HOW MUCH ENERGY DO WE NEED

Towards End-Use Based Estimation for Decent Living

प्रयास
Prayas (Energy Group)

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May 2015

Authors

Shripad Dharmadhikary

Rutuja Bhalerao

प्रयास

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About Prayas

Prayas (Initiatives in Health, Energy, Learning and Parenthood) is a non governmental, non-profit organization based in Pune, India. Members of Prayas are professionals working to protect and promote the public interest in general, and interests of the disadvantaged sections of the society, in particular. Prayas (Energy Group) works on theoretical, conceptual regulatory and policy issues in the energy and electricity sectors. Our activities cover research and intervention in policy and regulatory areas, as well as training, awareness, and support to civil society groups. Prayas (Energy Group) has contributed in the energy sector policy development as part of several official committees constituted by Ministries and Planning Commission. Prayas is registered as SIRO (Scientific and Industrial Research Organization) with Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India.

Prayas (Energy Group)
Unit III A & III B,
Devgiri, Kothrud Industrial Area,
Joshi Museum Lane, Kothrud
Pune 411 038. Maharashtra
Phone: 020 - 2542 0720; Fax : 020 - 2543 9134
E-mail: energy@prayaspune.org
Website: http://www.prayaspune.org/peg

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Any shortcomings or weaknesses in the report are our own.

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Executive Summary

How much energy do we need for ensuring a decent standard of living for everyone is one of the basic questions at the heart of energy planning, yet it is one that is rarely addressed in any particularly meaningful manner. Many projections estimate energy demands based on energy requirement for GDP growth. Yet, GDP growth does not necessarily result in provision of basic needs of everyone. Some energy demand projections have therefore tried to estimate energy needed for specific developmental goals, or for indices that work as proxies for such developmental objectives. A set of such developmental goals can form the normative framework that defines a decent standard of living.

This paper reviews various methods of energy demand estimations along with some examples. It starts with the Planning Commission's 2006 Integrated Energy Policy, which essentially uses GDP growth rates, and GDP-energy use elasticities to estimate India's energy use by 2032. The paper then looks at the Central Electricity Authority's Electric Power Survey that projects electricity demand for next 20 years, using a mix of trend line extrapolation and GDP growth based projection. Though both have some normative elements like 100% household electrification, there is essentially no direct link between the energy use and specific developmental goals.

Next, the paper looks at studies that have tried to project energy needs linked to specific developmental goals. One example is the use of Human Development Index (HDI) as an indicator of desired level of development. Data from all over the world has shown a remarkable co-relation between national HDI levels and the levels of per capita electricity use. This co-relation can also be used to estimate electricity needed to achieve a certain level of HDI, say 0.7. One issue here is that HDI captures only some of the desired developmental goals. Another aspect is that several countries have achieved higher HDI with lesser electricity use and these outliers can offer important insights for energy planning.

The paper also looks at the Planning Commission's 2014 report on Low Carbon Strategies for Inclusive Growth. The report creates a Low Carbon Growth Model and uses this to simulate the economy. One of the outputs of the model is the requirement of electricity and energy for the year 2030. The model explicitly incorporates 'inclusive growth policies as outlined in the Twelfth Five Year Plan'. The plan document presents these policies and 'twenty-five core indicators …of rapid, sustainable and more inclusive growth' giving targets for a range of parameters including poverty and employment, health, infrastructure, education, and so on. Thus, these indicators form a normative framework—not just for the energy and power sectors but for the entire economy.

Therefore, the energy projections of this model represent energy needed to achieve specific normative goals. A strength of the model is that these normative goals are a function not of only energy but of the totality of all the parameters of the economy. On the other hand, most normative goals are met in the model by the means of increasing financial allocations to the respective sectors. It is not clear if the model also forces a corresponding allocation of energy.

The paper then examines several other studies which include specific developmental goals and explicitly estimate energy needed for these goals. The UN Advisory Group on Energy and Climate Change calls for universal energy access, which includes energy for cooking and heating, lighting, communications and productive uses. The Poor People's Energy Outlook details energy needs of the energy poor and develops an indicator called Total Energy Access, with six key energy services that the people 'need, want and have a right to'. These are—lighting, cooking and water heating, space heating, cooling, access to information and communication technologies, and energy for earning a living. These efforts provide quantification of energy for some of these needs but not for others.

The last, but the most important set of studies examined by this paper are the bottom up, disaggregated energy estimate. These estimates start with a normative framework of specific goals in terms of goods, materials, and services necessary to meet a reasonable standard of living. Energy needed for these goals is calculated. In this manner, they create a framework where energy use is linked directly to the desired developmental goal. We have looked at four such studies. The first was carried out by Prof. Amulya

Reddy and his colleagues in the mid-1980s. Here, they set their goal as every person being able to enjoy a standard of living that was available to the citizens of western Europe in the 1970s. This is translated further into specific levels of activities like person-km of travel, energy used in households etc., and energy use for each of these activities is evaluated assuming the use of most energy efficient technology. They showed that 1 kW per capita would be sufficient to meet these needs.

Another study reviewed is more recent and carries out a similar exercise for China. Another effort, The 2000 W Society, as the name suggests, is a vision of the society where all energy needs are met at the level of 2000 W per capita per year. A fourth study, by Narasimha Rao, still a work in progress, introduces the concept that while the normative framework can be universal, the specific goals within it may differ across regions. For example, access to sufficient food is a universal goal, but the food itself, and energy needed for it may vary significantly, depending on cultural habits, vegetarian or meat eating practices etc.

Based on these studies, the paper also tries to bring out estimates of electricity and energy needed for India in the year 2032.

The review shows that bottom up, disaggregated approaches offer the best methodology for energy need projections. First of all, they need a well-defined normative framework, which makes the developmental goals of energy planning explicit. Second, since they are based on calculating how much energy is needed for each developmental goal, the other side of the coin is that they lay out *the distribution of the energy to specific end-uses (and end-users).* Other mainstream methods of energy projections often link energy needed to GDP growth or broader goals, and implicitly assume that just so long as a particular amount of energy is generated, the developmental goals will be met. This direct link between energy and its end-use and end-user also provides a good framework to monitor how energy is actually used. These studies reiterate the obvious, but very powerful and often forgotten message – that *this energy estimated for meeting basic needs will meet basic needs if it goes to meet basic needs.* One can't calculate it for basic needs and then divert it for other needs.

The paper also examines the sustainability of current energy production processes, which are largely acknowledged as being unsustainable. Examining the figures provided by the reviewed studies, two conclusions are that we have to evolve more sustainable means of generating energy and that an equitable distribution of energy (at global and other levels) will probably be a necessary condition for sustainably meeting the energy needs of all for decent living.

Given the power, and many advantages of the bottom up, disaggregated studies, this paper recommends such an approach be made the basis of energy planning in the country.

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1 Introduction

Energy is crucial to ensure life with dignity and to meet associated developmental objectives. How much energy we need for meeting developmental goals is one of the most basic questions at the heart of energy planning, yet it is one that is rarely addressed in any particularly meaningful manner.

Exploring this question in detail is also important to unravel the equation : Development = Gross Domestic Product (GDP) growth = Increasing energy use, which represents the conventional wisdom underlying today's development paradigm.

The answer to this question has significance at many levels—for energy planning, for energy security, and to determine the level of social and environmental disruption that can be accepted as 'justified'. It is critically relevant in assessing whether equity concerns are being met or not. It can also help in providing objective inputs for climate debate.

There have been some attempts to address the question of how much energy we need to meet developmental goals—being variously referred to as basic needs, reasonable standard of living, dignified living, decent living, and so on[1]. This note reviews various such efforts and offers some critical thoughts and suggestions based on the review.

2 Various approaches

Some of the most common methods for estimating energy needs are forecasts that use various sorts of trend analysis and extrapolations to project energy required to achieve certain GDP growth. However, in such methods, the link between energy requirements and specific developmental objectives is tenuous at best, and GDP growth is taken as being sufficient in itself.

Other methods attempt to project energy requirements necessary to meet more concretely specified developmental objectives. Often, these developmental objectives or desirable outcomes are represented by some proxies, which could be indices like the Human Development Index (HDI).

Last, but not the least, there have also been some attempts to carry out bottom up, disaggregated assessments of energy needed to meet specific developmental goals, where such a set of developmental goals form a detailed normative framework. For example, such a framework could specify the appliances each household should have, the extent of travel each person would be able to undertake, and so on.

An important concern with the first category of projections is that even if the energy demand is met, and the related goal of GDP growth is also achieved, there is no guarantee that developmental objectives would be met. The other methods, by linking energy demand projections to specific developmental goals, indicate that the allocation of energy to various sectors is equally important to ensure that the specified goals are achieved. Thus, implicitly or explicitly they direct the distribution of energy between various end-uses and end-users. This can be a powerful tool to help energy sector become more equitable and effective in meeting developmental objectives.

Figure 1 presents these broad approaches diagrammatically. Note that the boundaries—particularly between the second and third approach—may not be necessarily be so sharp and these methodologies can be seen as two ends of a continuum.

