India's Energy Challenges

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Meeting a Billion Aspirations

Thanks to the revolution in information technology, material aspirations of over one billion Indians have been 'globalized.' Roughly 400 million Indians, classified currently as desperately poor, aspire to be lifted out of poverty and move into proper homes with electricity. The rest seek to educate and entertain themselves with cutting-edge communication devices and move around in motorized personal vehicles. The 'globalized' aspirations of a billion Indians are unfortunately on a collision course with a carbon budget that has been 'nationalized' under multilateral climate forums.

While climate change is defined as a borderless global problem, responsibility for causing – and the liability for addressing – the problem is apportioned strictly according to sovereign borders. Under this supposedly unquestionable premise, while India's size in terms of population numbers gives it a significant economic advantage, it becomes an enormous disadvantage when it comes to climate liability. For the present climate regime, India has the unenviable challenge of steering a billion economic aspirations within a constrained ecological budget. This in essence is India's energy challenge. India has to more than triple its energy supply in the next two decades while halving carbon emissions merely to deliver the very basic energy services such as lighting and heating to the majority of its population.

Factors that contribute to India's low per capita carbon emissions – poverty, low carbon lifestyles characterized by vegetarian or low protein diets, low vehicle ownership, use of non-motorized and public transport – are the very factors that the pursuit of economic aspirations is designed to change. Based on aggregate figures, India is the world's fourth-largest energy consumer with a total primary energy demand of 621 million tons of oil equivalent (Mtoe) in 2008, equivalent to the primary demand of Brazil, Indonesia and Saudi Arabia combined,[1] as well as the fourth-largest polluter emitting accounting for roughly 1.7 billion tons of CO^2 equivalent in 2007.[2] As per projections by the International Energy Agency, India is going to become the second-largest contributor to the increase in global energy demand by 2035, accounting for 18 percent of the rise.[3] India's energy consumption is estimated to more than double by 2035 growing on average by about three percent per year, a rate of growth significantly higher than in any other region.[4] Its per-capita consumption is also going to increase rapidly. Yet even by 2035, India's per capita energy consumption at 1.0 toe will be less than one-quarter that of the OECD.[5]

Moving from Carbohydrates to Hydrocarbons

India's per capita carbon emissions are as low as 1.5 tons which is one-third of the global average and less than one-tenth of the largest emitter. This is primarily because of the 400 million

Indians who draw their 'energy' only from carbohydrates they consume and the carbon they collect in the form of twigs used to burn 'subsidized' hydrocarbon. This perverse inequality in energy consumption is facilitated partly by the supply of female labor in India (fueled only by the meagre food they consume) that is deployed to collect and burn carbohydrate and carbon-based fuels. The economic rationale that sustains this exploitation is that the 'opportunity cost' of female labor is negligible as long as the women remain uneducated and unskilled. It is not uncommon to see female labor being used to ferry liquid petroleum gas – among the highest forms of energy available today – in cylinders weighing 16 kilograms to remote regions of India that lack motorable roads or pipelines. This is a net energy deficit system which, by definition, cannot generate energy surpluses that are necessary for 'wealth generation' through productive economic activities.

To increase the opportunity cost of female labor, substantial investments must be made in education that in turn requires massive investment in energy supply. Even the provision of basic lighting services that would facilitate the education process in poor households is a huge challenge. To provide roughly 80 million households (in which 400 million people live) with just two 60-watt electric bulbs that can be used for about four hours a day, India will have to increase its current generating capacity by about 10 - 12 percent. In order to meet the goal of increasing the per capita availability of electricity to 1,000 kilo watt hours – the level prescribed by the United Nations as the minimum needed for acceptable quality of life and also the key policy goal of the government – India needs to increase its power generating capacity by 400 to 500 percent.

Even the electricity consumption of those with access to electricity in India is below global average partly because electricity is unavailable and partly because it is unaffordable. Just under one-sixth of electricity users in India consume over 100 kilo watt hours per month, compared to the U.S. average of 900 kilo watt hours per month.[6] The per capita consumption of electricity in India at less than 500 kilo watt hours is one-fifth of the world average of over 2,500 kilo watt hours.[7] The energy intensity of households in India is roughly half that of a household in Brazil with a similar income, or one-third that of a household in the U.S. in the same income category.[8]

The absence of modern energy services among the poor is at the heart of economic exclusion of large sections of the population in India. Current reforms and investments in the energy sector are focused on market development and privatization primarily to limit budgetary deficit and to establish macro-economic stability. Economic disparities are likely to widen under such a policy regime, with the economically well-off sections of the population using their access to modern energy services for further economic emancipation while families without energy services remain locked in net-energy deficit subsistence traps.

