EMPOWERING BIHAR: POLICY PATHWAY FOR ENERGY ACCESS

A GREENPEACE REPORT

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Acknowledgements
This report has gained substantially from their critical feedback.
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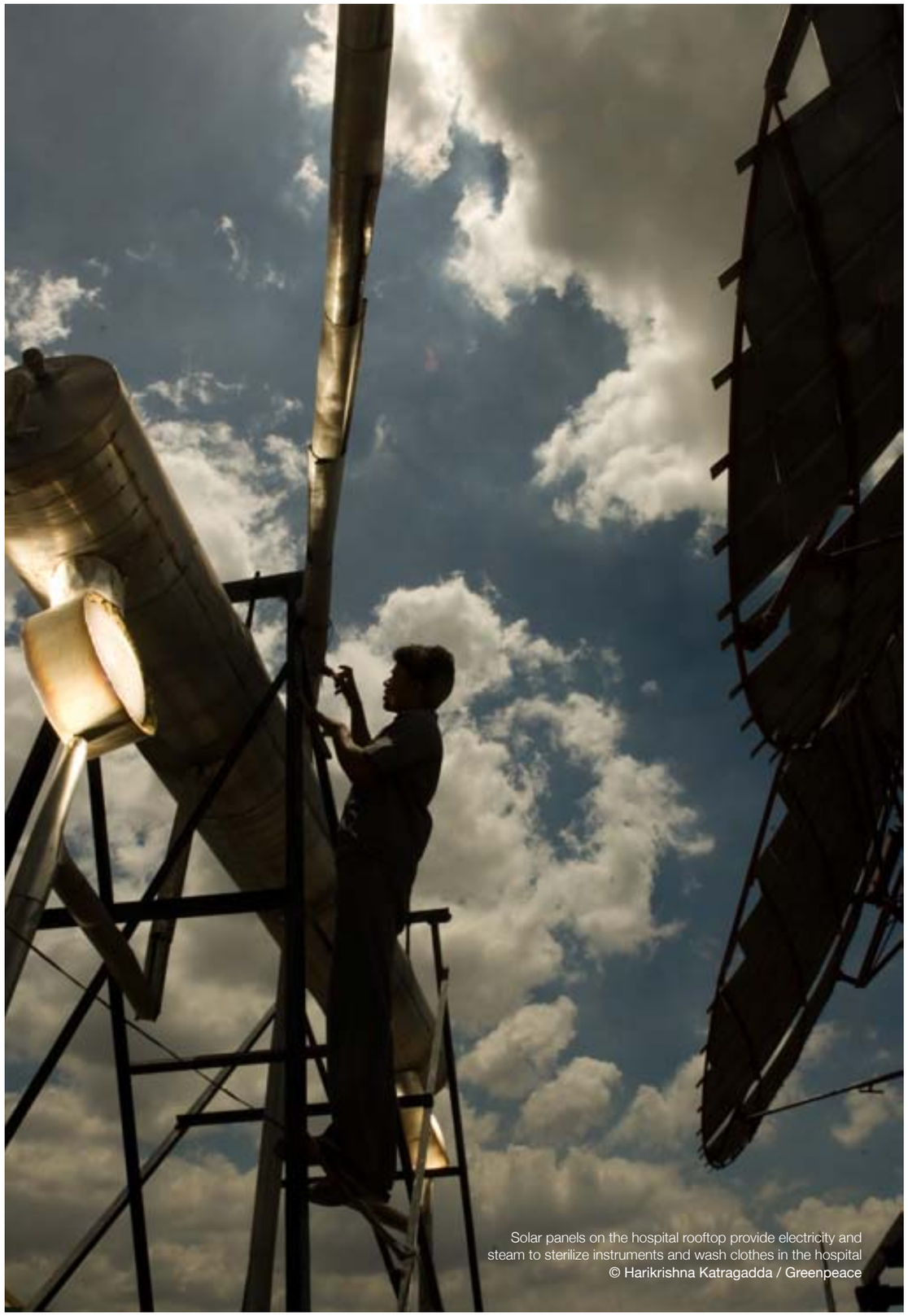
Printed on 100% recycled paper

CONTENTS



Solar panels on the hospital rooftop provide electricity and steam to sterilize instruments and wash clothes in the hospital
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FOREWORD

India is facing a severe energy crunch, around 400 million rural inhabitants still lack electricity, making energy access a development imperative. At the same time, economic growth is sending national energy requirements soaring. India's GDP is on pace to grow by 8% in 2010, and domestic energy demand is predicted to more than double by 2030.

The energy shortage is most acute among India's rural poor and here in Bihar more than 80% of the population still live in the rural areas, the majority of whom rely on conventional and traditional fuels for their energy needs. As India's government and energy sector seek to provide more modern and reliable energy services to these communities, a fledgling market in cleaner, more efficient energy products is emerging. This huge and under-served rural Indian market offers significant opportunities to support the sustainable energy solutions of the future.

In recent years, a number of domestic companies have developed clean energy products and services specifically targeting India's rural "Base of the Pyramid" population – the 114 million households who spend less than INR 3000 a month on goods and services. Successful (though small scale) business models such as solar-based home electricity systems and lanterns, energy-efficient cook-stoves, and electricity services generated from decentralized sources such as micro hydro and biomass gasifiers are increasingly finding a market among such households.

Realizing this potential would be a win-win situation for state government of Bihar, for India's people, for entrepreneur's and for the global climate: profit-making clean energy solutions bringing light to millions of Bihar's and hence India's poorest households.

I commend Greenpeace's recommendations to the Bihar government and to a wide audience both in the state and nationally and look forward to their rapid implementation.

Dr. Shaibal Gupta

Asian Development Research Institute (ADRI)

EXECUTIVE SUMMARY

Energy is a prerequisite for the economic development of any country or state. The case is no different for the eastern Indian state of Bihar. The state has witnessed a promising growth in the recent years and is set to tread for significant economic advancement in the years to come. At this juncture what Bihar needs to propel its growth further is to meet the electricity requirement with a strong political will to do so.

This report illustrates the changes that are needed to be made both in institutional and government policies to enable Bihar to meet the energy requirement for its rural areas. About 89 per cent of the state population (12.6 million households) resides in the rural areas and almost 95 per cent of these households are dependent on kerosene as a source for lighting. Providing electricity to this population is the first step towards a significant economic growth.

The present government in Bihar has taken several positive steps to bridge the gap between demand and supply of electricity in the rural area. However, it still faces several economic, technological and financial constraints in reaching its goal. These include poor infrastructure in the rural areas, low credit ratings, limited finances, increasing gap in demand and supply of electricity and poor performance of the state electricity agencies due to their internal constraints.

Nevertheless, Bihar has several natural and strategic advantages in terms of its location, climate and geographical conditions. The state has high solar energy potential, which could be the main source of energy for the state in the coming years. Bihar is primarily an agriculturally dominant state therefore it has high potential of producing agricultural residue which could be good raw material for energy production. Also, the state has great potential for small scale hydro power and small scale wind power in the northern parts of the state.

These constraints and the inherent natural strengths of the state create conducive environment for the establishment of decentralised energy systems all across to provide electricity to rural populace.

The suggestions this report extends, in this regard, are aligned with the state's needs to increase its investment capacity, generate developmental benefits and minimise environmental damages. The vision that has emerged for an overall energy-led development of Bihar is as follows:

"A state-wide network of decentralised energy plants (stand alone and micro-grids) developed with support from state government agencies, in collaboration with private entrepreneurs for an effective and accelerated economic development of the state".

In order to achieve the said vision following changes are recommended:

In the immediate term: Composition and Institutional Changes:

- Integrated energy planning: state-wide natural resources and appropriate technology.
- State-incentivised emergence of a new private business model, particularly for setting up energy services companies (ESCOs) to decentralise power generation. The focus should be on promotion of alternative business opportunities in the electricity sector.
- Empower relevant government agencies to promote decentralised energy generation.
- Showcase Bihar nation/world-wide, as an evolved market for decentralised energy.

In the long-term: Governance Structures and Policy Changes:

- Policy to facilitate decentralised energy use to improve power supply/state economy.
- Create supportive institutional avenues for micro-grids.
- Institutionalise supportive regulatory structures and encourage governance support through the Electricity Regulatory Commission.
- Evolve energy pricing models through a mix of regulation and competition.

Decentralised energy system offers opportunities to Bihar to transform its rural areas by significantly enhancing their economic capacities. Some of the challenges that must be confronted to achieve this goal are:-

1. Institutional and governance design changes to facilitate technology-led progress.
2. The government must debate on missed opportunities – not using natural resources, such as fertile soil, abundant useable natural waste material and solar potential.
3. Strong political will and a fresh white paper on decentralised energy development.

The Structure of the Report:

- Chapter 1 focuses on background in relation to power status in Bihar.
- Chapter 2 highlights the existing gaps in the current supply and demand.
- Chapter 3 analyses the existing situation & explores possible technology options.
- Chapter 4 concludes to draw feasible strategy options to meet energy needs.
- Chapter 5 draws a road map of policies, programmes, governance structures and institutional structures to meet the strategy options.

ENABLING SUSTAINABLE ENERGY ACCESS TO RURAL AREAS IN BIHAR

Approximately 85 per cent of poor people in rural India use non-conventional or inexpensive sources of fuel for lighting and cooking, for example, firewood, cow dung or kerosene. About 45 per cent of this population does not have access to electricity and relies on kerosene for lighting. These fuel sources are harmful not only for the user's health but also contribute to pollution and environment degradation. Besides, these fuel sources restrict economic growth as several income generation activities require reliable access to energy. Non-availability of proper power is the key cause for lack of economic development in rural India.

BIHAR SITUATION

The state of Bihar with an area of 94,163 square kilometres and a population of 82.9 million has 45,098 villages. About 89 per cent of the population (12.6 million households) resides in the rural areas. The State has a population density of 881 persons per square kilometre (national average is 312 persons). Bihar is endowed with a very fertile soil, favourable climatic conditions and sufficient ground water for cultivation of a vast variety of crops.

Because of these inherent natural strengths and a strong political will, Bihar has witnessed a higher growth in a decade than the national average. The state's decadal growth rate (2000-2010) has been approximately 28.23 per cent as against the national average of 21.54 per cent. Details of some of the economic growth indicators are given in Table 1. However, according to 2001 census, almost 95 per cent of rural households are still dependent on kerosene as a source for lighting, which is a significant proportion as compared to that in the urban areas (40 per cent). According to the Rural Electrification Corporation Ltd Report 2004, transmission wires have still not reached 50 per cent of the inhabited villages in Bihar (ranks 2nd followed by Jharkhand in the list of states with least electrification). Table 2 gives a brief scenario of the energy and infrastructure related situation in rural Bihar.

Table 1: State Domestic Product at constant prices in Bihar 1993-94 and 2005-06 (Rs Lakhs)

S. no.	Type of industries	1993-94	2005-06	% change
1.	Primary	11,12,867	20,97,698	88.49
2.	Secondary	2,26,486	7,16,345	216.29
	Sub-total	13,39,353	28,14,043	110.10
3.	Transport, Commerce and Trade	4,43,469	7,82,521	76.45
4.	Finance and Real State (tertiary)	9,41,845	18,33,735	94.69
6.	Gross SDP	22,81,198	36,19,819	58.68
7.	Population as on 2007 (thousands)	68,432	90,197	31.80
8.	Per Capita GSDP	3,334	4,013	20.36

ENERGY FOR BIHAR - POLICY PERSPECTIVE

Power availability scenario in Bihar in the year 2000 (post bifurcation) became significantly critical, as several power generation plants fell within the newly created State of Jharkhand. Currently, Bihar's power system has a peak of about 1,500 MW under the constrained demand scenario whereas the availability is about 950 MW. The situation leads to wide-scale rationing of power to all categories of consumers. The current power availability barely covers 50 per cent of the villages and 6 per cent of the households in the state. Presently, the annual per capita consumption of power is 95 units in Bihar (national average is 717 units), according to the CEA General Review 2009 (17th Power Survey of India data 2007-08).

The National Electricity Policy aims to achieve an annual average of 1,000 unit per capita consumption by 2012. This growth is based on increased generation to meet the peak energy demand, besides implementation of the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), which targets electrification of all Indian villages by 2012.

Bihar is a large beneficiary under the RGGVY scheme. According to the REC (Rural Electrification Corporation), Bihar has already received huge amount of funds under the scheme.

But, there had been very little progress in the electrification process and also in the electricity generation/supply sector. Nevertheless, demand keeps increasing as new villages and households demand access to electricity. Besides, industrial consumption of electricity is expected to go up as government has taken several initiatives to promote investment. These include the Bihar Single Window Clearance Act 2006 and the Bihar Infrastructure Development Enabling Act 2006 along with the State Government's new Industrial Incentive Policy. This is feared to increase the demand and supply gap in the near future.

Table 2:
Infrastructure and assets in rural areas of Bihar

Infrastructure	Indicators	(%)
Total housing	Number of residential houses	84.0
	Shops and offices	2.4
	Schools, colleges etc.	0.5
	Hospitals, dispensaries etc.	0.2
	Factories, work sheds etc.	0.5
	Others	12.3
Lighting in houses	Kerosene	94.5
	Electricity	5.1
	Solar	0.3
	Other oils	0.0
Banks	Number with access	18.6
Assets	Radio, transistor	26.5
	Television	5.5
	Telephone	1.0
	Scooter. motor cycle etc.	2.4
	Car, van etc.	0.7

Source: RHS Bulletin, March 2008, M/O Health & F.W., GOI

Keeping development pace with states like Karnataka, Tamil Nadu and Delhi, the Bihar government has initiated several measures to ensure affordable access to electricity to its rural people. An increase in generation capacity is a priority for the government to meet its socio-economic growth targets set forth to achieve in next 5 years. The biggest challenge before the government is to provide energy access to rural areas. Only about 52.80 per cent of the villages are electrified, which leaves about 85 per cent of the population with no access to electricity.

