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Water Energy Nexus: Role of Community Institution Models

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Final Technical Report

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Introduction to Water Energy Nexus in South Asia

1.1 Introduction

Groundwater use in South Asia is booming and this region has emerged as the largest exploiter of groundwater in the world (Shah, 2002). Pumping up an estimated 250 billion cubic meters of groundwater, which is increasing annually, groundwater is supporting over half of irrigated agriculture in this region. The positive benefit of increasing use of groundwater irrigation is, almost all nations in this region have achieved food self-sufficiency. Researches also have shown that groundwater has contributed significantly to rural wealth creation (Shah 2001).

However, the flip side of such high withdrawals of groundwater is that the very future of irrigated agriculture in this region, which is increasingly thriving on groundwater, stands threatened due to its unsustainable use and consequent serious environmental outcomes. Further, there are much larger implications on the regional economy, notably because of the excessive energy that is being used to lift this resource.

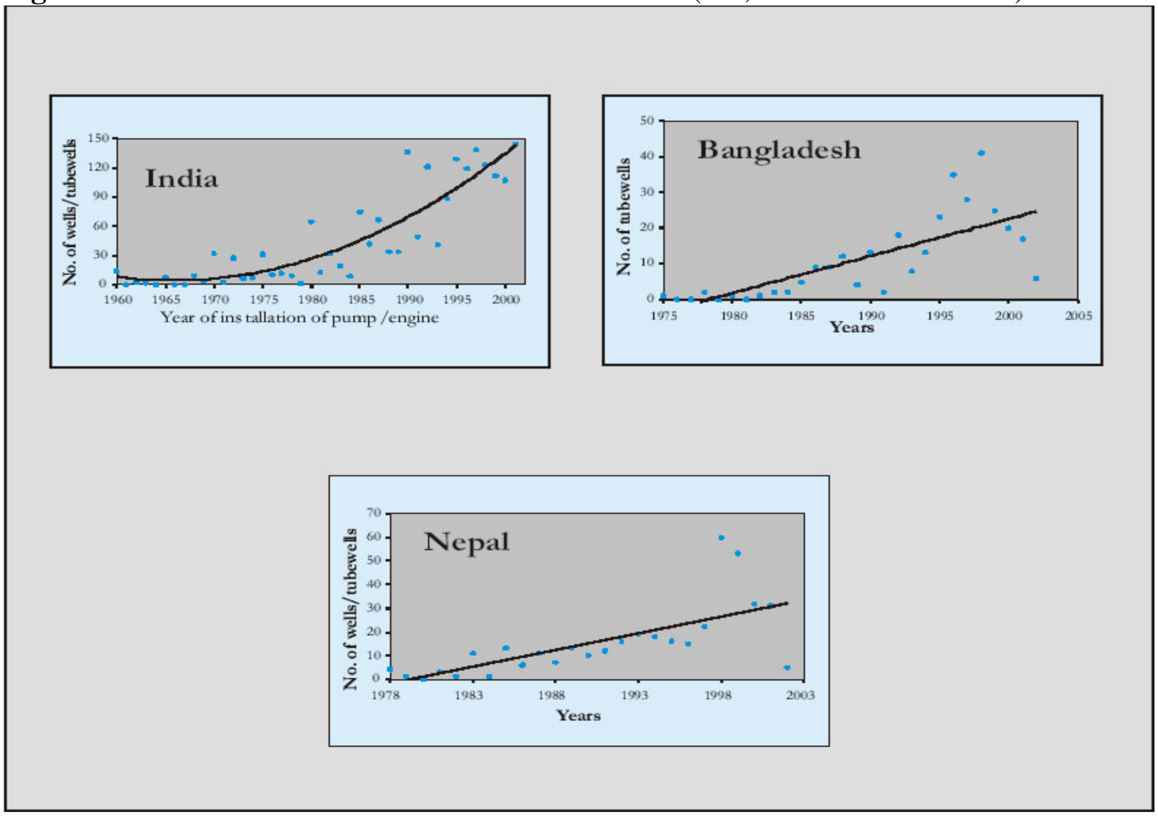
Studies by IWMI and partners in the South Asian countries and outside the region suggests that mutually reinforcing energy and water management policies and practices can "right the balance" in terms of sustainable groundwater use and at the same time ensure a viable energy economy that supports a thriving groundwater economy.

1.2 Water-energy nexus in South Asia

Groundwater pumping and energy are intrinsically linked by the simple fact that energy is required to pump up the water from the underlying aquifers. These energy forms range from animal and human power (treadle pumps) to diesel, electricity and non-conventional sources such as wind, solar, etc.

Use of groundwater in the past had been to supplement rainwater and cropping was restricted to only one season. With increasing demand for food and agriculture, groundwater has gained ascendancy as the prime necessity to support food production and energy policies were drawn to facilitate its development. With irrigated agriculture in South Asia coming as the mainstay, energy stakes have risen sharply. In India, during the early `50s, the total cultivated area was about a third of the total landmass of the country and 17% of this was irrigated, groundwater accounted for 25% of this irrigated area. By 1999, the net sown area increased to 48% of total landmass with one-third of it being irrigated, groundwater has increased to 60% (www.agricoop.nic.in). In Pakistan, the total number of electric tubewells increased 8 times, from less than 50,000 in the early `70s to over 400,000 by 2000 (Qureshi, 2002). In Bangladesh, the number of electricity driven pumps shot up from less than 2000 in 1981-82 to over 82,000 by 1999-2000 (www.bangladeshgov.org/reb/about_reb.htm). Similar large-scale proliferation of pumps is seen in the entire of South Asia that was driven mostly by some myopic energy policies and agricultural policies.

Figure 1.1: Proliferation of tube wells in South Asia (`00,000 wells/tube wells)



Source: Groundwater Governance in South Asia: Governing a colossal anarchy, A.Murkerji, T.Shah, Water Policy Research, Highlight# 13,IWMI-TATA Program, Anand, 2003

Managing the pressures on the groundwater resources from such huge numbers of groundwater draft structures is complicated further by the fact that in South Asia, the groundwater economy directly influences the livelihoods of a vast majority of population (see table 1.1). Here, groundwater extraction is characterized by millions of scattered pumpers, who typically use small pumps to lift small volumes of groundwater to irrigate small patches of lands. For example in Iran, less than half a million of groundwater abstraction structures are used to pump up 45 cubic kilometers (Km^3) of groundwater while India pumps up about three and half times more water and for this employs over 50 times more number of pumps.

Table 1.1: Groundwater Use Characteristics in Selected Countries

Country	Annual GW use (km^3)	No of GW structures (million)	Extraction/structure (m^3/year)	% Population dependent on GW
India	150	19	7900	55-60
Pakistan-Punjab	45	0.5	90000	60-65
China	75	3.5	21500	22-25
Iran	45	0.37	123000	12-18
Mexico	29	0.07	414285	5-6
USA	100	0.2	500,000	<1-2

Source: (Shah et al., 2003)

Controlling groundwater abstraction in South Asia is further constrained because here 'Rule of Capture' prevails in terms of accessing it. The 'Rule of Capture' is a situation where one who can capture has the right to use (Burchi, 2002). Therefore, any landowner (including even a tenant) can extract as much groundwater as he can. The volume of groundwater he can extract is not related with the extent of overlying land. In India, this unlimited right to water is in theory restricted by the India Easement Act, 1882 and Irrigation Laws, which "proclaim the absolute rights of government in all natural waters", this has however not altered the view of groundwater user that he has unlimited access to it (Moench, 1999) and seeks to access it.

Given this perception and practise of unlimited access to groundwater, the alternative mechanism to control groundwater extraction would be through managing energy supply. However, in this regard, in India (and till recently in Pakistan), the energy (power) pricing policies were extremely farmer-friendly. In almost all states in India, agricultural power supply is priced on a flat rate, based on the horsepower of the pump used. Such tariff structure, which offers zero marginal cost of pumping, actually acted as incentive for farmers to make all efforts to get bore wells drilled and pumps installed.

Similar was the status in Pakistan, till the Government decided to hike the power tariff and converted from a flat-rate supply to metered supply. The farmers responded by shifting to diesel. However, diesel, being costlier, the groundwater extraction has reduced (Qureshi, 2002). The experience in Pakistan provides conclusive evidence that changes in power tariff and tariff structure could bring about radical improvements in energy and water use in agriculture. However, the problems that Pakistan had to tackle following this shift from flat rate to metered supply and the increase in the tariff is something which democratic Governments can ill afford. In Pakistan, after the tariff changes were brought in force, there was a mass resistance to this from the farmers. There was large-scale tampering with meters and finally, the army was called in to control this (Shah, 2003, quoting Qureshi, 2002).

In India, there is a very strong resistance to metering and rationalizing in agricultural power tariff. The simple mentioning of metering agricultural consumers made Haryana rethink on power sector reforms in the State. The Government of Gujarat introduced an increase in rates per horsepower for agricultural consumers. A massive protest from the farmer communities demanding a complete withdrawal of this hike followed almost immediately. In Andhra Pradesh, the Government proposed a hike in agricultural tariff and immediately withdrew due to the protests. Yet, the ruling political party lost the grass root elections that were conducted soon after that and incidentally lost the State Assembly elections a few years later and one of the major reasons ascribed for this was the Government's policy changes with respect to agricultural power supply. In Madhya Pradesh, although the Government laid ample emphasis on rural development through infrastructure, it had not laid enough emphasis on water and power supply to farmers. The result was complete rout in the State Assembly Elections here as well.

These results made the other State Governments to scurry for cover under protected agricultural power supply. Tamil Nadu, which repealed the free power policy a couple of years earlier, reverted to it, almost immediately after the election results in Andhra Pradesh and Madhya Pradesh. Maharastra made similar announcement, specifically with eyes on the imminent elections in this State. All these examples show that power supply and water are very important issues that have a very strong significance on the political fortunes.

With political compulsions not allowing any change in the power pricing policy and its structure, the situation that has already emerged is a lose-lose proposition from the energy and water sectors' perspectives. On the one hand, the power utilities are grappling with the problems of maintaining quality power supply to an increasing consumer base and recover appropriate tariff (see box). Frequent power cuts and voltage drops characterize power supply to agriculture (World Bank study, 2001). Farmers are coping with this unreliable power supply by pumping for as long as power is available because they are not sure if power would be available when they want it for the next irrigation and in any case such over pumping is not causing them any additional expenditure due to flat rate tariff.

Box 1.1

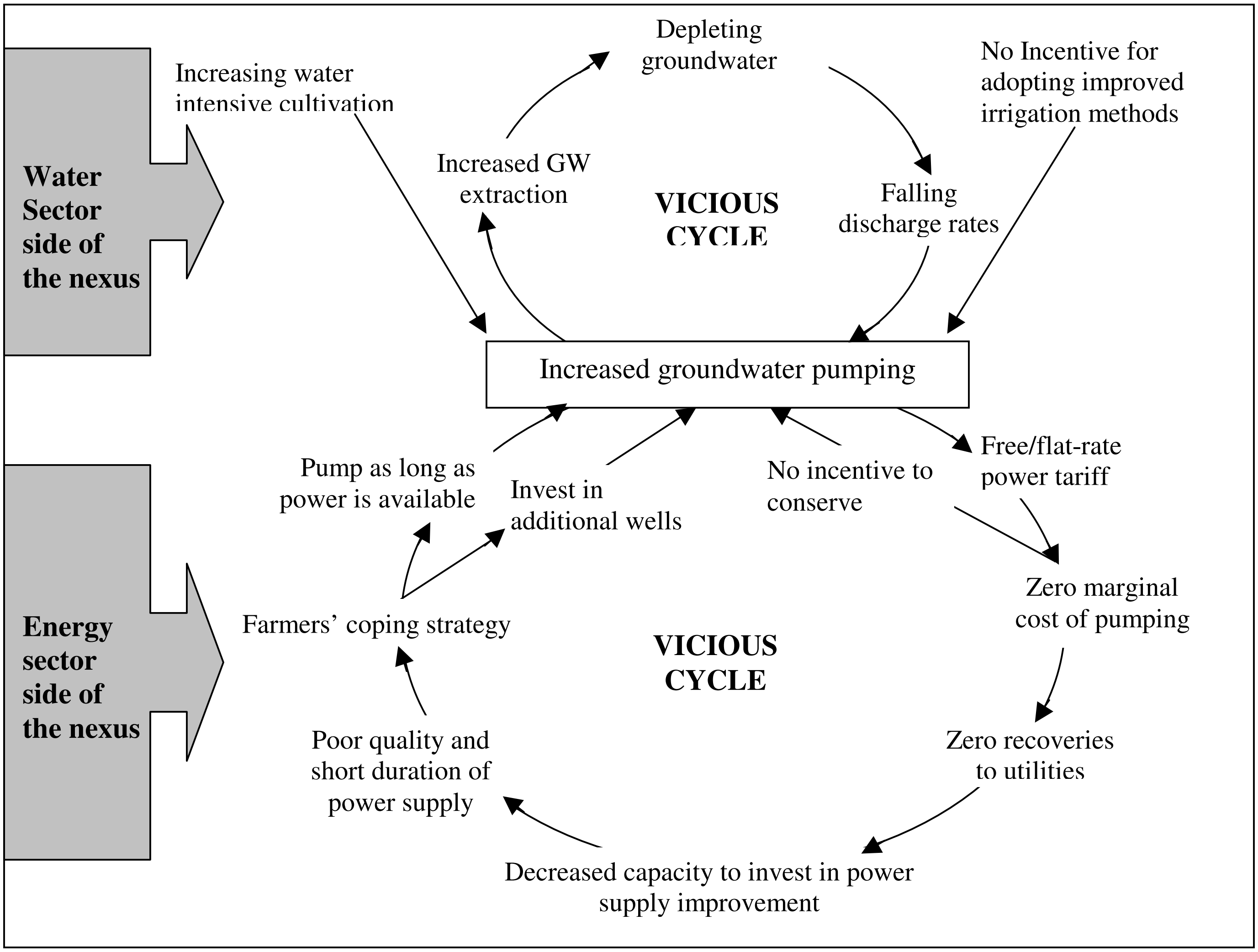
"The consumption pattern of power in the state [Andhra Pradesh] showed that about 39% power sold is consumed by farm sector, but it contributed only about 3% of the revenues because of the highly subsidized tariff".

Source: Power Sector Status and Tariff in Andhra Pradesh, 2000-01

On the other hand, the farmers are facing the problems of groundwater depletion. In Bangladesh and in West Bengal of India, where the local geological conditions have inherent arsenic depositions, the depletion of groundwater is exposing this to atmospheric oxygen and is resulting in arsenic contamination. Similarly, in regions with fluorine depositions, fluoride contamination is increasing. These are contaminating the drinking waters and leading to health problems. Along the seacoast, due to lowering of hydrostatic pressures, there is seawater intrusion, thus contaminating the freshwater aquifers.

This pumping behaviour is depleting the groundwater resources, thus requiring still longer hours of pumping. This is core of the energy-water nexus, which depicted in the schematic diagram below (figure 2).

Figure 1.1 : Energy-Water Nexus



The need is to evolve mutually reinforcing policies that support a thriving energy economy that supports a vibrant and sustainable groundwater irrigated agriculture.

1.3 A Brief on Power Sector Reforms

The electricity systems in the South Asia mainly rely on large-scale power plants and extensive networks of transmission and distribution that delivers electricity at an 'affordable' price. However, this system of power supply gradually rendered electricity or other energy carriers - as a 'political good', and not a private good or public good (Sinha, 2004). Strong political support to highly subsidized supply to agricultural consumers had a direct effect on groundwater resources. At the same time, the existing systems also resulted in widening social inequity as sizeable portions of rural population are left un-served or under-served (Sinha, 2004).

The electricity sector transformation in the South Asia represents a paradigm shift from the existing state owned utilities and it is arguably the most ambitious change management exercise ever attempted in the government domain (Sankar, 2002). It has involved change in the entire process by which the electricity sector was managed (and politically controlled) by the state, and envisaged a greater participation of the private sector. Starting from the early 1990s, a set of institutional reforms – including unbundling, corporatisation and privatisation of ownership, and introduction of competition in generation and distribution sector – began to be promoted as a global solution to the problems of the electricity industry (Dubash and Chella Rajan, 2001; Sundar and Sarkar, 2000).

The concurrent movement of unbundling, private ownership and competition aim to rationalise the sector's development. Advocates maintain that governing the electricity industry according to market dynamics, rather than socio-political considerations, promises to result in more efficient operation (Byrne and Mun, 2003). The ongoing reforms in the energy sector, have reiterated the need to address the rural electricity distribution, especially issues such as access, electricity subsidy for irrigation and other low capacity end users (Sinha et al., 2003). The distribution losses due to supply of electricity to low and scattered energy demand and theft of power, have warranted steps to be adopted to check the losses and manage electricity distribution at a decentralised level.

1.4 Community Institution Models: A Virtuous Approach to Water-Energy Nexus?

The electricity sector reforms focuses at macro and micro issues. Macro issues relate to restructuring, developing appropriate regulations, and large schemes, which promotes reforms by providing incentives. At the micro level, are the issues concerning rural power distribution and poverty impacts of energy sector reforms. When the reforms started in 1995 micro level issues were not given specific attention. Issues of rural electrification and electricity for agriculture were pushed aside as these were not considered of significance to the reforms but rather hindrance.

As the reforms program progressed it became imperative that the key to the success of reforms would be in addressing distribution reforms and within that rural power distribution[1]. Since 1999, reforms in the sector are resulting in developing new initiatives to manage rural electricity distribution, emphasising on community participation and a more community oriented institutional models.

