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REVIEW ARTICLE

INFLUENCING FACTORS OF ENERGY CONSUMTION IN RURAL AREA OF MAHARASHTRA

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Influencing Factors of Energy Consumtion in Rural Area of Maharashtra

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From the trend analysis as well as the regression analysis it is now clear that there is positive relationship between total primary energy consumption to GDP, population, and per capita energy consumption, however a negative relationship do exist between the energy use and the production of the energy resources in case of India. From the study one can summarize that total primary energy use is one of the key components of the GDP. Population is an important factor for the total primary energy consumption and one of the major contributors for the demand of more energy resources. Per capita energy consumption in the economy has a positive relationship with the total energy use. Hence it is one of the important factors of the total energy consumption. As evidence from the developing countries more the nation develops economically, the demand for energy resources also increases. Our findings also suggests in the same way, as increase in GDP, Population, Per capita consumption leads to more demand of energy resources.

The study provides an overview of the energy sector development in India during the last fifty years and the likely energy scenario in the year 2020. The initial part of the study gives a comprehensive picture of the progress made in creation of the energy supply infrastructure, the changes in sectoral energy consumption pattern and the energy-economy relationship as evolved over time. The long term projections of energy demand are made using a spread sheet based model. The model essentially follows the DEFENDUS approach as developed by Prof. A.K.N. Reddy and his associates but with suitable modifications made by the authors in regard to the methodology of projection of energy demand for different sectors. The scope of the present study encompasses building up of energy demand scenarios for different sectors of the economy under various assumptions of changing patterns of energy use, efficiency improvements, inter-fuel substitution, satisfaction of energy demand for energy services, etc.. The study is centered primarily around three scenarios; Business as Usual (BAU), Efficiency-Oriented Scenario (EFF) and Environmentally Constrained Scenario (ENV). The projections under each Scenario take into account the overall availability of resources and the likely growth in the demand for energy in the economy. While BAU denotes a Scenario based on the existing trends in the energy sector, EFF considers the scope for reduction in the energy intensity of the economy, based on end-use efficiency, inter-fuel substitution and other demand management measures. In the ENV Scenario, the emphasis is on minimizing the adverse environmental implications of the energy system under different sets of assumption. The various implications arising out of the energy demand projections in the three scenarios have been discussed. The study also attempts to estimate the costs and benefits of renewable energy development by analyzing the implications of exploitation of hydel power potential in the overall context of power sector development needs arising out of the demand for power as projected in the three scenarios for the year 2019-20.

It is useful to look to the experience of other countries that have attempted to promote household use of hydrocarbon-based fuels. The standard approach is to change relative fuel prices by fiscal means. Worldwide, a number of countries, particularly oil producing countries, have had zero or negative taxes on kerosene and other fuels such as diesel and LPG. Countries that subsidize LPG include Côte d'Ivoire, Ecuador, India, Senegal, and Venezuela. LPG subsidies, however, typically benefit middle- and higher-income families in urban areas, and hence are not pro-poor. Some countries have made efforts to make LPG subsidies more pro-poor. For example, Côte d'Ivoire and Senegal have specifically targeted their subsidies at smaller cylinders to make each refill more affordable, promoting the use of 6 kg and smaller cylinders as opposed to the more commonly used 12.5 kg cylinder. However, despite the subsidy (about 25 percent, as of December 1999) making unit costs lower for cylinders smaller than 12.5 kg, consumers in Côte d'Ivoire have not switched to 6 kg cylinders: in 1999, less than 10 percent of LPG was sold in the subsidized 6 kg bottles. In Senegal, 2.75 kg and 6 kg cylinders have historically been heavily cross-subsidized by larger cylinders, and LPG has become the principal cooking fuel for many urban households. However, the urban poor still find (subsidized) LPG expensive, using instead charcoal, which is cheaper and can be purchased daily. The government of Senegal is now in the process of phasing out its LPG subsidy entirely because of its high fiscal cost.

