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Management of Community-Based Energy Interventions in Rural Areas of India: Issues and Perspectives

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ABSTRACT

Development priorities of communities are seldom considered and local stakeholders are often not engaged in planning and implementation programmes for improving quality of life. Energy interventions, particularly, face an up-hill task in this regard because of the sheer absence of effort to link energy concerns with other developmental priorities of communities. Organizing the community around a particular issue is a highly complicated task, largely because of issues such as 'ownership' of asset(s) and equity in cost and benefit sharing.

The paper brings forth the critical factors that may determine the success or failure of community-level energy interventions through a social analysis of three village-level experiences of installing solar photovoltaic pumps for domestic use in northern India. The lessons derived hold particular relevance within the current policy framework, in which technology alone is not sustainable unless appropriate investments in building human and institutional capacity are made. Copyright © 2006 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

OVERARCHING RELIANCE ON BIO-RESOURCES TO BRIDGE THE GAP BETWEEN ENERGY DEMAND AND supply has had a heavy toll on the environment and the well being of the rural populace in India. Despite several efforts (primary government based) to encourage fuel substitution and promotion of renewable energy, rural India still lacks access to commercial fuels, with traditional fuels (fuel wood, animal dung, crop residues, kerosene) dominating its fuel mix. About 78% of the rural populace continues to rely on fuel wood as the primary energy source for cooking (NSSO, 1997). Although 87% of villages have been declared electrified, barely 43% of rural households actually have electricity connections, leaving the un-electrified homes and poor dependent on kerosene for light-

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ing (Census of India, 2001). This is on account of both the inability of households to afford electricity connections and low demand on account of the poor reliability and quality of the existing supply. The net result is that at least 70–80 million rural households still depend on kerosene lamps for meeting a basic need such as lighting (GOI, 2002).

Policy makers and planners have addressed these issues through a host of household and community based energy programmes promoting fuel substitution, energy efficiency and conservation (through renewable sources). Reviewing the efforts made so far through a host of projects/programmes, one finds a trail of a compartmentalized approach. While the successes lie within these compartments, the failures emerge from the inability of these individual successes to make a holistic impact on the energy options for the masses. This is especially true in the case of community-based interventions irrespective of the technology being promoted (solar, biomass based, etc.). There are very few cases of successful community based energy interventions in rural India. These few successful projects normally have had strong institutional support (e.g. government, NGOs). Amongst the most commonly highlighted problems in managing community based energy interventions in rural areas has been the lack of adequate organizational arrangements at the village level to take leadership, and accept responsibility and social inequities, making sharing of benefits difficult in the absence of good leadership (Ravindranath *et al.*, 1992). Hence, ensuring a sound technology or adequate finances for such projects alone is not sufficient to ensure the success of such interventions. The paper looks at some of these issues of community leadership and stakes/ownership in the socio-cultural setting typical of rural areas, which more often than not determine the success of community based technological interventions. The discussion makes particular reference to solar photovoltaic pumping for domestic applications through the analysis of three village-level case studies in northern India.

Current Status of Solar Water Pumping in India

In the early 1980s, a special project was initiated to demonstrate and popularize the SPV (solar photovoltaic) pumping system under the NASPED (National Solar Photovoltaic Energy Demonstration) programme for agriculture and related uses. The programme was coordinated by the DNES (Department of Non- Conventional Energy Sources), which is now the MNES (Ministry of Non-Conventional Energy Sources). The ministry seeks to popularize SPV water-pumping systems by developing the marketing infrastructure and obtaining direct feedback on the performance and utilization of these systems for meeting the specific needs of the users in different agroclimatic conditions. The programme is primarily implemented through the IREDA (Indian Renewable Energy Development Agency) (interest subsidy provided by the MNES) and the state nodal agencies with provision of subsidy and soft loan (5% per annum to users, 2.5% per annum to financial intermediaries). The maximum amount of subsidy is fixed at Rs 250 000 per system. Similarly, the maximum amount of soft loan is limited to 90% of the price of the system after subsidy. The soft loan is allowed to be repaid over a maximum period of 10 years with a one year moratorium. Awareness generation and training (to users, local technicians and mechanics) are integral components of the programme.

The programme covers all categories of users and water-pumping systems in the range of 200–3000 watts of PV array capacity. A cumulative total of 4208 SPV water-pumping systems were installed by 31 December 2001. The majority of the systems are being used for agriculture and horticulture. In terms of performance, 76% of the solar pumps surveyed in a recent study were found to be functional (including those installed during the period 1994–96) and about 81% of the users were found to be satisfied with the performance (MNES, 2000).

