Indian Energy Security Status: What are the Economic and Environmental Implications?

By Nathaniel Babajide

INTRODUCTION

India's energy system is facing a rapidly increasing energy deficit despite the government's keen attention in developing renewable sources of energy, especially nuclear, solar and wind. Statistics from British Petroleum (BP) (2015) reveal that fossil fuels constitute more than 90% of the nation's Total Primary Energy Consumption (TPEC) with coal accounting for 56%, while crude oil and natural gas contributes 28% and 7%, respectively. This couples with the fact that India heavily depends on foreign energy to meet its domestic energy needs.

The purpose of this paper is to examine the economic and environmental implications of energy supply insecurity in India by accessing the extent to which the country's primary energy sources are efficient and diversified. The paper is structured into five sections, including this Introduction. Section 2 provides an overview of the economic, energy and environmental situation in India. Section 3 presents the methodology and results of key energy security indicators adopted. While Section 4 presents the results of the analysis performed on the considered energy security indicators, Section 5 concludes the study.

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OVERVIEW OF INDIA'S PRESENT ECONOMIC AND ENERGY SITUATION

Economy and Energy Outlook

India is one of the world's fastest emerging economies despite an estimated population of over 1.30 billion people which makes it the second most populous country in the world after China (World Bank Development Indicators (WDI), 2016). The economic liberalization of 1991 ushered the country's economy into the limelight. The adopted mixed economy system has greatly fostered Indian economic performance in the last few decades and positioned it among the fastest growing economies in the world.

As illustrated in Figure 1, the country's GDP and per capita GDP growth in the last few decades have been intermittent and was sharply altered in 1991 and 2008 due to the global financial crisis but recuperated in subsequent years. In 2010, the economic growth bounced back after which it dropped to 3.7% in 2012. The GDP growth rose from 6.9% in 2013 to 7.3% in 2014 estimated at $1.6 trillion (in constant 2005 US dollar value). In sum, the Indian economy ranked third and ninth largest in terms of Purchasing Power Parity (PPP) and nominal Gross Domestic Product (GDP) respectively, in 2014 (WDI, 2016).

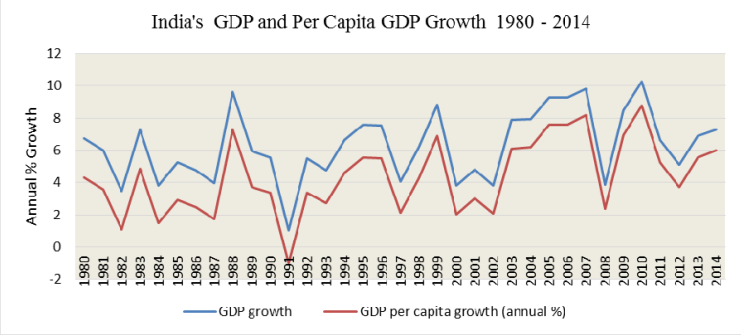

Figure 1: India's GDP and Per Capita GDP Growth 1980-2014
WDI, 2016

By using 6% of the world's primary energy, India is the third-biggest energy consuming nation (after China and United States) and sixth largest LNG importer (Energy Information Administration (EIA), 2015). This originates primarily from the country's limited domestic fossil energy resources which makes it highly dependent on foreign crude oil and natural gas imports sourced predominantly from the Middle East. Nevertheless, India's energy demand has continued to grow at an alarming rate, the pace that led to its emergence as one of the top energy importers in the world, specifically in fossil fuels.

As the most abundant domestic fossil-fuel resource, coal constitutes the lion's share of its total energy consumption. The recent growth in its coal demand has been startling, from 260.2 million tonnes oil equivalent in 2010 to 360.2 million tonnes in 2014 (BP, 2015). Like many other countries, coal is the backbone of electricity generation in India; over 60% of power production emanated from coal. After coal, oil contributes the second largest share of energy consumption as the country consumed roughly 3.85 million barrels of oil per day in 2014. This value depicts a 4.4% increase over the 2012 consumption estimate of 3.69 million b/d. Although natural gas accounts for about 7% of total energy consumption, its contribution has been declining in the last few years; it declined by 19.3% from 56.4 million toe in 2010