Worldwide experience shows that it is extremely difficult to use subsidies to induce the poor to switch to kerosene or LPG for cooking. The task is virtually impossible where free biomass is available and time is unconstrained because of the absence of income generating opportunities. Only when biomass becomes a commodity traded for cash, typically in urban and peri-urban areas, do the poor begin to consider alternative fuel options. Even so, the poor find fuels that can be purchased on a daily basis, such as kerosene or charcoal, more affordable than LPG, which can be purchased only one cylinder at a time. Add to this the higher start-up cost of LPG and its higher price relative to kerosene or charcoal, and LPG is out of reach for the poor. Kerosene merits special consideration because it is used for lighting by the poor. Absent a reliable source of electricity, making kerosene available and affordable to poor non electrified households has been considered important by many governments. However, no developing country government has been able to develop a successful kerosene subsidy scheme to set an example to follow. Subsidies need to be sizable to induce the poor to take up kerosene, but a large kerosene price subsidy leads to both massive leakage and lack of fiscal sustainability. A coupon scheme, which in principle can allow better targeting and be effective for some goods, does not seem to prevent or significantly reduce kerosene leakage as illustrated by the experience of Nepal. In another example, kerosene was heavily subsidized in Peru from the 1950s until 1991, when the subsidy was withdrawn. During this period, kerosene became the cooking fuel of choice among many households. Subsidized kerosene was not rationed, and a substantial amount was diverted to the automotive diesel sector or was smuggled out of the country. As in India, petroleum product subsidies in Peru amounted to billions of dollars by the late 1980s, eventually leading the government to withdraw the subsidy and liberalize the market.

Today, significant private sector participation has made LPG available at competitive prices in large and medium-size cities, with the result that LPG has become the fuel of choice. The findings of this study are broadly consistent with those of a series of studies conducted in mainly rural Mexico (Masera and others 2000), (The researchers found that the exclusive use of fuel wood for cooking tended to be concentrated among low-income households. When households began using LPG, in rural areas they almost never abandoned fuel wood, such that nearly all households that were using LPG were multiple-fuel users.

Furthermore, mixed fuel (fuel wood and LPG) users tended to consume more overall energy than fuel wood-only users. As a result, the fuel wood savings from adopting LPG, which ranged from 0 to 35 percent, were much smaller than would have been expected if fuel substitution alone had occurred.

In the Mexican study (Masera and others 2000), surprising results were found when smoke was measured during cooking. Ambient concentrations of particles smaller than 7 microns were measured around the cook. (In terms of health impact, the smaller the particle the more damaging it is. Particles smaller than 7 microns are therefore suitable for estimating the adverse impact of indoor air pollution on public health.) The average particulate concentration did not decrease consistently as income rose. In fact, the average concentration among the lowest-income households was 450μg/m^3, but this rose to 845μg/m^3 among the most affluent households where the highest proportion of LPG usage was found. While these findings need to be interpreted with caution because of the small sample size, they nevertheless illustrate the point that air pollution levels do not necessarily decrease monotonically with increasing wealth or by the simple expedient of adopting LPG. The researchers offered several possible explanations for these household pollution measurements results. For example, as income rises the kitchen area is more frequently separated within the house, and some affluent households also will remodel the kitchen, using materials that do not permit as much air flow: for example, replacing wooden walls with cement walls.

In some countries, governments do not subsidize LPG directly but use moral suasion to prevent retail prices from rising too high. One consequence of setting an arbitrary price ceiling that is unrelated to the international price is that such a move discourages investment in importation infrastructure by constraining the ability to recoup that investment, resulting in LPG supply shortages. This points to the importance of allowing market-determined prices to test consumer willingness to pay and of allowing market forces to equilibrate supply and demand.

Some governments also require all LPG distributors to supply a certain fraction of their total sale to “remote areas.” This tends to result in an inefficient and costly distribution system, because it is difficult for any one firm to take advantage of economies of scale. If supply to remote areas is a legitimate concern, it may be better to introduce a bidding process whereby a time-bound exclusive right to supply a remote area is given to one (or two) supplier(s) according to performance-based criteria, rather than to require every LPG distributor to supply a mandatory percentage of their product to these areas.

Reducing the start-up cost is another way of easing the transition to petroleum, and especially gaseous, fuels. The Government of Senegal began its LPG promotion program by removing all import duties on 2.75 kg LPG cylinders and on the cookers designed for these cylinders. In Guatemala, LPG dealers offer installment plans for the cylinder deposit fee and stove purchase. While it actually increases the total payment for start-up, this payment scheme helps households with cash constraints to take up LPG.