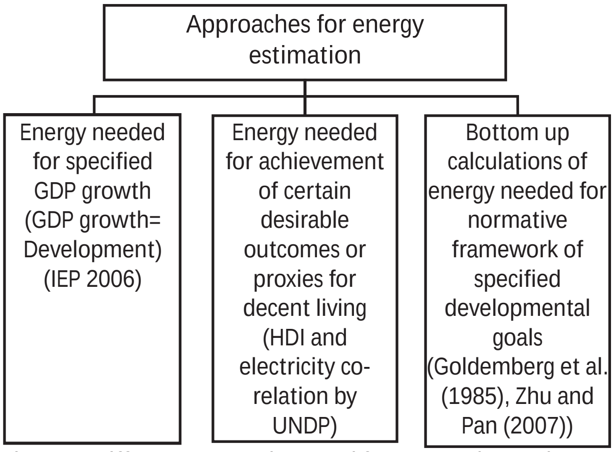

Figure 1: Different approaches used for energy demand estimation

1 We have used all these terms in the note, interchangeably, to broadly convey the same notion.

These approaches are explained below in detail and subsequent discussions attempt to draw some overall learnings.

2.1 Energy needed for specified GDP growth

One of the most common approaches to estimate energy needs is to project energy required to achieve a certain level of GDP growth, the assumption being that this GDP growth is synonymous with development. It implicitly assumes that GDP growth is equivalent to meeting developmental goals and that it translates into a good standard of living for all. Some examples of this approach are discussed below.

2.1.1 Integrated energy policy report of the Planning Commission, India

In August 2006, the Planning Commission, Government of India, brought out its report on the Integrated Energy Policy (IEP) (Planning Commission, 2006) which projected the energy and electricity requirements of India for the year 2031–32.

The IEP report bases its energy demand projections on the need to increase GDP by a certain extent. It states (Planning Commission, 2006, p. xiii),

"India needs to sustain an 8% to 10% economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. To deliver a sustained growth rate of 8% through 2031-32 and to meet the lifeline energy needs of all citizens, India needs, at the very least, to increase its primary energy supply by 3 to 4 times and, its electricity generation capacity/supply by 5 to 6 times of their 2003-04 levels."

The IEP report uses elasticities of GDP-energy use and GDP-electricity use and projects the future energy and electricity needs for two scenarios of 8% and 9% growth in GDP till the year 2031–32 (Planning Commission, 2006, pp. 18-20). The Total Primary Commercial Energy Supply (TPCES) needed in the year 2031–32 projected for declining elasticities by the IEP is given below in Table 1.

Table 1: Projected Total Primary Commercial Energy Supply for India in 2031-32, as per IEP

GDP growth rate	TPCES (Million ton oil equivalent (Mtoe))
8%	1514
9%	1823

Source: (Planning Commission, 2006, p. 20)

To compare, the total primary commercial energy available[2] in India in 2008–09 was 408.16 Mtoe as per TERI Energy Data Directory and Yearbook (TEDDY) (TEDDY 2012-13, p. 47)[3].

The IEP's projections for electricity requirements assuming declining elasticity are summarised in Table 2 below.

Table 2: Electricity requirements for India in 2031–32, for 8% GDP growth rate, as per IEP

Electricity generation	3880 billion kWh
Electricity at bus bar	3628 billion kWh
Peak load demand	592 GW
Installed capacity	778 GW

Source: (Planning Commission, 2006, p. 20)

For comparison, as per the Central Electricity Authority (CEA), gross electricity generation in the year 2008–09 was 840.9 billion kWh (CEA, 2010, p. 53)[4].

The IEP report projects the population of the country in 2031 at 1468 million, giving a required per capita generation of 2471 kWh/year at bus bar (Planning Commission, 2006, pp. 20,32)[5]. Making standard

2 TEDDY 2012–13 uses the word energy 'available', and from its table it is clear that this is the energy consumed at end-use, plus the losses in energy conversion, production, transmission, and distribution. IEP Report does not define supply but Table 1.1 in the IEP report and the associated text shows that total commercial energy 'supply' is used in the same sense of the total energy consumed at end-user plus all the losses (Planning Commission, 2006, p. 1).

3 Note that this energy availability includes production, stock changes, net imports, and includes fuels used for non-energy uses. However, it does not include non-commercial energy (such as bio-mass, animal and human power), which plays a significant role in India and was about 26 per cent of total primary energy consumption in 2007–08. (http://planningcommission.nic.in/sectors/index.php?sectors=energy).

4 The figure includes utilities and non-utilities (industries having captive power generation capacity of 1 Megawatt (MW) and above).

5 The report calls this as consumption. Presumably, Transmission and Distribution (T&D) losses are also counted in consumption.

assumptions[6], this will work out to be 2100 kWh per capita per year at the user/consumption end.

This required generation (or supply) is not allocated to any particular end-use, so this is not a normative allocation. We cannot say, nor is there any indication, about which needs and to what extent they will be met by this level of generation and whether this will go on to provide a decent standard of living[7]. Though some parts of the IEP report include certain normative provisions, and it has also at another place used some sectoral end-use projections, the essence of the IEP projection is to base the energy/electricity demands on the need to increase the GDP to a certain extent.

This GDP increase (without any further disaggregation into desired GDP growth rates for various sectors) is assumed to meet all the developmental goals and is the basic normative thrust of the IEP.

2.1.2 Electric power survey of Government of India (GoI)

The CEA every five years carries out an elaborate exercise called the Electric Power Survey (EPS) for forecasting the future electricity requirements of the country. The latest EPS, the 18th one, has detailed assessments for ten years (2012–17, 2017–22), and long term demand estimates for the later ten years (2022–27, 2027–32) (CEA, 2013).

The main aim of the EPS is to assess electricity demand—thus it is not a normative framework. For example, the 17th EPS report states that, 'The electricity consumption by the end consumer is the guiding factor for evaluating the electricity demand for the future' (CEA, 2007, p. 45). In other words, it looks at what the consumption by end consumer *would* be, and not what it *should* be.

However, the methodology used by the EPS to forecast demands has certainly normative elements. The EPS uses a mix of several methodologies to estimate future demand. The first is the Partial end-use Method (PEUM). The PEUM method is a combination of trend analysis (extrapolation) and an assessment of the end-use. The second method is the use of econometric modelling, partly used to validate the results of the PEUM (CEA, 2013, p. 16).

In the PEUM methodology used in the 17th EPS[8], eight categories of electricity consumption are identified, for example, domestic, commercial, public lighting, irrigation, industry (Low Tension (LT), High Tension (HT) <1 MW, HT > 1 MW), and so on. The forecast has been carried out for each category, each state and union territory for rural and urban areas, and aggregated to obtain the all-India and regional estimates (CEA, 2007, p. 32).

The methodology reveals some normative elements. For example, the estimates for domestic use are based on the number of consumers and their specific

6 Where the original studies have not given any figures for the following categories, we have assumed, for the year 2031–32, T&D losses as 15%, auxiliary consumption as 6.5%, conversion efficiency of electricity generation as 35%, and the population of India as 1468 billion (wherever needed) throughout this note. This set of assumptions will be referred to as 'standard assumptions' here onwards. The figures for population and auxiliary consumption are as per IEP. Overall generation efficiency of the electricity sector is based on the assumption that even in 2031–32, significant part of electricity will be generated by coal. As per IEP, in the 'middle' scenario (i.e. not coal dominated but full development of hydro and 63 GW of nuclear), about 61% of electricity will come from coal in 2031–32 (Planning Commission, 2006, p. 44). If coal dependency reduces then the effective efficiency of electricity generation will go up. But we have decided to err on the side of conservative estimation. Moreover, IESS 2047, or the Indian Energy Security Scenarios 2047, an energy scenarios building tool developed by the Planning Commission (http://indiaenergy.gov.in/), states that coal's share in total electricity generation in 2032 will be significant at about 54%. This is as per supply side scenario 2 which assumes a level of effort most achievable by the implementation of current policies and programmes of the government. Hence, the choice of conservative conversion efficiencies is further justified. IESS 2047 gives the T&D losses in 2032 as ranging from 8% to 18%. So we have taken them as 15%.

7 There are certain assumptions built into the IEP analysis, for example, that all households will be electrified by 2019–20 (Planning Commission, 2006, p. 30). But the report does not make this (and other such goals) an explicit objective based on which projections for electricity requirement are made. When something is an explicit goal, then the process can be made accountable for it. If it's an implicit or indirect goal (for example, GDP increase will result in more households being electrified) then there is much lesser accountability.

8 We use the details from the 17th EPS as all the volumes of the 18th EPS were still not published while this note was being written. Moreover, we are using the 17th EPS only to illustrate the methodology, which is the same as used by 18th EPS.

consumption. The EPS assumes that 100% household electrification is achieved as per the policy goal, and so the number for domestic connections considers that total households in the target year have been electrified[9].

The irrigation pump set consumption has been estimated by estimating the number of pump sets, their capacities, and the electricity consumption per pump set. For the first, i.e. number of pump sets, the EPS has used the 'programme of pump set installation furnished by State Electricity Boards/Utilities' (CEA, 2007, p. 33)[10], which can again be considered as a normative input. The average capacity has been worked out using the growth trend of the connected electric load and number of pump sets in the past years.

