Rural energy data sources and estimations in India

Preeti Malhotra, Fellow, TERI; I H Rehman, Fellow, TERI; Preety Bhandari, Senior Fellow, TERI; Ronnie Khanna, Research Associate, TERI ; Ritu Upreti, Research Associate, TERI

Introduction

One of the important features of rural energy is the dependence on locally available biomass resources. Since they are collected at zero cash cost, data collection on consumption is primarily recall-based. Similarly, local-level supply and demand is difficult to capture. Hence, there is an inherent problem of data availability and authenticity. Micro-level experiences are at times contrary to the macro assessments provided. The claims, therefore, made of successful energy transitions (both in terms of fuel and technology) or popularly known as 'fuel switch', happening in the rural areas, is perhaps an over statement. The following sections give a brief status of the present fuel/technology mix in the rural areas, a critique of the data sets available on consumption/supply that highlight trends and some of the key issues. The analysis has been presented with respect to the macro assessments and the micro-level evidence (surveys, case studies, etc.) bringing out the weaknesses in types of data available and assessments made vis-à-vis rural energy transitions.

Fuel/device mix in rural households

The rural population in India relies heavily on traditional biomass-based fuels (fuelwood, crop residues, and animal dung) for meeting its energy needs. Approximately 96% of rural households are estimated to be using biofuels (NSSO 1997). These fuels dominate the domestic sector and are primarily used for cooking. Fuelwood is the primary energy source for cooking used by rural households (78%) (TERI 1999a). In actual volumes as well, fuelwood ranks first, at 252.1 million tonnes, followed by dung-cakes, at 106.9 million tonnes and agricultural residue, at 99.2 million tonnes of annual consumption (TERI 1992). Similarly, the per capita consumption figures are also high for fuelwood at 250 kg, 50 kg for animal dung and 134 kg for crop residues (NSSO 1997) This is further corroborated by the energy consumption estimation given by NCAER (Natarajan 1997).

Most of the fuelwood used in rural households is collected from not one, but several sources, such as common lands, reserved/protected areas (government controlled forest lands), panchayat land, privately owned land, and revenue wastelands. Mostly women and children transport wood and other biomass fuels as head loads. The wood fuel and other biomass are burnt in inefficient traditional mud stoves (~20% efficiency) in poorly ventilated kitchens. In the northern states, where cooking of animal feed is common, *hara* is the cooking device used. It is also used for simmering milk. Portable mud and metal cook stoves are also used.

Petroleum products like LPG (liquefied petroleum gas) and kerosene form less than two per cent of the total energy consumption in the rural areas. Hence the large imports of petroleum products only marginally benefit the rural populace that constitutes nearly 70% of the population in the country. In rural India, kerosene is mainly used for lighting. According to the 50th round of NSS (NSSO 1996), around 62% of the rural households use kerosene primarily for lighting. Only two per cent of the rural households in India used kerosene as the primary cooking fuel. The total kerosene consumption in India during 2000/01 was estimated at around 11.5 million tonnes, out of which about 60% was for the rural areas. The PCA (per capita allocation) for states ranges between 10 and 24 kg a year. While allocating kerosene for the year 1999/2000, the maximum PCA has been frozen at 24 kg per annum (MoPNG 2000).

In case of LPG, since 1985, the consumption has grown from over 100 million tonnes in 1985 to over 6000 million tonnes in 1999. The number of LPG customers served by the four oil companies as on 1 January 2000 was 43.6 million (MoPNG 2000). However, the rural penetration during this period is just over one per cent of the total households (MoPNG 2000).

In terms of extension of grid electricity to the rural areas, the rural electrification programme, which is the largest rural energy programme today, claims to have electrified more than 85% of the 580 000 villages in the country (CEA 1996). However, at present, there are 80 000 villages in India that need to be electrified. Out of these, 18 000 are remote and geographically inaccessible where grid extension is not economically viable (1991 census). As per the 2001 census, the number of such villages is likely to be considerably higher. According to an

estimate, about 65% of the households in electrified villages do not receive benefits of electricity even now. This is both on account of inability of households to afford electricity connections as well as low demand on account of poor reliability and quality of the existing supply. The net result is that at least 70-80 million rural households still depend on kerosene lamps for meeting a basic need such as lighting (according to the draft Tenth Five-year Plan 2002–2007 of the Planning Commission, Government of India). Both electrified and un-electrified households depend on kerosene-based lighting devices. The kerosene devices used in rural areas have low luminous efficiency and a high specific fuel consumption. In a study of the usage of kerosene-based lighting devices in the rural areas of Uttar Pradesh (TERI 1999b); of the electrified households surveyed, 85% households were using home-made wick lamps for more than four hours a day (average) and the remaining were found to be using hurricane lanterns. Another interesting pattern of usage was that a majority of electrified households used bulbs for lighting in their living rooms and outer verandahs, but continued to use kerosene based lighting devices in the kitchen and for other miscellaneous activities.