Offering renewable and green energy technologies as energy solutions to poor rural households has not succeeded to the desired level, as it has predominately been a result of an energy policy which is very much a market-push agenda and not a 'development' agenda. Under this agenda, expensive 'green' energy is thrust on the poor either to demonstrate India's commitment to promote green energy or as a test market for new forms of energy technology – not as a means for development of the poor. Implementing any technological change in energy provision will have meaning only if it helps the poor move towards a system in which they have a substantial share of the power and hence, of society's material wealth.

Sustaining India's Coal-based Energy System

Coal is the main adjustment variable between 'business-as-usual' and 'low-carbon' energy paths for India because its formal energy system is essentially coal-based. Coal accounts for over 38 percent of India's primary basket followed closely by non-commercial energy sources such as firewood and animal dung, which account for over 26 percent. Hydrocarbons (oil & gas) account for 30 percent while hydropower contributes less than five percent. Nuclear power, wind and other renewable energy sources contribute less than one percent of India's primary energy needs.[9] Over 75 percent of electricity is currently generated in coal-based thermal power plants, and that share is projected to remain the same for the next two decades, with the volume increasing by over 400 to 500 percent.[10]

Until very recently, it was widely believed that India's coal reserves would last for over 150 to 200 years. More recent estimates suggest that out of about 98 billion tons of 'proven' reserves of coal, only 56 percent or 55 billion tons are extractable.[11] Depending on the rate of extraction of domestic coal, current reserves may last anywhere between 30 - 60 years.[12] For example, if coal production continues to increase at the rate of five percent per annum, proven reserves will be consumed in the next 45 years. Though a number of possibilities exist for technological improvements that can increase coal extraction and lead to new coal reserve discoveries, current trends seem to indicate that coal reserves in India are well on their way to exhaustion.

India is yet to move on to the second stage of its nuclear programme where it plans to use fissile plutonium to convert thorium and uranium into more fissile materails. In the third stage, India plans to develop advanced power systems using fissile uranium obtained from thorium. Despite doubts over the technical and economic viability of the thorium cycle, the Department of Atomic Energy (DAE), a tightly-held autonomous body that controls the Indian nuclear establishment, re-affirms its committment to the three stage program.

Domestic coal-based power generation may be limited to 300 giga watts if imported coal does not materialize as presumed. India's coal-based system is not a threat to global climate stability as is commonly believed because even if all coal reserves in India are used for power generation, Indian carbon emissions are unlikely to exceed 4.5 giga tons or three tons per person, which is lower than current global average levels. The real problem with India's coal-based system is its inefficiency. Thermal power generators in India perform well below global benchmarks in terms of thermal efficiency with efficiency levels of 27 to 30 percent compared to 37 percent in OECD nations.[13] Widespread adoption of efficient coal technologies will extend the life of domestic coal, reduce carbon emissions and lower costs of electricity.

An improvement of just one percent in efficiency can reduce coal consumption by three percent which translates into a reduction in annual coal consumption by about 100 million tons. This will lead to a reduction in annual CO_2 emissions of over 170 million tons (equal to the total emissions of the Netherlands). A variety of technical and institutional factors such as poor quality of coal, low Plant Load Factor (PLF), age-related deterioration, lack of maintenance, ineffective regulation, absence of competition and dubious tax policies contribute to India having one of the highest production cost for electricity in the world in Purchasing Power Parity (PPP) terms. To address these challenges, the government of India has launched a number of schemes, e.g., a market-based trading scheme that would facilitate trading energy efficiency certificates, introduction of supercritical technology, modernization of old thermal power stations, retirement of older small size units, comprehensive energy audits and setting-norms for energy usage. The success of these measures is critical because 'a carbon tax' cannot be imposed on the average energy consumer in India who is already overburdened with an 'inefficiency tax.'

Realising Nuclear Energy Ambitions

The recent waiver from the Nuclear Suppliers Group (NSG) that allows India to import nuclear technology has resulted in politically seductive pronouncements such as "40 giga watts of nuclear power by 2020" and "450 giga watts by 2050." Given that India was able to install only about 4 giga watts of nuclear power generation capacity in 60 years (albeit under severe technological and financial constraints), its ambition of increasing capacity by a hundredfold in the next 40 years can only be described as 'irrational exuberance.'

