Paper 5

POST-CARBON DEVELOPMENT: AN ANALYSIS OF COMMERCIAL AND RESIDENTIAL, TRANSPORT, AGRICULTURE, AND RURAL SECTORS IN INDIA

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Executive Summary

India's energy use has been expanding for the past five decades, with the last decade witnessing a shift from demand in non-commercial to commercial energy. The energy demand is further expected to increase as the economy grows further. Due to rapid industrialization there has been increase in electricity demand amongst residential and commercial buildings. Still about 84 million households do not have access to electricity. Various measures have been identified to tackle the problem but these remain difficult to implement. Voluntary guidelines have been formulated to address the sector and in due course of time these guidelines shall be made mandatory. Transport continues to contribute significantly to GHG emissions and there is an urgent need to promote public transport systems over private mode of transportation. Agricultural sector also contributes to a major share of methane emissions in the country and many initiatives are being undertaken to promote energy efficiency in the sector. Three- fourths of the rural households continue to depend on traditional sources of energy for meeting primary energy needs. These traditional sources such as fuel wood and agricultural wastes are inefficient. Providing cleaner sources of energy to villages is both a challenge as well as an opportunity. It is important to make villages self sufficient by tapping local sources of energy. Designing efficient chulhas, setting community sized biogas plants and setting up off-grid energy facilities are potentially viable solutions to this challenge. It is however important to explore ways to leverage finance to address the challenges involved in the sectors, hence creating a demand for technological leapfrogging. A bottom of the pyramid approach is needed to address these sectors wherein small technological interventions are made or local interventions are supported in large numbers to address multiple stakeholders. This paper looks at energy consumption in four key sectors namely commercial and residential, transport, agriculture and rural sector and highlights various energy related issues and also highlights potential opportunities for a low carbon intensive growth curve.

Introduction

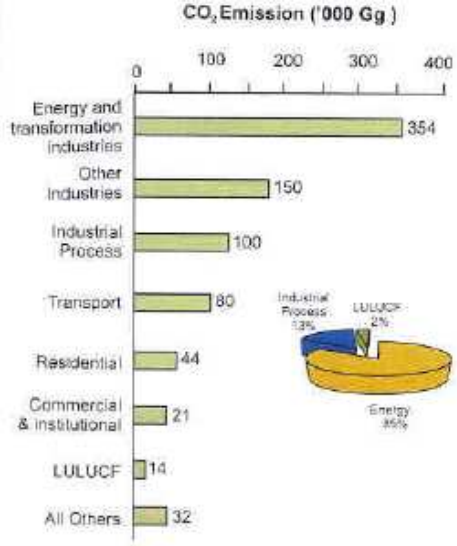
In India, energy use during the past five decades has expanded, with a shift from non-commercial energy to commercial energy. Given India's economic growth, the energy demand is expected to rise further. A set of development goals has been adopted by India in its Tenth Five-year Plan for country's development. These goals are also consistent with the internationally accepted MDGs (Millennium Development Goals), and the monitorable targets set in these goals have strong correlation with poverty alleviation, health, environment, and pro poor growth policies. Given their current status, attainment of most of the targets will require substantial energy, and thereby, will result in equivalent emissions. However, it is imperative for developing countries like India to avoid following the path of development taken by the developed countries. Therefore, graduation to low carbon or post-carbon development is the solution for achieving sustainable development. This paper brings to the fore the current scenario of energy consumption in four key energy consuming sectors, that is, commercial and residential, transport, agriculture, and rural sectors, and then highlights the issues involved in mitigating the emissions from the same. It also discusses the present energy needs in these sectors while projecting the future energy demands, and also

highlights the policy interventions adopted by the Government of India to moderate these emissions.

Current scenario

India has 17% of world population that accounts for only 4.2% of world GHG (greenhouse gas) emissions. Per capita emissions in India are also significantly lower than USA, Canada, Japan, and various developing countries such as Brazil. As per India's initial national communication, 65% of GHG emissions in 1994 came from the energy sector.