Electricity is critical for development. It provides access to modern education, is essential for industrial development, ensures access to modern health and fitness facilities and contributes to poverty alleviation as several income generation activities rely on power.

Bihar, due to insufficient power, lacks prospects and opportunities for individual and economic development. Hence, it is important to explore feasible opportunities and credible options to push electricity generation in the state.

This report draws a policy framework for the state of Bihar and provides suggestions necessary for the government to achieve its energy and development objectives. An `overall developmental focus' is the central component of any electricity access framework therefore the report is concerned about the following issues:

- Analysis of the current energy infrastructure and resource situation.
- Analysis of the significant technical and governance issues involved.
- Assessment of gaps in energy access to rural areas.
- Programmes, plans, structures and fiscal steps needed for an effective and sustainable energy access framework.

The diagram below shows the steps followed in the conceptualisation and development of these frameworks:-

Figure 1

PHASE I

Situation Analysis

Technical, Governance & Resource

PHASE II

Policy Analysis

Objectives & Priorities

PHASE III

Policy & Governance,
Options & Execution

Short-term
Long-term

Madi Devi a woman in her 50's sells alchohol for her living. She spends about Rs 150 every month to buy kerosene to light the lanterns. She earns about Rs 1500 every month to support her nine member family and says its not enough go for a power connection tough she would like to have it.
© Harikrishna Katragadda / Greenpeace

ENERGY SITUATION IN THE STATE OF BIHAR: TECHNICAL ANALYSIS

The chapter analyses the electricity situation in Bihar. Analysis is a critical part of any development planning process. The electricity situation analysis clearly highlights the intensity of the electricity supply-demand gap in the state and sheds light on significantly high future requirement. Moreover, the analysis helps identify such avenues for generation of power, which ensure integration of economic, social, institutional and fiscal strategies and stress on optimal and judicious use of scarce, natural and governance resources for various areas and populations.

ELECTRICITY SECTOR IN INDIA

Centralised electricity generation and grid network system restricts achievement of 100 per cent rural electrification targets. The State Electricity Boards (SEBs) have shown limited interests in rural electrification due to several economic and technological constraints. Heavy losses over the years also resulted in poor implementation of rural electrification programmes in India. Rural electrification continues to aspire to have long-term solutions for sustainable development and easy electricity access to rural India.

Following are the reasons for low rural electrification achievement:-

Low User Charges with High Transmission and Distribution Losses: Transmission and distribution losses of electricity in rural areas have been higher compared to urban areas. It costs also more due to long, dispersed distribution lines, poor infrastructure and low paying capacity. Moreover, electricity supply in rural areas is highly subsidised.

Low Collection of Revenue: The revenue collection has been very low in rural areas. Several investigations in the recent past have shown the rural population's willingness to pay, provided there is a reliable and continuous supply of power. This reflects that the government has failed to meet the expectation of the rural population. The per-unit collection of electricity has not only been low but has also slipped with time. Studies have indicated only 12.50 per cent unit cost has been realised against electricity used for irrigation. Due to these low revenue earnings, the State Electricity Boards did not adopt a positive growth policy for rural infrastructure or power supply.

Lower Technical and Operational Efficiency: Most of the State Electricity Boards operate at a lower technical and operational efficiency in rural areas due to political interference. Large number of unauthorised connections and power thefts only worsen the situation. Improvement in the technical and operational efficiency of grid electricity in rural and remote areas needs improvement in revenue recovery. This can be achieved with decentralised electricity provisions with large contributions from renewable resources ensuring sustainability. Instances from many developing countries confirm that supply of electricity is often interrupted and of poor quality, despite rural areas having grid connectivity. India's electricity sector has been confined to a centralised planning dominated by mostly thermal power which generally fails to supply the required demand. It is proved by the fact that about 70 per cent of rural population in India is living without electricity.

WHY THE STATE OF BIHAR?

After bifurcation of the state, most of the thermal power plants and natural resources went to the newly created state of Jharkhand. This contributed to the poor state of electricity in Bihar where only 52.80 per cent of villages have power. Most of Bihar's natural resources, like forests and mines (particularly coal mines) went to Jharkhand. Even if the government wants to set up new thermal power plants, availability of coal will be a critical factor. Presently, major part of Bihar's power supply is imported from Jharkhand State Electricity Board or from the National Thermal Power Corporation Plants. Taking the situation into account, it is necessary to explore new technical systems, decentralised rural electrification system and off-grid/ stand-alone devices.

ENERGY CAPACITY

The state-owned existing power stations generate only 586.10 MW of power. Bihar gets an allocated share of 1,233 MW of power from the central sector projects and draws an unallocated share of 25 MW. An additional probable share of 973 MW is expected from central projects during the next plan.

Table 1 gives the details of existing power situation in Bihar.
Table 2 provides the details of proposed projects in Bihar, which amount to 11,146 MW.
Table 3 presents the power situation in Bihar by the end of the 11th Five Year Plan.

Table 1: Existing power situation in Bihar

Type of Power	Name of the power station	Installed Capacity	Agency
Hydro	Kosi (4 x 4.8)	19.20	BSHPC*
	Sone E&W Canal (2 x 1.65 + 4. 1.65)	9.90	BSHPC
	East Gandak canal (3 x 5)	15	BSHPC
	Angoor	1.00	BSHPC
	Dhela Bagh	1.00	BSHPC
	Total	46.10	
Thermal	Barauni (2 x 50 + 2 x 110)	320	BSEB
	Muzaffarpur (2 x 110)	220	BSEB
	Total	540	

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Table 2: Proposed Projects in Bihar

Type of Power	Name of power project	Installed Capacity- mw	Agency
Hydro	Indrapuri Reservoir (5x90)	450	BSHPC
	Telhar Kund PSS (4x100)	400	BSHPC
	Sinafdar PSS (3x115)	345	BSHPC
	Panchghotia PSS (3x75)	225	BSHPC
	Hathiadah-Durgawati PSS (8x200)	1,600	BSHPC
	Dagmara Barrage (3x42)	126	BSHPC
	Sub total	3,146	
Thermal	Barauni Extn. (2x250)	500	BSEB
	Muzaffarpur (2x250)	500	BSEB
	Nabi Nagar	2,000	BSEB
	Katihar(4x250)	1,000	BSEB
	Pirapanti	4,000	BSEB
	Sub total	8,000	

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Table 3: Power scenario at the end of the 11th Five Year Plan

	Particulars	Amount
Peak	Peak demand (MW)	3,067
	Peak supply (MW)	1,534
	Peak deficit (-)/surplus (+)	-2,073
	Peak deficit/surplus (%)	-57.50
Energy	Energy requirement (MU)	19,905
	Energy availability (MU)	11,755
	Energy deficit (-)/surplus (+)	-8,150
	Energy deficit/surplus (%)	-40.90

Table 3 also indicates that Bihar is expected to face acute power shortage in the coming years. Therefore, despite efforts, the energy deficit in normal hours is anticipated to increase from 8.1 per cent in 2006-07 to 41 per cent at the end of next Five-Year Plan. Peak deficit is anticipated to rise from 17 per cent to 58. This necessitates exploration of alternative ways to meet the deficits. Renewable energy sources are one of the useful alternative ways.

Ninety-two potential hydropower project sites with an aggregate capacity of about 195 MW have been identified. This potential is mainly on irrigation canals and small streams. Six small hydropower projects of an aggregate capacity of 46.1 MW have been installed in the State by the end of 2006-07.

There is an estimated 200 MW potential for biomass-based power projects, including co-generation projects, in Bihar. Rice husk-based biomass gasification and combustion technology for industrial application and decentralised power generation may be one of the important sources of power generation in the state, particularly in the northern region of Bihar.

According to Planning Commission Report, about 65 lakh tonnes of rice is produced in the state every year by nearly 4,000 small and medium rice mills. This produces about 22 lakh tonnes of husk, which is sufficient enough to generate nearly 200 MW of power in a decentralised manner. Considering this, husk-based biomass gasification technology is the most appropriate and cost-effective option, which can sustain the captive power requirement of rice millers and other industries, besides meeting the energy requirement of the rural areas.

In last two years, 13 gasification systems have been installed in rice mills and other industries in Bihar for captive power requirement.

A study carried out by MITCON, Pune, under the Ministry of New and Renewable Energy (MNRE) sponsored project during 1999, pointed out the possibility of generating about 85 MW of exportable surplus energy from the 7 major sugar mills in Bihar. The examples of sugar and husk-based energy generation underline the significant potential of renewable energy and stress on an integrated approach towards energy planning. There are several small and medium industries with surplus captive and co-generated power, which could be supplied to the nearby households. This would also integrate the micro-grids with the centralised energy infrastructure.

A fairly large number of wind pumps have been installed and used by the farmers for minor irrigation, particularly in the Nalanda district in the recent past (1999 onwards). Post installation, due to inadequate arrangement for repair and maintenance and a lukewarm attitude of the state nodal agency, the wind pump programme could not be expanded and propagated. Out of the 117 wind pumps sanctioned by the Ministry to BREDA since 1994-95, only 46 have been installed.

Biogas is an important source of renewable energy for cooking purposes in villages. As per available estimates, the state has a potential of setting up about 9.4 lakh family-size biogas plants to meet the energy requirement for cooking but so far only 1.25 lakh plants have been installed. Solar photovoltaic lanterns have been fairly popular in the state and over 33,000 solar lanterns have been distributed. In addition, about 1,700 solar home lighting systems/street lights and 140 solar photovoltaic pumps for drinking water and minor irrigation have been installed.

DEMAND OF ELECTRICITY

The annual growth rate of electricity in India is estimated at about 8 per cent. The estimate for Bihar has been 14 per cent. The estimates are based on optimistic programme acceleration of domestic household electrification, resulting in 27 per cent compounded annual growth rate in domestic consumption. The energy requirement in normal hour and peak load growth has been worked out to be 2.5 times to that of the actual in 2004-05.

Table 4 details the electricity demand in Bihar indicated by 11th Electric Power Survey Committee.

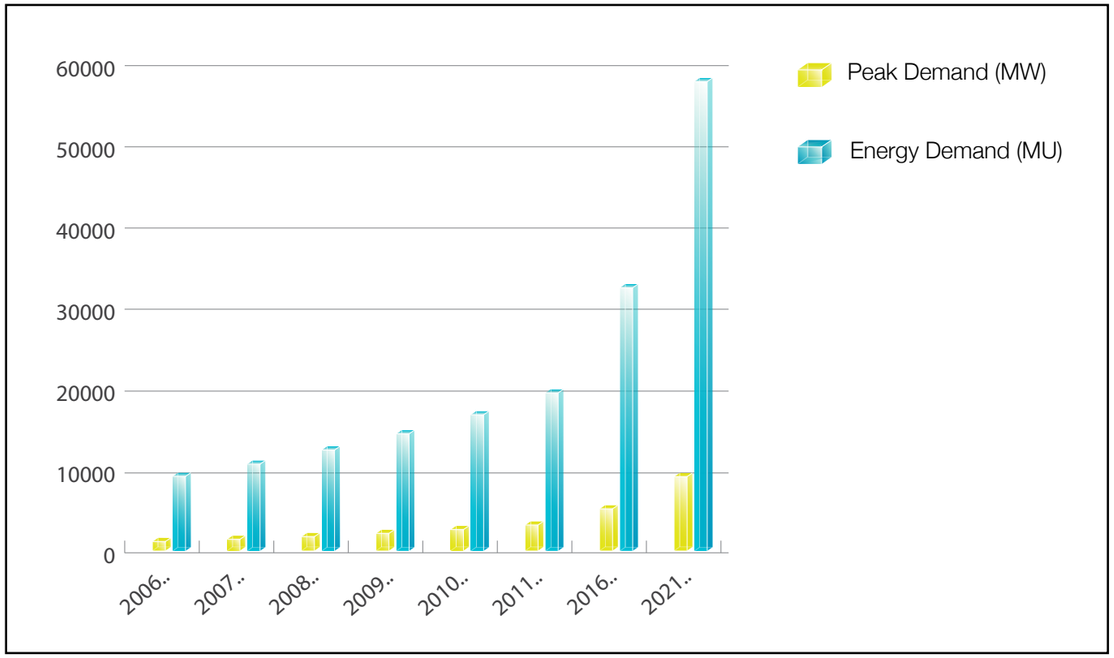
Table 4: Demand forecast of electricity in Bihar

Year	Peak demand (MW)	Energy demand (MU)
2006-07	1,570	9,629
2007-08	1,842	11,134
2008-09	2,177	12,874
2009-10	2,575	14,866
2010-11	3,046	17,213
2011-12	3,607	19,905
2016-17	5,598	32,857
2021-22	9,567	58,248

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Patna State Electricity Board distribution center.
© Harikrishna Katragadda / Greenpeace

Fig 2: Demand forecast of electricity in Bihar



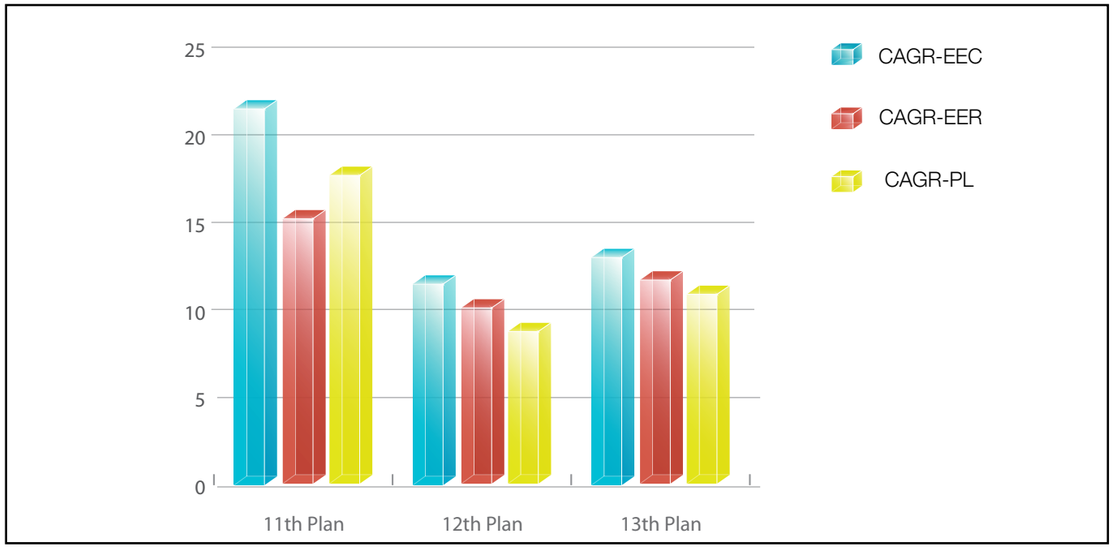
The 17th ESPC has taken an optimistic view with respect to Bihar and has suggested very high growth rate for Electrical Energy Consumption (EEC), Electrical Energy Requirement (EER) and for Peak Load (PL). **Table 5** gives the details:

Table 5: Power growth rate in Bihar

Plan period	EEC	EER	PL
11th Plan (CAGR) -5 years	21.98	15.63	18.10
12th Plan (CAGR) -5 years	11.98	10.54	9.19
13th Plan (CAGR) -5 years	13.50	12.13	11.31

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Fig 3: Power growth rate in Bihar



Shops in the Sariswa Village market use power generated by the Husk Power systems Pvt Ltd.

