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SHIFTING OF GOAL POSTS

Rural Electrification in India: A Progress Report

An analysis of ground realities of electrification with recipes for accelerated progress

Srinivas Krishnaswamy
March, 2010

Shifting of Goal Posts
Rural Electrification in India: A Progress Report

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Contact: Srinivas Krishnaswamy at sreenk@yahoo.com

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Address for communication:
'Vasudha Foundation'
Registered Office:
No.12, 9th Main, Banashankari - II stage
Bangalore - 560070, Karnataka, India

Delhi Resource Centre:
C/o CISRS House
14, Jungpura (B), Mathura Road
New Delhi - 110014, India

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FOREWORD

I have read the document prepared by *Vasudha Foundation* on Rural Electrification under the title “Shifting the Goal Posts.”

The report is factual and brings out the existing power scenario in India in a lucid manner. The fact that Rural Electrification has fallen far behind the achievements in power generation has been brought out clearly. There are wide variations in the achievements of the States as far as Rural Electrification goes. These claims are further clouded by the understanding of what exactly constitutes Rural Electrification. Definitions have changed repeatedly over the years and success stories have to be viewed in the context of definitions and meaning that is assumed by those who claim success.

The basic requirement of life-line access to power that is defined as *“ONE UNIT PER FAMILY PER DAY”* has, unfortunately been lost sight of. There are any number(s) of villages within a few kilometers of a massive thermal power plant not having a power connection. None can give the excuse of those villages being remote or no power source being available in the vicinity. Ultimately, the reasons are entirely commercial. But other reasons are handed out in a routine manner, since there is a basic disconnect between the policy makers and the officials in the field.

The scene is even more complicated when it comes to providing power through renewable sources of energy. Given the cost and intermittency factors, no meaningful system based only on renewable resources has been done anywhere in the country. Provision of lighting for a few hours a day has been presented as “Electrification through renewable sources”. It is very unfortunate that „a solution‟ to the problem of power supply to rural areas has not been attempted in a truthful manner over the years. Considering that there has been no objective study of the subsidies in the energy sector, the argument that, renewable power solutions need massive subsidies is misplaced.

It is in this context that one hopes that a few genuine NGOs like *Vasudha Foundation* take up and implement projects in villages with sincerity and commitment so that they can establish the feasibility of such solutions. Such projects need to serve as exemplary models to others, both in the Government and outside.

Shri. V. Subramanian, IAS (Retd.)
Secretary General, InWEA
Indian Wind Energy Association

About Shri. V. Subramanian: *He retired from the Indian Administrative Service from the post of Secretary to the Government in the Ministry of New and Renewable Energy (MNRE). He has a rich and varied experience in Finance, Aviation, Tourism, Power and Labour.*

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Executive Summary

The Indian Government's continuous shifting of goal posts with regard to rural electrification targets seems to have become a regular feature. Not only did the Government fail to achieve its 2009 target of 100% electrification of all of India's villages, with over 46% of the total households in India not having access to modern electricity.

Out of a total of 27 states in India, only 7 states can boast of 100% village electrification, with some states having more than 40% un-electrified villages. Till date, no Indian state can boast of 100% household electrification with only 3 states having less than 25% of its total households un-electrified.

India perhaps is the only country with a dubious record of announcing the first fully electrified district (with rural pocket), a good 63 years after its independence, as recent as in February 2010 and this district is Palakkad in Kerala.

Therefore, looking at the current pace of progress of rural electrification, the 2012 target to make India a "100% electrified country" seems rather uncertain.

India continues to face huge energy deficits. Frequent power outages and disruptions in electricity supply have become a norm too. The overall deficit of power is close to 86,000 Million kWh, with daily peak hours demand shortage being 13,000 Million kWh, resulting in power outages ranging from 2-20 hours on a daily basis. The rural population is invariably the worst affected, as more often than not in case of any demand and supply-based energy deficit, the priority is always given to meet the energy requirements of urban areas, with power cuts in rural areas ranging from 14-16 hours a day, on almost all days of the year.

An analysis of data collected from select villages in four states of India on the quantity and quality of electricity supply in rural India reveals that the average supply in the surveyed villages ranged from 2-6 hours with hours of supply usually being during the night times, which means very little use of the electricity for the rural population.

India also has the dubious record of being in the top slot of countries with regard to Transmission and Distribution (T & D) losses, which are 5-6 times more than the global average. The high T & D losses are due to a combination of theft, aging and poor transmission and distribution infrastructure, lack of proper metering and lack of a proper system for bill collection, particularly in some rural pockets. A very conservative average of T & D losses in the country puts it at a 30%, which is sufficient to wipe out the current electricity deficit.

The economic gap between the rich and poor in India has always been very high and so is the development gap between th e urban and rural centres and in some sectors such as the energy and electricity sector, the development gap between urban and rural areas is particularly large. The supply of energy needs for urban areas as against rural areas is at an average ratio of 70:30, cutting across all energy needs from heating to lighting to water supply.

Over the past 60 odd years, many a governments have accorded priority status to rural electrification with several policy initiatives undertaken and a number of programmes with ambitious targets announced. The Electricity Act 2003 also gave legal status to rural electrification and also necessitated the formulation of a "Rural Electrification Policy". The Government also attempted to change the definition of rural electrification with the intention of ensuring the maximum possible rural household and common area electrification in villages, which however, continues to be ambiguous enough, giving room for many a slip ups.

One of the major flaws in the definition of electricity, particularly in the rural context is that, it seems to be centered around delivery of electric lighting. However, what is required is the delivery of a range of energy services, ranging from milling, pumping of water for irrigation, electricity of allied agriculture enterprises, pumping of water for piped drinking water and sanitation and so on. In the current context and definition, only the needs for lighting would be met, even, if the government achieves a 100% rural electrification followed by a 100% household electrification, leaving all the other energy requirements unmet.

The budgetary allocation for rural electrification and for providing energy access to rural areas has seen a substantial increase every year with a near 8-10% increase every year in the last decade. Huge subsidies were also earmarked for the sole purpose of providing energy access to the rural population at an affordable price, ranging from subsidized kerosene, cook stoves, electricity tariffs and electricity connections.

However, almost every policy design, subsidies and budgetary allocations intended to benefit the poor, ends up benefiting primarily the well-off sections of the society resulting in continuous state of poor rural energy infrastructure. The electricity tariff for rural connection is one such classic case, which on paper, is highly subsidized with a flat monthly tariff ranging from Rs. 100/- to Rs. 150/- per month irrespective of consumption, however, given the poor quantity and quality of supply and the quantum of electricity consumption in rural areas, even this subsidized tariff paid by the rural consumer is almost on par with what a Urban domestic consumer is paying.

The case is the same even with regard to the supply of other energy fuels such as liquefied petroleum gas, kerosene etc, with the urban rich being the major beneficiaries of these subsidies with very little trickling down to the rural population.

One of the major reasons for this is the dogged continuation of tried and tested energy policies and systems despite its poor results by subsequent governments, both at the central level as well as the state level.

The policy of providing "Grid Centralised Fossil Fuel Electricity" continues to be the norm. The Government's argument in favour of central grid seems to be only a justification to continue with the old policies. In reality, this policy of the government has very little argument or rationale in its favour for the purpose of rural electrification. Some of the arguments of the government to persist with central grid centres revolve around the issue of "Equity", with the main line of argument being that there needs to be no differentiation between urban and rural consumers and therefore the mode of supply to the urban consumer needs to be made available to rural consumers as well. The government machinery also seems to believe that in the long run, the supply of electricity pattern in rural areas would be the same as it is in urban areas.

Further, subsequent Governments have also believed that centralized supply and generation of electricity from fossil fuel, primarily coal, is a proven technology and ensures energy security, also since India has fairly large coal deposits and reserves.

However, our analysis in the report and going by India's achievement in the electricity sector, clearly demonstrates that the current policy followed by the government on the contrary results in a inequitable supply of energy and electricity needs, primarily because of the growing needs and consumption pattern. Increased consumerism in urban centres moreover leads to prioritization of electricity supply in urban areas, with the rural areas getting the residue if any.

Further, our dependence on coal and fossil fuel will only trigger off energy insecurity, since our coal reserves are not enough to meet the huge energy needs of India. Also, given the poor quality of coal, India has to depend on imports for quality generation, even if it wants to pursue coal based electricity generation.

India is currently the fourth largest carbon emitter in the world with a total emission of around 1900 MT CO_2e[*] (Carbon Dioxide emissions), with the energy sector contributing to 67% of these emissions, amounting to 1260 MT CO_2e.[*] The emissions from the energy sector are expected to touch the 1700 MT CO_2e mark by 2012 and may even cross the 2000 MT CO_2e,[**] if it were to continue to persist with the current energy policies.

With the world already on the brink of dangerous impacts of climate change and India being one of the countries which is amongst the most vulnerable in terms of impacts of climate change, it is imperative that countries adopt and pursue energy policies which reduce their dependence on fossil fuel and provide green and clean energy as far as possible.

Therefore in the backdrop of climate change and given the fact that the current energy policies of the government have failed to achieve the desired results, this report provides a recipe for India to pursue a policy of decentralized energy solutions, particularly to address the huge energy supply gap in rural areas and to solve and readdress all the ills of centralized grid connectivity such as, inequitable supply between rural and urban areas, huge T & D losses and large scale environmental damage caused due to excessive use of fossil fuels.

[*] WRI, Climate Analysis Indicator tool, 2005

[**] Emission calculation based on projected growth of energy generation from coal fired power plants as in Integrated Energy Policy 2008, Government of India, Planning Commission

This report makes a strong case for decentralized energy systems by analyzing the progress or lack of it in rural electrification in India, in the light of hitherto practiced approach and tries to dispel some of the myths associated with decentralized renewable energy solutions.

The general perception in the policy circles in India is that the technology for renewable energy decentralized solutions is not as yet mature and price is the major barrier. However, this report on analyzing the budgetary provisions and costs incurred so far for rural electrification reveals that, while the relative high costs of renewable energy is definitely an issue, even a small shift of diverting a portion of the current subsidies and budgetary provision from fossil fuel based grid systems to decentralized renewable energy systems has the potential to bring about a cost parity in the short run, and in the medium and long run, renewable energy can compete with coal and other fossil fuels. As far as the maturity of technology is concerned, the report analyzes a number of successful as well as failed decentralized energy projects and has identified the main issues of concern, which is primarily the implementation model or the management model and not the technology *per se*.

The primary requirement for the success of decentralised energy systems is the involvement of the community in their design and management. This report analyses a number of management models being practiced in India and highlights their merits and drawbacks. Further, the report and analysis goes on to arrive and enumerate the certain minimum criteria required in a management model that could ensure a sustainable delivery of electricity and energy needs of the community, accompanied with the flexibility to incorporate the required additions and changes as per the changing energy and electricity needs of the people.

While India needs to reprioritize and shift considerable resources into an alternative pro-poor sustainable development and low-carbon intensive energy generation it must be acknowledged that the incremental costs for this approach necessarily have to be covered by technological and financial support from developed countries. This should happen as part of a multilateral approach to dealing with the global threat of climate change that does not undermine the right to development of developing countries, like India and takes into consideration the principles and realities of common but differentiated historical responsibilities and respective capabilities.

The so-called price barrier and the initial high subsidy support required for renewable energy solutions can also be partly met by way of financial support from developed countries as part of India's efforts to combat climate change. Therefore, what India now solely requires is "political will" and the change of mind set from the current energy policies to a paradigm shift in energy policies to ensure a long term sustainable, equitable, inclusive and energy secure solutions cutting across all sections of India.

Srinivas Krishnaswamy
Vasudha Foundation
March, 2010

Introduction

Indian Economy and Infrastructure: A Broad Overview

Growing at the rate of 9.6% in 2006 and 9.2% in 2007, India's economy has been one of the stars of global economics in recent years[1]. This growth had been supported by market reforms, huge inflows of Foreign Direct Investment, rising foreign exchange reserves, an IT and a real estate boom, and a flourishing capital market.

Despite the global slowdown, the Indian economy is estimated to have grown at close to 6.7% in 2008-09. The Confederation of Indian Industry (CII) pegged the GDP growth rate at 6.1% in 2009-10[2]. This scenario factors in sectoral growth rates of 2.8-3% (Agriculture), 5-5.5% (Industry) and 7.5-8% (Services), respectively.

However, India has had to compete harder than ever particularly, in the energy market place as India, unlike China, has been inept at securing new fossil fuel sources to meet its energy demands. Thus, the Indian Government is looking at alternatives, and has thus signed a wide-ranging nuclear treaty with the US, in part to gain access to "Nuclear Power Plant" (NPP) technology that can reduce its dependence on fossil fuel based energy sources.

The Government of India has set itself a highly ambitious target of electrifying all villages and habitations in the country by 2010. In addition to this, the Government plans to achieve 100% household electrification by 2012[3] . This plan also includes the government's intent of providing free electricity connection to all families living below poverty line.

The all the time more energy-intensive lifestyles being adopted by the India's growing middle and high-income population has also had a growing influence on the country's energy consumption patterns and has resulted in increasing the country's energy demands at a phenomenal rate.

Understandably, in view of the above factors, the key challenge facing India's energy sector is the huge "Demand and Supply" gap that exists with regard to electricity and energy requirements on the whole. The country already faces an enormous and substantive peak demand shortage of electricity almost all through the year. Power outages and disruptions are frequent throughout the country with the intensity of outages and power disruptions being the highest in rural and semi-urban areas.

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[1] 11th Five Year Plan Full Document: Planning Commission of India
[2] CII Growth Paper
[3] Brochure of Rajiv Gandhi *Grameen Vidhyutikaran Yojana*

The rural population is invariably the worst affected, as more often than not in case of any demand and supply-based energy deficit, the priority is always given to meet the energy requirements of urban areas.

Furthermore, with about 100,000[4] Indian villages and a further 50%[5] of India's households yet to be electrified, there is a lot of work that needs to be done-both in terms of policy framework as well as in undertaking implementation methods that will help cover this huge deficit.

Indian Economy and the issue of Climate Change

At this point in time, the Indian economy finds itself at the crossroads-being poised to achieve sustained GDP growth rate of 8% per annum and with hopes to enter the double digit figures at the earliest, while having to cope up with poor energy infrastructure and the challenge of reducing its carbon emissions growth in order to address the issue of climate change.

The general perceptions of the last couple of governance regimes has been that a good infrastructure particularly energy infrastructure would hasten the growth potentials and hence, the current energy policy aims at energy growth irrespective of the source of fuel. However, in the recent past, there has been a small change in the perspective with energy conservation and efficiency measures being given a priority, while renewable energy has an increasing role to play, though in overall terms it continues to be a very small player in the electricity generation mix.

As a step forward, the government adopted "The Integrated Energy Policy" in 2008. This policy document primarily draws a roadmap for India's energy sector from 2005 until 2031-32. It suggests a number of models which the government could adopt-ranging from a coal-dominated energy pathway to a pathway dominated by nuclear and renewable energy. However, as per this policy document, even in the nuclear and renewable energy-dominated pathway, coal would continue to be the major fuel source for meeting the country's energy and electricity requirements.

India is currently the fourth largest carbon emitter in the world with a total emission of around 1900 MT CO_2e (Carbon Dioxide emissions)[6], with the energy sector contributing to 67% of these emissions, amounting to 1260 MT CO_2e.[7] The emissions from the energy sector are expected to touch the 1700 MT CO_2e mark by 2012 and even the best-case scenario outlined in the integrated energy policy document will see India's energy emissions more than doubling by 2030.

However, under immense pressure to address climate change as a priority issue and take up strong carbon mitigation efforts, the Indian Government introduced a

[4] Ministry of Power: Report Card, 2009 and RGGVY website
[5] Ministry of Power: Report Card, 2009
[6] Source: World Resources Institute, CAIT tools, 2005
[7] Source: World Resources Institute, CAIT Tools, 2005

“National Action Plan on Climate Change” (NAPCC) in August 2008. NAPCC has a clear mandate to come up with detailed action plans in eight identified areas, key ones being energy efficiency, sustainable habitat, solar development and agriculture. While the detailed plans for some of these areas have been released with fairly ambitious targets and pathway, the Indian government does have the potential to do much more.

In light of this, the government has set up a high level committee to come up with a low carbon sustainable development pathway for India as recent as February 2010. This committee is expected to come up with broad recommendations in six months time, which is expected to form the basis of the country’s 12^{th} Five Year Plan (2012-2017).

With the Indian economy being at a crucial phase of development, climate change presents a golden opportunity for the economy to adopt an “inclusive” and a “sustainable” growth path, which also creates carbon space for the poor to grow.

India needs to re-look and reinvent its existing policies particularly those that relate to the poor, be it with regard to energy or any other issues. This is the time for India to do so and in the process also establish itself as world leaders in green technology.

Chapter 1: An overview of India's Energy Sector

Defining Electricity and Energy in India

The Indian Electricity Act of 2003 defines "electricity" as "electrical energy-generated, transmitted, supplied or traded for any purpose".[8]

However, in normal parlance, there is a tendency in India to mix the terms "energy" and "electricity". This is so because "electricity" is used to meet both heating and lighting requirements, while at the same time, normal fossil fuel or traditional bio-mass is also used to meet both lighting and heating requirements at the domestic end.

For instance, the popular fossil fuel – Kerosene is used for both cooking as well as lighting purposes in rural areas, with bulk of Kerosene being used for lighting purposes in areas which do not have access to electricity needs.

Similarly, bio-mass or traditional bio-mass is largely used for cooking and heating purposes, but in many remote areas of the country, biomass is used for lighting purposes as well, particularly in times of scarcity of Kerosene supply.

As per the Electricity Act[8], an "electrified household" is defined as "any household which has an electric wire going in from the main electricity line is deemed as electrified", not withstanding whether there is actual supply of electricity through that wire or not.

The state of Electricity Infrastructure

[8] The Indian Electricity Act of 2003

Institutional Framework

The Indian energy sector is dominated by two major factors:

1. Its dependence (over-dependence) on fossil fuels, and
2. The predominance of the Public Sector in almost all aspects pertaining to energy and electricity sector (such as mining rights; the generation, transmission and distribution of electricity etc.).

In terms of institutional framework of Energy sector within the country, there are a lot of confusing and often complicating overlaps as well. For instance, while the Ministry of Oil and Gas controls the production, supply and pricing of Oil including Kerosene, the distribution of Kerosene in both rural and urban areas is controlled by the Ministry of Food and Public Distribution. Whereas, the promotion of efficient use of traditional bio-mass is the main function of the Ministry of New and Renewable Energy (MNRE) through the promotion of energy efficient and comparatively low smoke emitting cook stoves.

To be precise, the Energy Sector in India is governed by four main ministries at the Central Government level, namely:

1. The Ministry of Power, which is in charge of electricity.
2. The Ministry of Oil and Gas, which controls pricing of oil and gas, licensing and their imports.
3. The Ministry of Coal, which controls pricing of coal, its imports and is also in charge mining of coal, and;
4. The fourth ministry has so far been a very small player in the scene, the Ministry of New and Renewable Energy (MNRE).

In addition to these Ministries, there is also the Department of Atomic Energy (DAE) which is in charge of all Nuclear Power Plants in the country. DAE works and reports directly to the Prime Minister of India.

All these ministries are guided in policy making by the "Power & Energy Policy and Rural Energy Division" of the Planning Commission of India.

Many of the large companies in the energy sector-be it those involved in exploration of Oil and Gas reserves, Oil and Gas refineries, Coal Mining and Coal Imports, or Electricity generation, distribution and/or transmission etc. are largely government owned. Though in recent times, some of these sectors have opened themselves to private participation and there are a few companies which have come in. However, areas like that of Nuclear Energy & Power generation are still under complete monopoly and control of the state.

Electricity is a "concurrent" subject under the Indian constitution. This means that both the Centre as well as the States have legislative powers to enact laws on any matter related to the electricity and energy sector as a whole.

As far as overall decision-making powers in the Energy sector are concerned, it rests as with various ministries (as pointed out earlier in this chapter). All these ministries coordinate energy-based issues as per their specific subject areas and are guided by their own legal framework, in terms of acts and policies on the issue.

However, Electricity sector is under the purview of the Ministry of Power at the Centre and under the "Energy Ministry or Power Ministry" (goes by either of these names) at the state level. The Electricity sector is governed largely by the Indian Electricity Act of 2003.

Prior to the enactment of this act, the sector was governed by a number of laws and amendments at varying points of time, each of them superseding the earlier existing law. In the early 1990s, the process of reform in this sector got started with the unbundling of the State Electricity Boards. This was done with the purpose of forming separate companies for various operations such as Generation, Transmission and Distribution and it also sought to privatize the Distribution Companies.

In the late 1990s, further reforms in the electricity sector were undertaken with the introduction of a "Central Electricity Regulatory Authority". States were also mandated to have their respective "State Electricity Regulatory Authority", designed to be an independent regulatory body to monitor and regulate the electricity sector with "tariff setting" being one of its main duties. The reason to have the state regulatory body independent of the government was to ensure that there was no government interference in the functioning of the regulatory authority.

Despite all these efforts, it was the enactment of the new Indian Electricity Act in year 2003 that brought in some amount of qualitative transformation of the electricity sector. This act tried to introduce what was hitherto unknown in the sector till then which was an influx of capital from the private sector with private sector participation. More importantly, this was done with the goal to bring in competition in the distribution sector, in order to ensure that market mechanism will help in assuring quality and quantity in the electricity distribution of the country.

The objectives of the Electricity Act further included subjects like rationalization of electricity tariffs, ensuring transparent policies regarding subsidies and promotion of efficient policies.

Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India had also enacted the Indian Energy Conservation Act of 2001, which is another salient legal framework governing the electricity sector along with the Electricity Act of 2003.

The Energy Conservation Act of 2001 provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drives and initiatives in the country.

The Current State of Play of Energy and Electricity in India

Generation: India is heavily dependent of fossil fuels to meet its energy requirements with fossil fuels supplying 80% of its primary energy needs and the balance being met through a combination of Hydro, Nuclear and renewable energy sources. In addition, traditional bio-mass or burning of wood and cow-dung remain the main source of energy supply in the rural areas.

64% of India's electricity comes from a combination coal, oil and gas (with coal being the dominant fuel contributing 55% share). India also has many large hydro power installations that supply close to 36% of its electricity requirements.

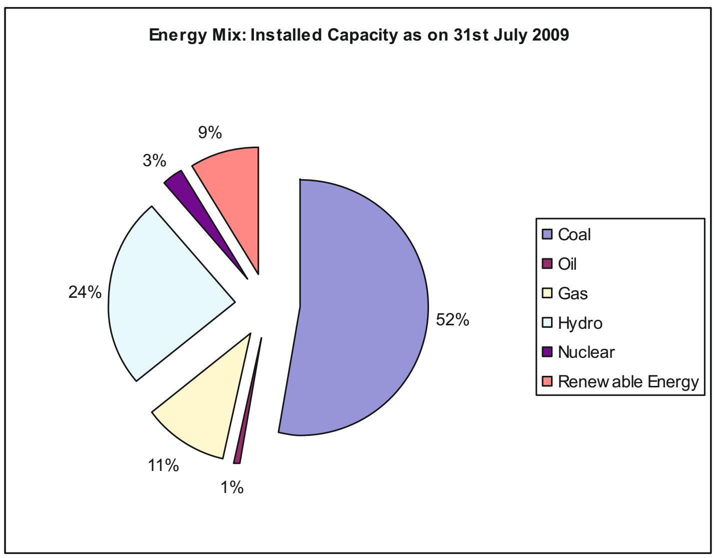

Figure 1 - Electricity Mix: Installed capacity as on 31st July 2009 (Source: Central Electricity Authority)

As is evident from Figure 1, renewable energy currently plays a very minor role in meeting India's energy supply.

India also has to depend on imports to meet much of its fuel requirements, with India being only self sufficient in terms of coal. However, considering that the coal in India is of very poor quality (i.e. with high ash content, low sulphur content and very low calorific value), much of India's coal requirements are also being met by way of imports.

India faces formidable challenges in meeting its energy needs and in providing adequate energy of desired quality in various forms and that too both in a sustainable manner and at competitive prices.

To deliver a sustained growth rate of 8% through 2031-32 and to meet the 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 (as per Government of India estimates). The Government projects the need to increase the installed capacity to 800,000 MW[9] by 2031-32 to meet the country's electricity demands by that year.

