India's energy policy future: Here be dragons[1]

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Abstract

India's energy policy in the future will have to navigate through largely uncharted territory. Never before has a country had to provide access to modern energy and build basic infrastructure for so many millions in so short a time, while also ensuring all-round development and growth in a situation constrained by limited natural resources, environmental degradation and increasing pressures brought on by climate change. There are no easy solutions to address such a complex and seemingly contradictory set of goals and India will have to find a development trajectory that fits its unique requirements. While there are some positive signs of recognizing the need for innovative and different approaches, the overall picture is currently not very encouraging. The key challenge that India has to address, in order to overcome these problems, is to improve its governance processes and institutions to make them more capable, effective and accountable.

1 India's energy needs

It is now well understood that there is a close correlation – if not causality – between access to modern forms of energy and the level of development of a nation. As can be inferred from Figure 1, there is a strong correlation between a small increase in per-capita energy consumption and significant improvement in development indicators for nations at the level of development of India (as measured by HDI in this example).

India's relatively low HDI levels are consistent with low levels of access to modern energy forms in India. Figure 2 depicts the energy access deficit in India as determined from the national census conducted in 2011 [3]. About a third of India (400 million citizens) does not have access to electricity and over 80% of Indian households, representing almost a billion citizens, use less than 100 kWh / month for their residential uses. An interesting contrast can be drawn between the average per-capita annual electricity consumption of an Indian and a citizen of the USA: while the average Indian consumes less than 600 kWh[2] annually, an average American consumes nearly 13,000 kWh annually. Similarly, 70% (about 850

[1] Legend has it that "Here be dragons" was used to denote uncharted territories on ancient maps (See, for example, http://en.wikipedia.org/wiki/Here_be_dragons).
[2] This represents the total electricity consumption across all sectors divided by the population, and not just the residential electricity consumption

million people) rely on traditional bio-mass and kerosene for cooking, rather than cleaner and modern sources of energy[3].

Figure 1: Correlation between energy consumption and HDI[4]

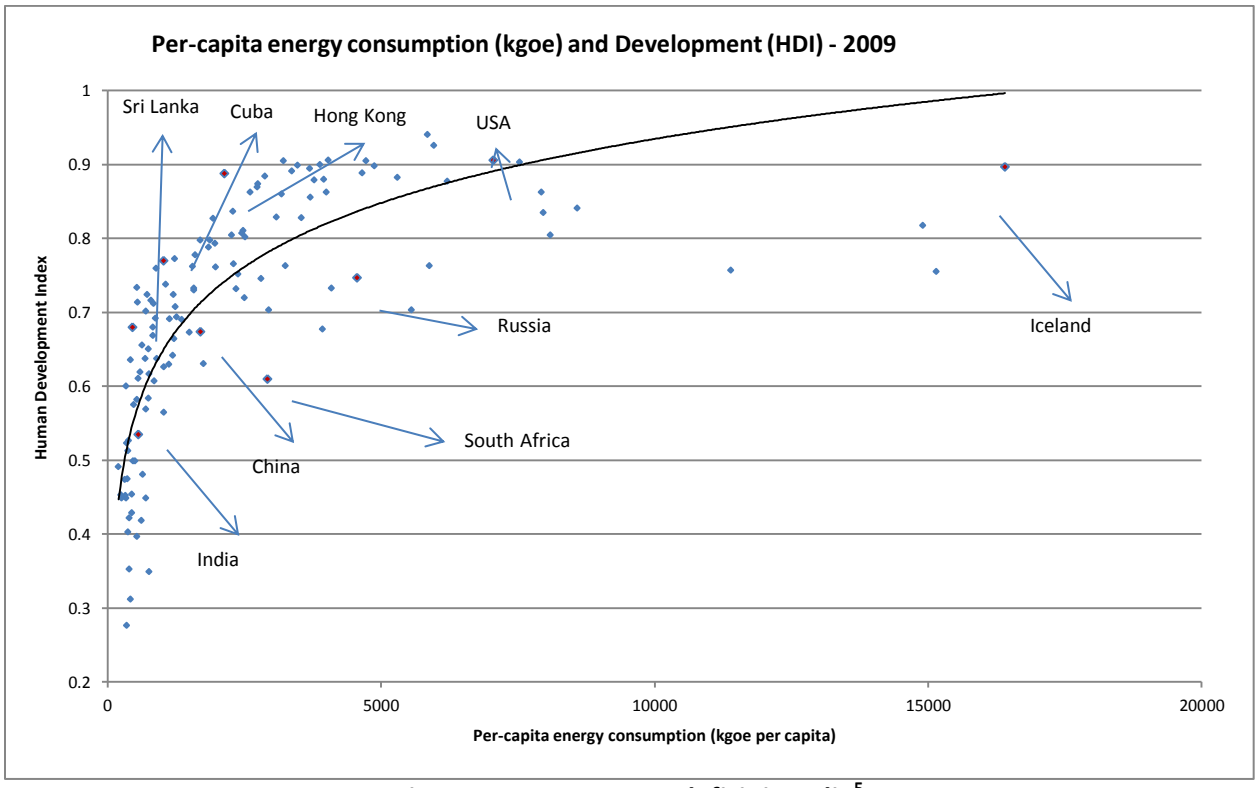
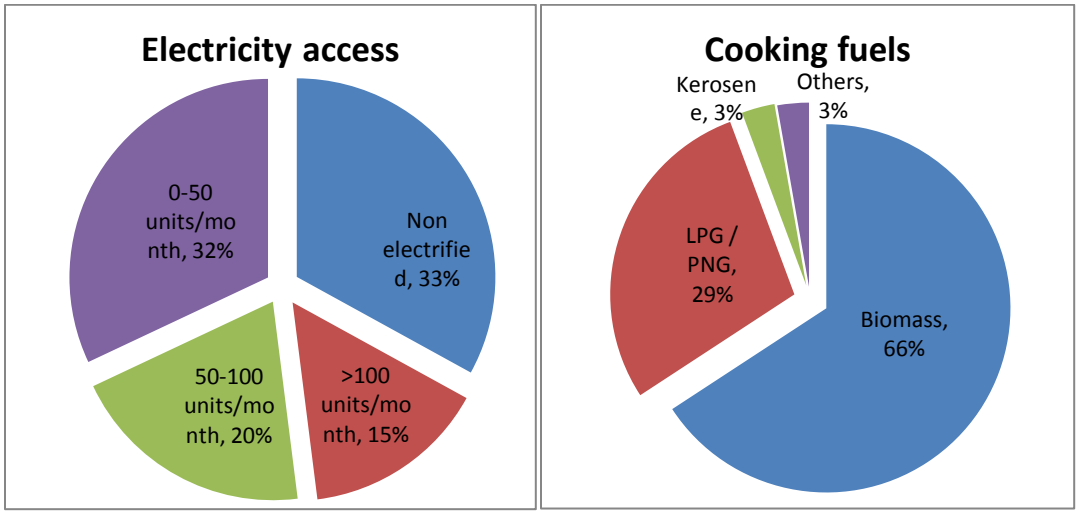