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The coverage of the pumping programme, however, is limited. In terms of the sector-wise use of PV modules, the pumping systems comprised 5.5% of the aggregate capacity (MNES, 2000). Therefore, only a fraction of rural India's irrigation or household needs is being met with solar pumping systems – a few of which cater to drinking water needs.

There is also limited experience and information available on use of such systems in a rural community setting. Such information would be beneficial for future rural energy programme planning and implementation. These lessons also hold particular relevance within the current policy context in which the technology push is not accompanied by making appropriate investments in building capacities of communities. Implementing successful decentralized drinking water schemes also requires considerable investments in building and strengthening local institutions, which are, as of now, missing from the national programme.

Community-Based SPV Water Schemes: Grassroots Experiences

Technology has always remained central to rural energy programmes in India. However, a people-centric approach becomes vital, especially where these technologies are meant to transform lives of rural people. The importance of assessing people's needs, making them aware of the options, enabling them to make informed decisions related to energy choices and a user contribution cannot be over-stressed for inculcating a feeling of asset ownership and a sense of belongingness to a programme. In this regard, socio-economic and political factors assume significance, especially in a rural setting. A study of such factors and assessment of their impact on the progress of the project/programme, as well as setting in place mechanisms for people's participation in interventions aimed at benefiting them, are essential ingredients to sustaining energy based interventions. The village-level development work of TERI (The Energy and Resources Institute), New Delhi, with respect to promotion of renewable energy to meet some of the basic subsistence and livelihood needs of rural communities, highlights the role and importance of socio-economic and cultural factors in planning and implementation of such interventions. The following sections describe the key factors necessary for successful implementation of community-based energy interventions through the social analysis of three village-level experiences with respect to PV based water-raising schemes. The lessons put forth are of immense value to governments, extension workers and other stakeholders in planning and managing community based decentralized energy interventions.

Committed Local Leadership

The commitment of local leaders to a project goes a long way in determining its timely and successful completion, and ensures its long-term success. More importantly, an accountable and transparent leadership ensures optimal utilization of the facility and an equitable distribution of benefits.

Under a specific project executed by TERI, a drinking water scheme was planned for the Lakhnipur hamlet of Lakhnipur village[1] in the year 1998/99 (TERI, 1997). A critical need for reliable potable water

[1] Lakhnipur village is located in the state of Uttar Pradesh in Jagdishpur block, Sultanpur district. The village is divided into four hamlets: Baj ka Purwa, Lakhnipur, Mathiya and Bhagu ka Purwa. The PV based drinking water scheme was designed for the households of hamlet *Lakhnipur*. The hamlet comprises 94 households and two dominant Hindu castes: the *Mauryas* and the *Harijans*. While the former are considered a higher caste group, the *Harijans* belong to the weaker section, and therefore often suffer from social exclusion and discrimination on many aspects, including access to resources. The main occupation of the locals is agriculture, while the *Harijans* primarily work as agricultural labourers, with an average daily wage of Rs 12–20.

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was expressed[2]. The village *sarpanch*[3] prioritized the Lakhnipur hamlet, after consultations through community-level meetings. The interesting feature was that Lakhnipur hamlet is dominated by Hindus, while the village leadership (that is, the *sarpanch*) belongs to the Muslim community. This decision of the *sarpanch* to select a Hindu dominated hamlet can also be seen as a political decision, which is also linked to the needs of the most vulnerable group in the community, the *Harijans*. Accordingly, a request to install an SPV based water-raising system[4] was submitted to TERI by the village *sarpanch*. This of course took time and the decision was reached only after having exhaustive discussions with the community under the leadership of the *sarpanch*. The entire civil works and installation was completed in two months, including designing and putting in place mechanisms for the operation of the facility and duties and responsibilities of the various stakeholders.

Providing Information and Options

In order to enable the local leadership and the community to make a choice, provision of requisite information to the community on the merits and de-merits of several options (both conventional and non-conventional energy) is critical. For example, in Garhi Natthe Khan village[5] (Malhotra *et al.*, 1998), after a careful assessment of the water supply system and the requirements of the village, the *panchayat*[6] was familiarized with the options available. A village meeting was organized to discuss the future course of action. It was decided that TERI would provide the villagers with information on all possible water-raising mechanisms available and an appropriate selection could then be done. Accordingly, the options of both conventional and non-conventional energy sources to raise water were explored in terms of investment requirements, running costs, available finances from the government/other sources, the *panchayat*'s role in implementation and cost-sharing. Also, the possible sites for installing the system were identified. The people were told about the capital costs; the water distribution costs, which included piping cost, storage and miscellaneous expenses for each site; and the technological options. They were also informed about the benefits and limitations of each technology and site.