India began its nuclear program early in the late 1940s with a three-stage plan that was designed to achieve energy self-reliance. During the first stage, India tested both light water and heavy water technologies and eventually picked pressurized heavy water technology. Heavy water reactors generated more plutonium than light water reactors for the same amount of mined uranium, a decisive criterion for India because it has high plutonium requirements for the second stage of the program and has scarce uranium reserves. Moreover, plutonium for military purposes was easier to obtain by reprocessing spent fuel from heavy water reactors than spent fuel from light water reactors.

India now has 15 operating Pressurized Heavy Water Reactors (PHWRs) and two operating Light Water Reactors (LWRs) with a total operating capacity of 4.12 giga watts. Three PHWRs, two Prototype Fast Breeder Reactors (FBRs) and one more LWR of total capacity 3 giga watts are under construction. There are plans to construct four more 500 mega watts FBRs by 2020, which would add up to a total FBR capacity of roughly 2 giga watts. These FBRs are to set the scene for the third phase of its nuclear program that plans for full utilization of the country's abundant thorium. Studies indicate that India would need 200 giga watts of FBR capacity to start introducing thorium-based fuel in the FBRs.

DAE argues that by 2050, India would face a power deficit of over 412 giga watts and suggests that it would be wiser to import 40 giga watts of nuclear reactors by 2020 rather than having to import over 1.6 billion tons of coal by 2050. If India manages to commission 40 giga watts by 2020, it would have launched – in 12 years – more than five times the nuclear generation capacity achieved in the previous 40 years. India currently successfully operates a number of nuclear reactors and its industry is able to supply most of the necessary equipment and has its research centers in lead positions in FBRs. Nevertheless, it faces seemingly insurmountable economic, legal, technical, logistical and commercial challenges that need to be overcome to meet its nuclear ambitions. At the very least, the government needs to establish a sound economic framework that would guarantee economic sustainability to its electricity sector.

Conclusion

In studying India's energy sector, it is easy to confuse the whole for its parts. The industrialized world is threatened by the whole or the aggregate level of India's energy consumption, which is comparable to the largest energy consumers of the world; but it often ignores the low per capita energy consumption levels that are comparable to the energy consumption levels of Mozambique. The magnitude of projected energy demand also captivates and engages Indian energy planners to such an extent that they often overlook qualitative aspects such as increasing efficiency in energy production and distribution, offering equity in energy distribution and ensuring compliance with environmental standards. Available technologies can play a critical role in the qualitative aspect of energy production and delivery, yet it is marginalized as it is not as politically attractive as the 'security of supply' framing of the energy problem.

India's energy challenge is threatening, both for India and the rest of the world, precisely because the well-known rhetorical conflict between the message of abundance and the message of scarcity seems to have suddenly become reality. Technology which has traditionally moderated the conflict between abundance and scarcity is once again seen as the savior that would deliver abundance for India and the rest of the developing world. Sophisticated global technological resolutions convey the message that energy technology solutions are automatic and could be confidently awaited. Yet it is unclear at this point whether the optimism is justified, given the scale and scope of India's energy challenge.

Notes

1. International Energy Agency, *World Energy Outlook 2010* (Paris, France: International Energy Agency).

2. Ministry of Environment of Forests, *India: Green House Gas Emissions* (Government of India: 2007).

3. IEA, 2010.

4. Ibid.

5. Ibid.

6. Narasimha Rao, Girish Sant and Sudhir Chella Rajan, *An Overview of Indian Energy Trends: Low Carbon Growth and Development Challenges* (India: Prayas Energy Group, 2009).

7. Ibid.

8. World Resources Institute data available at *http://www.wri.org/*.

9. IEA, 2010.

10. Central Electricity Authority, “Long Run Electricity Demand Forecast Using Econometric Model,” *Report on Seventeenth Power Survey of India* (Government of India: 2007): 273-289.

11. Ananth P. Chikkatur, “A Resource & Technology Assessment of Coal Utilization in India,” *Coal Initiative Reports* (Pew Centre on Global Climate Change, 2008).

12. Ibid.

13. Joël Ruet and Zakaria Siddiqui, “Shakti’s avatars: Which energy for India?,” in *Energy in India’s Future: Insights 7*, ed. Jacques Lasourne and William C. Ramsay (Paris: IFRI, 2009): 59-139.