Figure 2: Energy access deficit in India[5]



[3] A small percentage of the bio-mass based cook-stoves are 'clean stoves' that do not result in high levels of indoor air pollution. It is hard to find concrete numbers for the number of such stoves, but counting them as clean energy usage does not change the overall picture in any significant way.

[4] Source: [1, 2]

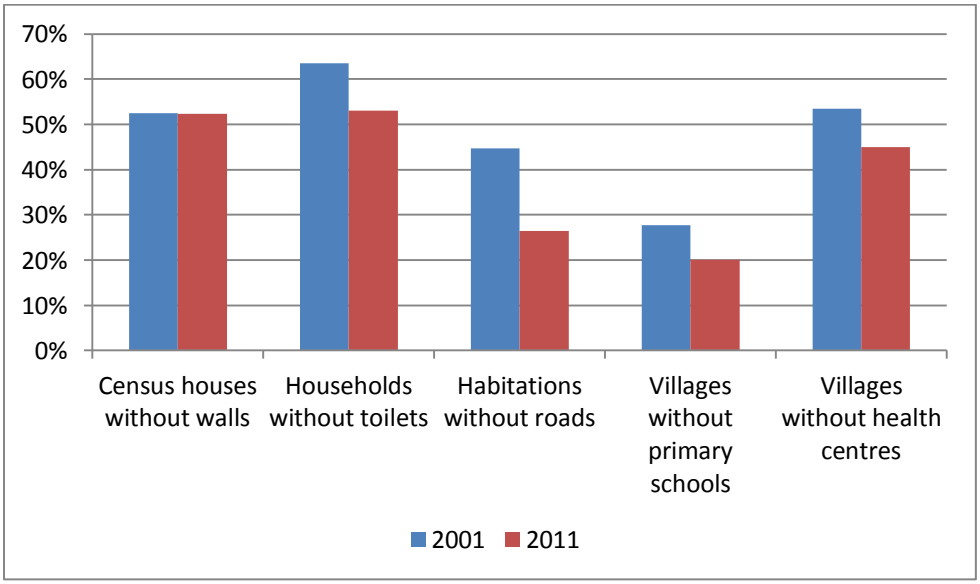
[5] Source: [3] and Prayas calculations

In addition to low levels of access to modern energy sources, India also suffers from a huge deficit of infrastructure required for dignified living. Figure 3 provides indicative estimates of the infrastructure deficit by collating data from different Government sources. A little more than half the houses in India don't have concrete or brick walls, more than half the households don't have toilets, nearly half the villages don't have access to health care facilities, about a quarter of the villages don't have all-weather roads and about a fifth of the villages don't have schools. Such an infrastructure deficit obviously needs to be bridged, in addition to providing access to modern energy, if India wants to provide its citizens with dignified lives. Providing such infrastructure would also require significant amounts of energy.