Figure 1: Activity-wise carbon dioxide emissions (1994)[1]



Residential and commercial sector

Various activities like cooking, lighting, and space heating, and household appliances consume energy in the residential and commercial sector. The total CO_2 (carbon dioxide) emission from the commercial sector in 1994 was 20 509 Gg, while for the residential sector, total CO_2 emission stood at 43 794 Gg in the same year (Figure 1). The population of India is about 1.027 billion, as per 2001 census of Government of India. Average number of members per household is 5.15 in rural areas and 4.47 in urban areas. Of every 100 households in rural India, 36 are *pucca* houses, 43 are semi-*pucca*, and the rest are *kuchcha* houses, whereas in urban India, the corresponding figures are 77, 20, and 3, respectively. About 30% of dwellings in rural and 4% in urban India do not have basic facilities such as electricity for lighting, a toilet, and drinking water.[2]

In India, 84 million households still do not have any access to electricity. These households are dependent on inefficient fuel resources for lighting and thus have adverse social and environmental impacts. Commercial energy use has been growing at a rapid pace in the residential area for quite some time now. Three major commercial fuels – LPG (liquefied petroleum gas), kerosene, and electricity – are witnessing an increase in demand. LPG is predominantly used for cooking in urban India, with 45% of households using it. India's commercial energy consumption in the residential sector is only about 22 MTOE (million tonnes of oil equivalent). About 60% of the total electricity is used for lighting, 32% for space conditioning, and 8% for refrigeration in the commercial sector.

Transport sector

The transport sector is one of the sectors contributing significantly to GHG emissions. It includes road, rail, aviation, and navigation. The transport sector accounts for a sizeable portion of the total petroleum consumption. The total CO_2 emissions from this sector in 1994 were 79 880 Gg, and among transport sub-sectors, road transport is the main source of CO_2

emissions and accounted for nearly 90% of the total transport sector emissions in 1994. However, today an efficient transport system is a critical infrastructure requirement in cities for greater economic productivity and better quality of life. This will add to the increasing GHG emissions, therefore, underscoring the need for a low carbon path development.

Agriculture sector

India is a largely agrarian society with nearly 64% of the population dependent on agriculture. Agriculture accounts for 43% of the total geographical area, though the share of agriculture in the gross domestic product has been continuously declining over the last 50 years. The end use energy demand in the agricultural sector in India is mainly attributed to two major agricultural operations, that is, land preparation and irrigation. The energy demand for land preparation depends on the extent of gross cropped area and the use of machinery. Initially, the uses of machines were restricted in the sector, but now as a result of joint efforts made by the government and private sector, the level of mechanization has been increasing steadily over the years. This has led to increasing demand for equipment like tractors, which are used for land preparations. The Annual average rate of growth for tractors manufactured was 9.73% during 1971–2001.[3]

In the total methane emissions of 18 583 Gg in 1994, the agriculture sector had a share of 78%. Enteric fermentation (8972 Gg) and rice cultivation (4090 Gg) were the largest sources of methane emission in the agriculture sector. Besides this, agriculture also accounted for the high N_2O (nitrous oxide) emission in India, constituting about 81% of the total N_2O in terms of CO_2 equivalent released in 1994.

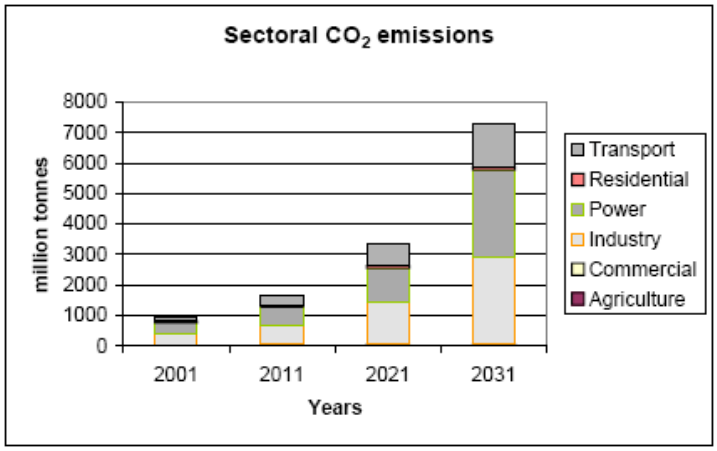
Rural sector

Rural population in India has increased by almost 2.5 times during 1951–2001. Most of the households in the rural areas still do not have access to modern energy forms. Around three-fourths of the rural households continue to depend on traditional fuel sources to meet their energy needs, primarily, heating and cooking. The dependence on fuelwood is reducing and the usage of LPG and other sources of energy is increasing. In rural areas, households use mainly three primary sources of energy for cooking, that is, firewood and chips, dung cake, and LPG. Crop residue and other biomass wastes are other alternative cooking fuels. In villages, only 44% of rural households are electrified as of now due to high cost of providing grid supply to remote villages, which is governed by distance from the grid, geographical terrain of the village, number of households, and load sensitivity.[4] As a result, a lot of subsidy is still provided to kerosene/diesel so as to make it accessible for rural population.