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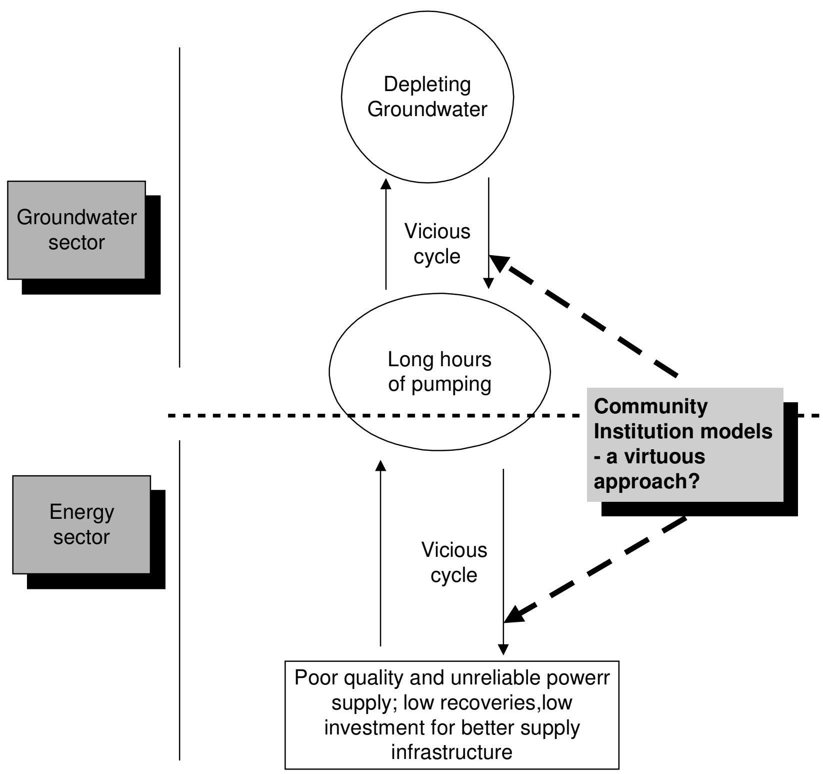
[1] Privatisation of electricity distribution in Orissa in 1999 was the starting point.

These community institution models were formed to manage electricity distribution in rural areas and assist the utilities in revenue collection. The role of these institutions in addressing the demand-side management issues such as water-energy co-management is not known.

The focus of the research lies herein; as it us our contention that for these community institution models to be effective in managing rural power distribution including revenue realization, they need to look into the demand side issues too. Putting systems in place for managing and addressing the problems of distribution would not be sufficient condition; if these institutions need to be more effective, then they also need to be part of the solutions on the demand side. The need for mutually reinforcing energy and water management policies and practices that can "right the balance" in terms of sustainable groundwater use and at the same time ensure a viable energy economy that supports a thriving groundwater economy, is essential. Community institution models can be that appropriate balance leading to a virtuous cycle (figure 3).

Fig 1.2: Energy – water nexus: community institution models – a virtuous approach?



The study attempts to draw lessons from the existing community institution models, to see if the experiences from these models can be extended in managing the energy-water co-management issues. The study looks at community institution models at two levels, viz., at cooperative level and at village level.

1.5 Structure of this report

Report has been organized in order to bring out the key findings of the study. The current chapter (Chapter 1) outlined the water energy nexus in South Asia and the key issues that confront both the energy and water sector in the region. Chapter 2, provided the goal and objective of the study and tabulates the four case studies conducted as part of this study. Chapter 3, goes into the three community institutions models we studied in India. Chapter 4 provides the water energy nexus issues in Bangladesh and an overview of the one case study undertaken there. The concluding chapter (Chapter 5) draws lessons from the four case studies and attempts to draw policy implication and issues of scaling up.

Chapter 2: Community Institution Models

2.1 Goal, purpose and output of project

The Goal of the project is to contribute to the *South Asia Regional Initiative for Energy (SARI/Energy)*, that foster cooperative energy research and outreach and address regional issues, barriers and common critical problems and challenges facing the energy sector in the South Asia region.

One of the several challenges faced by the energy sector in South Asia is power supply for agricultural use. The South Asian agriculture is very strongly related with groundwater development. Groundwater irrigated agriculture is booming here, supported by huge energy subsidies that leave that little incentive to conserve either energy or groundwater. Any move to correct this is often frustrated by very strong political resistance and the net outcome of continuing with the present subsidies is a vicious cycle leading to 'lose-lose' to both energy and groundwater sectors. The need is to realize this nexus between the energy and water sectors and initiate energy-water co management solutions.

> **Box 2.1**: Energy – water nexus: key issues
>
> - Groundwater based economy is the key source of livelihood for vast numbers of low-income households; population dependency on groundwater is high
> - Highly subsidized electricity supply triggers extremely high and often wasteful groundwater exploitation
> - There is a very high density of pumps (diesel and electric) with smaller capacity
> - One in four farming households have a pump
> - Large proportion of non-owners depend on groundwater markets
> - Competition to groundwater led to low ratio of pump to productivity
> - Absence of adequate groundwater policies and energy policies

Energy industry has facilitated formation of CIM in some parts of the country, mostly to address distribution and commercial management problems of electricity supply in rural areas. This study looks opportunities for expanding their roles to address the problem of over extraction and fast depleting groundwater resources, using energy management as indirect tool in the South Asia region.

The purpose of this project is to provide a clear understanding on the roles of community institution models (CIM) in addressing the energy-water nexus.

The objective of this research is to study the community institution models (CIM) to draw lessons and understand how the future attempts of developing community institutional models be adapted/modified to achieve the multiple objective of efficiency improvements in energy supply and energy demand for irrigation, and improving access to irrigation sources while arresting the depletion of groundwater resources.

The outputs of this project are:

1. Inception report including the background information on the community institution models (February 2004)
2. Quarterly technical report (April 2004)
3. Draft agenda and reports (including participation list) for National policy agenda meetings (June 2004) in India and Bangladesh
4. National Policy Workshops (June 23 - India and July 28 - Bangladesh, 2004)
5. National Policy Workshops Reports
6. Draft report
7. Final report

2.2 The Community Institution Models

The study focused on the CIM established by the energy industry in India and Bangladesh, thereby providing an opportunity to draw cross-country lessons. The lessons can be useful in identifying opportunities and constraints for scaling up these experiences. The models studied under this research are as given in the table below:

Table 2.1: Institutional Models covered under the study

Community Institution Model (CIM)	Location Year started	Initiator	General focus of the CIM
Village *Bidyut Sangha(VBS)*	In districts of Western and North eastern Orissa 1999	Xavier Institute of Management, Bhubaneshwar (XIMB) *Supported by*: WESCO, NESCO and DfID India	Village level electricity committee to manage electricity distribution, control pilferages and assist in commercial activities (meter reading, billing, bill distribution and revenue collection). Includes all categories of consumers
Transformer User Associations (TUAs)	Hoshangabad, Madhya Pradesh 2001	BASIX and VERVE *Supported by*: CIDA	Similar to VBS, *difference* is, this model focuses exclusively on agricultural users at transformer level, federated at sub-station level
Cooperative Electricity Supply Society (CESS), Sircilla	Sircilla revenue division, Karimnagar district, Andhra Pradesh 1970	State government and electricity board *Supported by*: REC	Formed under Cooperative Societies Act, CESS purchases power from the utility and manages distribution and revenue collection in its area of operation through a license from APERC
Kurigram-Lalmonirhat Palli Bidyut Samity	Greater Rangpur district, Bangladesh	Rural Electrification Board, Bangladesh *Supported by*: Government of Japan	KLPBS serves about 37000 electricity consumers in the region. Its revenue realization in 2002 was 98 per cent and system losses 14.41 per cent.

2.2.1 Data gathering

The issue of energy-water nexus in the context of South Asia and other countries is well researched and documented. Review of these literature formed the basis for overall structure of this project, which identified that there is little empirical evidence on community institutional models (CIM) and the roles they play or could play in energy water co management.

This study addresses this gap.

Preliminary data gathering efforts included collection of available details on the selected CIM from the public domain. This included reviewing available publications and the literature available on the Internet. Detailed review of this information was made and emerging issues were identified for each of the selected CIM. Following this, discussions were conducted with officials of Xavier Institute of Management – XIM (initiator of Village Bidyut Sangh), BASIX (initiator of Transformer User Association), the executive officials of Sircilla Cooperative Electricity Society (India) and Kurigram-Lalmonirhat Palli Bidyut Samity (Bangladesh). This information gave a basic background on the objectives of these models, their institutional structures and a general understanding of their operation and functions.

This was followed by visits to the offices of these institutions to organize in-depth discussions with the officials and obtain their administrative reports; evaluation reports and other published and unpublished material prepared by both internal as well external sources. Subsequently, the primary stakeholders (electricity consumers) were visited based on a random selection of sample. Their views and opinions on the effectiveness of the institutional intermediations being implemented and their understanding of the energy-water nexus were discussed during the several rounds of group meetings. The opportunities of these institutions to expand their responsibilities covering energy-water co-management also was obtained, which included the capabilities of the models to facilitate the same and the various options that could be taken as co-management solutions.

These findings were presented in Policy Dialogues, organized in India (Hyderabad) and Bangladesh (Dhaka). Presentations were also invited from other knowledge leaders to comment on the research findings and offer their own views and suggestions. These meets were attended by both energy and water sector representatives who learnt the different aspects of energy-water nexus and the roles played by the CIM initiated by the different energy industry players. The presentations and the discussions on the same provide further impetus to the project objective.

The data/information gathered as above were analysed and presented in this report.

Chapter 3: Community Institution Models – India Case Studies

3.1 Village Bidyut Sangha (VBS)

This is a village-level institutional intermediation, first implemented in some parts of Orissa, India and with some modifications to suit the local conditions this is also being tried in parts of other states such as Karnataka, Andhra Pradesh, Uttar Pradesh (NOIDA), etc. This research covered the implementation in Orissa, where considerable progress is already achieved.

Orissa is the first State in India to demonstrate advanced power sector reforms. Here, the three functions of the state owned power utility (Orissa State Electricity Board- OSEB) viz., generation, transmission and distribution have been unbundled, opened up for private sector investment and participation and has been able to attract private sector investments even in power distribution segment, an achievement, which other reforming States have yet been able to exhibit.

An important achievement of power sector reforms in Orissa is that almost all consumers in the State are metered as per directives from the Orissa State Electricity Regulatory Commission. It is also interesting to note that agricultural power tariff in the State compares quite favorably with respect to the Cost to Serve. Unlike in the most other States in India, where agricultural tariff is only a small fraction, here, the tariff is very close to the bulk supply tariff of Rs 1.38 per Kwh (see Box 3.1).

Box 3.1: Agricultural Tariff Structure in Orissa

Agricultural tariff to consumers with meters is charged at Rs 1.10 during the dry months of September to May and at Rs 0.80 during the rainy months of May to September.

Consumers who are yet to get meters installed are charged at a flat 144 hours of pumping. The bill amount is calculated by multiplying the connected load (HP of the pump*0.8, expressed in Kw) with 144 (average units estimated to be consumed per KW). The units thus estimated is multiplied with Rs 1.10 during dry season and Rs 0.80 during rainy season to estimate the bill for the consumer. Thus, the bill for a pump of 7.5 HP during the dry season would be Rs 950.40 per month and during rainy season, it would be Rs 691.20.

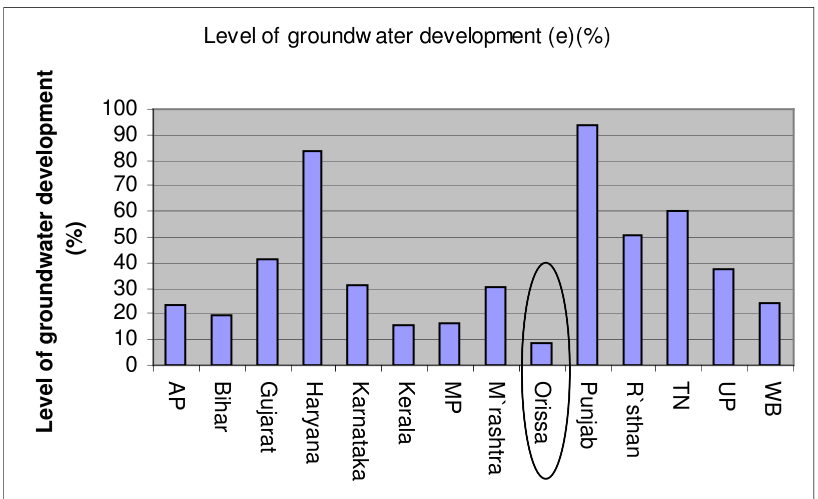
3.1.1 The Energy-Water Nexus in Orissa

The interesting feature that typifies rural power use in Orissa is its low consumption in agriculture sector and a large consumption by domestic segment (Rao. 2002, Panda. 2002; Mishra, 2004), which contrasts with other Indian peninsular states, where agricultural consumption far outweighs domestic consumption (Narayana, 2002).

Statistics available from the State Groundwater Department show that Orissa does not feature among the groundwater stressed States (State Groundwater Board, 2002). About 40% of the total area of the state only is under agriculture (World Bank, Report No:

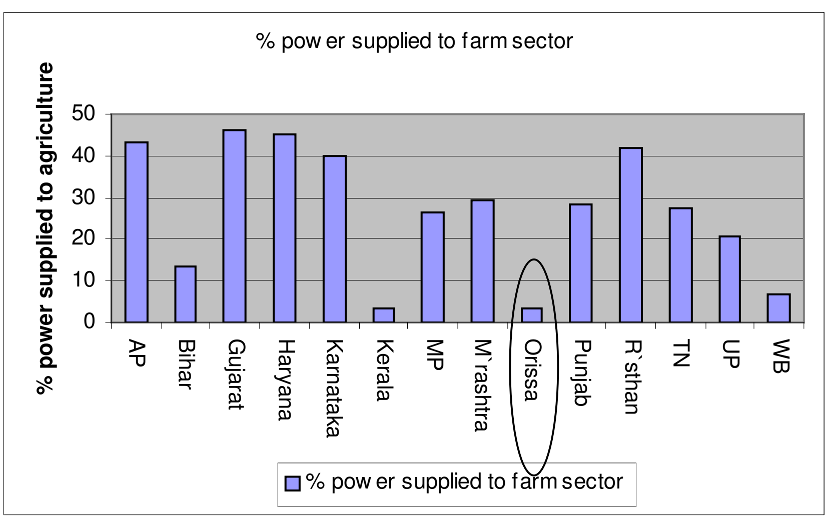
E207, 1995), of which 35% area irrigated. The state experiences a relatively high rainfall of over 1400mm, much of which occurs between June and September, causing intensive floods. Part of the state is well endowed with rivers and much of the irrigation water is derived from surface sources, which includes canals, river lift irrigation systems and tanks. Groundwater irrigation is low at 40% of the gross irrigated area in the state compared to the national average of 63% (CMIE, 2004). The net groundwater draft in the State is the lowest amongst most of the States, accounting to an average of 8.4% of the total natural recharge (see figure 3). There are indeed deviations in the extent of groundwater dependence within the state, with some districts such as Balasore, Bhadrak, etc showing a relatively higher groundwater use. However, even here, the draft accounts to less than 60% of the total recharge. In terms of energy use as well, Orissa shows major deviation with most of the other states, accounting to low proportion of energy used by agriculture sector. Typically, a village in Orissa has no more than 5 to 10 pumps, which explains the low groundwater use and low energy use in agriculture (figure 4). Thus, *prima facie* it appears that the magnitude of the energy-water nexus is not as threatening to the power industry as well as to groundwater resources as it is happening in most of the other states in India.

Figure 3.1



Source*: Anon 1999, India 1999: A Reference Annual Publication Division, Ministry of Information and Broadcasting, Government of India, New Delhi, pp 340-341.*

Figure: 3.2



Source: CMIE, Energy Report, 2003

Hence, the institutional intermediation being implemented in Orissa is oriented more towards addressing pilferages from rural domestic consumers, reducing arrears and improving the revenue collection mechanism to improve the overall financial viability of the rural power distribution.

3.1.2 The Institutional Intermediation in Orissa

The Village Bidyut Sangh (VBS), a community based institutional model, is being tried in two distribution companies[2] as institutional intermediation to address the problems that are plaguing rural power distribution, particularly those pertaining to arrears and pilferage, which were influencing viability of the power industry in the State.

VBS is an indigenous community based initiative that first evolved in a village called Shahjbahal in Bolangir district in 1996, in response to the differences of opinion between the power utility and consumers regarding the quality of power supplied and payments to be made for using this (Rao, 2002). This village, as in most other villages in Orissa is characterized by unreliable and poor voltage power supply. There were serious differences between the utility and consumers on the issue of payments for the power used and quality of power supplied. While the consumers demanded a better quality of power as specified by the state electricity regulator and therefore refused to pay, the bills went on getting accumulated as arrears. Eventually the only transformer in the village got burnt and the utility demanded atleast half of the arrears to be cleared for it to be repaired, which was the prevailing norm. The villagers refused to accede, claiming the bills were incorrect and as the controversy continued, the transformer remained unrepaired for nearly three years, leaving the village without electricity. The ensuing difficulties and social problems made two village opinion leaders to take the initiative to set the matters right by forming a local committee of power users (Rao, 2003). Using their collective strength, they got the utility to rectify the billing errors and at the same time applied peer pressures on the consumers to pay up the arrears and power supply got restored.

This and the subsequent activities taken up by this body demonstrated that appropriate mechanisms could be evolved to address the problems of (1) improving customer relationship, (2) acting as an interface between the power supplier and consumers and getting the consumers' grievances redressed (3) providing feedback on problems in distribution, (4) improving revenue collection and (5) also showed that it could be an effective platform to control power pilferage.

3.1.3Village Bidyut Sangha Model

Given that managing efficient power supply to rural regions in Orissa was becoming the biggest challenge, the VBS model in Shahjbhal promised effective solutions. The Xavier Institute of Management (XIM), Bhubaneshwar took the initiative to see if this experience could be replicated as an effective answer to the challenge being posed by

[2] After the initiation of power sector reforms, Orissa was divided into four regions, each being served by a distribution company. These distribution companies were carved out from the erstwhile Orissa Electricity Board

rural consumers. This institute therefore approached one distribution company, viz., Western Electricity Supply Company of Orissa (WESCO) with a proposal to replicate this model in 100 villages (Rao, 2002). Subsequently, Xavier Institute of Management (XIM), Bhubaneshwar has successfully scaled up implementation of this model to 4000 villages in WESCO and 1500 in Northeastern Electricity Supply Company (NESCO) (Mishra, 2004).