Because of the high recurring cost involved in other options, the *panchayat* decided to explore the possibility of installing a solar pump on a community well and asked TERI to make available to them more information on the same. Options such as electric pump sets were ruled out because of the unreliable and irregular power supply. Accordingly, information on system sizes, costs offered by different manufacturers, government subsidies available and various financing mechanisms was collected from several manufacturers and financing agencies. Based on this, details were furnished to the *panchayat* in

[2] As per the initial survey that was carried out in the hamlet, the two prominent sources of water were open wells (15) and hand pumps (19). A majority of the households raised water from open wells. For water raising, the traditional system of a pulley was applied. Initial discussions with villagers on the situation of drinking water in the village showed that the existing sources were insufficient to meet the needs of both humans and animals.

[3] The elected village head man.

[4] The SPV pump was installed in a shade free area of $15 \times 15\,m^2$. The water table at the site was at a depth of 12 ft, which went further down by 6–8 ft during peak summer months. The features of the SPV based water-raising pumping system were (i) suction head 7.5 metres, (ii) total dynamic head 10–12 metres, (iii) capacity of the pump 1.2 hp, (iv) type of the pump DC centrifugal surface mounted (Kirloskar Company), (v) operating voltage 60 V DC, (vi) SPV wattage 900 Wp, (vii) discharge (10 metres head) 60 000–75 000 litres per day.

[5] Gari Natthe Khan is located in Farrukh Nagar block, Gurgaon district, Haryana. It is approximately 65 km from Delhi, and 25 km from Gurgaon city. The village layout is such that a cluster of about 50 houses in the centre forms the main settlement. This is surrounded at the periphery by another 55 houses, within a radius of 1.5 km, which are locally known as *dhanis*. The total human and livestock population in the village in 1995 was 730 and 232, respectively. The people living in the village belong to several caste groups such as *Khatri*, *Ahir*, *Harijan* and *Yadav*. Broadly, the village community comprises the *Harijans* or the SC (scheduled castes) and the general or non-SC (non-scheduled castes). There is a local school in the village, up to the fifth standard. The nearest medical help is available at the block, about 7–8 km from the village. A majority of the villagers are engaged in agriculture but some also work as daily labourers while a few are in service. Nearly the entire village population consists of landowners having, on average, 1–2 acres of land. However, there are a few landless families who either work as agricultural labourers or take land on lease for farming. The major crops grown are wheat, mustard, millet and pulses.

[6] Village elected body.

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the form of a proposal, which was again discussed with the villagers. Some of the *panchayat* members were also taken to Dhanawas village[7] for exposure.

Comparative Advantage

Besides addressing a felt need, the alternative being offered should also have a distinct comparative advantage over the existing options available to the community. For example, about 70 families in Dhanawas village are currently using the facility of the solar photovoltaic pump[8] for fulfilling their needs for drinking and cooking. Thirty families also use it for feeding and bathing their cattle (Pal *et al.*, 1998). The villagers are satisfied with the performance of the system. According to them, the main advantage of the SPV system compared to piped water supply is the flexibility it offers in terms of time of usage. Unlike the PHD (Public Health Department) supply, which is time bound, the water supply from the SPV system is uninterrupted and continuous. Also, the PV supply is more reliable and does not rely on electricity supply, which is mostly erratic and of poor quality (of low voltage).

Ownership of the Asset

In all the villages, emphasis was on common ownership of the asset, including the land on which the PV pump was installed. For example, in Lakhnipur, the land on which the pump was installed was owned by the *panchayat* and hence was common property of the village. Regarding the ownership of the SPV pump, the purchase agreement included a lease arrangement for a period of 10 years during which the ownership of the system was to remain with the financing company. This arrangement is in accordance with the 100% depreciation scheme of the Indian Renewable Energy Development Agency (IREDA), Government of India.

Developing Joint Criteria

Any decision for a community-based system needs to be taken jointly; criteria need to be arrived at and finalized, and options weighed. For example, in Dhanawas village, the selection of the site for installation took a number of village-level meetings to resolve. The major factors considered were the following.

- *Type of source*. The site had an open well, which was utilized for installing the submersible pump.
- *Accessibility*. It was ensured that the maximum number of people is able to make use of the facility. Care was taken that the worst affected, that is the *Harijans*, are also able to use the facility.
- *Land ownership*. It was decided that the pump would be installed on community-owned land. This was to rule out the possibility of any dispute that may arise at a later point in time with respect to ownership of the pump.