These examples indicate that some normative elements are included in the estimations made by the EPS. While such elements are certainly a step better than just the link with a desired GDP, in as much as they disaggregate and present specific developmental goals, they are present only in bits and pieces.

The econometric model in the EPS uses an equation that basically derives electricity demand from GDP (per capita), electricity prices, electricity intensity of GDP, and the structure of economy (for example, share of service sector in the economy).

The projected electricity requirements for the years 2022 and 2032 are given below in Table 3 (CEA, 2013, p. 162).

Table 3: Forecast of electrical energy requirements and peak load for India till 2031–32 (utilities only) as per 18th EPS

Details	2021–22	2031–32
Energy requirements at bus bar (billion kWh)	1905	3710
Peak load demand (GW)	283	542

Source: (CEA, 2013, p. 162)

This compares well with the IEP projections of 3628 billion kWh needed at bus bar in 2031–32 and the peak load requirement of 592 GW. Note that EPS figures are for utilities only and do not include captive, whereas IEP figures are for the entire economy. In the last 15 years or so, installed captive capacity has been between 15–20% of utilities, and generation has been 15% of the utility generation. So the EPS figures given above would need to increase by around say 15% to make them comparable to the IEP figures.

In spite of having some normative elements, both IEP and EPS are far from presenting a framework that links energy use and consequently energy planning directly with developmental goals in a disaggregated and monitorable manner. Both are forecasts that tell us how much energy would be needed, but not how much should be needed, and for which purpose. We will now look at some studies that have tried to project energy needs linked to specific developmental goals.

2.2 Energy for achievement of certain desirable outcomes

In this section, we discuss some approaches that estimate the energy needed for certain desired outcomes or certain values of indicators, which are proxies for dignified living.

2.2.1 HDI based estimations

The Human Development Index (HDI) is a broad measure of human well-being, published annually by United Nations Development Program (UNDP). It is an index of the human development of a country based on various parameters linked to the GDP, health, and education. The index is in between 0 and 1 and generally it is accepted that a score of 0.7 to 0.8 or above indicates high level of well-being[11].

Several analysts have shown a strong co-relation between HDI of various countries and their per capita

9 Interestingly, this indicates that the 17th EPS implicitly assumes that all households will get grid-based electricity (as utility systems based electricity demand is being estimated) by the year 2011–12 (page 41).

10 This is subject to the 'total potential of energization of irrigation pump sets', which presumably is linked to the replenishable ground water sources in the area.

11 HDI report divides countries into categories of low, medium, high, and very high HDI. Till 2010, the medium HDI category was set to 0.500 to 0.799. So a HDI of 0.8 and above represented high development index. In more recent HDI reports, the system of setting absolute values for low, medium, high, and very high HDI has been changed to using quartiles. Hence, it would differ every year. For the latest year (2013) medium HDI works out to be 0.536 to 0.710. So we could take the desired value of HDI to be 0.7.

electricity consumption. A corollary is that this HDI-electricity use co-relation can be used to work out the required per capita electricity consumption for a desired HDI (say 0.7).

Figure 2 plots the HDI (2010) (UNDP, 2010) against the per capita electricity consumption for the year 2010 (The World Bank, n.d.).

From this plot, the per capita electricity consumption needed to ensure an HDI of 0.7 comes to about 2300 kWh per year, and at the generation end this is equivalent to 2895 kWh.

It should be noted that there are several outliers which may be of interest. For example, there are countries like Ecuador (1055 kWh, HDI 0.695) and Peru (1106 kWh, HDI 0.723) that have achieved HDI of 0.7 and above with relatively smaller per capita electricity consumption per year. On the other hand, there is South Africa with HDI of only 0.597 but a consumption of 4803 kWh per capita per year.

Some important elements of this approach are:

- Since the data is for many countries around the globe, there is certain robustness in the co-relation, even if causal factors are not analysed.
- HDI of 0.7 may not be the only developmental goal as HDI considers only selected factors.
- In general, distributional aspect (inequity) is not treated separately. Still, the spread and extent of the data means that some of this would be implicitly included[12].
- While the HDI-electricity consumption co-relation is robust, it hides great differences between the structures of the economies across various countries and their health and education services. Hence, the outliers may be of more interest than those that lie on the best fit line. These outliers can show how the same HDI can be achieved with less per capita electricity use.

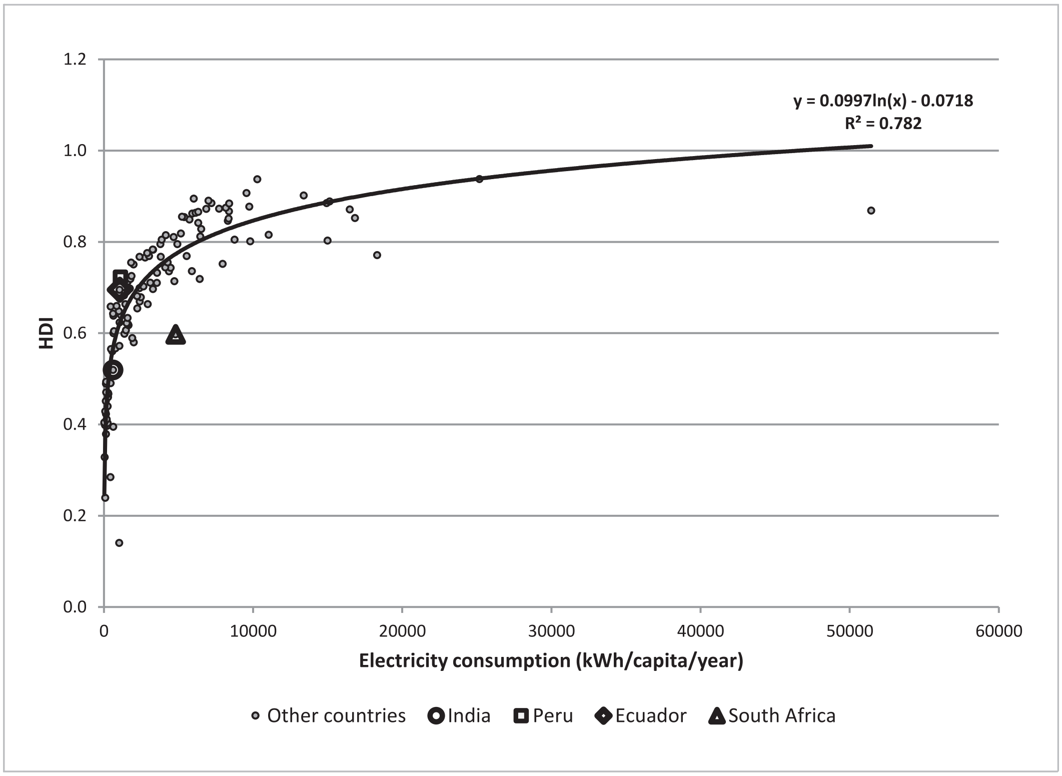

Figure 2: Electricity consumption per capita (2010) and corresponding HDI (2010) of different countries as per UNDP
Source: (UNDP, 2013; The World Bank, n.d.)

12 Recent HDI reports also present inequality-adjusted HDI for all countries (UNDP, 2010, p. 87).

- Sustainability of the required per capita electricity use (and generation) is an issue. (See below).

2.2.2 Ecological footprint and HDI

The Ecological Footprint (EF) is an index of sustainability of human activity, in terms of the land needed to produce what is used and the area needed to absorb the waste generated in the process (Global Footprint Network, 2009, p. 7). The footprint, compared with the 'bio-capacity', or the land and water area actually available, gives a measure of sustainability.

A report by World Wildlife Fund (WWF), Zoological Society of London (ZSL), Global Footprint Network (GFN), and European Space Agency (ESA) gives the EF of various nations for the year 2008 (ZSL, GFN and ESA, 2012, pp. 140-144). Figure 3 plots this EF (2008) against HDI (2008)[13]. A trend line is also plotted.

As per the report, for year 2008, the bio-capacity of the planet was 1.78 global hectares (gha) per capita (p. 141)[14]. We have indicated this in the form of a vertical line in Figure 3. Two important conclusions can be drawn from this chart:

- At the sustainable level of footprint (i.e. bio-capacity), the HDI possible is around 0.55.
- To achieve an HDI of 0.7, countries would require an EF of 3.14 gha, much higher than the current (2008) global sustainable bio-capacity. Figure 3 shows that all countries with HDI greater than 0.8 and most with HDI greater than 0.7 have a footprint higher than 1.78 ha.

The notable exception to this trend is Armenia (EF 1.73, HDI 0.7).