Growing energy and resources demands

The growing economy is opening new avenues for development, and urban areas are attracting population from rural India. Inability to enforce laws and guidelines strictly is making the growing years painful. With the increase in infrastructure, GHG emissions are set to increase. Figure 2 shows the current and future distribution of CO_2 emissions, by sector. The figure shows a consistent and substantial growth in emissions in the transport, power, and industry sectors in the coming years.

Figure 2: Sectoral carbon dioxide emissions related to energy sector[3]



Residential and commercial sector

During the period 1993/94 to 1999/2000, the number of households using electricity as primary source of lighting grew at the rate of 11% for rural and 6% for urban India. There has been a 30% increase in total electricity demand amongst residential and commercial buildings, primarily due to rapid urbanization and people opting for comfortable lifestyle. It is expected that this trend will continue in the future also. Electricity consumption in the commercial sector is growing at an average annual rate of 8.1% per annum.[5] In the BAU (business-as-usual) scenario, for the period 2001–36, energy demand for space conditioning (fans, coolers, and air conditioning) is expected to increase at the rate of 14.16% in rural areas and at 12.87% in urban areas, as air conditioning is set to become more popular in future.[3] LPG is the predominant fuel for cooking in urban India, with 45% of households using it.

Transport sector

The total energy requirement for the transport sector would increase rapidly, from 36 MTOE in 2001 to 432 MTOE in 2031.[3] While the increasing use of gasoline is attributed to enhanced use of personal motor vehicles, the increase in diesel consumption is largely on account of the increasing road-based freight movement. It is estimated that the country's net expenditure on import of petroleum products would increase from about Rs 1843 billion in 2001 to more than Rs 15 000 billion by 2031.[3]

These trends in fuel use can have serious implications in terms of the country's oil security. India's oil dependency, which is already about 68%, is estimated to increase to over 90% by 2030, if the current trends continue. The increase in two-wheelers and cars, with a marginal increase in buses, indicates that public transport has failed to keep pace with the growing needs of urban transit, resulting in higher congestion as well as increase in urban air pollution. Therefore, there is an urgent need to upscale activities promoting more public transport and discouraging private vehicles.

Agriculture sector

The country had an almost stagnant agriculture at the time of Independence, that is, in 1945 and, therefore, the use of commercial energy at that time in the sector was negligible. However, with the advent of Green Revolution and further infrastructural development, the requirement of commercial energy of the farm sector increased by several times. Power availability for carrying out various agricultural operations increased from 0.3 kW/ha (kilowatts per hectare) in 1971/72 to 1.4 kW/ha in 2003/04.[6] Besides the emissions from the use of energy, methane emissions from livestock form a significant component of agriculture emissions. These emissions are expected to rise further as the agriculture and land preparations become more mechanized and modern.

Rural sector
A major chunk of Indian population still resides in villages. India has managed to meet its energy demands in rural India by widespread usage of coal and solid biomass such as fuelwood and agricultural wastes, both of which are inefficient source of energy. Only 9% of households in rural India use LPG as their primary source of cooking. This scenario presents a challenge as well as an opportunity to provide cleaner sources of energy to villages. A lot of Indian villages do not even have basic facilities and providing them with power would raise the demand. In highest income group of rural India, there has been an increase in the number of families possessing durable goods such as fans and TVs. This in turn leads to increase in energy demand. It is important that the villages be provided with sources of electricity, depending on their geographical and physical location.

With the growth in the economy of the country, there will be a steady increase in energy demand. With the increase in expendable income, the demand for consumer goods is increasing. It will be difficult to meet the growing energy demand without proper planning and vision for future.