The basic objective of the XIM initiated VBS model was primarily to improve revenue collections from rural consumers and facilitate control of power pilferage and help the consumers get access to better quality and reliable power supply. As per the arrangements made by XIM, all consumers of power became members of the Sangh, which included both the legitimate, authorized consumers as well as the illegal, unauthorized consumers. These members select about 8 to 10 members within themselves to form an Executive Committee. The local power distribution company (WESCO and NESCO) has accorded official recognition to these Committees by issuing a formal Letter of Recognition. The XIM Project Implementation as well as the WESCO officials interacts with the electricity consumers in these villages through these committee members.

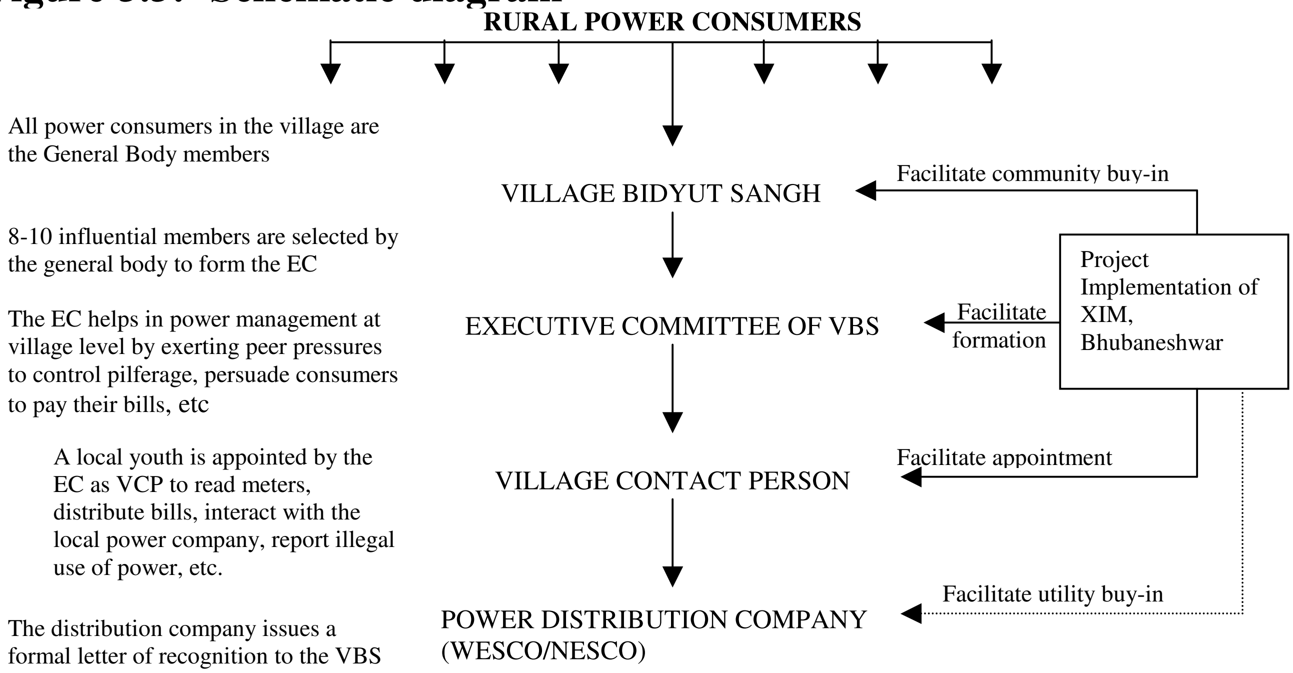
The important roles to be played by the VBS Executive Committee are (1) to exert peer pressures on consumers who draw unauthorized power and motivate them to take authorized connections, (2) motivate all consumers to make timely and complete payment for the power they use and (3) act as intermediary to take up any grievances of the consumers in terms of the services they get to the right authority as well as help the utilities by providing feedback on technical issues to enhance quality of power delivered.

The VBS Committee selects and appoints a Village Contact Person (VCP) who would be responsible for reading meters, bill distribution, identifying illegal power users, reporting technical problems etc as well as informs the other consumers of the program of the local power utility office for collections, regularization of illegal connections, disconnection of illegal connections, etc.

The distribution company pays the VCP a remuneration of Re 1.00 for reading each meter and another Re1.00 for every bill delivered. Initially, billing was bi-monthly. Since recent past, this billing frequency is increased to monthly duration. Therefore, the VCP gets Rs 2.00 per connection each month. Since there are several illegal consumers, this structure provides incentive to the VCP to get them converted to legitimate connections with proper meters installed, thus reducing power pilferage. The VBS is expected to help the VCP in achieving this by exerting their peer pressures.[3] To date, XIM has instituted over 5500 VBS in 8 electrical divisions within WESCO and NESCO[4] (Mishra, 2003).
The interesting part of this arrangement is there is no incentive at all to the VBS to perform any of the functions expected. The expectation from the VBS is to play an honorary role of advisor and has the powers to appoint and remove the VCP. The functional interactions in the process of forming the VBS is given in figure 3.3.

[3] Based on discussions with the project team of XIM
[4] Internal reports of XIM

Figure 3.3: Schematic diagram



Source: Based on discussions with project implementation staff of XIM, Bhubaneshwar

3.1.4 Franchising revenue collections: The next step

With the formation of VBS to facilitate social buy-in to the distribution reforms and reduce pilferages through illegally hooking on to a passing distribution line, etc, and appointing VCPs to read meters and deliver the bills, the next step to improve the commercial efficiency of the distribution company was to improve revenue collection. This was done by appointing franchisees.

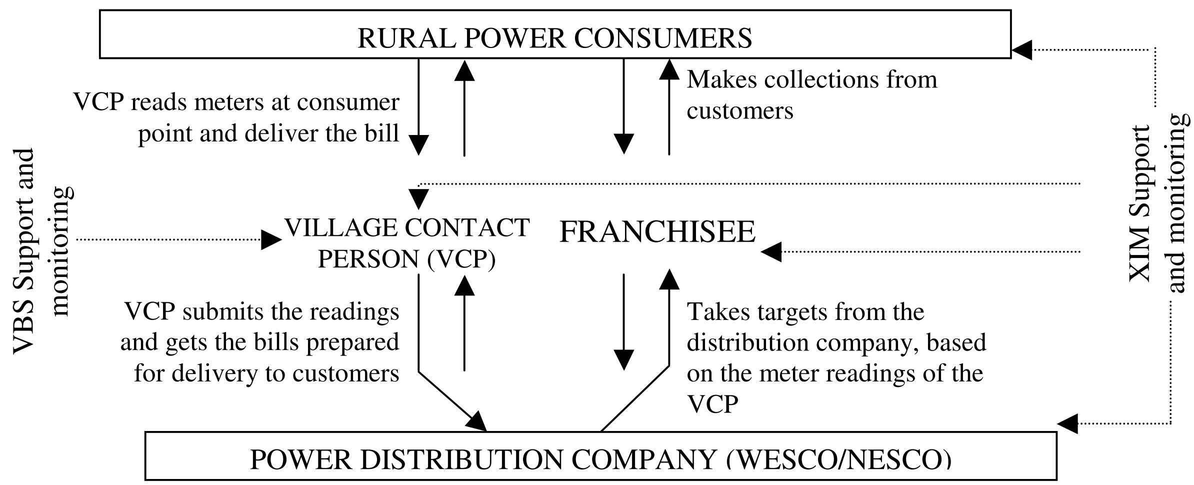
This stage of appointing franchisees to collect revenues commenced since 2002-03[5]. Franchisees operated at feeder level, covering all villages served by the given feeder. Typically, a feeder caters to 14 to 16 villages.[6] In each of these villages, VBS were already formed and VCP was appointed. The utility gives targets to collect revenues to the franchisees based on the billing (meter reading) details provided by the VCP. The franchisees' incentives are drawn depending on the achievements against these targets. A total of 30 such franchisees were appointed during the time of visit to Orissa.

[5] Internal reports of XIM

[6] Discussions with XIM Project staff

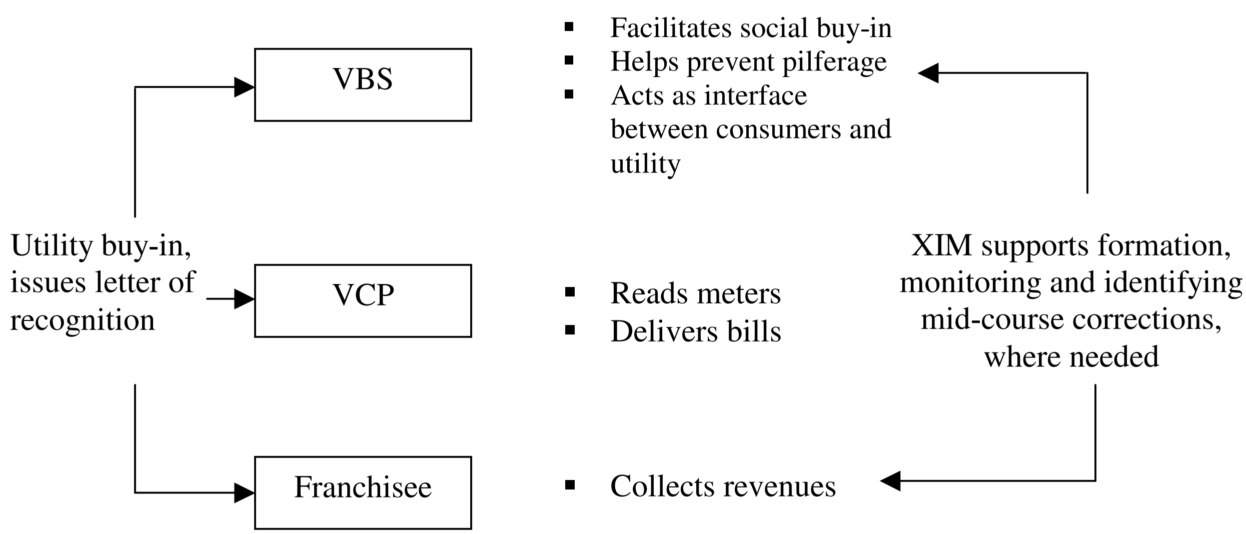
Schematically, the structure of collection based franchising to support the rural power supply management can be depicted as shown in figure 3.4 below:

Figure 3.4: Collection based franchising model



Thus the major commercial functions of taking measures to prevent pilferages, getting the meters read, billing and collection have moved from the conventional mechanism of using employees, giving opportunities for corruption to take place to decentralized, community-based institutional intermediation (see figure 7 below).

Figure 3.5: Decentralized commercial functions



Source: Based on discussions with project implementation staff of XIM, Bhubaneshwar

3.1.5 Input based franchising: The move forward

The above collection based franchising model experienced some constraints that negated the very effectiveness of franchising. Since the franchisee was to operate based on the meter readings provided by the VCP, it was highly important that the VCP functions efficiently and honestly. However, evidences from different researchers have shown that the effectiveness of VBS and VCP leaves lot to achieve (Mishra, 2003, Sinha, 2002). Since there is little for the VBS to gain (as incentives) by preventing illegal connections and power pilferage, these were not being controlled. Informal discussions with the VBS members have revealed that this being a sensitive issue, they would prefer not to ruffle consumers from their own village on issues of power theft. It is also learnt that the VBS is not exerting any watch on the functioning of the VCP. The VCP on the other hand was trying to add to his incentive by colluding with consumers and mis-report the meter reading. There were several instances where the VCP himself was pilfering power and even the VBS members were also indulging in the same[7].

Since, under the Collection-based franchising depends entirely on the data provided by the meter readings from the VCP and there enough reasons to suspect the authenticity of such data, the present implementation model has introduced some corrective measures, which gave rise to input-based franchising model.

[7] Discussions with the Executive Director, WESCO

Under this revised model, meters are fixed at feeder level and all consumer points. The franchisee is offered incentives based on the collections he achieves against the power supplied through a feeder as per the readings on the meter on the feeder and not by totaling the meter readings provided by the VCP. The franchisee tallies the feeder-level meter readings with the total of the consumer-level meters and cross-verifies the readings to correct any mistakes. Thus, the franchisee operates as a micro-retailer. On a pilot basis, one feeder in Bargarh district in western Orissa was given out on input-based franchising model.

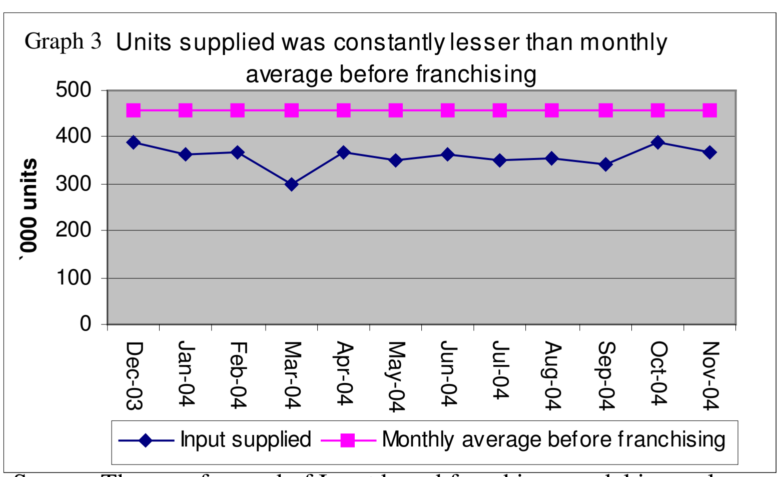
3.1.6 Costs, hidden costs, transaction costs

Given the spread of the consumers, the effectiveness of the above achievements would rest entirely on the financial feasibility. In this regard, the performance at the one feeder in Bargarh district, where input-based franchising was implemented showed that with metering of all consumers and designing an incentive structure that is based on the number of units supplied from a feeder, there has been a net reduction in the number of units supplied by 22% during the year. On a monthly basis too, each of the months showed a marked decline in the number of units supplied (see figure 8). The total value of the savings in power supply made through this feeder was 99972 units, worth Rs 1,37,961 (@ Rs 1.38 per unit which is the bulk supply tariff). While there had been a fall in the total units supplied, it is interesting to note that there was a marginal increase in billing by 3% in the year and the collection have actually gone up significantly by 23%, amount to over Rs 9.00 lakh. To the utility, this meant an increase of 40% on their collection to input, which is quite significant.

Against this, the average franchisee remuneration was Rs 11, 574 per month, totaling to an annual expenditure of Rs 1,38,888. This compares quite favorably with the expenditure the utility would have otherwise incurred, if it were to use conventional methods of using the staff of the utility, where, this cost was estimated at Rs 35,000 which totals to an annual expenditure of Rs 4,20,000. This includes only the incidental expenses of the vehicle costs, Petrol, Oil, Lubricants (POL), food allowance to a team of six members, their Dearness Allowance, etc and does not include the salaries of the staff.

Thus, the mechanism being implemented by XIM compares quite favorably with the conventional methods, leading to a general surge in interest in this model. (Mohanty, 2004)

Figure 3.6



Source: The way forward of Input based franchisee model in rural electricity supply, R.Mohanty, XIM, 2004

3.1.7 Opportunities for expanding the roles of the institutions to include water management

It can be seen from the above discussions that micro-privatization has indeed been helpful to the power distribution company to the extent of enhancing their revenues and facilitating their commercial management aspects. In the context of this research, the important point is to look for expanding the roles of the model being implemented to include groundwater management issues as well.

As mentioned earlier, in Orissa, there were no significant negative influences of energy-water nexus. Neither the groundwater resources were being over-exploited nor was the energy demand from agriculture sector hindering the finances of the power distribution company. It was quite interesting to observe that in the service area of feeder given out on input-based franchising in Bargarh district, all agricultural consumers were also metered and bills were raised based on the readings on the meter. Perhaps as a result of metering, during visits to the field, where a total of seven pumps were visited, only one was running. The farmers had switched off the pumps after completing their irrigation although power was available for 24 hours a day, although farmers were cultivating water-intensive crops like sugarcane. These fields were located on uplands along a canal of the Hirakud dam on river Mahanadi. This was recharging the aquifers and the average depth of the tube well was less than 15m and water levels in these wells were less than 10m.

Discussions with farmers revealed that they were not running their pumps beyond necessary because, if they did that, their bills would increase. Hence, there was a discipline in use of energy and water – an example to show that metering would indeed facilitate rational use of both energy and water resources.

However, visits made to other locations where meters were not placed, there was clear evidence of irrational use of both energy and water (see box 3).

3.1.8 Lessons Learnt

Orissa is a state where the energy-water nexus has not yet impacted the power industry as significantly as it has in most of the other states in India. However, given the need to promote irrigated agriculture to enhance farm incomes, it would not be too far, when proliferation of community lift irrigation systems and individual-owned pumping systems would happen in Orissa. Given this possibility, the local institutions being formed need to gear themselves to facilitate energy-water co-management, an issue that is not being considered currently.

The VBS experience has shown that due to lack of proper incentives, the members have chosen to be dormant. The VCP and the franchisees have demonstrated potential to be effective since they have incentives to operate. However, the VCPs have shown that notwithstanding the incentives offered, without proper inbuilt monitoring and control, they could also become counter-productive. This has been rectified by introducing the franchisee, whose own incentives are linked with the performance of the VCP and hence plays a direct role of monitoring and control them.

To conclude, it must be reiterated that community-based interventions that lack clear incentive structure (not necessarily in monetary terms) would largely be ineffective. Therefore, the power utilities would need to take a rational approach and build in an effective mechanism that includes monitoring and control, to make these institutions effective and efficient as well as sustaining

3.2 Transformer User Association, Hoshangabad, Madhya Pradesh

3.2.1 Introduction

BASIX, an NGO and VERVE, a consulting company undertook a joint initiative under Canadian CIDA funding support, an interesting experiment in the Hoshangabad district of MP to form transformer level power user associations of farmers. Initially the idea was to form two such transformer user associations (TUAs) which would undertake demand side management and intermediation between the utility and the consumers to improve the problems of inefficiency in use of power and irregularities in billing, collection supply system maintenance. Eventually the project expanded from just two transformers to forming a registered co-operative federation of all TUAs on one feeder. It was also proposed to install a decentralised biomass based power plant for the feeder.