Fuel mix in the agriculture sector

The agricultural development strategy for the Ninth Five-year Plan was based on the policy of food security announced by the Government of India to double the food production and make India hunger free in 10 years. Of all the inputs that are required to boost agricultural production, assured irrigation facilities are most important. In order to meet the growing water requirements of the country, the Government of India initiated rapid farm mechanization programmes along with policy measures such as under pricing of power and irrigation in the early 1950s. As a result of this, the number of pump sets increased manyfold (8 million pump sets in 2001 and 14 million pump sets in 2001/02) (Table 1). In a majority of the states, farmers pay for electricity on the basis of a flat rate per unit of installed horsepower. This is irrespective of the amount of water that is pumped out. Consequently, agriculture is the largest consumer of water in India, accounting for 85% of the total water used in the country (MoEF, 2001).

Table1 Progress of mechanization and energy consumption in agriculture sector

Year	Electric pumps	Diesel pumps	Electricity	Diesel
			(GWh)	(MMT)
1953/54	0.030	—	219.40	0.210
1960/61	0.199	0.283	832.93	0.305
1970/71	1.629	0.558	4470.23	0.799
1980/81	4.330	2.825	14489.06	3.181
1990/91	8.909	5.054	5032.40	5.405
1994/95	10.721	6.304	79300.94	6.245

Source: Maggo (1998)

Currently, of the total electricity consumption in the country the share of agriculture is 30%. The consumption is somewhat higher in states like Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, and Uttar Pradesh where agricultural electricity use is between 35%–45%. However, sale of electricity amounts to no more than 5-10% of the state electricity boards' revenues due to high subsidies. A case in point is Haryana, where 47% of electricity produced is consumed by the agricultural sector and contributes to less than 8% of the revenues generated. Similarly, figures for Andhra Pradesh are 45% and 4%, respectively. At the national level, farmers consume 33% of total power supply, while paying only 2.5% of the total revenues. Hidden in these numbers is the large proportion of unaccounted consumption (theft and losses) reported as agricultural use (Source: Energy efficiency in Indian Agriculture, S. Padmanaban, http://www.usaid.gov/in accessed on 23 August 2002).

Fuel consumption in the SMES sector

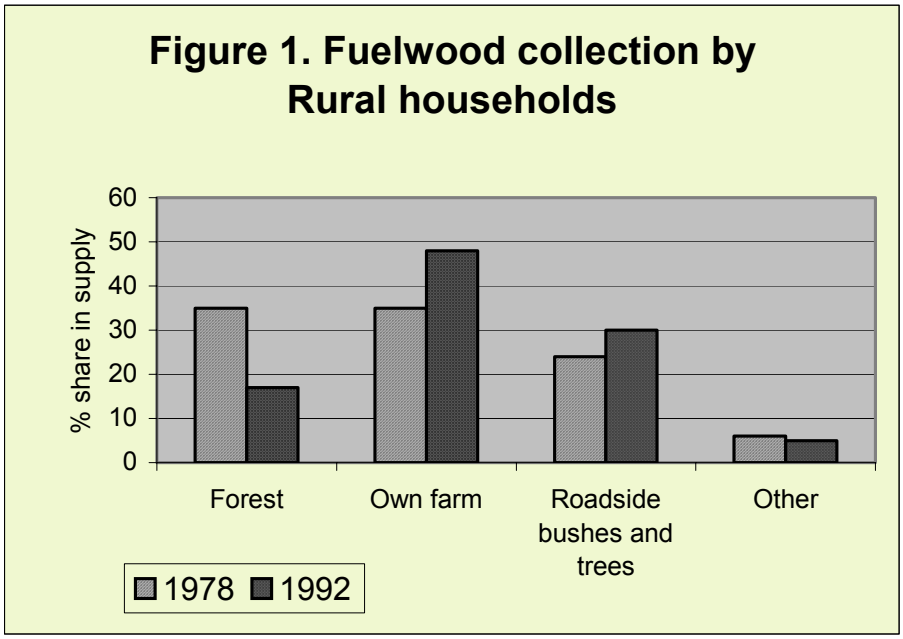
The small-scale industries occupy an important place in the country's economy. India has more than three million small-scale industries in the organized sector and about 15 million enterprises in the unorganized sector. These units account for about 40% of the total industrial output in the country and in terms of employment generation this sector is next only to agriculture contributing an estimated 14% to the GDP. The total expenditure per enterprise on energy (fuel and electricity) increased by about 200% between 1990 and 1995. The expenditure on fuel and electricity increased more than proportionately in

comparison to the total inputs. As per the estimate, of the energy consuming enterprises 28% use firewood as their source of energy while about 8% of the enterprises use charcoal to meet their energy needs. A large population of small enterprises uses fossil fuel as the main source of energy. In recent years, the prices of energy, both thermal and electrical, have been increasing steadily. For example, diesel oil prices have increased to Rs 17.05/litre (2001) from Rs 7.95/litre (January 1997). Similarly, other petroleum fuels have also registered a steep increase in prices due to the soaring international prices of crude oil. The electricity tariff for industrial customers is also generally much higher compared to agricultural customers. Further, with the various regulatory mechanisms coming into play, industrial customers may have to pay even higher rates. Also, concessional tariffs provided initially to encourage small industry are coming to an end, resulting in a sudden, heavy burden on such industries.

