Providing electricity to remote villages

Implementation models for sustainable electrification of India's rural poor

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Abstract

The Ministry of Non-conventional Energy Sources (MNES) aim to provide electricity to 25,000 remote un-electrified villages in India through renewable energy sources and distributed generation adopts the key policy instrument of capital subsidies and capacity building of local organizations. National and international experience shows, however, that this model would not suffice to make the electrification programme succeed in the long run. This study aims to evolve implementation models that would lead to sustainability. It was assumed that MNES in its policy aims wants to reach the poorest of the poor in the Indian villages, so the tribal villages were the aim of the study.

The implementation model that the Government of India currently aims to use for electrifying its remote villages with renewable electricity is inappropriate for a large number of the target villages. The planned uniform policy of capital subsidies of 90 to even 100% will over-subsidise many and under-subsidise the most needy. This conclusion stands out after a detailed survey in a number of poor and remote tribal villages in Orissa, and consultation of a number of stakeholders.

Implementation models should be more tailor-made in order to actually bridge the gap between costs and willingness to pay and to facilitate the reduction of the gap itself over time. The proposed implementation models recognize that providing electricity to remote villages is significantly more expensive than providing electricity to urban areas and grid-connected villages. Three types of implementation models for three types of villages, varying in economic situation, on which the policy should be tailored, were distinguished:

I. Villages with middle income families where ability to pay exists or will get built up with just the provision of electricity. The private sector would make investments into village electrification projects with government providing tariff assurance that will diminish over time and eventually stop.

II. Villages with low-income families where potential for increasing economic activity is very clear and can be realized with provision of electricity and business development services. The government would provide capital subsidies and diminishing revenue subsidies for a limited period of time. Private sector will take up responsibility for operation and maintenance and provide business development services for increasing economic activity including making crucial investments.

III. Villages with low-income families where potential for increasing economic activity is unclear. Thus, electricity has to be provided to improve the quality of life and more work has to be done to develop the potential for increasing economic activity. The government would provide capital subsidies and revenue subsidies for extended periods. It is hoped that the presence of private sector in the village will lead to development of potential for increasing economic activities. Subsidies could be reduced/terminated eventually.

The models above provide for a more balanced approach to the enormous diversity in villages and income levels in the portfolio of villages in the Indian village electrification programme. The challenges posed by ownership, affordability and post-commissioning provisions are addressed in a better way. The results of this study will be discussed with the relevant policymakers in the Government of India.

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Summary

The Ministry of Non-conventional Energy Sources (MNES) aims at electrifying around 25,000 remote un-electrified villages in India through renewable energy sources and distributed generation. This aim is part of Government of India's resolve to provide 'electricity for all'. As per the new government's National Common Minimum Programme (NCMP), access to electricity to all households is to be provided by year 2009. The key policy instrument that MNES is adopting to attain this goal is to provide capital subsidies and to facilitate formation and capacity building of local organizations to own and operate the projects on a sustainable basis. National and international experience shows, however, that the model of capital subsidies combined with initial capacity building of user communities or other village level institutions would not suffice to make the electrification programme succeed.

It is in this context that this study was taken up by ECN and TERI with funding support from Royal Netherlands Embassy and co-funding from ECN to examine issues related to sustainability through field study in select geographical areas and to evolve implementation models that would lead to sustainability. It was assumed that MNES in its policy aims wants to reach the poorest of the poor in the Indian villages, to which most of the tribal villages - the villages that were studied - belong.

The implementation model that the Government of India currently aims to use for electrifying its remote villages with renewable electricity is inappropriate for a large number of the target villages. The planned uniform policy of capital subsidies of 90 to even 100% will over-subsidise many and under-subsidise the most needy. This conclusion stands out after the project team of ECN and TERI examined international experience, did a detailed survey in a number of poor and remote tribal villages in Orissa, and consulted a number of stakeholders.

The study involved a micro study of a cluster of five villages in the tribal areas of Orissa and select tribal villages in Jharkhand. The area studied is representative of 11,000 unelectrified remote villages in Orissa, Chattisghad and Jharkhand. The villages that are regarded representative for thousands of remote villages in India have as characteristics that their inhabitants have a strong sense of community. The study was carried out through a combination of fieldwork by the project team and two commissioned studies. One of the studies was commissioned to M/s. Read Foundation in Bhubaneswar and the other was commissioned to M/s. Bhartiya Samruddhi Investments and Consulting Services Ltd. (BASICS). Both studies focused on gaining an understanding of the present economic condition of the villagers and the scope for increasing economic activities once electricity becomes available.

The key findings of the studies are:
1. Technically it is possible to set up distributed generation-based village electrification projects in remote villages based on local renewable resources. Out of the five villages studied, three were suitable for biomass-based projects and the other two were suitable for PV-based projects.
2. Average cash income of the villagers was as low as Rs. 3,000 - 5,000 per annum per household. Their willingness to pay for domestic electricity was about Rs. 30 per household per month, which is equivalent to their expenses on kerosene for lighting.
3. The present ability and willingness to pay is inadequate to meet even the operation and maintenance costs except in cases where most of these costs are capitalized and subsidized.
4. Under certain assumptions, it could be possible to facilitate increase of economic activities in these villages to double the cash incomes in about three years time with the provision of electricity.

5. Comparable villages in Jharkhand showed that the scope for increasing income through farm-based economic activity is much higher and can amount up to Rs. 20,000 to 30,000 per annum per household.
6. Provision of electricity only is not adequate and business development services such as marketing linkages, skill up gradation, and micro-finance support would also be required.

In a study for different implementation models in international literature, three main criteria for effective deployment of village electricity provisions were identified:

- Sense of ownership
- Affordability
- Post-commissioning.

These criteria can be in conflict with each other, as e.g. good provisions of post-commissioning would have a negative influence on affordability. Especially in areas with very low cash incomes, affordability is a critical point. Smart planning is required to still enable successful electrification of the villages.

A roundtable on ‘Sustainability of Remote Village Electrification projects’ was held as a side event of Delhi Sustainable Development Summit on 1 February 2005 to discuss these findings. In addition, consultations were also held with stakeholders such as government, private sector and implementing agencies, on alternate implementation models that should be adopted to ensure sustainability. These interactions led to the proposal of several alternative models of implementation.

The implementation models make out a case for bridging the gap between costs and willingness to pay and to facilitate the reduction of the gap itself over time. Three types of ground situations have been anticipated:

IV. Villages with middle income families where ability to pay exists/will get built up with just the provision of electricity. The private sector would make investments into village electrification projects with government providing tariff assurance that will diminish over time and eventually stop.

V. Villages with low-income families where potential for increasing economic activity is very clear and can be realized with provision of electricity and business development services. The government would provide capital subsidies and diminishing revenue subsidies for a limited period of time. Private sector will take up O&M responsibility and provide Business Development Services for increasing economic activity including making crucial investments.

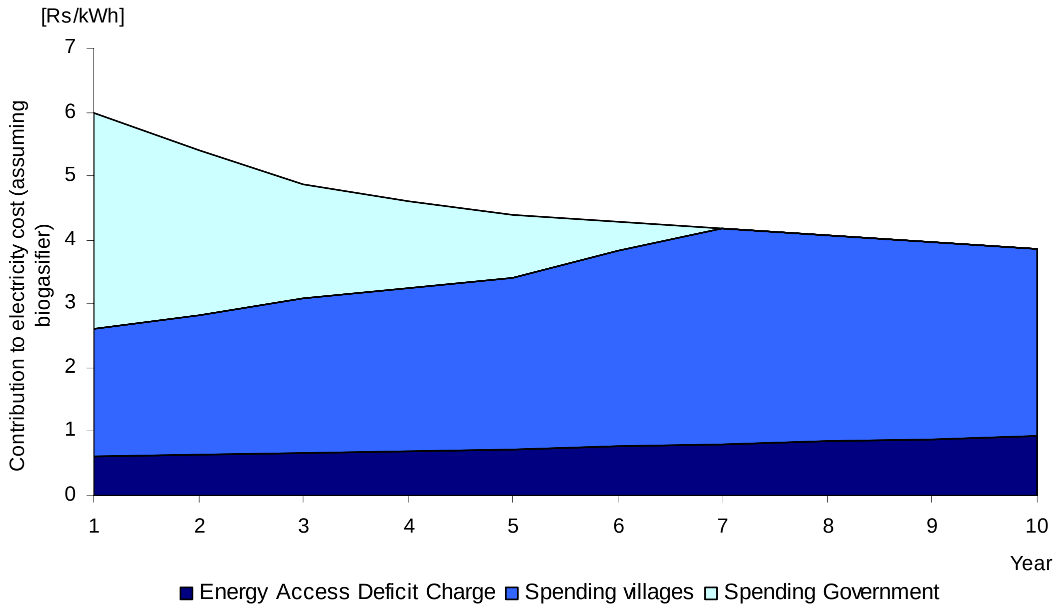
VI. Villages with low-income families where potential for increasing economic activity is unclear. Thus, electricity has to be provided to improve the quality of life and more work has to be done to develop the potential for increasing economic activity. The government would provide capital subsidies and revenue subsidies for extended periods. It is hoped that the presence of private sector in the village will lead to development of potential for increasing economic activities. Subsidies could be reduced/terminated eventually.

The proposed implementation models recognize that the total costs of providing electricity to remote villages are much higher than that of providing electricity to urban areas and grid connected villages. This is primarily because some of the technologies such as solar photovoltaic are expensive and other technologies such as biomass gasification are still under development. Also, the centralised generation and distribution systems have a cost advantage due to historical investments, which are fully depreciated, and because of the preferential treatment they received at the time of making of the investments. Added to this, the limited utilization of the capital infrastructure and manpower and remoteness of the village locations makes the costs of delivered electricity high be it through distributed generation or through grid extension.

The models provide for different types of financial support from the government for each of the different types of villages. Where possible from the village income point of view, the model makes a case for public-private partnerships to facilitate attainment of the target of electrifying 25,000 remote villages by 2007.

The costs for the Government of India are laid out in Figure S.1:

a)



b)

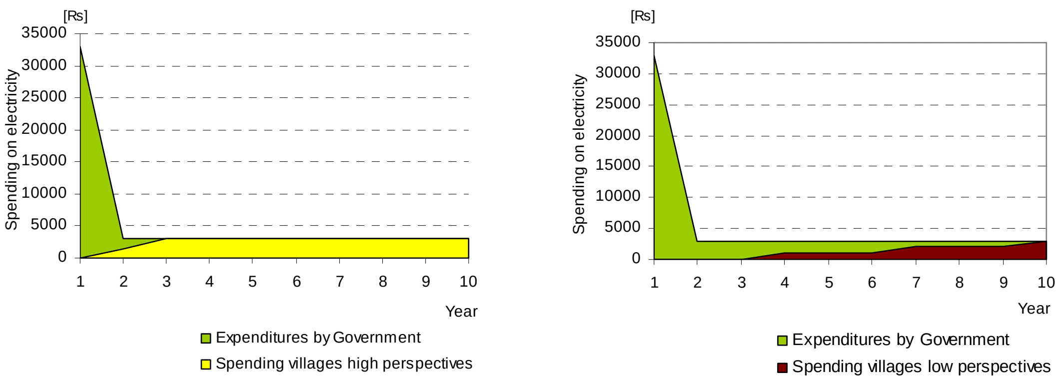


Figure S.1 *Development of electricity cost and spending over the period of a project for different implementation models*

a) *Development of electricity cost and spending over the period of a project. An 'Energy Access Deficit Charge', analogue to the telecom charge that is applied in India, is anticipated to be about 10% of the urban electricity costs. This is used to finance part of the rural electricity provision. The costs of electricity indicated here are general assumptions. The ability to pay increases and leads after several years to the ability to afford the electricity tariffs.*

b) *Two cases of electricity expenditure developments for the Indian Government. The left panel represents highly prospective communities which can generate extra income quickly and can cover the O&M costs themselves within a couple of years; the right panel for low-prospective areas which need support for a longer period of time.*

The cost development marked with (a) provides for a revenue subsidy for the consumers which will however decrease over time (as the cost for electricity will come down due to economies of scale and learning) and as the ability to pay of the villages will go up. The 'Energy access deficit charge' is proposed. It means to charge the urban electricity consumers in order to be able to cross-subsidise the rural consumers, for whom the prices for electricity are higher. The cost development for the government marked with a (b) is for the villages in categories II and III, respectively. In category II, the income will go up rapidly and revenue subsidy can stop within two or three years.

In the situation of category III, this will happen gradually over time, where the villagers should be aware that their initial revenue subsidy will be cancelled over the course of time. The numbers for cost of electricity are approximations based on the experience of the authors. The models above provide for a more balanced approach to the enormous diversity in villages and income levels in the portfolio of villages in the Indian Village Electrification programme. The challenges posed by ownership, affordability and post-commissioning provisions should be addressed as good as possible in this work. The results of this study will be discussed with the relevant policymakers in the Government of India.