Policy relevance

The Government of India has been active in formulating policies that promote the usage of efficient technology across various sectors. Standardization of various sectors is also being undertaken in consultation with industry representatives and involvement of panchayats in rural India. The effective implementation of these policies will be a challenge for the various departments involved in the formulation of these policies.

Residential and commercial sector
The potential of mitigating climate change by addressing the concerns in the commercial and residential sector has been acknowledged. However, the various measures identified have been difficult to implement because the sector comprises multiple sources of emission. This makes the task of both implementing measures and monitoring emissions tedious. The BEE (Bureau of Energy Efficiency), which has the main objective of improving energy efficiency in various sectors, has been successful in developing energy efficiency labels for various appliances like refrigerators; certifying energy managers and auditors; conducting energy audits in government buildings; developing demand side management programmes; and establishing benchmarks for industrial energy use. The BEE has also come up with ECBC (Energy Conservation Building Code), which sets minimum acceptable energy standards for commercial buildings. In rural India also, the government is targeting electrification of those unelectrified remote census villages/hamlets, where grid connectivity might not reach by 2012 through its RVE (Remote Village Electrification) Programme.[7]

For bringing about a decisive improvement in the living standard of the relatively poorer sections of society, the government plans to provide cleaner fuels for cooking and electricity to all by 2012. As per the 2001 census of India, only 55.8% of households had access to electricity in 2001. Providing adequate and clean energy to all within the target period is by no means an easy task and calls for concerted implementation of combined time bound action plans to enhance resource availability and generation capacity.

Transport sector
The inevitable rise in emissions from the transportation sector can be moderated by increasing the reliance on public transport and by bringing improvements in efficiency standards. The Government of India has made significant policy interventions, including continuous improvements in the emissions norms to enhance the air quality in the urban centres in the wake of rapidly increasing vehicular number. The Government of India announced the Auto Fuel Policy in 2003, which comprehensively addresses the issues of vehicular emissions, vehicular technologies, and the provision of cleaner auto fuels in a cost-

efficient manner while ensuring the security of fuel supply. The policy includes the road map for reduction in emissions levels of the new vehicles. Besides proposing the enhanced quality of liquid fuels, the policy also encourages the use of CNG (compressed natural gas)/LNG (liquefied natural gas) in the cities. In addition, the judiciary has also played a crucial role in reducing vehicular pollution in the past decade.

The NUTP (National Urban Transport Policy) emphasizes the development and usage of extensive public transport systems (including non-motorized modes) over personal vehicles. The policy also underlines the importance of cleaner technologies like CNG and stresses on the role of the central government in encouraging research, development, and commercialization of cleaner technologies. By encouraging public transport and promoting renewables and energy efficiency efforts in the residential and commercial sector, the Government of India is laying the foundation for green cities. But many areas like water harvesting, solar heating, and efficient lightning are still in nascent stages and have not picked up in the market. The reason is lack of awareness and high cost of the equipment. This is the area where there collaboration is needed to facilitate transfer of cheaper or well-developed technologies from other countries.

Agriculture sector
Agriculture is a critical component of Indian sustainable developmental policies and many initiatives are being taken to promote energy efficiency and increase the resilience in the sector. Accelerating the growth rate in this sector and raising the living standards of the rural poor will also build adaptive capacity, which will help in development and poverty eradication. Government programmes on Watershed development, crop insurance and setting up of boards like The National Wasteland Development Board and National Afforestation and Eco-Development Board have lead to increased resilience and forest cover thus addressing both adaptation and mitigation.

Rural sector
Major chunk of Indian population resides in rural India and it is important to ensure that rural India becomes self-sufficient to meet its energy demand by tapping local sources of energy. The IEP (Integrated Energy Policy) estimates the use of 6 kg of LPG or its equivalent per household per month for cooking and 30 kWh of electricity per household per month for lighting. It also recommends setting up of community-sized biogas plants; improving efficiency of *chulhas*, and providing financial incentives to women who collect fuelwood to set up off-grid energy facilities. The developed countries can help by supporting finance and promoting local sources of cleaner energy. The IEP estimates that 30%–40% of rural energy needs can be met with biogas, if most of the animal dung available in rural India is fed into biogas plants. The biogas development programme promotes biogas units for recycling of cattle dung to harness its fuel value without destroying the manure value. Toilet-linked biogas plants are also being popularized for sanitary treatment of human waste. Over 3.5 million family-type biogas plants and 3902 community, institutional, and night-soil-based biogas plants have been set up till March 2003. Over 35 million improved *chulhas* have been distributed under the NPIC (National Programme on Improved Chulha) up to March 2003, with a view to conserve fuelwood, eliminating smoke from kitchens and reducing drudgery of women and girl children.