However, it must be pointed out here that the rationale behind these projections is based on an increase in *per capita* consumption of electricity from the current level of 481 kWh[10] to at least 1000 kWh by 2020 and is linked to a 8% GDP growth. Very clearly, the government electricity demand projection is closely connected to GDP growth and is not looking at a sustainable electricity growth pattern.

As on July 2009, the total installed capacity of all electricity generation in India was 151GW or 151073 MW, of which coal was the dominant fuel source with an installed capacity of 79 GW followed by large hydro of 37GW with Renewable Energy sources as a whole contributing to 13 GW.[11]

In terms of actual generation in the financial year ending 2009, the electricity generated was 691.038 Million kWh, while the estimated demand during that period was 777,039 Million kWh[12], taking into account only the existing electricity connections.[11]

Demand: As far as the domestic and rural sectors are concerned, the demand for energy in India is primarily for cooking, lighting, pumping of water for irrigation and transportation and with regard to other sectors, the demand is primarily to meet the requirements of industries and the transportation needs.

The Indian electricity sector is currently besotted with a number of problems, issues and concerns, such as, poor efficiency, lack of demand side and peak hour power demand management measures, unrealistic pricing systems etc. and yet "very high" *per capita* consumption by "few".

India has always been an energy-deficient country, with shortages ranging from 3-6% annually. As of end 2009, India faced a shortage of 86,000 Million kWh[12] in terms of overall electricity requirements, while the daily peak hours demand shortage was 13,000 Million kWh[13]. This results in fairly large scale power cuts ranging daily from 2 – 4 hours in almost all the major cities, over 4-6 hours in towns and with villages bearing the brunt of the shortage with power cuts ranging from 8-14 hours a day on an average.

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[9] Source: Integrated Energy Policy 2008, Government of India, Planning Commission

[10] Planning Commission, 11th Plan approach paper

[11] Source: Ministry of Power

[12] Source: Central Electricity Authority

[13] Source: Central Electricity Authority

The power shortage is not uniform across India. The lack of uniformity can be attributed to a number of reasons, ranging from poor governance and ineffective implementation of demand side management practices to electricity load management. States which have effectively enforced minimum energy conservation and renewable energy norms such as, mandatory installation of solar water heaters, mandatory use of energy efficient pumping systems for water and so on, have a comparatively low daily peak demand shortages.

For instance, the Southern region had comparatively low energy shortages of 6-12%[14] as compared to 9-22% [15] in the Northern region. One reason for this is that all major cities in South India have fairly operational demand side management systems coupled with certain mandatory norms such as, solar water heaters for all commercial and large residential buildings in major cities.

However, the same logic does not necessarily apply to the Eastern region comprising of Bihar, Jharkhand, West Bengal and Orissa, which have relatively low shortage levels of 2-5% in the region with Bihar being the highest with 16.2%.[16] The main reason for low energy shortage in these states is largely due to low level of electrification and also because of the fact that these states have the largest number of un-electrified villages and un-electrified households and therefore, their demand is not very high.

The western region with the exception of Maharashtra also registered comparatively low shortage levels, but this is primarily attributed to the fact that most of the states in the Western region are small and tourism is their main industry, with very little large industries. Gujarat is one exception, but again, good governance, robust demand side management practices coupled with a large programme to replace energy inefficient water pumping systems with efficient ones has yielded results. The shortage in Maharashtra was high at 21.4%[17], while the average shortage in the rest of the region was 11-14%.

As of end 2009, the peak supply of electricity was 96,785 Million kWh while the demand was 109,809 Million kWh.

The growth in energy demand is in the region of 5 – 8% annually with the peak demand for energy growing at 2% annually, as can be seen from Figure 2.

"Frequent power outages and power disruptions are commonplace in urban India, with power supply in rural areas being the surprise element" – one does not know when it comes, when it goes, or whether it comes or not!

[14] Source: Central Electricity Authority
[15] Source: Central Electricity Authority
[16] Source: Central Electricity Authority
[17] Source: Central Electricity Authority

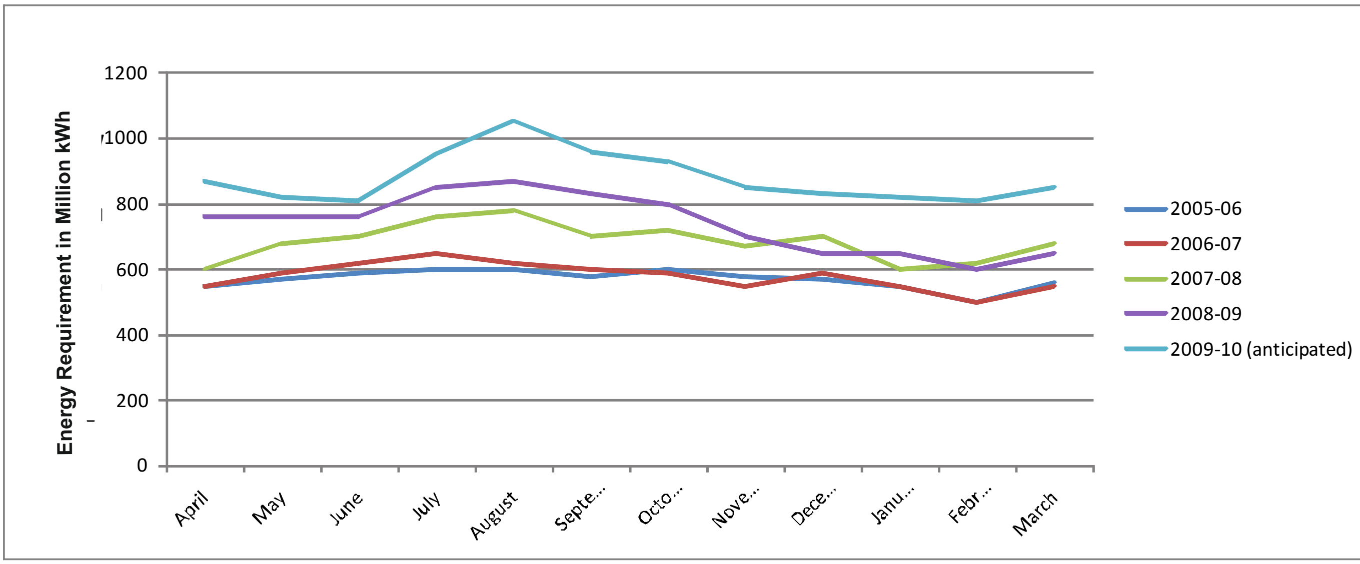
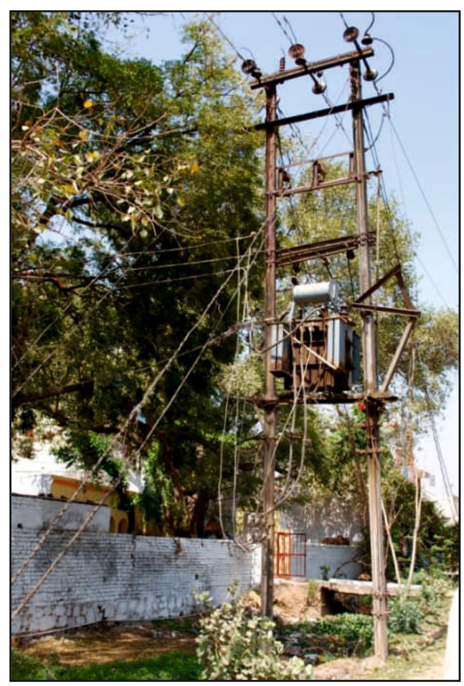


Figure 2 – Growth and monthly variations in Energy demands from 2005-2010 (Source: Ministry of Power)



Typical transformer (photo on Right) and Electric poles with wires going everywhere, some for genuine connectivity and some questionable.. (note the water bottles hung on wires in the photograph on the left by people/families opting for electric theft)

India ranks amongst countries with the highest Transmission and Distribution (T & D) losses, way ahead of even some of the African countries with its T & D losses pegged at 32.5%[18]. In sharp comparison, the T & D losses in developed countries such as Germany and the US are between 4-6%, while they are roughly around 7% in China.

[18] Ministry of Power, Presentation on T & D Loss

The T & D losses vary amongst different states and utilities. In some states and utilities T & D losses are as high as 67%. Majority of North East Indian states report huge T & D losses ranging from 50-67%.[19]

Some of the progressive states of India such as Andhra Pradesh, Tamil Nadu, Karnataka have reduced their T & D Losses to about 18-20%, but even these figures are nowhere close to the international standards of 4-8%.[20]

The high T & D losses are due to a combination of theft, poor and aging transmission and distribution infrastructure, lack of metering, huge volumes of faulty and non-functional meters, poor rural area billing and bill collection infrastructure and mechanism. Governance is the major issue and states which have an improved governance in the electricity sector have fared better in containing T & D losses as compared to states where governance continues to be poor.

India has the dubious record of being on the top slot of countries with regard to Transmission & Distribution losses, which are 5-6 times more than the global average.

The Planning Commission in its mid-term review (MTR) of the financial performance of 20 major states' electricity sector (done in early 2010 as part of the assessment of the electricity sector in the 10th Five Year Plan), has identified, outdated electricity distribution networks, inefficiencies in metering and billing and poor power procurement planning by the electricity distribution companies for the high T & D losses. This mid-term review estimated the total loss to the distribution companies (due to T & D losses) being at a high of Rs. 30,000 Crores or Rs. 3000 Billion every year.

The Electricity Regulatory Commissions of various states have imposed very steep norms on distribution utilities to reduce their losses, and in some cases, have even come up with penal fees for failing to reduce the losses. Further, the Union Government under its Accelerated Power Development Programme (APDP) has also come up with a 'reward and penalty' scheme to states to fast track the process of reducing T & D losses. APDP is primarily aimed at providing central government grants to accelerate reforms in the transmission and distribution in the states. Despite this, the losses have not been contained and remain a major issue that needs to be tackled on war footing.

Electricity Generation: Supply Vs Demand
- The Growth Story over the last 60 Years

Supply: Energy has been universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption.

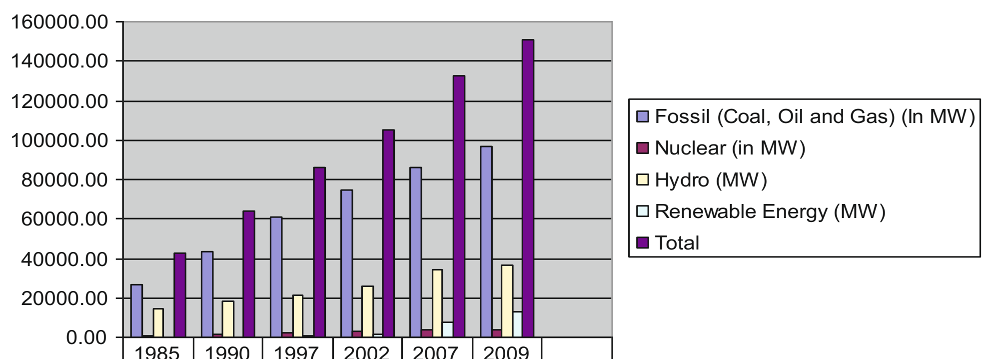
To trace the rate of growth of the electricity sector since 1985, the installed capacity at the end of 1985 or the 6th Five Year Plan period was 42,585 MW. The period between 1985-1990 and 1990-97 saw a spurt in the growth in the generation sector, with 48% and 39% growth respectively.[21]

[19] Ministry of Power, Presentation on T & D Loss
[20] Ministry of Power, Presentation on T & D Loss
[21] 5 year plan documents of the Planning Commission

However, there was a slowdown in the growth between the period 1997-2002 and 2002-07, with the growth rates being just 26% and 25% respectively. The primary reasons for this were that some large projects did not perform or take off during the period 1997-2002. The period 2002-07 saw a greater focus being given to distribution reforms rather than on generation projects. The premise for the same being that the distribution sector needed to be revamped and it made sense to add generation capacities only after the reform processes had achieved some of their desired objectives, such as reduction in T & D losses.

Therefore, in 2002-2007, a series of reforms were introduced ranging from the formation of an electricity regulatory authority to a number of electricity companies unbundling their operations and forming separate entities for generation, transmission and distribution.

The other highlight of this period was that during this time the government made conscious efforts to rope in the private sector in to generation projects with a complete review of the hitherto existing financial framework.



	1985	1990	1997	2002	2007	2009
Fossil (Coal, Oil and Gas) (In MW)	27029.70	43746	61010	74429	86015	96794
Nuclear (in MW)	1095	1565	2225	2720	3900	4120
Hydro (MW)	14460	18307	21658	26269	34653	36917
Renewable Energy (MW)	0	18.14	902	1628	7761	13242
Total	42584.	63635.	85795.	105045	132328	151073

Figure 3 - Sources of Electric Supply from 1985-2009 (Source: Planning Commission)

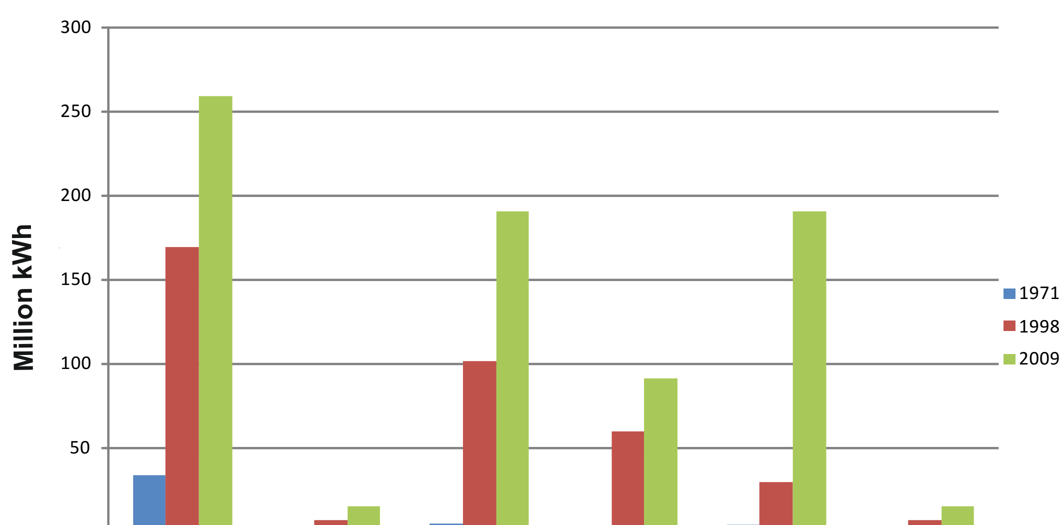
Demand: In keeping with the trend of its growth rate, India's energy consumption has also been increasing at one of the fastest rates in the world due to population growth and economic development. Therefore, the electricity sector has also grown significantly since India's independence and particularly since the 1980s.

From the time of India's independence in 1947, the demand for electricity has grown rapidly. Electricity consumption has increased by an average of 6-7% per annum since 1947, with the growth in the electricity generation sector being 3.8% per annum in the current decade at 3.8% per annum, while the average for the last 25 years has been roughly 1.5% per annum.

From a modest consumption of 51,000 Million KWh in 1971, the figure has increased to 9,62,000 Million kWh as of December, 2009 with the trend in energy consumption patterns seeing a number of changes over a period of time. The category of domestic and agriculture consumers has increased both in terms of actual number of consumers as well as in terms of energy consumption, while the consumption in industries has reduced substantially from as much as 67% of energy consumption in 1971 to 35% in 2008, while contributing to over 26% of the GDP.[22]

The fast growth in the residential and agriculture sector is primarily the result of economic development and the increase in the number of electrical appliances being used. It has been accompanied by a gradual shift from non commercial sources of energy (such as biomass) in the household and commercial sector. This has also been accompanied with the reduction in the use of coal for process heat in industry and the use of Kerosene for household lighting.

Figure 4 shows the trend of growth in electricity consumption in India since 1971.



	Industry (Million kWh)	Transport (Million kWh)	Agriculture (Million kWh)	Commercial and Public Services (million kWh)	Residential (million kWh)	Others(Million kWh)
1971	34.17	1.53	5.10	3.06	4.59	2.55
1998	169.20	7.52	101.52	60.16	30.08	7.52
2009	259.08	15.24	190.50	91.44	190.50	15.24

Figure 4 - Trend of growth in electricity consumption in India since 1971 (Source: Planning Commission)

India currently has a total of 144 Million electricity consumers with the final sales of electricity being 7,62,000 Million kWh at the end of the financial year 2008-09.[23]

[22] Plan Documents, Planning Commission, Government of India
[23] Ministry of Power

India's *per capita* electricity consumption is amongst the lowest in the world and currently constitutes less than one-fifth of the world average of 2,596 kWh. Only one-sixth of Indian households using electricity consume over 100 kWh per month, compared to the average US household consumption of over 900 kWh per month.

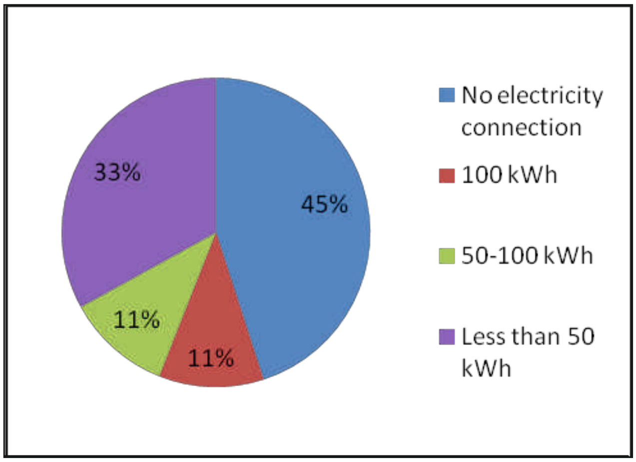


Figure 5 - Distribution of Household Monthly Electricity Consumption (2005)
(Source: Prayas Energy Group)

The residential sector comprises about 39% of the final energy consumption in India, and the commercial sector accounts for 19% of final commercial energy consumption.

Energy for cooking and heating in rural areas: Firewood and chips along with dung cake have remained the primary source of meeting energy needs for the rural population even as recent as June 2000 and the situation as of 2009 has not improved substantially.

Petroleum and other products: The total consumption of petroleum products grew at the rate of 5.7% per annum between 1980-81 and 2003-04. However, growth in petroleum consumption has moderated to 2.95% per annum over the last six years (2000-01 to 2006-07).[24]

Consumption of petrol and diesel grew at 7.3% and 5.8% per annum respectively between 1980-81 and 2006-07.[24] This is the outcome of the growth of personal motorized transport and the rise in share of road haulage.

Between 1970-71 and 2001-02[24(1)], the numbers of two-wheelers rose from 5,75,893 to 4,14,78,136; three-wheelers from 36,765 to 18,81,085; cars from 5,39,475 to 57,17,456; buses from 93,907 to 5,52,899 and trucks from 3,43,000 to 20,88,918.

The vehicle population continues to grow at higher than historical rates. However, in the last 5 years growth in consumption of petrol and diesel has been far more moderate at 6.9% and < 1%, respectively.

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[24] Ministry of Petroleum and Natural Gas

[24(1)] Prayas Energy Group Report titled "India Energy Trends"

Chapter 1 - Summary

- Indian economy has been growing at a fairly rapid pace, particularly in the last decade. However, the electricity sector has not kept pace with the rapid growth of the economy.
- In terms of institutional framework, while the Ministry of Power is the main ministry responsible for electricity, there are a number of other ministries involved in the overall energy sector as well.
- The Government links Energy growth to GDP growth. But there is a need to de-couple it from GDP growth, and energy growth projections should be made using a sustainable pattern of consumption. Energy Projections should factor in efficiency, energy conservation and demand side and peak hour power demand management measures.
- India continues to be a power deficit country with an overall deficit of close to 86,000 Million kWh and with daily peak hours demand shortages of 13,000 Million kWh.
- Power outages range from 2-20 hours on a daily basis, with rural areas getting the least supply with power cuts in there ranging from 14-16 hours on a daily basis.
- The country is yet to grapple with its huge T & D losses which are currently at a high of 32.5%. In comparison to international standards of 4-8% T & D losses or the losses in some of the developed and even developing countries,
- India's T & D losses are amongst the highest in the world.
- Poor governance in the electricity sector is one of the main reasons for T & D Losses to continue to be high.
- Coal continues to be the mainstay of India's electricity generation and the share of coal and other fossil fuel in the energy mix is about as high as 70%.
- There continues to be a big gap between urban and rural electricity and energy infrastructure with centralized grid supply being the main source of electricity supply to both urban and rural areas
- In addition to there being a huge gap in development between urban and rural areas, there is also a lack of uniform development of states, while some states have had a high level of development, some others have shown a very poor rate of growth and this has had its impact on energy and electricity sectors too.
- India's per-capita electricity consumption is less than one-fifth of the world average of 2,596 kWh. Only one-sixth of Indian households with electricity consume over 100 kWh per month, compared to the average US household consumption of over 900 kWh per month.
- Traditional bio-mass is still the main source of energy supply in rural areas with Kerosene also being used as the main source of lighting in rural areas, in addition to being used as a cooking fuel.

Chapter 2

All about Rural Electrification:

Progress Report thus far…

Rural Electrification: What it means and what it entails?

Prior to the enactment of the Indian Electricity Act of 2003, for the first time in October 1997, the Indian Government brought out a loose definition for "Rural Electrification" and according to it, "A Village should be classified as electrified if electricity is being used within its revenue area for any purpose whatsoever."

Given the loose nature of the definition, it was again re-defined to read as, "A village will be deemed to be electrified if the electricity is used in the inhabited locality, within the revenue boundary of the village for any purpose whatsoever."

The above two definitions were generally used in "Government records" and documents but did not have any legal contours to it.

The first real mention of the term "Rural Electrification" in a legislative and therefore a legal framework was when it found mention in the Indian Electricity Act of 2003, which means that no other act which had governed the sector up till 2003 had ever mentioned Rural Electrification.

Section 6 of the Electricity Act of 2003 for the first time mandates what is now commonly known as a "Universal Service Obligation" by stating that the Government shall endeavor to supply electricity to all areas including villages and hamlets.

Section 5 further mandates the formulation of a "national policy for rural electrification" focusing primarily on management of local distribution networks through local institutions.

Section 4 of the Act gives a further boost to stand-alone generation and exempts rural distribution networks from licensing requirements, thereby opening the doors for private investment and promotion of people-centered and managed electricity distribution and generation systems in rural areas.

The "National Rural Electrification Policy" (NREP) which was formulated thereafter also makes more than a mention of this.

With the formulation of the new policy, there was a change in the definition of an "Electrified Village" and this new definition which was introduced on February 17

2004, came into immediate effect. It states, that "a village would be declared as electrified, if[25]:

1. Basic infrastructure such as, Distribution Transformer and Distribution lines are provided in the inhabited locality as well as the *Dalit basti* hamlet where it exists.
2. Electricity is provided to public places like Schools, Panchayat Office, Health Centers, Dispensaries, Community centers etc.
3. The number of households electrified should be at least 10% of the total number of households in the village.

This definition, though an improvement of earlier known practice of terming a village electrified even if one common village area had an electric pole and a light, it still falls far short of what section 6 of the Electricity act of 2003 mandates, according to which a village can be termed electrified only if there is electricity supply to all hamlets as well.

In addition to the 10% household electricity connection criteria, neither the NREP nor the Electricity Act of 2003 have any other criteria such as minimum hours of electricity supply in a day, nor on a minimum number of days of supply in a year. It also does not also define what the minimum quantum of supply would be, whether it would be sufficient for just lighting purposes or be enough to run irrigation pump sets or any heavy duty machinery such as flour mills or enough to even run a dozen or so electric sewing machines under one roof. In most villages, the supply in electrical jargon is "single phase" which is just about enough to power 4-5 lights and 1-2 fans in each of the households and nothing more.

So in other words, "rural electrification" primarily refers to providing lighting needs, while everything else has to depend on "other sources of energy" such as Kerosene, wood chips and dung cakes for cooking, additional lighting & heating needs and diesel for irrigation pump sets.

Institutional Arrangements Governing Rural Electrification in India

The primary responsibility of implementing and delivering on Rural Electrification programme in India rests on the Ministry of Power at the Centre and the Ministry of Energy in the states.