1. Introduction

This report focuses on the implementation models for provision of electricity to remote villages through renewable energy. It especially looks at sustainability of the plan of the Government of India, to electrify 25,000 remote villages by means of renewable energy. This section outlines the background for remote village electrification, gives an introduction to the Government of India's plans and discusses the objectives and methodology of the project.

1.1 Recognition of village electrification

It is generally accepted that access to modern energy services is a prerequisite for development (Johannesburg Implementation Plan, 2002). This means that electrification of remote villages, often populated by the poorest people, should be targeted in a progressive manner (Energy for Development, 2004). Rural poverty and lack of access to modern energy currently live in symbiosis. The benefits of providing energy services, notably electricity, are twofold: on the one hand, it alleviates poverty by providing better living conditions, and on the other hand, it allows the initiation of economic activities, for instance in the productive sector or because irrigation becomes possible. There are other benefits in terms of improved indoor air quality, security, and enabling of education in the evenings (Chaurey et al., 2005).

Electrification, however, should not be seen as a goal in itself. To ensure a stable income situation, which in its own guarantees sustainability of the energy provision, it is important to realise that energy provision alone will not be a panacea for reaching higher levels of development. Access to modern energy facilitates development, but the development should be spurred from other sectors of the livelihood, including notably entrepreneurship and access to markets. Other prerequisites include the availability of clean water and sanitation.

There is international recognition for the need for access to energy services. The Johannesburg World Summit on Sustainable Development named it one of the themes, among water and sanitation, health, agriculture, and biodiversity, which are essential to meet the Millennium Development Goals (MDGs). The MDGs include halving worldwide poverty by 2015 and also ensuring environmental sustainability. The International Conference for Renewable Energy 2004, held in Germany in June 2004, paid explicit attention to the need for provision of energy to the poor. The governments present agreed on an international action programme, which identified a very long list of actions, implemented by governments, by multilateral organisations, and by civil and private sector stakeholders, to bring forward renewable energy (International Action Programme, 2004). In addition, the Energy for Development Conference in the Netherlands in December 2004 highlighted the need for sound energy policy and energy sector management (Conclusions by the Chair, E4D, 2004).

The variety of international forums that put energy high on the poverty agenda also incenses national action in industrialised countries. The Netherlands, for instance, currently boost a programme to provide modern energy services to ten million people by 2015 in the light of the MDGs. The preferred instrument of the Dutch government is the public-private partnership. An agreement with the company Free Energy Europe was recently signed for the electrification of 60,000 households in Sri Lanka.

Theoretically, village electrification is best done through grid extension. This gives the most reliable and extensive source of power, with virtually no capacity limits. The villages can use the electricity for lighting and audiovisuals, but also for cooking, mechanical energy, and irrigation. However, the grid also poses problems, especially if the ability to pay the electricity bills is very low, or if the electricity supply is unreliable.

In India, there is a structural problem with electricity, even for well-established customers. Also, grid extension may be costly if the villages are located a long distance from the grid. In a significant number of cases, in the case of otherwise high costs and sufficient availability of renewable energy sources, village electrification through off-grid, renewable electricity is the preferred option. However, electrification through renewable energy has problems of its own and should be just as well thought out as electrification through the grid.

1.2 The Indian context

Electrification of a country should always be seen in the context of the national electricity situation. In the case of India, there is reason for concern. On the one hand, the economy has grown by some 8% in the last fiscal year, which is among the world's highest in developing countries. The agricultural sector, important for poverty-related issues, grew even faster. Optimism reigns in the Indian business sector (IEA, 2004). On the other hand, there are numerous problems, especially in the energy sector. India's per capita energy use is among the lowest in the world, which mainly demonstrates that large portions of the population do not benefit from the growth of the economy. The Indian electricity production is for about 60% controlled by the State Electricity Boards (SEB) (Thakur et al., 2005). Production is not sufficient for demand, losses are a big problem and the end-user prices are, often for political reasons, not economically sustainable. This leads to an electricity sector, which needs an estimated 1.5% of the government budget to be spent on making up for the losses by the state electricity companies.

Part of the problem of the energy sector in India is the distribution of responsibilities for the sector. In India, five ministries are involved with energy matters. The main ministry in terms of electricity is the Ministry of Power. The Electricity Act of 2003 aimed at restructuring the energy sector in order to allow for a competitive electricity sector. The Act also draws out a national policy on electrification and local distribution in rural areas (Thakur et al., 2005).

According to the 2001 Census of India, household electricity access in rural areas is about 44%. This number, however, is not uncontroversial. Other sources claim much lower electrification access, as low as 30%. The official number for village electrification is much higher: 88%[1]. The differences in this may be caused by the different definitions of the electrified village. The Census definition was 'A village will be deemed to be electrified if electricity is used in the inhabited locality within the revenue boundary of the village for any purpose, whatsoever'. Recently, this definition has been changed to include.

1. Basic infrastructure such as Distribution Transformer and Distribution lines are provided in the inhabited locality as well as the Dalit Basti/hamlet where it exists. (For electrification through Non Conventional Energy Sources a Distribution transformer may not be necessary).
2. Electricity is provided to public places like Schools, Panchayat Office, Health Centres, Dispensaries, Community centres etc.
3. The number of households electrified should be at least 10% of the total number of households in the village.

In general, electricity access varies greatly per state as well. States where cash crops are grown and where market access is good commonly have higher incomes. There, many remote households can afford commercial electricity provision, potentially through decentralised renewable energy.

[1] See http://powermin.nic.in/JSP_SERVLETS/internal.jsp?query=electrification&searchin=all.

The Government of India 'Programme for Electrification of Remote Census Villages and Unelectrified Remote Hamlets of Electrified Census Villages through Non-Conventional Energy Sources' aims at electrifying the mentioned habitations by means of energy sources such as solar energy, small hydropower, biomass, wind energy and hybrid systems. The first aim is the unelectrified remote villages, which should be electrified by 2007. In 2012, the individual households and the hamlets of remote electrified villages should also have received electricity. In some states, this means that over 80% of the households still need to be electrified. Part of the work has been delegated to the Ministry of Non-Conventional Energy Sources. This Ministry should electrify 25,000 villages by 2007 by means of decentralised renewable energy.

1.3 Objectives and methodology

This study was started to look at the village electrification situation in India, with an emphasis on the question how the poorest of the poor can be served without compromising the success of the programme. Since the Government of India announced the full electrification of the country's villages by 2007, it is relevant to examine the implementation model that the Government of India plans to use for the execution of this programme.

The objective of the project is twofold:
1. To provide insight into the practical aspects of implementing a remote village electrification project based on a location specific study. The study will provide input to the policy formulation being undertaken by the Government of India in the context of its remote village electrification programme.
2. Review the appropriate implementation models for electrification under different circumstances so as to develop a sustainable village electrification implementation model, especially the public-private partnership model.

In the light of Objective 2 this report will propose an implementation model for remote village electrification. This model will be compared to the plan that the Government of India formulated to reach its target of electrifying 25,000 villages by 2007 with renewable energy. The project can therefore make a contribution in assessing models for implementation of rural electrification and specifying the potential instruments. Issues that need to be resolved in this respect involve both the economic disincentives against renewable energy implementation, especially in very poor areas, and the institutional structure. The project focuses on the sustainability of the project and on the questions of how it can be ensured that the renewable energy will remain in place. This notably translates into questions on ownership and post-commissioning.

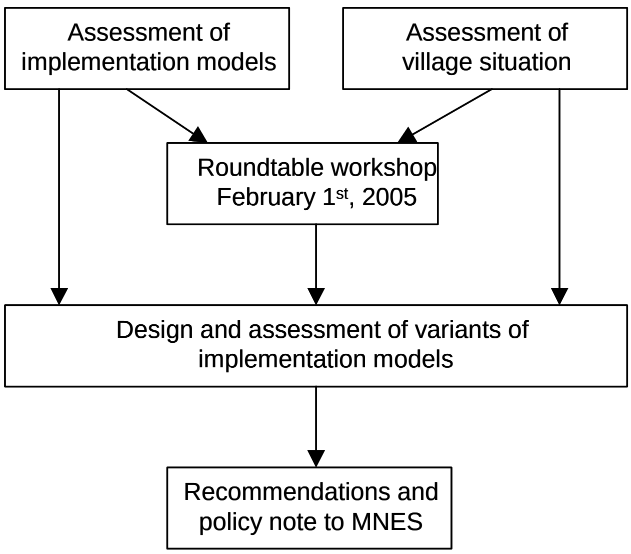


Figure 1.1 *Methodology of the project*

The methodology applied combines an approach of looking at international experiences with rural and village electrification with a grass-root survey of five unelectrified, very poor villages in the state of Orissa. Both approaches provide insights that are indispensable for determining a sustainable approach towards village electrification. The first part, the assessment of implementation models, will be reported in Chapter 2 of this report and will distil success factors for application to the Indian situation. The village survey in Orissa, included in Chapter 3, will reveal the specific circumstances in the country of India for village electrification and will therefore determine the applicability of the international experience. The selected villages are tribal villages with their own characteristics, but are nevertheless regarded representative for about half of the 25,000 villages that MNES plans to electrify by 2007. Several surveys have been done, also in Orissa and Jharkand villages that have gotten access to electricity before, notably to estimate whether the extra income generation is sufficient to cover some of the costs of the systems and the operation and maintenance requirements. These studies were carried out by BASIX and the READ Foundation, two NGOs, providing micro-credits and providing training for village electrification, respectively.

A roundtable workshop involving a number of stakeholders was organised in the periphery of the Delhi Sustainable Development Summit to discuss the results of these studies in an expert group. The results are in Chapter 5. In addition to this, stakeholder interviews have been conducted with a broad group of stakeholders, particularly those who would be involved in a public-private partnership model. Special attention has been paid to governments, financial institutions and system suppliers.

Based on the above, the MNES plans will be assessed in Chapter 4 and an alternative sustainable implementation model will be developed in Chapter 5. The assessment of the MNES plans will culminate in a policy paper, which is included as an Executive Summary in this report.

2. Implementation models

An implementation model is defined as the total of provisions and policy leading to the realisation of a certain goal or operation. In this case, the goal is village electrification. In the case of village electrification, the effectiveness of the implementation model depends on a successful interplay between both the facilitating circumstances (mostly associated with the institutional structures on all relevant policy and decision maker levels) and the recipient conditions (such as energy needs and usefulness). The general conditions for sustainable village electrification can be summarised as follows:

- Usefulness for the users: the systems should be appropriate to the user and should fulfil the needs.
- Sense of ownership: the beneficiary should feel responsible for the system. This is important as lack of ownership may cause neglect and eventual system failure.
- Affordability: The costs of the systems (including O&M costs) should not exceed the ability to pay of the users.
- Post-commissioning: Sufficient measures should be taken in order to ensure long-term functioning of the system, and in order to provide the beneficial effects of electrification.

Each of these conditions can be fulfilled by choosing an appropriate implementation model. Good insight in the usefulness of the energy for the users is a prerequisite but it is not a component of the implementation model. It should be tackled by conducting a good and representative inquiry into what villages would like to do with their electricity. This determines the usefulness of technologies and in that respect also the technologies themselves. A technology decision tree, developed by TERI, is in Annex I and technologies for five case villages are in Chapter 3 of this report.

The study, however, does not focus on the technical aspect, as this is quite straightforward and usually well managed. The real challenge in any implementation model, and the Village Electrification programme in India in specific, is how to bridge the gap between institutional facilitation of ownership and financial provisions for affordability. It should be noted here that affordability is not an absolute term, but very dependent on the local economic circumstances. These are very unfavourable in the areas targeted by the village electrification programme, which poses significant challenges.

In addition to the financial and institutional aspects, based on international and national experience with village electrification, this section aims to examine success factors in a systematic way. A synthesis section at the end of the Chapters highlights the success factors.

2.1 Institutional issues

A large number of organisational and regulatory issues can positively or negatively influence the implementation of electrification within a region. Organisational and regulatory issues are strongly interlinked. For a number of implementation possibilities to succeed, a well arranged institutional framework on both the national and local level is needed. The intermediate level is also of importance as actors and institutional and regulatory arrangements on this level should bridge between the rural villages on the local level and national institutions and arrangements.