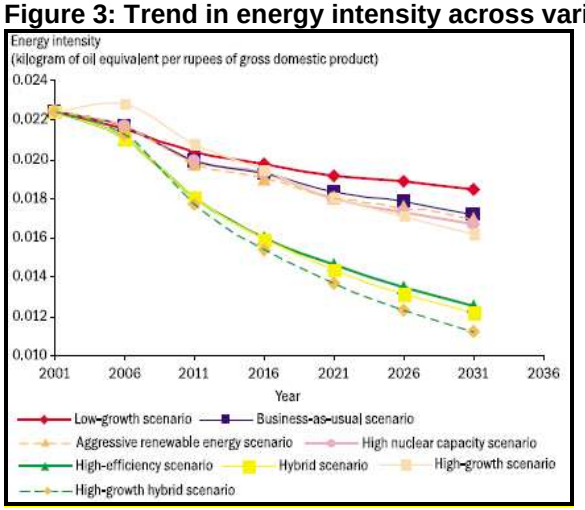
Post-carbon: the road ahead

The climate change problem has put a question mark on the growth patterns. The unsustainable development undertaken in the past has started showing its negative side effects. Continuation of such development path will lead to the growth in CO_2 emissions.

Figure 3 shows the trends of energy intensity for various scenarios in India over the modelling time frame. The energy intensity clearly shows a declining trend in the BAU

scenario. However, it may not be enough, and to achieve possible reductions, it is imperative to get more support from the international communities.

Figure 3: Trend in energy intensity across various scenarios, from 2001 to 2031



For following an efficient scenario, cleaner technologies and finance would be needed.

Residential and commercial sector

The BEE has been doing substantial amount of work in the residential and commercial sector to improve energy efficiency. The programmes formulated by the BEE are still not mandatory and it will take them two to three years to make the various guidelines mandatory. The availability of technology is not as much of concern as the cost of technology. GHG emission reduction from buildings fall into three categories: (1) reducing energy consumption and embodied energy in buildings, (2) switching to low carbon fuels, and (3) controlling emissions of non-CO_2 GHG gases.[8] Better space heating systems, shell retrofits including insulation measures, and efficient lighting will play a key role in reducing emissions from the sector. Improved cooking stoves, especially biomass stoves, and efficient appliances can provide a major breakthrough in the sector. Occupant behaviour and choices being made by the consumer determine the energy usage in buildings. Hence, it becomes important to address measures beyond technological interventions.

Transport sector

The transport sector presents large opportunities for emission reduction. In this sector, there is a significant scope for reducing the consumption of hydrocarbon fuels, and thereby, reducing CO_2 emissions through fiscal and policy interventions directed at enhancing the use of public transportation, promoting rail-based freight movement, and providing a boost to the use of alternative fuels such as bio-diesel, and so on. However, this would require institutional and regulatory reforms in the transport sector. Bringing about energy efficiency in the transport sector through appropriate policy changes can also contribute effectively to reducing oil import dependency of the country. A study by TERI says that CO_2 emissions from the transport sector can be 33% lower in the HYB (hybrid) scenario as compared to the BAU scenario for 2031.

Biofuel is also receiving a great deal of attention as a substitute for petroleum fuels as it can potentially be produced from several agricultural sources and has low-emission characteristics. The two biofuels considered as the potential fuels for surface transportation are bio-diesel and ethanol. Switching from higher carbon-intensive fuel to lower carbon-intensive fuel, such as from coal to gas, and use of alternative fuels (bio-diesel, ethanol, and so on) need to be promoted.

Agriculture sector

Standardizing fuel-efficient irrigation pump sets, retrofitting existing pump sets for higher energy efficiency, improving animal feeds and digesters, applying synthetic fertilizers efficiently, enhancing the use of organic fertilizer, and rationalizing power tariffs for the agriculture sector are some of the initiatives taken to address mitigation in the agriculture sector. Better water and crop management, development of water-resistant species, and insurance are some of the measures taken to increase adaptation. Many of these measures would serve to reduce CO_2, methane, and N_2O emissions.