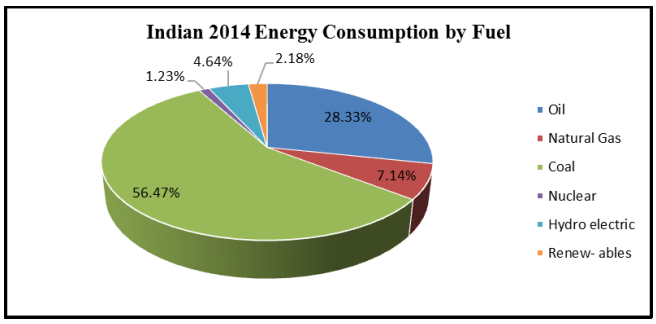

Figure 2: India's Energy Consumption by Fuel in 2014
Source: BP, 2015

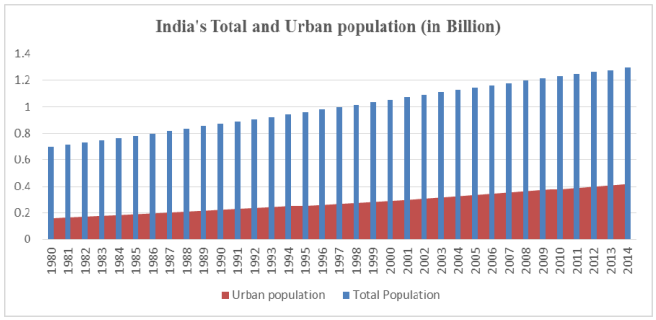

Figure 3: India's Population and Urbanisation Trend: 1980-2014 in Billions
Source: WDI, 2015

to 45.6 million toe in 2014 (BP, 2015). However hydro, nuclear and other renewables are responsible for the remaining 8%.

Moreover, the nation's population and urbanization growth rate has undoubtedly propelled a robust increase in its energy demands (WDI, 2015). Though the country launched its family planning policy as far back as 1952, it has not been able to bring its budding population growth rate under control. With the current population of 1.30 billion people and an annual growth rate of 1.23%, India is the world's second most populous country after China. This signifies that about 18% of the world's population resides in India. In a similar vein, since independence, rural- urban drift in India has been escalating as the United Nations (2007) report on the state of world population revealed that the Indian urbanization rate is faster than that of the rest of the world, and projected that by 2030, 40.76% of India's population will be dwelling in urban centres compared with around 28.4% in 2007. Therefore, India's rising population and urbanization growth places intensified pressure on energy use, urban infrastructure and environment and occurrence of any supply disruptions can cause severe strain on economic growth.

As of 2014, about 21% and 30% of India's total and rural population was respectively without electricity access (WDI, 2015). In recent years however, the country has made notable strides in improving modern energy access to the citizenry. Even with that, about 240 million people (19% of the population) are still without electricity access) while the electrified regions are still characterized by rolling electricity blackouts (EIA, 2015). The vast majority of the population without access is concentrated in few states with almost two-third residing in two most populous northern states of Uttar Pradesh and Bihar. Additionally, over 80% of population without electricity access dwells in rural areas (IEA, 2015).

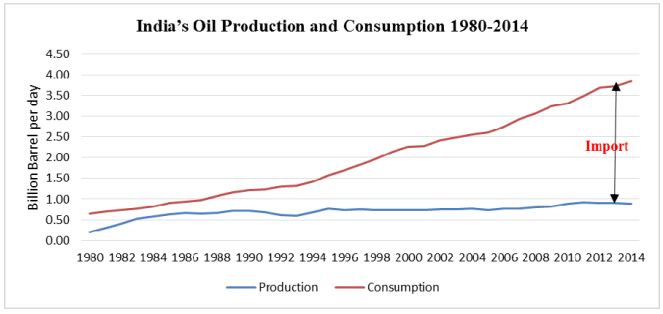

Figure 4: India's Oil Production and Consumption 1980-2014
Source: BP, 2015

Indian Oil Production, Consumption and Import

Indian energy policies are principally dominated by the issue of growing demand deficit, soaring import dependence and increased focus on renewable energy sources mainly nuclear, wind and solar energy. However, rapid economic growth has placed greater emphasis on its increasing energy demand as a source of energy insecurity. Limited fossil fuel reserves and static local production capacity are the basic characteristics of India's evolving energy insecurity. With heavy reliance on foreign energy sources before the 1980s (As depicted in figure 4), the nation's rapidly growing economy is becoming more vulnerable to the likely risks of global and regional energy supply interruptions.