The Ministry of Power is primarily responsible for all Grid-connected supply and is also the main governing body of the current rural electrification programme which is termed the "Rajiv Gandhi *Grameen Vidhyutikaran Yojana*" or "Rajiv Gandhi Rural Electrification Programme"(RGGVY).

MNRE also plays a minor role in the Rural Electrification implementation with the responsibility of powering and energizing identified remote villages which have been

[25] Ministry of Power Notification dated 17th February 2004

deemed unsuitable for grid power, either due to its terrain or its geographic location – remote areas.

MNRE is also responsible for promoting stand alone renewable energy products ranging from Solar Home Lighting Systems, Solar Cookers, Solar Lanterns, Bio-gas plants and bio-mass gassifiers. This is over and above the entrusted responsibility of powering remote villages under the RGGVY.

Therefore, for the implementation of the RGGVY, both the ministries are expected to work in tandem with mutual consultation and cooperation in identifying remote villages. In practice however, villages which the Ministry of Power has not been able to electrify for various reasons often fall into the plate of the MNRE, and many a times, end up being in "no man's land".

In addition to these two key ministries, the Ministry of Rural Development also has a hand in determining and requesting the fast tracking of rural electrification projects and often deals with the Ministry of Power in forwarding its requests.

The main agencies in addition to the ministries involved in rural electrification are the Rural Electrification Corporation, the financing arm for rural electrification projects, the Bureau of Energy Efficiency, which primarily comes in to ensure efficient water pumping systems, as it is one of their priority areas and the Indian Renewable Energy Development Agency (IREDA), which is the funding arm of the Government for renewable energy projects. The IREDA primarily funds solar water pumping systems for farmers, small bio-mass gassifiers and other stand alone renewable energy products which are used by the agrarian community such as dryers and so on.

Rural Electrification being the priority area for the last two governments, the Prime Minister's Office and the Planning Commission are also key players, though all day to day needs are dealt by the two main ministries, Ministry of Power and MNRE.

Overview of various Rural Electrification Programmes and Five Year Plans

Over the past sixty years, there have been a number of schemes and programmes with the exclusive purpose of accelerating village electrification. Some of the more important programmes have been the following:

- Minimum Needs Programme
- *Pradhan Mantri Gramodaya Yojana* (*which translates to* Prime Minister's Village Programme)
- The Accelerated Rural Electrification Programme
- The Accelerated Electrification of 100,000 Village and One Crore households
- *Kutir Jyoti* Scheme (*which translates to* Small household lighting scheme)
- Rajiv Gandhi Village Electrification Programme (RGGVY) – An ongoing scheme

Each of the Five Year Plans had programmes earmarked for village electrification. While some of these programmes were implemented in the names of the above mentioned schemes, others were implemented as routine plan implementation.

The rural electrification programme got a boost in the period of the 3rd Five Year Plan, with the establishment of the "Rural Electrification Corporation" in 1969, with the mandate to finance and promote rural electrification projects all over the country. It provides financial assistance to State Electricity Boards, State Government Departments and Rural Electric Cooperatives for rural electrification projects. It was only the 3rd Five Year plan which almost achieved its target as far as village electrification is concerned, with some of the five year plans not even reaching half of its slated targets of electrification.

The 1st Five Year Plan (1951-56): Support for irrigation Projects. Track record of rural electrification was 1 electrified village/ 200 villages.
The 2nd Five Year Plan (1956-61): "Rural Electrification" declared as "special interest area", and proposed to cover all towns with a population of 10,000 or more. Only 350 out of a total of 856 were eventually electrified.
The 3rd Five Year Plan (1961-66): ensured the establishment of the "Rural Electrification Corporation" and over 30,000 villages were electrified, as against a target of 37,000 villages.
The 4th and 5th Five Year Plan (1969-74 and 1974 -1979): focused on target areas such as energization of pumpt sets and also issued guidelines for village grind connectivity for all villages with a population of 5000 and above.
6th, 7th and 8th Five Year Plan (1980-89 and 1992-1997): saw a number of projects such as "improved *chulhas* or cook stoves", "Bio-gas plants" etc. and also saw the establishment of what is today called the Ministry of New and Renewable Energy or MNRE. This period also saw the launch of "accelerated rural electrification programme"
9th and 10th Five Year Plan and the current 11th Five Year Plan (1997-2012): Launch of *Kutir Jyoti Yojana* and the Rajiv Gandhi Rural Electrification programme

Rajiv Gandhi Village Electrification Programme

The rural electrification programme of the Government of India is currently under a comprehensive scheme called the "*Rajiv Gandhi Grameen Vidyutikaran Yojana*", which was launched in 2005. This programme has taken over the hitherto existing schemes such as the *"Kutir Jyoti Yojana"* and also adopted some salient features of the earlier electrification programmes and initiatives of the Government such as, the Minimum Needs Programme. The *Pradhan Mantri Gramodaya Yojana*, the Accelerated Rural Electrification Programme and the Accelerated Electrification of 100,000 Villages and One Crore households.

The current programme envisaged the creation of a rural electricity distribution backbone with at least one 33/11KV sub-stations of adequate capacity in geographical blocks where these do not exist, a village electrification infrastructure with distribution transformers of appropriate capacity in villages and other habitations and decentralised distribution generation systems based on conventional sources where grid electricity supply is not feasible or cost effective.

The rural electrification programme aims at providing grid or centralized electricity to as many villages as possible and looks at a decentralized or distributed generation approach only in areas where grid infrastructure may seem difficult due to either tough or hilly terrains or remote areas which are not serviceable through normal transmission lines.

The current programme envisages 100% village electrification by 2009 and 100% household electrification by 2012. This would mean that the programme should aim at electrifying at least 156,00,000 households per year for the next three years while electrifying close to a 100,000 villages by this year end. The track record so far has been that this programme has been able to electrify only 19000 villages in its 4 years of existence.

Source for all the above: Planning Commission's Five Year and Annual Plans and RGGVY brochure and website

Rural Electrification: A Report of achievements over the years

India has over 600,000 villages and hamlets put together, with over a 100 Million households in the rural areas alone.[26]

At the time of Indian independence, there were a total of 1500 villages which had electricity. From that position, we have traveled a fairly long distance and achieved electrification of over 493,000 villages by the end of July 2009.[27] However, what really matters is that, a good 63 years after independence we are yet to boast of a 100% electrification, both village as well as household electrification.

The rural electrification programme literally took off only in the mid 1950s, and saw a rather steep growth in village electrification in the 1960s, 70s and 80s up till 1990. The three decades between 1960 and 1990 saw close to 450,000 villages being electrified. This puts the average number of villages electrified during that period at 15,000 per annum.

The early and fast pace of electrification during those years could be attributed to the fact that the villages which were in proximity to large cities and town had an advantage owing to their nearness to large towns and cities and hence infrastructure could also provided at relative ease.

However, the period from 1991 to 2009 saw a huge slump in the speed of rural electrification, with just about 12,116 villages being electrified from a total of 481,124 electrified up till 1990 to 493,240 villages electrified up till December 2009. The average number of villages electrified in this period (1991-2009) was 637 per annum. In the mid 1990s and early 2000, India saw a wide range of reforms in the electricity sector, starting from unbundling of the various operations in the sector such as, generation, transmission and distribution amongst separate companies, privatizing some of the operations, introducing a regulatory framework both at the central level as well as the state level and in the formulation and promulgation of a new electricity act to replace all the then existing laws governing the electricity sector.

The reforms period had its share of teething problems with new organizations initially groping in the dark vis-à-vis their roles and responsibilities given the new framework and therefore, a number of existing projects were put on hold by default, which included the rural electrification sector, thus leading to a slowdown in rural electrification.

The period between the mid 2000 till date continued to see a slump in the progress of rural electrification primarily due to the challenge of providing transmission and distribution infrastructure to rural areas, with the villages closer to the grid and the major towns and cities having already been electrified, what remained un-electrified

[26] Census 2001
[27] RGGYV Brochure

were villages which were far from main grid lines and towns. The fact that the governments were determined to provide villages with centralized grid electricity connection and not look at decentralized models was the main problem of slow electrification and continues to remain the main problem till-date as well.

Figure 6 traces village electrification over the years starting from India's independence in 1947 till date.

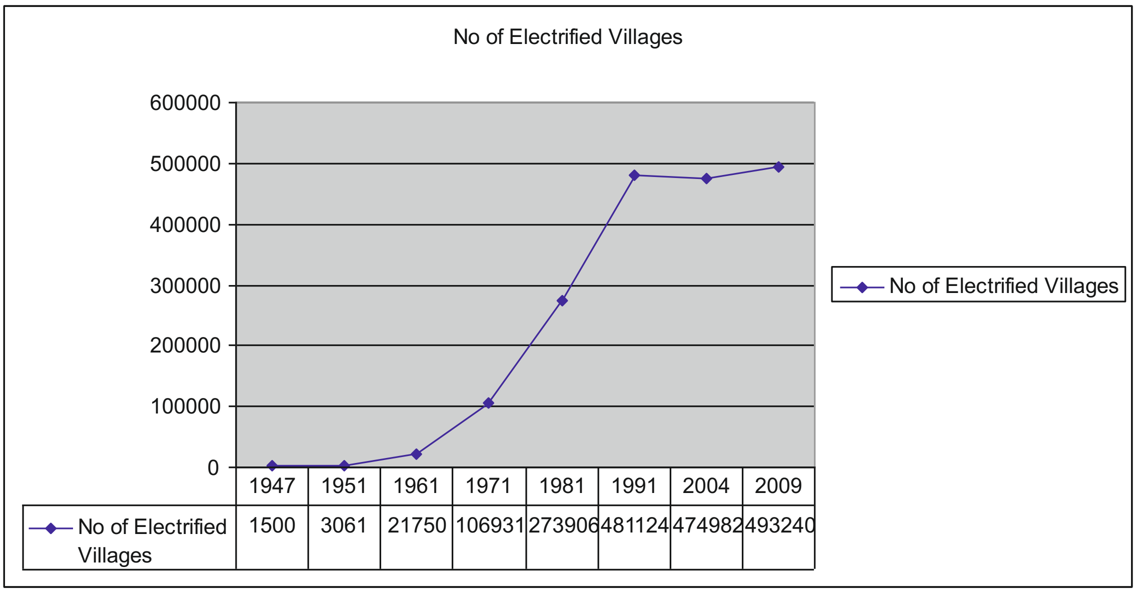


Figure 6 - Village electrification over the years starting from India's independence in 1947 till date (Source: RGGVY Brochure)

Further, the progress of village electrification has not been uniform across India. As on July 2009, only 7 states had achieved 100% village electrification, with five of them being smaller states and two of them being formerly Union Territories. The only two large states which can boast of 100% village electrification today are Andhra Pradesh and Tamil Nadu, both of them from the Southern part of India. Some of the larger states such as Bihar, Jharkhand, Uttar Pradesh, Rajasthan, and Orissa are woefully behind in village electrification with the number of un-electrified villages ranging from 10,000 to as much as 25,000.

A total of 11 states of India had un-electrified villages of more than 10% with four states being in the dismal category of having more than 40% un-electrified villages with Jharkhand and Bihar on top of the list at 70% and 39% un-electrified villages, respectively. Jharkhand is a classic example of a state which has shown complete apathy to its village population with just 9000 villages out of a total of 29,000 villages being electrified so far.

The main reason for poor electrification in these states is primarily poor governance. Both the states of Jharkhand and Bihar have for long been lagging behind in electricity infrastructure and governance and have also been the states where electricity reforms were not implemented till as recent as in 2007. This is also applicable to Uttar Pradesh and Rajasthan to some extent, though, in Rajasthan, the problem of rural connectivity is also because of it being the largest state with close to 300,000 plus square kilometers of land with a large part of it being desert tracts. Rajasthan being on the sensitive India-Pakistan border with large parts of the state in the border region has also added to the problem of connectivity and access, though, there is a fairly large tribal population who habitat those regions. Table 1 gives an indication of the number of un-electrified villages in each of the Indian states.

Table 1 - Progress Report of Village Electrification across Indian states as on 30th June, 2009 (Source: Ministry of Power, Rural Electrification)

States	Total Number of Villages (2001 Census)	Electrified Villages as on June 2009	% age of Electrified Villages	Unelectrified Villages as on June 2009	% age of Unelectrified Villages
Andhra Pradesh	26613	26613	100.0	0	0.0
Arunachal Pradesh	3863	2195	56.8	1668	43.2
Assam	25124	19741	78.6	5383	21.4
Bihar	39015	23914	61.3	15101	38.7
Chattisgarh	19744	18877	95.6	867	4.4
Delhi	158	158	100.0	0	0.0
Goa	347	347	100.0	0	0.0
Gujarat	18066	18015	99.7	51	0.3
Haryana	6764	6764	100.0	0	0.0
Himachal Pradesh	17495	17183	98.2	312	1.8
Jharkhand	29354	9119	31.1	20235	68.9
Jammu & Kashmir	6417	6304	98.2	113	1.8
Karnataka	27481	27458	99.9	23	0.1
Kerala	1364	1364	100.0	0	0.0
Madhya Pradesh	52117	50226	96.4	1891	3.6
Maharashtra	41095	36296	88.3	4799	11.7
Manipur	2315	1984	85.7	331	14.3
Meghalaya	5782	3428	59.3	2354	40.7
Mizoram	707	570	80.6	137	19.4
Nagaland	1278	823	64.4	455	35.6
Orissa	47529	26535	55.8	20994	44.2
Punjab	12278	12278	100.0	0	0.0
Rajasthan	39753	27506	69.2	12247	30.8
Sikkim	450	425	94.4	25	5.6
Tamil Nadu	15400	15400	100.0	0	0.0
Tripura	858	491	57.2	367	42.8
Uttar Pradesh	97942	86450	88.3	11492	11.7
Uttaranchal	15761	15213	96.5	548	3.5
West Bengal	37945	36934	97.3	1011	2.7

Status of Rural Household Electrification

The progress of rural household electrification has been rather slow in India. In the initial years of India's independence, priority was given to overall village electrification with primary focus on energizing irrigation pump sets. This focus continued till the end of the Green revolution and it continued to remain a priority, though in the last two decades or so, some amount of prominence was given to household electrification also.

From a Government's perspective, what was thought to be an immediate, short term and a medium term solution of providing Kerosene at subsidized rates to rural masses for lighting purposes unfortunately ended by being the norm and continues till date.

While the quantum of supply of Kerosene in absolute terms to rural areas have increased by a factor of four at the least, the subsidy which the government provides has increased by more than a factor of eight in just over the last six years, from Rs. 3750 Crores in 2002 to Rs. 28,000 Crores in 2009, with some states continuing to price Kerosene at the level of 2002.[28] Furthermore, over 60% of the rural households who procured Kerosene used it primarily for lighting purposes with just 4% of the households using it as a cooking fuel as well.[29]

A rural village shop lit by the Kerosene lamp

As a result, rural household electrification continues to be the most neglected segment with over 46% of the rural households in India yet to be electrified. This number

[28] Report of the expert committee on A Viable and Sustainable System of Pricing of Petroleum products, Government of India, 2nd February 2010

[29] National Sample Survey (NSSO) 56th round

further increases, if we also factor in households which earlier had electricity connections but no longer have due to a multitude of reasons such as, inability to pay for the connection, faulty wiring, red-tapism etc. Further it also does not factor in hamlets and if hamlets are also added, then the number of households without electricity will be in the region of 54%. This translates to just over 4,44,41,601 or 44 Million rural households electrified as on August 2009.[30]

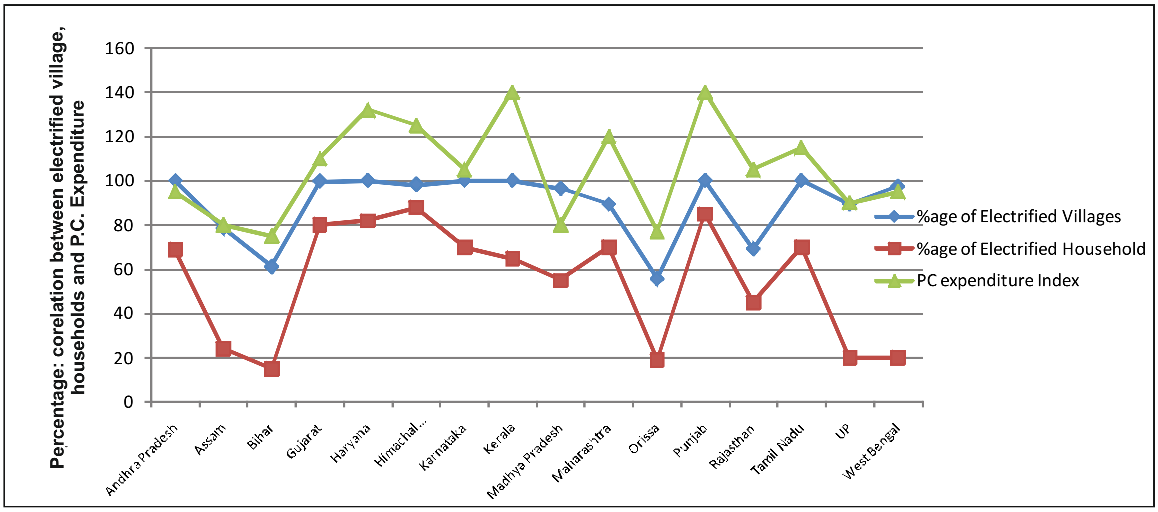


Figure 7 - Co-relation between household electrification and electrified villages. (Source: Centre for Energy Policy and Economics, Working Paper No. 51, November 2006, authored by Kemmler Andreas, based on NSSO 56th round data)

Figure 7 shows the co-relation between household electrification and electrified villages. Household electrification has clearly not been able to keep pace with village electrification in comparison. Further, the progress of rural household electrification has not been uniform across India, while some states have made fairly fast progress with rural household electrification being as much as 90%, some states, particularly that of Jharkhand, Orissa, Uttar Pradesh, Bihar have as low as 10% household electrification.

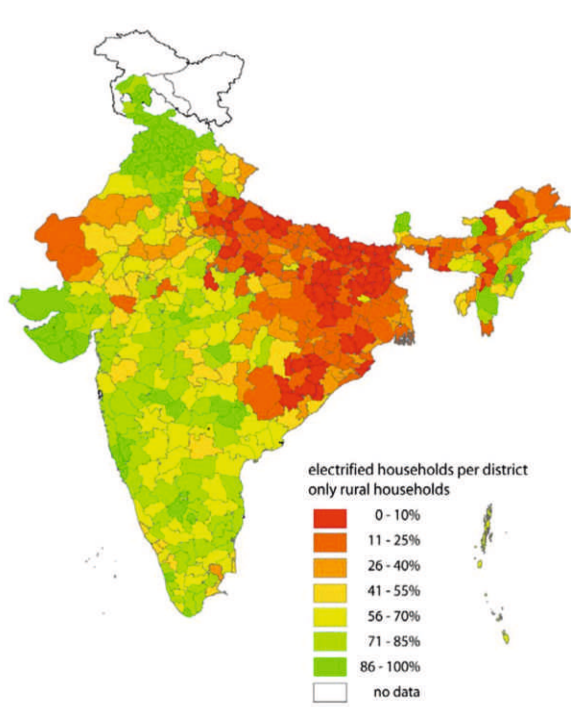


Figure 8 (On Left) - Map of India gives a broad overview of the states and rural household electrification (Source: Centre for Energy Policy and Economics, Working Paper No. 51, November 2006, authored by Kemmler Andreas)

As is the case with village electrification the North Eastern States such as Bihar, Jharkhand, Orissa have failed miserably with number of un-electrified households being in the

[30] National Sample Survey (NSSO) 56th round

region of 75-90%, with virtually no state in India which can boast of a 100% household electrification.

A close look at the pace of both village electrification and particularly household electrification in various states reveals a number of interesting analyses.

Firstly, all the smaller states, particularly those which have big urban or metropolis centres were the ones which were able to tackle rural electrification successfully. Therefore one can see that only 3 out of a total of 27 states in India have achieved a household electrification of more than 75%. These states are Delhi, Haryana and Goa. Delhi and Goa for instance were Union Territories for a long time before they got state hood.

Further, there seems to also be a relationship between GDP and electrification, with states having a higher GDP rate such as the four southern states of India, namely Karnataka, Andhra Pradesh, Tamil Nadu and Kerala, plus Maharashtra, Gujarat, Punjab, Haryana have had a higher and faster pace of household electrification, with the number of un-electrified households being in the region of 25-35%. States with medium GDP such as Central Indian states of Madhya Pradesh and Rajasthan have done a shade worse with un-electrified households being in the region of 35-50% and states with low GDP, which includes Jharkhand, Bihar and Orissa have a very high percentage of un-electrified households.

State Governance also seems to be an important issue, with states having had good governance or comparatively good governance have done better, which clearly indicates that the money earmarked for the purposes has been utilized for the same. Almost all the states which are doing badly in terms of electrification have not as yet reformed their utility companies and most of them are in huge debt with cumulative losses running into Billion of rupees.

Yet another interesting observation is that states which have good agriculture productivity have also done well and states, particularly districts which are barren have done badly. This is despite the fact that many of the states or districts also are home to a number of thermal power stations, or are rich in coal and other natural resources. These states include Orissa, Jharkhand, Bihar etc. This could mean that the bulk of the power generated through resources mined in these states have been diverted to large industries with very little available to the rural areas.

"Tomorrow never seems to come!"

A good two months after the 2009 target time line for 100% village electrification has elapsed, 100,000 plus villages and hamlets are yet to be electrified along with close to 46% of India's household not seeing the light of modern electricity.

India is perhaps the only country with a dubious record of announcing the first fully electrified district (with rural pocket), a good 63 years after its independence, as recent as in February 2010 and this district is Palakkad in Kerala. However, it must be noted here that districts with predominant urban pockets have already been 100% electrified.

As far as energizing irrigation pump sets is concerned, as stated earlier, this was the priority of the Government and energizing pump sets was serviced under both village electrification programme as well as the "Green Revolution Programme" of the Government in the initial years post independence. This focus of the programme has been primarily for irrigation purposes and is not really aimed at either providing piped drinking water or water for sanitation purposes.

The progress in terms of energizing of pump sets for irrigation purposes has had a boost between the years 2007 and 2009, with over 100,000 pump sets being energised. The Government in 2008-09 estimated that the average demand for electricity for irrigation purposes was in the region of around 170 tWh, which would be supplied to all electrified villages as a standalone system. This covers a total of around 4,93,000 villages electrified up to 30th June 2009 and with approximately 48% households being electrified in the electrified villages.

The use of pump set for drawing water for drinking and sanitation purposes in rural and semi-urban India

Table 2 gives an overview of the progress of pump set energizing and achievements in India as on 30th June 2009.

Table 2 - Progress Report of Pump set energisation as on 30th June 2009 (Source: Ministry of Power)

States Exceeded the estimated Potential for Energising Pumpsets: As on June 2009			
States	**Estimated Potential for Electrical Pumpsets**	**No. of Pumpsets energised**	**Achievement (in %age)**
Andhra Pradesh	1,981,000.00	2,440,823.00	123.20
Goa	7,800.00	8,143.00	104.40
Gujarat	779,800.00	910,965.00	116.80
Haryana	470,800.00	526,398.00	111.80
Himachal Pradesh	14,200.00	14,399.00	101.40
Karnataka	1,357,000.00	1,729,295.00	127.40
Kerala	435,600.00	490,054.00	112.50
Maharashtra	2,449,800.00	3,013,183.00	123.00
Punjab	751,000.00	966,073.00	128.60
Rajasthan	630,600.00	909,976.00	144.30
Tamil Nadu	1,662,600.00	1,990,259.00	119.70
States which have fallen short of estimated Potential in Energised Pumpsets: June 2009			
States	**Estimated Potential for Electrical Pumpsets**	**No. of Pumpsets energised**	**Achievement (in %age)**
Assam	254,000.00	3,675.00	1.40
Bihar & Jharkhand	1,352,200.00	283,175.00	20.94
Jammu & Kashmir	67,200.00	9,714.00	14.50
Manipur	37,600.00	45.00	0.10
Meghalaya	14,200.00	65.00	0.50
Nagaland	10,000.00	194.00	1.90
Orissa	1,214,000.00	74,625.00	6.10
Tripura	14,800.00	4,865.00	32.90
Uttar Pradesh & Uttaranchal	2,610,000.00	918,331.00	35.18
West Bengal	650,000.00	115,942.00	17.80
All Union Territories put together	50,000.00	13,349.00	26.70

Energizing of pump sets however needs to be looked at not just in absolute numbers but in terms of beneficiaries, both in terms of villages, hamlets and households. While in terms of villages, close to 55% of the villages have been benefited by pump set irrigation in terms of availability of water for drinking and sanitation, the total number of households benefited amounts to 48%. The disparity here is primarily because in a number of hamlets energizing of pump sets has not been linked to the water, sanitation programme.