The above discussion highlights the large unmet demand for energy in the country. Moreover, this demand is typically from a segment of the population that would be less able to pay high prices of such energy and infrastructure.

Official demand projections such as the Integrated Energy Policy (IEP) [4] also project large increases in energy demand, though these may not necessarily be based on such bottom-up assessments. For example, the high energy efficiency, maximum renewables and nuclear scenario (scenario 11) of the IEP projects an *incremental* electricity demand between 2026-27 and 2031-32 of about 800 billion kWh which is comparable to the total electricity generated in the country in 2010-11 [5].

Figure 3: Infrastructure deficit in India[6]



2 Limiting factors

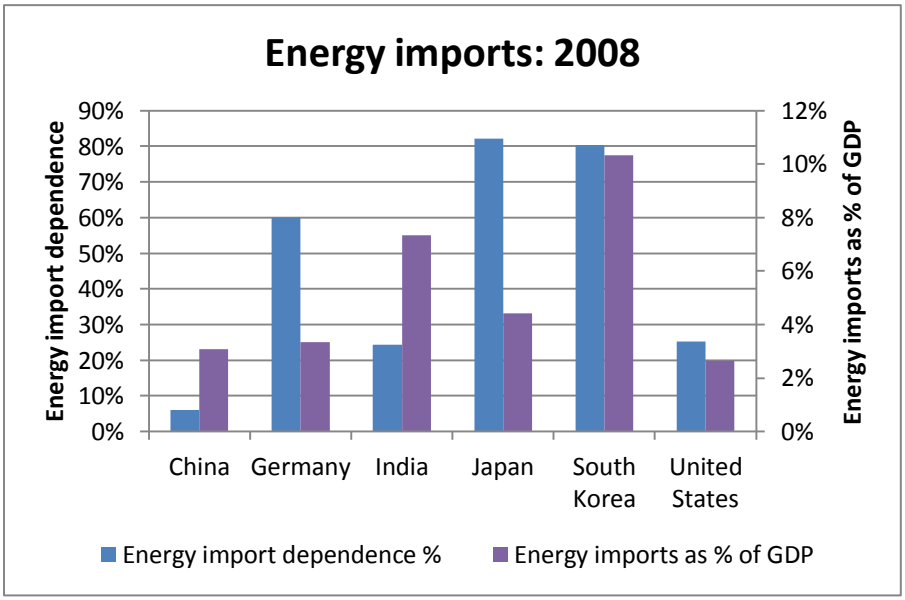
What would be the implications of such large increases in demand for a country like India? We present three implications of such an increase in demand, which would act as limiting factors to satisfying India's energy needs by pursuing a 'business-as-usual' path.

[6] Source: [3, 6, 7] and Prayas estimates. Data related to schools and health centres in villages is for 2002 and not 2001.

2.1 Resource constraints

The first implication is the impact on India's energy security and larger economy. India's energy import costs as a percentage of its GDP is significantly higher than the share of energy import costs in the GDP of many other countries [8]. As shown in Figure 4, though India imported only 24% of its commercial energy requirements in 2008, it spent 7% of its GDP on energy imports. In contrast, Japan imported 82% of its energy requirements but spent only about 4.5% of its GDP on such imports.

Figure 4: Energy import dependence and share of GDP[7]



Given increased energy demand projections, the country's energy imports are only expected to increase, as India is not a resource rich country. India is not endowed with large resources of oil and gas, and imports about 80% of its oil requirements. Though India is believed to have reasonably high reserves of coal, these are of poor quality and there are doubts about accessing the reserves effectively. Projections of energy production and demand given in the country's 12th five year plan [10] indicate increasing energy imports during the 12th and 13th five year plans. Assuming a modest 5% annual increase in unit cost of imports, India's energy import bill rises significantly and takes up a higher share of the country's GDP by 2021-22, even if the GDP is expected to increase by about 8% p.a. (Figure 5).

Such an increase in the import bill exposes the country to many energy security and economic risks. Firstly, higher imports will almost surely lead to an increase in energy prices. In turn, this will make it harder to universalize access to clean energy and costlier to build the required infrastructure, particularly since the segment of population whose needs have to be met have a low ability to pay for it. Secondly, increased exposure to energy imports would imply a greater vulnerability of the country to geo-political risks. This could manifest in the form of either price fluctuations or supply vulnerabilities. Thirdly, it would have consequences for the country's macro-economic stability as it would increase the country's trade deficit significantly. Energy imports already contribute over 60% of the country's trade

[7] Source: [2, 9]

deficit according to data from the Ministry of Commerce, and an increase in import quantities and prices would only worsen the situation.