The use of natural gas as a household fuel is limited in India, although its use can potentially expand in the future given recent large gas discoveries. Establishing a distribution system for households is expensive, but it is worth considering the many advantages of natural gas. Aside from electricity, natural gas is the cleanest commercially viable household fuel. Its greatest drawback is the fact that it is primarily viable only for urban and peri-urban areas, because laying down distribution networks to rural areas would in most cases be prohibitively costly. It nonetheless can serve a useful purpose by supplying a large number of urban households; and with growing urbanization, the percentage of the population that can be served by natural gas will increase. Where indigenous sources of natural gas exist, as in some parts of India, it can be far cheaper than LPG or kerosene. Except where electricity is specifically required, it is perhaps the only fuel that can meet all the energy needs of the urban poor, including heating. Targeted subsidies are also easier to construct, because it is more difficult to "divert" natural gas piped to the household than it is to divert kerosene or LPG. The simplest approach would be to structure the tariff so that there is a small first block, enough to meet the cooking and limited amount of heating needs of poor households, at a (low) "lifeline rate." This first block could be cross-subsidized by higher blocks so that the scheme entails no government subsidies. Analysis of household use of natural gas in Pakistan indicates that a reasonable first block can cover about 25 to 30 percent of all consumers and those who consume less than the first block limit consume only about 5 percent of the total gas sale to households.

The Indian Government has already undertaken or planned for several policies and initiatives that encourage sustainable energy growth – both in terms of improved efficiency of use and in terms of its environmental implications. Several policies and measures have for example focused on improving energy efficiency, enhancing renewable and clean energy forms, bringing about power sector reforms, promoting clean coal technologies, promoting cleaner and less carbon intensive fuels for transport, and addressing environ-mental quality.

The Indian Government has actively been pursuing a multi-pronged strategy for the promotion of renewable energy sources. Against a target of 3,075 MW, the country added 4,613 MW capacity based on renewable during the Tenth Plan. During the Eleventh Plan period, the MNRE aims to have 10% of grid interactive power generation installed capacity and 4% of the electricity mix based on renewables.

The study of alternative sources of fuels has be-come increasingly important in recent years. TE-RI's pioneering work in terms of exploring Jatropha curcas as a bio-diesel plant and in associating with the National Mission on Bio-fuels to study the techno-commercial viability of bio-diesel production from its seeds constitutes an important step in this area.

The analysis presented in this report significantly advances, we believe, the understanding of sources of energy demand in the residential and the transport sectors in India, and the accuracy in predicting their trajectory over the next decade. In doing so, we have presented a consistent and robust framework for national and sector level demand forecasting, which relies on separating the drivers of energy demand, and the intensity of its use in meeting that demand. We believe this to be a critical step in developing a comprehensive strategy of national energy demand management – the need for which is becoming ever more urgent for large developing countries like India. The analysis as performed in this way reveals several interesting features of energy use in India. In the residential sector, an analysis of patterns of energy use and particular end uses shows that biomass (wood), which has traditionally been the main source of primary energy used in households, will stabilize in absolute terms. Meanwhile, due to the forces of urbanization and increased use of commercial fuels, the relative significance of biomass will be greatly diminished by 2020. At the same time, per household residential electricity consumption will likely quadruple in the 20 years between 2000 and 2020.

In fact, primary electricity use will increase more rapidly than any other major fuel – even more than oil, in spite of the fact that transport is the most rapidly growing sector. The growth in electricity demand implies that chronic outages are to be expected unless drastic improvements are made both to the efficiency of the power infrastructure and to electric end uses and industrial processes. In the transport sector, the rapid growth in personal vehicle sales indicates strong energy growth in that area. Energy use by cars is expected to grow at an annual growth rate of 11%, increasing demand for oil considerably. In addition, oil consumption used for freight transport will also continue to increase.