The Indian oil requirement has grown swiftly over the last decade while local production is relatively stagnant. The nation's domestic production can meet just about 25% of the national oil needs thereby making the country a leading net oil importer, with import volume in 2014 being 3.3 times higher than local production. With approximately 3.0 million b/d import volume, India is the third-largest crude oil importing country, behind the China and U.S. About 75% of the Indian oil requirement is imported from of a number of oil exporting countries (including Saudi Arabia, Iraq, Nigeria, Venezuela, Iran etc.) as presented in Figure 5.

In summary, the largest share of India's oil imports came from

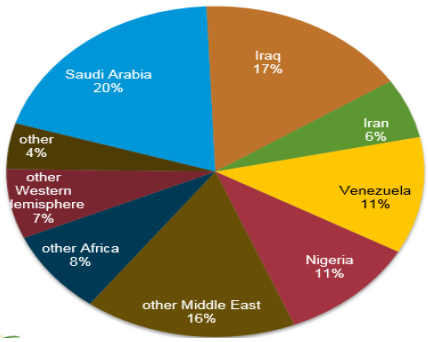

Figure 5: India's Crude Oil Imports by Source 2015
Source EIA, 2015

OPEC member countries which as of 2015 accounted for about 70% of the total import while non-OPEC members supplied the remaining proportion.

Indian Energy Related Emissions and Environmental Implications

Due to its rapidly growing fossil fuel consumption and low level of energy efficiency, India presently occupies third position among the world's biggest emitters. The vast majority of greenhouse gases such as carbon dioxide (CO_2), methane and sulfur oxides emitted by India emanated from its energy sources principally through consumption of solid, liquid, and gas fuels and gas flaring. Figure 6 reveals the increasing CO_2 emission trend in India, rising rapidly from 990.98 million metric tonnes (Mt) in 2000 to 1834.11Million Mt in 2012, denoting about an 85% increase within this period. Coal is vividly highlighted as the greatest source of increasing CO_2 emission in India accounting for 69.8% of the total emission, followed by oil (23.7%) while the remaining 6.5% stemmed from natural gas in 2012. The increasing fossil fuel combustion give rise to the quantity of sulfur dioxide (SO_2) released into the atmosphere which in turn reacts with atmospheric oxygen to form acidic rain and also causes global warming.

At present, fossil fuels constitute more than three-quarter of the world's primary energy consumption and this heavy dominance of hydrocarbons accordingly poses GHG emissions and climate change threats on the world. The condition is further aggravated by high energy-consuming countries like China and India that use fossil fuels to meet their increasing energy need. Consequently, a majority of the Indian cities and towns are now facing various forms of environmental degradation signaling a global warming danger for India and world at large.

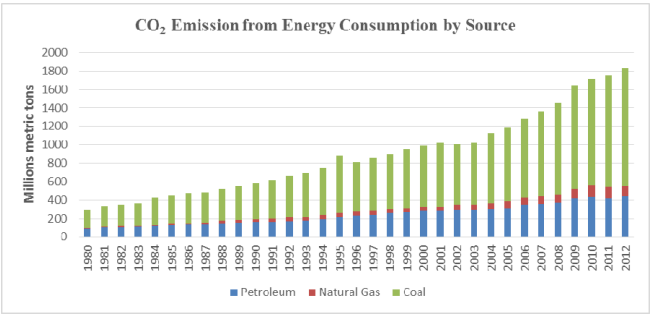

Figure 6: India's CO_2 Emissions from Energy Consumption by Fuel 1990-2012

Source: Author's computations from EIA, International Energy Statistics, 2014

In conclusion, the era of energy surplus has gone in India, and energy shortages, import dependency, supply disruptions and power failure has become the order of the day. The country is equally faced with sequential energy intensity increases thereby making its energy supply strongly susceptible to external vulnerabilities. The widening dominance of coal in the country's primary supply mix also imposes mounting environmental risk on the nation and the world at large. Therefore, the expanding economic growth, widening energy demand, accumulating supply shortages, rising oil imports and growing environmental threat have raised the need for a lasting solution to India's energy problem.