[7] Dhanawas is about 7 km from Farrukh Nagar town, the block head quarters, Gurgaon district in the state of Haryana; and about 45 km from Delhi. Agriculture is the primary occupation, while some people are in government service in nearby towns. The primary crops grown in the village are wheat, mustard, sorghum and bajra. In terms of basic infrastructure, while TERI was working in the village, it only had a primary school and was connected to the main road. The village was also electrified. The villagers of Dhanawas are divided into clans, which were locally called '*pattis*' (these were *Ranjit*, *Khora*, *Naga* and *Bhagat*). *Pattis* are based on family lineage – each *patti* comprises several families bound by common ancestry. Besides these four *pattis*, the village also had some representation from other communities such as *harijans* and other backward classes.

[8] A submersible pump of 1.5 hp capacity was installed. The site already had an open well (6.5 m deep, 1.35 m in diameter) on which the pump was installed. A storage tank of 5000 litres capacity was kept 5 m above ground level. The delivery head was more than 22 m. The discharge rate was 75 litres per minute for a sunny day. The discharge pipe was connected to the pipeline, which was laid by the PHD in the village, so that all the households in the village could benefit.

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- *Adequate space*. The site was to have adequate space to install a storage tank, solar panels and a junction box.
- *Adequate insulation*. The site also had to be where there was adequate insulation.

People's Stake: Cost Contributions

In community-based interventions, it is important to have a community's monetary stake as in the extension of the services from the facility provided. In Dhanawas village, after about six months of operation of the SPV pump, the families living at a distance from the pump site started requesting that this water be piped to a few other sites within the village from where other households could conveniently fetch water. The need for increasing the storage capacity was also heightened by the fact that the water being pumped was far in excess of the current storage capacity of 5000 litres. The matter was discussed at length in several village meetings and within the Village Energy Development Committee (VEDC).[9] While everyone agreed that this would increase the utility of the pump manifold, the main problem that was being faced in this regard was one of availability of funds. The *panchayat* did not have enough funds to pay for the decentralized piping and distribution system, which was expected to be in the range of Rs 2 lakhs. In the absence of any other source of funds, it was decided that the user households who availed of this facility would make contributions towards the initial investment.

The work on this system was commenced, and a tank with three taps was put up for a cluster of 12 households. Household contributions of Rs 8000 per household were collected for this purpose. The money collected was used in installing the tank and associated civil works. The cluster of user households also formulated a set of rules and regulations for the use of the facility. Water was to be used strictly for drinking and other domestic purposes. No washing or bathing was allowed at the tank site. Cattle were not to be brought to the tank site. As the system was decentralized and made modular in nature, it was decided that the distribution pipes would be extended and additional tanks would be constructed as and when other clusters of households were in a position to mobilize money.

Hence, at times, an indirect factor, such as prestige, can be introduced in a project. This can work especially where the cost of the intervention is to be borne by those who will not directly benefit from the project. For the installation of an SPV water pump (community use) in Garhi Natthe Khan, the problem of drinking water insufficiency was being faced by a cluster of 55–60 households. They were, however, not in a position to make a cash contribution. On the other hand, those households that were relatively well off were not in need of drinking water, being located in the fields where the groundwater situation was much better. However, when it was suggested that the names of the contributors and the amount contributed would be inscribed on a stone plaque at the installation site, the suggestion was welcomed by many.

Problem Analysis

A detailed analysis of the problem involves establishing a cause–effect relationship. Such an exercise ensures that all the facets of the problem have been factored in for designing the intervention. Problem analysis in the case of a community-based intervention also serves as a useful input to stakeholder analysis. Garhi Natthe Khan village had been central to TERI's research, from 1995 to 1997, on developing

[9] The VEDC (Village Energy Development Committee) was formed in Dhanawas village as a formal body that would participate in the planning and implementation of energy-related activities and manage them. The committee was formed with the written approval of the village *panchayat*. It consisted of five members, including the *sarpanch*, one member from the weaker section (the *harijans*) and one member from amongst the elderly in the village.