The intent of this report was to use as wide an array of available data at the highest level of detail possible. Undoubtedly, some already available sources were overlooked. In general, however, the authors feel that the greatest gaps in data availability arise from a lack of accurate statistics in some cases, such as in the transport sector. In this way, we hope to highlight areas where the greatest gains could be made through more thorough unearthing of data sources or, if necessary, completing the surveys and statistical analysis necessary to generate new data sources. We found that the transport sector lacks consistent data reporting from national source, specifically on the stock of vehicle in use and fuel economy of vehicles. Finally, only a few data points were found to describe the unit energy consumption per appliances types and little is known on their typical life time and hour of use. Future data collection on these issues will allow refining the first energy use breakdown matrix developed in this report for India.

An analysis of Maharashtra's power situation reveals an average energy shortage of 1,900 MW in 2006-07 (18.3 per cent) for MSEDCL and a peak shortage of 3,600 MW in 2006-07. The seasonal variation in shortages has been quantified using the monthly load duration curves.

Based on the high growth projection of MSEDCL, the average and peak energy requirement in 2007-08 have been computed as 11,100 MW and 14,100 MW respectively (corresponding to state average energy and peak demand projection including Mumbai of 13,100 MW and 16,200 MW). If the actual generation remains at 2006-07 values, this will result in an average shortage of 2,600 MW and a peak shortage of 4,500 MW. The planned capacity by MSEDCL in 2006-07 should become operational by 2007-08 contributing to about 1,000 MW of energy and peak demand. The state can provide incentives to induce captive power plants to augment generation and sell electricity to the grid. This will provide an average of 750 MW of energy to the MSEDCL grid.

Lighting efficiency and solar water heaters can help reduce the need for load shedding by 165 MW. The realisation of these estimates would need policies to ensure:

(a) Guaranteed payments to captive power for generation to the grid: In addition for captive generators using diesel, the tax on diesel fuel may be exempt for the units sold to the grid.

(b) Innovative lighting efficiency programmes with agreements with manufacturers to recover capital costs from the electricity bills. Successful programmes are the Illumex project in Mexico, and Procel in Brazil and the programme adopted by Bangalore Electricity Supply Company Ltd.3

(c) Use of mass media to educate/inform consumers: The Bureau of Energy Efficiency has already initiated standards and labeling programme for major energy consuming appliances.

(d) Innovative financing and dissemination strategies for solar water heaters along with the equipment manufacturers.

(e) Feeder-wise strategies for energy conservation and load reduction. If the amount that can be supplied by MSEDCL is kept constant (or specified) and user groups are able to devise strategies for managing their consumption within this, they may be exempt from load shedding.

This study quantifies the shortages and provides an analysis of options. There is a need to adopt better techniques for quantifying the shortage and understand its variation. The utility and consumers should explore options for energy efficiency and load management and minimise the need for load shedding.

The sustainability of bio energy depends largely on how the risks associated with its development – especially pertaining to the land use and climate implications of large-scale feedstock production and potential social inequity – are managed. Hence, while the much touted positive impacts related to bio energy activities are well accepted, it is also important to be cautious about safeguard mechanisms against possible negative impacts.

BETs have significant benefits from energy security and green house gas (GHG) mitigation potential. However, for all practical purposes, it is vital to clearly define land use policies to ensure restriction of bio energy cultivation to areas that are not in competition with other uses like agriculture, biodiversity etc. Also, during GHG calculations of bio energy, fossil fuel/fertilizer inputs in bio energy production and downstream processing should also be taken into account like GHG benefits from by-product utilization which varies significantly with local conditions. At project approval stage, a relatively simple yet verifiable estimation of GHG life cycle crops must be submitted before appropriate authorities which can indicate reduction vis-à-vis life cycle GHG emission of unprocessed crude oil combustion of approximately 90 kg/GJ (WWF, 2007).

Greater use of more energy-efficient technologies in India would in many but not all cases pay for themselves in the form of energy savings. This prompts the following questions:

(1) What influences some firms and households to adopt more energy-efficient technologies? and

(2) Is this rate of adoption efficient? With answers to these questions, one could help design policies to improve the economic efficiency of energy use and explore opportunities for international cooperation and co-financing to further improve energy efficiency as a measure for reducing global CO_2 emissions.