Rural sector
Various government programmes are trying to make energy available to villages in rural India. The efforts are concentrated on providing local sources of energy to them. However, by having better financing structures, more sustainable models of growth and energy consumption can be promoted. The solar power can be of high relevance in villages. Grid-free electricity is also an option that can be made affordable by proper financing, that is, by subsidizing the available technology in place of subsidizing inefficient sources of energy such as kerosene. Biomass-based cook stoves can play a crucial role in meeting the energy demand of rural India.

Scope for Indo-EU collaboration
There is a huge energy shortage and almost 50% of population in India does not have access to electricity. Major chunk of this population resides in rural India. Providing them with energy is the need of the hour to improve their quality of life and promote livelihood options. India has various programmes trying to tackle this challenge. However, the two main factors that make it difficult to provide electricity to far-off villages are finance and technological breakthroughs. Financial support is required for the mass deployment of existing technologies, for example, to deploy solar technology, the upfront cost is an issue. This is where a European organization can venture in by providing finance for supporting already existing technologies or making available latest technologies on a large scale. For example, biomass-based technologies, which are more efficient than already existing technologies, can be taken on a bigger scale. Small hydro projects, which target the local ecology of a village, can help fulfil the energy need as well as improve the groundwater table of the local areas. Such projects should necessarily be based on local terrain and can be indigenous. European agencies can share their experiences or adopt some villages to take up this particular technology. Such a project has the potential to address other aspects as well, besides meeting the energy demand of the village.

The programme shall further depend on the core competence available with the EU companies and their willingness to share the same with the parties based in the developing countries. It will also provide European companies with new markets. As of now, there have been no major instances of technology being transferred from developed countries to developing countries. A major effort needs to be undertaken to successfully take up this issue.

Conclusions

Undoubtedly, India has to develop economically, and there is a growing international pressure for reducing carbon footprints. This justifies technological and financial support to the country. The possibility of accepting post-carbon scenarios shall only be possible if developing countries have the technological and financial support.

For technology transfer, it is important to create linkages that ensure real action. This would require addressing issues related to grants for scaling up technologies to a profitable level, the problems inherent in dissemination of such technologies and leveraging the opportunities

that venture capitalists provide by bringing in more investment for such projects. Some of the technologies might be critical for various vulnerable societies but because of the IPR (Intellectual Property Rights) issues involved they might not reach the part of society where these are actually needed. For addressing the same, it would be good to explore the possibility of removing the IPR involved so that they can be made available to the communities in dire need. Thus, the technology in public domain should be made available as early as possible and the patents should not act as obstacle, especially with respect to sustainable development. It is important to reach a consensus on IPR issues before the end of this year. Publicly funded and privately owned technologies should be opened to access.

Another point of concern is the inability of the CDM (clean development mechanism) to effect actual transfer of technology on a substantial scale. While on financing front, mechanisms should not be limited to CDM and GEF (Global Environment Facility) only, and collaborations on regional scale are needed to upscaled. It is important that greater efforts are made to promote CDM projects, which showcase profitable instances of technology transfer. This can be done by ensuring a better price for credits coming from such projects or giving priority to such projects in the CDM cycle. A new financial mechanism agreed upon at a global scale would be difficult to reach in a constrained time frame and it may also result in shifting the focus from improving already existing mechanisms. More stress is needed on research to provide models that percolate the benefits at community level. Principle of payment for ecosystem services can be relooked to involve communities in climate protection. Along with technological and financial barriers to take up de-carbonization pathway, lack of adequate infrastructure networks and non-affordability of modern energy services constrict the willingness to take up clean growth challenge. Emphasis on demand side management by taking up judicious pricing, checking electricity theft, and reducing transmission and distribution losses is urgent so that the pressure of producing more and more power is reduced.

India is witnessing an unforeseen growth in all spheres and the Government of India has started acknowledging the threat of climate change. The country is yet far from accepting the boundaries on growth, created by carbon taxes and other regulations due to developmental prerogative. The possibility of living in post-carbon scenario is a threat that can only be nullified by an active participation from all the countries.

Endnotes

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