Table 6 presents the wide difference between requirement and availability of electricity in Bihar. Table 7 details the forecast projected by the 17th Electric Power Survey for 2006-07, which is higher by 14.30 per cent than the actual. Table 8 shows the 17th Electric Power Survey which forecasted the transmission and distribution loss in Bihar.

Table 6: Power supply position

Year	Requirement (MU)	Availability (MU)	Deficit (MU)	Deficit(%)
2002-03	8,096	7,422	674	8.30
2003-04	7,588	5,878	1,710	22.50
2004-05	7,201	6,476	725	10.10
2005-06	7,955	7,218	737	9.30
2006-07	8,425	7,741	684	8.10

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Fig. 4.1: Power supply position (requirement and availability)

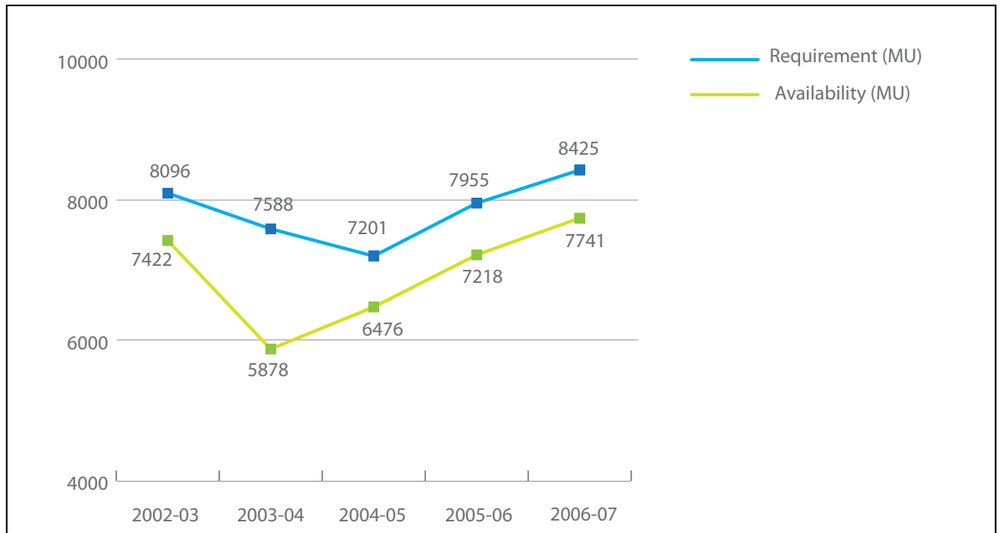


Fig. 4.2: Power supply position (deficit)

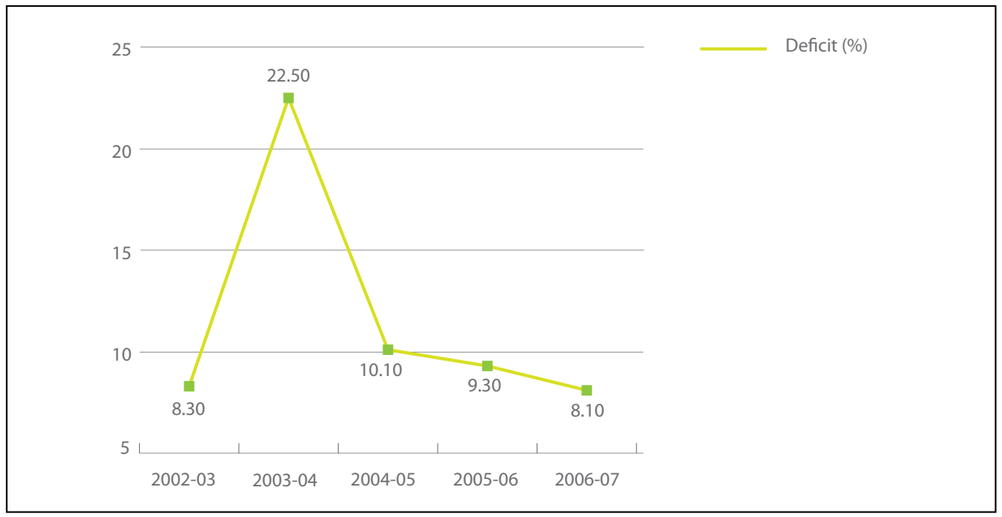


Table 7: Power supply position – peak

Year	Requirement (MU)	Availability (MU)	Deficit (MU)	Deficit(%)
2002-03	1,389	1,325	64	4.60
2003-04	973	788	185	19.00
2004-05	980	980	0	0.00
2005-06	1,314	1,116	198	15.10
2006-07	1,399	1,162	237	16.90

Source: *Road map for development of power sector in Bihar, Government of India, July 2007*

Fig 5: Requirement and availability

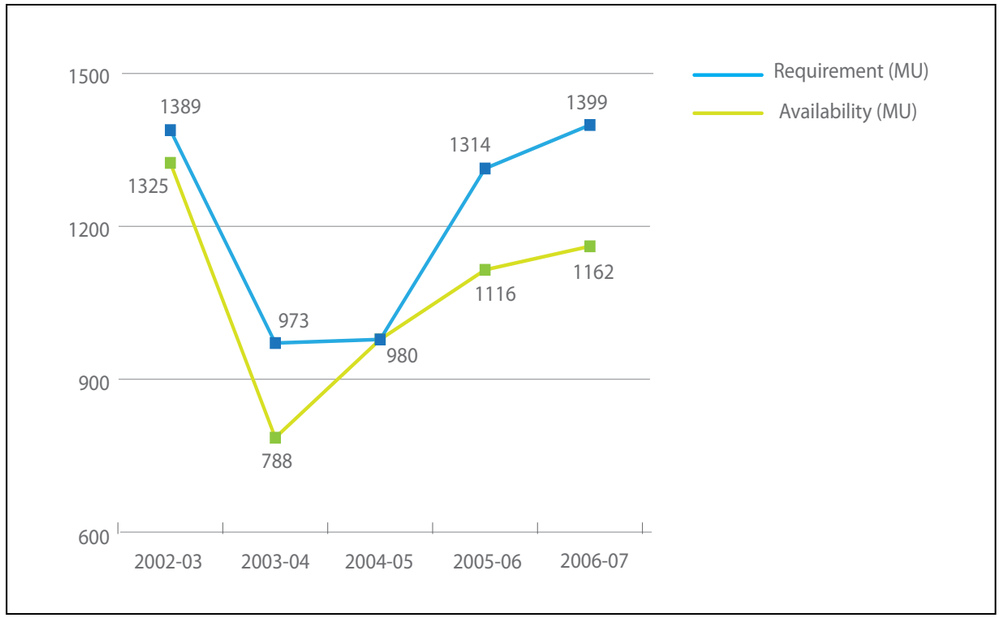
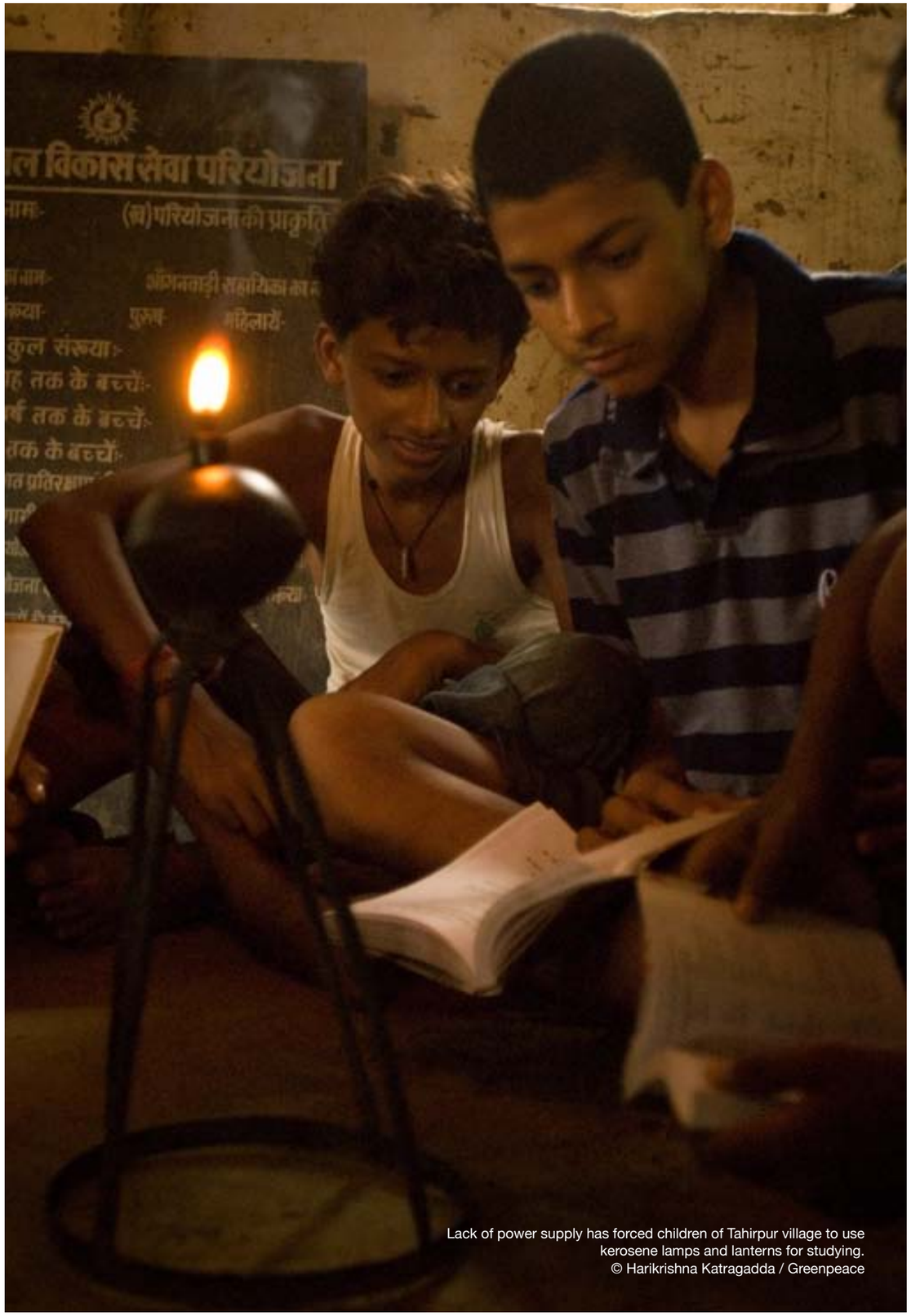


Table 8: Transmission and distribution losses

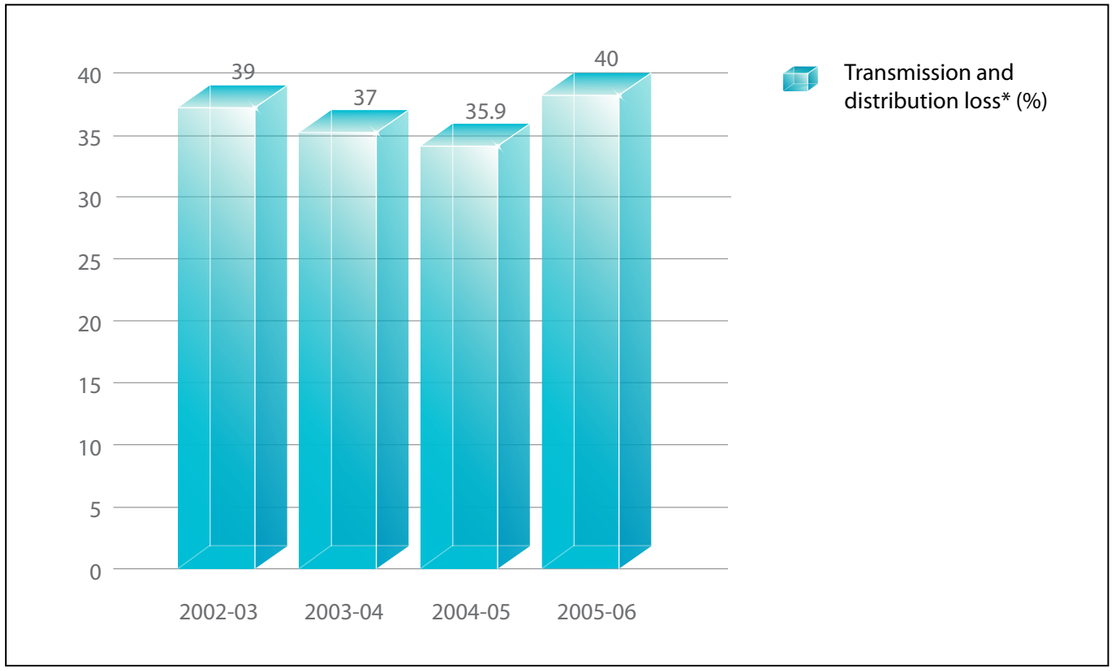
Year	Transmission and distribution loss* (%
2002-03	39.00
2003-04	37.00
2004-05	35.90
2005-06	40.00 (Estimated)

Source: *"General Review"*



Lack of power supply has forced children of Tahirpur village to use kerosene lamps and lanterns for studying.
© Harikrishna Katragadda / Greenpeace

Fig 6: Transmission and distribution losses



An overview of the current power situation in Bihar, the future plans and the supply-demand gap indicate an urgent need for alternatives/renewable energy promotion initiatives for increasing energy supply in the next 5 years.