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a participatory framework that would be sensitive to the role of women in rural energy. As part of the need assessment exercise, the villagers, especially the women, prioritized the need for a reliable supply of water for drinking purposes. A sample survey was carried out to determine the present consumption and future requirements of water. Field visits were made to the present sources of water, including the piped water supply station, to assess the gravity of the situation. The *panchayat*, particularly the *sarpanch*, was actively involved in the above exercise. Local help was also taken to carry out the field survey. The analysis showed that most of the groundwater in the village was saline and hence not potable. There were some pockets near the village that had potable water. These, however, were privately owned. The villagers were receiving piped water from a supply station (2.5 km from Garhi Natthe Khan village). However, due to irregular supply of electricity, the water supply was grossly inadequate and unreliable. The village only received water for about three hours each day on average, which met less than 20% of the total domestic water requirements of the village. The 10 hp pump installed at the supply station was supplying water to nine villages including Garhi Natthe Khan. The villagers received water only twice a week, on average.[10] Sometimes there would be no water for days together and the women would have to carry pots of water from long distances. The alternate sources of water included a hand pump (the women were able to fetch only one container a day, approximately 20 litres, which was not sufficient even for drinking purposes), open wells (the saline water was unfit for both human and livestock consumption), and private tube wells (the tube wells were located in the fields and were thus too far to fetch water). Only households located in the fields used private tube wells for drinking purposes.

Accordingly, a problem tree (Figure 1) was drawn to determine the cause–effect relationship and to determine the areas of interventions. Various PRA (participatory rural appraisal) tools were used to draw the problem tree, such as resource mapping, matrix scoring, focused group discussion and transects. The problem tree was finalized and approved by the community.

Stakeholder Analysis

Analysis of stakeholders and their stakes is very crucial for community-based interventions, especially those addressing basic needs of the community. The main factor considered for site identification in Garhi Natthe Khan village was the ownership of the land on which the source was located. It was unanimously agreed that the source should be a CPR (common property resource) and in no case should it be private property. The following analysis was performed for the site that was finally selected. The site was within the complex of the village temple. It was assessed that if the pump were installed at the temple site, it would serve the following purposes: (1) people, out of religious sentiments, would agree to donate money for site preparation;[11] (2) it is the *panchayat* land, therefore village property and (3) it has potable water. It was further analysed that if the boring were done to about 35 feet, supplies could be ensured for 6 hours/day. On the other hand, if the boring were done to about 120 feet, supplies could be ensured for 24 hours.

Following these discussions, the TERI team carried out a site and stakeholder analysis exercise. The results of this exercise are given in Tables 1 and 2 (Malhotra *et al.*, 1998).

From the analysis presented in Tables 1 and 2, it became evident that if the pump were installed at the site of the temple, funds for the intervention would come easily. As this site was of religious impor-

[10] Data maintained at the pumping station showed that for the month of May 1995, the total operating time of the pumps was around 82 hours in the first 26 days of the month. This indicated an average running time of only 3.16 hours per day.

[11] This was especially relevant as only 55–60 households located in the village faced water shortages, and it was not a problem for the people living in the fields. It was the latter group that had contributed money on religious grounds in the past.

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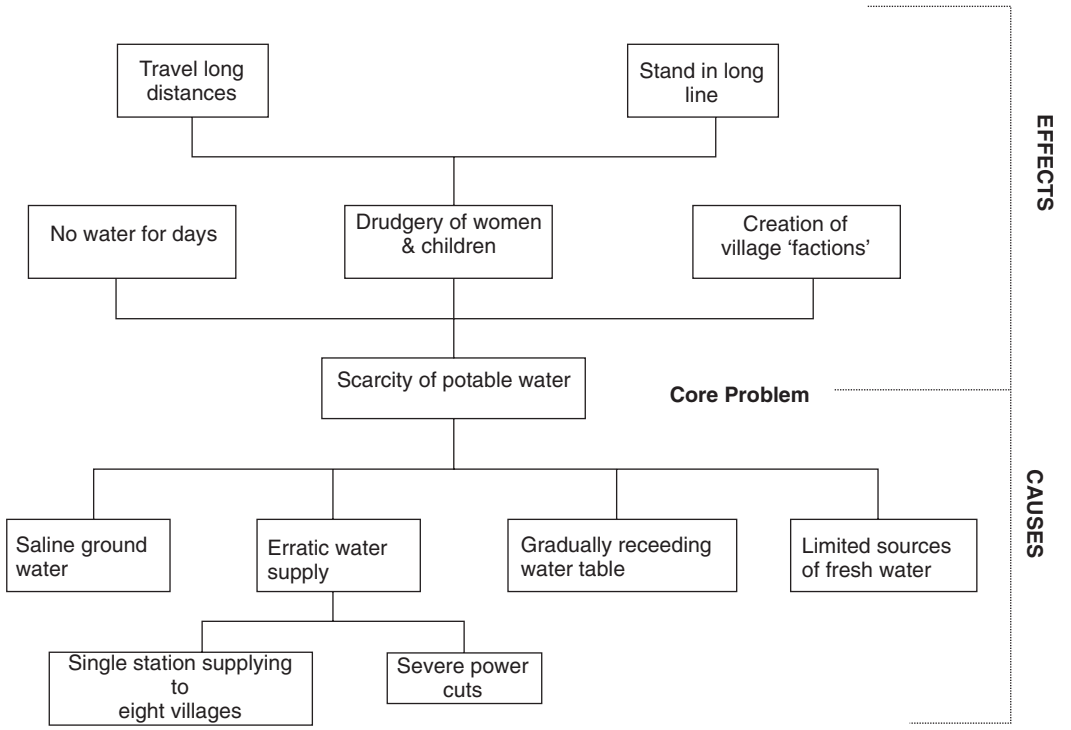