The diffusion of energy-efficient technologies is usually a slow process, whether in developing or developed countries. The speed of diffusion can be retarded by a variety of factors. A fundamental barrier is government policies that distort prices. One example of induced energy inefficiency is the high electricity prices charged to industry, which stimulates self-generation using inefficient dieselpowered generators. Sathaye et al. (2005) provide another example in a sector not reviewed in this study, agriculture. They report that the energy efficiency of agricultural pump sets in India is extremely low, which coincides with policies that heavily subsidize electricity use for farmers.18 Replacing most pump sets would be fully cost-effective if electricity were priced at marginal cost; however, the subsidies to electricity have prevented their replacement.

Lack of information is another barrier. Since there are information externalities in this case—adoption by one person conveys information to non adopters—governments can provide information about energy efficiency by requiring that appliances and machinery be labeled to show their energy usage and that efficiency claims be certified. This is beginning to be done in India, through the Bureau of Energy Efficiency, but some labeling programs are still not mandatory.

This chapter has clarified the two-way linkages between energy, on the one hand, and poverty, women, population, urbanisation, and lifestyles, on the other. The relationship between energy and these major global issues is dialectical—the global issues determine energy consumption, and in turn, energy systems influence the issues. If attention is focused on the global issues as the cause, then energy becomes the effect. But if the focus is on energy as the cause, then one can see the myriad ways in which energy shapes the global issues.

It has also been shown that current energy consumption patterns are aggravating various global problems, leading to further un-sustainability. But energy can also contribute to the solution of problems; in particular, poverty, the situation of women, population growth, unplanned urbanisation, and excessively consumptive lifestyles. To realise energy's enormous potential in these areas, it must be brought to centre stage and given the same importance as other major global concerns.

A goal is an objective to be achieved, a strategy is a broad plan to achieve the goal, and a policy is a specific course of action to implement a strategy. Policies are implemented through policy agents working with policy instruments. The goal for energy systems is sustainable development. Energy strategies to advance this goal should be derived from the details of the linkages between energy and social issues. In particular strategies should emerge from the manner in which energy can contribute to the solution of social problems.

Thus poverty alleviation in developing countries should involve the energy strategy of universal access to adequate, affordable, reliable, high-quality, safe, and environmentally benign modern energy services, particularly for cooking, lighting, income generation, and transport. Poverty alleviation in industrialised countries requires the energy strategy of universal protection and maintenance of access to affordable energy services, particularly for space heating and lighting. Improvement in the position of women requires energy strategies that minimise, if not eliminate, arduous physical labour at home and at work, replace traditional biomass-based fuel-stove cooking systems with modern (preferably gaseous) fuels and cooking devices, and use the intrinsic managerial and entrepreneurial capabilities of women in de-centralised energy systems.

Control over population growth can benefit from energy strategies that increase life expectancy and reduce infant (and child) mortality in developing countries through modern fuels and cooking devices that render unnecessary the physical labour of children for household chores such as gathering fuel wood, cooking, fetching drinking water, and grazing livestock—and that improve the quality of life of women. Accentuating the positive aspects of urbanisation and alleviating its negative aspects require energy strategies that exploit the advantages of high-density settlements, provide universal access to affordable multi-modal public transportation, and reduce the 'push' factor in rural urban migration by improving energy services in rural settlements.

Finally, reducing energy consumption through lifestyle changes requires a strategy—using pricing and taxation—of discouraging the use of energy-intensive devices and encouraging the use of energy-conserving devices.

The comparisons across all of these groups have been consistent across different periods and have held when energy prices were high in the 1980s, low in the 1990s, and increasing in the early years of the current decade. As a result, we would expect these patterns to hold in the current run-up in energy prices. Overall, many of the groups that spend the highest share of their total expenditure on home energy costs—such as the elderly and the poor—are the same groups that spend the lowest shares on gasoline and motor fuel. This suggests that when gasoline and home energy prices rise in tandem, as has happened recently for gasoline/fuel oil and natural gas, the effects on the different groups are more similar than would be suggested by only looking at one energy source. The one exception to this is the working poor, who consume both home energy and motor fuel in large quantities.