2.1.1 National level

The national level provides the boundary conditions under which an electrification project should be embedded. The next organisational issues on national level are of importance for the electrification of villages (Zomers, 2001):

- *The embedding of the electrification projects in national electrification plans and, possibly, financing schemes*. A country should have a national electrification plan in order to ensure compliance with other regional initiatives. As electrification of rural areas is beneficial from a number of perspectives, in general return of investment is low, subsidies or other financing schemes are needed to ensure implementation. Financing of electrification projects, can also be available from other sources
- *Integrated planning.* Rural development is generally seen as the most common objective of electrification. Many rural electrification models have been planned and implemented as independent technical activities isolated from economic and social developments in an area. As a result, systems installed were often under-utilised, as local populations could not afford to purchase necessary equipment. Rural electrification should therefore be seen as an element in rural development and should be part of a broader social development plan (Zomers, 2001). This viewpoint is supported by the outcomes of research on the impact of electrification of rural tribal population (BASIX, 2005).
- *Organisational issues.* The most important causes of substandard performance of electrification projects are of an institutional nature such as a lack of accountability and autonomy, serious political interference and political instability. Organizations involved in rural electrifications need room to manoeuvre in order to function well. The organization should e.g. not be forced to set economically low tariffs as a result of political interference, and need to have access to e.g. foreign exchange. Also, policies supporting rural electrification should not conflict with other policies relevant for the region. Conflicts between policies regulating collection of biomass and policies stimulating electrification by means of biomass based electricity is a classic example.
- *Tariff setting.* Tariff setting is one of the regulatory issues that can strongly influence organisations' motives to engage or not to engage in rural electrification projects or the financial profitability of such projects. The following tariff structures can adversely influence possibilities for decentralised generation (UNDP/World Bank, 2001):
  - A flat kilowatt-hour tariff in an entire geographical area. As decentralised generation is generally more expensive than grid production, decentralised generated electricity cannot be sold for the same price unless production subsidies are available.
  - A strong focus on the sale of electricity per kWh. A fixed price electricity services fee can be more suitable to serve poorer rural populations.

Political and other developments on a national level such as the development of a more neoliberal approach to energy markets may also influence the implementation of electrification projects. The effects of such developments can be positive as well as negative on a local level. Energy market reforms leading to less political interference in utility operations are seen as positive developments as it increase the autonomy of actors involved. The possible unbundling of production capacity and grid operation is seen as a negative development for electrification as it discourages the development of multifunctional distribution systems with a variety of dispersed generators.

2.1.2 Local level

Village and rural energy supply systems are implemented on a local level. A large number of public or private entities may be the owner of the installations. Local NGOs, or branches of national NGOs may have a supportive role. As electricity may be new, an intermediary can provide useful help in planning.

The ownership of the installation and responsibility for the maintenance and operation may lie with different organisations or entities dependent on the financial structures chosen.

Community participation is now widely accepted as a pre-requisite for ensuring equity and sustainability of local infrastructure investments, such as water supply or electrification. The practice, though, is not simple. Experience with electrification co-operatives, for example, is variable, and depends on the local culture and the extent to which all members of a community have been involved in decision making (e.g. women's groups, farmers clubs, etc). There has been more success where intermediary organizations have helped the local planning process.

Local organisations can be viable and successful in providing power to communities. It is important that local organisations are flexible and sensitive for local and conditions. Research in three countries shows that the organisation should meet certain conditions for making this work. (Zomers, 2001). Success factors include the ability to do long-term managerial, financial and technical assistance, involvement of local people in the planning of the local power supply system as involvement promotes the identification of solutions and productive use of power and eases implementation, and support of an indigenous and autonomous organisation for local initiatives. This organisation should guide external assistance and ensure that rural electrification projects are properly designed.

2.1.3 Intermediary level

The *Intermediary Level* provides an integrating link between the national and local levels, ensuring that plans and policies match the needs of consumers, owners and suppliers. Intermediaries may be NGOs, government bodies or private concession holders contracted by government. In most cases, an intermediary can provide considerable help in explaining, facilitating and planning a suitable choice from what are normally not familiar technical options.

The role of the intermediary level institutions can include the following:
- provision of appropriate guidance and support for policy formulation,
- advice on development of a national rural energy strategy, including definition of grid coverage,
- development of networks within the sector to guide communities on sources of advice, expertise and equipment,
- supply of equipment,
- support and advice to manufacturers,
- provision of financing,
- community planning,
- identification of training requirements, running training courses for manufacturers, developers, operators, local government, communities,
- developing proposals for technical standards and setting standard suppliers' contracts to include technical support and warranties,
- promotion of electrification and electricity use.

Usually, a project will have different intermediary level actors. In electrification, the supplier of the equipment will for instance not be the financer of the programme. Legal advice and the setting of project standard, to both public and private actors, would be a function preferably done by an independent body.

2.1.4 Private sector

The private sector is mentioned here separately, as it raises questions essential to the scope of this report. Private sector incorporates:

- farmers (with small or large holding) and those in allied activities,
- informal sector operators: trading, other services, household enterprises, small manufacturing, rural non-farm, rural and urban labourers,
- private small, medium and manufacturing and service units,
- large scale Indian and multinational corporations.

The private sector - be it financing institutions or a supplier of equipment - usually fits in the intermediary level. Because of inefficiency in government-led projects, involvement of the private sector, especially in the form of public-private partnerships, is not seldom seen as a panacea for effective implementation of projects. In the case of projects or programmes with a healthy market, able to pay the price required for commercial provision of services, public-private partnerships, where the private sector brings in efficiency and the public sector social responsibility, it may indeed work. In Section 2.4, a more detailed explanation of public-private partnerships is given. When the target group of the policymakers, or market segment for the private sector, belongs to the poorest of the poor and has an extremely low purchasing power, it is usually less interesting for the private sector.

Financing institutions can also participate in a public-private partnerships, Their role can be restricted to providing financial credit (e.g. micro-credits are common in the electrification sector), but it can be expanded to guidance of accounting issues or on whether the project is technically sound. It may be that the financing institution or bank has low confidence in the government programme or in the level of development of the customers in the villages. Because the ability to pay is very low in electrification projects for the rural poor, this may be a major barrier for financing sector involvement.

2.2 Ownership

A number of private and public entities can act as owner of electricity supply systems. Electrical supply systems are ideally owned by those with the highest stake in their success. Lack of ownership is broadly recognised as one of the main barriers to success of electrification efforts. Ownership is the result of interplay between consumer demand, use of energy, and the stake invested in the energy provision.

In the case of electrification, the users are individual households, small enterprises or a village community. Possible structures are:

- Public ownership. The installation is owned by a public or national utility. This option may be useful if the systems are provided under a government programme and there is insufficient local capacity to own the systems or to use a private company.
- Private ownership. Two possibilities: the installations remain in the hands of the equipment supplier, or the financier, or the equipment is owned and maintained by an intermediary company serving as an energy service company.
- Individual ownership. Wealthier individual or households may act as owner of small-scale electricity supply systems such as solar home systems.
- Community ownership. The village community, often structured by Self Help Groups or otherwise institutionalised, owns the installation. Community ownership is a form of cooperative ownership.

Especially for poor, remote villages, community ownership and individual ownership are options. Private ownership is only viable if the villages are accessible enough to enable cost-effective maintenance by an energy service company.

Public ownership is not recommended, as the users will not have a stake in the energy provision. Experience shows that the programme will be less successful if that is the case. The choice for individual or collective solutions depends on e.g. the organizational structure within the village and differences in income level. Individual systems can be used if no strong collective organizational structure exists under which electrification can take place. Individual systems are an option if individual households have sufficient income to purchase a system of their own. Here, the hope is that the advantages of electrification will tickle down to the poorer layers of the population.

The use of individual systems may however also have an opposite effect, as these systems may lead to larger differences in income within regions, individual systems have a larger chance to get stolen and heavily subsidized systems could be sold to urban residents which would normally not be entitled to subsidised electricity supply.

Community or cooperative ownership can therefore been seen as the most appropriate for rural electrification projects, if the boundary conditions, the existence or the development of an organisational structure and the ability to pay throughout the community, can be fulfilled.

Points of attention for cooperative ownership are (Zomers, 2001):

- The likelihood of success is significantly increased if the initiative to form a cooperative comes from stakeholders and not from external promoters.
- Cooperatives work when there is a communal stake in the project, to make sure that the villagers contribute towards the cost and/or necessary activities. This stake could be the mutual interest of having a school where education is given during the evenings, or having the possibility to practice some crafts (like leaf-plate making) or other income generating activities. Also entertainment (radio/TV) could generate a stake, although the effect is more limited than the income generating activities.
- Cooperatives can become political and can be used for other development activities than electrification only. Case studies show that this diversion of attention may lead to mismanagement and deterioration of operational performance.
- Cooperatives may have weak management structures, and may need strong management administrative and technical support.

Self Help Groups (SHGs) can play a role in the daily maintenance of installations when installations are owned by community-based cooperatives. The SHG could be responsible for collecting the money from the villagers for the installation and to keep the installation up and running. When a biomass-based installation is installed in a community, a forestry SHG could be started to co-ordinate the collection of biomass.

2.3 Affordability and financing issues

Financial issues play a role in rural electrification on both local and national level. On a national level, financial support mechanisms for electrification are of importance. Locally, the possibility to obtain credit may be of importance.

2.3.1 Public and private sector

Electrification efforts generally need public as well as private support. The implementation of electrification programmes often results in high capital investment with insufficient financial returns. Electricity providers therefore cannot and will not use their own capital or obtain credit to implement the installations. Reliable public support is necessary to make the investment worthwhile.

If countries have the objective to increase access to electricity for disadvantageous populations, subsidies are needed (UNDP/ World Bank, 2001). Subsidies can cover part of the investment costs and may support emergence of markets for equipment and electric services. Subsidies can however lead to market distortions and may keep the prices high, as there is no incentive to decrease the costs of installations. Subsidies should be implemented in a clever way to avoid misuse and to stimulate cost reductions for the installations.

The following approaches have been applied in recent projects in order to apply subsidies appropriately (UNDP World Bank, 2001) and notably to create a market without perverse market distortions:

- support for access to energy but not financing consumption or even the systems,
- stimulate market participation of several system suppliers,
- equitable use without creating or reinforcing a monopoly,
- neutrality in terms of technological choices,
- support only for decentralised energy programmes that will not be viable without the subsidy,
- reliance on available financial resources if subsidies are to be maintained.

Depending on the implementation model chosen, credit possibilities play an important role on a local level. Table 2.1 describes the array of financial sources that may be available on local level (UNDP/World Bank, 2001).

Table 2.1 *Local sources of finance*

Source	Borrower	Availability and costs
Family or friends	Consumer or maybe dealer	Very common, possibly limited resources
Money lenders or savings collector	Consumer or dealer	Common, credit can be expensive (30%/a)
Supplier credit	Dealer	Rare and unlikely for a untested product or service
Informal savings institutions (local)	Consumer	Very common, limited capacity
NGOs	Consumer or community	Often targeted programme with small loan amounts
Credit Union	Dealer or Cooperative	Leverage local savings with little support
Local banks	Only to established business or group	High transaction costs restricts loans to relatively large amounts

(UNDP/ World Bank, 2001, p 311)

Conditions under which credit is given are also of importance. Payback of loans could for instance follow a seasonal structure in which lenders pay back a larger share of their debts during harvest. For the case of individual electrification, small and relatively easily accessible finance sources would be favoured. Under a government programme, the government itself could also act as a financier.

2.3.2 Financial implementation models

Three main financing models for rural electrification systems exist (IEA, 2003). In principle all three models are suitable for both individually and community owned installations, the role of individual users and possible collective owners of the installation does however shift. The role of subsidies is not considered in this list.

1. Cash Sales: The system is sold directly to the end user who immediately owns the system.
2. Credit System: the end-user receives a credit in order to acquire the system. Three types of credit systems can be discerned:
   a. Dealer credit
   b. End user credit
   c. Lease purchase.
3. Fee for service. The end-user pays a fee to an energy service company (ESCO) and in turn receives an energy service.

Within these three main categories there are all sorts of variations of division of costs and risks possible, depending on which partners are involved (public and/or private organizations), who provides credit, who is project owner etc. etc. The advantages and disadvantages of the three-implementation models are described below.

Cash sales

This is the simplest financing model. Depending on the cost the user could either be one household (for example in the case of solar home systems) or a complete village (normal in the case of biomass combustion technologies). The payment is up-front. Operation and maintenance is the responsibility of the end-user. This implementation model is only possible in the case of very cheap technologies (in the beginning, these systems were often of low quality, which caused a mistrust in decentralised electricity in some areas), and even then it is normally only available for the 'wealthiest of the poor'. Government support could come from capital subsidies, but the possibility exists that the systems are acquired and sold off to cash the subsidies. This is of course not the aim of such a programme.

Credit sales

Credit sales can be dealer credits end-user credit or lease-purchase constructions To reduce the high initial investment, which is the main disadvantage of the cash sales model, a credit facility or installed payment facility can be used. The financial risk is transferred from the end-user to a credit provider (directly or through the technology provider). The credit provider can either be the technology provider, a specific credit provider or the government. In return for taking on this financial risk, the end-user normally has to pay rent or provide some sort of warranty. In the case of non-compliance with the payments, the end-user risks the loss of the system. Depending on who is credit provider, different structures for operation and maintenance and credit retrieval should be set up. The coordination between the two could prove difficult.

Main success factors are:

- The company that runs a credit scheme must thoroughly evaluate the creditworthiness of its clients and must be able to issue penalties or to retrieve the system in case of bad debts.
- The boundaries of ownership must be clear in case of the need to issue penalties.
- Clear arrangement for payments and penalties in case of non-payment, for example the retrieval of the system.
- The payment schedule must be designed to fit the income cycle of the client.
- The warranty period must exceed the payment facility period.
- Clear advice to the end-users regarding the limitations of the system.