This raises the very important question about whether

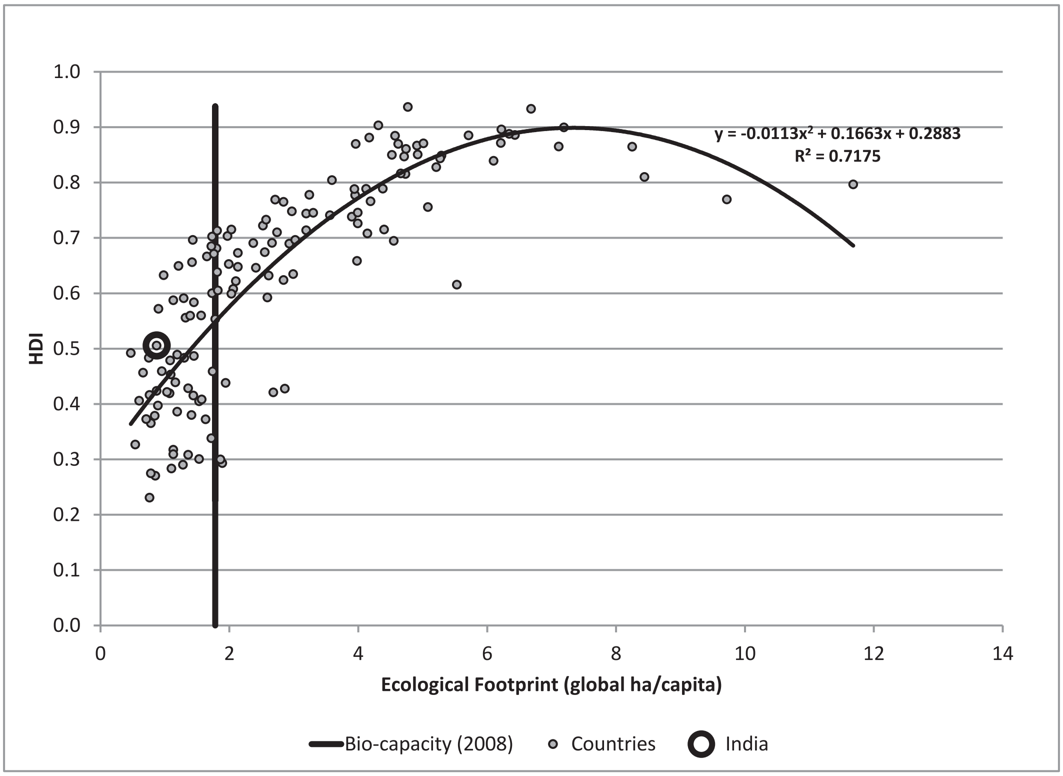

Figure 3: EF 2008 (gha/capita) and corresponding HDI (2008) of different countries

Source: (ZSL, GFN and ESA, 2012)

13 Post 2010, HDI reports give the HDIs for earlier years recast using the new method of calculating HDI. We have used recast HDI for year 2008, so it is HDI 2008, but as per the new method.

14 This bio-capacity includes cropland, grazing land, forest land, fishing ground, and built-up land.

it is at all possible to meet the objective of a high HDI in a sustainable manner[15]. At the least, it indicates that the conventional approach to achieving a high HDI is unsustainable and there is a need to re-examine these approaches.

Let us now look at some energy needs estimates that are based on energy requirements for more directly specified developmental goals.

2.2.3 Low Carbon Inclusive Growth Report of GoI

In April 2014, the Planning Commission, GoI, released *The Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth* (Planning Commission, 2014). The report presented strategies for inclusive growth in various sectors of the economy which would also result in lowering carbon emissions. Power and energy were crucial sectors, and the report has predicted the requirement of electricity and energy for the year 2030.

The report creates a Low Carbon Growth Model and uses this to simulate the economy under two scenarios—the Baseline, Inclusive Growth (BIG) scenario, which 'incorporates inclusive growth policies as outlined in the Twelfth Five Year Plan, and serves as the reference scenario' and the Low Carbon, Inclusive Growth (LCIG) scenario which 'incorporates low carbon strategies while maintaining the inclusive growth interventions as introduced in the BIG scenario' (Planning Commission, 2014, p. 21). It may be noted that both the scenarios result in a GDP growth rate of 7%.

The inclusive growth policies of the 12th Five Year Plan are elaborated in Volume I of the Plan Document, which also gives some 'twenty-five core indicators ...of rapid, sustainable and more inclusive growth' (Planning Commission, 2013, p. 35). These indicators present specific targets for a range of parameters including poverty and employment, health, infrastructure, education, and so on. Thus, these indicators form a normative framework—not just for the energy and power sectors but for the entire economy.

Therefore, the energy and power projections of both the scenarios—developed to meet the inclusive growth indicators—represent a projection of demand to achieve specific normative goals. It must be pointed out that the model achieves these normative goals not merely as function of energy but of the totality of all the parameters of the economy (which is a strength, as almost no normative goal would be achieved only through use of energy only). On the other hand, most normative goals are met in the model by the means of increasing financial allocations to the respective sectors. It is not clear if the model also forces a corresponding allocation of energy enabling us to know the required distribution of energy amongst various sectors and end-uses to meet the normative goals.

The report gives the following projections for requirements of energy and electricity (Planning Commission, 2014, pp. 31,32).

Table 4: Primary energy requirement and electricity demand for BIG and LCIG scenarios in 2030 for India

Details	BIG (Baseline Inclusive Growth)	LCIG (Low Carbon, Inclusive Growth)
Primary energy demand (Mtoe per year)	1146	1108
Electricity demand[16] (billion kWh per year)	3371	3466

Source: (Planning Commission, 2014, pp. 31,32)

15 The HDR 2013 also notes this relationship between HDI and EF, and presents a figure (Figure 1.7) showing this co-relation (UNDP, 2013, p. 35). This also raises a set of interesting questions about what could be the limiting factors globally and for India in achieving a high HDI. Would it be land, water, or any others, particularly those that are not internationally tradable? The question of use of natural resources to achieve a level of development has also been raised by people like Sagar Dhara, who say that 'sustainable development' as understood in conventional terms is an oxymoron. http://www.teacherplus.org/2011/december-2011/sustainable-development-%E2%80%93-an-oxymoron

16 The report uses the terms electricity 'consumption', 'demand', and 'generation' at various places to refer to these figures. Hence, it is not clear whether these are projections of electricity needed at the use-end, or of gross generation. The difference will be the amounts of T&D losses and the auxiliary consumption, which we have taken as per standard assumptions. Since the Low Carbon report directly compares these figures to IEP figures, we assume that they represent the same parameter as IEP figures do, which is 'gross generation'.

The approach used by the Low Carbon report has a clear normative framework—the policies and indicators of inclusive growth as set out in the 12th Plan document—but it does not present directly the energy needed for each of these objectives.

We now look at several attempts where energy requirements are associated with specific developmental objectives though not all are actually energy demand projections. These approaches broadly include a normative framework that lays down what are the desired levels of various activities (lighting, appliance use, transport, and so on) and the energy needed to achieve this level of the activities.

2.2.4 UN Advisory Group on Energy and Climate Change

In 2009, the secretary-general of the United Nations (UN) established a high-level Advisory Group on Energy and Climate Change (AGECC) with a mandate to 'provide recommendations on energy issues in the context of climate change and sustainable development' (AGECC, 2010, p. 2).

The report of the AGECC was brought out in 2010. The report considers 'three incremental levels of access to energy services and the benefits they can provide'. These are—level 1 (basic human needs), level 2 (productive uses), and level 3 (modern society needs). The report also offers a definition of 'energy access'[17]. It says that 'for the purposes of this report we have defined universal energy access as 'access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses' – i.e., levels 1+2'. (AGECC, 2010, p. 13).

The three levels are elaborated and part quantified as follows:

- Level 1, basic human needs—[18]

Electricity for lighting, health, education, communication, and community services (50–100 kWh per person per year); and modern fuels and technologies for cooking and heating (50–100 kgoe of modern fuel per capita per year, roughly equivalent to 1200 kWh at higher end (AGECC, 2010, p. 9) or improved biomass cook stove)

(a) Level 2, productive use—

Electricity and modern fuels to improve productivity, including agricultural activities like water pumping for irrigation, fertilizer, mechanized tilling, commercial activities like agricultural processing, cottage industry, and transport

This need is not quantified.

(b) Level 3, modern society needs—

Modern energy services for many more domestic appliances, increased requirements for cooling and heating (space and water), private transportation. This is quantified at around 2000 kWh per person per year of electricity.

2.2.5 Poor People's Energy Outlook

The Poor People's Energy Outlook (PPEO) is a series brought out by Practical Action, a charity organisation based in the United Kingdom (UK) and working in many different parts of the world. The group has brought out such reports for the years 2010, 2012, 2013, and 2014. The PPEO 2010 reiterates the importance of the UN initiative on universal energy access by 2030, and states (Practical Action, 2010, p. v):

"But today's approach to providing energy access to those who lack it is, from a poor person's perspective, fractured and incoherent. National energy planning still assumes that the formal energy sector will be the principle means to ending energy poverty. ... The energy provided by rural electrification programmes is rarely sufficient or affordable for cooking, the most energy-consuming household activity. This leaves millions of families who have been lucky enough to benefit from such a programme preparing their evening

17 Universal access to modern energy services by 2030 is a major initiative of the UN. See, for example, http://www.sustainableenergyforall.org/ or http://www.sustainableenergyforall.org/objectives

18 AGECC has taken these figures from (IEA, 2009, p. 132). The lower end of the range, i.e. 50 kWh/person/year is for rural areas and higher end (100 kWh) is for urban areas. It does not give what needs are expected to be covered by this electricity. But (International Energy Agency, 2010, p. 249) gives it as 'a floor fan, two compact fluorescent light bulbs and a radio for about five hours per day. In urban areas, consumption could also include a television and another appliance, such as an efficient refrigerator or a computer. Consumption is assumed to rise every year until reaching the average national level'.

meal under the glow of an electric light – in a smoke-filled kitchen over an unimproved wood or dung-burning stove. Meanwhile national planning for improved access to mechanical power, which is so necessary for small enterprises and the development of local economies, remains almost entirely forgotten.