Source: Malhotra *et al.*, 1998.

Figure 1. Problem analysis: cause effect relationship

Ownership	*Panchayat*
Area	2 acres (approximately)
Location	At the temple (central point in the village)
Water depth	35 feet
Present use	A water trough at the site, which is occasionally used for drinking water for cattle
Other features	A cement storage tank is located at the site; the money for the tank was raised from the *panchayat*, individual donations and household contributions. Not in use due to leakage.
Advantages of installing SPV pump at the site	Security of the pump and panel (by temple authorities) Common property/ownership Easy access Easy fund raising (from villagers) Monetary contribution from the temple

Table 1. Site analysis for SPV pump, Garhi Natthe Khan village

tance, the security of the pump would also be taken care of. However, doing so might give more control to the temple priest in the distribution of water. Based on this analysis, the TERI team chalked out the following strategy: (1) check the potability of water at the site; (2) confirm the depth of ground water and (3) assess the approachability of the villagers (all socio-economic groups) to the site. It was decided that this would be done by (1) gathering the views of the villagers regarding the suitability of the site, potability of water and its depth and (2) confirming the suitability of the site from the local bore well digger.

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Stakeholders	Stakes	Benefits	Check-points for TERI team
Priest	Prestige (glorification)	Assurance of • monetary contribution from temple, • individual donations from villagers and • fixed monetary contribution from households	Equity in access and distribution of water
Villagers living in fields	Prestige	• Individual donations	–
Villagers living in the main village	Basic need	• Fixed monetary contribution	–
Sarpanch	Political mileage	• Access to *panchayat* funds	Group glorification (*sarpanch* and his in-group)

Table 2. Stakeholder analysis: SPV pump installation in Garhi Natthe Khan

Discussions with the villagers, however, revealed that the site does not have potable water. The local bore well digger also confirmed this. Hence, it was safely concluded that a particular influential group (the temple authorities) were trying to usurp the benefits (ownership of asset). This was discussed in a village-level meeting and was clarified. The site and stakeholder analysis in this case, therefore, helped the project team and the community to take appropriate decisions.

Accordingly, a new site was identified along with an independent group nominated by the community, which included some *panchayat* members. The new site identified, however, was a private property. Dialogue with the landowner was initiated, who after several deliberations agreed to give the land on lease to the community for an initial period of ten years.

Analysing this village experience, groupism (existence of in- and out-groups) is a common hindrance to implementation of community projects in heterogeneous communities. Groupism in Garhi Natthe Khan village was strongly reflected when the question of making personal investments for community benefit arose. Other situations where the group behaviour clearly surfaced was while assigning credit for the work accomplished, distribution of benefits, prestige and ownership.

Accordingly, the major blocks faced in the implementation of the designed scheme in Garhi Natthe Khan were as follows.

1. Lack of cohesive action on the part of village *panchayat*, with each member trying to derive benefits for individuals belonging to their in-group or for themselves. These benefits were both monetary and prestige or ownership based.
2. Refusal to make personal investments that did not benefit their in-group directly.

These benefits and the actors involved have been summarized in Table 3. Thus, while the cost bearer was a particular group/individual, the beneficiary was perceived to be from the opposition or out-group. In this case, the groups or factions were politically determined. These results were shared and discussed with the community.

Local Management

Local management of community-based energy interventions is vital for the sustenance of these interventions, especially at the post-installation stage. A study carried out by the Administrative Staff College of India, Hyderabad, revealed that 34% of the installed solar pumps were not functioning due to lack of

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Nature of benefits	Beneficiary	Cost bearer	Explanation
Monetary	Group and community	Individuals and community	Drinking water was a problem of only a cluster of 55–60 households in the village, mainly belonging to the *Harijan* community. So, the rest of the households were not willing to make contributions or allow the use of *panchayat* funds for 'group benefit'.
Ownership	Individual	Individuals and community	The ownership of the system was strongly seen as that of the owner of the land where the pump would be installed.
Prestige	Individual and group	Community	Installation of the pump was seen as the personal achievement of the S*arpanch* and his supporters.