Rural Electrification systems practiced:

Grid vs. Stand alone Decentralized Systems

The Rural Electrification Programme primarily aims at providing "Grid" power and "Grid quality power" to villages. The main premise behind this move is to ensure that there is no discrimination between urban and rural power supply systems.

The current rural electrification programme aims at providing 33/11KV sub-stations of adequate capacity in geographical blocks where these do not exist i.e. providing a village electrification infrastructure with distribution transformers of appropriate capacity in villages to ensure village supply.

Decentralised energy systems have been earmarked primarily for remote villages and areas where setting up sub-stations or distribution transformers with transmission lines is economically un-feasible or the terrain being difficult, such as mountainous regions and areas with vast forest cover.

Out of the total 493,000 villages electrified so far, only around 4399[31] villages have been electrified through a standalone decentralized energy systems, which is primarily a combination of home lighting systems or bio-mass gassifier units, with the remaining 488,600 villages being electrified through centralized grid system.

However, in addition to the 4,399 villages, power plants to the tune of 2200 kW peak have been supplied and with an average of roughly 5-10 kW peak requirement for every village of average size, it would be safe to assume that a further 300 odd villages have been powered through stand alone solar power plants.

But, what is revealing is the number of standalone renewable energy systems which have been installed for specific functions, they are so huge that these stand alone systems are used more often than not to supplement the inadequacies of grid supply with a small component of the installations complementing the grid connectivity in the villages.

For instance over the last sixty years, up to 30th November 2009, a total of 402,938 solar home lighting systems were installed primarily in rural areas and of these 402,938 home lighting systems, about 300,000 of them were installed in electrified villages. About 15% of the home light systems were replacements, while the remaining are first installation equipments that continue to work fine.[32] These systems were primarily installed by private companies with some subsidy support from the government. However, the above also include those which have been installed without any subsidy from the government but with the help of rural financing companies and cooperative societies.

[31] Ministry of New and Renewable Energy
[32] Ministry of New and Renewable Energy

In addition to this, a total of 670,000 solar lanterns have been provided primarily for the use in rural areas, with over 60% of them being supplied to people in electrified villages. A total of 40,25,781 bio-gas plants have been provided in rural areas, with roughly 15,00,000 of them being large community based bio-gas plants. A total of 70,474 street lights have been provided, covering over 65,000 villages, 35,000 of which are in the category of "electrified villages".

Table 3 - An up to date picture of the number of standalone decentralized systems installed so far and those working as on date (Source: Computed on the basis of information obtained from MNRE documents and Ministry of Power)

	Bio Gas Plants (no)	Bio-mass gassifiers (MW)	Street Lighting System (Nos.)	Home Lighting System (Nos.)	Solar Lanterns (Nos.)	No of Households covered (approx)
Andhra Pradesh	433414	15.38	3733	1628	35152	**100,000**
Bihar	125488	0.49	690	2771	50117	**115,000**
Chhattisgarh	25499	0.51	1409	7028	3192	**20,000**
Goa	3828	0.02	283	223	603	**3,000**
Gujarat	395552	14.51	2004	5918	31603	**311,000**
Haryana	51314	1.06	3793	22698	41465	**43,000**
Himachal Pradesh	45225	0.01	2994	16840	22470	**42,000**
Jharkhand	3079	0.18	620	4035	16374	**3,000**
Karnataka	400614	5.56	2271	23038	7334	**375,000**
Kerala	117227	0.73	1090	32326	41181	**100,000**
Madhya Pradesh	266389	4.74	6054	1307	8564	**200,000**
Maharashtra	753831	3.82	3491	825	8683	**600,000**
Orissa	232190	0.07	5819	4485	9882	**197,000**
Punjab	88344	0.7	3037	4620	14995	**73,200**
Rajasthan	67080	0.23	6632	50551	4716	**65,000**
Tamil Nadu	213015	5.41	2672	1557	16818	**193,000**
Uttar Pradesh	416998	4.89	950	52997	51683	**387,000**
Uttaranchal	8179		1169	43331	56523	**7,600**
West Bengal	285462	7.35	2111	76304	3662	**200,000**
All States	**4,020,328**	**70.96**	**60,355**	**393,649**	**529,901**	**3,105,300**
Other Union Territories	5453	1.16	10,119	9289	140,158	**4700**
All India	**4025781**	**72.12**	**70474**	**402938**	**670059**	**3,110,000**

From Table 3, it is clear that roughly 3,110,000 households have stand alone renewable energy systems to meet some energy requirement or the other, be it heating or lighting and with 85% of these systems still working . With roughly 60% of them being installed in electrified villages, it seems very evident that these systems were procured due to inefficiencies and lack of dependability on the grid system.

It is also evident that lighting is not the only energy need of people, but people also use energy for other purposes. The 4 million bio-gas plants are testimony to the fact that people want to shift from traditional bio-mass use for cooking to more modern and environmentally friendly cooking fuel. 72 MW of bio-mass gassifiers also illustrates that people are looking for energy and electricity needs for purposes other than lighting, which include amongst others those that enhance their livelihoods such as cooking, milling, drying etc.

Perhaps, with the exception of China, no other developing country or a developed country can boast of such large deployment of decentralized energy systems, while it has for now covered just about 3 million of a 100 million plus households. This means that the already large market for decentralized energy solution is 'really' large with huge potentials and, just the right policies could possibly trigger of a boom for decentralized energy solutions.

This also goes on to establish that to meet the energy requirements of rural population a wide range of solutions are required, and just an electricity connection for lighting will not suffice.

Thus, necessitating that the Government while investing on providing grid connected electricity to the villages has to also concentrate on providing decentralized equipments at a subsidized rate, which means that there is clearly a volume of avoidable expenditure on the part of the government. A very rough and back of the envelope calculation of the possible avoidable expenditure of the government shows that approximately 10-15% of the current expenditure could be avoided. Considering that 60% of the electrified households have also had to opt for decentralized energy system, which means that many of these households could possibly have avoided a central grid electricity system. This translates to so much savings on part of the government in providing the required infrastructure and also savings on the part of the community for both grid electricity connection as well as the additional costs for standalone systems.

Yet another point, which needs to be stressed here, is that given the quantum of decentralized systems being installed, people's sense of reliability on these systems cannot be questioned and it also points out to the fact that people will be willing to

Budgetary allocation in the Last 7 years: Grid vs. Decentralised Energy

The Planning Commission along with the Ministry of Power had estimated the total cost of the Rajiv Gandhi Rural Electrification Programme (RGGVY) to be in the region of Rs. 40,000 Crores[33] or Rs. 400 Billion to realize the target of a 100% village electrification by 2009 and a 100% household electrification inclusive of all hamlets in India by 2012.

Between the period 2005 and 2009 (up till December 2009), a total amount of Rs. 15,641.61 Crores [34]or Rs. 156 Billion has been spent by the Government exclusively for Rural Electrification programme. This sum does not include all standalone decentralized energy systems and subsidies thereof provided, which did not come under the purview of the RGGVY programme.

Of the total Rs. 15,641.61 Crores spent, the total expenses incurred in providing financial assistance to states and to meet the national target of grid connected expenses worked out to Rs. 15,300 Crores or Rs. 153 Billion of which the share for renewable energy systems was Rs. 396 Crores or Rs. 3 Billion. This not only included expenditure on new electrification but also towards household electrification in an already electrified village.

In addition to the above, MNRE has spent Rs. 1249.06 Crores or Rs. 12.49 Billion as funds provided to states for renewable energy projects. This includes grid as well as off-grid projects, with the grid projects primarily being in the wind sector.

Taking the whole period of the 10th Five Year Plan, between the years, 2002-2007, MNRE was able to electrify 2617 villages with a total expenditure of Rs. 211 Crores, which translates to an average cost of Rs. 8,10,000 per village. In contrast, in the 10th Five Year Plan Period, the Ministry of Power spent Rs. 6000 Crores to electrify 50,000 villages, at an average cost of electrification Rs. 12,00,00 per village.

While the above example clearly shows that decentralized energy systems were definitely more cost effective than Grid connected systems, it is difficult to look at similar comparisons in the previous plan period, for the sole reason that at that point of time, all rural electrification systems were largely through grid and home lighting

[33] 11th Plan Approach Paper, Planning Commission

[34] Computed based on information from Planning Commission, 11th Plan document and from Ministries of Power and Renewable energy

systems. Other standalone installations were not considered as either rural electrification or part of rural electrification. However, the trend that we see in the 10th Plan seems to be the case in the 11th Five Year Plan too. One of the reasons attributable to this is that in the period 2007-2009, the village electrification programmes though grid has seen a tremendous slow down. Tables 4 and 5 provide detailed budgetary information for both renewable energy projects as well as for Grid connectivity rural electrification projects. These tables have been compiled from Information from Ministry of Power and Ministry of New and Renewable Energy.

Table 4 - State Wise funds provided for all Renewable Energy Projects

States/UTs	2004-05	2005-06	2006-07	2007-08	Total (in Crores)
Andhra Pradesh	7.59	12.19	17.63	11.81	41.64
Bihar	0.06	0.41	6.98	5.82	13.21
Chhattisgarh	1.39	5.5	6.49	12.14	24.14
Goa	0.08	0.21	0.4	0.89	1.5
Gujarat	2.22	3.5	7.28	8.6	19.37
Haryana	1.576	1.48	6.52	6.05	14.05
Himachal Pradesh	12.82	2.57	15.42	6.15	24.14
Jammu & Kashmir	5.74	10.13	2.1	8.47	20.71
Jharkhand	0.05	12.65	3.12	14.16	29.93
Karnataka	5.38	4.05	14.71	13.36	32.11
Kerala	1.33	1.37	1.94	1.07	4.38
Madhya Pradesh	4.99	5.78	10.14	10.33	26.26
Maharashtra	6.61	10.21	17.36	33.3	60.87
Orissa	2.16	3.31	9.67	5.36	18.35
Punjab	1.45	1.65	6.85	6.52	15.02
Rajasthan	3.02	5.23	4.7	13.56	23.5
Tamil Nadu	6.11	3.37	3.34	2.06	8.77
Uttar Pradesh	10.1	4.27	6.23	14.76	25.25
Uttarakhand	1.52	10.58	17.36	9.6	37.54
West Bengal	5.61	17.01	27.78	10.08	54.87
India	**152.14**	**185.7**	**281.72**	**371.64**	**839.06**
Rural Electrification	**27.74**	**40.66**	**47.00**	**54**	**169.40**

Table 5 - State-wise Funds Released under Remote Village Electrification Programme in India (2002-2003 to 2007-2008)						
State	**2002-03**	**2003-04***	**2004-05***	**2005-06***	**2006-07**	**2007-08 (Rs. in Lakhs)**
Arunachal Pradesh	108.63	484	66.08	293	156.28	4.11
Assam	88.5	0	23	32	346.58	1862.57
Chhatisgarh	595	332.13	8	275.5	363	290.5
Gujarat	0	8.61	0	45	-	-
Haryana	0	83.88	0	0	123.99	-
Himachal Pradesh	0	12	15	160	64.88	-
Jharkhand	105.8	837.41	0	1197	312	1011.23
Madhya Pradesh	109.25	0	0	28	177.21	402.24
Maharashtra	0	313.63	0	285	810.86	940
Manipur	730	33	79.01	381	585.59	87.87
Meghalaya	322.55	0	175.85	0	135.72	102.59
Orissa	0	0	42.89	5.5	496.27	276
Rajasthan	0	184.5	176.22	247	51	575.46
Uttaranchal	344.61	720.05	50.52	147	346.63	88.38
Uttar Pradesh	0	1342.7	0.57	0	-	-
West Bengal	357	2388.95	72.05	953	1366.3	-
Others	-	64.46	13.9	51	-	-
Total	**3476.84**	**8578.67**	**1785.49**	**4152**	**5707.3**	**5640.95**

The Pricing of Grid Supply in Rural Areas

The norms for pricing have been varying depending on the programme which has been in vogue at varying periods of time. However, the common underlying norm in every programme has been to provide electricity connection to families living below poverty line (BPL) and those belonging to economically weaker classes at nearly 100% subsidized rates. The norm has also been to ensure that while all capital costs which include wiring etc. are borne by the government, the connectivity would largely be single point connectivity, which primarily amounts to one bulb.

However, the current programme RGGVY looks at providing at least 1kWh of electricity per family free of cost to all those families who are living BPL.

For all the other categories of families, there is a connectivity charge along with either a flat monthly rate, irrespective of what the consumption is, or a metered charge, where the charge is as per consumption, though the rate is highly subsidized.

As of now, the onetime connectivity charge for a rural household which does not come under the BPL category is Rs. 1500/- for a non-metered connection and Rs. 2000 for a metered connection. In addition to this connection charge, there is also a monthly charge based on consumption, and if it is a flat rate for a non-metered connection, it varies from Rs. 75/- per month to Rs. 100/- per month depending on the state. If it is based on metered consumption, the average tariff for rural areas is in the region of Rs. 2/- per kWh to Rs. 3/- per kWh again depending on the state, the region and the season. During election times and immediately post an election, invariably, there is a promise for "free electricity" which tends to be rolled back after a certain time period.[35]

The tariff for rural population is highly subsidized and is 1/3rd of the average tariff for urban domestic consumers and 1/6th of those paid by urban commercial establishments and industries.

Despite the highly subsidized tariffs, the rural masses find it unable to pay for it, though; it is largely to do with the erratic and poor quality supply.

Quality of Grid Supply in Rural Areas

To assess the quality of grid supply, Vasudha Foundation and Judav, Jharkhand, created a very brief questionnaire in the form of a very simple log book to record the daily hours of electricity supply and also the time of the supply on a daily basis and placed it in 20 villages in India covering two districts in each of the three states of Bihar, Jharkhand and Karnataka.

The two key districts that we chose in Jharkhand were the Hazaribagh District, known for its rich natural resources and mines and Ranchi District, the capital district of Jharkhand. In Karnataka, we chose two districts, one being Mandya district and the other Chennapatna district, both in close proximity to both, Mysore as well as Bangalore (now called "Bengalooru") Bangalore is the capital city of Karnataka and the IT Capital of India and Mysore, is known to have had the highest number of tourists this year and also a district with very high heritage sites. In Bihar, the districts of Sheikhpura and Patna were selected on a random basis.

Bihar and Jharkhand were selected for this random sample study as these states have the highest number of un-electrified households with a poor track record of electricity distribution and the state of Karnataka and Tamil Nadu was chosen since they are one of the most progressive states and the identified districts in Karnataka were less than 80 Kms from Bangalore which is an upper class metro city.

The purpose behind this exercise was three-fold:

1. To get an idea of the actual hours of supply and time of supply.
2. To gauge the quantum of supply, whether it was suited to cover usage beyond a couple of lights and fans, and
3. To assess the quality of service, in terms of time taken for repairs, the time taken to rush hardware in case of replacement (particularly transformers) and also the ability and capability of the local distribution companies to react to technical power breakdowns.

[35] Source: Average from tariffs of various utilities

The log book (see annexure for format) was placed in the identified villages in the six districts in June 2009 and continues to be maintained even today. It was aimed that in the given the time frame, all important weather seasons get covered.

Log book data covers 120 days of summers, (June-September), 60 days of Autumn (October and November) and 60 days of winter (Dec-Jan). The monsoon season coincides with the summer season, while winter in Jharkhand and Bihar sets in around mid-November usually.

JHARKHAND

RANCHI DISTRICT : Out of the information collected for the period of 244 days, till Feb 2010, roughly 60 days of information was during peak summers and 60 days of moderate summers with coinciding rainy season, two months of autumn and two months of peak winters.

In the summer months, out of the total 120 days of records available with us, there were a total of 27 “no electricity days”, out of which 7 days were due to break down and technical faults. In the remaining 93 days, the average hours of supply ranged from 6-9 hours, with power cuts during the peak morning hours, intermittent supply in the afternoon for about 2-3 hours and bulk of the supply of the remaining 3-6 hours in the middle of the night.

From the information collected on break down and technical faults, we learnt that the average time taken for rectifying a problem ranged from a minimum time of 4 hours to as much as 48 hours in some cases and in case of a transformer problem that required a replacement of the transformer, the time taken to rectify it was as much as 3-4 working days.

The maximum breakdown of supply due to technical faults was recorded during the rainy season. It was also noted that any breakdown during the monsoon season results in inordinate delay in rectifying the problem, even if it was something as small as a blow-up of fuse.

The autumn and winter months saw better electricity supply, with electricity supply on almost all the days (except for 3 days) the hours of supply ranged from 9-12 hours. Though even in these months (except for 3 days), there was absolutely no supply of electricity in the peak morning hours between 6AM and 9AM and so was the case in the evening between 5PM and 9PM.

The villages in the district of Ranchi recorded a total 1500 hours of electricity supply over the period of 244 days, averaging to 6.14 hours per day.

JHARKHAND

HAZARIBAGH : In Hazaribagh as well, we analysed information which was available through the log book entry for a period for 247 days, covering more or less the same time frame as in the case of Ranchi district. The situation of Hazaribagh was even more dismal than what we saw in Ranchi District.

The summers saw a supply of less than 4 hours on most of the days, with over 32 days of absolutely no supply. The autumn and winter months saw a supply of 6 hours a day. Bulk of the supply was during the night hours in all the seasons, with some day time supply during the autumn and winter months. Rectifying of technical faults again took as much as 4-5 working days, depending on the nature of the defect or the problem.

The average supply of electricity factoring in both, the good and the bad months and factoring in "no-supply" days amounted to roughly 1100 hours over a period of 247 days, averaging to 4.45 hours a day.

BIHAR

SHEIKHPURA DISTRICT : In terms of time frame of information, it was the same as in Jharkhand with log book information available for a period of 239 days.

The summers saw a supply of less than 3 hours on most of the days, with over 45 days of absolutely no supply. The autumn and winter months saw a supply of 5 hours a day. Bulk of the supply was during the night hours in all the seasons, with some day time supply during the autumn and winter months.

In August 2009, the people from some of these villages gathered at the main electricity office in the capital of Sheikhpura district and literally burnt down a part of the office in protest of the poor and virtually no electricity supply for 45 days!

Rectifying of technical faults here as well took as much as 4-5 working days, depending on the nature of the defect or the problem.

The average supply of electricity factoring in both, the good and bad months and factoring in the 45 "no-supply" days amounted to roughly 940 hours over a period of 239 days, averaging to 3.50 hours a day.

BIHAR

PATNA DISTRICT : People in the villages of Patna district had a comparatively better supply as compared to the citizens of Sheikhpura district. The people here got a summer supply of around 4 hours per day with a autumn and winter supply of 6 hours of electricity per day. Bulk of the supply was during the night hours in all the seasons, with some day time supply during the autumn and winter months. Surprisingly, 23 out of the 120 summer days also had day time supply for a period ranging from 1-2 hours. However, this region saw a total of 36 "no-power" days in all.

Rectifying of technical faults took as much as 4-5 working days, depending on the nature of the defect or the problem.

The average supply of electricity factoring in both, the good and bad months and factoring in the 45"no-supply" days amounted to roughly 1056 hours over a period of 243 days, averaging to 4.34 hours a day.

Other interesting information:

In all the villages that we covered in the four districts of Bihar and Jharkhand, amounting to 20 villages, the most common issue in addition to the above was in terms of the quantum of supply. Invariably the quantum of supply was not enough to even operate a tube light, primarily due to low voltage, leave alone any other appliance.

We understand from the villagers that, while they all were supplied with tube lights and CFLs by the electricity companies, they had to replace the tube lights with normal incandescent bulbs, primarily due to the fact that the tube lights which were ordinary ones did not light up on most power supply days, due to poor voltage.

The villagers also recounted one incident which happened about a couple of years back in Bihar, where in a transformer burnt out and it took the administration 4 months to replace it and that too just before the state was scheduled to go in for elections.

The other common feature in all the four districts was in terms of availability of lines man or technical person/s to rectify faults. We understand that most linesmen were reluctant to come to the villages and this also added to the time taken to rectify faults. Perhaps, one reason for this can be attributed to the fact that all the four districts are known for its high level of naxalite activities and invariably government servants tend to become the target of the naxalites.

The other common issue which we found on talking to people, particularly from the utilities was with regard to inventories of important supplies. Most of the small offices of the utilities do not have immediate stock of transformers or for that matter even spare ones. Additionally, the transformers installed in villages are primarily "hand me downs", which are used and rejected transformers from cities and towns. The utilities neither have the required expertise nor necessary equipment to handle replacement of transformers nor therefore, have to depend on other big offices for men and machinery in case of problems.

With the average supply working to roughly 4 hours per day, at a current tariff of Rs. 100/- per month on a flat rate basis; factoring that bulk of the supply is during the night times, when there is virtually no usage, the average rate that a rural household is paying is almost on par with what an urban household is currently paying. Therefore, in light of the above analysis, the so-called subsidy for rural consumers is suspect, though; it does not apply to people living below the poverty line, as they are entitled to free electricity supply.

KARNATAKA

MANDYA AND CHENNAPATNA DISTRICT: Given the proximity of these villages to some of the key and important cities in a progressive state, one would have expected the situation to be a lot better than what we observed in the states of Jharkhand and Bihar, but unfortunately, that is not the case.

The average summer supply in the villages in these two districts ranged from a high of 8 hours to a low of 4 hours per day, with the winter and autumn supply being almost the same. The villages saw a total of 14 days of no electricity supply.

Bulk of the supply was during the night hours; with some supply in the evening hours, but virtually no or limited supply either during the peak morning hours or during the peak evening hours.

It must be noted here that both these districts have very powerful members of legislative assembly and Members of Parliament with one of them currently a minister in the Central Government. In addition, a former Prime Minister of India also has great interest in these districts. So, in terms of priority, these districts do have precedence of sorts, but despite that, the total supply over the period of 257 days of recording information, amounted to 1400 hours of supply with an average of 6 hours of supply per day, with little less than 2 hours of day time supply.

Rural Electricity supply is highly subsidized, but the rural consumer ends up paying as much as the urban consumer.

While the general perception is that progressive states, particularly states which have had a high level of electrification both in terms of village electrification as well as household electrification fare better in terms of reliability of supply, from our study of the two districts in Karnataka, we find that this is not necessarily the case.

While we could not collect information from other states, we did undertake a general check on the information so collected and found that in states where the intensity of electrification was high, the reliability was low, particularly in areas which are remote and far from major towns and district head quarters. In fact, the states where household electrification was more than 70%, recorded a very high peak demand deficit, which in turn has a bearing on supply of electricity to villages.

Chapter 2 - Summary and Key Findings

- The progress of rural electrification in India has been dismal to say the least, with over 100,000 villages yet to be electrified and over 54% of rural households not having access to electricity.
- "Goal Posts" or targets have been shifting virtually every year, with the current target of 100% village electrification set for 2009 already having gone off the mark and with the target of 100% household electrification by 2012 also likely to miss the mark.
- In the last two years, the government has managed electrify just under 13,000 villages and less than 50,000 villages in the last five years.
- Only 7 out of a total of 27 states of India can boast of 100% village electrification, with only 11 states having less than 10% un-electrified villages and with 4 of the large states having more than 40% un-electrified villages.
- Only 3 states of India have less than 25% of households with no electricity access, while the remaining 24 states have un-electrified households ranging from 25 to as high as 90%.
- All the rural electrification programmes starting from the second plan period have had fairly ambitious plans and targets. But invariably not one of the programme or plan has managed to successfully implement the programmes and all have fallen way short of targets, with the exception of the *Kutir Jyoti* Programme, which has only been comparatively better implemented of all the programmes so far, but still did not achieve its desired targets.
- Grid connectivity continues to be the *mantra* of the government with huge budgetary allocations, while it continues to not deliver.
- Renewable energy for rural electrification has been a late entrant to the game with very low targets and proportionally lower budgetary allocations too, but it has delivered results.
- There has been a phenomenal increase in budgetary allocations for rural electrification, with an incremental increase to the tune of 8 to 10% every year in the last five odd years, but has not yielded results.
- The two ministries involved in the rural electrification, namely the Ministry of Power and MNRE seem to be working in parallel and not in coordination. This is clearly evident from the fact that while the target specifically for rural electrification given to MNRE is low, the same ministry has been promoting stand alone systems in electrified villages.
- A brief analysis of the villages electrified through grid and non-grid systems and comparative analysis of the amounts actually spent by the respective ministries reveals that the costs for both are more or less the same. This is testimony to the fact that grid power is cheaper is a myth.
- The quality and reliability of supply has been pathetic to say the least. This is evident not only from the log book data collected from 20 odd villages covering the 6 districts of Karnataka, Jharkhand and Bihar, but also from the fact that a number of households from electrified villages are opting for decentralized standalone renewable energy options such as home lighting

systems, solar lanterns, bio-mass gassifiers etc. This further testifies the point that Grid electricity has failed to deliver.