The Poor People's Energy Outlook seeks to highlight today's energy access apartheid, as a first step to ending it."

The PPEO details the energy needs of the energy poor and proposes a new set of minimum standards and indicators, called Total Energy Access (TEA). Six key energy services that the people 'need, want and have a right to' are identified. These are—lighting, cooking and water heating, space heating, cooling, access to information and communication technologies, and energy for earning a living (Practical Action, 2010, p. ix).

The PPEO 2012 focuses on the energy access and its link to earning a decent living. In particular, it emphasizes why providing energy access to farmers and farming is critical (Practical Action, 2012, pp. ix,x).

The 2013 report includes energy requirements for community services of health care, education, public institutions, and infrastructure services in the TEA. But it quantifies only some of these parameters such as health (25 kWh/day for a rural clinic with certain specifications), school (5 kWh/day for a primary school), street lighting (1 kWh/12 hour night for 80 W outdoor efficient bulb), and so on (Practical Action, 2013, pp. 12,18,22).

Some of the standards are quantitative (for example, 'lighting' is put at 300 lumens at household level), and some are qualitative (for example, 'earning a living' requires that 'Access to energy is sufficient for the start-up of any enterprise').

The important contribution of this effort is that it presents energy needs from the point of view of the poor.

2.3 Bottom-up, disaggregated approaches

2.3.1 Amulya Reddy and others –1 kW per capita

This exercise was carried out by Prof. Amulya Reddy and his colleagues as a thought experiment in the mid-1980s (Goldemberg, Johnsson, Reddy, & Williams, 1985). In this approach, they listed various services and products that constitute a good standard of living along with the per capita level of activity for each service or product. This level of activity or use for each service or product was equivalent to the standard of living in 1970s of Western Europe, Japan, Australia, New Zealand, and South Africa (WE-JANZ). So the normative framework was the standard of living equivalent to that of the WE-JANZ of 1970s.

The energy needed to provide each unit of each service or product was also listed (the energy intensity of the product or service), based on the best available (most efficient) technology at that time. The product of the energy intensity and the activity level gave the total energy needed per capita for maintaining this particular component of the standard of living.

They found that about 1 kW per capita of final energy would be needed for provision of all the services and products taken together. The break up for this was 210 W per capita of electricity and 839 W per capita of energy (fuel). This 839 W energy component does not include primary energy needed for generating electricity.

The estimates included both, direct use and indirect or embedded use of energy (i.e. energy in manufactured goods). Energy use for services appears to be included under the head 'commercial'.

The values chosen for the per capita consumption rates of basic materials in this 1 kW scenario were from 'the period near the peaks of the curves of activity level/consumption rates' (Goldemberg, Johnsson, Reddy, & Williams, 1985, p. 196). Therefore, this would take care of higher use of basic materials in the infrastructure build-up phase[19].

19 It may be noted however that, the authors say that 'the absolute levels of basic materials production and use are not likely to be higher during infrastructure building period than the beginnings of the post-industrial phase (e.g. the mid 1970s of Western Europe), because although basic materials play a *diminishing relative role* in economic activity as the economy matures, these materials continue to play an increasing *absolute role* for a long time thereafter, as wider uses are found for these materials'. (Emphasis in original) (p. 196).

The total energy and electricity needed for India in the year 2031–32, worked out on the basis of the 1 kW per capita framework, and based on standard assumptions are given in Table 5 and Table 6, respectively.

Table 5: Total primary energy needed in 2031–32 for India, estimated as per 1 kW requirement per capita

	Mtoe
Primary energy for only energy use	928
Primary energy for electricity generation	835
Total primary energy	1762

Source: Authors' calculations based on Goldemberg, Johnsson, Reddy, & Williams, 1985.

Table 6: Total electricity needed in 2031–32 for India, as per 1 kW per capita approach

Per capita electricity	1840	kWh per year at end-use
Per capita electricity	2315	kWh per year at generation
Total electricity needed in 2031–32	2701	Billion kWh per year at end-use
Total electricity needed in 2031–32	3398	Billion kWh per year at generation end

Source: Authors' calculations based on Goldemberg, Johnsson, Reddy, & Williams, 1985.

As a comparison, gross electricity generation in the year 2008–09 was 840.9 billion kWh (CEA, 2010, p. 53)[20].

The sectoral distribution of this 1 kW energy per capita requirement (electricity and fuel) is given in Annexure 1.

Some limitations of this framework are that it does not differentiate between peak and base needs and some uses are not included (for example, fans, space heating, cooling, laptops/computers, mobiles, and so on).

2.3.2 The 2000 W Society

The 2000 W Society, as the name suggests, is a vision of the society where all energy needs are met at the level of 2000 W per capita per year. The initiative has come from Switzerland and it is being carried out by Novatlantis (Novatlantis n.d.). It is the 'Sustainability program established by the Swiss Federal Institute of Technology, aims to establish local, national and international networks as a means of promoting the 2000 W Path' (Novatlantis, 2010, p. 2).

The idea emerged from the fact that when it was initiated (around 2007), the global average per capita energy consumption was 2000 W. Swiss consumption at that time was 5000 W, not counting energy contained in imports of about 4000 W per capita (Paul Scherrer Institute, 2007, p. 1). The Swiss Federal Institute of Technology had carried out studies to demonstrate the feasibility of the concept. They believe that 'daily life in Western Europe could actually be powered by less than one-third of the energy consumed today' (Novatlantis, 2010, p. 2).

One articulation of this vision presents the following breakup of the 2000 W.

Table 7: Sectoral energy use reduction from current 6500 W to 2000 W for Switzerland

Sector/ end-use	Current use[21]	Proposed in 2000 W vision
Housing	1600	500
Mobility	1700	450
Food	750	250
Consumption (manufactured goods)	750	250
Infrastructure	1500	550
Total	6300	2000

Source: (Novatlantis, 2010, p. 11)

It is not clear whether the 'consumption' target (manufactured goods, and so on) includes imports and the energy embedded in that. The initiative has developed a broad framework for achieving the target, has been carrying out related research, and has also taken up pilot projects in several cities.

One important aspect of this vision is the recognition that 'It is not the level of 2000 W alone that is decisive, but rather how this power is produced' (Paul Scherrer Institute, 2007, p. 1).

2.3.3 China case study for calculation of energy for basic needs

Xianli Zhu and Jiahua Pan (2007) present a calculation of primary commercial energy requirement for basic

20 The figure includes utilities and non-utilities (industries having captive power generation capacity of 1 MW and above).

21 It is not clear which year the 'current' figures refer to, but the context in the book implies that they are from 2006 or 2007. The figures for current use total 6300 W in the table, but the title for the table, taken from the original reference, mentions 6500 W. The figures are also different from that in another reference (5000 W) (Paul Scherrer Institute, 2007).

needs in China for a population of 1.3 billion assuming 75% urbanization (Zhu & Pan, 2007).

Methodology

The study assumes ten basic needs (Annexure 2), puts their activity levels at the current activity levels of these activities in the Organization for Economic Co-operation and Development (OECD) countries, and also adopts the energy intensities in OECD countries of these activities. Using these activity levels and energy intensities, the study calculates total primary commercial energy requirement using the life cycle approach. Thus, the normative standard is put at the level of use of goods, materials, energy, and services of OECD during periods varying from 1983 to 2004 for these ten categories of basic needs. However, 'no wasteful and luxurious consumptions' were included in estimation. Both direct and indirect energy consumption was considered for each basic need. For example, the direct energy requirement for food included cooking energy requirement (LPG) and indirect energy requirement included the energy needed for growing food, its transportation at various stages, processing, and packaging.

Total primary energy requirement for basic needs for China as per the study has been worked out at 2401 Mtoe per year, which is about 77 Giga Joules (GJ) per capita per year (about 2.5 kW per capita).

Some issues to take note of are as follows:

- While energy needed for creating infrastructure is included, existing stock of infrastructure is not considered while calculating the total energy requirement for infrastructure part of basic needs.
- The energy requirement for infrastructure is not equally distributed over their life period. A simplified approach of distributing this energy requirement equally over the life of infrastructure is fine for a basic estimate, as done by this study, but detailed planning will need to consider this phasing.
- Reasons behind assuming certain levels for some of the needs, for example, housing area per capita, household electricity use, (1000 and 800 kWh per capita per year for urban and rural population respectively), mobility levels, and so on, are not clear.
- Some of the assumptions about energy requirement for housing, manufacturing of transport vehicles, newspaper printing, writing and printing paper, and so on, are taken from older references (housing: 1993; transport manufacture: 1983; newspaper printing, writing and printing paper: 1993). The efficiencies may have improved with time. For example, for paper sector the primary energy intensity has reduced from 119.48 MJ/kg in 1993 as taken in the study to 6.6-22.4 MJ/kg (LBNL, 2008, p. 2).
- Energy requirement for exports is not taken into consideration, which is high for China. Since international trade related activities are responsible for significant employment, not considering the energy needed for trade related activities raises the question of whether this employment can be sustained.