It appears that BASIX-VERVE had undertaken this expansion from the initial two-transformer initiative to 64-transformer-feeder level initiative, mainly because they found that efficiency improvements are not possible unless power supply is improved and some economic incentives are offered to farmers. It is not possible to do so at the transformer level. Feeder is the lowest level at which power supply is regulated by the utility. So, bringing together all users of a feeder and having a dedicated power plant for them would give better control over power supply conditions to the farmers' body. Otherwise, given the uncertainties in power supply conditions and lack of appropriate incentives due to fixed rate power tariff system for agriculture, the motivation for efficiency improvements would be nonexistent and any imposed improvement would also prove to be ephemeral.

However, the project stopped at the stage when TUAs had been formed on all the 64 transformers of the Naseerabad feeder. The feeder level cooperative was yet to be registered and the work on the decentralised power plant had not even reached the drawing board. In the meanwhile 35 progressive and relatively large farmers of the area have picked up the idea and got the co-operative registered in November 2003 as Krishak Urja Vikas Swayatt Sahkarita Samiti with a membership capital of Rs. fifty- four thousands only. There is a difference of opinion on why the project was stopped mid-way after an encouraging start and enthusiastic support from the farmers. Senior officers of BASIX in Hyderabad told us that while forming TUAs, they had put a precondition that farmers will clear all their arrears to the utility before forming the association. Farmers did so and a significant proportion of the arrears were cleared Just before the assembly elections in MP, the government announced a waiver of all arrears of electricity bills of farmers to appease them. Now, these farmers in the project area who had cleared their dues felt cheated and lost interest in the project implementation. Thus according to them (BASIX) the project became a victim of electoral populism in the state. However, this does not seem to be the main reason as we found out both from farmers and one of the project staff that though farmers were encouraged to clear the arrears of electricity bill, it was not the essential precondition for forming TUAs. Several farmers had not cleared their dues and yet they were members of TUA.

Officers of MPLEAP (BASIX's Madhya Pradesh arm) said that withdrawal of the funding agency, CIDA and project's inability to mobilize funds from alternative sources forced the closure of the project. One of the project staff who worked on mobilizing farmers to form TUAs said that the project was stopped due to problems and irregularities within the project implementation team while farmers, the potential beneficiaries of the project are clueless about it and still hopeful about some sort of revival of the project.

In fact farmers in the area cleared substantive proportion of their arrears not to meet the preconditions imposed by BASIX-VERVE project but to get a separate sub-station for their area. A separate 3.1 MVA capacity substation had been sanctioned for the area since long but it was not being implemented. A delegation of farmers led by the local MLA went to meet the Chief Minister, Sri Digvijay Singh with a request to get the work done. He put a condition that he would help only if farmers in the area cleared at least 70% of their arrears towards MPEB. Farmers in the area were incurring huge productivity losses in wheat crop. So, the farmer leaders took it upon themselves to collect dues from all farmers. Collection camps were organized in villages and 73.38% of dues were cleared within 15 days of meeting with Chief Minister. The CM kept his promise and the new sub-station became operational within six months, well before the onset of the new wheat season. The new sub-station has resulted in marked improvement in the quality of power supply in the area. Voltage has improved and frequency of outages has gone down.

We went to study the project with the knowledge that it has been aborted. Our purpose was mainly to explore the working of TUAs formed in during the project now after almost two years of withdrawal of the implementing agency. The write-up offers our assessment of the potential effectiveness and replicability of the BASIX model of improving the system of power supply to agriculture. The unique features of this model are 1) its exclusive focus on agricultural consumers; 2) its emphasis on the demand side management measures to improve to improve the energy use efficiency in agriculture; 3) organizing farmers around transformers and feeders and 4) its attempt to adopt a business model to make the whole exercise commercially viable and self-sustaining. This paper offers our assessment of the BASIX model and its potential for solving the complex problem of energy-irrigation nexus in Madhya Pradesh. Since the project got aborted prematurely, the focus of our discussion has shifted towards understanding the larger context in which the experiment was carried out.

3.2.2 Water Energy Nexus in Hoshangabad

The project covered 17 villages on the Naseerabad 11 KV feeder in the Babai block of Hoshangabad district. These villages are very close to the Tawa River and the Tawa command area. However, only three of these seventeen villages are in Tawa command area while other 14 depend solely on groundwater for irrigation. Water table is at around 40-70 feet from ground in the rabi season and pumping is done mainly from submersible pumpsets with modal size of 5 HP. The aquifer is rich and discharge is in the range of 28-35 m^3/hour for a 5 HP pumpset.

3.2.3 Cropping Pattern and the Nature of Irrigation/Energy Demand

Soyabean is the main Kharif crop in the area while wheat is the main rabi crop. Tuver and Gram are the second important crops in Kharif and rabi seasons respectively. According to farmers, the soil is fertile and rich in organic matter with high porosity. The region receives around 800 – 1000 mm annual rainfall and some of the villages even get flooded affecting the Soyabean crop. Irrigation is required mainly for wheat crop which is irrigated four to five times depending on power availability. Soyabean and Tuver, the two kharif crops do not need irrigation while Gram needs just one or two irrigations. A 5 HP pumpset takes 8 to 12 hours to irrigate one acre of wheat and farmers seek to provide a total of 50 hours of irrigation to every acre of wheat they grow. This translates into an end-use energy requirement (for irrigation) of about 190 kWh per acre of wheat. This is also close to the total per acre annual energy requirement for irrigation in this area. Thus power demand for agriculture in this region is limited and highly seasonal. Pumps are operated only for four months from November to march. Farmers in the area receive fairly high yields of wheat ranging from 15 to 22 quintals per acre which is much higher than the national average. However, according to farmers, the wheat yields are highly sensitive to power availability; productivity loss due to restricted power supply of poor quality is as high as 20-25 % of the potential yield. In extreme cases, when a farmer does not have his own pumpset, land has to be kept fallow in rabi season or only Gram is taken.

3.2.4 Power Availability Condition and its Impact

MPEB commits to provide six hours of daily supply for agriculture. Often farmers receive three-phase power supply for just four hours a day due to severe shortage of power in the state. Single phase power supply for non-agricultural usage is available for an average twelve hours per day in the rural areas. Power availability for pumping is not only extremely restricted but also of very poor quality in terms of voltage and frequency of outages. Farmers commonly use phase splitting capacitors to keep their pumpsets running even during single-phase power supply. Pump density is also very high with several large farmers having as many as six pumpsets and tubewells to be able to extract maximum amount of groundwater during the limited hours of power availability. Restricted power availability means that water exchanges between pump owners and non-owners are extremely restricted; water markets are quite underdeveloped and every farmer is forced to own pumpsets and tubewells. This has resulted in unnecessarily high pump density in the region and compulsions for inadequately capitalized farmers to lease out land or keep it fallow in rabi season. Thus, rationing of this extreme kind, where power is available just for six hours in a day, is ineffective, inefficient, inequitable and unproductive. Uncertainty in power availability is so high that large farmers often invest in diesel generators for running their submersibles. Most of the gensets have a 5 HP motor and 7.5 KVA alternator and they burn 1.5 to 2 liters of diesel per hour of operation. This means that just the energy cost of irrigation using diesel generators is as high as Rs. 40 to 50/hour. This is equivalent to Rs. 11-14/kWh of energy which is very high. Only large farmers use generators to irrigate their crop and rental markets in generators is rare if any. The cost of unused energy or poor quality power supply is even higher. According to farmers, productivity loss of 5 quintals/acre of wheat is common which means a loss of Rs. 4500/acre to the producers. As mentioned earlier, farmers here need just 190 units of timely energy supply for every acre of wheat. Due to problems in that they end up loosing as much as 4500 rupees worth of yield which means that the cost of unused energy is as high as Rs. 23.68/unit or even higher if we add the costs of frequent pump repair and maintenance imposed by poor power supply conditions.

3.2.5 Power Tariff

Like in rest of India, most of the pump connections are charged at a flat rate in Madhya Pradesh also but the tariff rates are higher here than say a state like Gujarat. Gujarat Electricity Board supplies 8 hours of daily three-phase power supply for an annual charge of Rs. 650/hp. Against this, Madhya Pradesh Electricity Board charges Rs. 1200/hp/year for just six hours of three-phase power supply. Effectively, the flat tariff in MP is almost two and a half times higher than in Gujarat. In a region like Hoshangabad, where annual pumpage is low and limited to just four months in a year, the effective per unit tariff realization should be reasonably high for the utility. But this is not so because the utility is not able to collect bills from farmers. The collection to billing ratio for farm sector consumers is as low as 19 % in the state. Farm power supply was free in MP from 1993 to 2000 for pumpsets upto 5 HP capacity and a small flat rate was levied on bigger pumpsets. This encouraged large scale underreporting of pump size in the state. With the beginning of power reforms in 2000, not only the free tariff facility was abolished but tariff rates were revised upwards thrice in three years. Unfortunately, these were also the years of drought and severe power scarcity in the state. So, while the demand for power was higher than ever, the supply conditions were extremely poor and deteriorating against a steeply rising tariff rates. Farmers refused to pay and the arrears kept mounting. Government first launched a scheme called *Samadhaan* on 2^{nd} October 2002 wherein interest on arrears was waived and farmers were given a facility to repay the principal amount of bills in installments. The deadline of the scheme was extended several times with new concessions every time. But the scheme did not achieve much success. *Bijali* (electricity) became the main issue in the run up to the assembly elections in the state and finally in December 2003, the government wrote off all the arrears to farm sector. New billing cycle has started from January 2004 but farmers are persisting with non-payment. A history of free power provisions and waivers of arrears of electricity bills has created a culture of non-payment of electricity bills in the rural areas of Madhya Pradesh. This culture of non-payment alongwith large scale power pilferage is the biggest problem in the energy-irrigation nexus in Madhya Pradesh. It renders any adjustments in tariff rates fruitless, leaves no incentives for demand management or efficiency improvement and almost forces the utility to de-electrify the rural areas. Against this, mode of charging tariff (i.e. metered or flat rate) and level of tariff rates and extent of subsidization built in them are all issues of second order.

MPEB has also been trying to meter farm connections and there is a provision to charge farmers at Rs. 1.20/unit. However, farmers resist metering mainly because of the provision of the minimum charge system under which a consumer has to pay a minimum amount of Rs. 60 per month even if he has not operated his pump at all during the period. Besides, he is also required to pay rental for the meter (Rs. 12/month in this area) and sales tax over this whole amount plus a high rate of interest if there are any arrears accumulated from these charges only. Not only that, if the meter reader feels that the consumer's meter reading is lower than normal; he can charge him based on the average reading over last three assessments. Farmers are reluctant to pay the minimum charges for periods when they are not using their pumpsets and they are also skeptical about the arbitrariness of meter readers.

3.2.6 Transformer User Association: the Sustainable Rural Distribution Project (SRDP)

The initiation of the Transformer User Association (TUA) by BASIX as a Sustainable Rural Power Distribution Project (SRPDP) in MP, was in the context of the growing inefficiencies in the performance of the energy sector, especially on technical and commercial side, and TUA approach was seen as a decentralized approach to manage rural power distribution. Among different consumer categories, very aptly, power supply to agriculture was selected for intervention. Agriculture is the biggest power user in rural areas, accounting for almost three-fourth of the total rural power consumption (KPMG and IPA, 2004); it receives the highest subsidy among all consumer categories and is most important for rural livelihoods. The project started with the premise that there are large scale inefficiencies and irregularities in power distribution to farm sector which cause revenue loss for and inconvenience to both the utility and farmers. These can be reduced substantially by improving end-use efficiency in both energy and water use. Better customer relationship management will help in reducing irregularities in power usage and bill payment. The project sought to create power user groups called TUA at the transformer level for peer monitoring, undertaking demand side management (DSM), and intermediation between the MPEB and end users of power. It was expected that the energy savings and productivity gains achieved through DSM measures would ensure the financial viability of these user associations. The MPEB was expected to benefit through improvement in collection of arrears of electricity bill, reduction in pilferage and regularization of meter reading, billing and bill collection. It would also have to deal with far less number of people reducing the transaction cost.

The pilot project started on a 100 KVA distribution transformer in Amkheri colony of Bachhwara village in Hoshangabad district. In the pilot phase five main activities were carried out:

1. Complete mapping of the distribution system showing all regular and irregular connections through which energy is used from the system. 21 pumpsets and 20 households were connected to the transformer. Out of these 21 pumpsets, only 11 had regular connection while other 10 used power illegally.
2. Meter-reading, billing, bill collection, complaint redressal and utility's information system were documented in detail for better understanding of the loopholes in the customer-utility relationship.
3. Baseline estimation of technical parameters like status of the power distribution infrastructure, level of distribution losses (both technical and commercial) and pumpsets efficiency measurements was carried out and a simple model was developed to assess the commercial implications of these inefficiencies for both the utility and users.
4. Agricultural users were mobilized to form TUAs. A local NGO called Samdarshi Seva Kendra was involved in the process of social mobilization. Farmers were convinced to adopt DSM measures for efficiency improvement and they were encouraged to regularize their connections and clear their dues of electricity bills.
5. Finally a plan was developed to establish such TUAs on at least 50 transformers of the Naseerabad feeder and federate them into power users' MACS. There were 64 transformers on Naseerabad 11 KV feeder and by the end of the project; TUAs had been formed on all but one transformer.

Motivating farmers to come together to form user associations required tangible incentives. Energy saving through DSM measures would be possible only if there was a significant improvement in the availability; quality and reliability of power supply. This required substantive investment in improving the power supply infrastructure which only MPEB could do and even they were not in a financial position to make such investments. Also such improvements had to be done at least over the whole feeder even to benefit the two TUAs which were proposed to be formed initially. These two factors probably forced two important changes in the overall project design: a) forming TUAs on all the transformers of a selected feeder and b) then setting up an independent biomass based power plant to serve the feeder. The idea of having a dedicated power plant for the feeder created a great deal of enthusiasm among farmers in the area and became the main source of motivation for participating in the project. As discussed above, the cost of unused energy and poor power supply condition was very high for farmers in the region. Therefore, they were prepared to pay any price for assured and unrestricted power supply of high quality. While the project staff went about forming TUAs on all the transformers of Naseerabad feeder, the independent power plant became the project for farmers. They told us clearly during the fieldwork that the prospect of having a dedicated power plant for the area was the main reason for their involvement in the project. They did everything they were asked to by the BASIX people to get a power plant of their own.

3.2.7 Achievements of the Project

The Hoshangabad experiment mainly tried to test the viability and potential of using better informed user groups for improving the rural power distribution system on the lines of water user associations in canal command areas. The pilot project was undertaken to examine and flag the issues involved in doing so and not to design a blue-print for replication. It identified two main areas for improvement: a) increasing end-use efficiency and b) improving communication between the utility and users. Similar experiments have been carried out in Orissa on a much larger scale. Singular focus on pump-owners and organizing them along the power supply system boundaries differentiates it from the VBS in Orissa.

The project assumptions proved to be true on the two pilot TUAs where the work started first. Following the formation of TUAs, irregular connections were regularized and current dues of electricity bills were repaid. As a lateral benefit of the project, for the first time, MPEB could come to know of the actual agricultural load on the Naseerabad feeder. There were 836 pumpsets with a connected load of 2.98 MW on the feeder against MPEB's record of 629 pumpsets with a connected load of 2.254 MW.

The project could also mobilize a large number of farmers to come together to form TUAs. Even the 207 farmers with irregular connections showed in interest in joining the TUAs. This created a significant social capital. After the project ended pre-maturely, the farmer leaders of the area took upon themselves to get the co-operative registered. This cooperative is now trying to raise funds from government and non-government sources to set up a bulk milk chiller in the area to promote dairying.

The documentation of the processes involved in meter-reading, billing, bill collection and complaint redressal is another valuable output emerging from the project.

Farmers who joined TUAs were made aware of the fact that they will be required to pay two to three times higher tariff for the power supplied from the independent power plant if it comes up and they will be charged based on consumption. Still all farmers showed keen interest and extended all possible support for making project a success. This brings out concrete evidence that farmers are willing to pay for an assured power supply that meets their irrigation requirement.

Inspite of a good beginning, a well equipped project team and actively supporting stakeholders, the initial successes of the Hoshangabad project could not be sustained. The 64 TUAs have not become functional, the pumps continue to be highly inefficient and arrears are mounting again. Basically the intervention does not seem to have created any lasting impact on the energy-irrigation nexus in the area. Reasons for this failure lie more in the overall policy environment in which the experiment has been carried out.

- Farm sector power consumption continues to be billed at a flat rate. This leaves no incentives for farmers to improve efficiency.
- Power availability remains uncertain and voltage low. Oversized pumpsets, often with poor winding (having more space between turns) are energy inefficient coping mechanisms for this problem. Any project of education and awareness for efficiency improvement will not work unless the basic causes of efficiency are not removed.
- Culture of non-payment seems to have firmly set in among power users in rural MP in both farm and household users. Even the new government, which has five years to go before next elections, is not able to force disconnections and the state government seems all set for another round of waiver sooner or later. The last one cost the exchequer rupees 800 crores. Thus power supply to agriculture seems to have become a power play between farmers and the utility in MP. Under such conditions, it seems implausible that farmers would come together to pay when they can get away with it. Farmers will not pay unless there are substantive improvements in quality of power supply and provision of severe and sure penalties for non-payment.