Main failure factors:

- Unexpected high inflation rate/change of exchange rate.
- Late or non-payment of the credit.
- Theft/replacement of unpaid systems.
- High interest rates and down payments.
- Inadequate financial administration leading to high administration costs.

Fee-for-service models

In the fee-for-service models an energy service company (ESCO) owns the system, and provides an energy service to the end-user, who pays a periodic fee (e.g., monthly) to the ESCO. The end-user is not responsible for the maintenance of the system and never becomes the owner. For collective systems the cooperative could provide the services for a fee to its members.

Main success factors ensuring that the fee-for-service model is a success are:

- Government should consider issuing a clear long-term licence, or time-limited exclusive agreement, to an ESCO to start selling electricity services in a certain region.
- Legislation is often required to permit electricity sale by parties other than the utility.
- Relatively stable country/economy in order to encourage long-term investment.
- Clear definition of system ownership and acceptable loads. For example, who owns the lamps, fittings, wiring? Which loads are allowed, which not (e.g., B/W TV)?
- Clear arrangement for payments and penalties in case of non-payment, for example the retrieval of the system.

Main failure factors include late or non-payment of the energy fee and too high expectations of the service leading to disappointment and non-payment by end-users.

Table 2.2 gives an overview of the attributes of the main implementation options. The credit sale option has been split up further for the overview. The choice for a specific financing model is very much dictated by the financial possibilities of the user(s) of the electricity and the willingness of partners involved to bear (financial) risk.

Table 2.2 *Programme structures*

Structure	Ownership	Financing	Product flows	Service flows	Money flows
Cash sales	All components owned by consumer.	n/a	Individual or cooperative purchases the system, installation by private sector or consumer.	Provided by private vendor, generally on a fee for service basis, through service contracts.	Lump-sum payment to vendor. Servicing paid by consumer at time of service.
Dealer or end user credit	All components are owned by the consumer; the installation may be used as loan collateral, although other loan security may be needed.	Provided from commercial bank, coop or vendor.	Individual purchase of system, installation by private sector or NGO.	Provided by private vendor, usually on a fee for service basis, through service contracts.	Proceeds of loan used for lump-sum consumer payment for equipment. Monthly consumer loan repayment. Servicing paid by consumer at time of service.
Leasing purchase	Important components owned by intermediary, other components usually owned by customer.	Provided from intermediary through lease agreement.	Bulk purchase of systems or components; installation by intermediary or supplier under contract by intermediary.	Provided by intermediary or private vendor under contract to intermediary; may be included as part of the leasing agreement.	Monthly consumer payments to intermediary. Intermediary pays equipment suppliers, administrative staff and bank loans; service technicians may be paid by consumer or intermediary.
ESCO/ Fee for service	Important components owned by the company, other components may be owned by the company or consumers.	Provided by ESCO by service agreement.	Bulk purchase of systems or components; installation by ESCO or supplier under contract by ESCO.	Provided by ESCO as part of agreement.	Monthly consumer payments to ESCO, ESCO pays equipment suppliers, service and administrative staff and bank loans.

Note: adapted from (World Bank, 1996)

These financing models on the individual or community level can theoretically vary within a government electrification programme, although usually a uniform financing structure is obvious. The government programme itself raises different questions, which are addressed below.

2.4 The role of public-private partnerships

Currently, much confidence is given to a public-private partnership implementation model for large-scale electrification programmes. A public-private partnership is a voluntary agreement with a pre-defined aim between a public and a private entity (ECN, 2003). Public entities are generally defined as not-for-profit institutions, which have a non-financial objective, such as increasing development, improving the environment, or improving health conditions. Private entities are for profit, e.g. suppliers of goods or services, or banks.

The confidence in the merits of public-private partnerships lies in the fact that the model anticipates that the economic sustainability will be provided by the private partner, and the social and environmental sustainability by the public entity. Below is a discussion of what public-private partnerships signify, and under which conditions they may work.

2.4.1 Public-private partnerships: balancing interests

The novelty of a public-private partnership is that the private and public sector, which traditionally are opponents in many respects, agree on a mutual dependence in the implementation of a project or a programme. Charging: the public sector tends to mistrust the private sector in having beneficiary aims beyond making profit, and the private sector thinks that the public sector is unable to work efficiently. The aim of agreeing on a public-private partnership is to combine the best of both sides: the efficiency and effectiveness of the private sector will work to achieve the charitable goals of the public sector.

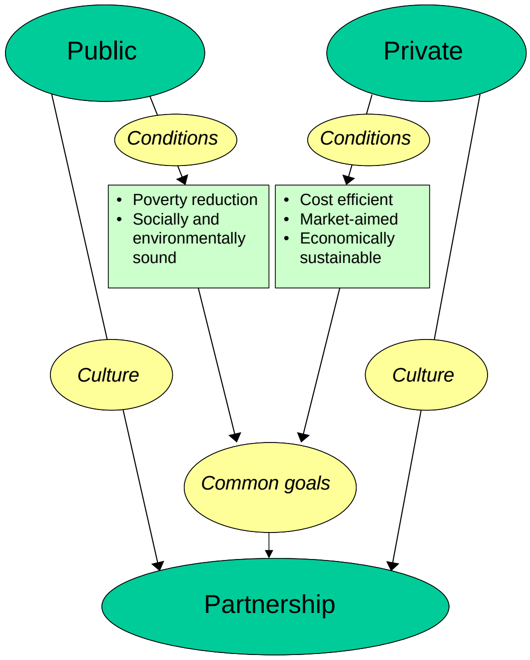


Figure 2.1 *Conceptual framework for public-private partnerships in the context of the WSSD*

The concept of public-private partnerships is not new, but they have been given new meaning in a world which is increasingly liberalising and which is experiencing a government withdrawing from the implementation of projects and programmes. It is therefore not surprising that the country that has a low interference with society, the United States, already has a long history in public-private cooperation. It is new, however, that this mechanism is internationally recognised and that so much emphasis is put on it in the context of development, notably the Millennium Development Goals[2].

During the United Nations World Summit on Sustainable Development, in Johannesburg in September 2002, an international framework for public-private partnerships was established. This was done mainly because of a lack of agreement among governments for implementation plans for e.g. renewable energy or poverty alleviation. Especially governments that were already far progressed in liberalising the sectors that would be subjected to the implementation plans were inclined to rely on the private companies in those sectors for implementation, and shifted from the traditional 'Government to government' or 'Type I-agreements' to the so-called 'Type II-agreements' (ECN, 2003).

[2] See http://www.developmentgoals.org.

The criteria of the United Nations are that the partnerships should bear a relationship to and should complement the binding, Type-I agreements. Partnerships are intended to turn political commitments into action through a series of commitments and action-oriented coalitions that are focused on deliverables. Partnerships should contain specific modalities including targets, timetables, monitoring arrangements, coordination and implementation mechanisms, and arrangements for predictable funding and technology transfer. Hundreds of such public-private partnerships have been registered in the meantime (Castro, 2002).

A conceptual framework for understanding the issues at stake in a public-private partnership is given in Figure 2.1. Public and private sector have different interests in the establishment of a public-private partnership and therefore, the conditions that they apply are different. This figure is given in the context of WSSD, which means that poverty reduction is the one distinguishing goal of the public sector. It should not be underestimated that a partnership may fail because of different expectations of the private and public parties involved. The culture of the different institutions may be a serious inhibition for success, which goes beyond the explicit aims of the partnerships. Eventually, the partnerships have no use unless the partners can agree on common goals, even though they are found through differentiated interests.

The interest of the private sector is often in enhanced market development or image improvement, the latter mainly in the context of corporate social responsibility. The private sector would be aiming for financial or economic sustainability. The interest for the public partner, whether it is an NGO or government, is to achieve development in the context of WSSD or alleviating poverty while at the same time maintaining social or environmental sustainability.

2.4.2 Public-private partnerships and village electrification

In theory, the concept of public-private partnerships may work well for the provision of energy to remote areas. There have been several examples, where for instance the government provides the initial infrastructure for market development of PV systems or co-finances post-commissioning and training, and the private sector can use this to be able to provide the energy services in markets it would normally not exploit. This works well for obtaining ownerships and post-commissioning, but it lacks one of the three dimensions identified in 2.4: affordability.

To be able to get full electrification coverage, and to reach even ‘the poorest of the poor’, private sector involvement will be a challenge (ECN, 2003). The reason is the conditions that the private sector imposes on public-private cooperation. Both economic sustainability and the chances for market development are small when the customers are among the most unprivileged with a very low cash income, as is the case in the villages in Chapter 3. This is the essential problem that this report tries to address by a different implementation model as explained in Chapter 5.

2.5 International and national examples of electrification programmes

The scale of the Indian policies for village electrification is unprecedented, and to compare national or international experience with projects of a similar size is unrealistic. However, the financial and institutional models applied in other countries and in India itself may provide some guidance on what are success and failure factors.

Of each of the projects and programmes, the financial and institutional arrangements will be evaluated. Also, the projects will be scored on the axes as identified in Section 2.2: affordability, ownership and post-commissioning.

2.5.1 International projects

Internationally, especially PV systems projects have been implemented widely, with varying results. A more extensive review can be found in EDRC (2003) and in ECN (2000).

Solar home systems in Tanzania

In Tanzania, the company Free Energy Europe has been setting up a distribution network of small solar home systems, of 20 Wp per system. Because of the small size, the systems are affordable but still supply sufficient power for one or two lights and a radio or black and white TV. Free Energy Europe is providing the systems to a network of non-specialised dealers in Tanzania. Non-specialised means that the dealers sell the SHS apart from a number of other products. The systems are purchased by the costumers by cash sales. Apart from an initial subsidy from ODA for the development of the dealer network, the systems are not subsidised. They are sold for approximately 50 US$ for a 14Wp system, including invertor, and two lamps. This implementation model, without any direct government subsidy, has achieved the sales of over 1 million systems worldwide, and is with that more successful than any government programme so far (Van der Vleuten et al, 2003).

The model would score high on the fields of usefulness of the technology and of ownership, as the customers take the step to purchase the system themselves. Post-commissioning is not arranged but the provider claims that there are no problems with the systems. The affordability is obviously there for a large group of customers (penetration rates of 20 to 40% are reported in some areas in Kenya with 10 to 20 Wp systems), but even the smaller systems are probably out of reach of the poorest of the poor.

South Africa concession programme

The South African government decided to make available electricity to all its inhabitants. Part of the programme is the expansion of the grid, which the national energy company Eskom is executing. For remote areas, in 2000, the government provided concessions for selected equipment suppliers to supply solar home systems of 50 Wp to households with an 80% subsidy from the government. In the Eastern Cape province, for instance, this concession was obtained by Eskom/Shell (ERC, 2004). These companies provided solar home systems that could provide power for two lights and a radio or TV.

In South Africa, jealousy with the people that did get a grid connection (which enables more applications, including cooking to be done with electricity) played a role in the valuation of solar power. A significant number of initial customers dropped out and indicated different reasons for that (ERC, 2004):

- The fee for service (58 Rand per month, which is about 10 US$ and almost Rs. 500) was perceived as too high for the services provided.
- The technical performance of the systems was bad (much failure) and repair took a couple of days.
- The systems did not provide the services that were most wanted.

It can therefore be concluded that both affordability and post-commissioning were not well done. Also the usefulness for the user was obviously a weak point. The rather high subsidy of the government of 3500 Rand (625 US$ and Rs. 30,000) per system did not manage to compensate for the lack of finance sufficiently for many families. The fee for service model even brought financial problems to several as they used more electricity than they could afford, and ended indebted.

Solar home systems in Bolivia

The NGO Energetica sells solar home systems (50 Wp, including three lamps and an invertor for 400 US$) through a combination of cash sales (about 15% of the costumers) and credit sales through micro-credit (85%).

Special about this programme is that the repayment of the credits is done with much attention to the agricultural productive seasons and the availability of cash during those times. The systems are not subsidised by revenue or capital subsidy, though the service by Energetica is paid out of donor money. The post-commissioning includes a two-year guarantee, and a minimum of five visits during those years. This therefore seems well arranged, as well as the usefulness of the technology and the ownership. The affordability is probably lower, and the target for the systems was to provide 500 of them, probably only to those farmers having substantial cash income. This is a rural electrification programme not aimed specifically at the poorest of the poor.

2.5.2 Projects in India

Micro-hydel project in Karnataka

Technology Informatics Design Endeavour (TIDE), a Bangalore based NGO has implemented 6 village electrification projects based on micro-hydel technology in Karnataka in the period 1999 to 2003 with funding support from Indo-Norwegian Environment Programme. Out of the 6 projects, 4 were community owned which involved the formation of a community organization for ownership and management.

The institutional and financial model adopted by TIDE is as depicted below.