Figure 5: Projected Indian energy imports[8]

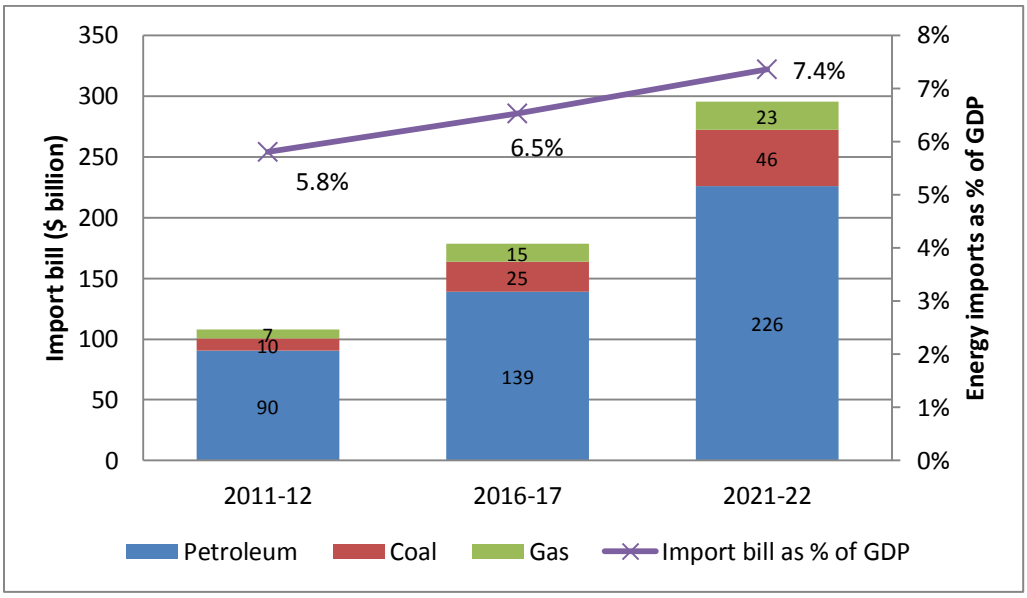
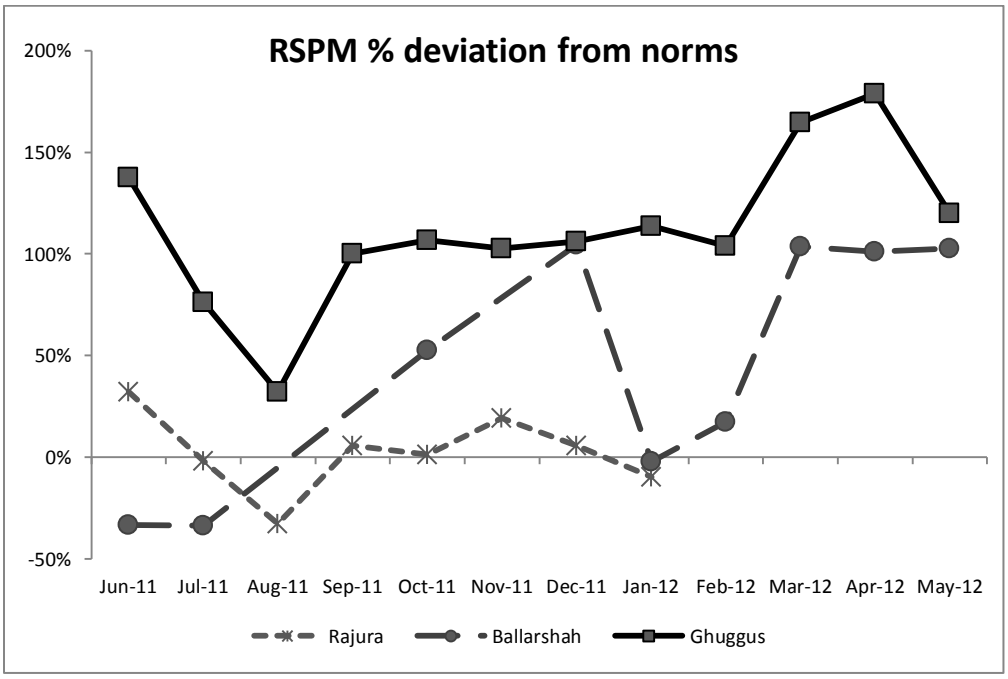


Figure 6: Air pollution in areas with coal mining and associated industries[9]



2.2 Socio-environmental constraints

[8] Source: [10, 11, 12, 13]
[9] Source: [14]

The second implication relates to the significant negative socio-environmental impacts of exploiting domestic energy sources such as coal, and energy transformation processes such as power generation. Evidence gathered from regions with extensive mining and power production indicates air and water quality that is considerably worse than the norms [14 - 16] – this is also indicated in Figure 6. Weak monitoring capacity and mechanisms in the concerned agencies such as the pollution control boards and the Ministry of Environment and Forests have not helped to mitigate this. This is exacerbated by the social dimension of such activities which involves displacement and loss of livelihoods [17]. Increased exploitation of domestic sources and/or significantly greater number of power plants will only worsen these impacts, unless suitable corrective mechanisms are instituted to address these problems and implemented in the right spirit.