One, the capacity gap is evident through the above analysis. The state will need substantial manpower and financial resources to increase electricity supply in the short, medium, and long run. Moreover, a reliable, steady supply of either coal or gas will be essential. Renewable sources available in Bihar can easily fill this gap.

Two, the time frame of growth is three to five years. With low infrastructure development and a distributed (spread out) population, reaching a substantial number of people through centralised plans will be a challenge for the state. Stand-alone energy systems with localised generation and supply require low capital and limited infrastructure resources. They can be installed in a much shorter time and their comparatively low capital cost as compared to that of the centralised grid, makes them receptive/amenable for private equity and private collaboration.

Three, the environmental obligations of the nation and states are growing along with threat of climate change and the resultant international pressures. Use of coal and gas-based plants will increase this pressure on the state whereas electricity generation through renewable resources can bring laurels for the state. By utilising renewable and sustainable technologies for developmental purposes, the state can project itself as a progressive government and can thereby legitimately claim support from international bodies for economic growth.

Renewable energy systems, both large-scale and decentralised, in collaboration and co-operation with private investment, are clean and sustainable source of energy. The state of Bihar, with its abundant natural resources in the form of rice husk, sugarcane, weed from wetlands like Daincha, widespread solar radiation and ample water for small-scale hydro, can easily be a leader in renewable energy production. The national government report *'Road map for Development of power sector in Bihar, Government of India - July 2007'* clearly indicates the high renewable potential in the state.

SOCIO-INSTITUTIONAL SITUATION AND TECHNOLOGY ANALYSIS

This part of the report conducts an integrated analysis of socio-technical aspects, governance and state resource in order to establish a comprehensive understanding about a majority of integrated technologies and governance systems for rural Bihar.

STATE'S SOCIO-INSTITUTIONAL SITUATION AND RESOURCES' ANALYSIS

Bihar has a vast stretch of fertile plain along with river Ganges and its tributaries Gandak, Bagmati and Kosi, which provide water to the state. Additionally, the state is located at a non-coastal region near the Tropic of Cancer, with an average annual temperature between 14-28 degree Celsius and an average annual rainfall of 1,205 millimetres *(www.mapsofindia.com).* Thus the state has several natural and strategic geographical and climatic advantages.

The census of India 2001 estimates that about 42 per cent of the population in Bihar lives below the poverty line and earns through non-farming economic activities. About 38 per cent of the state population lives in temporary shelters of thatched *(kuccha)* roof and only about 4.5 per cent of the rural population has any form of motorised transportation. More than 45 per cent of the population has no access to any battery or motor-operated equipment (like radio, television, telephone etc.). Lack of basic facilities and modern day equipment hamper awareness and in turn adversely impact the economic growth.

In terms of income generation, the size of the industrial sector in Bihar is about 3.5 per cent of the net domestic product, which is significantly below the national average of 20.1 per cent. Small industries/businesses and artisan-based commercial setups dominate the industrial sector. Agriculture remains the most active income generation activity. The basic character of rural Bihar reflects a synthesis of traditional and small-scale industries.

The state's overall physical infrastructure needs substantial improvement. As per RHS bulletin 2008, the state has only 366 rural dispensaries, 70 referral government hospitals and 8 medical colleges to cater to 45,000 villages and only about 10 per cent of population has access to total immunisation. The state has approximately 71,832 schools, which include pre-primary to senior secondary schools. Less than a per cent of state colleges are in rural areas and only 50 per cent of the children residing in rural areas are able to complete basic primary education.

The investment rate (credit and deposit) in Bihar is much lower than the national average. Only about 21 per cent of the rural population has access to any bank credit. During 2004-05, the average per person loan in Bihar was Rs 1,575 against Rs 5,000 in Madhya Pradesh and Rs 27,500 in Maharashtra. Lower level of credit dispensation indicates the presence of local money lenders giving money at higher interest. Both the low credit and high interest borrowing negatively impacts the commercial potential of the local population.

The power situation discussed in detail in the Chapter 2 clearly shows that; a) huge supply and demand gap, b) low capacity of the state to bridge the gap, c) difficulties in centralised supply due to lack of infrastructure, capital and human resource, and d) low availability of a reliable supply of conventional fossil fuel.

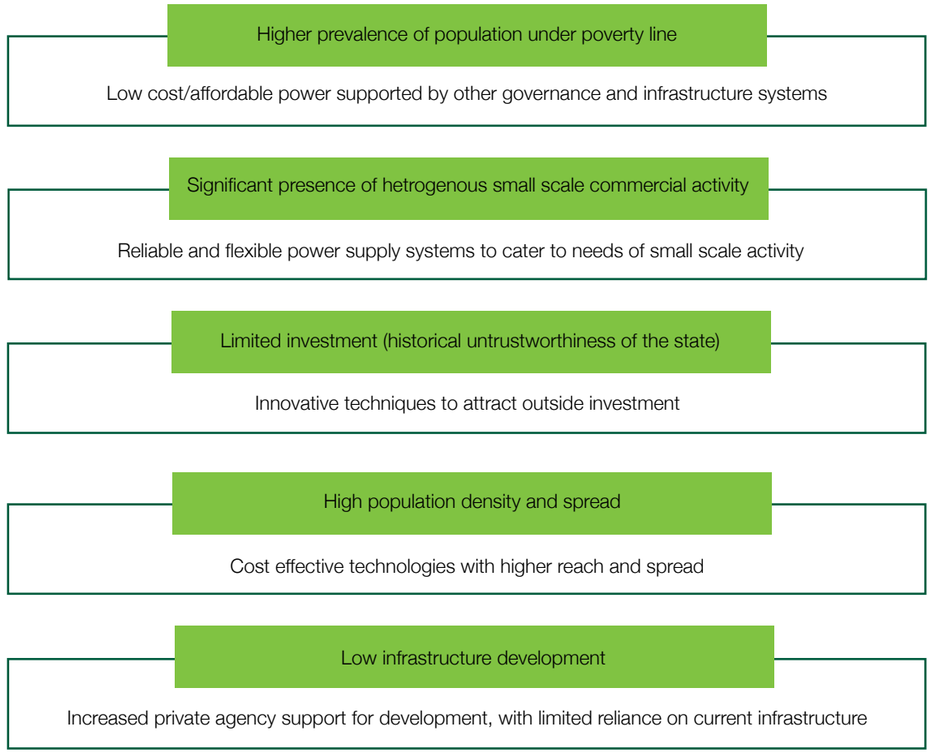
These resource availabilities and limitations put their own pressures and constraints on the planning for development-led energy access initiatives.

Low investment flows, significant supply-demand gap, availability of renewable raw material, high population density, spread-out and underdeveloped infrastructure highlight the failures in centralised planning and necessitate a search for alternate technical systems for power generation and distribution in the widespread areas of rural Bihar.

The next step, therefore, is to explore the technologies available. The section below conducts a socio-technical and governance analysis taking into account a range of energy technologies. This assessment of the management and governance needs for various energy technologies will provide clarity on the systems that are best suited to meet the needs of the rural communities. Considering the constraints and pressures faced by the government, the systems need to be developed in a reasonably short time span.

A summary of the significant constraints and resultant needs are given in Figure 7.

Figure 7: Resource Summary of Strengths, Constraints, and Opportunities



SOCIO-TECHNICAL AND GOVERNANCE ANALYSIS

Referring to Annexure, Table 1 presents analysis of socio-technical and governance aspects of various electricity systems with a focus on development-led planning. The analysis is in alignment with issues of overall economic, infrastructural and commercial growth. It demonstrates the following:

- As a technical system, the centralised grid requires intensive capital investment besides having huge capacity to provide electricity to large number of establishments (household, commercial, others). However, the system becomes economically unfeasible when providing electricity to scant population in large spreads and depends in subsidy support. Alternately, the decentralised systems have a local reach. These systems use local raw material and have a small spread. Moreover, the operational capacity of the decentralised system is determined by the supply and demand sources. The technology functions as a flexible system, which operates according to local demands. Hence, the cumulative local impact is enormous.

- The centralised grid has a very high capacity factor (high plant load) that facilitates the setting up of relatively large-scale, economic or commercial activities in rural areas. This in turn provides the producer with economies of scale (reduces per unit cost and positively impacts economic viability of that commercial activity).

- The decentralised systems have a low capacity factor and can support small and medium scale commercial activity. Significantly, they are highly flexible and allow to be tailored to local conditions and needs, i.e. supply can be adjusted and designed to optimise agriculture, commercial and households needs.

- The decentralised technologies, as stand-alone, small-capacity technical systems, can cater to a vast number of area spreads and are suitable for remote locations. They are also the most cost-effective systems. However, they can be managed by community participation. But, local cooperation and consent is a critical requirement for the success of this system. These constraints create several positive externalities, such as a technically capable workforce, employment opportunities and an investment avenue for local population.

1. Both centralised and decentralised systems provide basic power to the consumers. The centralised grid system has higher capacity, which can provide power for commercial

use. Moreover, its sheer size and the ownership structure (state-owned) makes the system more lucrative for generating funds through the market. However, decentralised systems have more positive, holistic and developmental impact on the society because of their local and socio-economic dynamics. These systems utilise local raw material, generate employment by engaging local human resources for operation and maintenance of the system and create local investment. Moreover, these systems provide higher entrepreneurial opportunities due to their need for limited financial resources and higher returns on investment (as will be more clearly observed through the case studies in the next chapter).

2. Power loss during transmission and distribution is significantly higher in the centralised systems. The decentralised systems, being local in their supply and demand, lead to limited power loss and radically improve efficiency. Moreover, the localised generation and maintenance increase supply security.

- From environment (climate change) perspective, decentralised systems has several benefits:

1. Use of local, biodegradable waste resources, reducing the need for waste management and no need of capital-intensive infrastructure support.

2. Flexible, easily and effectively manageable as they are far less resource dependant.

3. Allowing the governments to interact internationally through carbon trading and carbon mitigation societies.

A comparison of both systems in terms of operational and commercial feasibility strongly advocates a mandate for decentralised systems in Bihar. Facing significant supply and demand gap, Bihar's main power providing agency, the Bihar State Electricity Board (BSEB), has low financial and human capacity to fulfil the existing gap. Moreover, the BSEB faces difficulties in centralised supply due to lack of infrastructure, scarcity of capital/human resource in the state and low availability of a reliable supply of conventional fossil fuel.

These limitations put several pressures and constraints on the centralised, government-sponsored planning for development-led energy access initiatives. By enabling the installation of decentralised systems with private investments and partnerships, the Bihar government will drastically cut its need for finances to install huge power generation plants, expensive transmission networks and maintenance costs.

Decentralised systems will also prove more cost-effective for the state in the long run by boosting commercial activities in the rural areas and thereby creating positive indirect impact, such as access to modern educational aids and health.

The western world has awakened to the challenges of promoting sustainable energy. They are actively helping several governments by disseminating suitable technologies, skills and knowledge. They are also offering financial support with grants and loans for local economic development. The state of Bihar can access this support by encouraging decentralised energy systems in the state. Part of its financial and technological needs can be met through these various financial aids by the developed nations.

To summarise, decentralised systems can create a platform for Bihar government to develop and overhaul state's current energy and infrastructure situation in the rural areas. It would also enhance energy security, commercial activity, foster economic development and empower people. Therefore, small-scale, decentralised energy models are the best solution for mitigating the energy crisis in the state.

DECENTRALISED ELECTRICITY GENERATION: A NOTE

Decentralised Generation (DG) is known in different parts of the world by different names, such as: distributed generation, on-site power, stand-alone, embedded generation, captive power, back-up generation, uninterrupted power, cogeneration or district energy. Decentralised electricity generation signifies "an electric power source connected directly to the distribution network or on the customer's side of the meter." It is energy generated at or near the point of use. The size of the power plant may vary from micro-DG (below 5 kW), small DG (5 kW-5 MW) and large DG (50-300 MW).

Decentralised rural electrification in the state of Bihar will have several potential advantages because of…

i) Locally available renewable sources.
ii) Significantly less transmission and distribution losses.
iii) Viability in remote areas as compared to grid electricity.
iv) Financial accessibility to small investors due to lower capital cost.
v) Low involvement of scarce government resources.
vi) Capacity building of local community.
vii) Job creation through operations and maintenance.