METHODOLOGY

Basic Energy Security Indicators[1]

To compute the security of energy supply in India, analysis of the country's primary energy was conducted and the adopted key energy security indicators stated in APERC (2007) and Bhattacharya (2011) namely:

Diversification of Primary Energy Supply (DPES)

This indicator was derived by modifying the Shannon bio-diversity Index which reflects the significance of energy diversification in relation to abundance and conformity of sources. This is calculated as;

$$DPES = ß / Ln\ η \quad but\ \ ß = -\Sigma (Q_i LnQ_i)$$

Where: β is the Shannon's bio-diversity Index and Q is the fraction of energy source in TPES, Ln is the Natural log, i is the sources of energy and η is the number of energy sources used.

Net Energy Import Dependency (NEID)

NIED is the DPES import adjusted version and it is calculated thus;

$$NEID = \{1 - (Y / EDI)\} \quad While\ Y = -\sum (a_i Q_i\ Ln\ Q_i)$$

Where Y is the import reflective PEDI, ai = (1-ki) and ki is the fraction of net import in PES of energy source (i). All other variables remain as earlier defined.

Net Oil Import Dependency (NOID)

NOID measures India's net oil import dependency by considering the oil imports and exports and is likewise adjusted for oil consumption intensity as a primary source of energy. It is estimated thus:

$$NOID = [Importoil / PESoil] \times [PESoil / TPESenergies]$$

Middle East Oil Import Dependency (MEOID)

The MEODI estimates the extent to which India relies on oil imports specifically from the middle-east oil exporting countries and is obtained as follows:

$$MEODI = \{Middle\text{-}East\ Importoil / PESoil\} \times 100$$

Carbon Free Energy Portfolio (CFEP)

It shows the share of non-carbon energies in the nation's overall energy portfolio. This indicator evaluates the extent of India's efforts to shift away from a carbon concentrated energy mix to a carbon free energy portfolio by measuring the share of hydro, nuclear, and other renewable in TPES. The metric is evaluated thus:

$$CFEP = [PES\ hydro + PES\ nuclear + PES\ renew] / [TPESenergies]$$

It thus reveals the environmental challenges emanating from energy sources.

INDIA'S ENERGY SUPPLY CHALLENGES: EVIDENCES AND TRENDS

This section presents the outcome of various measures of Indian energy security employed. To begin with, the Indian energy diversification index reveals that the degree of diversification of primary energy supply (DPES) in the country is apparently high, increasing over the last three decades-most significantly in the 1980's through 2000 rising from 68 to 83 (see Table 1) - signifying a considerable degree of energy source diversification. However, the rate of stagnancy as well as decline in the diversification index between 2000 and 2012 is too obvious and demands significant attention. Customarily, the DPES values below 50 infers countries that heavily rely on few energy sources to meet their domestic demand while the higher value (above 50) denotes a reasonable level of diversity in the nation's energy sources. Hence, India's higher DPES suggests that the nation is less prone to energy supply security risk because of availability of sizeable energy supply sources for its economy.

Years	1980	1985	1990	1995	2000	2005	2010	2012
Normalised PEDI	68	74	79	81	83	83	84	82

Table 1: India's Diversification of Primary Energy Supply from 1980 - 2012
Source: Author computations IEA, 2014

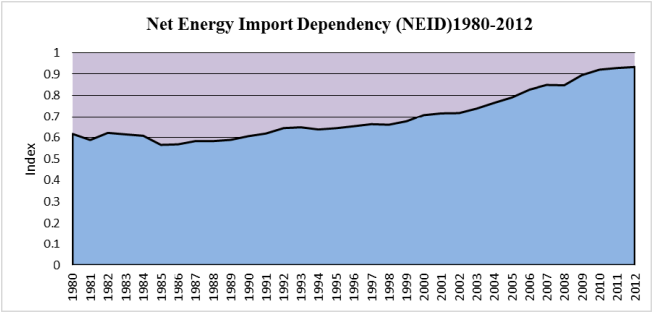

Figure 7: India's Net Energy Import Dependency (NEID): 1980 – 2012
Source: Author computations IEA, 2014