Table 3. The beneficiaries and the cost bearer: installation of SPV water pump in Garhi Natthe Khan

maintenance, non-availability of spare parts and lack of awareness of technology among the users (MNES, 1996). Accordingly, in Dhanawas, a local person was trained for the operation and servicing of the pipeline, taps, etc (Malhotra *et al*., 2000). Information regarding whom to contact for repair of the pump was provided to the *panchayat*. An AMC (annual maintenance contract) was signed with a local technician in this regard. The expertise of the technician was assessed by TERI. The technician was paid for his services through contributions from user households. The technical expertise (monitoring) was provided by TERI for a specified time period.

Clear Definition of Roles and Responsibilities

Division and clarity in roles and responsibilities of various stakeholders is important for managing community-based interventions. This needs to be done at the planning stage itself and capacities need to be enhanced accordingly.

TERI's role in the management of the water distribution system in Dhanawas decreased gradually. While the initial discussions on setting up such a distribution system were facilitated by TERI, the responsibilities of collection of contributions, drawing up of rules and regulations, and regular maintenance and upkeep of the system were decided and executed with the villagers. The panchayat and the VEDC (Village Energy Development Committee) took up the following responsibilities:

- maintenance of the pump and the distribution pipeline;
- resolving of conflicts and problems arising in the distribution of water and
- carrying out of repair works.

Planning for Future Needs

Planning for future needs/growth in demand contributes significantly to the sustainability of a community-based energy intervention. Seeing the growing usage of the pump water, some experiments in Dhanawas were done by TERI in 1996 (the SPV pump was installed in early 1995) to see whether the existing capacity would suffice for the coming summer months. The data collected indicated that the output in summer would be about 4500 litres per hour and 40 500 litres per day (assuming 9 hours of sunshine). In winters, it was expected to reduce to about 25 000 litres per day and 32 000 litres per day during monsoons (again on a sunny day). However, this was not assessed to pose a major problem because the consumption of water would also decrease substantially during these months.

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The people of Lakhnipur village wanted to develop a water source, as there was an acute shortage of potable water in the village. Moreover, they were keen on experimenting with a new technology, which they felt would be more reliable than the erratic piped water supply dependent on grid electricity. The people not only donated labour for installation works, but also provided financial support for construction. Though an engineer from the system supplier guided the installations; the villagers prepared the site, dug the bore well and installed the pump. They also constructed the storage tank, water trough, bathing area and boundary wall. The village *sarpanch* played an active role in supervising the project and provided money for the construction works from the *panchayat* funds. The pump and the facilities were arranged to be the common property of the village, supervised by the *panchayat*. In this regard, the village *panchayat* was responsible for ensuring (Shukla *et al*., 1999)

- proper operation of the system;
- management of fund in case of repairs;
- security of the system;
- no misuse of the facilities.

For routine operations and maintenance, a local person was deputed by the village *panchayat*. This individual was trained in carrying out minor repairs, that is, oiling the motor, replacing carbon brushes, cleaning the modules and adjusting their orientation etc. The trained person was also provided with some spare parts. The pump has been running now for four years, without any major faults reported or breakdown of the management systems put in place.

Box 1. Lakhnipur: combination of committed leadership, community participation and clarity of roles and responsibilities for collective action

In Garhi Natthe Khan village, for mobilization of financial resources, the following options were considered.

- *Joint contribution* – the *panchayat* pays a significant portion of the amount. The remaining sum comes in the form of household contributions.
- *Billing system* – a particular household pays the entire amount and individual households pay a fixed monthly charge for the water used.
- *Voluntary contribution* – the panchayat pays a portion of the cash-down payment and well-off families contribute the rest. Names of people who contribute towards this worthy cause are inscribed on a plaque near the pump.

It was, therefore, decided that depending on the payment option the ownership of the system would be determined. If the contribution were to be joint or voluntary, the system would be in the name of the village *panchayat*. Otherwise, it would be in the name of the individual household.

Box 2. Garhi Natthe Khan: financial decisions determining ownership status

Interlinking Factors

Many of the factors described above are interlinked, and accordingly, affect the outcome of the community project. In this regard, two examples are discussed. The first is from Lakhnipur village, where both committed leadership and addressing a felt need contributed to the success of the project (Box 1). The other example is from Garhi Natthe Khan village, where the outcomes of one factor greatly influenced the determination of ownership status (Box 2).