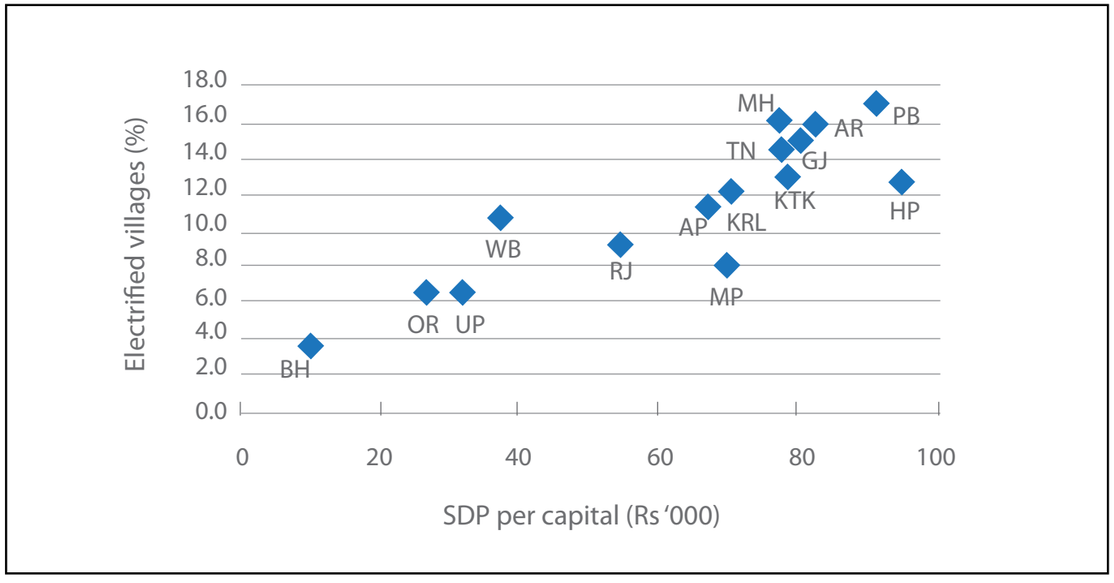
In addition to above-mentioned benefits, economic growth of rural areas is likely to be accelerated, which will generate more employment and secondary business opportunities for rural community. The policy as well as the strategy of the Government of India is to set up Rural Electricity Distribution Backbone (REDB) and Village Electricity Infrastructure (VEI) at places where grid connectivity is available. However, in most remote areas, where grid connectivity is not possible, decentralised electricity is the means of supplying electricity.

The Planning Commission has envisaged that a 9 per cent growth rate of the Indian economy in the 11th Five-year Plan cannot be achieved without significant increase in the availability of electricity. A correlation between access to electricity and increased State Domestic Product (SDP) has been proved true. Figure 8 gives a relation between percentage of villages electrified and State Domestic Product.

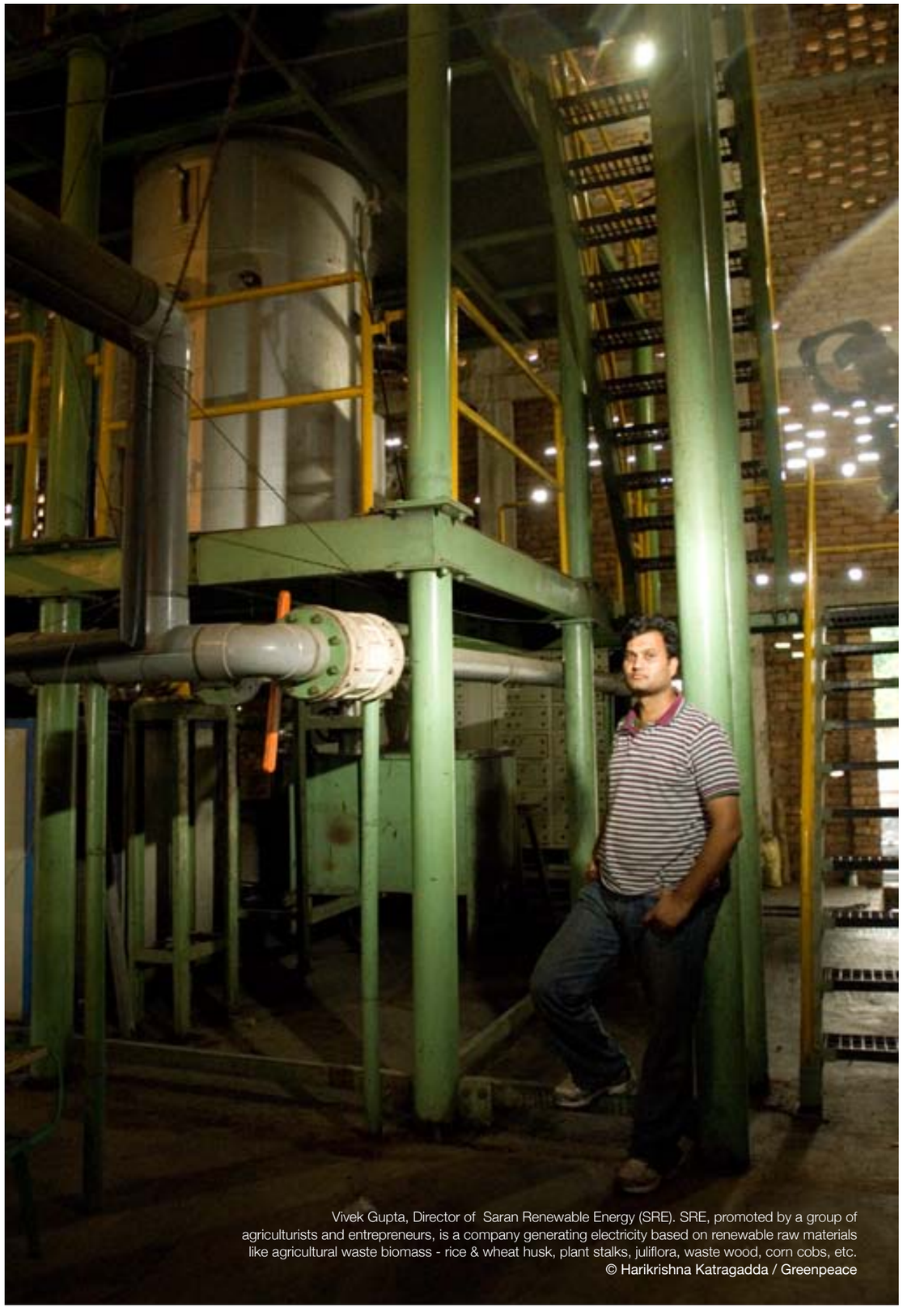
The entire analysis in this report clearly demonstrates the high potential of decentralised generation from locally available renewable sources, such as biomass, hydro, wind and solar. The rural areas of the state have a wide variety of biomass, which is readily available due to large-scale agricultural activities. Hilly and coastal areas are ideal locations for harnessing wind energy whereas for solar energy large surface in the rural areas can be used.

The Decentralised Energy system also has other advantages, for instance, less transportation cost, no cost for grid connection and effective use of local resources. Consequently, clean, cost effective and reliable electricity can be generated with considerably reduced transmission and distribution losses.

Figure 8: Percentage of villages electrified and State Domestic Product



Source: *Cust 2007a*



Vivek Gupta, Director of Saran Renewable Energy (SRE). SRE, promoted by a group of agriculturists and entrepreneurs, is a company generating electricity based on renewable raw materials like agricultural waste biomass - rice & wheat husk, plant stalks, juliflora, waste wood, corn cobs, etc.
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CASE STUDIES OF DECENTRALISED RENEWABLE ENERGY SYSTEMS

This section narrates three case studies of decentralised energy generation and supply companies (private and government) using renewable raw material, in order to substantiate the situation and analyse the technologies.

ONE - HUSK POWER SYSTEMS:

Owned privately by three people, Husk Power Systems provides electricity to about 40,000 households/1 lakh people across 125 villages in Bihar. The company uses rice husk as the main raw material to produce electricity and has 35 plants currently in operation and 25 under installation. Most of the plants are 32kW installed capacity (aggregating to a total installed capacity of 2MW). Each of these biomass gasification plants uses about 330 kg (300-350kg/day or 50-60kg/hr.) of rice husk to generate power for six hours a day. The company was established with the help of international agencies and government subsidies.

Husk Power operates on the BOD (build-operate-distribute) model, with technical and equity support from an international agency. The plants run for six hours per day providing electricity at a monthly rate of Rs 80-100 for a 30 watt connection (2 15 watt CFLs). The 6-8 hour supply costs the user Rs 12.5–13.5 per unit/kwh. Currently, the power supply is not metered and each household is charged as per the number/power of equipment used in the daily supply. Monthly payment is collected in advance by Husk Power employees.

The cost of producing 32kW of electricity per month is Rs 22,000, which includes cost of raw material, salaries and maintenance. The proprietors expect to recover their investment costs within 3 years. Each plant employs four-five people to run and maintain it. Husk Power Systems has put in their own distribution lines. Each line has a fuse to ensure no one draws power excess to what was informally agreed upon and to counter power theft. The ash residue (burned rice husk waste) from the plants is given to producers of incense sticks.

Husk Power Systems operates on several innovative ideas and mechanisms as part of their business model. Broadly, this system of husk power utilises a natural waste material found in abundance, locally. Rice husk is a natural waste found in several parts of the country, making this model replicable to other parts of the country. Using a waste material for biomass feed helps achieve cost-effective monthly operations. Also, the proprietors own the entire system from generation to revenue collection with virtually no dependence on government or outside support. The company has also integrated the system with other externalities, like carbon mitigation by encouraging customers to use energy-efficient CFL bulbs, by selling the ash residue to incense stick manufacturers and also by selling the rice husk char to solar panel manufacturers.

Specifically, the model maximises energy use and minimises distribution/system losses by keeping an optimal mix of plant wattage and distance served. (Please refer to Annexure Table 2, End user survey: Husk Power systems).

TWO - SARAN RENEWABLE ENERGY:

Saran Renewable Energy Limited (SRE) is a build & operate model of decentralised electricity operations in three villages of Bihar. The electricity distribution is outsourced to local people, who had already been providing electricity to the village through diesel generators. SRE provides electricity to about 250 households and about 50 pump sets with the help of a biomass gasification plant with an approximately 120kW capacity. The plant largely runs on fast growing Dhaincha weed (sesbania grandiflora) along with some wood chips. The plant tastes bitter and cannot be used as fodder. It typically grows on sizeable empty lands in and around Saran district. About 1.25kg of Dhaincha produces one unit of electricity at the cost of Rs 8. Dhaincha costs Rs 1.5-2.00 per kg in the market. The electricity is sold to the distributors at Rs 10 per unit.

SRE was largely established with private equity along with 25 per cent of financial support from government agency MNRE, under its various technology and commerce related schemes. Typically, the plant operates for 6-7 hours per day in the evenings, providing power to about 4-5 villages in the area. The lines are not metered and consumers pay a flat monthly rate of Rs 60 per bulb and Rs 140 per fan.

The biggest barrier before the company is reliable supply of raw material for smooth functioning of the power plant. In order to ensure constant supply, the proprietors supplied Dhaincha seeds to the local farmers at a nominal price, which they could sow on empty flood-prone wastelands. The power plant can sustain on about 75 acres of wasteland sown with Dhaincha. SRE purchases Dhaincha at competitive prices, i.e. an acre of grown Dhaincha for Rs 10,000 or more. This ensures income to farmers and economic use of non-fertile lands. However, the farmers have not shown enthusiasm to sow the wild plant despite clear economic benefits. The reasons: lack of trust in the long-term business feasibility and commitment of Saran Power. The model depends on local environment/ situation.

The other constraint is lack of significant financial support from government agencies concerned, like BREDA, RGVVY or commercial banks. The banks do not consider the electricity sector in Bihar a safe investment. The government subsidy approval has several contradictory conditions attached to it, which did not qualify the technology used by SRE (mix of biomass and diesel) for several subsidies. The proprietors got

about a 10 per cent subsidy on the total cost of technology and installation.

One of the achievements of this power system has been the successful management of local dynamics. SRE integrated the existing diesel power providers into its system, as distribution franchisees. This also incorporated the already existing micro-grids into its operations. Saran now supplies electricity to about 80 per cent of users in the villages of Garkha Block. About 75 per cent of the distribution is being managed by diesel power generator owners. However, trust among the stakeholders, farmers and the proprietors remain elusive and so is the government support, causing the biggest bottleneck for the system to run effectively. (Please refer to Annexure Table 3, End user survey: Saran Renewable Energy).

THREE - BIHAR STATE HYDRO-ELECTRICAL POWER CORPORATION (BHPC)

The Bihar State Hydro-electric Power Corporation (BHPC) , a Government of Bihar undertaking, has been working "to initiate and facilitate the development of hydropower resources in the state of Bihar". Besides, it aims to "work out policies and strategies to address the future demands of the power sector while keeping in view the imperatives of clean technology and social objectives". With about 12 projects in operation and 23 under construction, BHPC is one of the largest developers of renewable energy in the state.

Bihar has been making rapid progress in harnessing its small and large hydro potential. BHPC expanded its generation capacity from 18.3 MW in 2000 to 47.1 MW at the end of the 10th Plan period. Several new capacities were identified. At present, 15 projects are under construction, with the financial assistance from NABARD, which will add 14.1 MW of power to the State's generating capacity. Besides, 46 sites have been identified for future plans, which, when completed, will add 140.80 MW of additional capacity in the small hydro sector.

In its current plan, BHPC has embarked upon an expansion programme, which seeks to set up large pumped storage projects in Bihar with a total capacity of 2,570 MW. The company seeks to enter into partnership with private investors for co-operation, joint-venture or for developing small hydro-electric plants. About 39 micro and seven small (not exceeding 25 MW in size) hydro-electric projects have been identified for future development. These could be in-house operations or joint ventures in co-operation with private investors. The list of identified sites includes 17 sites in the basin of river Kosi. Projects sites have also been identified in Dagmara. Apart from being commercially attractive, these projects also have the potential to provide energy to relatively under-developed areas of Bihar. These sites appear to have a potential of 97 MW. The Asian Development Bank has indicated willingness to extend financial assistance, as per their norms, for the project.