2.3 Climate constraints

The third implication is the impact of such an increase on climate change. Measured by any metric, India does not emerge as a country responsible for climate change and therefore, any obligations to accept limits on its GHG emissions [18]. However, it is also true that India as a country, and its poor in particularly are highly vulnerable to the impacts of climate change. For this and other reasons, India needs to play a constructive role [19, 20] in battling this global challenge and undertake some actions to 'bend the curve' of its GHG emissions without sacrificing its development imperatives. The projected rapid increase in energy consumption will require to be managed very carefully in this context.

Any simplistic approach to satisfying the country's energy demands is unlikely to work. A business-as-usual fossil-fuel heavy approach will have macro-economic and socio-environmental risks. On the other hand, an aggressive push for renewables 'at any cost' will badly affect the development agenda of providing universal energy access and basic infrastructure, since it is expected that the cost of renewable energy is likely to be higher than fossil-fuel energy for the short to medium term.

Over the next few decades, India's energy policy will have to navigate through uncharted waters. Never before has a nation had to rapidly meet the developmental aspirations of so many millions under such constraints of natural resources, economy and the environment. It will not be easy to find appropriate solutions amidst these constraints, and doing so will require innovative and carefully calibrated policy formulation and institutional design.

3 Frameworks for India's energy future

In this section, we explore some broad frameworks for India's energy future that can help in achieving the desired goals of achieving development objectives at a minimal cost to the environment, and without endangering the country's energy security. Conventional economic wisdom suggests that

- human development requires GDP growth,
- GDP growth requires increasing consumption of energy and
- Increasing consumption (and production) of energy will have some negative socio-environmental impacts.

However, none of the above relationships are rigid and attempts should be made to weaken these links. This will simultaneously improve developmental indicators while using lesser energy and reducing environmental impacts. For example, suitable development policies can ensure that equivalent GDP growth can result in better development for its citizens (say, in the form of reduced malnutrition or infant mortality or maternal mortality etc.). Improving the efficiency of the economy can help in reducing the amount of energy required to achieve a unit increase in GDP. Finally, negative socio-environmental impacts of increased energy production and consumption can be reduced through a combination of better technology and better formulated and implemented policies.

Focusing on the energy sector, we present two broad frameworks in tune with the principles laid out above – namely, improved developmental policies at greater economic efficiency and causing minimal impact on society and environment.

3.1 RIR framework for the electricity sector

In the electricity sector, a framework called the 'Reduce-Improve-Replace' (RIR) framework has recently been proposed [21] as a way forward. The essence of this framework is to

- Reduce the high end 'luxury' energy consumption through a suitable combination of incentives and disincentives. For example, telescopic electricity tariffs that are steep for high consumption would protect those using lesser amount of electricity and send a signal to the high-end consumers of electricity to reduce their consumption.
- Improve the efficiency of electricity use through a combination of incentives for efficiency improvement, penalties for inefficient consumption and introducing standards for energy usage. This is a well-known method to enhance energy security.
- Replace fossil fuels with renewable sources of electricity. While this is also a well-known approach in the context of energy security and climate-change, it must be kept in mind that given the higher costs of renewable energy today in comparison to more conventional sources, policies to encourage renewables should be carefully calibrated to ensure that the poor are shielded from the impacts of shifting to the costlier energy source.

3.2 ASI framework for the transport sector

In the transport sector, the 'Avoid-Shift-Improve' (ASI) framework is well known [22, 23]. According to this framework, the principles underlying a shift towards sustainable transport solutions, which minimize socio-environmental impacts and enhance energy security, are as follows:

- Avoid travel, i.e. minimize travel demand, to the extent possible through better planning and design. Thus, a city would have neighbourhoods that are mixed use, i.e. they would have residential locations, commercial outlets and opportunities for employment, education and entertainment all in close proximity so that one's needs are met with minimal travel. Similarly, locating industries appropriately so that the supply chain and major consuming centres are reasonably close would ensure that the demand for freight movement is minimized.
- Shift to more efficient modes of travel, as a means of improving overall systemic efficiency. For example shifting freight from roads to rail will greatly improve the energy efficiency of freight

transport, while shifting passenger transport within a city or town from private motorized transport to modes such as public or non-motorized transport will significantly improve the efficiency of passenger transport.