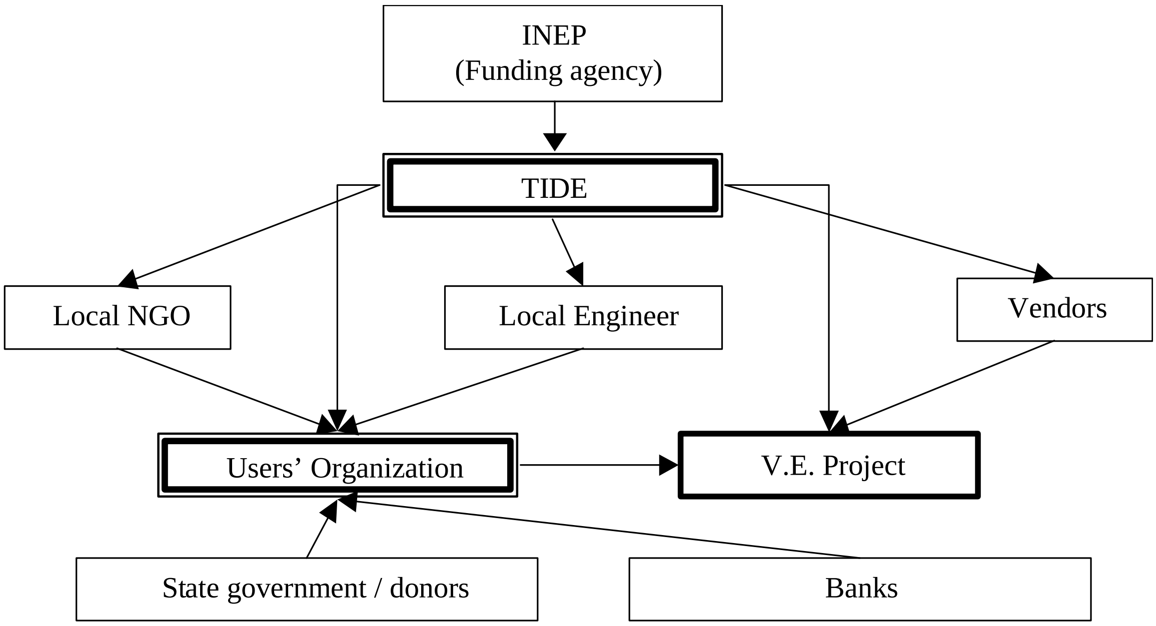


Figure 2.2 *Institutional and financial model adopted by TIDE*

User community organizations were formed at each of the project locations for the purpose of owning and managing the projects. Project layout, capacity and configuration were finalized in consultation with the villagers. The villagers also agreed to take up all the civil works themselves at their cost as their contribution to the project. The villagers mobilized grants from donors and state government to meet the costs of civil works. In a couple of instances, the user organizations have taken bridge loans from banks to meet construction costs pending receipt of committed grants from donors and state government. Local NGOs have facilitated this.

TIDE engaged the services of local NGOs to mobilize the community and to facilitate capacity building of the community. TIDE also engaged the services of a local engineer to provide technical support to the community to take up civil works. All the equipment, distribution lines and accessories were provided by TIDE to the user organizations through vendors.

The funding provided by INEP was utilized to provide the equipment, and the technical and capacity building services to the villagers along with meeting the costs of a small core team within TIDE that managed these project. With this funding arrangement the typical sharing of costs of project infrastructure worked out to about 50% provided by TIDE and 50% by the villagers.

The villagers pay monthly tariffs, which vary between Rs. 50 and 150 per month per household for electricity. The day-to-day operation is completely managed by the users' organization with select members of the community taking on the operator responsibility. The user community has been able to meet all recurring costs with these tariffs. However, capital servicing costs are not covered. The process adopted for selection of site and implementation of projects has ensured a high level of ownership.

The villagers have reasonable cash incomes since they grow cash crops such as areca, cardamom, and therefore are able to afford tariffs that can pay for all recurring costs. This has ensured proper post-commissioning operations. TIDE has now completely withdrawn from these projects and provides technical advice and guidance when called upon.

Remote Island electrification by West Bengal Renewable Energy Development Agency
In Sunderban region in West Bengal, the West Bengal Renewable Energy Development Agency (WBREDA) has installed 11 solar PV power plants of different sizes. All the power plants have been established with financial support from MNES. For some power plants, soft loan assistance from IREDA under the World Bank Market Development Programme has also been used. Power plants have been installed to cater to both the domestic and small commercial requirements of electricity. There are provisions of two type of domestic energy supply, one with 3 energy saving lamps and other with 3 energy saving lamps, one fan point and one TV point. Consumers take a connection depending upon their affordability. Rs 500 needs to be deposited as initial installation charge for 3 light connections and Rs 1000 for the extended package. The energy charge of Rs 80/month is collected for 3 light connection and Rs 130/month the extended package.

A Village Energy Committee (VEC) was formed at each of the project location. Their prime responsibility is to collect the revenue for smoother operation of the system. However the operation and maintenance of the power plant has been taken up by other agencies, under the supervision of WBREDA.

The post commissioning includes 2-5 years of assistance in operation and maintenance (varies from plant to plant). Though O&M is required after this period, calculation shows that the revenue projected to be collected is sufficient to run the system after the period. The post-commissioning in this model therefore seems to be organized well. The usefulness of the technology is well understood as there are plenty of small-scale commercial activities coming up around the project. The system is also affordable for most of the consumers. However the actual ownership is not with the villagers and it is uncertain how this will influence the success of the project. Also, the affordability is limited to those households able and willing to pay the connection costs.

Rural Electrification project in Komna district of Orissa
The project was implemented through UNDP assistance where UNDP and MNES were the funding agencies (90% shares from UNDP, 10% from the MNES) and the Orissa Renewable Energy Development Agency (OREDA) was the implementing agency. This project was formulated with two basic objectives i) capacity building to plan, implement, operate and manage rural electrification projects, and ii) demonstration of decentralized energy intervention in the context of integrated development such as enterprise development. 25 Villages were selected for electrification under this project. The project had earmarked a corpus fund of Rs 4,00,000 for every village for the maintenance and upkeep of the plant.

This corpus of about Rs. 10,000,000 was deposited in a bank account at the beginning of the project itself. The interest accrued over the period of four years is about Rs. 2,000,000. 75% of this amount would be distributed equally to each VEMC (Village Energy Management Committee) and 25% will go to the OREDA's local office to take care of the staff salary. The total project cost of the solar plant includes operational provisions for 10 years, so post-commissioning seems to be arranged well. Whatever revenue is collected from the sale of electricity can be saved for expanding the plant in future. The affordability is within the reach of the consumer as more number of consumers are now interested for such service. The operation and maintenance of the system is to be taken up by the villagers once the assistance for that is over. The ownership would be with the VEMC in the subsequent stages.

2.6 Synthesis: essential ingredients for implementation models

This section lays out the basis for the further analysis of sustainability of village electrification implementation models, in Chapters 4 and 5. Summarising the above, four main aspects of successful electrification are identified:

- Usefulness for the users: the system should be of appropriate size, technology, and energy provision for the users.
- Sense of ownership: Ownership is more than legal ownership, notably also a sense of responsibility. It is connected with the usefulness; as users will feel more responsible if they use the system regularly.
- Affordability: affordability is a relative term. There are many individual households that can afford their own energy supply, but still do not have access to electricity provisions. The main problem, however, is to maintain affordability, even for households with extremely low cash incomes.
- Post-commissioning: Ensuring that the villages can take responsibility for simple operation and maintenance actions as much as possible, and provide (both financially as in terms of the service company) for the circumstances where more demanding repair is needed. This term also includes further provisions that enable the villages to generate extra income.

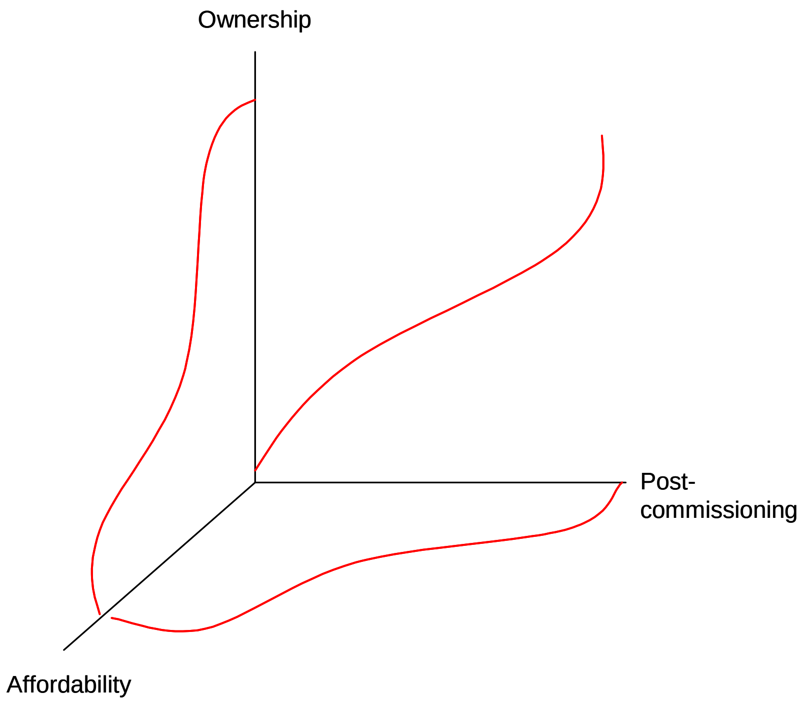


Figure 2.3 *Schematic representation of aspects of sustainability of a village electrification implementation model*

The usefulness for the users is a separate issue and will only very briefly be included in this analysis. The other three ingredients are not mutually independent. For instance, the customer-dependent affordability influences the way post-commissioning is employed, and the sense of ownership changes with the stake the users have in the installation and therefore with affordability.

The three financing models identified (cash sales, credit sales and fee for service provisions) are crosscutting to these essential elements. Ownership, affordability and post-commissioning all vary with the financing models employed.

Figure 2.3 provides a schematic way of looking at the different ingredients. The lines indicate the interrelations between the two axes in a situation where no flanking policy is implemented. Affordability decreases rapidly with the better provision of post-commissioning and ownership. Depending on the costs of the technology applied, at a very basic and possibly unsustainable level of ownership and post-commissioning, affordability increases to acceptable levels for a number of villages. Post-commissioning increases with sense of ownership to an optimal level.

The examples in Section 2.5 have all been rated qualitatively on ownership, affordability (for the very poor) and post-commissioning. It is shown that neither of the programmes and projects cited score high on all three areas. In international PV projects, especially the affordability is a key issue. The successful projects score high in ownership and post-commissioning, but are not affordable for many of the villages in the programme of the Government of India. Sometimes, there are small successful projects, but they require an enormous effort from government, local NGOs and up to 10 years of operation and maintenance assistance. The question is whether it is a sustainable model when the donor is supposed to invest in the project for 10 years.

3. Remote tribal villages and what electrification can do

This Chapter will give results on a detailed survey done in five remote villages in Orissa without access to electricity. A general characterisation is given first, followed by the selection process for the villages, and characterisation of the approaches to the energy need. To what extent their energy supply can be provided by decentralised renewable energy is in Section 3.4. Affordability issues are analysed in the last sections of this Chapter.

3.1 Orissa characteristics and OREDA survey background

The Orissa state is located on the Eastern Coast of India surrounded by Andhra Pradesh in the South, Chattisghad and Jharkhand in the west and West Bengal in the North. It is one of the economically backward states of India and is ranked very low on various parameters viz. infrastructure, investments, and agriculture[3]. As per 2001 census, Orissa has a population of just over 36.7 million with more than 31.2 million (85%) in rural areas. The literacy rate of rural males is around 75% whereas that of rural females is less than 50%. The population density in rural areas is 204 per square km.

A group of 5 villages was selected within Rayagada district of Orissa, which forms a part of KBK region, which is considered as the most backward region of Orissa with about 72% of the families living below poverty line. Tribal communities dominate this region comprising mainly of four primitive tribal communities: Bondas, Dadai, Langia Sauras and Dangaria. Almost all the blocks in this region are included in Tribal Sub Plan (TSP) and thereby are eligible for special plan assistance from the Government of India.

Rayagada District Profile
Rayagada was carved out as a separate district from Koraput in 1992 as a part of the extension plan of districts in the state. The total geographical area is 7073 km^2. The district has 2667 villages in 11 blocks with population of 832,019, out of which 473,379 are tribals. With such a huge tribal population, all the 11 blocks of the district have been covered under the TSP.

Koraput district profile
As per 2001 census, the population of Koraput district is 11,78,000 with population density of 134 per square km. It has 1997 villages in 14 blocks. The total geographical area of the district is 8807 square km. The district has the highest population growth in the state. It is primarily a tribal district with more than 70% of the total population comprising of scheduled tribes.

Topography
Forest covers 1880 square km in Koraput district and 2812 square km in Rayagada district. The forest was very rich in sal, peasal, teak, sisoo, baja, mahul, bamboo etc. However during last few decades, there has been a rapid increase in deforestation rate leading to large-scale degradation of forests. The region has abundant mineral resources including precious and semi precious stones.

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[3] India's best and worst states, India Today, August 13, 2004.