Energy transitions: performance

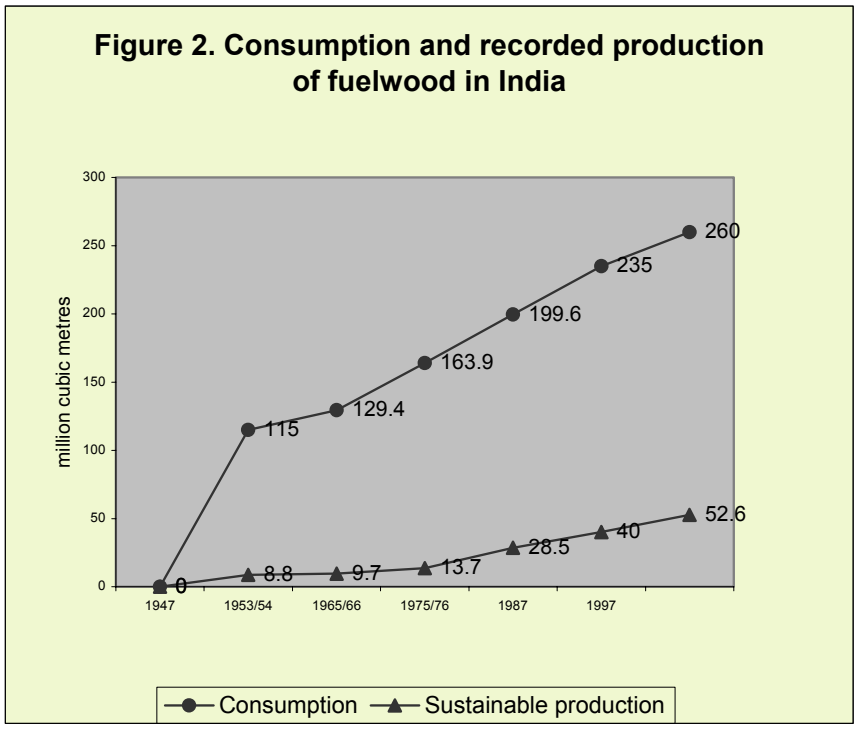
Several macro-level and micro-level assessments have been done to determine the nature and extent of energy transitions happening in the rural areas of the country. These assessments have further been used in planning for the energy needs of the rural people. Despite the numerous government-led initiatives to encourage fuel switch to the use of fossil fuels in rural areas (e.g., subsidies on kerosene and electricity), there has been an increase in consumption of all biomass-based fuels over the years. There has also been a definite shift to the use of superior biomass in the form of logs. This is amply borne out by the fact that during the period 1978/79 to 1992/93 the share of firewood in the form of logs rose dramatically from 18.95% to 32.49% on account of programmes of social forestry, which were initiated in the early 1980s (Aggarwal 1998). However, during the same period the share of firewood percentage of households using a particular fuel) in the form of twigs fell from 67.6% in 1978/79 to 62.9% in 1992/93.

There has also been a major shift in the source type for supply of fuelwood (Figure 1) showing a decrease in dependency on forests. The supply of fuelwood from individual agricultural fields and roadside bushes and trees has increased.



Source: www.rwedp.org (7 December 2001)

The gap between consumption and recorded production of fuelwood has, however, been increasing, indicating the seriousness of the fuelwood problem in India (Figure 2).



Source: Forest Survey of India (1988)

This gap is widely believed to be met from illicit and unsustainable exploitation of biomass resources. At the present rate of consumption, this will clearly result in further degradation of the biomass resource base, and containing this demand would be a major concern in the future.

In case of commercial fuels the consumption of kerosene by rural households has increased from 414 thousand kilolitres in 1978/79 to 10 500 thousand kilolitres in 1999/2000 (TERI 2000). However, the end use penetration rates are not very impressive. For instance, oonly 1.3% rural households use LPG for cooking in the rural areas (CMIE 1996a). Similarly, only 1.34% rural households use kerosene for cooking (CMIE 1996b). The 50th round of NSS (National Sample Survey) states that two per cent of rural households could afford to use kerosene or gas as the primary source of energy for cooking (GoI 1997). People are not shifting to, say the use of LPG for a variety of reasons. Firstly, the alternative, fuelwood, is freely and easily available. Since a majority of the rural population 'collects' wood and therefore does not have to incur a cost, their first choice is always biomass. Other problems relate to the lack of infrastructure support (e.g., absence of facilities for refilling at doorstep) wherever LPG has managed to penetrate or due to inappropriate policies[1]. Lack of awareness among rural communities is another factor for the slow rate of adoption (fear of the cylinder bursting) as much are the cooking practices and eating habits that are acting as road blocks to the speedy penetration of LPG in the rural areas.

[1] In most of the companies, the policy is that the cylinders will be refilled after 21 days. However, owing to logistic and economic reasons, rural customers usually take 3 months to get the cylinders refilled.