3.3 Cooperative Electricity Supply Society (CESS) - Sircilla

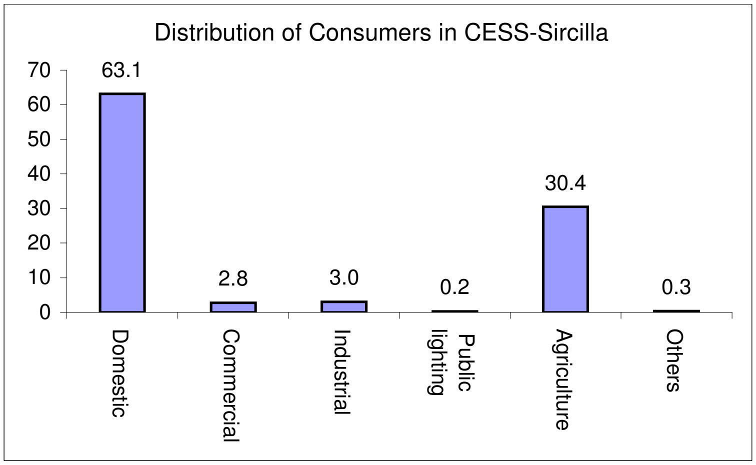
CESS is one of the oldest initiatives promoted to enhance the reach and effectiveness of rural power distribution and management. CESS Sircilla was among the first five electricity cooperatives to be established in the country. This is located in Karimnagar district of Andhra Pradesh[8].

3.3.1 Introduction

During the mid 1960s, the government of India felt a need to establish a separate organization to enhance the pace of rural electrification, with the primary view towards enhancing food production and to improve the quality of life in the rural regions. The organization established in response to this realization was the Cooperative Electricity Supply Society (CESS). On a pilot basis five locations were chosen, of which Sircilla was one. The state electricity regulator has accorded recognition to CESS Sircilla (CESS-S) as “rural electricity supply company” (RESCO). CESS-S has an area of operation that extends over 173 villages, 109 hamlets and also included supply to 9 urban centers. The area of CESS-S operation is coterminous with the entire revenue division. CESS-S currently has a total of over 1.64 million consumers, of which domestic consumers account for the highest proportion (see figure 3.7).

[8] The other CESS are in Lucknow (Uttar Pradesh), Kodinal (Gujarat), Mulpravara (Maharashtra) and Hukeri (Karnataka)

Figure 3.7



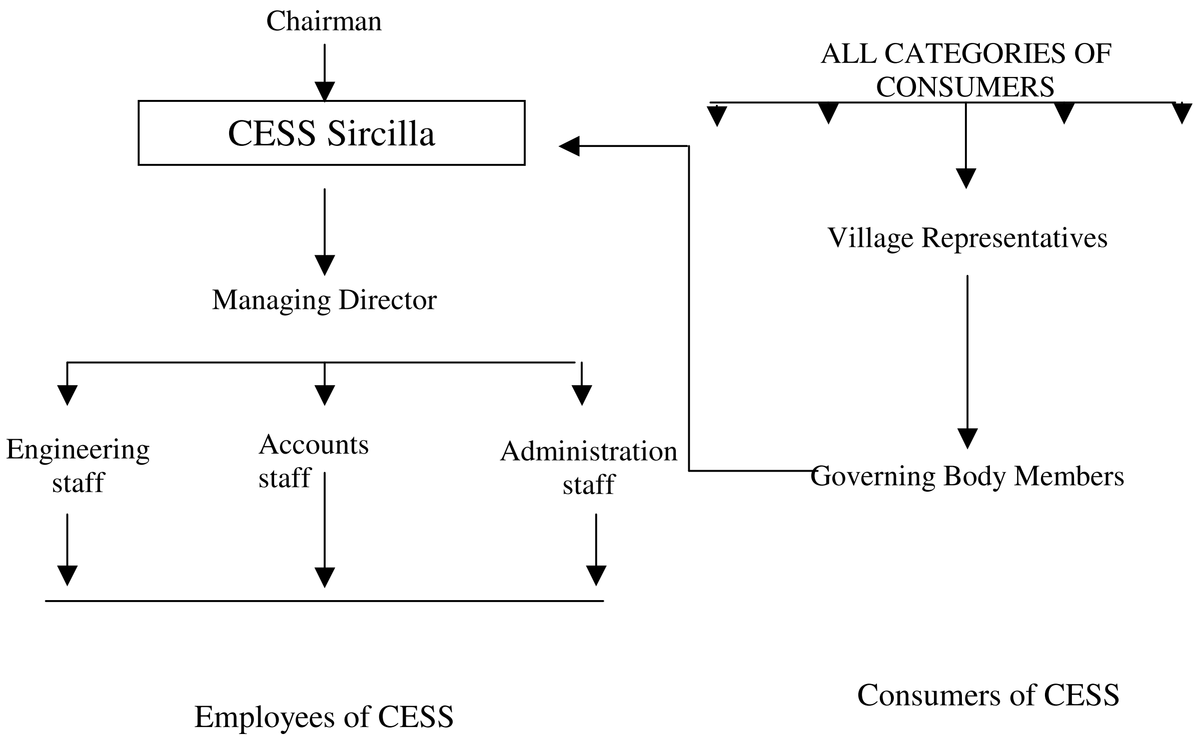
3.3.2 Structure of CESS-S

CESS-S differs from the other power suppliers in the state to the extent that here, each of the consumers has to purchase some shares in order to become members and enjoy the power supplied. The value of each share has remained unchanged since inception, pegged at Rs 20 per share. The number of such shares depends on the category the consumer is placed in. A domestic consumer has to purchase 1 share while an agricultural consumer has to purchase 1 share per horsepower of the pump that is to be used. The commercial consumers have to purchase 3 shares and industrial consumers have to purchase 5 shares for each connection. Even the public services and utilities also have to purchase shares at 3 per connection for streetlight and 5 for temples, mosques, etc.

The shareholders form the general body of the electricity cooperative. These members are represented by Village Representatives, appointed at village to represent a maximum of 250 consumers. If a village has more than 250 consumers, there would be more than one Village Representative. These representatives would represent all consumers during the General Body Meetings and to select/elect members for the Governing Body (GB). The GB has 11 members and a chairman/Person-in-charge. Ideally the Chairman also should have been elected, however, for several years, elections have not been conducted and the Chairman for the past several years had been a government nominated person. Currently, the District Collector, an officer form the Indian Administrative Services is appointed as the Chairman.

Broadly, the structure of CESS-S can be depicted as given figure 3.8.

Figure 3.8: Organizational structure of CESS-Sircilla



Apart from the fact that the consumers are shareholders of the society, for all practical purposes, the management is like an extension of the state power utility/local power distribution company. The employees treat themselves as separate and the consumers consider themselves as consumers only. Neither looks at the other as partner in the process of power supply management.

The role of the Village Representatives seems to be restricted to attending the Governing Body meetings and approving the Annual Reports. In way, this position is more a "decoration designation" than has any functional utility in the overall management process.

Discussions with the officials in CESS-S revealed that unlike in other places, the problem of recoveries here is not too significant. In this regard, CESS-S employs the help of the village panchayat. The abstract of the bills for each village are sent periodically and the collection agent visits twice a month on prior appointed dates. The villagers come forward on those dates and make the payments. Corrective measures for defaults are swift and they entail prompt disconnection. CESS-S has three squads of patrolling teams, which are responsible for taking corrective steps to prevent illegal tapping of power, tampering of meters and disconnecting supply to defaulters.

3.3.3 The energy-water nexus: implications on the finances of CESS-S

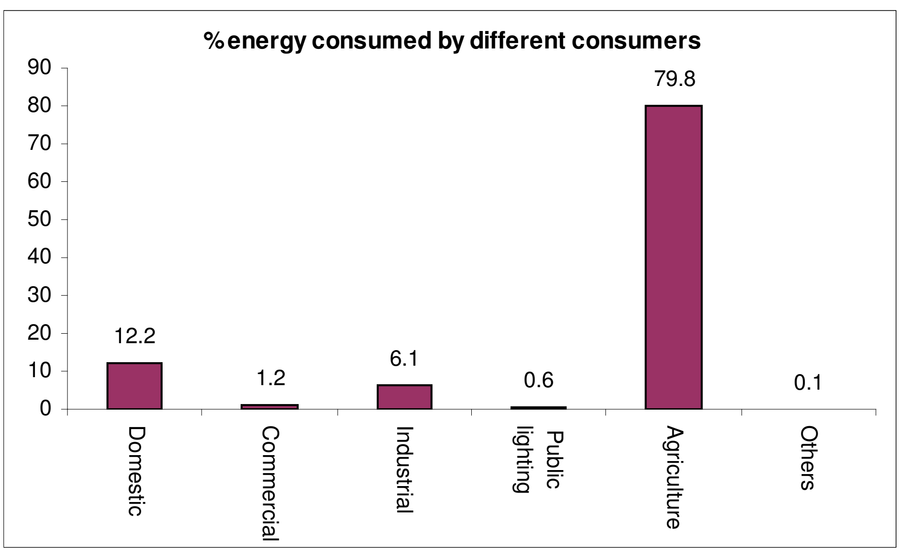
CESS-S purchases power APTRANSCO on bulk supply tariff and retails to the consumers. The tariff at which CESS-S supplies to the consumers as well as the tariff at which it purchases from APTRANSCO is determined by the state electricity regulator. Currently, the bulk supply tariff (BST) is 38 Paise per unit.

There had been a steady upward revision in the BST from 15 Paise during the late `90s to 25 Paise in 2000-01, revised upward to 36 Paise in 2002-03 and again revised upward to 38 Paise in 2003-04. There is a proposal to again revise this tariff in the coming financial year 2004-05.

The implications of this upward revision are seen on the finances of CESS-S. Bulk of the consumption is recorded by agricultural consumers, who pay the lowest. This segment, which accounts for about 30% of the total consumers of CESS-S, consumes nearly 80% of the power supplied (see figure 3.9). The tariff recoveries from the different consumers made during the last financial year is given in the table 3.

Table 3: Tariff recovered at different consumer categories (Rs/Kwh)	
Consumer	Tariff recovery (Rs/Kwh)
Domestic	2.23
Commercial	5.65
Industrial	2.71
Public lighting	1.83
Agriculture	0.24
Others	4.69
Overall average	0.72
Source: Annual Accounts, CESS-S, 2002-03	

Figure 3.9



It can be seen from the table and figure above that while agriculture accounts to the highest proportion of power consumed, the tariff recovered from this segment is the lowest. It is important to point here that as per the Annual Accounts for the year 2002-03, the overall average tariff recovery needed to meet all expenses including the bulk supply tariff, which the CESS-S pays to APTRANSCO and to meet the other establishment costs and overheads should have been Rs 0.79 per Kwh. CESS-S has been able to just meet the operating costs by including the interests on the membership share value and other investments. Now the proposal of the state electricity regulator to increase the tariff means, there is an immediate need to revisit the consumption by the different consumer segments and the tariff being charged.

Further, a major initiative towards development of textile industry is coming up in Sircilla. Power supply to this consumer also would be the responsibility of the CESS-S. However, with much of power being used up by agriculture segment, there is not much surplus available to cater to this potential demand.

In addition, CESS-S has been instructed to maintain three-phase supply for a minimum of 18 hours in all the nine urban centers to which it is providing electricity. This too means, there is a need to free up power to cater to this additional demand.

Of the different problematic areas identified, agricultural power supply is identified as one of the major thrust areas. This segment, which uses up nearly 80% of the power supplied, contributes to less than 27.5% of the revenues recovered.

3.3.3 CESS-S Initiatives in energy-water co-management

CESS-S is perhaps one of the very few power utilities that have realized the presence of energy and water nexus and that one is impacting the other quite negatively. The entrance to the corporate office carries a board that promotes the need for groundwater recharge and methods to achieve this. The need for looking at the co-management options also stem from the fact that the state electricity regulator had put a cap on the maximum volume of power CESS-S could supply to agricultural consumers. For the current financial year, this is set at 266MU. In order to achieve this, CESS-S has planned to launch initiatives that enhance productivity of energy use in agriculture and reduce the demand.

Since the Chairperson of CESS-S is the District Collector, who has the responsibility of implementing other developmental initiatives in the district, of which water conservation and recharge is one of the major activities, CESS-S also is considering this as one of the important activities to be taken up. However, the planning and implementation of such activities are being taken up by CESS-S staff, who traditionally are electrical engineers. Their lack of understanding of the subject and the implications it would have on their power consumption situation was evident from the programs they propose to take up. One of the first activities to be taken up is to recharge dried wells. CESS-S has earmarked a small budget from their own resources for this purpose. However, they have overlooked the fact that by recharging dried wells, there would be an addition to the demand from agricultural consumers, because the farmers owning these wells would also start pumping.

The other activities being considered are to promote a change the cropping pattern that is showing increased trends in cultivation of paddy. In this regard, the discussions with the officials of CESS-S showed that they are looking at the synergies between cropping pattern change and the development of textile industry. It was informed that they would also consider taking the textile industry representatives to promote increased cultivation of cotton, the output of which could feed a spinning industry, currently lying unused.

The discussions with the Managing Director of CESS-S revealed that they do not have the expertise nor the managerial capabilities to effect a change in water use in agriculture and would quite open for inputs from other. However, CESS-S firmly believes that energy-water co-management is indeed the need to help them tide over their financial impasse.

3.3.4 Conclusion

CESS-S, although a co-operative, has very little involvement of the local communities as direct partners in the management processes. The present management system has evolved itself into an extension of the local power utility. Perhaps, the only reason for CESS-S to look at energy-water co-management options could be because of the Chairperson, who looks at energy management at a more holistic manner.

There are no institutional linkages with local communities, apart from them being consumers, in this whole process. CESS-S instead is looking for institutional partners to help them achieve their desired objective of reducing energy use by the agriculture segment.

Chapter 4. Water Energy Nexus in Bangladesh: Towards a Co-management Option

4.1 Introduction

The key challenge facing the South Asian countries is to reduce abject poverty of a large proportion of the population inhabiting the region. The countries also have been facing other serious problems such as rapid population growth and subsequent densification, depletion of natural resource base, vulnerability of large population to natural hazards, unplanned rapid urbanization etc. The latter elements, in one hand, are known to decelerate development of the south Asian countries, while on the other hand these complicate the processes of addressing poverty.

In recent decades since independence, Bangladesh has been experienced doubling in population and rapidly increasing food demand, while farmers contributed to attain near-self-sufficiency in terms of foodgrain. To many, the expansion of irrigated high input agriculture and effective utilization of crop lands during dry winter and subsequent moisture-stressed pre-monsoon summer have been the key factors in increasing food production and maintaining food security in the country (Shahabuddin and Rahman, 1998; Faruqee, 1998; Ahmad and Ahmed, 2002). The development has been marked by a proliferation of millions of small capacity tube wells dispersed across the country (NMIDP, 1995).

In order to irrigate moisture-stressed croplands, the farmers had to rely mostly on ground water due to the fact that rainfall during the dry months had always been scanty and surface flows of the rivers reduce significantly due to combination of natural hydrological patterns and deliberate withdrawal of water from regional rivers by upstream countries. Currently, almost 81% of all water used in the country is harnessed from groundwater aquifers (Halcrow *et al.*, 1992). In recent decades, expansion of irrigation coverage has become an indicator of development in rural Bangladesh. More recently, during the past two decades, electrification of rural areas opened up new frontiers for irrigated agriculture in rural Bangladesh (REB, 2002).

Since irrigated agriculture is considered as a major means of advancing economic growth and reducing poverty, as indicated by the National Policy for Economic Growth and Poverty Reduction (NPEGPR[9], 2003), it become imperative to analyze whether rapid expansion of electrified irrigation poses any threat to long-term sustainability of resources, in terms of both water and energy resources.

The current study, with limited resources and inadequate focus, examines whether the nexus between water and energy (electricity) resources do exists in Bangladesh and if it is evident, what recommendations may be forwarded to the relevant policy making to address the issues in order to ensure optimal utilization of resources – perhaps in an

[9] Commonly known as the Interim Poverty Reduction Strategy Paper (IPRSP), developed in Bangladesh under the aegis of the Ministry of Planning and the World Bank.

integrated manner. The focus here is to find out a preferred community institutional mechanism which would not only ensure long-term sustainable solution to the problem, also highlight importance of a holistic integrated approach to address water-energy nexus, if it does exists. Such an attempt fits very well under the SARI Energy Initiative Programme of South Asia, administered by the Winrock International, Inc. The study is jointly undertaken in India involving three community institutions and in one community institution in Bangladesh.

4.1.1 The energy-water nexus in Bangladesh

During the past few decades, the minor irrigation development using the water lifting devices like deep and shallow tube wells (DTWs & STWs) and low-lift pumps (LLPs) are playing a vital role in increasing food production in Bangladesh, particularly in growing the high yielding varieties (HYV) of rice and other diversified crops during the dry period (November – April). In Bangladesh, in the absence of necessary surface water sources for irrigation during the dry period, the ground water has been mainly utilized through pumping with DTWs, STWs and Treadle pumps etc. as a constant and dependable source of irrigation water supply (Sahabuddin and Rahman, 1998).

As a consequence of increasing population and demand for food production, irrigated agriculture has become a major way of eking out a living in rural Bangladesh since late 1970s. Irrigation is now overwhelmingly dependent on groundwater resource. The groundwater pumping and energy are closely linked with the fact that energy is needed to pump up the water from the underlying aquifers. These energy forms the range from animal and human power (treadle pumps) to diesel, electricity and non-conventional renewable sources such as wind, solar etc. In early days of irrigated agriculture, human/animal power and diesel were the major forms of energy being used, while in recent years electricity is rapidly replacing the other forms of energy. Use of renewable energy sources are yet to be taken seriously for providing energy for irrigation in the country.

With expansion in irrigation, the ground water has gained ascendancy as the vital resource to support food production and the energy policies are to be drawn to facilitate its development. With irrigated agriculture in Bangladesh about 26,718 DTWs, 72,918 LLPs and more than 0.78 million STWs are operating under different capacities (NMIC, 2002). Most of the water lifting devices are still diesel operated. With the introduction of electricity supply for irrigation by REB only a certain percent of the devices could be electrified. In the face of increasing crisis for diesel supply and high cost during the irrigation season, there has been tremendous demand from the farmers for electrification of their irrigation devices in spite of knowing the frequent disruption of power supply and load shedding (deliberate power outages). Load shedding is considered to be a measure to cope up with electric power crisis prevailing in the country during the peak summer season, the peak of which coincides with that of the peak irrigation season.