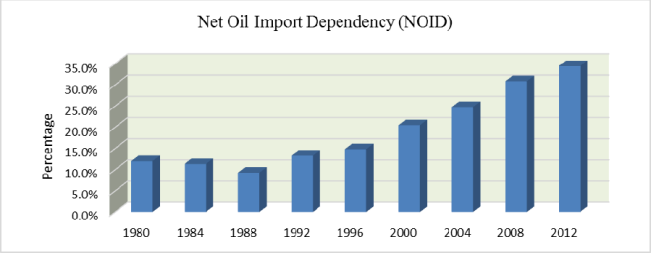

Figure 8: Net Oil Import Dependency (NOID): Selected Years
Source: Author computations IEA, 2014

In spite of the fact that Indian DPES predicts a minor energy supply risk, the impact of import reliance on the nation's energy supply configuration is confirmed in the Net Energy Import Dependency (NEID) as presented in figure 7. This measure (NEID) depicts the level of total primary energy supply that is weighted by the supply intensity of each energy source. The NEID estimates reveal that Indian's net import dependency is relatively high indicating that the country principally depends on foreign energy supplies to meet its local primary energy demand. From 1980, India imported more than half of its primary energy so as to meet its growing national energy requirement.

With the deduction that oil is currently the prime source of energy in India, obtaining sufficient oil supply constitutes a concern for India's energy supply. To this end, the net oil import dependency (NOID) together with the middle-east oil import dependency (MEOID) tends to reveal anticipated vulnerability associated with securing adequate volume of

this vital energy resource. Evidence from NOID (calculated by the share of oil in TPES) exposes a sharp upsurge in Indian net oil dependency rising from about 12% in 1980 to more than 34% in 2012 – an increase of roughly 187% over the period of 32 years as indicated in figure 8 below. This also portrays the need for more diversified primary energy sources in order to achieve a secure and efficient energy portfolio.

Furthermore, the result of MOID provides the historical account of India's heavy reliance on foreign oil supply specifically from the middle-east. This index reveals that India had progressively relied on Middle-east oil to satisfy its domestic oil needs. In figure 8, India imports about 20% of its foreign oil requirement from the Middle-east countries while in 2010 the oil supply obtained from this region has increased to around 36%. Hence the result from NOID also suggests that Indian oil import will vividly rise in future unless appropriate measures are adopted to avert this trend.

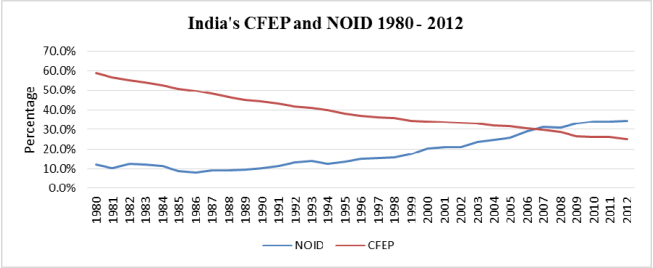

Figure 9: India's Carbon Free Energy Portfolio (CFEP) and NOID: 1980 – 2012

Source: Author computations IEA, 2014

With growing global campaign for clean primary energy sources, as means of curbing energy-related GHGs emissions, the CFEP measures country's level of diversification towards renewables and low-carbon energy resources. As evident in Figure 9, India's CFEP trend has been declining over the years due to its increasing utilization of fossil fuel in meeting its widening energy demand. This trend signals the country's increasing vulnerability to environmental degradation and climate change threat. As such, the Indian government needs to expedite action towards halting the increasing proportion of fossil fuels – principally coal and oil to avert this declining CFEP trend over time.

CONCLUSIONS

The objective of this study is to examine the economic as well as environmental implications of energy supply security in India. Investigation of the key features of the contemporary and the future projections of Indian primary energy supply structures were carried out to identify the inimical challenges facing the India energy system. In its 2050 energy security pathway, India has a boisterous ambition of providing 200GW of energy from solar radiation, reducing energy consumption and promoting environmental sustainability.

In pursuit of energy security in the future, there is need for massive and strategic construction of energy reserve facilities to guard against supply disruption risks and energy market instability. Also, utmost priority should be given to the development of renewable and unconventional technologies as this will ultimately yield astounding economic benefits and reduce environmental degradations.

Footnote

[1] Data used for the analysis was sourced from International Energy Agency (IEA -2016 Edition) via UK ESDS.

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