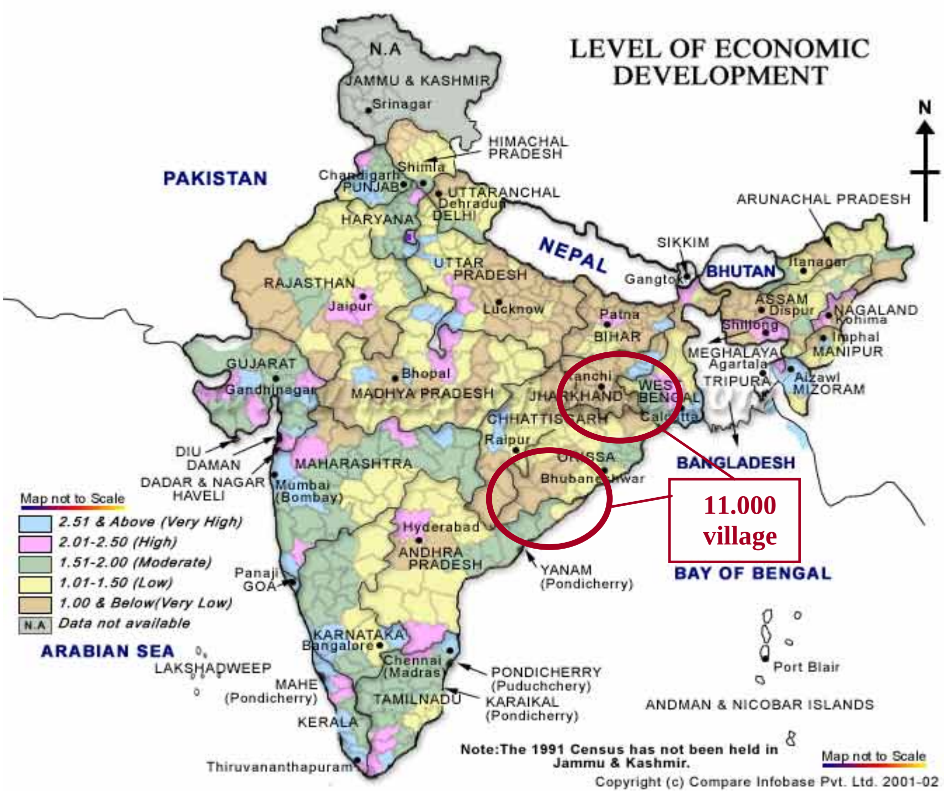
Climate
This region is within the Southeastern ghat agro climatic zone with warm and humid climate. The average annual rainfall in this region is over 1500 mm. Temperatures range from 40-45 degrees Celsius in the summers and dipping down to 2 degrees Celsius in the winters. Soil types are red, mixed red and yellow.

Development Indicators
Below poverty line percentage is more in Koraput and Rayagada district as compared to some of the other districts in KBK region. Out of total 30 districts, Koraput and Rayagada occupy 20th and 27th position respectively in the state's economy. Figure 3.1 shows the district profile of Rayagada and Koraput.

Table 3.1 *Rayagada and Koraput District profile*

Socio-economic indicators	Koraput	Rayagada
Population		
Population (2001)	1,178,000	823,000
Population (urban)	198,000	115,000
Population (rural)	980,000	708,000
Scheduled Caste [%]	11	12
Scheduled Tribe [%]	44	48
Literacy		
Literacy rate [person, %]	36.20	35.61
Literacy rate [male, %]	47.58	47.35
Literacy rate [female, %]	24.81	24.31
Below Poverty Line families [%]	83.81	72.03
Access to Basic Amenities % of village electrified	66.74	54.40

This region is also representative of other regions where un-electrified villages exist. There is also a strong correlation between unelectrified villages and economic backwardness. In the map of India in the next page, the encircled regions within Orissa, Chattisghad and Jharkhand have about 11,000 villages out of the 25,000 remote unelectrified villages.



Source Compiled from District Statistical handbook of Rayagada and Koraput, 2001.

Figure 3.1 *Location of the tribal villages in the MNES village electrification plan*

TERI undertook an assignment of preparation of 'Detailed Project Reports' for 300 villages in Rayagada and Koraput districts of Orissa for Orissa Renewable Energy Development Agency (OREDA). These villages were identified out of the 1000 remote villages certified as unelectrifiable by grid by the local electricity supply utility. This DPR preparation exercise was carried out as a planning exercise prior to sanction of funds for implementation.

The fieldwork related to this project was carried out in five selected villages out of the studied 300. In addition, some villages in Jharkhand state where tribal population who were economically active and economically inactive were also studied to understand the scope for revenue generation in the geographic area of interest.

3.2 Brief description of the villages

This is a region where many villages are unelectrified and lie on the periphery of the reserve/protected forests. One of the major impediments to the social and economic development of villages in this region is the lack of basic economic infrastructure. Most of the villages are in extremely remote inaccessible areas. Due to the undulating texture, the villages are not connected by road with nearby villages or towns.

3.2.1 Common Practice

Figure 3.2 *Shifting cultivation: a prevailing practice*

These tribal communities live within and on the periphery of reserve and protected forest. Main occupation of the people is agriculture and labour. They wake up early in the morning, complete their entire domestic chore by 7 am and then go out for daily work. In most areas both men and women are engaged in work. They depend primarily on the forest for their livelihood. People collect forest produce and sell it in the nearby market. Shifting (Poddu in local language) cultivation is the prevailing practice adopted by almost all villagers of this region. Due to such practice, the forest resources are being depleted to a large extent. There is no permanent migration of people out of this region. In some cases, seasonally one or two members of the family go to nearby places for labour.

3.2.2 Methodology followed for selecting case cluster of villages

The following criteria have been set while selecting the villages for detailed study:

- The villages should be in a cluster.
- The villages should be remote but reasonably accessible.
- The villagers should be keen for electricity.
- There should be scope for income generation activities.
- There should be a strong community cohesiveness.
- Institutional arrangements should be in place.
- Community participation should be feasible.

In this context, the five villages of Jimbakuti, Jodie, Rengalpadu, Suruni and Tambalbai were selected. Their data are:

Table 3.2 *Geographical information on the villages*

[Km]	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Distance from road head	39	32	32	34	30
Distance from railway station	39	47	47	50	45
Distance from block office	39	47	47	50	45
Distance from ration shop	8	7	5	7	5
Distance from market	10	35	8	11	13
Distance from petrol pump	55	47	47	50	45
Distance from 11kV line/DT point	8	7	3	4	5

3.2.3 General information on the villages

The five selected villages are located in close proximity to each other and the average distance between each village is 2 to 2.5 km. All villages are accessible by a dirt road. The villagers are very keen for electricity. They had requested the concerned authority many times for getting electricity. There is a large scope for income generating activities/enterprise development, such as Non-timber Forest Produce processing (NTFP), mango processing, tamarind processing, tailoring, broom making, wool knitting, oil expelling etc. The villagers are furthermore keen to participate in community-based programmes. Very good community cohesiveness is observed. There exist village level institutions such as Self Help Group (SHG) in every village. These SHGs are very active. The villagers in each five villages are willing to participate in every aspect of management of the plant. They were ready to contribute both in cash and kind.

Table 3.3 *General information on the villages*

	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Number of households	38	56	57	50	62
Population	228	320	377	282	274
Male	122	164	165	132	130
Female	106	156	212	150	144
Literacy [%]	32	61	86	55	28
Male	24	45	62	36	19
Female	8	16	24	19	9

The inhabitants of the villages in general mainly spend time on farming for their own subsistence. The land they have available per village, however, differs, as is shown in the table below.

Table 3.4 *Land record (collected from the revenue office) of selected villages*

Name of the village	Total geographical land [Hectare]	Total revenue land [Hectare]	Total grazing land [Hectare]	Total revenue forest land [Hectare]	Total waste land [Hectare]
Jodi	556.14	102.76	5	1.14	441.9
Suruni	1171.52	49.52	2.65	1.41	1122
Tambalbai	155.69	96.77	5.09	9.50	48.6
Jimbakuti Rengalpadu	Land related secondary information is not available				

3.2.4 Economic situation in the villages

The field survey yielded that the income level (cash income) of almost all households is about Rs 3,000-5,000 per annum. The income does not vary substantially among households, although there are landowners and landless, which results in a difference in income and wealth. The cash income is generated by among other things the selling of tamarinds, mango's, and jackfruits. The production of paddy, millet etc is only for own consumption. In some seasons, selling of forest produce gives them some income, but this is not very substantial.

3.3 Energy needs assessment (demand)

Demand has been assessed in the categories of domestic; commercial; industrial; community and agricultural sectors. Domestic and community level demand has been classified under minimum-load category, while the others are considered as desirable. During survey, different categories of demand have been ranked on the basis of preference given by the villagers. Table 3.5 shows the demand preference matrix. It is observed that the villages would like to use electricity mostly for domestic purposes whereas agricultural load comes as the second priority.

Table 3.5 *Preference matrix*

	Villages				
Categories	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Domestic	1	1	1	1	1
Commercial	3	3	3	3	3
Community	4	4	4	4	4
Agriculture	2	2	2	2	2
Industrial	5	5	5	5	5

3.3.1 Household load

The household electricity demand assessment was done on the basis of the villagers' requirements as articulate during the survey. The domestic load has been estimated for two situations: Minimum load or desirable load.

Figure 3.3 *A typical house*

Minimum load

It is observed that the typical houses in these regions have two rooms and one veranda. All these portions would be used during the evening lighting hours, especially if income generation activities are promoted. Therefore three lighting points (CFLs) would be required to meet the lighting requirement. However from the field survey it is revealed that apart from lights, villagers of this region are interested in other electricity services too such as operation of TV, radio, tape recorder etc. Thus the minimum load per household has been assessed as 60W as follows:

2 CFLs of 11W consuming maximum of 15W each	30 W
Load for entertainment	30 W

This would also be adequate to switch on three light points (CFLs) simultaneously. Alternatively one light along with small fan/B&W portable TV/tape recorder etc can be used. Apart from being the source of entertainment, TV and radio are also important as a medium of education and awareness generation and can play an important role in the development of this backward region.

Desirable load
The villagers would be better off with extra convenience: two-fluorescent lamps (one of 50W, other of 30W) and 40W of additional load (TV/fan), which could be switched on simultaneously. From convenience point of view to the end-user, 120 W load is more desirable.

Type of demand	Load [W]	Provision
Minimum household demand	60	3 CFLs (11W) or one CFL (11W+one connection for radio/B&W portable TV/small fan/tape recorder etc)
Desirable household demand	120	2 fluorescent lamp +TV/fan/radio

3.3.2 Community demand

Lighting load for schools in the village for community activities in the evenings, point for community TV, load for primary health centres (PHC), Panchayat Ghars/community hall, streetlights and pump for drinking water supply are considered as community load. However current community load requirement was assessed on the basis of existing infrastructure of the village. Load for streetlight and some miscellaneous community load is considered as community demand.

One streetlight of 11W is suggested for every 10 households. It is seen that in this region, houses are in rows, sharing common wall and facing each other. The width of the houses varies from 10-15ft and there are around 15 houses in one row. The street lights would be set up in such a manner that two light points will cover two rows (length of each row is within 50m) which face to each other.

Provision for community loads such as community TV, lights at community halls etc., has been made. This is estimated as 40W in very small villages with less than 20 households and 100 W in larger villages.

Type of community load	Street light(s) + other miscellaneous load such as light at common halls, community TV etc.

3.3.3 Commercial demand

A village electrification project providing only lighting leads to improved quality of life but may not lead to sustainability in the long run. For additional income generation, it is necessary to develop other loads in addition to lighting for the betterment and economic stability of the village such that load development leads to continuous flow of revenues.

From this perspective, several activities that could be taken up by extending the working hours by providing lighting were listed in consultation with the villagers. However, to release the villagers' time to carry out such income generation activities, some of the activities that take up their effort and time such as paddy hulling, flour milling etc. need to be mechanised.

The purpose of assessing the commercial load is to assess the current as well as the potential electricity demand for commercial/income generation activities. Demand assessment was done on the basis of existing use and load pattern with willingness for such services.

	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Existing Commercial Load	Video parlour	Nil	Small shop	Nil	Rice huller, flourmill, shop
Planned economic activities	Lighting based income generating activities				

In Tambalbai, the existing infrastructure (12 horsepower system) has been set up by Mahila Sanghs. Total amount of Rs 55,000 has been expended for this purpose, which was taken as loan under SGSY scheme. The existing commercial load is run by diesel. Total 30-35 litres of diesel is consumed in one month and these machines run for 3-4 months in a year.

In addition to milling, bangle trading is another activities taken up by Mahila Sangh. Tamarind selling, mango processing and selling are some of other activities, which contribute to the cash income to the villagers. Some small income generation activities such as opening of small shops are expected in near future. During discussions with villagers, they expressed a keenness to operate the existing mills through the proposed power project paying ‘commercial’ tariffs for electricity.