- In addition to the poor reliability of supply, the quantum of supply is also not enough to even light a decent tube light, leave alone provide energy for livelihood enhancement or even for irrigation purposes. Yet again, a case of failure of grid electricity.
- The farther the distance between the village and the district headquarter or towns, greater is the problem both in terms of quality of supply as well as quality of service. The average time taken at the best case scenario for rectifying technical faults ranges from a minimum of 24-48 hours to as much as 5 days. There have been instances where the time taken to rectify major problems such as transformers is as much as 3.5 months.
- The very definition of "Rural Electrification" or "Electrified villages" gives ample scope to get away by supplying very little electricity, despite the revision in the definition. With only 10% of household and some commons being supplied with electricity enough to deem a village "electrified", leaves out the 90% of the households in the villages and almost all of the hamlets, making it an inequitable supply.
- Governance is a major issue and it also has a bearing on states where electricity distribution companies and utilities are not functioning effectively, with huge cumulative losses and hence no money for future investments or for the matter even routine maintenance.

Chapter 3

The Rich vs. Poor Story

Is Energy and Electricity Exclusive to the Urban Rich?

This section takes off from the previous one, which gave a broad overview of rural electrification in India and its progress or lack of progress over the past sixty years, since India's independence.

India is home to 30% of the 1.6 Billion people in the world who lack access to electricity. Together with China, these two countries account for almost half of the 2.5 Billion people in the world who are still dependent on traditional biomass for cooking and heating. National statistics conceal considerable disparities and inequalities within these countries.

While access to electricity across different segments of the population has become more equal, the gap in consumption levels has increased across various segments i.e. between urban and rural households; between distinct administrative and geographical regions and; between the top and bottom expenditure deciles of the population.

Glimpse of Delivery or access to Energy: Urban vs. Rural Comparison

Typically, India comprises of large cities or metropolis, state capitals and cosmopolitan cities, major cities-which do not fall in the category of either metropolis or state capitals, large towns or state zonal headquarters, towns, district head quarters, *taluk* headquarters, large villages or wards, *panchayat* villages, small villages, remote villages and finally hamlets or what is known as *'Dhanis'*.

By 1980, India could boast of a 100% electrification of all cities, district head quarters and even *taluk* head quarters with urban household electrification levels of close to 60%.

At the same year, village electrification stood at 40% and grew steadily to cross the 80% mark by 1995, but saw a slump post that year, particularly after the year 2000.[36]

In sharp contrast, urban household electrification continued to grow at a steady rate to finally touch 94% as of 2009.

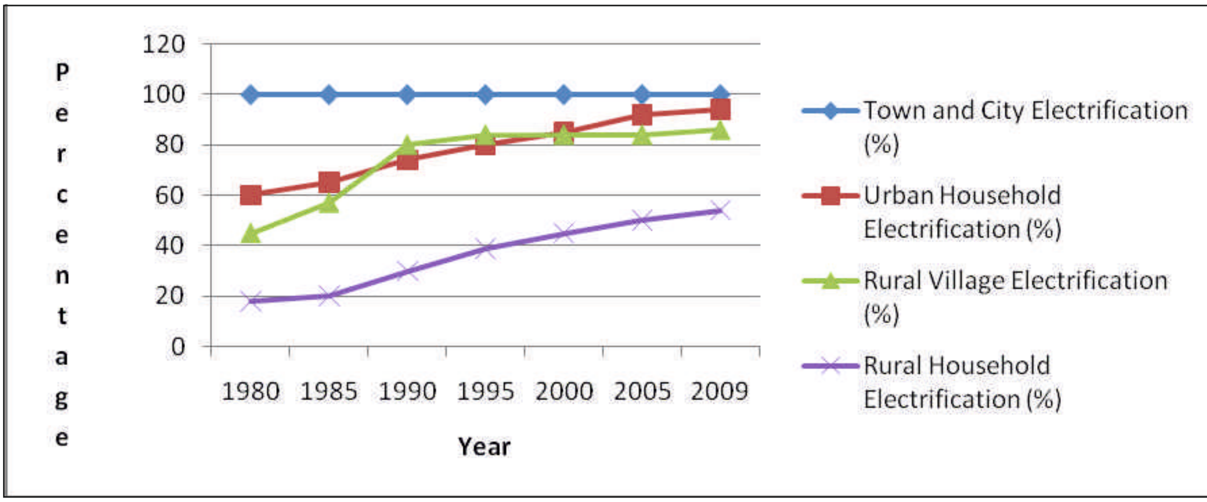
Rural household electrification, as we saw in the previous chapter, had a much slower pace. At best, the pace of rural household electrification can be termed as being fairly steady yet sluggish. By 1980, 20% rural households had been electrified, but by 2009,

[36] Al figures are from Ministry of Power statistics

the figure of rural household electrification had only managed to scrape past the 54% mark.

Figure 9 gives a graphic description of the electrification trends in India amongst the four categories from 1980 till 2009.

Figure 9 - Electrification Status and Trends from 1980 - 2009
Source: Compiled based on the information from Ministry of Power



The pace of electrification between urban and rural areas varies at the level of every state. On one end, in some states there are huge gaps between rural and urban electrification, while on the other hand, a state like Goa has recorded the same level of rural and urban electrification.

A brief analysis of the average consumption of electricity by the rural and urban population, which is also related to the quantum of supply, revealed that with the exception of Goa, there is virtually no other state in India where the urban electricity consumption is equivalent or almost equivalent to the rural consumption. The gap is lower in smaller states of Haryana and Kerala but, very high in most of the other states in India.

Again, the numbers also reveal a co-relation between high electrification rate and consumption. There is also a trend that states with high electrification rate also have a comparatively low rural consumption, which is attributable amongst other reasons to the minimal supply in the rural areas. The only exception to the case being Bihar and Jharkhand where low electrification intensities have not had a positive impact on rural consumption, primarily because of low levels of village electrification in these two states. Figure 10 gives a bird-eye view of this trend.

Figure 10 - Rural-Urban Electricity consumption pattern (Source: computed based on the information and data obtained from CEA and Ministry of Power)

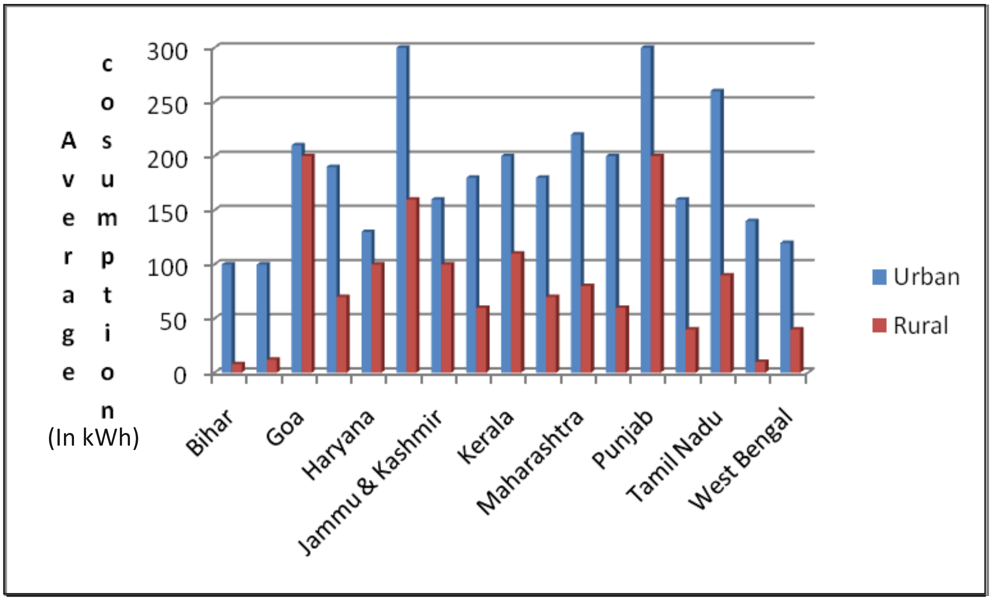
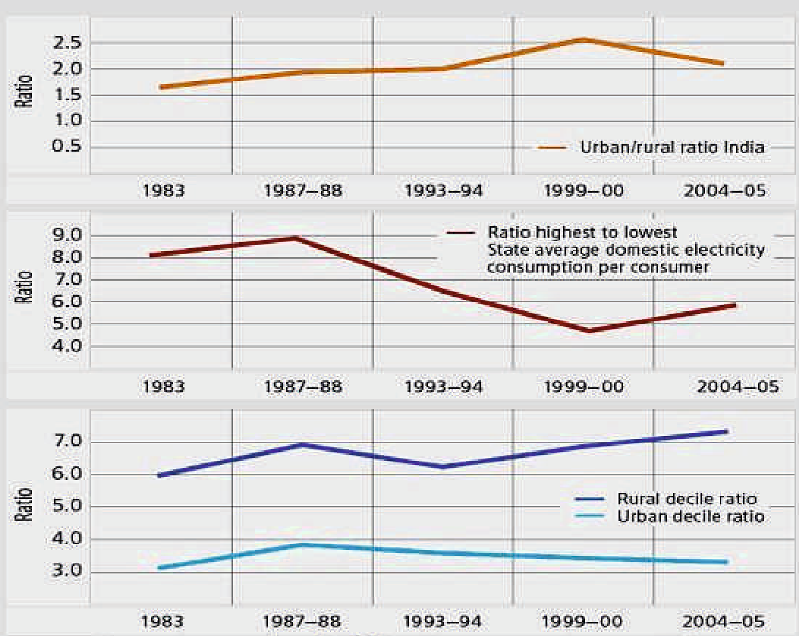


Table 6 below gives an overview of mean household electricity consumption across India and depicts the Urban vs. Rural Consumption pattern, highest electricity consuming state vs. lowest and, between the richest 10% vs. poorest 10% in rural and urban areas.

Table 6 - Mean Household Electricity consumption across India (Urban vs. Rural, Highest vs. Lowest Electricity Consuming state, 10 Richest vs. 10 poorest)



Comparing mean household electricity consumption across India. *Top*: Urban versus rural electricity use. *Middle*: Highest electricity consuming state versus lowest. *Bottom*: Electricity use by richest 10 percent versus poorest 10 percent in rural and urban areas.
Data source: National Sample Survey Organisation (NSSO), Ministry of Statistics and Programme Implementation, Government of India, New Delhi. Data from several rounds of the household consumer expenditure survey.

So far as electricity delivery and quality/reliability of delivery are concerned, almost all the large cities have close to 24 hour supply. Even when there are outages, these are planned and announced well in advance. For instance, during summers, Bangalore city sees a power cut of 1 hour every day during peak hours and the time of the power cut is announced much in advance to the citizens. The power cut schedule is also rotated for each locality, in order to ensure that the inconvenience in terms of the timing of the power cut is shared by all citizens of Bangalore.

A well-lit shopping mall in an urban Indian city

In general all metropolis and capital cities of India enjoy very little power outages, with close to a 24 hour supply. Furthermore, in large cities, the time taken to address a technical problem including major ones such as replacement of transformers is done within a maximum span of 12 hours, irrespective of the time of the day the problem surfaces.

The situation in towns and district headquarters is not so similar. The average power outages range to around 4 hours every day. The earlier chapter dealt at length with regard to the situation in villages.

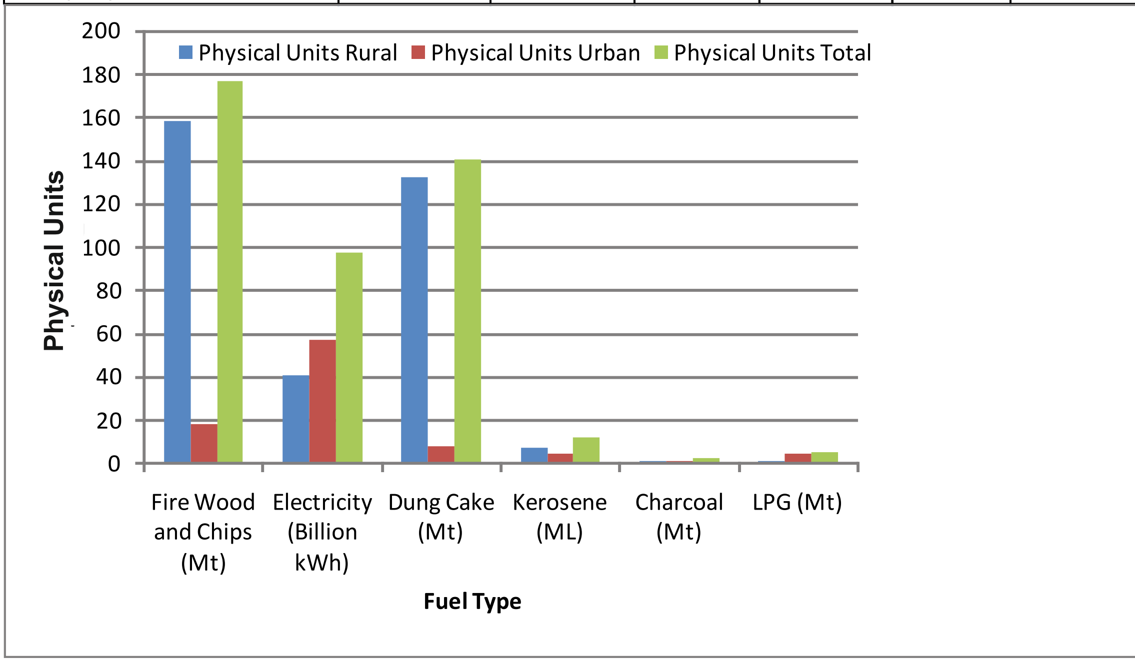
So, clearly, both in terms of electricity consumption, delivery, access and reliability, there is a huge gap between urban and rural consumers and, though the extent of the gap continues to differ from one state to the other state, the general trend remains the same.

Energy Consumption Pattern: Rural vs. Urban

Despite the fact that rural India has a much higher geographical area and is home to more than 70% of India's population, the electricity consumption of urban population is approximately 17 Billion kWh more than the consumption of the rural population.

Table 7 - Household Energy Consumption in India from July 1999 to June 2000
(Source: National Sample Survey 1999-2000; Department of Statistics, Government of India)

Fuel Type	*Physical Units*			*Mtoe*		
	Rural	*Urban*	*Total*	*Rural*	*Urban*	*Total*
Fire Wood and Chips (Mt)	158.87	18.08	176.95	71.49	8.13	79.62
Electricity (Billion kWh)	40.76	57.26	98.02	3.51	4.92	8.43
Dung Cake (Mt)	132.95	8.03	140.98	27.92	1.69	29.61
Kerosene (ML)	7.38	4.51	11.89	6.25	3.82	10.07
Charcoal (Mt)	1.2	1.54	2.74	0.49	0.63	1.12
LPG (Mt)	1.25	4.43	5.68	1.41	5.00	6.41

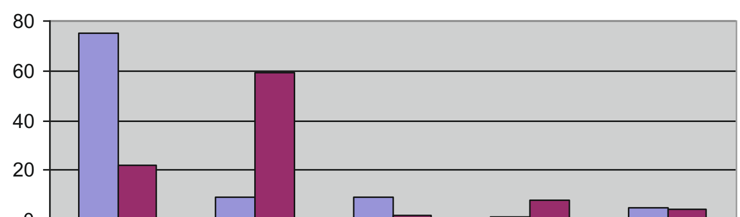


The 55th round of the National Sample Survey (NSS), done in the year 1999-2000, revealed that for 86% of rural households the primary source of cooking energy was firewood and woodchips or dung cakes. In urban areas as well, more than 20% of all households relied mainly on firewood and chips. Only 5% of the households in rural areas and 44% in urban areas used LPG.

Kerosene was used by 22% of urban households and only 2.7% of rural households. Other primary sources of cooking energy used by urban and rural households include coke, charcoal, *gobar* gas (cow dung gas), electricity and other fuels.

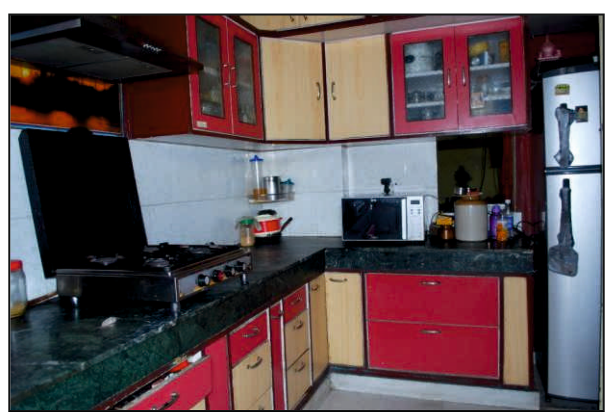
The fuel of the poor: Firewood and Cow dung (Gobar)

Figure 11 - Energy Source and Usage for cooking purposes: 2007 Survey (Source: Computed based on information from NSSO and Planning Commission)



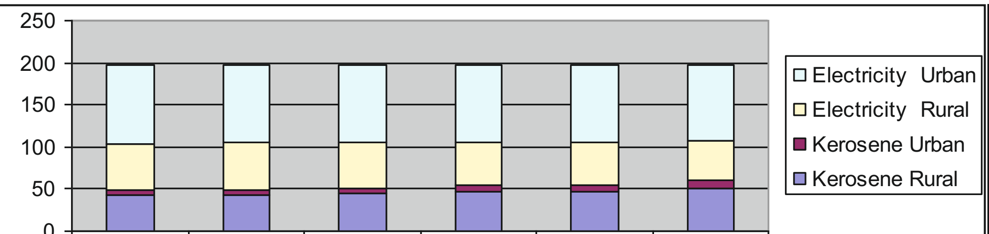
	Firewood and chips	LPG	Dung cake	Kerosene	Other sources
Rural: Household Hours of Usage (%)	75	9	9	1	5
Urban: Household Hours of Usage (%)	22	59	2	8	4

Rural: Household Hours of Usage (%) Urban: Household Hours of Usage (%)



The photograph on the left shows a village women cooking food on chullah/cooking stove in a rural kitchen fueled by burning coal chips and firewood in contrast to the photograph on the right showing an Urban Kitchen featuring multiple electronic gadgets

As can be seen from Figure 12, Kerosene continues to remain the main source of lighting for rural households, while electricity is the dominant source of lighting in urban households. While the percentage of rural households connected to electricity seems to be in the region of 56%, it also includes households which have a line connected, irrespective of the fact that electricity supply is/may be non-existent.



	July 2006 – June 2007	July 2005 – June 2006	July 2004 – June 2005	Jan 2003 – Dec 2003	July 2001 – June 2002	July 1999 – June 2000
Electricity Urban	93	92	92	91	91	89
Electricity Rural	56	56	54	51	51	48
Kerosene Urban	6.4	7.2	7.1	8.3	7.8	10.3
Kerosene Rural	42	42	44	46	47	50

Figure 12- Percentage of households with primary source of energy used for lighting (Source: Computed based on information from NSSO and Planning Commission)

In a survey conducted by the NSS on electricity usage in 2006-07, it was clearly indicated that the urban household spends almost double the amount spent by a rural household towards purchasing " fuel". It must be pointed out here that the expenses incurred on fuel need not necessarily mean a cash transaction, but this is also computed on the basis of human effort and time involved, particularly for rural households in which people spend a lot of time and energy in collecting fuel (which is in the form of traditional bio-mass such as fire-wood, wood chips, charcoal, cow-dung etc.).

Pricing for Energy: Rural vs. Urban

The tariff for electricity in the rural areas comes highly subsidized with an option given to the rural households for either a flat monthly rate ranging from Rs. 100/- per month to an option for metered consumption at a tariff rate of Rs. 1.50 to Rs. 2/- per kWh depending on the state.

However, the metered option for rural households comes with an additional and fairly high connection fees. Given the fact that the time taken to install a metered connection can sometime be much as one year and that many a times faulty meters get installed, the general trend amongst rural masses is to go in for a flat rate connection.

In the earlier chapter, we clearly saw that based on the hours and time of supply, the amount of money which a rural consumer pays (despite the fact that it is a highly subsidized rate) is still not commensurate with the energy supply. Therefore, if one even considers a medium case scenario where in the supply of electricity ranges from 10-12 hours a day with just 3-4 hours of day time supply, the average tariff works out to almost as much as what a domestic urban consumer pays today.

However, if the rural consumer opts in for a metered connection, then, it will be definitely much cheaper than what an urban consumer pays today.

As of today, a good 71%[37] of the rural consumers have a flat rate connection with just about 29% opting for metered connection. Of the 29% opting for metered connections, there is an average of 5% connections which are defective and hence rendered non-functional.

So in case of electricity pricing, there is actually no major difference between an urban and a rural consumer, primarily due to the quality of supply in rural areas.

As far as other energy sources are concerned, the two major fuels where the government spends a huge amount on subsidy to facilitate easy access to consumers at a reduced price are, Kerosene (for cooking and lighting) and LPG (for cooking).

The subsidized price of both Kerosene and LPG is more or less the same irrespective of whether the consumer is an urban consumer or a rural consumer. However, while there is a cap on the consumption of subsidized Kerosene, there is no such cap on the consumption of LPG, although though the government is on the verge of bringing a cap on domestic consumption of LPG as well, soon.

In the earlier graphs and tables, we were able to see the consumption patterns of both LPG and Kerosene across the rural and urban population. Whereas, the consumption of LPG is higher in urban areas (primarily for cooking purposes), the consumption of Kerosene is higher in rural areas (primarily for lighting purposes). The domestic consumption of LPG has increased from 9.3 MMT in 2003-04 to 12.3 MMT in 2008-09, with the sale of subsidized LPG constituting 86.5% of the total LPG sales as in 2008-09[38]. The consumer subsidy on LPG has grown from Rs. 5,523 Crores or Rs. 55 Billions in 2003-04 to Rs. 17,600 Crores or Rs. 176 Billion in 2008-09[39].

Almost every policy design intended to benefit the poor, ends up benefiting primarily the well off section of the society!

The average consumption of LPG cylinders in a poor rural household is roughly 5 cylinders (of 14.2 kgs capacity) per year, while the rich rural consumers use slightly more. In comparison, a low income urban LPG consumer tends to consume roughly 8 cylinders per year, while the top income brackets (Middle Class, Upper Middle Class and the Rich) use nearly 40% of the total LPG sold in an year, and spend less than 5% of their total expenditure in procuring the same. [40] In sharp contrast, every year, on average, only 8% of the rural consumers use LPG. As far as Kerosene is concerned, there is a cap on consumption of subsidized Kerosene for rural consumers. The cap is 3.5 litres per month, with just about 1.6% of

[37] Data collected from various electricity distribution company websites and averaged
[38] Report of the high powered committee appointed by the Planning Commission to look at pricing of fuels and subsidies, 2nd February 2010
[39] Report of the high powered committee appointed by the Planning Commission to look at pricing of fuels and subsidies, 2nd February 2010
[40] Report of the high powered committee appointed by the Planning Commission to look at pricing of fuels and subsidies, 2nd February 2010

the rural consumers using Kerosene for cooking and the rest use it mainly for lighting purposes.

The above statistics and data clearly reveal that even with regard to the supply of other fuel sources, the urbanites are much better off than the rural rich and the rural poor are the worst sufferers of all!

Photograph on the left: shows Perfect Co-existence! - Diesel Genset and Grid Electricity Infrastructure
Photograph on the right: shows good (re)use of electric wires to hang and dry clothes in a rural household!