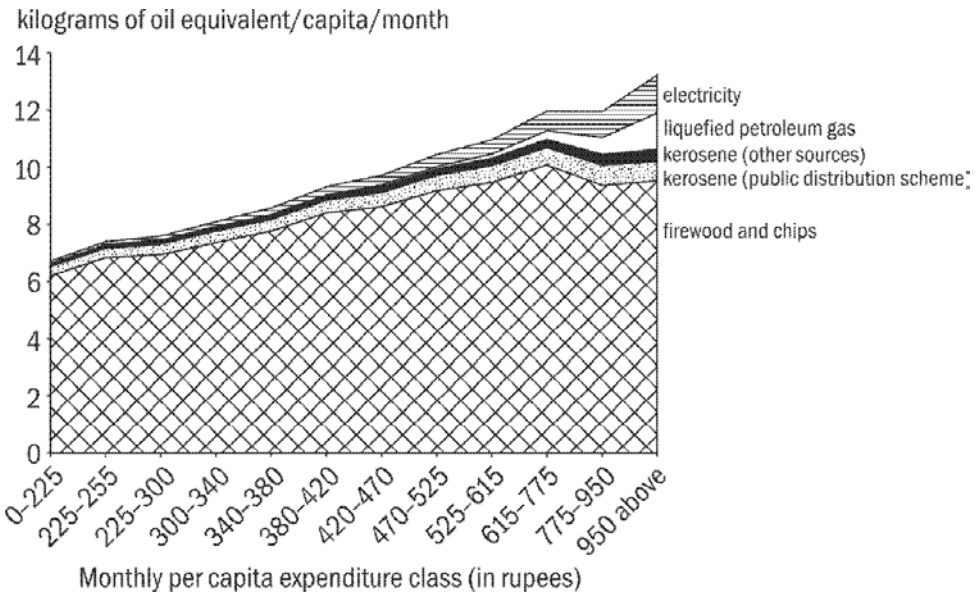
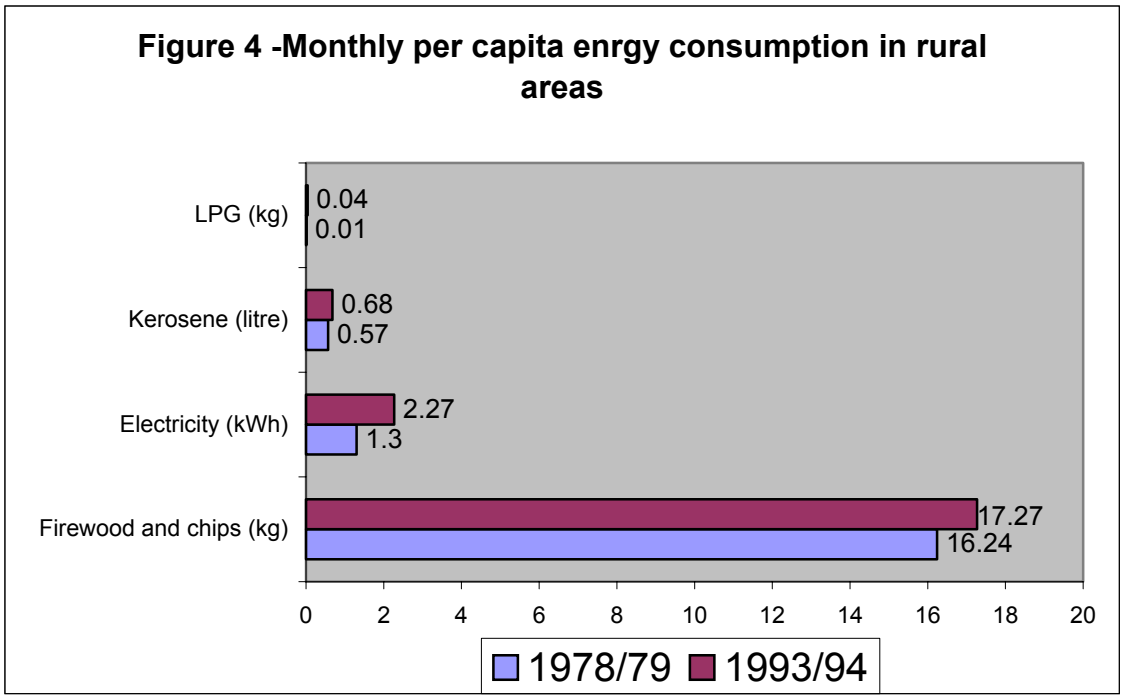


Figure 3 Gross energy consumption: Rural, by expenditure class
Source NSSO 2001

In terms of the extent of 'switch over', only one per cent of the households in the rural areas has switched over from firewood and chips as a source of cooking since 1987/88 (GoI 1997a)[6]. While the dependence of rural households on dung-cake, coke, and coal has fallen and that on kerosene and gas has risen over successive NSS rounds, the percentage of households (77%–79%) dependent on firewood and chips has remained constant (GOI 1997). This further reiterated by the rural energy consumption figures for the latest round of NSSO (Figure 3).



Source: NSSO, 1997. Consumption of some important commodities in India. Report No. 404. New Delhi: National Sample Survey Organization, Department of Statistics, GoI.

The monthly per capita figures between 1978/79 and 1992/93 also show an increase in the consumption of fuelwood, LPG and kerosene fuels. However, the increase in the consumption of LPG and kerosene is marginal while that for fuelwood and electricity it is significant (Figure 4).

With regard to rural electrification, the NSSO 50th and 55th round surveys carried out in 1993/94 and 1999-2000, respectively, have indicated that the households using electricity as main source of electricity has increased from 37% in 1993/94 to 53 % in 2000.