In conformity with the strategies at the national level, BHPC seeks to develop environmentally sustainable plants and link them up with poverty reduction plans at the state and national level. Rural electrification is one of the aims with an understanding that access to electricity is vital for social and economic development of rural Bihar. With less than 10 per cent of rural households having access to electricity, this is seen as an emerging opportunity to venture into decentralised generation through small hydro power and rural power distribution along the existing small hydro generating stations. BHPC has already initiated steps in this direction by inviting private sector, whose role is crucial because of significant investment requirements of the state. The public sector undertakings and government cannot possibly meet these requirements alone.

Table 3: Performance of hydropower in Bihar

Year	Generating Plants		Under Construction		Identified	
	Number	Capacity (MW)	Number	Capacity (MW)	Number	Capacity (MW)
2000	6	18.3	10	41.5	59	41.6
2001	3	24.9	-	-	37	27.6
2002	3	24.9	-	-	43	29.25
2003	4	44.1	5	7	38	22.25
2004	4	44.1	11	11.95	35	40.4
2005	4	44.1	14	13.4	32	38.95
2006	6	46.1	16	15.1	46	140.80
2007	7	47.1	15	14.1	46	140.80

Source: *www.bhpc.com*

LEARNINGS:

The case studies show a pattern of growth and constraints which call for a review of existing policies and governance structures.

One: The case studies demonstrate operational level of problems like difficulty in maintaining the distribution system due to theft, non-availability of steady raw material and non-availability of speedy and technical support for system maintenance. These operational problems indicate gaps in institutional and structural support from the government.

Two: Conflicting structures for providing technology subsidies and lack of private sector investments in potentially profitable options, like hydropower projects, reflect policy gaps.

Three: Existing dominance of diesel generator operators at the local level and no local support for raw material production, despite economic incentives, indicate severe support deficit from the local government as well as from specialised agencies like BREDA, REC etc.

ANALYSING EXISTING POLICIES FOR DECENTRALISED ENERGY PLANNING

The National Renewable Energy Policy and Plan (2006) encourages foreign investment in rural energy initiatives. With 100 per cent FDI approval in a joint venture and a 5-year tax holiday, there is no special requirement of industrial clearance. Moreover, soft loans are provided for equipment manufacturing used in decentralised energy systems. The plan envisages an increase in the share of renewable energy by 10 per cent of the total new power capacity. It also provides solar water heaters for one million homes and assures electrification of 24,000 villages by clean energy technologies, by 2012.

The state of Bihar, in line with the national policy recommendations, has developed two policy documents to promote energy/electricity access. These are Bihar Policy for Promotion of New and Renewable Energy Sources (2009) and Policy Guidelines for Private Sector Participation for Developing Non-Conventional (Non-Grid) Energy Resources.

Furthermore, the Electricity Regulatory Commission has discussed and documented access to rural areas and promotion of decentralised energy systems in its Annual Revenue Requirement document (ARR) 2009. The section below analyses these policies and documents.

ASSESSMENT

The policy of Bihar Government for promotion of New and Renewable Energy Sources (2009) is aligned with the National Renewable Energy Policy and Plan (2006). It encourages private players to invest in renewable energy. Some salient features of the policy are:-

- ACQUISITION OF LAND

The policy specifies access to land either through direct purchase by the developer or taking on lease the government land in industrial areas. The government facilitates speedy land use change from agricultural to non-agricultural besides assisting private investors in acquisition. However, three reasons in the policy guidelines may create problems in its practical implementation, making it ineffective in practice…

1. The policy talks of easy lease of government, 'industrial' land. However, there is limited or no land marked as 'industrial' in most rural areas. This automatically makes the land in rural areas unavailable through government lease. Hence, direct purchase is the only option before the private investor.

2. The policy does not specify an `industrial land'. The option of government support (through lease) is available to all private investors other than those investing in decentralised energy systems. Thus, it deprives the investor of the latter category of the government support. The energy policy document stresses the land to be 'industrial'.

3. The 'industrial' land option also becomes unfeasible for decentralised systems as each system requires very limited space for installation and generation (e.g. biomass gasification units).

- AGENCIES INVOLVED FOR PROJECT EXECUTION

The policy specifies agencies involved in the execution of a renewable decentralised project. It is State Investment Promotion Board (SIPB) which gets a first look at the project proposals and sanctions approvals for setting up renewable energy plants. The project evaluation and recommendation is handled by the Bihar Rural Energy Development Authority (BREDA). Post installation, the investor has to coordinate with the Bihar State Electricity Board (BSEB) for sale and transmission of power while negotiating with the Electricity Regulatory Commission (ERC) for the supply and pricing. The policy claims a transparent and comprehensible system. However, the process of dealing with multiple agencies for various clearances is cumbersome and time consuming.

Also, the main agency for industrial development - Department of Industries - is not at all involved in the process. Its involvement is necessary for expert support strategy, marketing, access to infrastructure, training facilities and for accessing subsidies, loans and incentives.

The case of Saran Power Limited highlights the limitation faced by a small investor because of this gap. Saran Power requires help in raw material procurement and its supply side management. The Departments of Industries and Agriculture are well equipped to support and facilitate but their non-inclusion in investment and development of electricity industry hampers successful entrepreneurial implementation of decentralised energy systems.

- GRID INTERFACE

The policy says the renewable/decentralised energy investor has to supply a minimum of 25 per cent of power generated, to the Bihar State Electricity Board (BSEB) on a mutual agreement. The sale of power to a third party (directly to consumers) requires the developer to spread distribution lines at his own cost. But by selling at least 50 per cent of the power to the BSEB from a minimum of 2 MW plant, the company can save 50 per cent transmission cost. For this the investor signs a Power Purchase Agreement (PPA) with the BSEB. This can ensure transparency and cost effectiveness for both the investor and the BSEB in providing power to the state. However, some questions do arise...

1. The State Electricity Board gives limited or practically no support to the investor for smaller level of power generation. But, as the largest power producer and supplier in the government sector, the Board has tremendous capacity to provide various supports to the

investor in the initial stages.

2. With a generation capacity of 2 MW or more, the investor is mandated to sell 50 per cent of the power to the grid in order to receive any support from the BSEB. This significantly restricts the competitive and profit space of the investor. The investor does not get the flexibility to sell and buy his produce at will or according to business principles of profit. Moreover, this inhibits local development because at least half of the power produced by the investor goes to the grid, and is not accessible to the local consumers.

3. Modern day research has developed several mix technologies (using both renewable and non-renewable raw material) to ensure reliable power, keeping in mind the fluctuating nature of supply of natural raw material. The existing policies do not acknowledge these technologies and thereby exclude them from receiving government support.

These issues indicate the need to incorporate business principles in these policies. The renewable energy policy must look at the technologies from the investor's point of view and build systems and structures, accordingly.

- PROJECT MONITORING

The policy stresses on adhering to schedules, including dates and report submissions. Each project has to submit a six-month report incorporating 'the copies of permits/clearances/consents received from various departments/authorities, as applicable and documentary evidences of the same'. This requirement significantly indicates a highly bureaucratic approach to project monitoring. Moreover, the Bihar Electricity Regulatory Commission (BERC) is in no way involved in the monitoring and regulation of the process.

The policy should incorporate simple procedures to monitor the compliance and progress of the projects. Most importantly, *monitoring of compliance has to be the responsibility of the government agencies rather an onus on the investor to prove his work.*

OTHER SALIENT POINTS OF NOTE

- The Bihar Electricity Regulatory Commission (BERC) has taken a very positive step towards defining and encouraging biomass/biogas based renewable energy generation. The `Tariff Document on Biomass and Biogas based Cogeneration 2009' highlights the high potential of the raw material with specific mention to sugarcane (ethanol), used in Bihar for co-generation. The document also details the government's incentive policy for power generation using ethanol (this is primarily generation of power within the distillation plants for their utilisation, in simple terms cogeneration) or special pricing policy/subsidy for buying machinery.

  The potential of other raw materials abundantly available in Bihar like rice husk and Dhaincha are as mentioned briefly in the policy. In practice, these two resources are the most extensively used raw material for renewable energy production in Bihar but ERC has no clear incentive or regulation for the same.

- The renewable energy policies and incentives are applicable to technologies that use only renewable resources and not for mixed technologies, which use both renewable and non-renewable resources. The exclusion of mix technologies substantially reduces the market potential for private sector participation in the rural energy access program. For example, Saran Power Limited received limited subsidy due to its mix-fuel technology.

- The role and responsibilities of the ERC in promoting and supporting renewable and decentralised energy systems is not explained in the policy. As the main regulatory authority for the electricity sector, it plays a major role in the promotion of renewable/decentralised energy systems, which needs to be defined clearly.

OVERALL GAP ASSESSMENT: A SUMMARY:

Assessment of the energy scenario, survey of electricity consumers and analysis of existing state level policies clearly reveal the following significant gaps in energy access in rural areas:

Resource Gaps:
- Limited government resources (human/financial/knowledge) to promote new technologies.
- Low financial strength of the government to support large-scale/capital-intensive investments
- Limited infrastructure development in the state.

Access Gaps:
- Low per capita electricity consumption in rural areas.
- Low commercial electricity inputs for overall economic growth of commerce and industry.
- High non-commercial energy consumption from local resources.

Policy Gaps:
- Limited regulatory structures for private investment in energy sector.
- Limited incentives and motivations for private sector involvement.
- Lack of systems and structures to promote rural energy technologies.
- Limited technical reach of policies.

Institutional / Governance Gaps:
- Limited involvement of significant authorities like department of industry and electricity regulatory commission.
- No clear mandates/yearly targets/dedicated government body to promote rural power.
- Non-alignment between regulations and feasible decentralised system operations.
- Non-alignment between energy regulators and establishments of decentralised system operations.

The gaps reveal the requirement of a comprehensive approach, which integrates electricity needs along with appropriate techno-financial solutions for overall effective and economic development and acceleration of agricultural and rural areas.

Filters used to eliminate solid particles and tar from the gas generated at an 8 kVA power plant owned and operated by Husk Power Systems Pvt Ltd.
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FRAMEWORK TO ENABLE SUSTAINABLE ENERGY ACCESS TO RURAL AREAS

The elements of policy, governance and capacities suggested in this section are based on the principle of inclusion, state's increasing investment capacity, generation of developmental benefits and reduction of environmental damage. The proposed framework takes a top-down approach, as the essential nature of energy for development requires extensive institutional and government intervention. The changes are recommended at the policy level, supported by various implementation processes and structures.

The vision for overall energy-led development for the State of Bihar emerges as follows:

"A state-wide network of decentralised energy plants (stand alone and micro-grids), developed with support from state government agencies in collaboration with private entrepreneurs for a high impact and accelerated economic development of the state".

The strategies, which are elaborated in the following section, are listed in Box 1.

IN THE IMMEDIATE TERM

- Integrated energy planning: state-wide natural resources and appropriate technology.
- State incentivised emergence of new private enterprise models, particularly energy services companies (ESCOs), developed through innovative and alternative business opportunities in the electricity sector by use of decentralised generation
- Empowerment of relevant government agencies to drive the expansion of decentralised energy.
- Showcasing the state as an evolved decentralised energy market, nation-wide and worldwide.

IN THE LONG-TERM

- Transform the state's economics and energy supply through use of decentralised energy by creating facilitative policy structures.
- Create supportive institutional avenues for micro-grids.
- Institutionalise supportive regulatory structures and encourage governance support through the Electricity Regulatory Commission.
- Develop innovative energy pricing models by mixing regulation and competition.

Box 1: Enablers for energy access to rural areas:
State-level challenges

Immediate term - Composition and Institutional Changes

- Integrated electricity planning
  - Resource and technology plan
  - Rural electricity infrastructure development plan
- Incorporating electricity in the Rural Industrialisation Plan 2008
  - Small Scale Industry (SSI) model of implementation
- Meeting the renewable energy obligations
- Agency capacity building
  - Human resource
  - Financial

Long-term – Changes in Policies and Governance Structures

- The Role of the Electricity Regulatory Commission
  - Regulatory structures
- Policy change for better economics
  - Large generation and micro-grids
- Tariff design to encourage DE and micro-grid
- Structural changes for clarity and efficiency
  - Roles and responsibilities
- Policy modification for private participation
  - Integration of business principles
  - Developing hydro and solar power

Immediate Term - Composition and Institutional Changes:

Policies without organisational capabilities and implementation structures are ineffective. For example, the decision to provide interest-free loans to farmers or rural cooperatives for investment in any energy system that utilises local raw materials, has to be supported by a clear directive. Incentives are also given to local banks for loan facilitation. Thus, the establishment of related institutions is crucial for policy to work credibly. Institutional structures contain various government arms - executive, legislative, judicial and so on.

Integrated Electricity Planning:

The need for an integrated approach to rural electricity is imperative for Bihar to progress economically. Energy capacity increase should align with other developments and electricity infrastructure strategies. To achieve this a few steps are needed:-

STEP 1: RESOURCE & TECHNOLOGY PLAN FOR RURAL ELECTRICITY:

- Identify population, energy needs at different times of the year, investment required, local investment possibilities and financial capacities of the population.
- Identify nature and amount of raw material available for decentralised renewable energy systems at different times of the year.
- Analyse and develop feasible technologies and locations emerging from the above- mentioned two points.
- Map the locations in districts and talukas and enlist the government infrastructure support, required and available.

This can be the mandate of district administrations and the Bihar Rural Electrification Corporation (REC). The district level plans will identify the areas having raw material potential for their own energy systems outside the grid. The plan will also define the areas (state-wide), having economic viability for private (single, multiple, or cooperative) ownership of electricity systems. This investigation will provide the state with a clear district/area-wise plan to meet the electricity needs of the state. However, infrastructure support, financial assistance and policy support is required for this plan to work effectively.

STEP 2: INTEGRATION OF RURAL ELECTRICITY INFRASTRUCTURE DEVELOPMENT WITH EMPLOYMENT & WELFARE SCHEMES:

The aforementioned rural electricity infrastructure needs should be integrated in the on-going schemes of rural development like Rural Employment Guarantee Scheme (MGREGS) or the Rajiv Gandhi Rozgar Yojna (RGRY). The financial support from the Rural Electrification Corporation (REC) for rural electricity infrastructure development can be an official mandate of the Bihar Rural Energy Development Agency (BREDA).