It is generally found in the country that the illiterate farmers often flush their lands with more than adequate water, the majority of which is drawn from groundwater aquifers, and thereby triggering a gradual and slow lowering of piezometric surface of the resource base. Further, due to lack of on-farm water management practices, the farmers lose a significant proportion of water being applied and compensate that amount by drawing/applying additional amounts of irrigation water. The practice is also fuelled by erratic and unreliable supply of energy, particularly in the pre-monsoon peak season, when the confused farmers become reluctant to depend on erratic supply of energy at time when the system demands assured supply of top-soil moisture to cope with increasing evapo-transpiration. Such a wasteful practice of applying unnecessary amounts of groundwater has been putting the long-term sustainability of the resource at risk, especially when the resource availability is also being threatened by exogenous factors such as global climate change, potential abnormal changes in hydrological conditions at regional scales etc. On the other hand, the tendency to apply increased amounts of irrigation water requires increased utilization of power, which unfortunately occurs simultaneously throughout the country and contributes to frequent power outages and tripping – the latter two forces the power supply system to be more erratic and increasingly unreliable. The management of the two finite and very important resources, therefore, faces a nexus. Figure 4.1 provides the vicious cycle of water-energy nexus prevailing in Bangladesh.

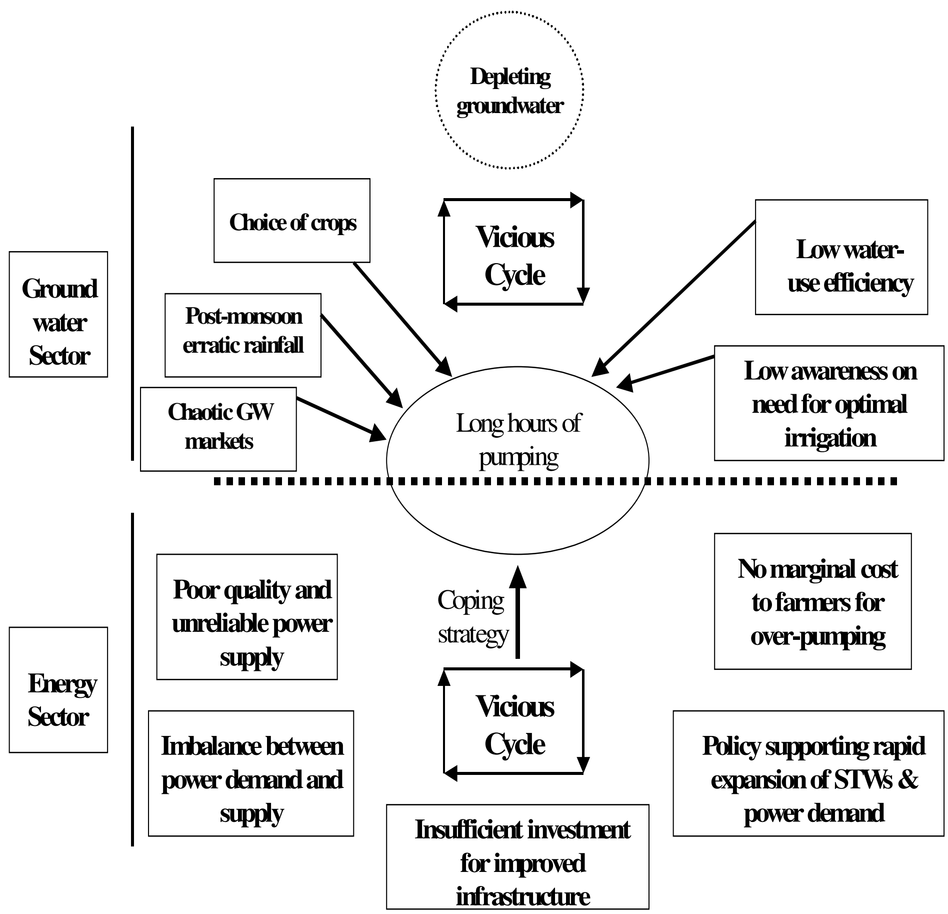


Figure 4.1: Energy-water nexus: the vicious cycle in Bangladesh

Note: Modified from Narayana *et al.*, 2004.

Now, the question is, under the limiting conditions the electric energy which could be supplied for irrigation, to what extent it is utilized in the context of proper utilization of groundwater resource – the latter also being a limiting resource. In this connection the necessary awareness, training and water-saving irrigation culture and practices are important in order to ensure efficient utilization of limited electric power supply and lifted groundwater resource. Unfortunately, however, all these are almost absent in most of the cases in Bangladesh. Therefore it is the need of time to think about co-management of water and energy for their safe and efficient utilization.

4.2 Community institutions in Bangladesh: the PBSs

Palli Bidyut Samity (PBS) is perhaps the only community institution model that has been dealing with utilization of power for facilitation irrigation, drawing water primarily from ground water sources. This is an autonomous association of rural electricity users are formed through direct involvement and encouragement of the Rural Electricity Board (REB), which was established in 1978 to advance the Rural Electrification Programme (REP) of the country. It Is the REB that helps organize the prospective consumers of rural electricity into formal and informal groups, electric and other cooperatives, societies, associations and companies for the purpose of execution and management of electrification schemes. REB also helps organize programmes for the preparation, execution, operation and management of rural electrification and related works.

PBSs are governed by the bye-laws of the Rural Electrification Board (REB), under the Rural Electrification programme (REP). Since all the PBSs are run under the same systemic approach and legal framework, there exists very little difference in day-to-day activities and functioning of various PBSs. Therefore, any PBS under the REP of the Ministry of Energy and Mineral Resources (MOEMR) represents the institutional model that exists in Bangladesh to deal with the potential nexus as presented in earlier sub-section.

It is to be mentioned here that, the role of a PBS is not necessarily limited to providing power for irrigation and the subscribers do not necessarily represent farming communities. The membership in each PBS includes a host of other users, where farmers constitute only a smaller proportion of the membership.

A PBS is generally formed to serve 5 to 9 Thanas. The Board of Directors of a PBS, usually 10 to 15 in number, is selected by the REB following a criteria approved by the REB. The Directors may be school teachers or elite of the area having no past record of criminal offence or loan default. REB is the final authority for appointment of Directors for a new PBS for a period of three years.

Any member of legal age, firm, association, corporation, club or organization may become a member of the *Samity* (i.e., an association) upon receipt of electric services from the *Samity*. Upon applying for member and fulfilling other criteria, a Cerificate is issued as a conclusive proof of the membership to the PBS. There is a modest membership fee of about Taka 20.00. Each applicant is supposed to purchase electricity services as soon as it is made available to her/him, pay at monthly rates fixed by the PBS Board and approved by the REB. The membership may be terminated as per bye-laws, and upon termination of a membership, the fee is returned to the former member. In order to facilitate construction, inspection, operations, maintenance, improvement, replacement or relocation of power lines and other facilities of the PBS, each of its members is supposed to grant and/or provide right-of-way upon request by the PBS.

A PBS supposed to convene and held an annual meeting of its members. In addition, special meetings may also be convened by resolution of the *Samity* Board; approved by two-thirds of the members of the *Samity* Board or by 10 per cent or more of all its members.

The business and affairs of the PBS is administered by a Board of Directors. Power of the PBS Board is exercised only by actions and determinations taken in a regular or special called and legally held meeting of the Board, with such actions and determinations recorded in the official minutes of the PBS Board meetings. Individual members of the PBS Board are not allowed to attempt to guide, direct, influence, or interfere whatsoever in the day to day management and/or operations of the PBS unless authorized by a resolution passed by the affirmative vote of not less than two-thirds of all members of PBS Board, with such resolutions approved by the REB.

4.2.1 Functioning of a Typical PBS

According to the bye-laws provided by the REB, a PBS is allowed to operate on a co-operative and non-profit basis. The PBS Board sets, with concurrence of the REB, rates, fees, rents or other charges for electric energy and other facilities, supplies, equipment or services furnished by it. The Board is also responsible for making payments for all operating and maintenance expenses necessary or desirable for the prudent conduct of its business.

The members of a PBS take active part in electing their representatives in the Board of Directors, thereby they can directly influence policy making. A PBS, on the other hand, makes sure that the members timely pay for their consumption of electricity. This is manifested in the low rate of system loss compared to the large electricity distribution systems in the country, such as the Power Development Board (PDB). A comparative study reveals that, the PBS-led REP in Bangladesh experiences an average of 16% system loss compared to corresponding loss of over 30% in case of PDB.

PBSs, in most cases, have high efficiency to realize their bills from the consumers. The better performance, compared to that of PDB, is due to the fact that PBSs are better organized in terms of providing door-to-door connections and surveillance. A typical PBS employ, after providing extensive training, village-electricians – one in almost every village – who, in addition to providing various services in each electrified village, take note of meter readings and help collection of revenues for the PBSs. The village electricians receive a token amount as incentive for each bill and also the privilege of rendering services to the customers as an 'enlisted service provider' under the PBS. Moreover, for every irrigation-related connection, there is a system of taking an advance minimum charge which is generally collected through banks with the application for an irrigation-connection. If the real consumption surpasses the minimum units of electricity, a bill is prepared according to actual units consumed and the user must pay for the arrears following the harvest. This ensures payment of revenues. Furthermore, the employees of PBSs are held responsible for ensuring a certain minimum level of collection of revenues, which is generally regarded as a performance indicator for a PBS Official.

PBSs do not directly promote electrification of irrigation pump sets. The only incentive is actually provided by the government, by offering a reduced tariff structure for electrified pumps for irrigation compared to other connection-types. For example, the Kurigram-Lalmonirhat PBS charges about BdTk 3.70 per kilowatt-hour of consumption, while it charges about BdTk 5.65/KWh for commercial services. However, REB determine tariff structure for variety of usages of power in concurrence with the Ministry of Energy and Mineral Resources, while REB purchases power from the PDB and for that, the Government endorses the rates fixed by the REB. It is intriguing to note that, towards determining the power tariff for various usages under the PBS system, the actual subscribers of the PBS electricity has no participation in the governance process.

4.2.2 Problems Encountered by PBSs

Some PBSs operate with a financial deficit while some show exceptional profit margins. The financial strength of a PBS depends on a number of factors: organizational efficiency of servicing and collection efficiency of bills, service coverage, types of services being rendered, fraction of power sold as against amount purchased etc. Customer mix, load factor, date of commercial operation, debt service – all having major impacts on the financial viability of PBSs.

The demand for electricity for running irrigation equipment is already high. However, it would be much higher than that of today, had there not been any shortage in power supply due to paucity of national capacity to deal with peak demand. Frequent power failure and load-shedding is a major impediment. The Power Development Board (PDB), the producer and major distributor of electricity in the country, is given monopoly control over 33 KV source line, from which PDB can divert electricity to anywhere, without issuance of any prior notice to PBSs and their consumers. Since irrigation is a time-dependent affair, withdrawal of power seems to be major problem counteracting irrigation-led agricultural development.

Perhaps the greatest concern regarding services of PBSs is the reliability of service. Similar to that in urban areas, the peak load is attained at dusk, mostly to satisfy household lighting demand. A sharp rise in peak demand could never be satisfied by any PBS, which eventually leads to power outages. In order to find a solution to meet increased demand at dusk, small power generation units with capacity of about 10 MW are now being promoted in addition to large power plants. Three such smaller plants are now being installed on the basis of Build Own Operate to serve selected PBSs, while eight others are pending. Ageing of a few generation and transmission equipment has been causing problems in delivering reliable services. Adequate measures are now being contemplated to monitor and as necessary, refurbish aged installations.

4.3 Role of PBSs in Providing Power for Irrigation

The PBSs are local-level autonomous cooperatives to provide and manage activities in relation to electrification in rural areas of Bangladesh. Since 1978, REB has been promoting to form PBSs in rural areas across the country. A total of 67 PBSs are now servicing over 30,600 villages through 2.75 million connections and 120.445 kilometers of power distribution lines across the country.
location of PBSs in Bangladesh. As a consequen
reached rural households and farms, rural health care and educational centres, commercial establishments, and growing industrial sectors – dynamically changing the employment, production and well-being scenario of the rural Bangladesh. Electricity is promising a marked improvement in welfare and livelihood the rural people.

Since the inception of REB, the strategic focus was to electrify irrigation pumps and tubewells, and to provide power to agro-based industries as well as to serve domestic and commercial demands. Formation PBSs has contributed immensely to mechanized irrigation in the country. Propelled by the activities of PBSs, the electricity-powered irrigation exhibited phenomenal growth throughout the 1980s and 1990s; the number of irrigation equipment supported by electrical power grew from only 22 in 1983 to over 103,980 in 2002. A total of 103,980 irrigation equipment are now being operated (REB, 2002), which constitutes about one sixth of total irrigation equipment being used in the country (Barkat *et al.* 2002). On an average, there are as many as 1,552 irrigation connections per PBS today, which has increased by 776 times during the past 20 years. Due to rural electrification programme, about 15% of the country's net cropped area is now being irrigated by electrically powered equipment.

4.3.1 Impacts of Rural Electrification Programme and PBSs

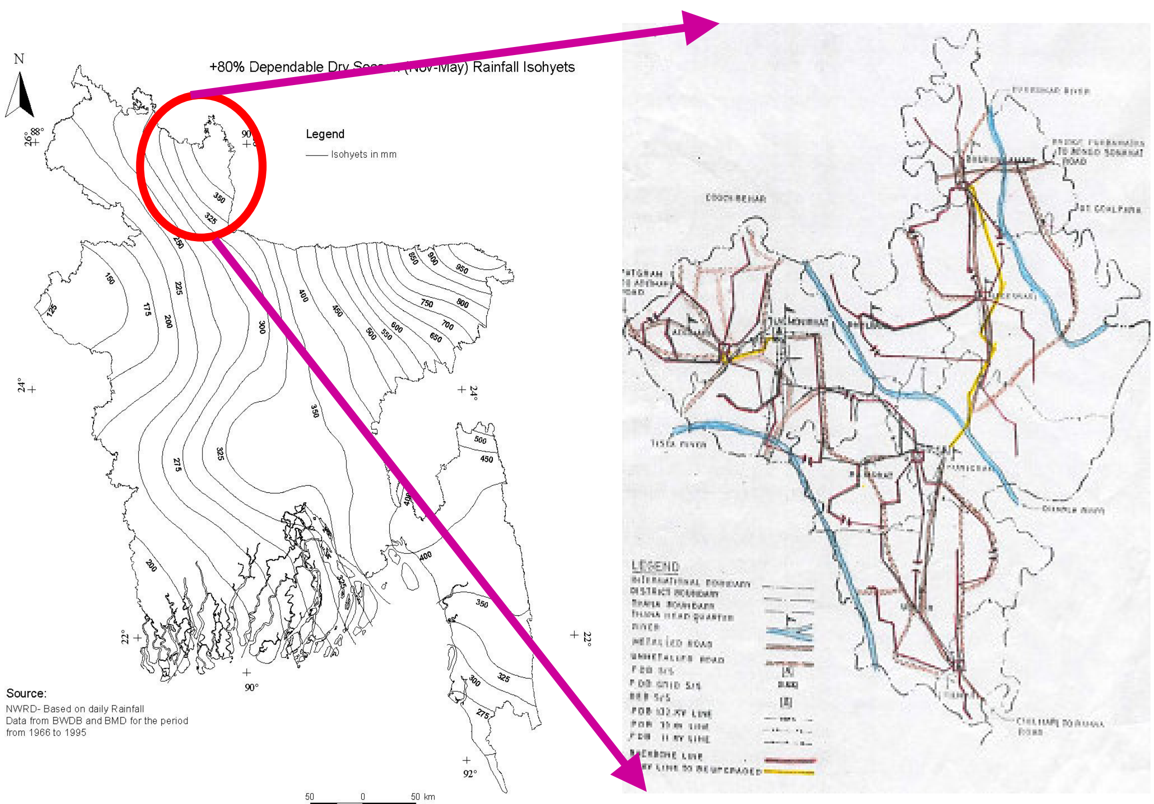
PBSs have enlightened rural people immensely during the past quarter century by accelerating the process of broadening developmental choices in creating economic opportunities, social facilities, political freedom, transparency guarantee, and protective security. In a recent study, Barakat *et al.* (2002) notice that, recent success of attaining foodgrain self-sufficiency can be partly attributed to rural electrification, where PBSs have direct contribution. It is revealed that, rural electricity contributes one-third of the food self-sufficiency in Bangladesh. The REP covers, through its 103,690 irrigation equipments, about 2.3 million acres of land for HYV Boro and Aman, which is 34% of the total irrigated land under Boro and Aman. REP-irrigated land produces 4.1 million tons of HYV Boro and Amman, which is about 29% of all similar types of rice produced in Bangladesh. An estimated 1.1 million persons are directly involved in farmlands using

RE-connected irrigation equipments, which is a testimony of employment benefits accrued from rural electrification in Bangladesh.

4.4 THE KURIGRAM-LALMONIRHAT PBS: EFFECTIVENESS OF THE MODEL INSTITUTION

The Kurigram - Lalmonirhat Palli Bidyut Samity (KLPBS) was established in 1996 at Muktaram (Trimohoni), Kurigram with financial assistance from Japan. Figure-3 shows the location of KLPBS, while the detailed map of KLPBS servicing area is provided in Figure-4. The KLPBS serves 9 Upa-zillas of two districts Kurigram and Lalmonirhat of greater Rangpur district, as indicated in Figure 4.4. It has five energized sub-stations with a total capacity of 25MVA. The KLPBS serves about 31,200 households in 495 villages through 2,193 kilometers of transmission and distribution lines. Figure 4.5 provides an account of year-wise construction of lines under the KLPBS programme. The organization is run by 200 employees. About 400 village advisers of which 3 are female advisers provide guidance and participate in the governance process of the PBS.