Glimpse of electricity consumption between urban rich and urban poor/slum dwellers

The urban poor households constitute about 6% un-electrified urban households in India, with the bulk of urban poor not having any access to proper shelter either. This component of the population is also the largest consumer of Kerosene and traditional biomass in the urban context. They consume about 8% of the total Kerosene consumption and roughly 22% of the total consumption of wood chips and dung cakes (which are primarily used for cooking, heating-during winters in North India and lighting too).

The urban poor also have a very low consumption of LPG, to an average tune of just 8 cylinders (of 14.2 kgs capacity) per year. In contrast, the urban rich consume less than a percent of wood chips and coal, that too primarily for heating water for bathing and/or for lighting up a fancy fire place in the homes of the rich in hilly regions of the Northern India during winter months. The urban rich also consume roughly 2% of subsidized Kerosene primarily to run generators for back up electricity.

Chapter 3 - Summary and Key Findings

- It is very clear that energy and electricity have been exclusive to the urban population, particularly the rich.
- There is also a very huge gap between supplies of energy to meet the needs of urban areas as against the rural areas. The average ratio stands at 70:30.
- The fuel subsides meant for the benefits of the poor have also been diverted to the rich. The case of subsidized LPG and Kerosene being key indicators.
- The so called subsidy to the poor for electricity supply seems to be non-existent due to poor quality and erratic nature of electric supply.
- In terms of priority of access, the government seems to have concentrated on the urban population so far, whether it is regarding the speed of electrification, or with regard to making LPG cylinders available to the poor.
- While there is a cap on the consumption of Kerosene, there is no such cap on the consumption of LPG by the urban population, with some households having more than one LPG connection; though the government is in the process of introducing norms to correct this.

Chapter 4

Central Grid vs. Decentralised Energy Solutions

- A Case for Decentralised Energy as the Preferred Option for Rural Electrification

- The Issues of Concern with Grid Electricity : For & Against

The analysis presented in the earlier chapters of this report, very clearly indicates that Grid or Centralised Electricity Supply has failed to deliver either in qualitative terms or in quantitative terms particularly with regard to rural electricity supply. It has also demolished a huge number of so-called facts which the proponents of Grid Electricity have been positioning themselves so far, such as, reliability, costs, availability of technology & know-how, equity and energy security amongst various other issues.

The following table identifies key issues of concern. It matches the arguments in favour of Grid and Centralized Electricity Supply with a counter argument, taking examples and cases from the analyses presented in the earlier sections of this report. *The arguments in favour of a Central Grid are primarily those which are often quoted by Government sources and those in the Policy circuit.*

Argument in favour of Central Grid	Counter Analysis of the argument
Equity No Differentiation between urban and rural consumers. The mode of supply to urban consumers needs to be made available to rural consumers as well. In the long run, the supply of electricity pattern in rural areas would be the same as it is in urban areas.	Equity The Equity argument is faulty here primarily due to the inequitable treatment met to rural consumers with priority access being given to urban consumers. As urban centres tend to grow and with increase in disposable incomes of the urban rich, the urban energy consumption is bound to increase which will result in continued prioritization of urban centres for energy supply with de-prioritization of rural areas.
Reliability and Economics and Technology argument It is a reliable and extensive source of power, with virtually no capacity limits. Capable to adjust depending on changes in consumption patterns. 24 x 7 supply.	Reliability and Economics Current experience in rural areas indicates erratic supply, both in terms of quality and quantum. Frequent drop in voltage resulting in some appliances being rendered non-functional including traditional tube lights. Sometimes even abrupt surges in voltage result in burning or destruction of domestic appliances.

Good quality supply

No hidden costs or regular maintenance to end users such as battery replacements, inverter replacements etc.

Grid Power is cheaper than Decentralised energy as the cost of generation from coal fired power plants is in the region of Rs. 2.5 per kWh to a maximum of Rs. 5/- per kWh for the new and improved coal fired power plants and ranges from Rs. 0.50 to Rs. 1.50 per kWh from large dams.

Generation capacities can be increased as and when necessary. India has sufficient supplies of coal and therefore ensures energy security.

India has the technology and knowhow for a central grid, but not so for decentralized energy solutions.

We also have a problem with regard to disposal of batteries and other consumables.

With a centralized grid supply, a good energy fuel mix is possible, thereby reducing the end cost to the consumers.

Lack of ability of poor people to pay for high-cost decentralized energy solutions.

Failed Renewable Energy Projects and lack of mapping of renewable energy resources and resource-rich regions.

Delivery time for servicing of technical faults is very high.

An open invitation to steal energy from live high tension wires leads to increase in T & D losses.

Centralised set up for bill collection, metering etc. with no people's ownership or partnership.

Battery and other consumables though need to be replaced at intervals of 5-7 years. If there are community-owned and managed systems, the costs are offset from revenue.

This ensures sustainable use of energy and promotes and mandates efficiency and energy conservation practices.

Communities can maintain the set up and it can lead to employment generation at the community level.

Reduces manpower and heavy electrical equipment inventories at local utility offices, thereby reducing cost overheads and capital costs.

Saves on Transmission infrastructure which varies depending on the distance between the village and the main sub-station.

More importantly decentralized energy cuts transmission and distribution losses by a large percentage, primarily because one cannot steal from such an energy set up that easily.

This frees Government or public land by reducing setting up of sub-stations for every 10 odd villages.

To meet the requirement of 100% village and household electrification, government estimates setting up of at least 30,000 MW of new power plants. But by going in for decentralized energy systems, and avoiding 30,000 MW[41] of electricity, carbon emissions in the region of 200 Million tones can be avoided every year.

India's coal reserves are fast depleting and given the poor quality of Indian coal, thermal power generating companies are shifting to imported coal. So, the argument of energy security in favour of coal is a myth.

On the other hand, India has been a exporter of Solar PV and wind turbines and has mature technologies of both, as well as technologies for bio mass and bio gas.

[41] Planning Commission, 11th Plan Approach paper

	By creating a huge local market for renewable energy, we will also be increasing the manufacturing base and thereby increasing our exports. As it is, bulk of the Solar PV modules and wind turbines manufactured in India are exported. This way, our local domestic market will also increase. Decentralised energy solutions can create a space for promoting entrepreneurship amongst rural masses, while generating employment and also help in livelihood enhancement. Reduces huge displacement costs which are involved in the setting up of large coal fired power plants and dams. It also reduces the rate of destruction of habitat, environment and the rich flora and fauna of India. Despite the high subsidies given to rural population for electricity, the actual cost that they pay in relation to the electricity supply is very high and almost on par with urban domestic consumers. Bulk of the subsidies is lost in the huge T & D losses and the high cost of transmission infrastructure for rural connectivity. Decentralised energy systems could reduce our dependence on import of oil and gas and thereby improve our GDP. Failed renewable energy projects are largely due to the management and mode of implementation rather than the technology *per se*. As far as mapping of resources is concerned, it can be done by involving rural people and there is a scope for increase in investments in R & D in the renewable energy sector.

The other advantages in a decentralized model are:

a) Low gestation period
b) Reduction in cost of grid upgradation and maintenance
c) Saving on opportunity cost of plant shutdown
d) Reduced wastage due to low efficiency
e) Low cost of installation
f) Reduced cost of externalities

Renewable Energy Solutions-
Some elaborated Arguments and perceived barriers

1. *Lack of Technology for Decentralised Energy and lack of energy mapping for sources*: While there is some truth in this argument particularly in terms of energy mapping of sources such as, for bio-mass or to gauge wind potentials or small hydro potentials in the area which also include soil testing and so on, such mapping doesn't require engineers. The Government of India under MNRE has budgets amounting to Rs. 500 Crore per annum for promoting Renewable energy solutions. A small part of this budget could be used for research, instead of wasting it on full page advertisements in newspapers on a regular basis as is being done so far.

   Technologies do exist and some of the technologies and designs in India are at par with the rest of the world. India exports its Solar PV panels to countries such as Germany and Japan and, had the quality of India's exports in this regard been suspect, such developed countries wouldn't have been purchasing the same from Indian companies.

   A fundamental prerequisite for any decentralised energy project is that of "getting the economics right". The cost model for decentralised energy must show an appropriate return, after consideration of investment in new technologies, operation and maintenance costs.

   Although many decentralized energy systems use proven technology, there is a common misconception by those unfamiliar with it that the sector is characterized by intrinsically unproven, expensive and risky technologies. A robust system of technology validation and performance rating will thus be an essential component in any policy that sets targets and incentives for installing decentralized energy capacity.

2. *Political Will*: Political leadership and investment in public education has a critical role to play in paving the way for decentralized energy solutions to be accepted by local communities. The main problem here is that our politicians tend to pass on sops such as, free electricity during election time and people are not made aware that at some point of time, they will have to pay for electricity they would use.

   Furthermore, there is also a feeling that grid electricity is far superior to renewable energy solutions and this feeling has to do with a number of renewable energy projects which have failed. There is very little drawn from successful projects though.

3. *Failed Renewable Energy Projects*: A number of renewable energy projects, particularly, solar projects in rural areas have failed. These projects have not failed due to either dearth of technology or usage of inferior technology. The factor which has led to the failure of these projects lies in its poor planning and

implementation and more importantly the management and maintenance of such programmes.

For example, in some of the tribal areas in Kerala, Government with the help of some agencies installed solar energy supported electrical systems. They could install the instruments and other things in a very scientific and professional way. However, after some time the batteries which were used in solar lamps and other fittings were stolen and sold by the locals. This is mainly because of lack of ownership by the local community in the implementation of the programme.

The other reason for failure of renewable energy systems is the lack of proper sizing of the system. In many cases, they are either significantly oversized or significantly undersized. Often the capital cost is subsidized. Hence, there is no incentive to optimally size or plan the systems. Our analysis of actual data from a few systems clearly reveals a possibility of 25-50% reduction in costs by optimal sizing and planning.

4. *Multiple use of Grid electricity as against Renewable energy solutions*: The other argument in favour of grid electricity is that a grid can in typical cases power and solve multiple requirements of domestic and agricultural needs without having to invest in standalone equipments for generating power alone.

   For instance, it is said that grid power has the capacity to supply electricity to run everything, from an automatic dryer for agricultural operations to running of a flour mill and other allied small scale agro-based industry and also for meeting requirements of domestic lighting, heating, running agricultural pump sets.

   However, the ground reality is that, given the current track record of reliability of supply, and also based on reading into the government's priorities in the coming years, it can be safely said that quality and high quantum of energy supply is not even on the government's remotest radar! Having missed the deadline of achieving 100% village and hamlet electrification which was slated for 2009, the current priority of the government is to just ensure and prioritise that at least 1kWh of electricity supply is made available to all households by 2012.

   Going by the government's track record of electrifying-only 13,000 villages in the last two years and with just under 50,000 villages from the day RGGVY was launched in early 2005; if the government continues with its existing policy of Grid connected power, then achieving the 2012 target of 100% rural electrification would take the government at least another 10 years to achieve.

   On the other hand, it is possible to have a multipurpose mini-grids set up in quick time through renewable energy, with bio-mass being one option or a hybrid system which can be a combination of solar and bio-mass. Even going in for standalone renewable energy products for different solutions could still be a more cost-effective way, since that would ensure that all energy related requirements are covered to the fullest extent.

The Role of Governments, financial institutions, micro-finance and Private Sector in Decentralised Energy Solutions: What have they done so far?

The issue which continues to remain intriguing is the whether the Government not really doing enough to push decentralized energy options?

Furthermore, are other institutions like the Financing Institutions, either REC or IREDA or any Micro-financing set ups not really doing enough, or are they?

Talking of the Government, yes, the government has not done enough to push for renewable energy options and it is very evident from the very goal that the government has set for itself as far as rural electrification is concerned. The Government's budgetary allocation is focused towards pushing for grid connectivity in villages than investing in decentralized renewable energy solutions.

While the rural electrification programme (RGGVY) does have a section on decentralized distributed energy generation, the sum of money allocated to it is a paltry Rs. 540 Crores or Rs. 5.40 Billion as against the Rs.5000 Crores or Rs. 50 Billion spent on centralized grid power. This Rs.5.40 Billion is also not over and above the targets set for the MNRE but is rather a part of that.

So, the question then is why is that so?

Notwithstanding the arguments which are generally put forth by the government as detailed in the earlier section of this chapter, the other key reasons are:

a) Management of these Projects
b) Maintenance and operation
c) Financing, who stands guarantee for these projects?
d) Security of the equipment

Despite the fact that Section 5 of Electricity Act of 2003 does give the mandate to the Government to use the services of local networks and institutions such as, the *Panchayat* Institutions in rural electrification and also Section 4 of the same Act gives mandate for decentralized distributed generation, still the fact remains that the Government or the utilities are yet to let go of the control they have over electricity distribution to networks other than what the government or the utilities control.

While on one hand, they do not want to lose control over the generation, management and operation of decentralized distributed generation projects, on the other hand, they are not willing to confess to the fact that they also do not have the sufficient man power or operation structure to oversee the management and further, and neither do they (in most cases) enjoy the confidence or trust of the local communities.

This also comes in the ways of maintenance and operations of projects and as is the case in most of the failed renewable energy projects, post-installation, everything is forgotten. People are not even trained to undertake simple care and maintenance of these set-ups and since there is no sense of ownership of the same amongst the people, they tend to treat these systems as temporary solutions.

As far as local financing is concerned, there have been cases, which we will see in the later sections of this chapter as to how a number of co-operative societies and micro-financing groups have come forward in collaboration with NGOs and renewable energy service providers to install home lighting systems and small power plants in villages.

But in the case of government financing, it works, only if there is a guarantee being provided and the guarantee which they expect is from the government or the utility. But, since, the utility is not interested in decentralised renewable energy based distribution systems, the financing for these projects rarely take off.

As far as the private sector is concerned, by and large, their focus till date has been only on projects where there is a huge subsidy element. However, they are also a little wary about these projects, since there has been considerable delay in getting access to the subsidy amount, with the time taken to release the money ranging sometimes from 5 to 7 years.

Our policy makers too perhaps believe in what Fred Palmer, Senior Vice President of Peabody Energy, the Coal Giant once said in 2007 that, "People use fossil fuels because the good Lord put them on earth for us to use".

"They however need to realize that the Good Lord also gave us Sun, Wind, Water to also be put to good use".

However, the private sector has a major role to play in the decentralized energy segment. Already, private sector in India is increasingly looking towards the rural sector for market expansion, though at present their attention is restricted to the automobile and agriculture sector and not really into the electricity and energy sector. One good example of the role of private sector in the agriculture sector is that of ITC Limited's *e-chaupal* programme, which primarily aims at bridging the link between farmers and markets using information technology solutions. This has helped in removing the shackles that the Indian farmers have traditionally been bound in, which includes debt, dependence on local intermediaries and selling at throw away prices and so on.

While the electricity sector is no where similar to the agricultural sector, there is a possibility of private sector involvement in it, which will ensure that there is required investment for decentralized energy systems, while at the same time, ensuring that it is sustainable, as profit is the motive. However, for any decentralised energy model to be successfully implemented, it is essential that there is community involvement, which can be made possible by making the community "share holders" of the initiative with private sector companies.

A number of private sector companies are fast getting into the power generation sector, though their current focus is primarily on coal and gas based electricity generation. With the right kind of policies and incentives, these private companies can also be encouraged to enter into renewable energy based decentralized energy systems.

The Economics of Decentralised Energy Options vs. Centralised Grid

The general perception is that all decentralized energy options are very expensive and inefficient and that they are dependent on nature, particularly solar and wind.

Below is a brief of how some of the decentralized energy systems work, their general economics and kind of systems and technology which are available today:

Solar Photo Voltaic (Solar PV):
Photo Voltaic or Solar cells as they are also called convert sun light in to electrical energy. A Solar PV system comprises of a PV module made up of many cells, which is connected to a inverter and a battery. The PV modules covert the sunlight into energy and is stores in the battery.

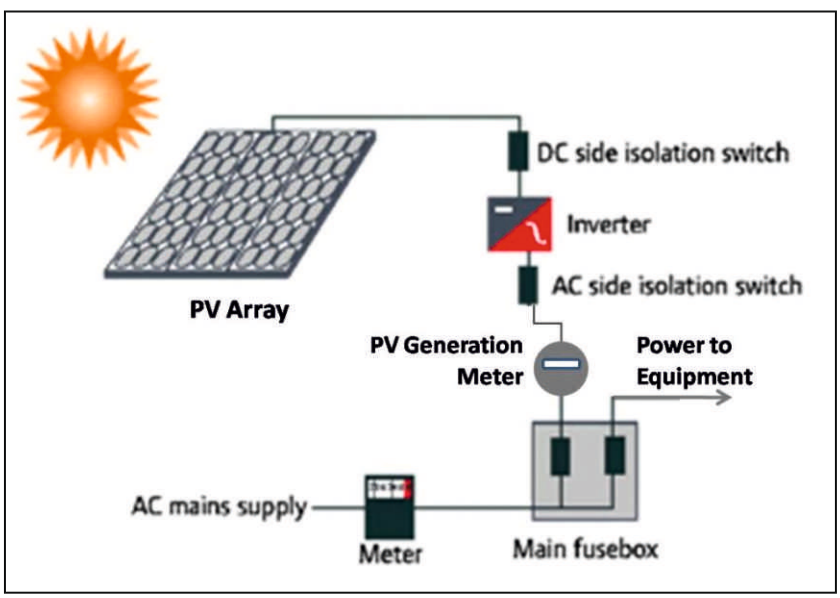


Figure 13 –Schematic Diagram explaining the working of a Solar PV Panel for energy generation (Source: www. blog.mapawatt.com)

India has very high solar generation potential and it is estimated that all of India's electricity needs can be met through solar alone, given that India is blessed with 300 days of sunlight with a very high intensity rate.

Photograph on the left shows a street light being powered by a solar panel whereas the photograph on the right shows a solar panel (marked by an arrow) powering a primary school in a village

Solar PVs are very expensive and costs roughly Rs.18 Crores or Rs.18 Million for a 1 MW plant. The average efficiency of a solar PV system is in the region of 17-20% and particularly with the kind of sunshine received across India; the efficiency rate sometimes is as high as 22%. The efficiency rate is based on the hours of sunlight and the average number of sunny days in a year. India, typically has 6 hours of sunlight with 300 sunny days, the number increases in the Southern part of India and the desert region of Rajasthan.

A village of an average size of about 50 households with an average size of a household being 7, translating to a total population of 350, with an average land holding of roughly 3-5 acres would require a solar power plant of about 20 kW peak to take care of 100% irrigation (water pumping needs), all household electricity requirement including entertainment and also take care of a couple of flour mills and electrified sewing centres.

"The use of solar energy has not been opened up because the oil industry does not own the sun."

-Ralph Nader, quoted in Loose Talk, 1980, Linda Botts, ed.

The cost of such a system would be in the region of Rs. 50,00,000/-, which means that the cost for powering one household with a 24 x 7, 365 days of regulated and sustained supply would be in the region of Rs.100,000/- with a cost of replacement of batteries and other consumables in 7 years time at a replacement cost of Rs. 100,000/-.

In kWh terms, the cost of generating 1kWH is estimated to cost roughly Rs. 18 with a recovery of entire costs over a period of 8 years, which could also include debt component.

In comparison, scientific studies done on the cost of generating 1 kWh of grid power to a village which is in a distance of 20 Kms has been computed at Rs.22.50 per kWh, which includes cost of transmissions lines, manpower, maintenance, office set up, grid set up etc.[42] (A detailed table and graph showing various cost comparison is at the end of this chapter)

The cost of setting up a 1MW of coal fired power plant with modern efficient technology is in the region of Rs. 5 Crores or Rs. 50 Million. The advantage with Solar PV system is that it can be used for something small such as a home lighting system or can be large enough to meet the requirement of an entire town.

Solar Home Systems (SHS) and small solar panel systems have been used in such niche applications especially in projects that require small loads of 20-100W. However, there have been a number of large projects such as the one in Sagar Islands in Sunderbans and Leh in Kashmir.

Solar lanterns have been successful in southern India and are becoming more widely available in northern parts. MNRE under its PV programme has distributed around 610,000 systems, totaling to around 20MW of capacity. This includes solar lanterns, home lighting systems, street lighting systems, water pumping systems, and an aggregate capacity of about 1.2 MW of standalone power plants.

<u>Wind Power</u>:
A Wind Mill comprises of rotor with three propeller blades arranged as one can see in a typical electric fan, but in this case, it is arranged in a horizontal manner. The wind pushes the blades, which makes it turn. The blades are connected to a gear box where using the magnetic field, the mechanical energy created by the movement of the rotor or the fan is converted into electrical energy.

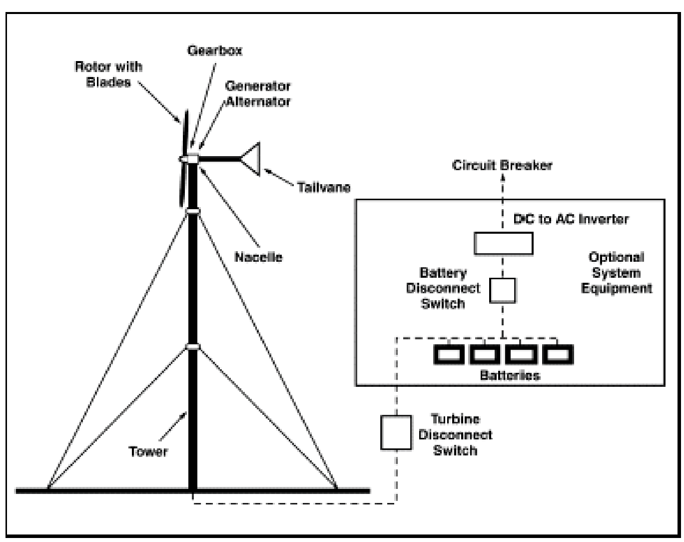


Figure 14 - Schematic Diagram of a working of a windmill (Source: www.omafra.gov.on.ca)

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[42] Source: Research paper of on Rural Electrification in India: Economic and Institutional aspects of Renewables, written by *James Cust, Anoop Singh and Karsten Neuhoff,* December 2007, published as part of the series of EPRG 0730 & CWPE 0763. See also table and graph at the end of this chapter.

India has huge wind power potential with the MNRE estimating it to be in the region of 50,000MW, while the Indian Wind Energy establishment estimates the potential to be in the region of close to 100,000MW.

In terms of cost, wind energy is one of the most economical options amongst other renewable energy particularly solar, as the average cost of generating 1kWh of wind energy works to roughly Rs.3 per kWh.

The average cost of setting up a 1MW wind power plant works to Rs.5 Crores or Rs.50 Million, with an efficiency of roughly 34% and can even go up to 42% in regions which have very high wind velocity such as some places in Tamil Nadu, Gujarat, Karnataka etc.

Wind Power is typically a grid connected system, though; there is a possibility of having small roof top generators, though the efficiencies of these roof top generators currently available in India are not very high.

However, with a wind system it is possible to power a cluster of villages, though the costs will be marginally higher than conventional grid system.

Bio-Mass:
Waste wood, crop residues and other such organic bio-degradable matter are deposited in a huge pit which is allowed to decompose. The decomposed matter gives out methane and this is used to run a gassifier or a turbine which will convert the mechanical energy into electricity.

The typical fuel for a bio-mass gassifier can be any waste agriculture residuals such as paddy husk, wheat husk, fallen leaves, wood waste, and a whole range of seeds which are found aplenty in rural India.

The use of bio-mass gasification technology for rural electrification still remains limited, though the potential for it is huge. The current installed capacity stands at 150MW with the government estimated potential being 30,000MW. However, there are many successful bio-mass gassifier projects in India and some of them have been functioning since the last decade or more.

Fuel supply plays a crucial role, as one needs to confirm the various properties of the woods before using them.

The typical cost per kWh from a bio-mass plant varies from Rs.2.50 to a high of Rs.6 with the capital costs ranging from Rs.10,00,000 to Rs.30,00,000 for a 1 MW plant, making it one of the cheapest in capital costs.