Quantitative assessment of fuel mix

Macro-level assessment

For Indian rural energy planning, the main agencies involved in the process of data collection and making estimations at the national/macro level are the NCAER (National Council for Applied Economic Research), NSSO (National

Sample Survey Organization), CMIE (Centre for Monitoring of Indian Economy), and TERI (Tata Energy Research Institute).

Several efforts have been made by these agencies and others (e.g. working groups set up by the government) to determine the fuel mix in rural areas. Prominent among these are ESI (1965), Working Group on Energy Policy (1979), ABE (1985), EDSG (1986), NCAER (1985), REDB (1991) etc. However, most of these are sample surveys and the actual energy use is only an estimation using some standard norms while doing the surveys. Internationally comparable, cross-sectoral, or time-series data is either non-existent or incomplete. Most of the frequently used data in estimating rural household consumption patterns comes from the surveys of the NCAER and the NSSO. One of the initial household level surveys on rural energy consumption was done in 1962 by NCAER that was used in the ESI (Energy Survey of India Committee) report, which was published in 1965. Following this, the Working Group on Energy Policy was set up in 1977 by the Government of India, which used the results of the 18th and 28th rounds of the NSS to project the aggregate energy demand. After these initial efforts, several more studies were done to estimate energy consumption (demand).

NCAER Most of the above mentioned studies have relied on the surveys done by the NCAER (in 1978/79 and 1992/93). The survey of 1978/79 was first of its kind at the macro level, which covered 13 010 sample households spread over 18 states of which the rural sample was 7500 households in 600 villages selected from 300 districts. This survey estimated that 89.7% of the household energy is consumed for cooking in rural areas, while lighting and all other end uses account for only 6.3% and 4.0% of the total energy consumed respectively (NCAER 1985).

The NSSO is a unified agency under the Department of Statistics, Government of India, which undertakes all types of survey work. The subject coverage of the socio-economic surveys includes survey on consumer expenditure, employment and unemployment, manufacturing establishments and enterprises, and trading establishments and enterprises in the unorganized sector. The surveys are repeated every five years. Subjects like land holding, livestock holding, debt, and investment are covered once in 10 years.

With respect to rural energy, NSSO collects data on primary sources of energy for cooking and lightning from households throughout the country. The survey gives per thousand distribution of households by primary sources of energy for cooking and lighting for each household (occupation) type and social groups (SC, ST and other households). It also gives the distribution of households by MPCE (monthly per capita expenditure) class for each source of energy for cooking and lighting. The survey covers the entire country and uses the stratified sampling design for data collection.

The data, however, is limited only to the household sector and does not focus on energy requirement for agriculture and rural industry. As a result, two vital components of rural energy are overlooked and it is not possible to form a comprehensive picture regarding the distribution of energy consumption in the rural areas. It would have been particularly helpful if the economic categories of farmers had also been considered in the survey. Moreover, the consumption levels for rural cooking and lighting are available; but the supply of fuels at the district, state, and country level are not available. Moreover, the data does not have some basic information, like the number of villages electrified, for an energy planner to use.

CMIE Energy Survey. This is an energy database put together by the CMIE. This contains extensive data on the energy sector from petroleum to coal. The mandate and design of the CMIE survey, however, does not include a number of issues related to rural energy planning. Some of these issues have been discussed below.

The primary problem with this data set is that energy consumption for petroleum products like kerosene is not segregated into rural and urban components. Only the consumption figures have been given and there is no data on the supply of these products at the national, regional, or state level. Moreover, the data does not address the demand, supply, and consumption of traditional sources of energy like fuelwood. Also, the data on renewables, capacity, type and place of installation is not available.

REDB database. The REDB database has been compiled by TERI, New Delhi. The REDB database gives the per capita consumption values of various fuels used in the rural areas, especially in the household sector. It is based on the several micro surveys done in different agro-climatic regions of the country. The surveys are recall based. The database, however, is too geographically scattered, the sampling is non-uniform and primarily focuses on per capita consumption.

TEDDY (TERI Energy Data Directory and Yearbook). This country-specific database records domestic production, trade, conversions and losses, and delivered energy consumption for major types of commercial energy sources. This data is compiled by TERI, New Delhi. The national energy balances are calculated on an annual basis. The limitations of this data set with regard to its use for rural energy planning is that it is not primary, and usually derives from the above-mentioned sources and has the limitations of the parent source. However, an effort has been made to put together and collate data from different sources and therefore represents a rich repository of data on rural energy.

Micro-level studies

In addition to the macro-level studies, several micro-level case studies have been conducted which corroborate the fact that cooking continues to dominate the rural domestic sector with biomass as the predominant energy source. Some examples are Nishanka and Misra (1990); Bose et al. (1991); Ravindranath and Chanakya (1986); Puri (1988) etc. For example, Bose *et al.* made a comparative analysis of rural energy consumption patterns and the resource potential of three un-electrified villages in the *tarai* region of eastern Uttar Pradesh—Maulaganj (dist. Gorakhpur), Arro (dist. Pratapgarh), and Bishnapur (dist. Bahraich). The study mainly examined how the energy consumption patterns in these three villages – representing agriculturally advanced, moderate, and backward categories, respectively – are influenced by the local availability of energy resources. The analysis indicated a heavy reliance on biomass fuels (of the order of 98%) for meeting domestic energy needs. Several such micro-level studies at the block and district level have also been done by TERI, New Delhi, that has primarily fed into the REDB database.