At present there are a few shops in different villages. Due to lack of lighting facility the shops have to be closed in the evening. With the availability of light, the hours of opening of shops could be extended. The survey indicated that mango processing, mango pickle making, tamarind processing and packaging, millet packaging, wool knitting, broom making, beedi making, and oil extraction through manually driven oil expeller would be the small income generation activities electrification of the region. However all the activities would not be started in every village and activities would depend on the availability of resource.

During the survey it was also revealed that currently, villagers are not utilizing the resources properly because of lack of exposure. It is expected that once electricity reaches in these villages and villagers are exposed to different programmes, the economic activities will gradually grow up. Though villagers have no prior experience of above mentioned small income generation activities, they are very keen about taking up these activities.

3.3.4 Industrial demand

There was no existence of industry in this region. Discussions with DRDA officials revealed that all the small-scale industries, which were in operation in the past in near by regions, had closed down because of lack of financial viability.

3.3.5 Agricultural demand

Agriculture in this region is primarily based on rain. As discussed above, shifting cultivation is the common practice. Cultivation of millet, maize, arhar etc., is mostly done on the hill slopes. Paddy is cultivated in relatively plain areas. At present, due to water scarcity some lands remain uncultivated which can be used for cultivation once irrigation facility is available for them.

During the survey, agricultural demand came mostly from those villages situated in relatively plain areas and where there is a scope for paddy cultivation. In the villagers view, with irrigation facility, number of crops and cultivation area can be increased and crops such as paddy, millet and vegetables can be grown.

Agricultural pumping load was considered wherever villagers expressed a keen interest. This load has been included in desirable load and adds to energy and capacity requirements.

3.3.6 Total energy requirement of villages

Total energy requirement of the villages is calculated on the basis of minimum and desirable load profile. Total minimum load of the village includes minimum domestic load and community load whereas total desirable load includes total desirable domestic load, community load, commercial load and agricultural load. Table 3.6 shows the electrical energy assessment of the villages.

Table 3.6 *Electrical energy assessment of the villages*

Name of the village	Minimum energy requirement of the village [kWh per village per day]	Desirable energy requirement of the village [kWh per village per day]
Jimbakuti	14	36
Jodi	22	79
Rengalpadu	22	50
Suruni	19	44
Tambalbai	23	75

3.4 Renewable energy potential assessment (supply)

In order to estimate which villages would be suitable for which type of renewable energy resource, a resource assessment has been done. The assessment is based on primary information collected from the field and on the secondary data available from different sources. The renewable energy resources investigated are: solar, biomass, hydro, wind, sources of biogas, hybrid system.

Information such as land use pattern (types of land - forest, revenue, cultivated, grazing, waste), crop pattern (types of crops that are grown in the particular village), type of tree species grown in the forest area, types of fuel wood, depth of underground water (water table), forest norms etc. was collected from government departments and published documents.

The feasibility of the energy source for the particular village depends on the match between potential for supply and the identified demand, which was assessed in the preceding section.

- *Availability of solar resources*: Mean daily global solar radiation in this region is 5.4 kWh per square meter per day with approximately 250 clear sunny days.
- *Availability of biomass resources*: Availability of woody biomass for power production and land availability for energy plantation were the two options that were checked. Sustainable production of biomass from forests was estimated using the data on area of forestland and the expected yield per hectare. The right to access to forest was also checked.
  The availability of biomass for power generation on a sustainable basis was estimated by deducting the existing biomass consumption for domestic purposes[4]. From the land record (see Table 3.4) as well as from the field visit, it is observed that plenty of wasteland is available in 3 villages (Suruni, Tambalbai, Jodi) where dedicated energy plantation could be done.

[4] The current domestic requirements of biomass for the villagers were obtained from the household level questionnaire. It is observed that the fuel wood consumption was mainly for cooking and found to be 5-6 kg per household/day (with 4-5 members in a household).

Therefore for these villages current supply of biomass option could be from the existing source (from where they are collecting the fuel wood) until the energy plantation is not fully operational. Even villagers are keen for supplying required biomass at the plant site. Land record for village Jimbakuti and Rengalpadu is not available in the revenue office. However, from the field visit and interactions with villagers (in these two villages), it was revealed that supply of biomass at the plant site on long-term basis could not be ensured.

- *Availability of hydro resources*: Though a stream is flowing in the periphery of this region, it is not perennial and there is no head (height), which is required for the required power generation.
- *Availability of biogas resources*: The availability of biogas resources has been assessed on the basis of total cattle population available in the village and the potential of the biogas that can be obtained from the existing cattle source. Table 3.7 shows the electrical energy generation potential from cattle dung in each village.

Table 3.7 *Electrical energy generation potential from cattle dung*

	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Cattle population	77	145	110	98	81
Dung production per day [kg]*	231	435	330	294	243
Electricity generation potential [kWh]	9.3	17.5	13.2	11.8	10.0

* Dung yield per cattle head per day is 3 kg.

Table 3.8 *Comparison of minimum energy requirement of each village and the energy generation potential from cattle dung*

Village	Minimum energy requirement of the village [kWh per day]	Desirable energy requirement of the village [kWh per day]	Energy generation potential from cattle dung (biogas) [kWh per day]
Jimbakuti	14	36	9.3
Jodi	22	79	17.5
Rengalpadu	22	50	13.2
Suruni	19	44	11.8
Tambalbai	23	75	10.0

From the table it is observed that in no case, energy generation potential from cattle dung (biogas) is sufficient to meet at least the minimum energy requirement of the village.

- Availability of wind resources: Though wind data is not mapped in this region it is observed from local sources that wind potential is not sufficient and too variable to meet the minimum power requirement of the villages.
- Potential for hybrid electricity generation: The option for electricity generation from hybrid system has also been explored. As there is no hydro as well as wind resources available for these villages, the option for any hybridisation with these two technologies have been eliminated. Therefore for these 5 villages, there is no potential for hybrid electricity generation.

Summary of results
Table 3.9 summarizes the feasible technological option for 5 villages. A type of resource is considered feasible if the supply can meet the demand.

Table 3.9 *Feasible technological options for the 5 villages (revise based on demand analysis)*

Type of resources	Jimbakuti	Jodi	Rengalpadu	Suruni	Tambalbai
Solar	+	+	+	+	+
Biomass	-	+	-	+	+
Small hydro	-	-	-	-	-
Biogas	-	-	-	-	-
Wind	-	-	-	-	-
Hybrid	-	-	-	-	-

3.5 Technology selection; introduction to the technology selection tool

The technology selection (as explained in detail in Annex I) has been carried out as per the technology selection tool that was developed by TERI as a part of the 300 villages study undertaken for OREDA. Briefly, the technology selection tool involves the following:

1. Based on energy demand assessment and resource assessment finding technologies that can meet local energy requirements.
2. Choosing the technology based on a hierarchy of choices.

On the basis of technology selection tool, technologies selected for these 5 villages are as follows:

- Jimbakuti Solar PV based power plant (mini-grid system).
- Jodi Biomass gasifier based power project
- Rengalpadu Solar PV based power plant (mini-grid system)
- Suruni Biomass gasifier based power project
- Tambalbai Biomass gasifier based power project

3.6 Other issues

Technical ability

In the present context, villagers are not technically competent to upkeep the power plant as they are not familiar with the system. However in all villages under study, they have shown their interest for learning all operation and maintenance aspects of the system and are hopeful to perform basic operation and maintenance of the system in subsequent stages if proper training is given to them.

Willingness to pay (WTP) for the service

Economic viability is an important issue that affects the sustainability of village electrification projects. Willingness to pay (which in the case of these poor villages is basically the same as ability to pay) was assessed from this perspective. It was found that willingness to pay was limited and was related to the expenses incurred on kerosene for lighting. Willingness to pay for domestic electricity ranged between Rs. 20 and Rs. 50 per household per month. The willingness to pay some upfront contribution to meet the capital cost of the project was also assessed. This ranged between Rs.100 to Rs. 650 per household. It was also found that initial installation charge could go up to Rs 1000 per household if installation provision is given.

However, there is a large scope for development in some cases, villagers are unable to give definite answer on WTP because this concept is new to them.

Institutional suitability and stability
Operation and maintenance a power plant is a routine activity and a proper organisational structure is required to ensure reliable operation. Community involvement in this activity is very helpful. The willingness of the community to take up operational and maintenance responsibilities was assessed during the survey. Past experience of collective action is one of the instruments to measure the cooperation among the community. Their experience in linking with Government programmes is also a useful measure.

From this perspective, the experience of the villagers in community action such as formation of Self Help Groups, and a Village Development Committee (VDC) was assessed. The presence of any NGOs in the village and their activities were also noted. Very strong community cohesiveness was observed during the survey. There exist some active SHGs in almost all villages, which are involved in several income-generating activities such as bangle trading, cosmetic trading etc.

Willingness to take responsibility
Villagers have expressed their interest to take the responsibilities in order to operate and maintain the system. They are willing to participate in every aspect of management of the plant. They are ready to contribute both in cash and kind.

3.7 Ability to afford village electrification

Two studies were conducted to evaluate the ability to afford village electrification. Below follow summaries of the results of the studies, as well as a simple case to summarise the findings.

3.7.1 Enhancing tribal livelihoods

This section evaluates the two studies done: one speculative study by the READ Foundation on what could be done in the five target villages in Orissa, and a second by BASIX on the real experiences in the state of Jharkhand.

Evaluation of five target villages in Orissa
The findings of the study have been generated by interactions with the tribal in various Focus Group Discussions, which have been held separately with women SHG members, farmers, tribal engaged in non-timber forest produce collection, traders, intermediaries for collection of the primary data. Secondary data have been collected from the block development office, and several other organisations.

The findings indicate that on electrification of the villages, value-addition of the locally available minor forest produce is possible with minimal intervention which will generate an additional average per household, per annum income to the tune of Rs. 2800, by a conservative estimate. The economic impact can be realized in a time scale of 0 to 24 month (READ, 2005).

The tribal villages are very much interested to light their houses, mainly because they want to join with the mainstream of development process of the country. It is expected to boost their morale and bring a change in attitude. It may also help in children’s education resulting from the extra time availability. During evening due to illumination more cash income can be generated. SHGs will play a major role as financing source for various small horticultural as well as for trading activities.

Electrification will also facilitate the process of socio political empowerment of these marginalized communities through capacity building trainings and awareness generation activities.

Findings in Jharkhand

BASIX has performed a study on the impact of village electrification on enhancing tribal livelihoods (BASIX, 2005). The objective of the study was to study the livelihood patterns of tribals and assess the potential impact of electrification on the livelihoods of the 7.5 million tribal populations in Jharkhand (2001 census), contributing to 28% of the total population in that state. The primary tribes are Santhals, Mundas, Paharias and Oraons. While the Santhals and Paharias are mostly found in the Santhal Pargana region, the Mundas and Oraons are found in South Chotanagpur belt. The socio-economic characteristics differ between tribal communities.

There are 32,620 villages in Jharkhand. As per 1991 census less than 10 percent of the village households are electrified. The government claims to have electrified 45% of all villages. Agriculture is the primary occupation of all the tribal communities in Jharkhand with paddy being the staple crop, which is cultivated in the kharif season. Due to lack of rainfall and alternative irrigation facilities during Rabi and summer, most of the poor tribal communities undertake dry-land crop cultivation during this period besides non-timber forest produce collection, labour and migration. The advanced tribal communities like Oraons undertake vegetable cultivation with the help of irrigation pump sets.

The study shows that the impact of electrification will be different from community to community. In case of advanced tribal communities like Oraons who are already using diesel pump sets for irrigation, electrification will result in direct savings of approximately Rs. 4,500 per annum. Moreover, many of them will undertake vegetable cultivation especially during Rabi and summer if reliable power is made available. As per the survey, this can generate additional income of approximately Rs. 20,000 per household.

The authors of BASIX (2005) argue that electrification will have less impact on backward tribal communities like Mundas, Paharias and Santhals, unless it is provided along with other services like input and market linkage, technology and knowledge transfer about cash crop cultivation, financial linkage for availing loans to purchase irrigation pump sets and risk mitigation techniques. This is due to fact that these tribal communities presently undertake cultivation of crops that are totally rain-fed due to lack of irrigation facilities. Since cost of irrigated agriculture is high, only cash crop cultivation will be remunerative under electrification.

The research shows that it is possible to increase the income of these farmers (having land holding size of 2 acres) by approximately Rs. 80,000 (farmers will have to pay for availing the above services, which has not been deducted from the incremental income) per annum if reliable electricity is provided along with all other package of services. However, electricity by itself is not the answer.

In the non-farm sector, the few tribals who own enterprises whose operations need power as a direct input (such as photocopying shop) will benefit more and are willing to pay for power than those who need power only for lighting. However, most tribals are still not adept at advanced non-farm activities, and hence it will take some time before they value electrification.

3.7.2 The case of Tambalbai

It is clear that in the existing circumstances, the villagers are not in a position to afford both the capital and the recurring expenses involved in setting up, operation and management of village electrification projects. The above shows that, though electrification could provide benefits, sensible policy is needed to generate those benefits. We use the case of Tambalbai to show what the impact of electrification may be:

Name of village	Tambalbai
Households	62
Population	274
Occupation	Farming, Labour
Cash incomes/hh	Rs. 3000 – 5000 p.a.