Figure 4.4: Map of KLPBS



As per statement up to April 2004, the KLPBS could connect 43,747 consumers, out of which 4,234 were to run irrigation equipments. Figure 4.6 graphically presents recent achievements made by the KLPBS in terms of connecting various types of consumers. A total of 77 DTWs and 4,100 STWs have been connected by the KLPBS for electrified irrigation. The command area of the electrified irrigation devices was estimated at about 63,000 acres, where an additional 3,800 metric ton paddy is produced per year. It is estimated that, about 8,500 additional employments has been created by the electrification of irrigation equipments in the area served by the KLPBS. In addition to that, the employment generated in industrial sector and cottage industries (for women) was about 9,500 and 2,350 respectively.

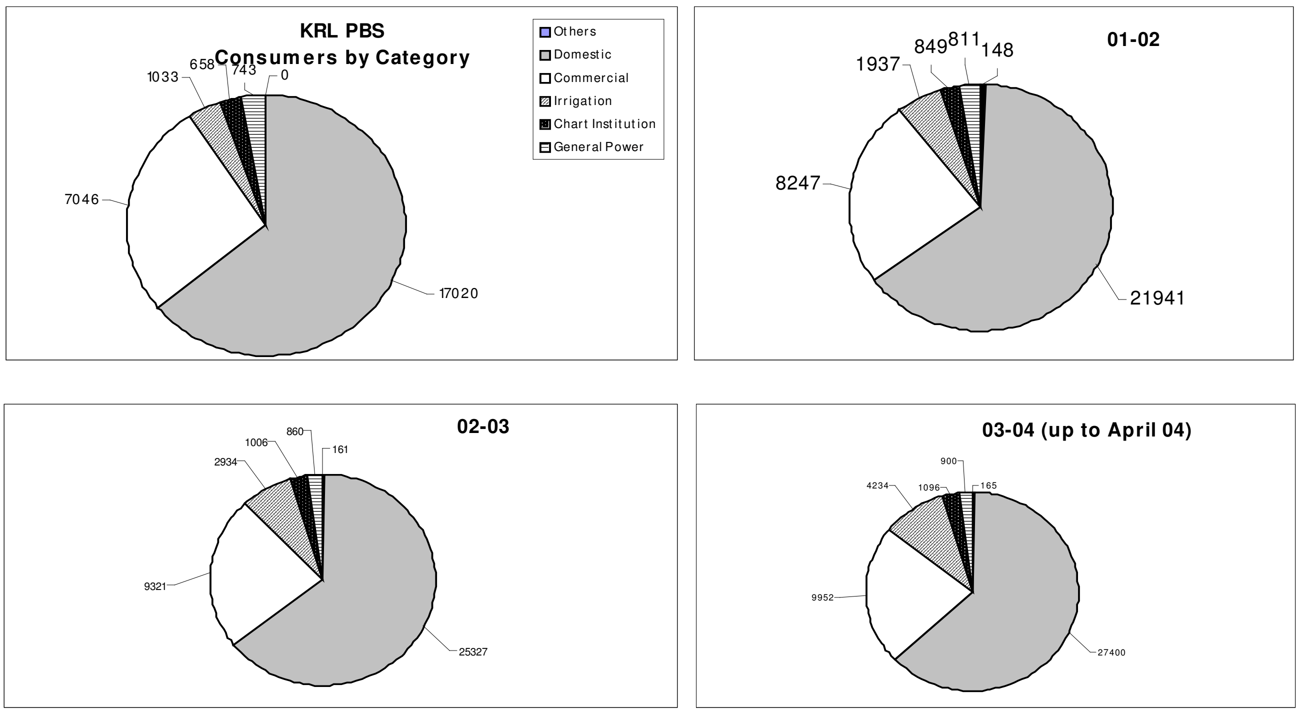


Figure 4.6: Recent achievements in providing electricity connections by KLPBS

The PBS, since its inception in 1996, has very significantly advanced its electricity distribution capacity in the service areas. Its consumer connection increased from a mere 267 in 1995-96 to 43,747 up to April 2004 (Figure 4.7). During the past more than nine years, its efficiency in collection of bills increased from a low 43 percent to about 98 percent, and its system loss reduced from over 50 percent to 11.73 percent - showing a gradual and significant increase in efficiency of running the organization (Figure 4.8).

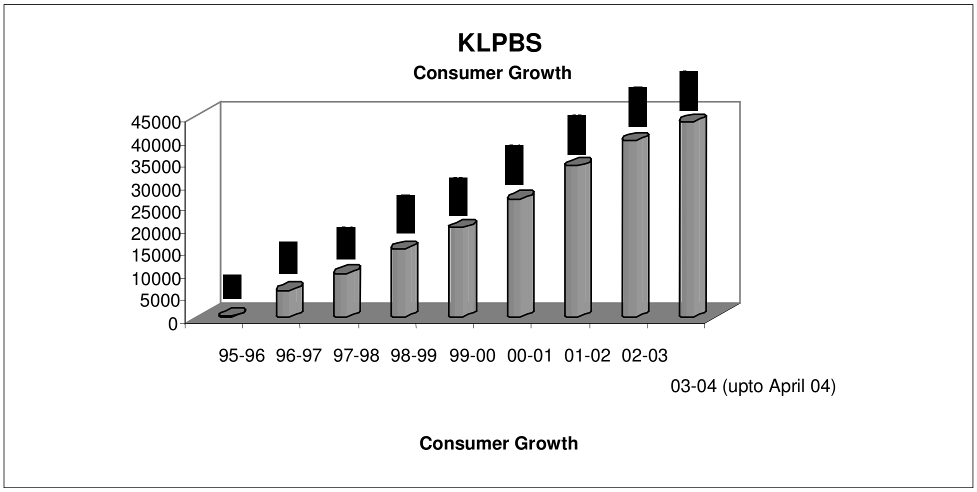


Figure 4.7: Year-wise growth of consumers in KLPBS

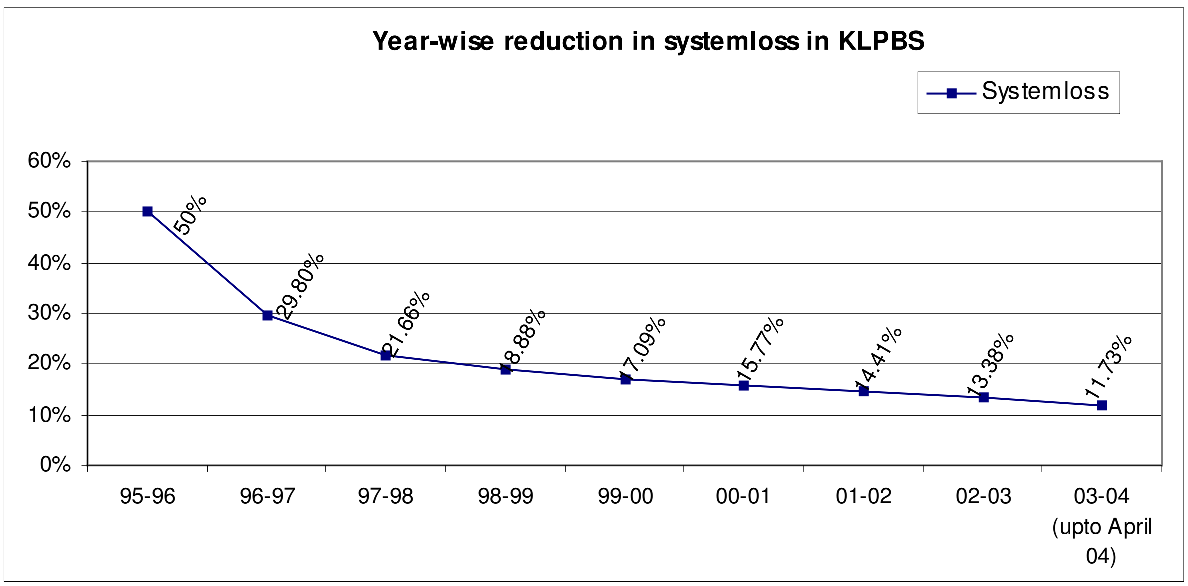


Figure 4.8: Year-wise reduction in System loss in KLPBS

4.4.1 Current Deficiencies of KLPBS

In order to assess whether the current institutional model may provide insights into addressing the energy-water nexus, an extensive PRA/FGD process was carried out in the KLPBS serviced areas. The Research Team made several field visits and Focus Group Discussions (FGDs) in Kurigra and Lalmonirhat areas. Annex-1 provides the list of people who have contributed in the PRA/FGD and subsequent key informants' interviews. During the field visit to KLPBS, the research team made a series of discussions with the General Manager (GM), Deputy General Manager, Assistant

General Managers responsible for Member Service, Construction, Operation & Maintenance, Finance and Power Use, the President & Secretary of the KLPBS, village Adviser including female Adviser of the KJLPBS.

On discussion with the concerned personnel of KLPBS and going through their mode of operation and status of performance it appeared that, there exists a serious power crisis as the gap between the demand and supply is continuously increasing day-by-day. As a result there is too much load shedding and frequent power disruption with voltage fluctuation resulting in burning out of electric appliances, particularly irrigation motors. Through the Complain Section of the KLPBS, the *Samity* receives a large number of complains from the consumers, particularly in respect of power supply for irrigation. The situation becomes worse when it occurs during the peak irrigation demand period. Under such situation, the PBS is simply helpless, since the supply is under total control of the Power Development Board (North Bengal Zone). It may be mentioned here that, the minimum allocated power that the PBS is supposed to get is not practically being supplied by the PDB.

From the field visits and focus group discussions, it is reported that, in spite of load shedding, even during the designated hours for running electrified irrigation pumps (i.e., during 11 PM till 6 AM)[10], there was frequent disruptions of power supply and sometimes occurring for as many as 10~20 times per hour. There was complains for burning out the electric motors used for irrigation due to frequent voltage fluctuations. As reported by the KLPBS, during the same irrigation season a total of 447 pumps were reportedly burnt out due to voltage fluctuation.

From the field visits, it was observed that, in the absence of any regulation for well spacing there is too much concentration of tube-wells particularly the STWs. In many cases it is observed that the STWs are installed very close to each other, even within 50 ft distance. Whereas, in technical (engineering) terms, the distance from one STW to another STW should ideally be about 800 ft. Similarly, there are installations of several STWs within the command area of a DTW. This is also due to social conflict and lack of coordination between the pump owner, and water users. The current community organization in dealing with utilization of both power and water appears to be totally ineffective in resolving the issue of tubewell spacing. There is no existence of formal water users group. Proper on-farm water management practice is totally absent, which is perhaps typical in most of the areas in Bangladesh. Under this condition, obviously there is over-pumping for which not only increased quantum of irrigation power is needed, also such irrigation practices cause wastages of water. At this moment in the area under the KLPBS, although there is no evidence of depletion of groundwater resource-base – as observed elsewhere in the country, precarious power management in the area might potentially cause gradual depletion of groundwater resources and subsequent lowering of the aquifer.

Although, the PBS has made contribution towards attaining self-sufficiency in food grain production through electrification of the irrigation equipments, but due to shortage of

[10] As suggested by the REB/MOEMR through media campaign in 2004.

power supply, it could not meet the necessary power demand during the peak irrigation period. The frequent power failure and load-shedding during the critical period resulted in significant reduction of expected crop yield. Farmers believe that, production from irrigated rice cropping could have been much more if adequate quantum of sustained (hazard-free) power could be made available during the peak irrigation period.

Moreover, in the absence of any existing regulation in sitting and installation of tube wells, the farmers have the freedom to install tube wells in their fields as and where they desire. An area, which could be easily commanded by a single STW, there has been several STWs (2-4 nos.). Within the potential command area of a DTW there are several STWs too. As a result there has been a continuing groundwater harvest with excessive installation of wells particularly STW.

After installation of a tube well when a farmer applies for electric connection, PBS has to respond to that if it is within the reach of their power transmission line, despite having tremendous shortage of power supply. The current regulatory regime does not allow a PBS to control sinking of a tubewell: irrespective of its spacing and the power demand it might add to the current aggregate demand. Under this condition, the gap between power demand and supply is increasing resulting in more load-shedding and frequent disruption of power supply.

When there exists insecurity of power supply, the farmers tend to draw groundwater in excess than necessary, just to ensure that the standing crop do not face moisture stress. Moreover, there exists little knowledge regarding proper on-farm water management. As a result, there is misuse of both energy and water resources in electricity-driven irrigation practices[11].

On discussions with the Focus Groups (FGD) at different places under KLPBS, it appeared that there are complains from the participating farmers mainly regarding not getting power and water supply in needs. Many of the farmers are water users only, without having a pump of their own. They virtually purchase irrigation water from 'water vendors', the pump owners. Inadequate and unreliable availability of power for running irrigation equipments often lead to tension between water users and water vendors. In the FGD, the electric motor owners complained about load shedding with frequent disruption in power supply, while the water users mainly complained about inadequate and unreliable water supply. In the absence of any water user group, there is lack of co-ordination between the motor owners and water users groups. The existing community institution model, the KLPBS, has so far given no attention in resolving tension between the water users and water vendors.

Since the water users are dissatisfied with water vendors concerning timely and adequate supply of irrigation water, they strongly feel that ownership of a electrified pump would perhaps ensure the resource in need and it would also help them becoming independent of the 'whims of water vendors'. Since there is no regulation of sinking a pump, individual

[11] The tendency of overpumping is also observed in diesel-powered irrigation practices, due primarily to lack of knowledge regarding efficient water management.

farmers purchase one and apply for electric connection to the PBS. This results in increasing demand for additional installation of STWs. On discussions with the concerned personnel of REB and KLPBS including the village Women Adviser, it appeared that, they all are concerned about the aspects discussed above and stressed on the policy issues, scope and provisions.

4.5 OPPORTUNITIES FOR CO-MANAGEMENT?

4.5.1 Potential Solutions

In order to address water-energy nexus in Bangladesh, efforts must be made to ensure optimization of both the resources. Both demand-side and supply-side management aspects of both the resources need to be given due attention in order to reach to an agreeable solution. Given the nexus and resulting complexities in resource management in Bangladesh, one may contemplate activities/approaches in three different time-frame: a) short-term (or immediate) activities, (b) short- to medium-term activities and (c) medium- to long-term activities. Brief outlines of each of the activities/approaches are given below.

4.5.1.1 Short-term activities

A) *Increase power supply in the region:* There is no denying in the fact the power made available to the KLPBS by the PDB is grossly insufficient, particularly so in the peak irrigation period. The picture is more or the same in case of other PBSs throughout the country. According to PDB statements published in the news media, unless national level power production capacity is significantly increased, providing power to meet the ever increasing demand would be extremely difficult. Increasing power supply will call for a substantial increase in capital investment, perhaps foreign direct investment – the latter has been declining steadily due to socio-political factors.

   It is understood that, the supply side scenario will be boosted up rapidly throughout the northwestern parts of the country if the Barapukuria Coal-based Power Plant starts operating in late 2005, as scheduled. Under the Barapukuria Coal-based Power Generation Project (BCPGP) of the Ministry of Energy and Mineral Resources, it is envisaged that a total of 100,000 tons of coal will be mined per annum, some 85% of which will be utilized for generating power. It is also envisaged that, due to the location of the power plant and poor power generation capacity in the northern districts, the newly generated power from coal will primarily be supporting power distribution in the Northern districts of the country. In order to increase power generation and supply for the northwestern zone of Bangladesh, the government must ensure scheduled implementation of the power generation project. The government should also ensure fair share of the generated power to rejuvenate REB system across the North Bengal Zone.

It is to be mentioned here that, the BCPGP might not be able to produce electricity in due time. In such a situation, as an intermediate measure, a very small proportion of power from other power-rich zones may be diverted to the North Bengal Zone, particularly during the peak irrigation season. This minor step will help maintain minimum energy services necessary to counteract the prevailing energy-water nexus in the entire North Bengal Zone.

B) *Improvement in quality of power supply:* It is also necessary to improve upon current dismal supply-side performance in power supply. Insufficient supply and synchronized operation of a huge number of electrical appliances, including irrigation equipments, often causes frequent voltage fluctuations. In order to arrest this voltage fluctuation, the quality of power must be improved. It is anticipated that, with the supply of power from the Barapukuria Coal-based Power plant, both quantity and quality of power supplied to the Northern Bangladesh will be significantly improved.

C) *Judicious expansion of power supply:* Until the power supply scene is improved appreciably enough to ensure quality power for the already electrified irrigation pumps, KLPBS and similar other members of the PBS system should refrain from offering connections to new aspiring members of respective PBSs. The REB, under prevailing policy regime cannot discourage farmers to seek new connections for irrigation. However, the PBS Customer Service section may provide voluntary advocacy for discouraging new connection for irrigation if alternative options are available to aspiring farmer. To the least, the PBSs must inform its members about potential setbacks in irrigation as well as in the crop production system which is caused and aggravated by the new connections.

4.5.1.2 Short- to medium-term activities

A) *Installation of 'Capacitor Banks':* The Government has recently decided to procure and install several 'Capacitor Banks' to ensure sustained power supply. Unfortunately, these 'capacitor banks' will be installed in Dhaka and Sylhet area, which will not be very useful in areas where irrigation demands are high due to the existence of rice-based dominant cropping patterns. It is revealed that the capital investment of a "Capacitor Bank' is only a fraction compared to the annual opportunity cost of not having adequate power for irrigation. On the contrary, the estimated cost of poor quality power escalates if one adds up the losses incurred by the farmers due to burning of irrigation and other electric appliances. The government, therefore, must re-examine needs for installation of increasing number of 'capacitor banks', particularly one for the entire Rangpur-Kurigram-Lalmonirhat region so that supply-side scenario can be greatly improved through quality enhancement.

B) *Whither re-introduction of regulation on well spacing:* In the past, when irrigation was advanced under direct guidance of Bangladesh Agriculture Development

Corporation (BADC), there was a policy[12] that maintained a minimum distance between two irrigation equipments (wells), depending on their types, command area, and capacity. In order to make irrigation a way of livelihood for every capable farmer, the regulation in relation to spacing between two equipments has recently been lifted. In the absence of any regulation concerning spacing, authority of the PBS has put into severe constraint to justify feasibility of sinking two or more wells in close proximity. Now, virtually anybody can apply to a PBS to get her/his equipment connected with the electric supply system and draw water as per demand, without giving any consideration on how that might affect the groundwater aquifer.