Issues in data collection and estimations

Survey information as proportion of households

The problems with such survey related information are several. Many a times the survey information on end-uses is not given in terms of energy shares, but rather as the proportion of households that use certain energy sources to satisfy different end-uses (example, GoI. 1995. Housing and Amenities. Occasional Paper No. 5 of 1994. Census of India. New Delhi: Government of India; NCAER. 1981. Domestic Fuel Survey with Special Reference to Kerosene (1978/79). New Delhi: National Council for Applied Economic Research; GoI. 1979; National Sample Survey 1973/74, 28th round. Report of the Working Group on Energy Policy. New Delhi: Government of India). Data of this kind cannot be used to estimate actual consumption for each energy source or end-use accurately. This is especially true where many households use multiple energy sources for specific end-uses, such as firewood and kerosene for cooking or kerosene and electricity for lighting. Similarly, information on impact of incomes on energy transitions is also given in % terms as percentage of rural households by primary source of energy for cooking for each MPCE class (e.g. NSSO. March 1997. Energy used by Indian households. Report No. 410/2. New Delhi: National Sample Survey Organization. Department of Statistics, Government of India). Such data set again is not very useful, considering that rural households are known to use multi fuels and for many the primary source of energy is more a factor of availability or is guided by socio-cultural preferences.

Survey information as end-use consumption

End-use consumption is often difficult to define because one appliance frequently provides several end-use services. For example, a cooking fire often serves as the only source of space heating, water heating and, in many cases, lighting. In addition, unless repeat surveys are carried out in the different seasons, a skewed picture of energy consumption may emerge. Further, most of the survey information is presented fuel wise rather than end-use wise.

Use of recall based method

Some of the survey information is based on recall. The biases introduced as a result can skew the estimations. Field experience shows that people often over estimate the amount of fuel they use for a particular end use. This is generally done with the objective that some project and programme will then be implemented to reduce such high consumption levels and therefore the people hope for receiving some benefit. Further, especially in case of traditional fuels such as biomass, people find it difficult to 'average' the amount of wood they might be using in a day. Often people get confused between the head loads they carry and the quantities they feed into the fire. Attempts are made to carry out some measurements like weighing how much one basket or head load of wood or dung cake weighs. However, still, estimations tend to be over- or in some cases under-stated.

Similarly, the information collected in consumer expenditure surveys is also normally based on respondents' recollections of expenditures over a recent period, such as the preceding week. In urban areas it is easier since bills (of electricity and LPG) are available. Estimates are, therefore, reasonably good. With all other energy sources, especially biomass fuels, there are obvious risks that respondents fail to estimate their expenditure (if any) correctly. Further, with the flat rate tariff for fuels such as electricity in the rural areas, it is difficult to relate expenditure with consumption levels.

Lack of end-use wise consumption data for conventional fuels

With regard to conventional energy sources, such as electricity and kerosene, a disaggregation of the major demand categories into end-uses is difficult, since organized efforts to study patterns of rural energy use are few and far between. Often, the main sources of consumption data are the supply companies and utilities, but their data is seldom broken down by end-use or even end-user groups.

In the context of rural electrification in India, the information primarily is reported in terms of villages or households electrified. On the other hand, the information on un-electrified villages in each state is difficult to come by since these are remote and are geographically scattered. Also the information on percentage of households using electricity is generally based on the census data.

The sample surveys cater more to the issue of energy expenditure than rural electrification. The quality aspect of rural energy is merely anecdotal and no systematic information exists on it. Alternatively, the grid reach information is provided in terms of circuit kilometres of network developed. It is very difficult to get the information on where all these grids are available and also the future plans for its extension at any central location. Neither is it possible to get information on the load that can be supported at the village electrification points.

Issues in local surveys

The consumption data for traditional fuels in national-level assessments are generally approximate, based on assumptions, given that these fuels are either collected from the surrounding countryside or are traded in informal markets. Thus, the only way to determine traditional fuel consumption more accurately is by conducting local surveys of household and fuel trading practices. Although many such surveys have been conducted in India, few of them have been large enough or carefully prepared enough to provide reliable estimates of national or sub-regional consumption of traditional fuels. In addition, surveys are seldom repeated at regular intervals. Without such surveys, national energy balances are of little value in assessing trends in household energy use.