Annexure 2 summarises the end-use wise distribution of the energy needed for meeting basic needs in China.

2.3.4 A conceptual framework for estimation of decent living emissions

Another important effort in this direction is the attempt to develop energy required for decent living, and 'decent living emissions' by Narasimha D. Rao and Paul Baer (Rao & Baer, 2012). Their methodology has the basic elements of such an effort, that is, a normative framework for what constitutes decent living and energy intensities for each of these elements. They indicate 'decent living as the consumption by households of a set of basic goods including adequate nutrition, shelter, health care, education, transport, refrigeration, television and mobile phones'.

However, going beyond this, they also bring in some innovative aspects to the methodology. First of all, while the decent living norms are presented as universal across the world, there is a recognition that these universal entitlements will translate into country specific energy requirements due to cultural, climatic, and other differences between countries. For example, food habits may mean a higher share of meat in diets for some countries, resulting in higher energy requirements as compared to other countries with a largely vegetarian diet.

Another important part of their methodology is the recognition that apart from the regular energy requirements to meet these basic needs, energy will be needed 'one time' for creation of infrastructure that is essential to deliver these needs. Thus, they calculate energy needed for decent living in two parts—the maintenance needs and the explicitly indicated infrastructure build-out needs. In doing this, they also account for the existing infrastructure, so that the build-out consists of bridging the 'infrastructure gap'.

Last but not the least, in setting the norms for electricity supply (for households), they not only include the quantity of supply but also suggest that 'Decent living requires electricity to be provided with a minimum level of reliability and quality, whose energy requirements have not been previously assessed'.

The study is still a work-in-progress, and at the time this note was being written, the final numbers from this important study have not yet been out.

3 Discussion

The summary and comparison of these various studies and approaches is given in Table 8.

3.1 Implications for energy planning

Among the various approaches and their respective estimates presented above, we focus this discussion mainly on the bottom-up, disaggregated methods since they represent attempts to most directly link energy needed to specific developmental goals.

Table 8 shows the different estimates for energy needed for dignified living. One issue is that in trying to derive a macro picture these studies essentially take up sectors and end-uses with immense diversity (for example, the great range in the kinds of dwellings in India) and aggregate them to one single figure; in the process hiding wide variations and diversity found in real world, papering over many significant differences. Moreover, there are many assumptions and generalizations behind each number. Thus, the numbers that emerge from these studies need to be taken as indicative rather than absolute.

This does not mean that the numbers are not useful. They provide some important insights and offer useful assessments of energy plans and predictions.

Table 8: Energy and electricity needed in India in year 2032 for dignified living based on various approaches

Sr. No.	Approach/ Study	Per capita in 2032			Total in 2032	
		Electricity (kWh)	Energy* (kgoe)	Energy (W)	Electricity (billion kWh)	Energy* (Mtoe)
1	IEP, India	2643	1031	1369	3880	1514
2	18th EPS, India	2703			3968	
3	HDI-Electricity co-relation, HDI=0.7	2895			4250	
4	Amulya Reddy and Others (1 kW per capita)	2315	1201	1594	3398	1763
5	China basic needs study**	1195	1847	2452		2711
6	Swiss 2000 W Society			2000		2211
7.1	Low carbon committee report: BIG scenario	2296	781		3371	1146
7.2	Low carbon committee report: LCIG scenario	2361	755		3466	1108
8	Current (2008–09) status for India	649	348		762	408

Based on standard assumptions if original references don't give specific parameters.
*- Energy includes primary energy needed for electricity generation.
**- Per capita electricity considers use only for household sector. Electricity use in other sectors is considered in respective sectors and not given separately.

For example, the total electricity generation needed in the year 2032 is projected by the IEP to be 3880 billion kWh per year. Using figures of the study by Amulya Reddy and others (Goldemberg, Johnsson, Reddy, & Williams, 1985), electricity generation needed in 2032 is around 3851 billion kWh. Similarly, the primary energy that will be needed in the year 2032 is projected by the IEP to be 1514 Mtoe. This is just about 20% less than what Goldemberg et al (1985) project at 1874 Mtoe. This means that if the assumptions made by Goldemberg et al (1985) are met, then the energy supply projected by IEP can potentially provide the entire Indian population in 2032 with the standard of living that Western Europe enjoyed in the 1970s (excluding space heating and cooling)[22]. Of course, whether this actually happens will depend on whether the energy supply in 2032 is distributed among various end-uses and users in a manner recommended by Goldemberg et al (1985). The IEP itself does not present any pattern of how the energy is to be distributed nor does it provide any estimates of the levels of standard of living that the energy supply will provide to Indian citizens in 2032. This highlights what IEP-like exercises lack, and also indicates how important it is to bring distribution into energy projection and planning.

Given this, we believe that an exercise to estimate in a disaggregated and bottom-up manner the energy requirement for dignified living in India—either as a fresh exercise or one based on the (Goldemberg, Johnsson, Reddy, & Williams, 1985) framework—would be worthwhile to take up even if it is only indicative in nature. Apart from providing indicative estimates of energy needed, it could also provide a reality check for official energy need projections like IEP, and offer a template to assess and evaluate them for the likelihood of achieving specific development goals.

Of course, one can question the objective or the goal itself of an exercise like that of Amulya Reddy and others (Goldemberg, Johnsson, Reddy, & Williams, 1985). That is, 'is the standard of living of Western Europe in the 1970s' an appropriate goal for a country like India?' One argument for this is that Indians (and people from all parts of the world) have a right to enjoy the standards similar to those enjoyed by people in Europe or OECD countries. So this would justify the goal. At the same time, there could be significant differences in the some of the requirements—for example, the food habits of Indians are very different than those of people in Europe. So the normative framework may have to include different standards for the food part.

Thus, an India-specific exercise may need to draw up a normative framework that could have elements of OECD/European standard of living but also India specific requirements for food, housing, and so on. Such differences would also lead to differences in the final numbers for energy required.

Another important point thrown up by these various estimates is that the energy needed for the same end-use can vary depending on the way the end-use is to be realized. For example, the energy required for meeting food needs could vary considerably depending on the level of processing, packaging, and transport involved. The China estimates reviewed here assume significant levels of such packaging and transport. In India, however, we may find much smaller (though increasing) levels of the same. In essence, these represent two different ways of meeting the food needs, and with differing levels of energy requirements. Thus, energy needed to meet any specified needs is not only a function of efficiency of energy use, but also of the way the needs are to be met. This can suggest ways to minimize energy consumption and yet meet the same developmental goals, though this might have some trade-offs including up front and/or lifetime cost implications or in the quality of end-use, say for example, convenience.

Possibly the most significant insight from these studies is that as important as the issue of 'how much energy' is the question of 'energy for what', particularly when we are looking at meeting desired and explicitly articulated developmental objectives. In such a case, identifying for what (end-use) and for whom (which end-user) the energy is needed, and how to ensure that

22 Perhaps better, since efficiencies would have significantly improved meantime.

energy does indeed go to meet these needs is critical.

More broadly, these estimates emphasise the importance and present illustrations of three fundamental elements in understanding how much energy we need for ensuring dignified living. These are—the framework, pathways, and methodology that these estimates present.

Framework

These estimates start with a normative framework of specific goals (in terms of goods, materials, and services) necessary to meet a reasonable standard of living. Energy needed for these goals is calculated. In this manner, they create a framework where energy use is linked directly to the desired developmental goal. Such a normative framework is central to any endeavour that attempts to map the energy needed for decent living.

Pathways

These estimates present energy needed for various elements of specific development goals. In this way, they lay out *the distribution of the energy to specific end-uses (and end-users).* Such distribution of energy is a necessary condition to achieve developmental goals. Other mainstream methods of energy projections often link energy needed to GDP growth, and implicitly assume that just so long as a particular amount of energy is generated, the developmental goals will be met. However, the above estimates highlight that not only does the energy need to be generated but that it also needs to flow through certain pathways, or to specific end-uses and end-users. They also indicate the pathways for specific goals.

These pathways can be broad and highly aggregated in nature, but by disaggregating them to the desired level, by bringing in details of diverse situations, not only can the quantitative estimates be made more accurate, but also the pathways along which the energy should be directed become clearer and more defined.

Methodology

In laying out the pathways, *these estimates also provide a methodology to estimate energy needed for various elements of specific developmental goals.* This is particularly important as the same levels of activities or services or material consumption can be met in many different ways. This allows us to examine whether the same needs can potentially be met by lesser levels of energy and with other important co-benefits.

Apart from directly linking energy needed to specific developmental goals, such an approach to energy needs estimation has several other advantages.