In this study we have compared to decomposition methods and a period-wise decomposition. We can see from the results that the general parametric divisia index approach has resulted a better output as compared to the multiplicative Lespeyres decomposition index. Since decomposition can be done using either, the energy consumption approach or the energy intensity approach, the analyst is faced with the problem if making a choice between the two. From the descriptive and the trend analysis we found that there is fluctuation in the annual growth rate of the energy consumption in the aggregate manufacturing as well as in the sub-industries. The changes are also not following the same direction. In case of few industries the changes in the growth rate is much higher than that of the total manufacturing industries. Again when we looked at the percentage share of the output to the aggregate manufacturing industries we observed that the share of the output are declining for few of the sub industries as well as increasing for few. The discussion on the energy consumption gave a picture of the energy consumption of the aggregate manufacturing, which is rising in the absolute terms, however the energy intensity of the Indian manufacturing is declining from 1990-2000. The energy intensity change in Indian manufacturing in mainly due to the change in the structural change and has a negative relation between them. Once there is a negative change in the sectoral share of output, the energy intensity of the industries are rising and vice versa.

However, the sectoral energy intensity has a positive relationship with the energy intensity of the Indian manufacturing. As the changes in the sectoral energy intensity are unidirectional to the changes in the aggregate energy intensity of the industries, they are driving the changes in the aggregate energy intensity of the Indian manufacturing. The analysis presented in this report significantly advances, we believe, the understanding of sources of energy demand in India, and the accuracy in predicting their trajectory over the next decade. In doing so, we have presented a consistent and robust framework for national and sector level demand forecasting, which relies on separating the drivers of energy demand, and the intensity of its use in meeting that demand. We believe this to be a critical step in developing a comprehensive strategy of national energy demand management – the need for which is becoming ever more urgent for large developing countries like India.

The analysis as performed in this way reveals several interesting features of energy use in India. Electricity consumption is expected to increase fast, driven by the demand of the residential and commercial sectors that add to the already increasing demand from the industry sector. Per household residential electricity consumption will likely quadruple in the 20 years between 2000 and 2020. In fact, primary electricity use will increase more rapidly than any other major fuel – even more than oil, in spite of the fact that transport is the most rapidly growing sector. The growth in electricity demand implies that chronic outages are to be expected unless drastic improvements are made both to the efficiency of the power infrastructure and to electric end uses and industrial processes. In the transport sector, the rapid growth in personal vehicle sales indicates strong energy growth in that area. However, our analysis indicates that in total energy terms, oil product consumption will remain comparable in the residential sector (in the form of kerosene), and in heavy industry. In addition, oil consumption used for freight transport will continue to outpace passenger transport. Even though the industry sector has experienced tremendous improvements in energy intensity per tonne of material produced, energy use from this sector is expected to continue to grow fast. The main reason is a strong activity projection in this industry sector driven by the demand for infrastructure development.

The intent of this report was to use as wide an array of available data at the highest level of detail possible. Undoubtedly, some already available sources were overlooked. In general, however, the authors feel that the greatest gaps in data availability arise from a lack of accurate statistics, more specifically for the transport sector. In this way, we hope to highlight areas where the greatest gains could be made through more thorough unearthing of data sources or, if necessary, completing the surveys and statistical analysis necessary to generate new data sources. For example, the sector with the least knowledge is the service sector, where data on floor space needs to be collected and surveys on energy use need to be conducted. We also found that the transport sector lacks consistent data reporting from a national source, specifically on the stock of vehicles in use and fuel economy of vehicles. Finally, only a few data points were found to describe the unit energy consumption by appliance type and little is known on their typical life time and hour of use. Future data collection on these issues will allow refining the first energy use breakdown matrix developed in this report for India.

Ultimately, the value of an analysis such as presented in this report will be measured by its use in subsequent research into energy demand in India. In particular, the analytical framework presented in detail here is designed with an eye toward development of detailed, realistic and robust energy efficiency scenarios for India. Such scenarios can be made by applying best practice technology options at the level of endues, equipment or process, thus ensuring that global improvements are underpinned by achievable bottom up policy and market interventions. The construction of such scenarios would go beyond an evaluation of savings potentials, providing the analytical elements for a comprehensive energy strategy, or roadmap.

Rural India has traditionally been reliant on biomass based fuels, such as firewood and cow dung, while urban India is riding the growth of LPG and PNG. Although rural and urban India show a division in their current use of cooking fuels, they are not united in their move towards cleaner cooking fuels. What stands in the way of a sweeping migration towards cleaner fuels are factors of affordability, availability, awareness, and to some extent, acceptability.

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