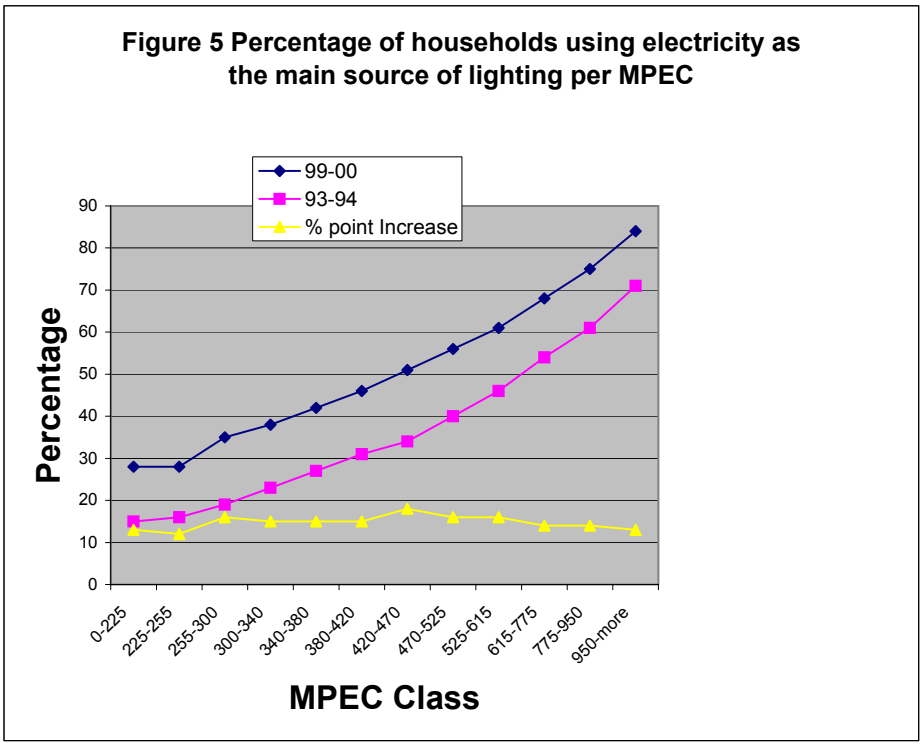
Issues in making assessments for energy transitions: level and extent

Income and energy transitions

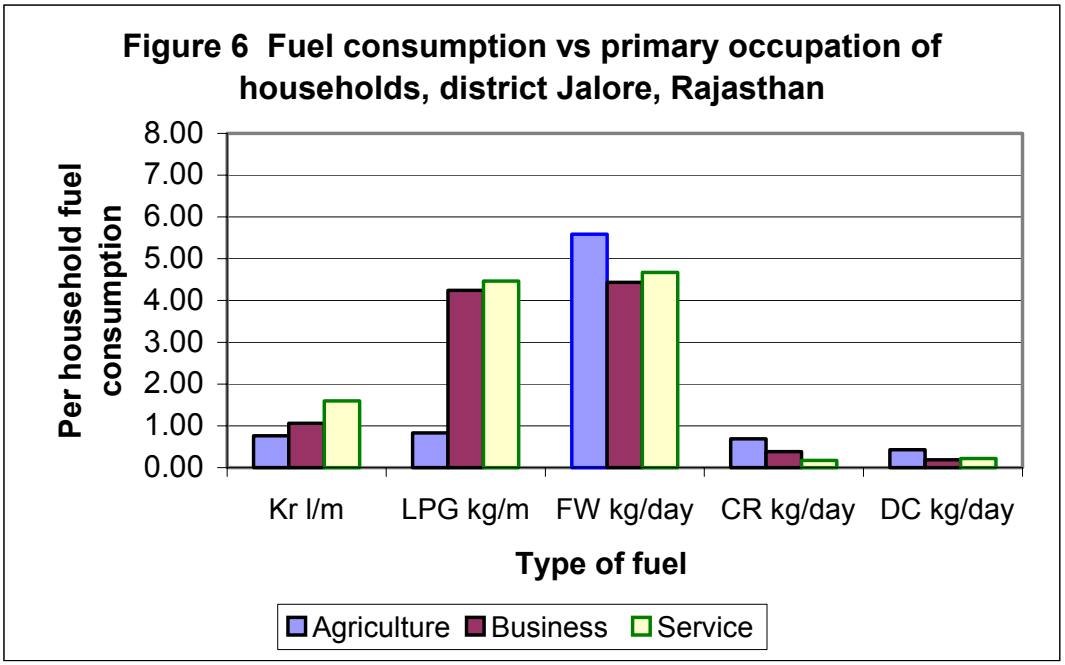
With regard to the estimation of energy consumption, estimates of per capita energy consumption have been used in the past that are based on field surveys and trends in population growth. This is partly because there is very little evidence of a correlation between energy consumption and income in rural areas.

To exemplify this, the data presented in Figure 5 below relates to percentage of households electrified according to MPCE levels. The Y-axis represents the monthly per capita expenditure class. The upper and lower bounds of the MPCE for each category has changed between the two time periods, but have a one-to-one correspondence. The interesting fact is that the percentage point increase is nearly uniform across the MPCE classes. The middle shows the bulge but ever so slightly. One needs to take into account the fact that only 86% of villages in India are electrified and the above sample is across all the rural areas. If one were to assume that the sample reflects the percentage of villages electrified, then the

percentage of households using electricity as primary souce of energy would be approximately 61 per cent. This also reflects the fact that there is not much correlation between expenditure levels and level of electrification.



Field experience also suggests that the switch to the use of superior fuels (e.g., LPG) is more to do with just increase in incomes. A primary energy survey in Jalore district in Rajasthan, done by TERI (2001) (Figure 6), showed that people



who are in service are using more LPG than those households whose primary occupation is agriculture. It was found that the people in service had better access (frequent trips to the urban centres on account of their work, hence refilling was not an inconvenience), increased level of awareness regarding the fuel and its usage (no misconceptions such as bursting of cylinder) etc. play a more important role in determining the switch over.

Variations in estimations

The national level aggregates of rural domestic energy consumption, as estimated by different studies, are presented in Table 2. It is apparent that across the different agencies responsible for data collection there are large and significant variations in estimations (Box 1). This makes it extremely difficult to use the data for planning or projecting rural energy requirements.