- Improve the efficiency of individual vehicles by improving the technology and/or fuels used in them. This can further help to improve the energy efficiency of the transport system by improving the fuel efficiency of buses, cars or trains. This element of the framework could also encourage vehicles to shift to alternative fuels and technologies such as electric vehicles or hydrogen cell powered vehicles.

Broadly, the paradigms listed above (RIR for electricity and ASI for transport) target the multiple objectives listed earlier: providing access to all, minimizing resource use and hence socio-environmental impacts, and discouraging excessive consumption. Specific elements of these frameworks that are suitable for the Indian context will need to be identified and converted into suitable policies. Similar frameworks and approaches can be developed for other sectors such as agriculture, health and so on.

It should be noted that while a framework as listed above would gradually try to increase the share of cleaner energy sources such as renewables in the energy mix, energy systems are 'sticky' and have long gestation periods as well as lifetimes. As a result, even if India embarks on a path aggressively embracing renewables and efficiency, it is likely that India would continue to depend on fossil fuels as its primary source of energy for about a decade or two. This is also indicated by the IEP [4] which predicts that even in the scenario with the least amount of fossil fuels, India will source over 70%, in comparison to over 90% currently, of its primary commercial energy from fossil fuels in 2031-32.

4 Current trends and challenges

4.1 The positive signs

In the electricity sector, India has initiated a few actions over the last few years that are consistent with the RIR approach.

Under the National Action Plan on Climate Change (NAPCC) [24], India has launched eight missions, one of which is the National Mission on Enhanced Energy Efficiency [25], under which various schemes have been initiated to improve the energy efficiency of India's economy. The Bureau of Energy Efficiency (BEE), set up under the Energy Conservation Act of 2001 [26], is charged with the mission of improving India's energy efficiency and has been the nodal agency that has driven the energy efficiency agenda. BEE has introduced schemes for standards and labeling of electrical appliances and improving the efficiency of energy-intensive industries. It has also developed codes for energy efficient buildings.

Another mission under the NAPCC is the Jawaharlal Nehru National Solar Mission [27] that proposes to give a significant boost to the solar power sector and targets a solar based grid connected power generation capacity of 20 GW by 2022. Similarly, the recently released 12th five year plan document [10] proposes the establishment of a National Wind Energy Mission, similar to the solar mission, to boost the wind energy sector. India has also introduced mechanisms such as tradable Renewable Energy

Certificates (RECs) and imposed Renewable Purchase Obligations (RPOs) on power utilities to promote adoption of renewable energy.

Figure 7: Two projections of electricity demand (Billion kWh)[10]

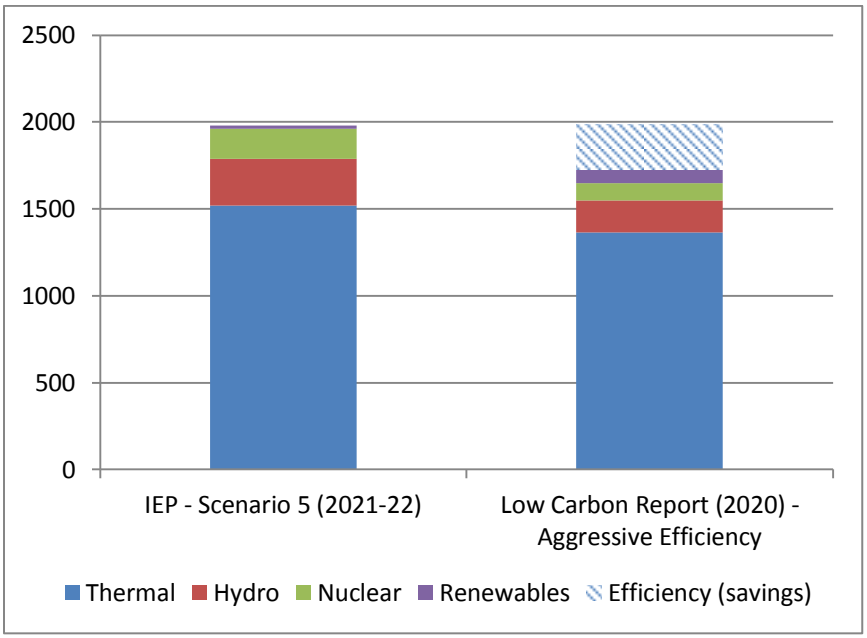
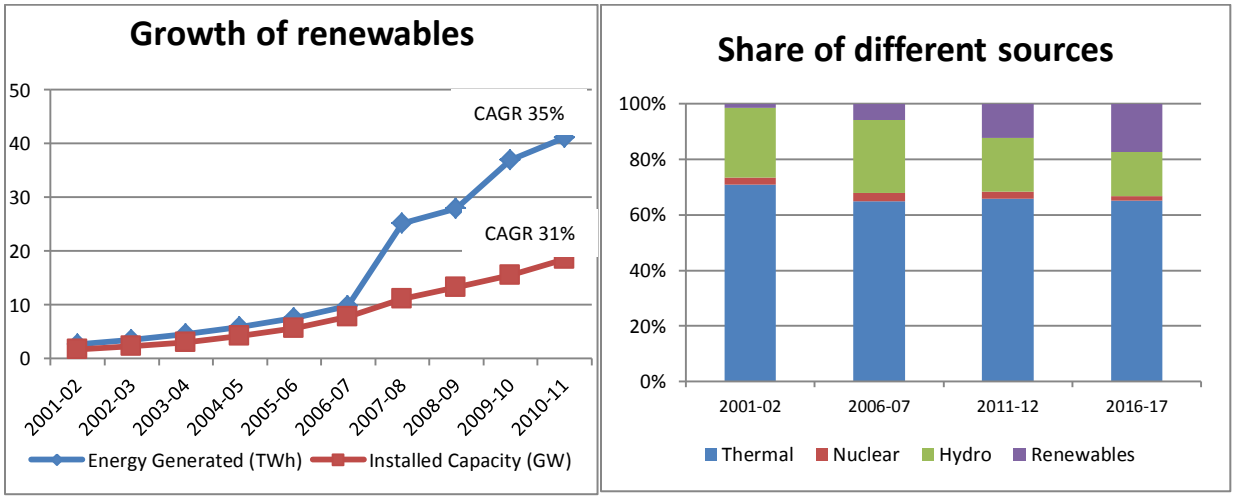