In terms of costs and its comparison to a grid electricity, assuming the cost to be in the average of Rs.4/- (average of Rs.2.50 and Rs.6), the cost becomes the same as in Grid supply, if the distance between a village and the grid is around 5 Kms. Any distance between the Grid and the village of more than 5 Kms makes a bio-mass plant competitive and if the distance is between 15 and 20 Kms between the grid and the village, then bio-gas plant becomes cheaper than the conventional grid supply by a factor of more than 2.[43]

Bio-gas:
Bio-gas plants primarily use cattle dung in a large pit and allowed to further decompose producing methane gas, which is used largely for cooking but also for some lighting purposes. Bio-gas plants were at one point of time very popular in villages, primarily due to the fact that a small bio-gas plant producing enough gas to run the kitchen of a normal household requires just about 4-5 kgs of dung which is fairly easy to obtain as most rural houses tend to have a couple of cows at the very least.

However, the main problem involved with bio-gas plants is that, a regular cycle of dumping fresh dung needs to be followed and importantly the dung needs to be fresh. The normal practice followed in a typical village in India is that they allow the cows to freely roam around to graze as it saves them the cost of providing cow or animal feed. Therefore, the dung tends to be scattered as and where the cows go for their grazing. However, in households which have a central area for cows to graze around, there is a more or less concentrated area where the dung is found and so it is easy to collect fresh dung. The other problem with bio-gas plant is that it requires sufficient quantities of water. The general thumb rule is one to two buckets of water for every bucket of dung. Since water is a scarce commodity, with piped water supply being a rarity in villages, this is a major issue. The third issue related to a typical bio-gas plant is that it requires regular cleaning to remove the slurry. The slurry needs to be removed at regular intervals and has good properties to be used as manure. But, generally, people tend to overlook the cleaning part, which leads to either the formation of gas being lower or gas getting clogged.

[43] Source: Research paper of on Rural Electrification in India: Economic and Institutional aspects of Renewables, written by *James Cust, Anoop Singh and Karsten Neuhoff,* December 2007, published as part of the series of EPRG 0730 & CWPE 0763

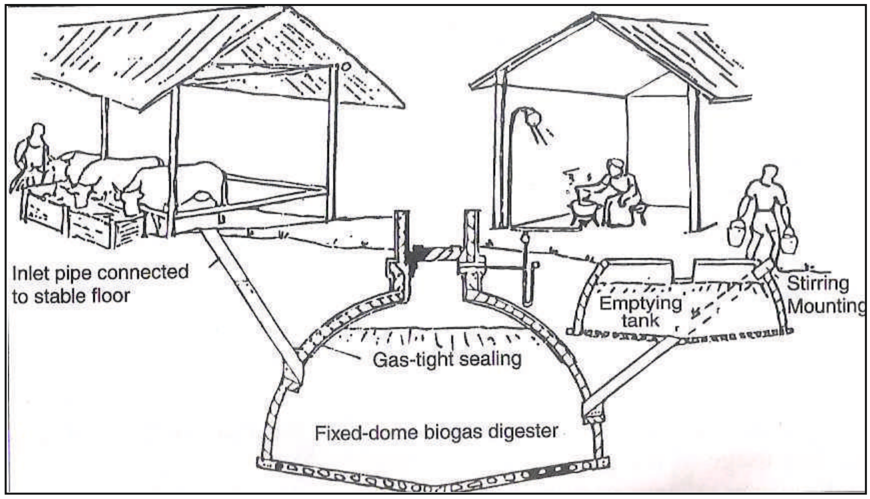


Figure 15 - Schematic Diagram of a Biogas Plant in a Village (Source: Alternative Sources of Energy, By N.S Rathore, A.N Mathur and S. Kothari, Indian Council of Agricultural Research)

A typical bio-gas plant for a household costs Rs.10,000 to a maximum of Rs.15,000 which includes a stove and even if a household has just one cow, it is enough for a small bio-gas plant. Bio-gas plants have the advantage of taking care of base load electricity and a good hybrid with solar will ensure constant electricity supply in villages, subject to the availability of the fuel source. Bio-gas plants are fairly efficient, as long as the engines are tuned regularly and the technology has matured with a number of local manufacturers that finding spares or repair or general maintenance is not a major issue.

Small Hydro:

The hydro uses the flow of water to run a turbine and the mechanical energy from the movement of the turbine is converted to electrical energy using magnetic fields. Small run-of-river hydro has enjoyed modest success in many locations across India as a localised, cheap, clean, reliable and minimal-impact electrification option.

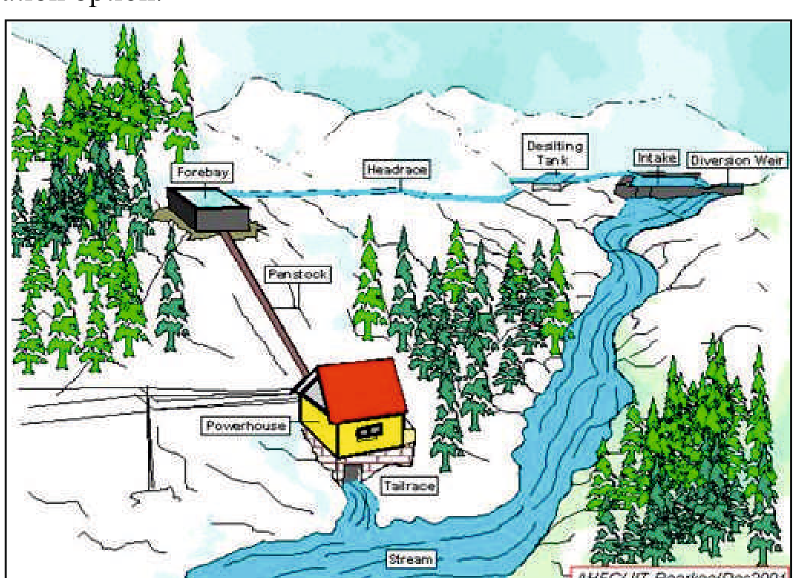


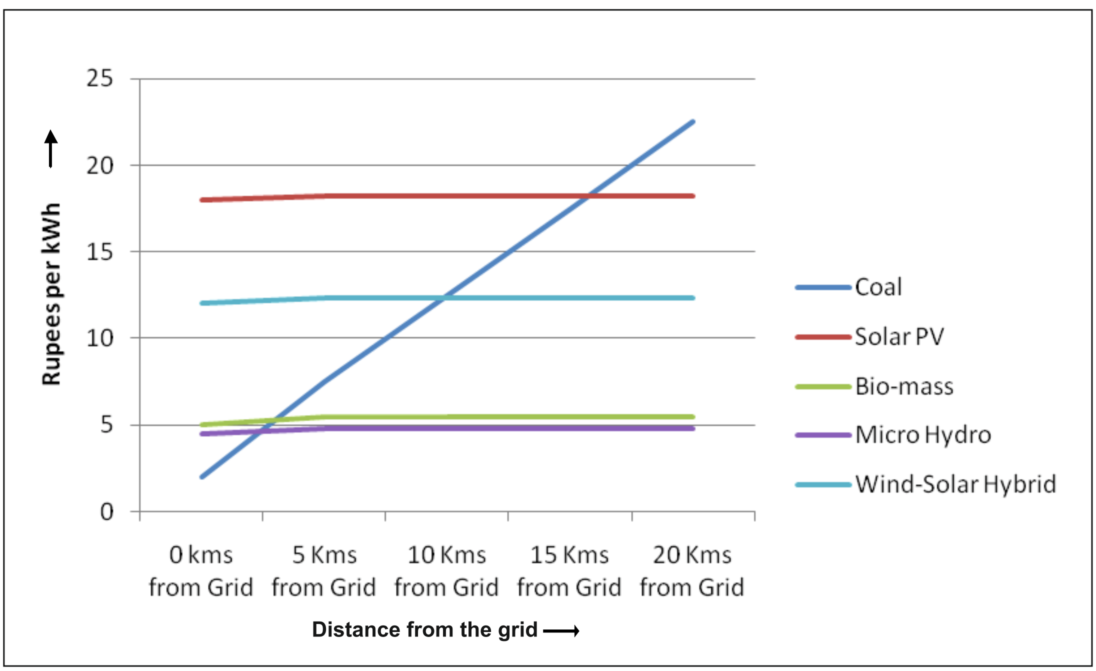
Figure 16 - Typical Arrangements of a Micro Hydel/Small Hydro plant (Source: Alternate Hydro Energy Centre, IIT Roorkee)

Currently only 210MW are installed across 267 projects, predominating in the north. Small hydro systems offer significant potential for wider deployment across mountainous rural areas. Across India significant untapped potential would allow for up to 15GW of additional capacity. Prospects for significant expansion of hydro-storage are smaller, and recent growth is stagnating.

The investment costs for small rural and remote hydro power projects in India can be Rs.10,00,000 for a 10 kW system for a village but, if it is clubbed with bio-mass gassifier as a hybrid unit, the costs tend to come down.

The typical cost of generating electricity from a small or micro hydro is in the region of Rs.3 to Rs.6 per kWh, with the average being Rs.4.50. Again, as is the case with bio-mass, the cost of generating energy from a small or a micro hydro becomes cheaper than the supply from a conventional grid by a factor of more than 2, if the distance between the grid and the village is more than 10 Kms.

Figure 17 – Generation, transmission and distribution costs based on distance between Village and Grid/33 KVA line



Cost Comparison of various sources of Electricity[44]

Source of Fuel	Generation Cost per kWh (Rs.)	Transmission Infrastructure Cost Per Km for a load of 100 kW	Other Maintenance costs/distribution on infrastructure etc (per kWh)	Total Cost of Generation per kWh per Km	Total Cost of Generation per kWh at a 5 Km distance from Grid/33KVA line	Total Cost of Generation per kWh at a 10 Km distance from Grid/33KVA	Total Cost of Generation per kWh at a 15 Km distance from Grid/33KVA	Life of the Unit
Coal	Rs. 2.00	Rs. 1/-	Rs. 0.50	Rs. 3.50	Rs. 7.50	Rs. 12.50	Rs. 17.50	30 years
Solar PV	Rs. 18/-	Nil	Rs. 0.20	Rs. 18.20	Rs. 18.20	Rs. 18.20	Rs. 18.20	25 years
Bio-mass	Rs. 5/-	Nil	Rs. 0.50	Rs. 5.50	Rs. 5.50	Rs. 5.50	Rs. 5.50	15 years
Micro Hydro	Rs. 4.50	Nil	Rs. 0.30	Rs. 4.80	Rs. 4.80	Rs. 4.80	Rs. 4.80	25 years
Wind-Solar	Rs. 12/-	Nil	Rs. 0.30	Rs. 12.30	Rs. 12.30	Rs. 12.30	Rs. 12.30	25 years

It is evident from the figure 17 that even at a distance of 5 Kms from the Grid to a village, the cost of generation from micro and mini hydro systems are more or less the same as the costs per kWh from coal fired grid based power plants; and at a distance of 12 Kms between the grid and the village, the cost of generation from wind-solar hybrid systems are on par with that of coal; and stand alone solar PV systems cost the same to generate 1kWh of electricity as coal for a distance of 18 Kms from the grid to a village.

These costs have taken into account very conservative plant load and efficiency factors for all renewable energy based systems, while it has taken the lowest current costs for coal based generation.

[44] Various research papers: Providing electricity access to remote areas by M R Nouni, S C Mullick and TC Kandpal, Science Direct publication, Hansen and Bower, 2003 etc.

It is true that currently solar PV systems are expensive and huge amount of Government support is required to promote this sector, but given its cost-competitiveness to coal fired generation for villages beyond 18 Kms from the grid and considering that coal fired power plants already enjoy a slew of benefits, the actual cost of generation from coal fired power plants may be even more than what is shown in the figure and tables above.

The only issue which needs to be looked into is the management of decentralized systems.

There have been a number of management models that have been tried. While it is difficult to point out the best, later in the chapter, we have looked at a number of successful and not so successful decentralized units functional across the country using either one single renewable energy source or a hybrid with single or multipurpose solutions.

Is there a Way Out?

National Solar Mission: One big hope for all decentralized energy projects, particularly Solar-based power projects and solar based decentralized distributed energy systems has soared with the launch of the "Jawaharlal Nehru Solar Mission" by the Government of India. Some of the key mile stones for the mission is to deploy 20 Million solar lighting systems for rural areas by 2022 and to promote off-grid applications with a target of 2000 MW by 2022 with a 200MW target for the next five years.

It has also announced a slew of incentives such as a 90% grant for the systems, with management left to the communities to set up such plants. The heartening thing about this is that a community which is interested in setting up a system in their villages can directly approach MNRE and not route it through the utilities.

Link to Rural Development:
The National Solar Mission also links the rural solar projects with rural development, which means that there is ample scope to link any proposed solar generation project in the rural areas with other renewable energy projects such as a hybrid solar with bio-mass and link it with other ongoing rural development projects such as the National Rural Renewal Mission (NRRM) or the National Rural Employment Guarantee Programme (NREGA) for additional funding if required.

The link to the National Rural Employment Guarantee programme can also ensure that there are suitable employment opportunities created in these small electrification and village energizing projects.

Learning from Successful Decentralised Energy Projects

Kasai village, Madhya Pradesh (biomass for electricity): Kasai is a remote, forest-fringe *adivasi* (tribal) village with 55 households and a population of 392. It is not connected to the grid. The village is endowed with abundant biomass resources in the form of wood (from forests and farmland), crop residues, cattle dung and oil seeds.

Since 2005, the Government has been supporting a project in the village to generate electricity from a small, 10 KW biomass plant. (MNRE is funding eleven such projects in Madhya Pradesh.) Although the government funded 100% of the capital costs, the project is being managed by the local community, with some technical support from the local Forest Department. For instance, villagers are responsible for gathering biomass for the plant and collecting Rs.120 a month from each household (£1.55p) to meet the plant"s operating and maintenance costs.

In addition to the maintenance fee, there is a user charge, based on the amount of electricity and energy consumed. A village committee comprising 11 members, five of whom are women, has been constituted to oversee the operation.

The plant generates all the lighting for households, school and streets, has enabled music systems and television to be installed in the village for entertainment, and supplies electricity for a flour mill, water pumping and a milk-chilling unit.

The project has helped stem migration from the area and has enabled a trebling of agricultural production due to the availability of water for irrigation. Milk is not spoilt due to the extreme heat, so it has become marketable. This could possibly help in bringing in a village dairy system, which could mean further livelihood enhancement for the villagers.

The setting-up of a flour mill will mean that people can process wheat and rice and sell the flour at a higher price in the market. Last but not the least, this project has also led to a household water piping system.

At this point, traditional biomass (dung, wood and charcoal) continues to be used for cooking and heating purposes. The existing system could be possibly modified to ensure that gas is supplied for cooking purposes too. This would help avoid the respiratory illnesses caused by burning traditional biomass indoors.

Gosaba island, West Bengal (biomass for electricity): Gosaba Island is one of the 54 inhabited islands (out of a total of 104 islands) in the Sundarbans, a large mangrove forest region situated on the Ganges Delta. Farming here depends almost completely on the monsoon and the area is low-lying.

After independence, the overall progress of the people remained severely hindered due to absence of electric power in the region. The conventional electric power line had not reached the region due to its geographical location, and also because most of these places are separated from the mainland by wide rivers or creeks.

Electricity was available to only a few houses situated near specific shops or market places. This was generated and supplied for 3-4 hours by means of small diesel generators. Customers paid Rs.4 per day *per point* (typically a 40W bulb or tube light), which was a very high rate (the present rate is Rs.18 per kWh). Kerosene lamps were the only source of light for students studying at night.

Then, a biomass gassifier power plant was commissioned on 20th June 1997 as a joint collaboration of the state and central government. It uses two fuels to generate electricity via gasification. The main fuel is biomass in the form of tree branches, twigs and bark (70%). The support fuel is diesel (30%). (Diesel is used here because when this plant was built; up till then the technology for generating power using only biomass was still not available). Local people called it the "wood electricity" plant.

One of the reasons for the project's success was that locals were involved in decision-making from the very start. Door-to-door visits were made and briefings on different aspects of the project were given to the village *panchayat* representatives, who in turn discussed it with the local people. A series of public meetings was held to raise awareness of the technology, its limitations, advantages, and the need for an energy plantation.

Concerned by the threat to their incomes, the local diesel operators initially opposed the setting up of the power plant. But other members of the community undertook a vigorous campaign to sell the benefits of the new approach (which included the health benefit of cutting the toxic fumes from the diesel generators). This dissipated the opposition to a large extent and some of the diesel operators were later employed in the plant.

The plant is locally owned and managed through the "Gosaba Rural Energy Cooperative". This body was set up by the West Bengal Renewable Energy Development Agency (WBREDA) in 1996. Members of the village *panchayats* are on the board, which is one of the ways of ensuring a good level of community ownership. The Cooperative sets the tariff, advises WBREDA on where the power line should go, and is responsible for collecting electricity bills from each household. It is a matter of pride that there have been no instances of electricity "theft"or of defaulting on bills.

For the energy plantation, trees were planted on 71 hectares of low-lying riverbank silt beds (*char* lands). After three years, the plantation was fully established and was providing a steady supply of wood to the plant. Additional biomass is supplied by local farmers.

This is a relatively large biofuel plant of 500 KW, benefiting 3,027 households and a total population of 18,220.

The availability of electricity has allowed students to study at night and achieve better exam results. Small-scale factories have been established which are using electric machinery to carry out boat repairs, welding, knife- and tool-sharpening and spice-grinding. An operating theatre is now functioning at the government health centre on the island. With the availability of refrigerators, it has become possible for the first time to store life-saving vaccines and medicines.

Electric pumps are now being used for irrigation; people are able to watch sports and other programmes on cable television, which was not thought possible earlier; films are being screened in newly-established video parlours; a computer training centre has also been opened; and electric sewing machines are being used to make fishing nets.

Gram Vikas projects in Orissa (solar, biodiesel, gravity flow for a piped water supply; lessons from previous biogas schemes):[45] Gram Vikas is an NGO and Christian Aid is their international partner working on rural development in the eastern, coastal state of Orissa. The NGO operates in 21 of the 30 districts in the state, in a total of 732 villages.

One of their principal interventions is the provision of a piped water supply and lighting for *adivasi* villages. Being remote, these villages are generally not connected to the grid. Gram Vikas's solution to the water supply problem is to install stand-alone, renewable pumping systems, driven by solar power, gravity flow and biodiesel - In the case of solar and biodiesel, by pumping water from wells in the village; in the case of gravity flow, from wells or autumns at a higher altitude connected to a water tower in the village.

Under the scheme, each household is provided with a toilet and washroom; water is piped to these units as well as to taps installed in the kitchen and yard. If the project involves solar, then lighting can also be supplied.

Measured purely in cost terms, gravity flow is the best option, followed by biodiesel and then solar. The installation cost for each in three villages of a similar size was: Rs.195,000 (£2,530) for gravity flow in Kerandi; Rs.325,000.

[45] The text for the following case-study comes from pp.32-3 *Community Answers to Climate Chaos: Getting Climate Justice from the UNFCCC*, Christian Aid report, 2009

(£4,220) for biodiesel (Kichiling); and Rs.500,000 (£6,490) for solar (Chanabogodo). So far Gram Vikas has installed 80 gravity flow systems – and the state government has been supporting this work.

Labour time is one factor that needs to be taken into account here. The small-scale biodiesel projects do require considerable labour inputs by villagers to succeed: for example, the time spent planting trees, harvesting the seeds or nuts, and then preparing the fuel (oil is extracted from the seeds or nuts and mixed with ethanol).

Gram Vikas previously supported biogas projects, which saw villagers using cattle dung to produce gas for cooking and lighting. This has made them aware of some of the maintenance challenges posed by this technology. Many of the biogas plants built in Orissa during the 1980s and 90s fell out of use because people were not trained in how to maintain them, the upkeep was time-consuming and families did not keep enough cattle to produce sufficient dung for the plants.

One advantage of Gram Vikas's current projects is that a "maintenance fund" is set up after the infrastructure is built. Every household makes a small contribution to the fund to cover the cost of future maintenance and repairs. One person in the village is nominated to operate the system. Gram Vikas's insistence on 100% community participation increases the chances that the project will last beyond the intervention period (usually three to five years).

Scaling up all these schemes, so that they cover whole districts, will of course require considerably more investment by government and donors. For example, in the case of solar, the Orissa state government is subsidising some village lighting and water supply projects. However, this support is not yet extensive enough to either pay for all the capital costs or transform the energy supply situation across whole districts.

A case study of Rural Electrification: Coming together of Private Sector, Government and People-Chhattisgarh Solar Rural Electrification Project: Chhattisgarh is India's most backward state. The state has suffered under decades of negligence from government authorities and continues to do so. The geography of the place is covered by dense forests and mountainous landscape making it an extremely difficult terrain for development activities. So much so, the government has notified that many villages would not get electrified since it is difficult to provide grid connectivity under such harsh geographical conditions.

A joint project of the Chhattisgarh Renewable Energy Development Authority and TATA BP Solar, aimed at electrifying 113 villages using solar power plant covering over 2000 households has been initiated here.

While this is a case of private sector and government participation, there has been little or no involvement of the local communities either in the project design, sizing up of systems (in terms of determining the quantum of generation) nor in its routine management and maintenance.

While the solar power packs ranging from 2.5 kW Peak to 6 kW peak are still functioning, the downside to projects are related to its long term sustainability. The key questions which will arise in the near future are:

a) Who will pay for the regular maintenance of batteries?
b) Who will pay for the replacement of batteries?
c) Who will pay for any repair or rectification of inverters etc.?

In this case, as far as the people of the villages are concerned, it is a government property and they have no stake in it, but does the government or the "utility" realize that it is their asset and they need to maintain it, only time will tell.

Hosahalli Village, Karnataka, by the Centre for Sustainable Technologies (CST), Indian Institute of Science (IISc) along with the community members: The performance and impact of a decentralized biomass gassifier-based power generation system in an un-electrified village are presented through this case study.

In Hosahalli village of Karnataka, lighting, drinking water, irrigation water and flour-milling services are being provided using power derived from the biomass gassifier-based power generation system. The system consists of a 20 kW gassifier-engine generator system with all the accessories for fuel processing and electricity distribution.

The biomass power system has functioned for over 21 years now (1988–2009) in Hosahalli village (population of 654 as of now). It meets all the electricity needs of the village. Using biomass electricity, lighting and piped drinking water supply has been provided for over 85% of the days during the past six years. The fuel, operation and maintenance cost has ranged from Rs 5.85/kWh at a load of 5 kW to Rs 3.34/kWh at a load of 20 kW.

Projects with the involvement of Micro-finance and cooperative banks: One of the pioneer NGOs in India working to promoting renewable energy solution in rural areas has been SELCO, responsible for creating the first and perhaps the only large networking of financing institutions for solar programme in rural areas, using the large network of regional rural banks.

The premise behind this pioneering project of SELCO is that people are not likely to receive good quality Grid electricity at least for the next 10-15 years. According to SELCO, what people require is not just a good decentralized energy product but rather a package which can also provide them with a loan to meet capital costs, products or set of products which will ensure meeting their sustained energy needs along with enhancing their livelihoods and also ensure that there is enough and more earned which will help them repay the loan.

SELCO has also been involved in pioneering some interesting innovations such as solar powered sewing machines which have helped tribal women in Gujarat by creating employment opportunities for them as well as prosper.

SELCO has installed over a 100,000 home lighting systems in the last decade or so. It is not the number which is the mile stone, but the fact that these home lighting systems were bought by the people/communities without any aid from the government or without any subsidy component but on a loan basis, bulk of which has been repaid and people are comfortable with the systems.

The other important mile stone for SELCO is its work with silk worm farmers. The silk work farmers were using Kerosene lanterns in their homes and establishment. SELCO with the help of a cooperative bank, managed to covert close to 85,000 Kerosene lanterns to solar lighting systems, which resulted in a better yield, as the smoke from the lanterns were also affecting the worms, which meant a decrease in the mortality rate of worms and therefore more silk. It also meant a saving of close to 24,000 tonnes of avoided CO_2 emissions.

Cases of Unsuccessful Decentralized Distributed Generation Projects

Village electrification in Kendrapada District of Orissa: In the aftermath of the 1999 Super-Cyclone which amongst other districts caused huge devastation in this particular district of Orissa, it also completely uprooted the entire electricity network in some of the villages in that district. Thereafter, the Orissa Renewable Energy Development Agency (OREDA) took up the work of electrifying some of the villages in Kendrapada district though the installation of solar home lighting systems.