Table 2 Estimation of household energy consumption (biofuels) - national aggregates

Data Source	Year of study	Fuelwood	Dung-cake	Crop residues
NCAER (1962-63, million tonne)	1962	97.2	52.2	26.4 (26.4)
FPC (1971, million tonne)	1974	122.8	67.3	37.8
WGEP (1976, million tonne)	1979	133.1	73.0	41.0
NCAER (1978-79, million tonne)	1985	79.3	66.7	29.5
REDB (1991, million tonne/yr)	1991	181.3	40.1	31.6
IREP (1992, million tonne/yr)	1992	169.0	54.2	62.8

Note: figure in parentheses pertain to rural areas

Source: Gupta and Ahuja, 1992; TERI, 1992; and NCAER, 1985.

Box 1 National aggregates: variations in estimations

There is a wide variation of estimates in annual (1991) rural wood usage pattern (excluding crop residues and dung), in different studies undertaken by different agencies like NCAER (1985), FSI (1988), IREP, and Joshi *et al.* (1992), ranging from 93mt (110kg/capita/yr) to 309 mt (492kg/capita/yr). The case studies done at the village level also show that the per capita fuelwood usage (excluding crop residue and dung) ranges between these two extremes (288.35mt).There is

another estimate (252mt/yr) calculated on the basis of the three estimates given by Joshi *et al.* (1992), which is much higher than the estimates of fuelwood use by FSI (1988) made for 1986, by NCAER (1985) for 1978/79 and FAO (1993) calculated for the 1991 population.

This wide variation among different estimates bring out the question as to which estimate is to be taken for further calculations.

Conclusion

The majority of rural energy data especially on the household energy is derived from the NCAER and NSSO surveys. Currently, the majority of other agencies and institutions do not have on their basic mandate rural energy related data collection. Hence, in order to overcome the problem of lack of consolidated information related to rural energy demand, supply, and consumption, it is desirable to allocate the responsibility of data collection to one agency. Moreover, it will also be necessary to evolve a system of continually updating the information. The need is to evolve a system to capture the data on an area basis, focusing on a synergetic approach involving patterns and trends in traditional and commercial energy consumption, and economic, social and environmental indicators of rural development.

References

Aggarwal A. 1998. False predications. Down to Earth 7(1): 29-39.

Bose, R. K, Puri, C., and Joshi, V. 1991. Energy profiles of three unelectrified villages in eastern Uttar Pradesh of India. Biomass and Bioenergy 1, 99-109.

CEA. 1996. General Review 1993-94. New Delhi: Central Electricity Authority.

CMIE 1996a. India's Energy Sector. Mumbai: CMIE. 323 pp.

CMIE 1996b. India's Social sectors. Mumbai: CMIE. 290 pp.
Nishanka, S. K and Mishra, M. K. (1990). Ecological study of an Indian village ecosystem-energitics. Biomass 23, 319-26.

FSI. 1988. State of forest report 1987. Forest Survey of India, Ministry of Environment and Forests, Dehra Dun, India.

FAO. 1993. Forestry statistics, today and tomorrow. FAO, Rome.

GoI. 1997a. Energy used by Indian households. Fifth Quinquennial Survey on Consumer Expenditure. NSS 50th round (July 1993 - June 1994). Calcutta: National Sample Survey Organization, Department of Statistics, GoI. 93 pp. [Report no. 410/2].

Joshi, V., Sinha, C.S., Karuppaswamy, M., Srivastava, K. K., and Singh, P. B. 1992. Rural energy database. TERI, New Delhi.

Maggo, J.N. 1998. Sectoral Energy Demand in the Ninth Plan and the Perspective Period up to 2011/12. A technical note. Planning Commission. 68 p.

MoF. 2001. Economic Survey 2000/01. New Delhi: Ministry of Finance, Economic Division, Government of India.

MoPNG 2000. http://petroleum.nic.in. Accessed on 12 October 2001.

NCAER. 1985. Domestic Fuel Survey with special reference to Kerosene (1978/79). New Delhi: National Council for Applied Economic Research.

NSSO. 1997. Energy used by Indian households. New Delhi. National Sample Survey Organization, Department of Statistics [Report No. 410/2]

NSSO. 2001. National Sample Survey 55th Round July 1999–June 2000. New Delhi: NSSO, Ministry of Statistics and Programme Implementation, Government of India.

Puri, C. 1988. Analysis of energy consumption and production pattern in Dhanwas: a survey report. TERI, New Delhi.

Ravindranath, N. H and Chanakya, H. N (1986). Biomass based energy systems for a South Indian village. Biomass 9, 215-33.

TERI 1992. Rural Energy Database–India. New Delhi: Tata Energy Research Institute.

TERI. 1999a. TEDDY (TERI Energy Data Directory & Yearbook 1999/2000) New Delhi: TERI.

TERI. 1999b. Field testing of improved kerosene lighting devices. Submitted to Research and Development Centre, Indian Oil Corporation (IOC), Faridabad. TERI Project Report No. 98/RE/61.

TERI. 2000. TERI Energy Data Directory & Yearbook 1999/2000. New Delhi: TERI.