Figure 8: Changing role of renewables[11]



These initiatives are reflected in official demand projections and actual achievements. As shown in Figure 7, two official electricity demand projections for comparable years from the Planning Commission – scenario 5 from the IEP for 2021-22 and the 2020 demand projected under the aggressive scenario of the interim report of the Expert Group on Low Carbon Strategies for Inclusive Growth [28] – show a

[10] Source: [4, 28]
[11] Source: [5, 10, 29]

dramatic difference. There is a significantly enhanced role for energy efficiency, or avoided demand, in the projections of the latter amounting to about 13% reduction in demand. In fact, the projected reduction in demand due to energy efficiency is greater than the total demand met from nuclear, gas, hydro and renewable sources put together, highlighting its importance.

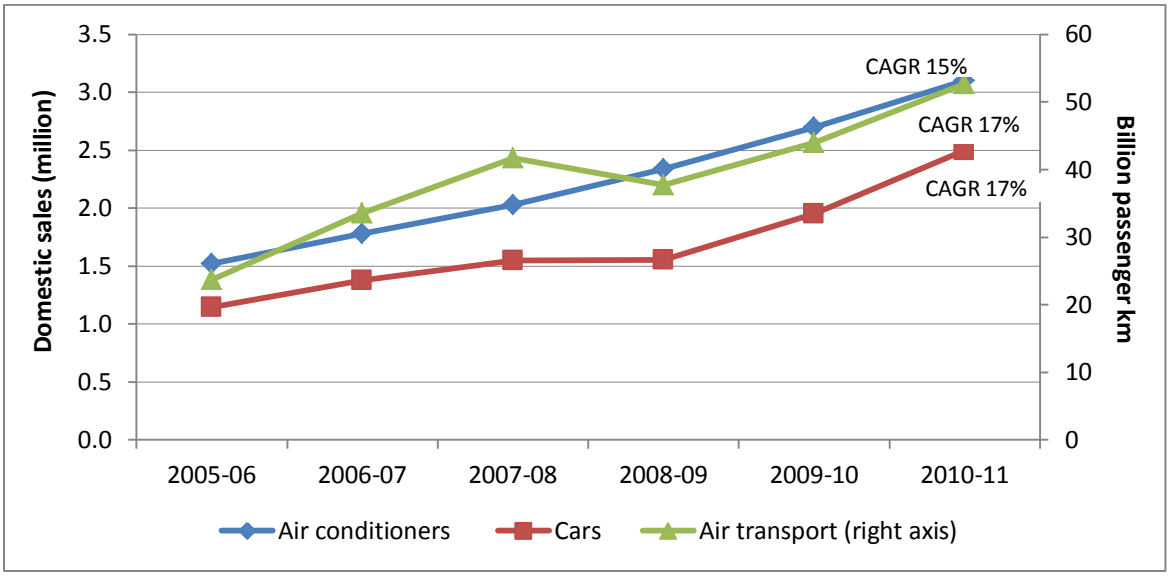
Similarly, the share of renewables has also been increasing significantly in the power basket. Figure 8 shows that renewable energy capacity has been growing at 31% per year over the last decade, with renewable based electricity generation growing at 35% per year – or doubling every two years. This is reflected in the fact that investments in the renewable energy sector were to the tune of about Rs. 20,000 crores (approximately USD 4 billion) in 2011-12. Not surprisingly, the share of renewables in the Indian power capacity basket has steadily increased and stood at 12% at the end of 2011-12 and it is expected to further increase to 17% by 2016-17 (Figure 8). India has also targeted that 15% of its electricity will be produced from modern renewable sources by 2020 [24], which represents an ambitious 6-fold increase in production from about 41 billion kWh in 2011-12 to about 235 billion kWh in 2020. These examples show that India is faring reasonably well on the 'Improve' and 'Replace' part of the RIR framework for electricity.