For one, the pathways when developed in detail provide a template against which subsequent use of energy can be monitored—to ensure or assess that energy is going to the correct end-use and is indeed achieving the claimed developmental goals. This makes the monitoring of the implementation a much more structured and effective endeavour, and in the process, makes energy planning and its implementation far more accountable.

This process also reveals where energy is a driver, a critical input, or a bottleneck to meeting a goal, and where it plays a more secondary role. For example, for providing effective health care, a good quality cold chain is considered important. And this needs energy. However, other factors like proper training of health workers, public awareness, availability of medicines and medical professionals may be more critical to achieving health outcomes. By revealing the precise nature of the role played by energy, and its relative importance, a disaggregated energy needs assessment can assist in development of policies, supporting interventions and cross-sectoral linkages that are necessary to make energy interventions effective in realising developmental goals.

Such estimates also indicate what levels of energy supply are necessary for meeting the needs of the citizens for a life with dignity. Therefore, they also offer pointers to which energy needs can be considered as being beyond basic needs, which energy uses are conspicuous consumption, and so on. This offers important boundaries in terms of what social and environmental disruptions can be considered as acceptable and justifiable, as they may be necessary to meet the basic needs; and as a corollary, what disruptions are not acceptable. It can also show limits beyond which, or uses for which energy consumption could be taxed or otherwise penalised or even barred. A word of caution is in order here. The mere fact that a certain amount of energy supply is needed for meeting basic needs should not be seen as a blanket sanction for any and every energy project regardless of its specific costs and impacts. Individual projects to meet these energy supply needs, and indeed even categories of projects or technologies for meeting these needs must get their sanction (or not) depending on their costs, impacts, broad public acceptance, and after establishing that they are indeed the least cost and most appropriate option.

Thus, an important learning from this kind of bottom-up, disaggregated approach is that just planning for capacity expansion or generation of more energy is not enough unless and until *policies, processes, pathways and structures too are simultaneously created which will ensure that the energy ends up in meeting specified developmental goals.* This naturally also presupposes *the specification of such developmental goals and underscores their centrality to energy (supply) planning.*

Coming back to our original quest of estimating the quantum of energy needed to meet basic needs or needs of dignified living, can we use these approaches to answer the question of 'how much energy do we need to meet basic needs?' The answer, with all the caveats presented above is yes, we can. However, we have to add something that is rather obvious but often forgotten—*this energy will meet basic needs if it goes to meet basic needs.* One can't calculate it for basic needs and then divert it for other needs.

Given all this, we strongly recommend that such an approach be enshrined as the basis for energy planning in the country.

3.2 Sustainability of energy supply

One important question is whether the energy required for meeting needs of dignified living can be obtained in a sustainable manner. We have seen earlier that every country that has an HDI greater than 0.8, and even 0.7, has an ecological footprint that is higher than the bio-capacity of the planet. This raises questions about ensuring this energy supply without serious consequences.

Certainly, ecological footprint is only one way to measure sustainability. Other measures may show different levels of ecological (un)sustainability. However, it is generally acknowledged that current means of energy production and supply have huge impacts on the environment, and are likely to be unsustainable.

This has several implications. First of all, it indicates that sustainability of energy supplies to meet these needs will be an important consideration or constraint in energy planning.

Second, given the high likelihood of current energy supply systems being unsustainable, it is imperative that we prioritise energy use for basic needs. The principle here is that if anything at all can justify unsustainable means of energy supply, it is that this energy is needed for basic needs of the people.

Third, it appears that current global energy supply is probably enough to meet the energy needs of everyone on this planet if it is distributed equitably. For example, studies reviewed in this note indicate that an energy supply of 1200 to 1800 kgoe per capita per year would be needed to provide energy for a dignified living. The IEA Key World Energy Statistics 2013 shows per capita total primary energy supply in 2011 to be 1884 kgoe (IEA, 2013, p. 48). Thus, there is enough energy as needed by these studies; the problem is that it is highly unevenly distributed among and within countries. Of course, even the current energy production is likely to be unsustainable. However, what this indicates is that we could potentially meet the needs of more people for energy for dignified living without increasing the extent of unsustainability, if we are able to achieve a better and more equitable distribution of the existing energy supply. In other words, more equitable distribution of existing and future energy supply can be a powerful way to meet energy needs in a more sustainable (or less unsustainable) manner. Indeed, possibly it may be the only way to do so.

Lastly, we need to make all efforts to innovate and shift towards energy sources and production methods that are more sustainable, so that we are able to meet the needs of everyone on this planet in a manner that does not destroy the ecology and environment of the earth. However, in doing this, it would still be imperative for us to re-examine the entire gamut of our energy needs (globally), and to see if we can cut these down. For it is unlikely that the planet will be able to sustain the kind of energy needs exhibited by the high energy consuming societies. In this context, the earlier mentioned re-distribution of energy could imply that we may not be in a position (at a global level), to meet certain needs, and indeed, it would be a message that we—as global community—are choosing not to meet these needs.

3.3 Impact on GDP and economic growth

One important concern is what would be the impact on economic growth if we adopt this approach of directing energy towards specific uses, which are of the nature of 'basic needs'.

The first question is whether this will affect economic or GDP growth, as energy, which is a driver of economic growth, will be 'diverted' to meet basic needs. In this context, it is important to understand that the GDP is essentially a measure of the goods and services produced in a country. The fulfilment of basic needs or needs of dignified living is certainly going to involve economic activities that produce certain goods and services. Thus, it will generate GDP, though extent of its growth may change.

A related issue is whether the fundamental structure of the economy itself would get transformed. It is possible that the suite of activities constituting GDP may change. Since GDP and economic growth essentially measure production of goods and services needed by people and since basic needs are by definition the priority needs of people, any such change in the set of activities comprising the GDP should be seen as a welcome step. Further, so long as the basic needs are being met, any decline in the growth rate itself may not be of such concern.

Undoubtedly, meeting basic needs is an important goal by itself as it is a right of the people. Ethics and justice demand that this need be prioritised.

However, we believe that provision of basic needs will also be an important and more effective driver of economic growth albeit in the long term. Provision of basic needs have generally longer gestation periods and call for larger structural changes. This will take time but is a necessary investment in human capital. Provision of basic services will increase the capabilities of individuals and ensure a more solid foundation for the future growth of the economy. Whether it is the conventional nuts and bolt manufacturing based economy or the newer knowledge-based economy, for all of these, meeting the basic needs of people is a pre-requisite and even a multiplier.

Apart from provision of goods and services, economic activities also meet (or ought to meet) the important requirement of employment generation and creation of purchasing power in the hands of the people. There is little reason to believe that directing energy to meet basic needs would generate less employment than other economic activities. If well-structured and planned, they could generate more and more wide-spread employment as they involve producing and delivering goods and services to all the people. Further, with rising population and increasing inequality, needs of a major proportion of Indians who are currently starved of necessities will increase. Providing for these needs can increase production and effective demand, thus driving the economy.

Moreover, there would be economic activities apart from those associated with the goods and services comprising basic needs; however, the energy for basic needs would be the priority, and energy needs above this could, if necessary, be subjected to more stringent conditions.

Energy investments in India come at the cost of our diminishing ecological and natural resources. In a sense, these endowments which are not even valued properly should be put to their best possible use, that is, which generate the most sustainable long term impact on our well-being. Meeting basic needs undoubtedly is the most important use of the natural resources. Also the question is not just to generate growth spurts but to ensure a sustained increase in GDP. This can only happen if meeting the wants of today's Indians does not compromise meeting the needs of future Indians. Thus, with long term growth in mind, it is prudent to invest to meet basic energy needs of today's population.

Hence, the question of the impact of such an approach to energy planning on GDP growth should not be worrisome because as long as human well-being is achieved and goods and services needed by people are being met, growth, and its rate itself, becomes largely irrelevant.

4 Conclusion

To conclude, we can say that bottom-up, disaggregated approaches to energy planning can help us answer the question of how much energy do we need for ensuring dignified living. By making these as disaggregated as we want, and as detailed as needed, we can make these estimates more accurate. The process by its very nature also indicates where and to which end-use and end-user the energy has to go—something that is as important to understand as the quantum of energy required. Along with this, the process can also offer insights into the best way to meet a particular developmental goal from the energy perspective, the relative criticality of energy as an input to meet the specific goal, and the policies and cross-sectoral linkages that are important to ensure that energy used does indeed help meet the objectives. Further, such bottom-up approaches can also help us to assess energy projections and plans in terms of their effectiveness in meeting developmental goals. Last but not the least, such an approach makes the monitoring of the implementation far more structured and relevant to the developmental goals, and makes the energy planning process far more accountable.

Such an approach not only ensures that economic activity meets the highest priority needs of the people, and thus is the most ethical choice, but is also likely to make growth more inclusive by creating more employment. It also lays a more solid foundation for future growth by investing in human capital.

It is recommended that such an approach be made the basis of energy planning in the country.