In reality, as discussed earlier, the absence of such a regulation has actually contributed significantly to aggravate the nexus. Increased number of irrigation pumps, searching for water from the same aquifer and drawing electricity simultaneously has put tremendous pressure on the demand side management, which is in turn causing a further degradation of service quality. Consequently, the downward spiral of the water-energy nexus is continuing.

It is understood that, to boost small-scale irrigation and to provide all the farmers an equal chance to get benefited from irrigated agriculture, the regulation of spacing has been lifted. People, on an individual basis, finds it favourable since it keeps one's right on the common national resource. However, on a collective basis, farmers find it against their interest because of the apprehension that in next peak irrigation season, a further increase in irrigation equipment would cause a complete disfunctioning of the supply side management. During the FGDs, there was a consensus that, in case if the net power supply in the region cannot be substantially increased, the PBS should not provide any more connection to new irrigation equipments. However, this is contrary to the current policy regime.

Lifting the regulation on pump spacing is believed to contribute immensely in very recent advancement in irrigation across the country. Adequacy of the policy, however, in the backdrop of long-term sustainability of resources needs to be re-evaluated. The Government must pay immediate attention to this important decision and examine how the potential long-term benefits of imposition of the spacing regulation fares against real-time benefits of expansion of irrigation and production, although in exchange of sustainability of resource use.

4.5.1.3 Medium- to long-term activities

[12] That Policy was implemented with Irrigation Management Programme (IMP) of the government under the Integrated Rural development Programme (IRDP). A the Upazilla (sub-district) level, a Committee named the Irrigation Management Committee (IMC) was constituted. The IMC was represented by Bangladesh Agricultural Development Corporation (BADC), Department of Agriculture Extension (DAE), and erstwhile IRDP (currently Bangladesh Rural Development Board). The Committee used to take care of the implementation of the policy and any installation of tube well had to be approved by the Committee.

It is well understood that, the current power demand for irrigation will only increase as the old diesel-operated equipments will be replaced by electricity-operated pumps and completely new electric pumps will help increase irrigation coverage. As a result of this anticipated rise in power demand and other increasing demands, national power generation capacity has to be gradually increased in a foreseeable future. It may be assumed that the issues concerning quality of power supply will also be adequately addressed in near future. Therefore, the water-energy nexus will be weakened significantly.

In order to seek a long-term solution, however, one must pay attention to improving upon the current level of water use efficiency. As indicated earlier, performance of Bangladesh in water use efficiency is perhaps the worst among the neighbouring countries in South and South-East Asia. Without an improvement in water use efficiency, any expansion in irrigation coverage will be translated into a consequent gradual depletion of ground water table and an increase in loss of energy used for pumping the water onto surface. Therefore, the farming communities must be helped in enhancing their capacity to increase water use efficiency, to a much higher level than the current levels.

To achieve so, a uniform approach of establishing on-farm water management (OFWM) may be considered. OFWM calls for water management at the farm level in order to attain maximum possible water use efficiency with optimum crop production. The major aspects concern with OFWM includes the following: i) water source (adequacy and reliability), ii) Pumping plant performance (installation, commission, operation and maintenance), iii) Water Conveyance and distribution system (planning, design, layout, construction, operation and maintenance), iv) Irrigation schedules (when to irrigate and how much water to apply), v) Water application method (type of crops grown and land topography) and vi) Overall farm water management with the formation of Water Users Group (WUG).

Currently, the importance of application of OFWM is almost ignored in field practices, despite recognizing its usefulness. Most of the water lifting devices (DTW and STW) are currently underutilized. Under the average conditions, in growing HYV of rice where the potential irrigation command area of a 2 cusec capacity DTW and 0.5 cusec capacity STW are 100 and 25 acres respectively, but practically it is limited to only 30-50 acres and 3-10 acres, respectively. Despite the encouragements shown under the National Water Policy to foster formation of WUG (MOWR, 1999), very little has done in the field to organize water users. In the absence of WUG and proper OFWM, the seepage and percolation loss due to faulty water conveyance, distribution and application system goes up to 30-50 percent resulting in very poor Water Use Efficiency (WUE).

To establish OFWM, one may envisage three-pronged approach:

(a) Capacity building of a farming community
(b) Facilitating formation of a community organization and allowing involvement of such an organization in decision making; and
(c) Facilitating an integrated management framework for establishing co-management of both the resources.

A) *Capacity building of a farming community:* Although OFWM practices require less resources and accrue increased benefits, due to lack of clear understanding, farmers do not practice OFWM. In order to convince farmers regarding potential benefits of OFWM, a national-level capacity building campaign needs to be initiated. Under this initiative, farming communities must be provided with adequate information regarding pros and cons of the OFWM. Simultaneously, an extensive demonstration programme should also supplement the information dissemination programme. Such a campaign will raise the awareness of the farming communities on issues concerning OFWM.

The second step should be dedicated to gradually impart training on OFWM practices. Indeed, the Department of Agriculture Extension, through its Water Management and Agricultural Engineering (WMAE) Wing, has been trying to implement such a programme in recent years. Such an activity needs to be extended across the country, under a common integrated approach, involving other partners. The Rural Development Academy, Bogra (RDA) has adequate experience in providing training, in cooperation with the DAE, which must be harnessed in order to deliver the services envisaged under this nation-wide programme.

It is to be pointed out at this stage that, the Barind Multipurpose Development Authority (BMDA) has been undertaking similar approach in areas where water draw-down in perhaps the highest in the country. They also provide farming communities with training on OFWM and help them manage irrigation system more efficiently. Their expertise might also be made useful. However, BMDA works in areas where the irrigation system is predominantly run by DTWs, which may not be so useful in STW-based irrigation systems.

B) *Facilitating formation of a community organization:* Because of the presence of a large number of farmers, it may not be at all possible to bring all the individual farmers under a training programme. Instead, it would be lot more easier to deal with representatives of farming communities. The National Water Policy calls for the formation of Water User's Groups (WUG), as a mini local-level organization, to work in tandem with relevant government agencies to plan and manage small scale water projects. Formation of WUGs, therefore, be promoted and brought under a national programme with a view to promote OFWM. Once representatives of such WUAs are imparted training on OFWM, they would be able to take collective decisions on spacing of pumps, irrigation sequencing etc. and resolve conflicts.

There is a system of governance, under the current PBS system. There are representatives of members of a PBS who are in-charge of an area. Under her/his designated area, the members may be inspired to form WUGs or Water User's Associations (WUA), which will collectively decide on number of connections required in their area, spacing of wells and on other matters, while they will practice OFWM upon receipt of training organized by the DAE, in coordination with the REB/PBS. Under such a co-management system, local level decisions will be influenced by the WUGs/WUAs, while decisions concerning quantum of power to be supplied can be negotiated with the PDB by the PBS/REB.

In order to facilitate the process further, a two-tier integrated institutional framework may be envisaged.

C) *Facilitating an integrated management framework:* An integrated (as well as coordinated) management framework may also be envisaged involving a number of major relevant national organizations and the community organization in question to put OFWM into practice. Realizing that, under the existing manpower and operating system, the OFWM issue can not be addresses by PBS itself, the mandates and efforts of DAE and the BRDB may be combined to enhance human capabilities to practice OFWM. The Community Organization, under the current structure of the PBSs, can arrange training on OFWM in cooperation with the DAE Officials deployed at Thana and Union Parishad[13] levels. Currently, DAe Officials are provided extensive training on such issues by the BRDB, especially by the RDA Bogra and other concerned institutions. It is envisaged that, with necessary co-ordination with the PBS, the DAE would be in a better position to facilitate extension of OFWM at the grassroots. Under this integrated framework, the PBS can take care of efficient power connection and supply to the properly sited tube wells with the adoption of necessary regulation for well spacing.

The existing (trained /to be trained) Block Supervisors(BS) working under DAE can better take care of the OFWM issues at the field level under direct supervision of the irrigation and water management specialist working under DAE. The BS can take care of the formation of WUGs with necessary training to the participating farmers. Different NGOs working for agricultural development can also assist in this regard.

According to the newly formulated Agriculture Extension Policy of the Ministry of Agriculture, the DAE has the mandate to take care of the OFWM issue within its scope, programmes and provision (MOA, 2001). The WMAE Wing of the DAE has already provided extensive training on practical OFWM to the field-level officials, including the Block Supervisors (BS). Demonstrations of OFWM technologies have been arranged across the country at farmers' fields in order to disseminate the technologies. It is envisaged that, in the working area of any PBS, the DAE Officials, primarily the BSs can further popularize the idea of OFWM, in cooperation of the PBS itself. In one hand, the PBS system should encourage its electricity users to become rationale in utilization of scanty resource where OFWM can play a significant role. On the other, the BSs of the DAE should facilitate extension of OFWM in order to ensure long-term sustainability of the agricultural resource base. This may be further facilitated by organizing WUAs through the involvement of the BRDB. In this process, a co-management of both the finite resources may be envisaged which, in the long run, would ensure sustainability of agriculture and food production in the country. The respective roles of DAE and RDA Bogra, as

[13] Union Parishad is the smallest tier of the local Government, where at least one BS of the DAE is deployed by the Ministry of Agriculture to promote sustainable agriculture.

experienced in their respective activities, are presented in Annexes 2 and 3, respectively.

4.6 Water pricing

At present, in fact, there is no direct price for water. Water is still treated as a God gifted natural resource. The cost paid by the consumers is predominantly the costs of lifting and supply only. A large majority of farmers do not have their own lifting device and pay high prices for the supply. This has created a market for water, especially during the peak irrigation period under Rabi season. Moreover, in irrigation practices, there is no provision for pricing against the amount of water use. Thus, there is no tendency among the farmers for economic use of water.

It is argued that, imposition of water pricing could, in one hand discourage farmers to misuse large quantum of water in excess of field capacity and in other hand, could raise awareness regarding the important finite resource. However, for the poverty ridden subsistence farmers, imposition of such a price by any government authority and subsequent collection could not only make rice production a loosing affair, it would also create repercussion which in turn could be politically suicidal. Under the present socio-economic and political context, the concept of water pricing may not be adopted but for future long-term perspectives, the issue can be kept in mind for due consideration in order to ensure judicious and economic use of this valuable and limiting water resource.

4.7 Conclusion

Bangladesh is burdened with high population and low land to man ratio. Attaining food self-sufficiency has already been regarded as a major challenge. With an ever increasing population, it will remain a major challenge in future. Unfortunately, livelihoods of a large majority of the country's population depend directly on crop agriculture. Furthermore, crop production has to contend with degrading land quality, high climate variability and future threats of climate change. In such a backdrop, the energy-water nexus will only add to the complex conditions in which agricultural sustainability will largely remain questionable. Therefore, the issue needs to be addressed and an appropriate policy intervention must be devised in order to counteract the nexus. It is also necessary to analyze the potential and drawbacks of the current community institutions that deal with the resources and try to find out mechanisms for an effective involvement of such a people-centric institution dealing with the problem.

Although the community institution in place, the Palli Bidyut Samities (PBSs), are currently dealing with the distribution of electricity at the grassroots, the PBS system does not have capacity to help address conservation and management of water in the context of Integrated water Resources Management (IWRM). Supply of adequate quantity of electricity, especially during the peak irrigation season itself is a major problem for the PBS system at large. Facilitating water management is regarded as an extra burden on the overall management aspects of the PBSs. However, there are other government agencies which have mandate to facilitate water management and integrated rural development. The policy regime also provides a conducive environment to achieve the goals of these agencies. The community organization involving power supply for irrigation, therefore, can be strengthened by the field-level activities and technology dissemination efforts of the other relevant agencies such as the Department of Agriculture Extension and Rural Development Academy. The current focus on the management of only one resource needs to be shifted to a co-management of both the resources, while an integrated programme must be devised to facilitate the process.

Chapter 5 Conclusion: limitations and Potential of CIM in Managing the Energy-Irrigation Nexus

The most important issue that is emerging with respect to role of community institutions in power supply and management in rural regions, is the recognition of the serious discordance between the consumers and utilities. The concept of involving community institutions was born out of this need to mitigate the differences by acting as interface between the utility and consumers. We have seen that the earlier attempts were in the form of cooperatives, where the Cooperative Electricity Supply Societies (CESS) was formed to enhance the reach to the rural consumers and The outcome expected is a solution to overcome the problems, especially related to commercial aspects such as controlling pilferage, regularizing billing and bill collection and improving service delivery.

Apparently, the utilities are seeing the involvement of these as institutional platforms to make forays into the reluctant set of clients, who are causing problems on commercial side and to a little extent on the technical side as well. However, an interest observation from this study is that there is little community in any of these community institution models. There is a small group of enterprising people taking interest in the innovations while other users are mostly detached. Two important roles these institutions however might play are: 1) ensuring social buy-in of the new ideas and providing legitimacy to the people and institutions involved in the process and 2) guarding the farmers from arbitrary behavior of the metering agent and protecting metering agent in turn from farmer non-compliance.

1. Social buy-in also depends more on the improvement in power supply condition (in terms of quality and/or quantity) and active support by utility than the community participation per se. Therefore, this has to be mainly a private initiative actively supported by the utility to be sustainable and quickly replicable on a large scale.

2. For farmers, power sector reform basically means: a) there should be increased hours of supply so that they can pump more water; b) there should be an improvement in quality of supply so that there would be reduction in the frequency of motor burn-outs and c) there should be a transparency in billing and

collection and promptness in upkeep of the distribution system. Whether farmers are willing to pay for all these improvements, and if yes, by how much, remains to be ascertained. In Hoshangabad, there was clear evidence that they were willing to pay. World Bank report on Haryana also suggests the same. Notwithstanding these sporadic cases, the general experience of the utilities suggest that they won't unless either i) a small group of farmers are effectively separated from the larger system and assured of improvements or ii) there is a massive transformation in the overall macro-environment, which seems unlikely in the near future. The free electricity adventurism even for a short while proves to be extremely damaging in long run as it brings about a culture of non-payment. Even if ability to pay is there, willingness (or inclination) to pay is not because getting away with non-payment becomes a social norm and higher payment is not expected to bring about any improvement in supply conditions.

3. The above discussion refers to only the energy side of the nexus. Groundwater is an open access resource. This means that it is perfectly rational behavior for an individual irrigator to go on pumping till his private returns exceed his private costs even if the social costs of pumping become higher than the private returns after a point. The challenge then is to internalize the externalities (social costs) price signals or direct restriction on amount of pumping. Direct volumetric restrictions are difficult to enforce even in a small area having only a few users. No wonder, none of these CIMs are even trying it. This impossibility of enforcement of direct regulation brings e-I nexus into play. Restricted and/or costly power can make access to groundwater costlier thereby indirectly bringing in the desired discipline and control. Conversely cheap and subsidized power supply of good quality can provide easy access to groundwater and hence enhanced livelihood opportunities in Orissa and Bangladesh.

4. Power supply is a monopoly of utilities and it a monopolist can control either the price of the good or the amount he supplies and not the both. In all the four cases studied here, the power price is determined by the regulator or the government and hence given for the community institutions with no control whatsoever. The prices decided are too low to make any difference to quantum or pattern of groundwater use even if collected regularly and promptly. Freedom to these institutions to levy a higher price from their users in-lieu of better supply may be considered. The regulatory board in Madhya Pradesh has made a remarkable move in this direction by offering farmers an option to get double hours of power supply for a 1.5 times higher flat tariff. This seems to be a good start, which should be followed elsewhere also. Now that price of power is exogenously determined, hours of power supply is the variable to be played with. Even that is ordained by the regulators with no leverage to the CIMs. However, the common experience is that rationing rarely becomes effective. Farmers draw much higher units of energy than their entitlement by 1) using phase-splitting capacitors, 2) using oversized pumpsets and 3) even having illegal connections. CIMs can improve the enforcement of rationing. However, hoping to draft in people's participation for this purpose is a pipedream. Supply augmentation is what

farmers want, so, there cannot be a people's institution to enforce just opposite of what they cherish. It will be a people's institution only in name.

5. However, there is another window of opportunity for these CIMs to make an effectives contribution to improving E-I nexus: scientific and responsive power scheduling of power supplies to agriculture. As of now power is supplied to agriculture for a fixed hours of power supply throughout the year irrespective of seasons and requirements. While the water and hence power requirements of agriculture are highly seasonal depending on the cropping pattern and the climatic conditions. In 40-50 days of a year, there is a critical need for irrigation when its marginal value product is also very high while in the rest of the year, the irrigation need is minimal and of limited value. Therefore, there is a need to evolve a supply schedule that responds to the requirement as closely as possible. If followed, such a power supply schedule would increase farmers' convenience, reduce wastage of both power and water and increase their productivities. However, designing such a schedule needs power sector to have a refined understanding of its consumers' needs which at present they lack in. it is here that CIMs with their excellent grassroots understanding can play a role.

6. In summary, CIMs can at best make metering functional, but that will not help the cause of groundwater overexploitation unless the power tariffs are very high. They may also help to improve the power supply conditions at the local level, but whether that would save water is doubtful. It may actually lead to increased usage of groundwater with increased production, which is desirable in situations like that of Orissa and Bangladesh but not in AP and MP where the need is to bring down the absolute use of groundwater. Also in most cases studied here, there are macro-level constraints to improving even the power supply condition specially the hours of supply. Rationing, essential for saving both power and water, is against what farmers want. Therefore, getting people to participate for making it successful is impossible in a meaningful way. Designing a scientific supply schedule and enforcing it successfully is where they can contribute.

In conclusion it can be said that all these models studied here and even others that one commonly hears of are initiatives from power sector for its own welfare. Irrigators are treated as a costly and powerful nuisance and not as consumers with genuine needs in the whole reform process. These community institution initiatives can bring in this perspective, which will be mutually beneficial.

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