BREDA is the nodal agency that carries out the remote village electrification programmes. The state government provides funds to BREDA for subsidy expenditure on various schemes. *Now, rural electricity infrastructure development should be added to it with clear annual targets.* Based on the technology plan developed for each region (district/taluka), BREDA should facilitate integration of electricity infrastructure development with asset building plans.

Integration of Electricity Access Initiatives with the Rural Industrialisation Plan 2008:

The Rural Industrialisation Plan 2008 developed by the state government is a pioneering and innovative road map for rural, economic growth in Bihar. The report defines establishment and promotion of industries largely utilising local rural resources and skills. Its basic character reflects in the synthesis of rural and modern lives. The industrialisation plan 2008 clearly outlines a *"development strategy based on location-specific agri-resource endowment….the major advantages would be product value addition and local employment creation."* Some of the salient features of the plan are…

- Cluster based development: Clubbing of areas to form 'economic clusters'.
- All infrastructure development to be geared for technology-related development.
- A major thrust on providing market linkages based on product cluster formation and effective strengthening of the credit and marketing links for security of the entrepreneur.
- Training of relevant government personnel for commitment and institutional support to the entrepreneurs and need for a semi-autonomous cell or unit in the Department of Industry to supervise, coordinate and promote rural industrialisation.
- Finance resource building at the government and private level by the establishment of a council for rural industrialisation and establishment of related coordination committees at district level.

STEP 3: SUPPORT FROM THE DEPARTMENT OF INDUSTRY

To support the above-mentioned salient features, a decentralised energy initiative (private-public partnership or private ownership initiatives) should become a mandate of Ministry/Department of Industry and Rural Industrialisation Plan 2008. The Ministry has created several infrastructure support institutions in the Rural Industrialisation Plan 2008 for the industrial sector. Access to finance (through loans, grants, and bank incentive schemes), entrepreneurial incentives and subsidies at several points in the generation supply chain (subsidy for installation, incentive for production and support for sales and marketing) and technology and knowledge support, are a few support examples the Ministry offers. For historical reasons, the electricity industry has remained outside this support structure. Integrating the private-public partnership or private ownership initiatives of DE/distribution generation at this juncture can provide critical support needed for the electricity industry to grow.

STEP 4: THE SMALL SCALE INDUSTRIES (SSI) MODEL OF IMPLEMENTATION

The decentralised energy initiative in rural areas requires a comprehensive model of support akin to National and State level models followed for micro and small-scale enterprises. The State should create this model under the Ministry/ Department of Industry along with a task force to support the implement structures. This task force should be given the responsibility of developing the entrepreneurial principles, similar to the ones created for the micro and small-scale industries. This task force will also identify potential barriers

and solutions to overcome them, will seek internally generated external sources of finance and other supports and will identify new institutional structures required to implement the DE growth strategies effectively.

The organisational and support structure needed includes:

- Schemes for international cooperation through government-led/supported MOUs
- Clear subsidies for establishment of DE systems, taking new technologies of mix fuel into consideration.
- Clear incentives for electricity generation (system efficiency) and sales (number of customers covered).
- Schemes for assistance in market development, in ensuring sales as well as sales spread and facilitating sales tie-up with renewable energy purchase obligations of the state.
- Creation of separate funds for regeneration and renewal of any DE firm (generation and supply) as and when required (This can also function as a contingency account in order to provide short term loans to the DE entrepreneurs. The fund can be managed by the REC.)

The task force activities can include:

- Monitoring execution and then evaluating the resource and technology plan in order to investigate DE potential.
- Identifying potential entrepreneurs (individuals and groups).
- Assisting in training and development in relevant areas of management, entrepreneurship and technology.
- Linking for financial tie-ups (state, national and international), helping mobilise required capital, assisting in insurance and creating safety nets.
- Linking and establishing interactions between the entrepreneur and the equipment suppliers and monitoring the supply chain activity.
- Creating associations and conducting annual state level conferences and workshops.
- Creating avenues for access to experts and market intermediaries.

The task force will monitor the progress and expansion of entrepreneurs in the field of decentralised and renewable energy systems for rural areas. This task force should consist of representatives from the relevant state government departments (Industries, REC, BREDA and ERC), experts from the industry and at least two representatives from the central government.

STEP 5: STRENGTHEN HUMAN RESOURCES AND FINANCIAL SUPPORT

Human resources and financial capacity development is required to strengthen the process of rural industrialisation and promotion of decentralised energy systems. A focused skill-building programme should encompass the following:

1. Management (technology, human, and markets) related training programmes for entrepreneurs, cooperatives, panchayats and other self-help groups.
2. Energy technology, technology transfer, facilitative governance and entrepreneurial support-related training for state government agencies like BREDA REC or Industry Department.
3. Self-employment promotion programmes for cooperatives and other rural community bodies to promote the spirit of entrepreneurship and economic outlook/perspective.

Moreover, access to credible and low interest financing can influence the success of energy access programmes to a great extent. Local cooperatives, panchayats and other groups realise the importance of energy for growth and development. They can come forward to create their own energy access initiatives provided they have a credible source of financial support. This financial support can come from commercial/ cooperative banks or non-banking financial institutions.

- The State Department of Industry and BREDA must develop direct links with schemes floated by the National Science and Technology Entrepreneurship Development Board (NSTRDB) for promoting technology-based entrepreneurship and schemes floated by the National Bank of Agriculture and Rural Development (NABARD) for financing self-help or joint ownership ventures.
- The financing scheme should include incentives for generation and sales, subsidies for establishment of the unit, and financial assistance (loans and grants) from banks and financial institutions.
- The tax system can also be used to reward businesses that install DE systems and successful DE entrepreneurs. Tax incentives could include reduced local taxes (property/ service), expanded capital, lower interest rates or priority access to select government resources

Promoting the Renewable Obligations

The international political and local economic benefits of promoting renewable energy are several. Internationally, it puts the state on the global map and invites funds from various agencies. Locally, it saves huge expenditures on non-renewable resources like coal and petroleum. It is a far-sighted and aware step towards micro and macro benefits.

STEP 6: CREATING CLEAR OFFICIAL MANDATES

All relevant state level agencies, like the department of Industry, the Electricity Regulatory Commission and the Rural Electrification Corporation, should be given mandates for promoting rural energy initiatives and DEs. Promoting DEs should be incorporated into their yearly plans, with clear targets and action plans.

STEP 7: COLLABORATIONS & CO-OPERATIONS FOR MEETING OBLIGATIONS

The electricity access roadmap must include actions by the state government to include both Indian and international stakeholders. Stakeholders can include international climate policy institutions, large Indian businesses, community cooperatives and civil society groups at different levels of planning, as appropriate. This can be in the form of a government initiated 'development think tank' or `work group'. This initiative can have several benefits:-

- Access to energy experts/specialists (technical, management and policy) from world over.
- Channel for enormous resources to be available for the state, especially institutional and financial, to enable Bihar's transition toward a low-carbon, economically developed society.
- Projection of the state on the national and world map for attempting to create a low carbon society and meeting the safe energy obligations. Positive impacts of this initiative will be in the form of grant/fund/support for other human development activities.

LONG-TERM POLICY CHANGE AND GOVERNANCE STRUCTURES

Policy and governance structures are the organisational arrangements that ensure effective long-term implementation of government obligations and abiding of rules and regulations. They are the strategic link between day-to-day operations and long-term governance benefits. Some of the governance structures and policy changes required to deal with energy access to rural areas are as follows:-

The Role of the Electricity Regulatory Commission (ERC)

The regulatory authority is the main government body to monitor the electricity industry. As a quasi-legal body it mandates to ensure the development of the industry. However, the policies for promoting renewable and off-grid electricity reflect either their absence or limited role in the decentralised energy sector. This is a significant gap and needs to be plugged at the earliest.

STEP 1: EMPOWER AND ENCOURAGE THE ERC

The government will have to empower and encourage the ERC for actively promoting decentralised renewable technical systems. The Authority should be encouraged to monitor compliance/implementation of entire DE related schemes and mandates. Besides, there can be many other encouraging gestures for entrepreneurs, like taking active interest in their business' well-being or inviting them to national and international forums to showcase their business.

STEP 2: REGULATORY STRUCTURES

Currently the DE systems in Bihar operate in an unregulated way. This has its advantages and disadvantages. The main advantage has been the freedom for the DE system to evolve as per local needs. The main disadvantage has been the lack of institutional support to this emergent technology-led electricity system. An unregulated DE system will face obstacles in progress, for example, getting local permits, property requirements, addressing utility charges and obtaining credit. Regulatory intervention can address these challenges besides protecting consumers' interest but this need to be done without hurting the entrepreneurial spirit.
The ERC can regulate the system as follows: -

1. Identify and undertake actions necessary to reduce any technical constraints in the current transmission and distribution system i.e. reinforcement of transmission and distribution lines and establishment of technical systems/ equipment to allow grid connectivity (to buy and sell to the grid from DE, independently or through micro-grid).
2. Identify and undertake actions necessary to reduce any raw material constraints in the current agriculture production system. For example, Daincha weed is a good raw material for some decentralised system technologies but being a weed it is not grown and produced naturally. In such cases the ERC should intervene to regulate production of this weed on non-productive lands, either through production by a government agency or through lease of government land to external agencies.
3. Study and design, along with the ministry/department of industry, incentives for generation and reliable supply of the raw material. The incentives should include, but not be limited to:

- Subsidies to help reduce initial system purchase price; (subsidy for infrastructure installation and support for national/international negotiations in DE technologies).
- Provisions of incentives for sale of energy, for example, slab rates for units sold or number of consumers served.
- Offset interconnection fee charged by electrical utilities.
- Streamline utility interconnection process by strengthening existing transmission system.
- Provisions of incentives considering the energy efficiency and emission performance of these systems.
- Provisions of incentives for system efficiency (enhancing reliability over time)
- Creating innovative financial mechanisms like microcredit systems, venture capital access, and clear leasing options (for land/equipment/expertise etc.) for entrepreneurs.
- Financial incentives in sync with the national policy options like a five year tax holiday for Foreign Direct Investment (FDI) in energy etc.
- Financing scheme should include incentives for generation and sales, subsidies for establishment of the unit and financial assistance (loans and grants) from banks and financial institutions.

4. Creation of Renewable Energy Support Fund, with the help of international donor agencies, to provide short term credit to micro-grids and Des.
5. Design service and quality standards through consumer protection laws: The ERC is expected to design laws to ensure that customers do not get trapped in any service contract with the DE operators. These laws also include information about electric quality standards, provide consumption and reliability data to consumers/states and resolve customer disputes.

POLICY CHANGES FOR BETTER ECONOMICS

The policy steps and mechanisms that help transform the economics of decentralised power generation for the entrepreneur, without overall economic loss to the government are:-

STEP 1: FACILITATE LARGE GENERATION AND MICRO-GRIDS

Micro-grid system is an emerging approach to provide reliable energy to far-flung areas without adding cost to transmission. It encourages local maintenance. A micro-grid is a network of several connected generation systems and a common distribution system. It allows locally generated energy to be transmitted to nearby communities, businesses and other facilities. Case studies show that the reliability and cost-effectiveness of stand-alone renewable and off-grid technologies are not sufficient enough to be implemented for the state's industrial and agricultural needs. Formation of micro-grids will mitigate this gap and will allow renewable technologies to meet significant demands while operating in small-scale applications. This will also solve the problems of intermittency and transmission losses/costs.
The policy changes required to encourage micro-grids are:-

- Removal of ceiling on sale and distribution of electricity as per megawatt plant size (under the current policy, the entrepreneur can put a plant of one megawatt or less to have the flexibility of generation and supply.)
- Minimise DE system interaction with the State Electricity Board: The DE systems and micro-grids should develop as business and interact with SEB only when selling/ buying from grid or when the entrepreneur outsources construction (distribution lines/installation of generation plant etc.) to the SEB. The SEB should act as a service provider to the entrepreneur.

The regulation change for the above policies could take any of the following options:

- OPTION 1: Remove MW barrier (generation) and allow the entrepreneur to set up larger systems/micro-grids, without a mandate to sell half of the power to the SEB (supply), but with a connectivity to the main grid for drawl of power when the local grid fails. The price of power to be drawn from the main grid is decided by the ERC and fixed annually per unit. This ensures flexibility to the entrepreneur for generation and supply. Additionally, it gives the entrepreneur an estimate of grid drawl cost in the long run. He is aware of his short and long-term costs and can plan efficiently.

- OPTION 2: Remove MW barrier (generation) and allow the entrepreneur to set up larger systems without a mandate to sell half the power to the SEB (supply), still with a connectivity to the main grid for buying and selling of power when the local grid fails. The power is bought at competitive rates. This ensures flexibility to entrepreneur and compels him to maintain the system efficiency for the cost of drawl from grid power is at competitive rates.

Additionally, the regulator will have to specify the limit of generation capacity, the number of customers it can serve and specify the characteristics required for an electric power system to qualify as a micro-grid. *However, this definition of a micro-grid should not be based on the number or type of generators that a micro-grid system can contain because such a restriction might prevent the micro-grid market from developing.* Rather, the definition of a micro-grid can be based on the number of consumers, use of raw material and the technical parameters of distribution and transmission networks used to ensure a size that is economically viable.

The state government should allow SEB to offer its expertise at competitive pricing to the DE entrepreneurs for use of its service. The regulators should fairly compensate utilities for the services provided.