4.2 The not-so-positive signs

However, the country is not faring so well when it comes to the 'Reduce' in the RIR framework for electricity and most aspects of the ASI framework for transport. Over the last five years, three indicators of high-end consumption, namely sales of air-conditioners and cars and amount of air travel, have all been increasing rapidly at over 15% per annum (Figure 9). In contrast, it is interesting to note that the number of households using electricity as their source of lighting and the number of households with toilets have increased at a much slower pace of less than 5% per annum over the last decade [3]. This suggests that the 'Reduce' in the RIR framework has not yet been internalized or institutionalized in policy formulation and there is insufficient attention to curbing high-end consumption vis-à-vis addressing the access and infrastructure deficit.

The indications from the transport sector are also not encouraging. India imports about 80% of its oil requirements, and the transport sector is primarily fuelled by these imports. Therefore, in the interests of energy security, there should ideally have been a strong push towards implementing the ASI framework and improving the overall efficiency of the sector. However, as shown in Figure 9, car sales are growing rapidly. In addition, the share of rail in freight is decreasing steadily as are the modal shares of public and non-motorized transport across cities [33, 34]. Weak railway infrastructure and poor railway services have partially contributed to booming aviation demand. Though there has been a lot of public discourse on introducing fuel efficiency norms for automobiles over the last few years [35, 36], India has not yet been able to enact and implement such norms. Consequently the combined consumption of the transport fuels, namely gasoline, diesel and ATF, has increased at a rate of nearly 9% per annum over the last 5 years [11] and the passenger-km logged by air has been increasing at 17% per annum as shown in Figure 9. It is evident that the ASI framework has not been internalized in the transport sector.

Figure 9: Growth of high-end consumption[12]



These issues of increasing high-end consumption co-existing with slower increase in access and limited natural resources, and insufficient attention to some key sectors are serious concerns that need to be urgently addressed by the country's energy policy.

4.3 The governance challenge

As discussed earlier, India's energy policy needs to navigate through uncharted waters. This requires innovative policy formulation, efficient implementation and effective regulation and oversight, which in turn requires capable, strong and accountable governance institutions.

Unfortunately, India's record on governance and accountable institutional mechanisms is weak. There are inconsistencies in data available from different sources as indicated in [8, 28]. Capacity of governing institutions is a serious concern. To cite just two examples, an important agency such as the BEE currently does not have a full-time head and the Petroleum and Natural Gas Regulatory Board has just three members instead of the full bench of five. There are problems of coordination across agencies as exemplified by various issues such as the mismatch between coal linkages given and coal production capacity, inability to develop rail corridors for coal evacuation and data mismatches across ministries. Finally, and perhaps most seriously, accountability mechanisms for various agencies are very weak – as illustrated by examples from the coal sector [37], oil and gas sector [38] and power sector [39].

In our opinion, the institutional and procedural weaknesses of governance in the energy sector represent the most important challenge to be overcome, if India has to successfully provide energy services to its millions at the least financial and socio-environmental costs.

5 Conclusions

[12] Source: [30, 31, 32]

India's energy policy future would be constrained by the triple challenge of providing clean energy access to all its citizens, possessing limited natural resources of its own and rising local and global environmental concerns. It is unlikely that any country has had to face such a challenge in the past. Therefore, it follows that India needs to chart out a unique path to meet its development challenges while addressing the other constraints.

Some broad frameworks have been presented for two sectors to guide the policy formulation process to address these challenges. Though there are some positive signs of following such a direction, the overall picture is not very positive. In our opinion, the most fundamental challenge that India has to overcome is to develop accountable and capable institutions that can then develop the innovative solutions that are warranted by the situation. A good beginning could be through setting up a dedicated multi-sectoral institution, such as an Energy Analysis Office, under the Planning Commission or the Prime Minister's Office to take a holistic view of the energy sector. Another step would be to significantly increase the transparency and public participation of governance institutions across the energy sector. While it may not be easy to develop such institutions and mechanisms, the country does not really have a choice in this regard as not doing so will seriously imperil the country's energy future.

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