5	5	137	137
Fossil Fuel Based Electricity	824	1659	1641	2924	2423
Nuclear power	27	82	87	164	237
Hydro Power Generation	144	214	214	248	324
Hydro and Nuclear	170	296	301	412	561
Solar PV	2	99	99	422	489
Solar CSP	0	11	14	105	185
Onshore Wind	32	129	129	390	423
Offshore Wind	0	6	6	62	92
Distributed Solar PV	0	55	55	164	193
Other Renewable Sources	46	86	101	203	281
Renewable Based Electricity	80	386	404	1346	1663
Electricity imports	5	15	25	71	126
Total	1078	2356	2371	4753	4773

Table 12

Some Key Implications (2040):

Share of non-fossil fuel based capacity in electricity: **57%-66%**

Per capita energy demand[1]: **503 kgoe/capita in 2012 to 1055-1184 kgoe/capita in 2040.**

Energy related Emissions per capita: **1.2 tons of Carbon Dioxide Equivalent/capita in 2012 to 2.7-3.5 tons of Carbon Dioxide Equivalent/capita in 2040**

Per capita electricity consumption[2]: **887 kWh in 2012 to 2911-2924 kWh in 2040**

CAGR of electricity supply (Ambitious scenario)**: 5.5% between 2012-2040**

CAGR of primary energy supply (Ambitious scenario**): 3.6% between 2012-2040**

Overall Import dependence (including non-commercial energy)**: 31% in 2012 to 36%-55% in 2040.**

Reduction in emissions intensity: **45%-53% by 2030 from 2005 levels**

[1] Per capita Energy Demand is defined as the primary energy supply in a year divided by the population in that year.

[2] Per capita Electricity Consumption is defined as the electricity generation in a year divided by the population in that year.

Conversion Factors

1 Mtoe	2.5 Mtce
1 Mtoe	11.63 TWh
1 Mtoe	1.11 BCM
1 Mtoe	0.8 MT LNG
1 Mtoe	7.33 Mboe

Table 13