STEP 2 - TARIFF DESIGN TO ENCOURAGE DE AND MICROGRID

Tariff and pricing structure can have a significant impact on the economic viability of distributed energy system. Therefore, a fair tariff and pricing system is essential. The pricing system should include:-

1. The contractual agreement between the ERC and the DE operator should supersede the basic rate set by the ERC for the public utility. In the early stages of any new technology, market-based pricing can make the new system uneconomic. Hence, to encourage DEs it is essential for the regulator to have separate tariff setting, which…
- Includes any grants from national and international agencies.
- Includes incentive slabs based on amount of generation (system efficiency and system reliability).
- Includes incentive slabs based on supply (number of customers served).
- Can be seasonal or periodic depending on the cost cycle of the DEs (the time frame and tariff should strike a balance between the raw material price fluctuations and an affordable price to the rural consumer).
2. Defining the grid-DE interconnection standards to avoid any tariff manipulations, for instance, either prohibiting access to the grid by providing expensive power (by the utility) or by supplying to the grid at a significantly high cost (by the operator).

STEP 3 - STRUCTURAL CHANGES FOR CLARITY AND EFFICIENCY

A simplified government structure with clear mandates is needed. The presence of several agencies in the installation of DE systems (SEB, ERC, BREDA, REC, RGVVY etc.) creates a non-transparent and cumbersome process and impedes progress of renewable energy in the state.

STEP 4 - ROLES AND RESPONSIBILITIES

- The Regulatory Authorities (ERC) should ensure implementation of all DE and micro-grid schemes and mandates.
- BREDA to ensure infrastructure development through various schemes like RGVVY, NREGS etc. besides organising funds from government and foreign donor agencies.
- REC to manage finances, incentives and subsidies for infrastructure development.
- The ministry/department of industry should play more active role in order to encourage entrepreneurship. They should take up information dissemination and knowledge sharing initiatives through state-wide workshops and dialogue with potential investors.
- Effective strategies/management practices/best-in-class technologies for promoting decentralised renewable energy systems.

STEP 5 - POLICY MODIFICATION FOR PRIVATE PARTICIPATION

The existing policies for promoting renewable energy and entrepreneurship in the power sector (Annexure 1 and 2) showcase very positive initial steps towards reliable access to power to all populations. They are facilitative in promoting energy access but require enhancement.

STEP 6: INTEGRATION OF BUSINESS PRINCIPLES

The government should focus on creating a large number of small-scale entrepreneurs serving a set of local communities or villages, using decentralised systems for energy generation. The additional support system required (other than discussed above) is discussed below.

- Incorporate all Small Scale Industries (SSI) business promotion models in the energy policy
- Remove technology-based constraints in the Renewable Energy Policy (2006) to include more modern models. This will ensure eligibility for subsidies/incentives on renewable technologies (especially incorporation of the mix technology, mix fuel options, and other new variations entering the market).

STEP 7: DEVELOPING HYDRO AND SOLAR POWER

Policies are required to encourage private participation in hydro and solar energy options.

Fr. Paul Mariadass, Director of Solar Alternatives and Associates Programmes(SAAP)
SAAP is a venture undertaken by the Jesuits specializing in using Science and Technology to serve the underprivileged sections of the society by providing a pollution free solar thermal power.
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Hydropower: The Bihar Hydropower Corporation has developed a plan for capacity expansion over the next few years and has invited participation bids from private parties. These initiatives need active government support. Besides establishing a task force, the government should initiate dialogue with large hydropower companies to invest in hydro power in Bihar. This could be incentivised in several ways:-

1. Project as corporate social initiative.
2. Provide special economic zone incentive (tax holidays, generation incentives etc.)
3. Partnership with other business benefits (link with other industrial development and industrialisation plans of the company)

Privately-owned companies like Reliance Energy and Torrent Power Limited are large and integrated power utility companies that generate, transmit, distribute, and trade electricity. They are also equity investors in the infrastructure business. These companies can be requested to be part of the `think tank' for Bihar and can be encouraged to commit investment in the state.

Solar Power: The strategic location of the state of Bihar in India (non-coastal and near the Tropic of Cancer) makes it conducive for generating solar energy. Several sunny parts of India are situated in these areas, giving the state of Bihar a huge solar energy potential, particularly in rural areas. PV cells placed on roof tops can provide concentrated lighting for the houses and energy for street lighting, community hall lighting and community water pumping.

As a separate initiative, the government must explore ways for partnership opportunities and incentives for private sector participation in setting up large integrated solar energy plants to cater to lighting needs. Currently India has about 9-12 solar cell manufacturers, 22-25 PV module manufacturers and 50 PV system manufacturers. Technology resources exist in India and have a growing market in the state of Bihar.

CONCLUSION

Decentralised energy systems offer opportunities to Bihar to transform its rural areas by significantly enhancing their economic capacities. Some of the challenges in grabbing these opportunities can be confronted by institutional and governance design changes in order to enable a technology led progress. Legislations enabling DE and micro-grids can unleash a wave of business innovations with significant benefits for Bihar. It reduces the need to expand costly new generation capacity transmission and distribution system and also relieves stress on the existing over-taxed transmission system. Simultaneously, it provides cleaner and more reliable power. A move is needed for opening the electricity sector to DE and micro-grid concept for better and reliable system.

The government must debate on the opportunities it has missed by not capturing the benefits of renewable resources-based DE systems, which derive basic premise from the inherent natural strengths of the state (high biomass potential/ high solar potential). A fresh Decentralised Energy White Paper coupled with a strong political will for an immediate action on the same is the need of the hour.

ANNEXURE - TABLES

Table 1
Socio-technical And Governance Analysis

Scale:
HIGH (DARK GREEN) – most essential /definite /can meet requirement
MEDIUM (LIGHT GREEN) – can provide/ can meet/ can require
LOW (LEMON GREEN) - least critical / cannot meet / not required

Stakeholders Governance	Needs and expectations	Renewable	Non-renewable (small capacity)	Non-renewable (large capacity)
		Bio-mass, Mini Hydro, Ethanol, Photo voltaic	Diesel generation	Grid
TECHNICAL SYSTEM REQUIRE-MENTS	Needs centralized management	L	L	H
	Can extend to the entire state	M	L	H
	Needs involvement of several external agencies	L	L	H
	Needs involvement of local agencies	H	M	L
	Needs large capital investment	L	L	H
	Needs external technical experts	M	L	H
	Impact on local ecosystem	L	H	H
	Impact on larger ecosystem	L	M	H
	Need for waste disposal system	L	M	H
	Overall cost of raw material	L	H	H
	Need for government infrastructure support	L	L	H
RURAL DEVELOPMENTAL IMPACT	Impact on local economy (employment)	H	L	L
	Impact on local economy (economic activity)	H	L	L

	Impact on local economy (industrialization)	M	L	H
	Ease of serving customers (rural areas)	H	H	L
	Supply capacity	H	M	H
	Reliable supply of power	H	L	H
	Quality of supply	H	L	L
	Use of local natural resources	H	L	L
ENTREPRE-NEURIAL OPPORTUNITY	High return on investment	H	H	L
	Quick return on investment	H	H	L
	Increasing return on investment	H	H	L
	Availability of quality raw material	H	L	L
	Positive impact of raw material on eco-syst	H	L	L
	Competition faced/ economic space to grow	L	H	L
FLEXIBILITY AND EXTERNALITIES	Leads to positive externalities like increased income, rural development etc.	H	M	
	Encourages competitive pricing	H	L	L
	Flexible mix of raw material and products	H	L	L
	Ease of increase in supply/distribution capacity	H	L	L
NEED FOR GOVERNMENT INTERVEN-TION	Competitiveness of state for investment	H	L	L
	R&D and efficiency improvement	H	L	M
	Infrastructure support :transport systems	L	L	L
	Infrastructure support: land (both for plant and raw material production)	L	L	H
	Annual increase in large investment by government overall	L	L	H
	Annual increase in large investment by government in rural areas	L	L	M
	Policy support (subsidies and incentives)	L	L	H
	Annual increase in large investment by private sector	L	L	L
	government agencies to coordinate and support technology in rural areas	L	L	H
NEED FOR FINANCE / FUNDING	Involvement	H	L	L
	Stake in its success	H	L	L
	Competitiveness of Bihar	H	L	L

Table 2
End user survey: Husk Power System

Questions		C1	C2	C3	C4	C5	C6	C7
Do you need electricity every day in the house?	Yes/ No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
For which activities do you use it currently?	Commercial: pump, mill etc.)	Pumps	Cinema	NA	Pump	NA	NA	Ata Chakki
	(Household: bulb, fan etc.)	Bulb, Cell phone, TV	TV, VCR, Bulb, Fan	Bulbs	Bulbs, Cell phone	Bulbs	Bulbs	Bulb, Cell phone, TV
Where do you get it from?		Husk	Husk	Husk	Husk	Husk	Husk	Husk
And for how long in a day?		6 hrs.	6 hrs.	6 hrs.	6 hrs.	6 hrs.	6 hrs.	6 hrs.
If you were to get power as much as you want, what other things would you use it for?	In the house At the farm Commercial level	They need power for community purposes. No street-lighting facilities. Government established solar street-lighting system, which operates nearly 8-9 hrs per day and is of much use. For schools and hospitals there is no electricity at nights. At homes, they cannot operate heavy appliances, as the power is single phase. Only 11KW generator can be in operation for lighting. More number of hours and three phases of power supply will allow use of heavier machinery/equipment.						
Do you get power every day for your pumps?		No. Only during seasons.	Evenings. It will be operated only when there is box.	NA	No. About 5 pumps are being operated by Husk during season.	NA	NA	It is owned by society. Operated using internal capacity.
How important do you think electricity is? And why do you think so?		The importance of electricity is well understood. Mostly answers range from needing power for many purposes relating to household needs to for irrigation purpose during season. Their preference is mostly for uninterrupted power.						
Do you know who provides the electricity?		Yes	Yes	Yes	Yes	Yes	Yes	Yes

What is the ONE advantage of getting electricity from the government?	We never saw govt power	Do not know	It will be good	We never saw govt power	We never saw govt power	Do not know	It will be good
What is the ONE advantage of getting electricity from the private people?	Good. We could get power because of them	It is good and continuous. Affordable prices.	Light is good and need not depend on kerosene lighting.	Electricity accessibility ---tee at affordable prices	Even though govt is not supplying Husk is supplying electricity at good rates.	No problem with Husk power plant. For functions also they supply.	Village has become Adarsh Gram. Power by Husk has its role.

What is the ONE advantage of getting electricity from the government?	Good quality (But won't come)	Cheap (nobody pays the bill so no need to take metered connection)	I do not know	Government power is always good	I do not know	It is good (First let them supply)
What is the ONE advantage of getting electricity from the private people?	Continuous	Good quality	Continuous	Continuous	Continuous	More reliable

Table 3
End user survey: Saran Renewable Energy

Questions		C1	C2	C3	C4	C5	C6
Do you need electricity every day in the house?	Yes/ No	Yes (Not for past two months)	Yes (Not for past two months)	Yes (But not now)	Yes (Not now)	Yes	Yes (But diesel generator)
For which activities do you use it currently?	Commercial: pump, mill etc.)	NA (All are households)					Supplies to shops
	(Household: bulb, fan etc.)	Bulb, TV	Bulb, TV, Cell phone	Bulb, Cell phone	Bulbs	Bulb, Cell phone	Mostly lighting
Where do you get it from?		Saran (Worker in saran)	Previously Govt., Later Diesel, now Saran	Diesel, then Saran	Saran	Diesel	Both his own diesel generators and saran
And for how long in a day?		6	Govt. (3 hrs. intermittent); Diesel & Saran (6 hrs.)	5-6	6-7	6	6-7 hrs.
If you were to get power as much as you want, what other things would you use it for?	In the house	TV etc.	Fans and other home appliances	For any purpose	Don't know	More time will be better.	NA
	At the farm	NA (As the power is supplied to pumps of not that village)					NA
	Commercial level	NA					Supplies to shops for more time
Do you get power every day for your pumps?		NA					Yes (But for shops)
How important do you think electricity is? And why do you think so?		For lighting. It is required	For children's education. Without electricity we have managed till now though	For lighting.	For lighting. If it is coming then good	For lighting	Need much more. It is useful as one of the sources
Do you know who provides the electricity?		Yes	Yes	Yes	Yes	Yes	Yes

USE OF BIOMASS AS A FUEL

Workers firing up the reactor of the 8KVA Husk Power plant owned and operated by Husk Power systems Pvt Ltd.
© Harikrishna Katragadda / Greenpeace

Case study 1&2 describes a decentralised model of electrification using biomass gasification technology, with “agri-waste” as feedstock. It should be noted that there are some concerns over the use of biomass as a fuel. These are:

• Conversion of food crop into fuel
• Conversion of land under food crops to fuel crop cultivation
• Conversion of agricultural waste into fuel as opposed to being converted into ecological soil nutrients
• The definition of ‘wasteland’ in India, and the danger that it may be used sweepingly and inaccurately to describe areas with both ecosystem functions and socioeconomic relevance.

All of these issues are critical considerations for sustainable agriculture and food security. To clarify, there must be no sacrifice of food for fuel. Greenpeace does not present the case study of Husk Power Systems and Saran Renewable Energy to particularly advocate the model of biomass gasification, or a blind scaling of this model regardless of which resources are available locally: to do so would be to contradict the very essence of the decentralised model.

There is much valuable information to be gleaned from these case studies, but their most important lesson is that decentralised power generation from renewable energy must be highly localised in both its design and implementation, with detailed assessment of, and sensitivity to, both local requirements and local resources.

Policies relating to this type of renewable energy must strive for local and regional understanding of resources, considering energy as a route for resource development, rather than a provision that is in conflict with resources.

‘Wasteland’ – this could mean all forms of land that are unfit for agricultural cultivation. (This does not include land used for cultivation of food crops, cash crops and cattle grazing)

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Greenpeace has been campaigning against environmental degradation since 1971 when a small boat of volunteers and journalists sailed into Amchitka, an area north of Alaska, where the US Government was conducting underground nuclear tests.This tradition of 'bearing witness' in a non-violent manner continues today, and ships are an important part of all its campaign work.

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