A total of 150 households were provided solar home lighting system in December 2000 with the capacity to power two lights and a fan. These were all installed by OREDA and it was a one off affair. OREDA did not provide the villagers with any manual neither did they give them instructions on the maintenance of the system, leave alone consulting them as to what are the limitations and boundaries of usage.

People were of the impression that the solar home lighting systems could also power televisions. However, the systems provided to the villagers were basic home lighting systems with a total of 400 watts peak output.

Furthermore, the villagers were also not trained in the maintenance of the system. They were also not informed that the batteries should not be unplugged from the system for use in other activities.

The result of all these was that, villagers rampantly disconnected the batteries from the PV systems and used these to power music system in times of marriage or village ceremonies. They did not maintain the batteries and added more appliances to the already overworked solar PV systems.

The first of the 150 solar PV system met with its untimely death in just under six months of its installations, very quickly followed by the rest of the 149. Some of the batteries were put to other use, many of them were sold as scrap and all the solar panel found its way to the grey market.

Within one year of the village being classified as "electrified", it was deemed "un-electrified".

Bio-mass Plant in Mandya district, Karnataka: Mandya is the sugar bowl of Karnataka and is also known for its vast fertile lands, thanks to it being in the heart of Cavuery delta. The area is famous for a vast variety of crops and agriculture produce ranging from Sugar Cane and Paddy to other pulses.

Mandya also boasts of one of the first sugar mills in the state.

In 1997, the Karnataka Renewable Energy Development Agency (KREDA) initiated a bio-mass gassifier unit in village Hosahalli. The bio-mass gassifier plant was fully funded by the government and was designed to initially cater to the village of Hosahalli and later on expanded to other nearby villages.

Hosahalli then had a total of 87 households with a population of 600 people, with agriculture being the dominant occupation of the people.

The bio-mass plant was designed to take in rice husk or paddy husk as the main source of feed and also baggase waste of sugar cane as supplementary source of feed.

The bio-mass plant was initially designed to generate 14 kW peak of electricity to the people, which at that time was estimated to be sufficient to meet not just the lighting requirements but also to irrigate vast tracts of land.

The management of the bio-mass plant was with the government and also the responsibility of procuring the fuel source was left to the three or four people who were employed to run the plant.

The end result was that, in a matter of two years, supply of bio-mass sources became a problem, people did not pay for the electricity usage on time and many defaulted for months and eventually, the plant had to shut down.

Analysis of Successful and Unsuccessful Decentralised Energy Projects

The one underlying and absolutely essential element for any decentralized energy project is the involvement of local communities in the designing and sizing up of a system. More importantly, it is essential that people understand that a renewable energy power system is as good as any permanent power system and is not a stop gap arrangement as many people tend to believe.

The second most crucial element is to ensure that people understand how the decentralized energy system works which includes them knowing the limitations of such a system as well as its positive elements.

The main limitation which they need to know is the lack of flexibility in usage patterns to a large extent. The main advantage of these systems is that they are a 24 x 7 energy source, but only, as long they are used properly and in the manner in which the system has been designed.

It therefore becomes crucial that people's requirements are factored in before the system is designed. This would help remove the one major obstacle to effective functioning and operation of the system.

The third crucial element is the ownership in terms of financial participation of the people. Therefore, even if there is a scope for a 100% subsidy or scheme from the government or any other agency, then also it makes sense, to collect some money from the people, as it then becomes their asset which needs to be cared for by them.

The fourth crucial element is to make use of the system in a manner which ensures multiple purpose usage, from lighting to heating to more importantly irrigation and water supply and even sanitation.

As of now, most renewable energy projects of the government have been focusing primarily on lighting and even with a fully electrified village, there is only enough electricity supply which can be used for lighting and cannot be used to power water pumping stations. Further, for cooking and heating purposes, traditional bio-mass continues to be used. Therefore, a good system will have to ensure a holistic energy supply, even if it is through a combination of equipments and products.

Yet another crucial element is to focus on energy for agriculture and livelihood with lighting as the added element. This becomes crucial especially when people will have to pay fairly large sums of money and hence start to prioritise. Therefore, all projects should factor in that element of energy for livelihoods with lighting and other needs as add on. Most of the projects which do not have this element have not sustained themselves in the long run.

The sixth crucial element is to ensure that there is government participation in the project, and most preferably only a financial participation. This ensures that local politicians do not exploit the situation by promising people free grid electricity, which may make them abandon a proposed renewable energy decentralized project.

Last but not the least, is to have a good management model, preferably with people's participation and a model which ensures that people have to pay for usage. This ensures that there is an economic model which will in addition to providing electricity use, will also help pay the people in the long run.

"Ideal Management Model"

There are a number of models which have been tried and tested in India, ones which unbundle the two functions of generation and distribution; with the ownership of generation lying with the government & utilities and that of distribution with people or *panchayats*.

There have been models where there is private sector involvement in installation and generation and with people's involvement in distribution.

A third model which again has been tried and tested is NGO ownership of generation, with rural cooperative distribution system for distribution, and a fourth model which is primarily people's ownership of generation and distribution, though these are largely small home lighting systems.

While each of these models has had their share of issues and concerns, the projects which have worked the best are those in which there has been involvement and participation from members of the community. People's participation and involvement is a must, right from the project's conceptualization, design and sizing of system, identification of the source and implementation and, in the design and sizing of system. Effort should be made to incorporate all identified needs of the rural community into this decentralised energy system to the maximum extent possible, particularly focusing on livelihood and agriculture needs.

Most of the successful projects so far have ensured that some of the above elements are etched in the project components. This has made these projects sustainable even over a period beyond 10+ years, which more or less means that these projects are there to stay and will not be taken over by grid connectivity.

The other crucial elements which are desirable would be the involvement of the village *panchayat* and the local politician from the very inception of the project. This also helps in speedier sanctions and budgetary support from Government and also makes them feel part of this.

All projects which are not routed through the distribution utility work best, as there is always a sense of distrust between the utilities and people and vice versa.

System design should also incorporate scope for future possible expansions and preferably scope for even adding on more villages to form a cluster. This will also ensure replicability of good models within certain geographic locations.

To summarise, some of the salient features which need to be incorporated into a decentralized model for it to be both, successful and sustainable are as follows:

- People-owned, operated and managed system
- People designed tariff system and demand side management
  Realistic pricing
- A centralised approach in managing fuel supplies – for instance a village managing committee which will maintain and procure fuel stocks at a centralised area
- A multiple fuel source to ensure constant back up and to optimize all available fuel sources
- More reliable than grid power, at least a 14 hours energy supply to start off with and then increased to a 24-hour supply
- Smokeless cooking energy
- Integrated approach – energy for cooking, energy for water- for irrigation, drinking purposes and sanitation, electricity for lighting
- Sufficient energy for livelihoods – rice mills, flour mills, and so on
- Local maintenance
- Availing government subsidies

Chapter 4 - Summary and Key Findings

- The Government's argument in favour of central grid seems to be only a justification to continue with the old policies. In actuality, this policy of the government has very little argument or rationale in its favour for the purpose of rural electrification.
- There is a need for the government to undertake an urgent paradigm shift in emphasis from "Centralised Energy" systems to "de-centralised energy" systems. There are clear advantages of the decentralized system which are evident from the following points:
    i. Reduced losses
    ii. Increased efficiency
    iii. Reduced infrastructure cost
    iv. Better quality
    v. Rural development and livelihood generation
    vi. Inclusive growth and energy secure communities
    vii. Potentially more democratic systems with participation of the people at all levels.
    viii. More importantly reduced carbon emissions
- There are a number of extremely successful decentralized energy projects in the country. The problem is not the technology or the know-how but rather the problems lies in the management and implementation of these programmes.
- Decentralised energy projects have proved to be cost effective and are comparable at the worst case scenario with central grid projects and are economically viable by a factor of 2 to 4 in the case of best case scenarios. A number of studies and calculations clearly show that even at a distance of 5 Kms from the Grid to a village, the cost of generation from micro and mini hydro systems are more or less the same as the costs per kWh from coal fired grid based power plants and at a distance of 12 Kms between the grid and the village, the cost of generating from wind-solar hybrid systems are on par with that of coal and stand alone solar PV systems cost the same to generate 1kWh of electricity as coal for a distance of 18 Kms from the grid to a village.
- Decentralized projects have low gestation period and require smaller land holdings, thus, ensuring that there is no large scale displacement of people, flora and fauna as is the case with many a large generation projects
- There are a number of rural development programmes and schemes and other central government programmes of which decentralized rural electrification can also be made part of.
- There needs to be a better coordination between the various ministries and agencies of the government, particularly the financing arms of the government and the ministries and between the two key financing agencies namely the REC and IREDA.
- This will ensure that there is proper funding available for people to opt in for decentralized energy systems. A network of financing organizations

initiated by SELCO is an eye opener which could be replicated by the two Government-run financing agencies as they have a wider audience and can reach out to a larger network.

- Educating people is crucial, as generally renewable energy systems are looked upon as stop gap arrangements. This should start off with the policy makers and local politicians who also have this perception.
- Utilities and Government need to realize that they cannot hold on to everything and they should start involving the local networks and institutions particularly the *Panchayat* system. Rural India also has a fairly large and in most cases a dedicated set of teachers of Government schools and institutions who can play a role in promoting renewable energy solutions in the villages and also help in initiating people's run energy models.

Chapter 5

The Way Forward

There has always been a huge "rich-poor" divide in India and this divide continues to widen at a rapid pace. There are a number of areas where it is amply clear that policies seem to favour the "rich", even if it was not the Government's intention. One such area where policies clearly favour the "rich" is with regard to "access to energy and electricity".

Photograph above: 'Many a slip between the cup and the lip!'

While the policy to subsidize oil and gas was primarily aimed at insulating the poor and vulnerable from the fluctuating volatility of the global prices of oil and thereby, ensuring them access to these resources at affordable prices; these policies ended up benefiting the rich and the affluent sections of the society with very little actually reaching the poor.

In addition to the rich-poor divide, there is also a huge Urban-Rural Divide and invariably the rural populations have been marginalized in terms of energy and electricity access.

Therefore, there is an urgent need for a paradigm shift in energy policies; a shift in emphasis from a centralized production model to a decentralized/democratic production model; to de-couple energy growth from GDP growth with energy growth projections and planning being made using a sustainable pattern of consumption.

Grid based centralized system of electricity generation and distribution has failed miserably to reach the rural populations and is unlikely to do so even in the next several years. This would be because priority electricity and energy supply will always be the prerogative of the urban centres.

Furthermore, the cost of providing centralized grid is also besotted with huge problems ranging from high T & D losses, low level of efficiencies, poor quality and inadequacy of supplies. In addition, they are expensive in terms of high cost of infrastructure.

A decentralized energy system on the other hand will ensure rural development and livelihood generation by providing quality power to the rural population ensuring an inclusive growth and a more democratic system with participation of people at all levels.

Therefore, in order to promote decentralized energy systems, as the very first step, the Government should put in policies that will incentivize decentralized systems, followed by ensuring that the remaining 100,000 villages which are yet to be electrified are energized through renewable energy based decentralized distributed generation systems.

Further, in un-electrified villages the government should also encourage models which are in the nature of community owned, built, managed, operated and maintained decentralized energy systems and also, encourage a sense of entrepreneurship amongst communities to take up such projects with financial assistance from the central government under their many schemes for rural electrification.

One pre-requisite for any rural electrification model is to ensure that electrification does not mean and should not mean delivery of electric lighting but should ensure delivery of a whole host of energy services, which are need assessed and need based and ensure the crucial elements of agriculture and livelihood needs are met, as this will be the only source of income for rural communities and hence will have a bearing on their ability to pay for energy services.

The financial sector also needs to be reformed to ensure that there is proper and adequate financial assistance which is provided to communities who wish to undertake such projects.

There is an immediate need for rationalization of electricity tariffs and to apply the principle of "Polluter Pays", with incentives on tariffs being given to those who consume less and who opt for renewable energy sources.

The power and energy sector involves many players: Ministries, Institutions, agencies, regulators and others, such as the Ministry of Power, the Ministry of New and Renewable Energy, The State Energy Ministries, The Central Electricity Authority, The Central Electricity Regulatory Commission, The State Electricity Regulatory Commissions, Rural Electrification Corporation, The Indian Renewable Energy Development Agency to name a few. There is little or no coordination between and amongst these various departments and agencies often leading to confusions, overlapping of targets, re-inventing the wheel in terms of

"Alternative energy is a future idea whose time is past. Renewable energy is a future idea whose time has come."

-Bill Penden quoted in Atlas World Press Review, April 1977 *

directing resources amongst other things. Therefore, it is required that these agencies work in tandem and in close coordination with each other to ensure efficient and smooth implementation of plans and programmes to bolster India's electricity and energy sector.

Priority needs to be accorded to states that have been lagging behind on both rural electrification as well as household electrification with strong reward and penalty systems. This could even include measures such as reducing economic assistance from the central government to state government on state's failure in meeting its electrification targets. As part of "Corporate Social Responsibility" initiatives, Public Sector Undertakings (PSUs), large corporations and industrial houses must be encouraged to invest in community based non-conventional energy projects. Companies which are into conventional power generation must also earmark a percentage of their power generation exclusively from renewable energy – starting with a small quantum with a progressive incremental change.

From an international perspective, large international players such as the World Bank, Asian Development Bank and other such multinational financial players need to re-look at the programmes that they have with Electricity Utilities and Electricity Distribution Companies to ensure that the programmes address the issue of decentralized energy setups particularly in rural areas. India has a multitude of bi-lateral and multilateral cooperation agreements with a number of countries and many of them are focused on energy cooperation. While the current focus is a mix of a wide range of interests from nuclear cooperation to energy efficient technologies and some on renewable energy technologies as well, there is an urgent need to ensure that the limited resources are focused more on renewable energy and people friendly technologies rather than on technologies for large conventional power plants.

The way forward for urban cities: A combination of Wind and Solar PV panels to meet electricity needs and installation of solar water heaters atop buildings

From a civil society perspective, organizations, particularly those which work with partner institutions having a base in rural areas and communities, need to ensure that greater time is spent in creating models and systems for decentralised energy that can be replicated; models which can create the space for energy entrepreneurs amongst rural communities; models which are clean, sustainable and ensure a 24 x 7 energy supply. India has a number of development organizations, disaster relief groups and other agencies. While their focus varies on issues ranging from agriculture to disaster relief; to child and nutritional issues; to gender issues to name a few, but all of them lack in adopting a holistic approach to issues being tackled by them and their projects tend to be very compartmentalized and focused. However, if these organisations were to refocus some of their programmes to make them more holistic, then rural development can be achieved in a balanced and more progressive way.

With 54% of India's households electrified & 100,000 villages being un-electrified; irregular voltage and erratic quality of supply and, power outages ranging from 6-18 hours being the order of the day, India finds itself at the cross roads of development. While India has come a long way in terms of development from what it was in 1947, it remains very much a developing country, with lots more to do and achieve. Furthermore, with climate change also becoming a very serious issue which needs to be addressed on a war footing, India has the opportunity to revamp its energy policies and embark on a pathway which ensures fair and equitable energy to all, ensure inclusive growth and a speedier eradication of poverty while at the same time reducing the country's growing carbon emissions.

Reference Material / Bibliography

The authors of this report have extensively referred to a number of documents, research papers, publications and websites, all of which have been listed below:

1. Planning Commission Documents:
    a. 10th Five Year Plan
    b. 11th Five Year Plan Approach Paper
    c. 11th Five Year Plan
    d. Annual plans for various years
    e. The Integrated Energy Policy
2. Ministry of Power (documents)
3. Ministry of New and Renewable Energy (documents)
4. Central Electricity Authorities (Reports)
5. Reports and orders from Central Electricity Regulatory Commission
6. Reports and orders from the State Electricity Regulatory Commission
7. Prayas Energy Group: Research and documents, particularly, their India Emission trends
8. Research and documents from the Centre for Energy Policy and Economics, Swiss Federal Institutes of Technology, paper No. 51, titled "Regional disparities in electrification of India – do geographic practice matter?" authored by Kemler Andreas
9. Research Paper by James Cust, Anoop Singh and Karsten Heuhoff, titled "Rural Electrification in India: Economic and Institutional aspects of Renewables", published in December 2007
10. Working Paper Series from the Centre on Globalization and Sustainable Development, particularly the paper authored by Vijay Modi, titled, "Improving Electricity Services in Rural India", December 2005
11. International Energy Agency: World Energy Outlook 2009
12. Research paper titled "Clean Distributed Generation for Slum Electrification in Mumbai", authored by David Schaengold, Woodrow Wilson School, Task Force on Energy for Sustainable Development, Princeton, New Jersey
13. Website of Rajiv Gandhi Grameen Vidhyut Yojana (Website of RGGVY)
14. Website of Rural Electrification Corporation
15. Website of Indian Renewable Energy Development Agency/IREDA
16. National Sample Survey reports – various rounds and survey studies
17. TERI reports and studies on India's energy sector
18. A Report by Ernst and Young, titled "Models for rural electrification – A report for the forum of regulators".
19. Research report, titled "Providing electricity access to remote areas in India: Niche areas for decentralized electricity supply, by M R Nouni, S C Mullick and T C Kandpal, A Science Direct Publication.

Appendix

APDP - Accelerated Power Development Programme
AREP - Accelerated Rural Electrification Program
BPL - Below Poverty Line
CEA – Central Electricity Agency
CII - Confederation of Indian Industries
CST - Centre for Sustainable Technologies
DAE – Department of Atomic Energy
FDI – Foreign Direct Investment
GDP – Gross Domestic Product
IT – Information Technology
IISc - Indian Institute of Science
IREDA - Indian Renewable Energy Development Agency
KJY - *Kutir Jyoti* Program
kWh - Kilo Watt Hour
LPG - Liquefied Petroleum Gas
RBI - Reserve Bank of India
MMT - Million Metric Tonnes
MNP Minimum Needs Program
MNRE- Ministry of New and Renewable Energy
MT CO_2e – Metric Tonnes of Carbon Dioxide emissions
NAPCC – National Action Plan on Climate Change
NGO – Non Governmental Organisation
NREP - National Rural Electrification Policy
NSS - National Sample Survey
NSSO- National Sample Survey Organization
OREDA - Orissa Renewable Energy Development Agency
PMGY - Pradhan Mantri Gramodaya Yojna
R & D – Research and DEvelopment
REC - Rural Electrification Corporation
REST - Rural Electricity Supply Technology Mission
RGGVY - Rajiv Gandhi *Grameen Vidhyutikaran Yojana* or Rajiv Gandhi Rural Electrification Programme
SHS - Solar Home Systems
Solar PV – Solar Photo Voltaic
T & D losses -Transmission and Distribution losses
TWh –Terra Watt Hour
UNFCCC – United Nations Framework Convention on Climate Change
USD - US Dollar

Annexure

A Typical Log Sheet Entry for assessing quality and quantity of electricity supply in Select Rural Areas

Village: Bawanbigha, District: Sheikhpura, State: Bihar

Population: 750 No. of households: 150
No. of electrified households: 30
Other Sources of Energy: Diesel gensets (water pumps & grinding mills)

Log Book for a typical day in June 2009 at Bawanbigha village, Bihar

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No			Routine Power Cut	
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 PM	12.10 PM	12.45	30 Minutes		Fan, if there is one
1 to 3	No				
3 to 4	No				
4 to 5	No				
5 to 6	No				
6to 7	No				
7to 8	No				
8 to 9	No				
9 to 10	9:00 PM	9. 30 PM	30 Minutes		Light
10 to 11	No				
11 to 12 PM	11:00 PM				
12 to 1 AM	12.00 PM				
1 to 2	1:00 AM	3 AM	2 Hours		Fan, if there is one. Sometimes pump set, if there is voltage
2 to 3	Yes				
3 to 4	No				
4 to 5	No				
5 to 6 AM	No				
Total supply			**3 Hours**		

Log Book for a typical day in July 2009 at Bawanbigha village, Bihar

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No			Routine Power Cut	
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	Yes				
11 to 12 PM	Yes	12PM			
12 to 1 PM	12.10 PM	12.45	90 Minutes		
1to 3	No				
3 to 4	No				
4to 5	No				
5 to 6	No				
6to 7	No				
7to 8	No				
8 to 9	Yes				
9 to 10	9:00 PM	9. 30 PM	90 Minutes		
10 to 11	No				
11 to 12 PM	No				
12 to 1 AM	No				
1 to 2	No				
2 to 3	No				
3 to 4	No				
4 to 5	No				
5 to 6 AM	No				
Total supply			**3 Hours**		

Village: Churchu, District: Hazaribagh, State: Jharkhand

Population: 1500 | No. of households: 255
No. of electrified households: 40 | Other Source of Energy: Nil

Log Book for a typical day in June 2009 at Churchu village, Jharkhand

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No			Routine Power Cut	
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 PM	No				
1 to 3	No				
3 to 4	No				
4 to 5	No				
5 to 6	No				
6 to 7	No				
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 AM	No				
1 to 2	No				
2 to 3	Yes				
3 to 4	Yes	4 PM	2 hours		
4 to 5	No				
5 to 6 AM	No				
Total supply			**2 Hours**		

Log Book for a typical day in July 2009 at Churchu village, Jharkhand

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No			Routine Power Cut	
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 PM	No				
1 to 3	No				
3 to 4	Yes				
4 to 5	Yes	5 PM	2 hours		Nil
5 to 6	No				
6 to 7	No				
7 to 8	No				
8 to 9	Yes				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 AM	No				
1 to 2	Yes				Fan
2 to 3	Yes				
3 to 4	Yes	4AM	3 hours		
4 to 5	No				
5 to 6 AM	No				
Total supply			**5 Hours**		

Village: Jarkanahalli, Dsitrict: Mandya District, State: Karnataka

Population: 450 No. of households: 130
No. of electrified households:90
Other Source of Energy: Diesel gensets (water pumps & grinding mills)

Log Book for a typical day in June 2009 at Jarkanahalli village, Karnataka

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No				
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 PM	No				
1 to 3	Yes				
3 to 4	Yes	4PM	2 Hours		Television, if one
4 to 5	No				
5 to 6	No				
6 to 7	No				
7 to 8	Yes				
8 to 9	Yes	9PM	2 hours		Light and television
9 to 10	No				
10 to 11	No				
11 to 12 PM	Yes				
12 to 1 AM	Yes				
1 to 2	Yes				
2 to 3	Yes		4 hours		Fan
3 to 4	No				
4 to 5	No				
5 to 6 AM	No				
Total supply			**8 Hours**		

Log Book for a typical day in August 2009 at Jarkanahalli village, Karnataka
(This month saw a total of 6 days of power disruption due to technical faults)

Time	Supply	Disruption	Total supply	Disruption Cause	Usage for
6 AM to 7 AM	No				
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	Yes				
11 to 12 PM	Yes				
12 to 1 PM	Yes				
1 to 3	Yes		4 Hours		Television
3 to 4	No				
4 to 5	No				
5 to 6	No				
6 to 7	No				
7 to 8	No				
8 to 9	No				
9 to 10	No				
10 to 11	No				
11 to 12 PM	No				
12 to 1 AM	No				
1 to 2	No				
2 to 3	No				
3 to 4	No				
4 to 5	No				
5 to 6 AM	No				
Total supply			**4 Hours**		

VASUDHA

GREEN WAYS FOR A GOOD EARTH!

Vasudha Foundation was started in 2009 with an aim to promote environment-friendly, socially just and sustainable models of development by focusing on alternative technologies and lifestyle solutions. The foundation is currently involved in setting up a decentralized energy model in a tribal village in Jharkhand, with support from Christian Aid, UK.

Address for communication
'Vasudha Foundation'
Registered Office: No.12, 9th Main, Banashankari - II stage. Bangalore - 560070, Karnataka, India
Delhi Resource Centre: C/o CISRS House, 14, Jungpura (B), Mathura Road. New Delhi - 110014, India

Help us to harness
the wind,
the water,
the sun,
and all the ready
and renewable
sources of power.

Teach us to conserve,
preserve,
use wisely
the blessed treasures
of our wealth-stored
earth.

Help us to share
your bounty,
not waste it,
or pervert it
into peril
for our children
or our neighbours
in other nations.

You, who are life
and energy
and blessing,
teach us to revere
and respect
your tender world.

A prayer by
Thomas John Carlisle