Conclusion

Comparing the three case studies, it can be concluded that successful community-based energy interventions need to (1) be based on an existing felt need, (2) secure adequate financial resources, (3) involve

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	GNK* water pump	Dhanawas water pump	Lakhnipur water pump
Conditions	Existing felt need	Existing felt need	Existing felt need
Villagers' contribution	Land, labour (proposed)	Land, labour	Land, labour, money
Agency's contribution	Finance, technical support (proposed)	Finance, technical support	Finance, technical support
Leadership	Lack of strong village leadership	Strong village leadership	Strong village leadership
Agency's presence	TERI's presence throughout	TERI's presence throughout	TERI's presence only for installation
Outcome	Pump not installed TERI withdraws	Pump installed TERI presence throughout	Pump installed TERI presence is nil

Table 4. Factors influencing success of community-based energy interventions: a village-level comparison
*Garhi Natthe Khan village.

a strong and committed local leadership and (4) make use of institutional back-up support. Table 4 summarizes the influential factors that determine the success of community-based interventions. In Dhanawas village, the scarcity of water for drinking was a problem expressed by the villagers. The need being there, TERI staff assessed the extent of the problem. The water pump was funded by an external agency. The villagers and the *panchayat*, on their part, contributed only labour, and no money. A common point, the *Harijan chaupal*, was selected for installation through discussions with the VEDC (Village Energy Development Committee) and the pump was installed. TERI bore the expenses of bore well digging and other civil works. The pump was installed under constant supervision of TERI. The village *sarpanch* showed keen enthusiasm in the project.

In Garhi Natthe Khan village, the scarcity of potable water was a need that was reiterated by the *panchayat* and the villagers. Possible water-raising options were henceforth explored by TERI at the behest of the *panchayat*. The financial resources for the pump were arranged by TERI and discussions were carried out with the *panchayat* on possible sites for the installation. The inability of the *sarpanch* to coordinate amongst the various groups in the village and his personal interest in wanting the plant to be installed on his land led to scrapping of the project.

In Lakhnipur village, where drinking water shortages were severe, TERI was approached by the village *panchayat* to mitigate the problem. With the full support of the village *panchayat* and the cooperation of the villagers, an SPV pump was installed in the village. While the expenses for the system cost were arranged through external funding sources, all costs for labour and civil works were borne by the village *panchayat*.

The experience in Dhanawas village shows that where people have no monetary stake in the intervention, sustaining the intervention becomes more a responsibility of the intervening external agency than the people benefiting from the intervention. In the case of Garhi Natthe Khan village, despite the existence of a felt need, lack of a strong village leadership was the main barrier. The conflicting interests of different stakeholders including the *sarpanch*, and the inability of the *sarpanch* to coordinate between these different groups, led to the scrapping of the project. In Lakhnipur village, the intervention was successful in all respects. The main factor that led to the designing and implementation of a successful intervention in Lakhnipur was the presence of a strong and committed leadership and the wholehearted cooperation of the villagers. The village *sarpanch* had the necessary skills of group coordination, fair benefit sharing, and protection of interests of all stakeholders.

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In all cases, a felt need among the villagers was the common feature. However, the experience in Garhi Natthe Khan village shows that this is not a sufficient factor for ensuring participation of people and successful implementation of an intervention. A strong village leadership with committed support for the activity is as important. This is further corroborated by the experience in Lakhnipur village, where both problem recognition and a supportive village *panchayat* led by a committed leader resulted in a successful intervention.

Another important lesson is that introducing a stake for people in the intervention can ensure increased participation. The most effective way is to include a monetary stake of the village institution or households or individuals benefiting from the intervention, as was done in Lakhnipur village. As of now, the system is maintained by a local youth, while the village *panchayat* is responsible for all repairs and other management problems, which may arise from time to time. It has thus been possible to leave the operation and maintenance of the system in the hands of the people.

From a policy perspective, it is important that, while the capital expenditure for such community-based systems needs to be met from outside (through government funding or others), the recurring expenses should be managed from the revenue generated at the local level. It is in this respect that NGOs (non-governmental organizations) and CBOs (community-based organizations), including the *panchayats*, can play a proactive role. These institutions can create the right social conditions for such interventions to be successful. In this regard, building social infrastructure should be an integral part of energy programmes. This needs to include elements such as awareness generation, skill development (technical, administrative), networking and leadership training.

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