■

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Annexure 1: Sectoral distribution of energy (electricity and fuel) requirement for 1 kW per capita energy as per Amulya Reddy and team

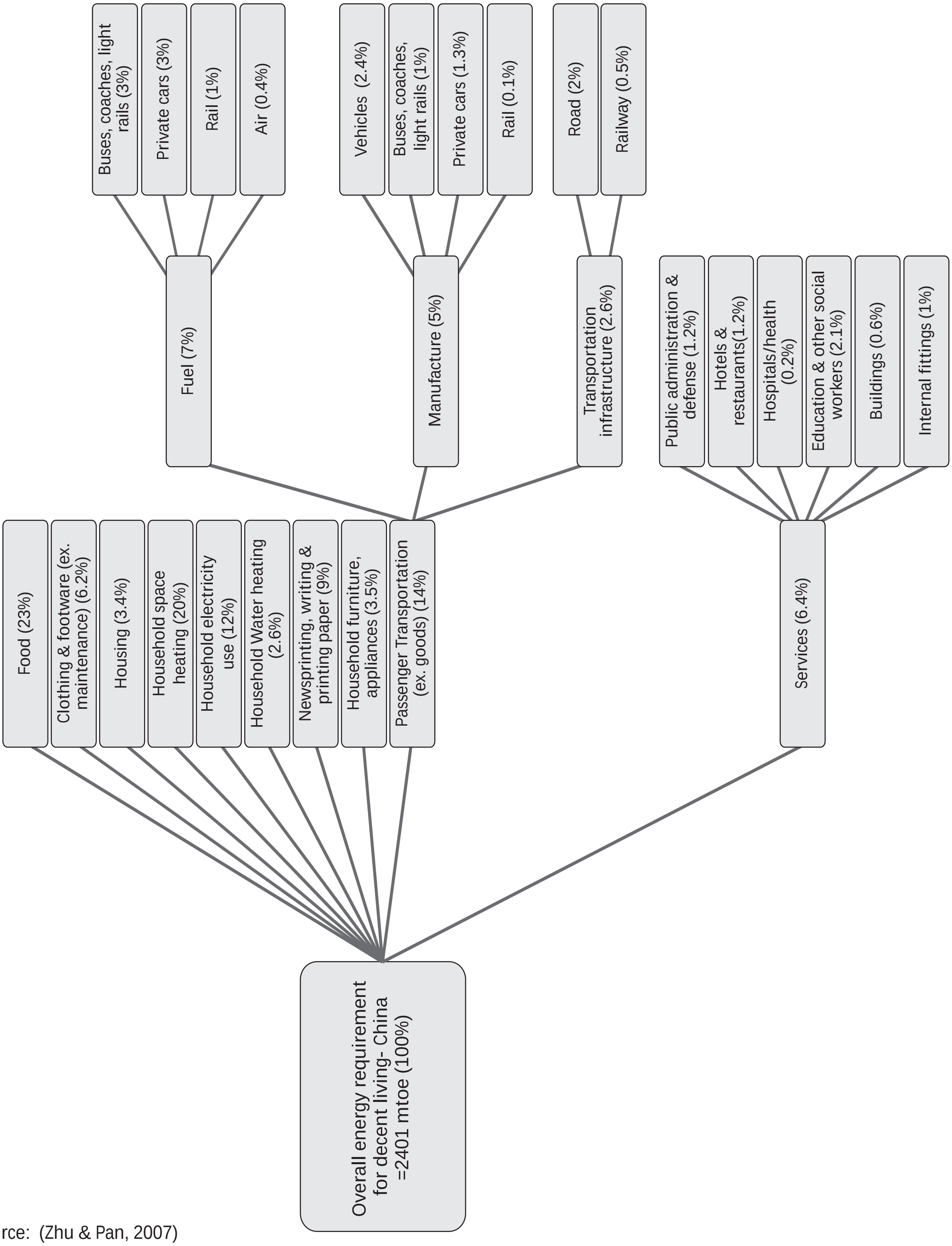
(Goldemberg, Johnsson, Reddy, & Williams, 1985) estimated the final energy use for a developing country in a warm climate, with a standard of living (except for space conditioning) comparable to that in WE-JANZ region in the 1970s. They estimated the energy needed for five categories of activities in terms of electricity and fuel using per capita activity levels equivalent to WE-JANZ, and the energy intensities of these activities if they used the best or most advanced energy utilization technologies available in the 1980s. Table given below summarises the per capita fuel and electricity needed for the five categories of activities.

Sr. No.	Activity	Energy use (W/capita)			% of total energy requirement		
		Electricity	Fuel	Total	Electricity	Fuel	Total
A	Residential						
1	Cooking		34	34	0.0%	3.2%	3.2%
2	Hot water	29		29	2.8%	0.0%	2.8%
3	Refrigeration	13.5		13.5	1.3%	0.0%	1.3%
4	Lights	3.8		3.8	0.4%	0.0%	0.4%
5	TV	3.1		3.1	0.3%	0.0%	0.3%
6	Clothes washer	2.1		2.1	0.2%	0.0%	0.2%
	Subtotal	51.5	34	85.5	4.9%	3.2%	8.2%
B	Commercial	22	0	22	2.1%	0.0%	2.1%
C	Transportation						
1	Automobiles		107	107	0.0%	10.2%	10.2%
2	Intercity bus		26	26	0.0%	2.5%	2.5%
3	Passenger train	4.5	32	36.5	0.4%	3.1%	3.5%
4	Urban mass transit	2	8	10	0.2%	0.8%	1.0%
5	Air travel		21	21	0.0%	2.0%	2.0%
6	Truck freight		32	32	0.0%	3.1%	3.1%
7	Rail freight	5		5	0.5%	0.0%	0.5%
8	Water freight		50	50	0.0%	4.8%	4.8%
	Subtotal	11.5	276	287.5	1.1%	26.3%	27.4%
D	Manufacturing						
1	Raw steel	28	77	105	2.7%	7.3%	10.0%
2	Cement	6	54	60	0.6%	5.1%	5.7%
3	Primary aluminum	11	26	37	1.0%	2.5%	3.5%
4	Paper & paperboard	11	24	35	1.0%	2.3%	3.3%
5	Nitrogenous fertilizer		36	36	0.0%	3.4%	3.4%
6	Other (residual)	65	212	277	6.2%	20.2%	26.4%
	Subtotal	121	429	550	11.5%	40.9%	52.4%
E	Agriculture	4	41	45	0.4%	3.9%	4.3%
F	Mining, Construction	0	59	59	0.0%	5.6%	5.6%
	Grand Total	210	839	1049	20.0%	80.0%	100.0%

Source: (Goldemberg, Johnsson, Reddy, & Williams, 1985)

Annexure 2: End-use wise distribution of total primary commercial energy requirement for basic needs of China as per Zhu and Pan, 2007

China's total primary commercial energy requirement for basic needs is estimated for following sectors shown in the figure. The activity levels and corresponding energy intensity levels are given in the paper.



Source: (Zhu & Pan, 2007)

Abbreviations

AGECC	Advisory Group on Energy and Climate Change
BIG	Baseline, Inclusive Growth
CEA	Central Electricity Authority
EF	Ecological Footprint
EPS	Electric Power Survey
ESA	European Space Agency
GDP	Gross Domestic Product
GFN	Global Footprint Network
gha	Global Hectare
GJ	Giga Joules
GoI	Government of India
GW	Gigawatt
HDI	Human Development Index
HDR	Human Development Report
HT	High Tension
IEA	International Energy Agency
IEP	Integrated Energy Policy
kgoe	kilo gram oil equivalent
kWh	kilo watt hour
LCIG	Low Carbon, Inclusive Growth
LT	Low Tension
Mtoe	Million ton oil equivalent
MW	Megawatt
OECD	Organization for Economic Co-operation and Development
PEUM	Partial end-use Method
PPEO	Poor People's Energy Outlook
T&D	Transmission and Distribution
TEA	Total Energy Access
TEDDY	TERI Energy Data Directory and Yearbook
TPCES	Total Primary Commercial Energy Supply
UN	United Nations
UNDP	United Nations Development Program
WE-JANZ	Western Europe, Japan, Australia, New Zealand, and South Africa
WWF	World Wildlife Fund
ZSL	Zoological Society of London

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1. An Assessment of Energy Data Management in India (2014)
   http://www.prayaspune.org/peg/publications/item/280.html

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How much energy we need for ensuring a decent standard of living for everyone is one of the basic questions at the heart of energy planning, yet it is one that is rarely addressed in any particularly meaningful manner. Many projections estimate energy demands based on energy requirement for GDP growth. Yet, GDP growth does not necessarily result in provision of basic needs of everyone. Some energy demand projections have therefore tried to estimate energy needed for specific developmental goals, or for indices that work as proxies for such developmental objectives. A set of such developmental goals can form the normative framework that defines a decent standard of living.

This paper reviews various methods of energy demand estimations, looking particularly at some bottom up, disaggregated approaches, and discusses their implications. Apart from providing better estimates of the quantity of energy needed, the power of such approaches lies in making a direct link between energy and its end-use and end-user, thus promoting equity, and providing a framework of better monitoring of how energy is used. The paper explores these aspects and also discusses implications of energy demand estimates for sustainability.

प्रयास

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