Economics

Technology selected, size	Biomass gasifier, 10 kW
Capital costs	Rs. 16.03 lakhs
Recurring costs	Biomass – extent of monetisation to be determined Cash expense of Rs. 30,000 pa for maintenance Operator wages

Revenues

Tariff/hh/month	Rs. 30
Annual revenues (domestic)	Rs. 20,600
Other revenue possibilities	Hulling & milling, irrigation water pumping and promoting

It can be seen that the revenues that can be generated from the current willingness to pay will hardly meet the operation costs. The villagers have expressed a willingness to provide biomass resource free of cost. But still, there would be a deficit to pay for expenses of maintenance and operator wages.

There is some scope to increase revenues through promotion of income generation activities. The potential for enhancing livelihood is also very large. Thus, village electrification will have to integrate into an overall economic development strategy so that drudgery reduces, quality of life improves, incomes increases and willingness to pay also increases. These are key issues that would have to be addressed in any implementation model.

4. Institutional and financial arrangements for village electrification in India

Key aspects of any implementation model are the institutional and financial arrangements anticipated. This section focuses on the institutional and financial framework adopted by MNES since the whole programme of remote village electrification through renewable energy is driven by MNES.

The key features of MNES framework are to provide capital subsidies through a network of institutions and to facilitate building of local capacity to operate, maintain, and manage. It is expected that the user communities will be able to pay for all operation, maintenance, and management costs and make the projects sustainable in the long run, with the support of the institutions with which MNES is networking.

In terms of financing the programme, and based on the implementation model as advocated by MNES, also other sources can be looked at besides the government and the villages themselves. There may be scope to use the Clean Development Mechanism for this purpose. Section 4.3 explores the room for that.

4.1 Institutional framework as foreseen by MNES

MNES has launched its 'Programme for electrification of Remote Census Villages and Unelectrified Remote Hamlets of Electrified Census Villages to Non-conventional Energy Sources' (RVE Programme) in December 2003. It has recently launched 'Test projects in Village Energy Security' within the framework of RVE programme with a slightly modified institutional model and with the objective of meeting all energy needs of the villages in an efficient manner.

The approach of MNES has been to provide capital subsidies to meet up to 90% of the capital costs of the projects subject to its benchmark costs. Also, having recognised the importance of sustainability of these projects MNES has promoted the concept of a long-term maintenance contract (10 years), the cost of which is capitalised.

The institutional framework adopted by MNES for RVE programme can be graphically represented as below:

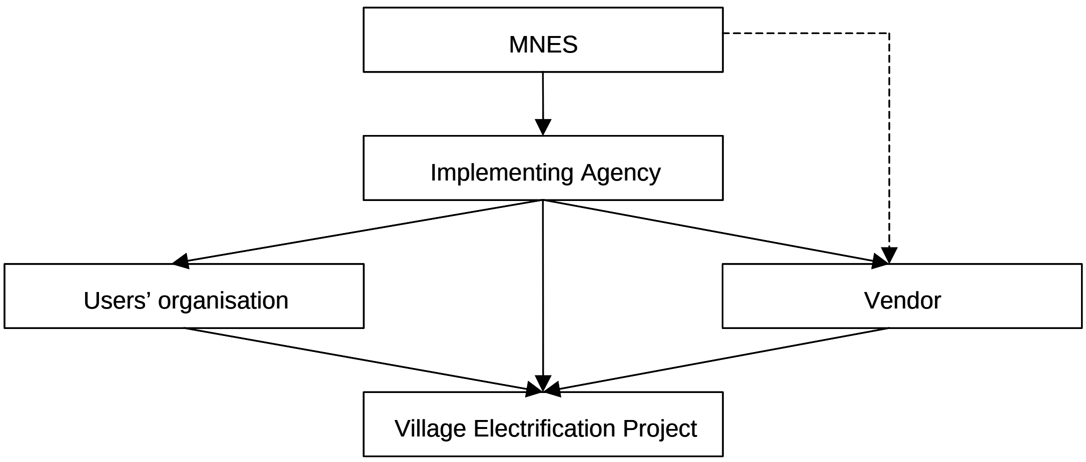


Figure 4.1 *MNES institutional model for RVE*

MNES evolves the funding schemes and detailed guidelines related to its administration. The funds for implementation are released to implementing agencies based on proposals received from them. MNES also empanels vendors and fixes standards and prices for the equipment.

The implementing agencies play a key role in implementation of these projects. They select the villages where projects are to be implemented, send proposals to MNES, organise balance of funds from other sources (state governments, local area development funds of elected representatives, villagers), procure equipment from vendors empanelled by MNES, supervise equipment installation & commissioning. The implementing agencies are also expected to form a local organisation of the users to operate and manage the project, take up their capacity building, hand-over the project to the users and thereafter withdraw. Operation of the project in a sustainable manner is expected to be the responsibility of the users' organisation for which it would get initial training from the implementing agency. The role of vendors is to supply, install and commission the equipment and to train the villagers in technical issues related to operation and maintenance. The vendor is also expected to provide warranty and maintenance support when the need arises.

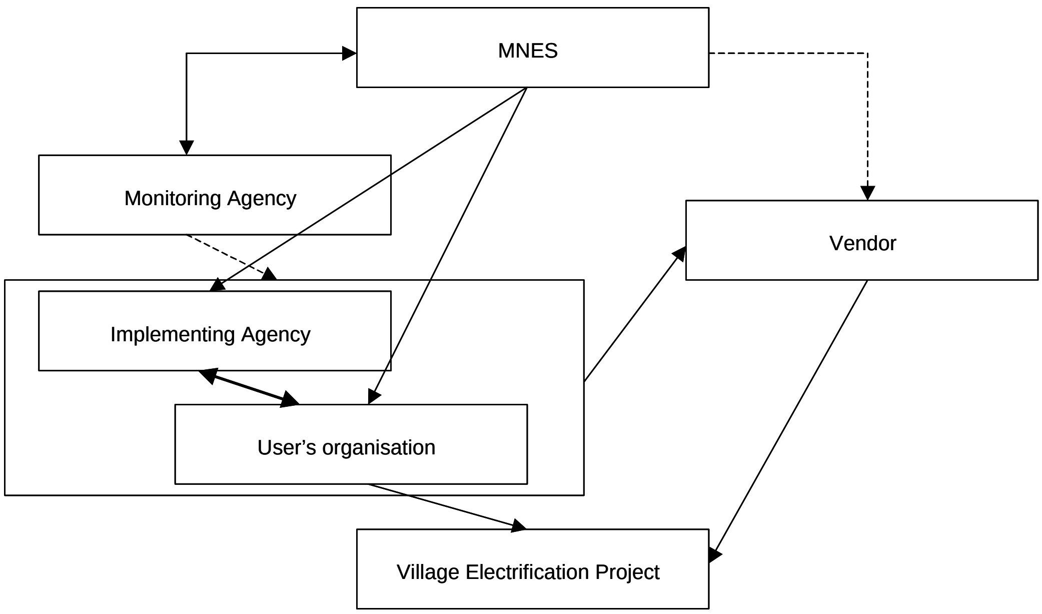


Figure 4.2 *MNES institutional model for VESP*

This model has been slightly modified for the VESP projects in view of the experiences gained. The modified institutional model is graphically depicted below:

The main modifications in the institutional framework are that MNES disburses its capital subsidy directly to the users' organisation into a bank account specified for the purpose. Role of the implementing agency is to identify the project, to make the proposal and to secure balance of funds from other sources. The implementing agency forms a partnership with the users' organisation and both of them work together to use the funds for implementation. They would directly interact with the vendors of equipment, supervise vendor's delivery and take up all necessary works essential for proper implementation. MNES pays the implementing agency a fee for this purpose. The monitoring agency is responsible to monitor the work under execution and report their observations to MNES based on which funds are disbursed. The implementing agencies are encouraged to engage the services of facilitators for training and capacity building of the users.

A more active role is envisaged for the users' organisation in planning and implementing of the village electrification projects in these test projects under VESP as compared to the RVE programme. It is expected that the more active role will result in a stronger sense of ownership leading to a higher probability of the success of the project.

The VESP projects also provide for meeting all energy requirements of the villagers such as lighting, cooking, water pumping and milling. Capital subsidy is provided up to 90% of Rs. 20,000 per household (or Rs. 18,000).

Even in this model, the onus for attaining the sustainability of the project is on the users' organisation. MNES has made a provision of meeting deficits in operating costs to the extent of 10% of capital costs if there is a strong case.

4.2 Overview of present institutions

Institutions involved in village electrification can be broadly classified involve the following:

- *State Nodal agencies (SNAs):* These are organisations set up by the different state governments to promote renewable energy in their respective states. SNAs have functioned as the implementing agencies for RVE and most other programmes of MNES in their respective states. However, for the test projects under VESP, SNAs have been designated as the monitoring agencies.
- *Rural Development departments/agencies:* Most state governments have departments/agencies for rural development, which have been implementing some of the renewable energy, programmes such as improved cook stove programme and biogas programmes. These agencies are now encouraged to become implementing agencies for undertaking the test projects of VESP.
- *Forest department:* Forest departments of various state governments have also implemented improved cook stoves and biogas programmes villages under their domain. Forest departments are now being encouraged to take up the role of 'implementing agencies' to take up some of the test projects under VESP.
- *NGOs/Private initiatives:* Major activities related to village electrification have happened through Solar Photovoltaic Home Lighting Systems. The total number of Home lighting systems installed is about 300,000 utilising subsidies provided by MNES (as on 31.03.2004). Thus, this has been a substantial activity. But, there is some doubt as to whether providing SHS can be called as electrification.
- Several village electrification projects have been implemented in different parts of India as not for profit initiatives outside the government funding. These initiatives are based on funding support from donor agencies/corporates. A few examples of these are:
    - Biomass gasifier projects by The Energy & Resources Institute in Chattisghad and Orissa.
    - Biomass gasifier based projects by DESI Power Private Limited in M.P., Karnataka and Bihar.
    - Micro-hydel projects by Technology Informatics Design Endeavour (TIDE) in Karnataka.
    - Micro-hydel project by WIDA in Orissa.

The above is not an exhaustive listing and there are many more initiatives.

All the different types of institutions have been able to install village electrification projects with varying degree of success. But, the key difference has been in ensuring sustainability. It is quite evident that the costs of delivery of electricity in remote rural areas with small capacity renewable energy projects are much higher than the willingness of users to pay. Apart from this there is also the issue of capacity building to manage a technically oriented activity like power generation & distribution and development of a sense of ownership.

The importance of the last two factors has been well understood from the experiences of the different NGO initiatives. This understanding has lead to the refinement of governments' implementation model too.

4.3 Other issues: potential role of the Clean Development Mechanism

In the model by MNES for the VESP, the implementing agency could try to obtain revenues from the CO_2 reductions by using renewable energy. This section explores the scope to do so. The Clean Development Mechanism (CDM) is one of the flexible mechanisms of the Kyoto Protocol, which was agreed under the United Nations Framework Convention on Climate Change (UNFCCC) in 1997. The Kyoto Protocol entered into force in 2005 and will reduce greenhouse gas emissions in order to prevent dangerous climate change. Industrialised countries have taken on an obligation to reduce emissions (notable CO_2 resulting from fossil fuel combustion) below 1990 levels. These countries can use emissions trading tools to comply with their Kyoto targets in a more cost-efficient way. The CDM allows them to obtain emission reduction credits (called Certified Emission Reductions, CERs) from developing countries by means of projects that reduce emissions. It is important to note that the CDM has two important conditions. Firstly, the government of the developing country should acknowledge and endorse the project and should indicate that the project contributes to its own sustainable development aims. Secondly, the project should be demonstrably additional, which means that the project developer should prove that he would not have implemented the project without CDM. The UNFCCC-based institution the CDM Executive Board requires a project to first outline what would have happened with the greenhouse gas emissions of the project activity if it would not be a CDM project. This is the baseline. Subsequently, the emissions from the CDM project are subtracted from the baseline and the emission reductions are approved.

Issues for CDM in connection with electrification through renewable energy are numerous. According to the guidelines for small-scale CDM projects, off-grid renewable energy projects can be implemented under the CDM as they will lead to emission reductions. The emission factor in the baseline that should be used is 0.9 $kgCO_2/kWh$ (based on the emissions resulting from a diesel generator). The additionality case for an electrification project as the one implemented by the Government of India is troubled by the fact that there is a policy for renewable energy electrification. However, the latest suggestions from the CDM Executive Board (which is the UN body overseeing the CDM) indicate that there may be a possibility to register policy-favoured projects as a CDM project, if there is reason to believe that the policy intentions are not likely to be implemented and significant barriers can be demonstrated.

The main problem in co-financing through CDM, however, could be the level of financing. Prices of CERs are currently around 5US$/$tCO_2$. Suppose that one village will get a 10 kW system, which runs for 6 hours a day during 300 days of the year. The electricity produced would be 18,000 kWh/year. Considering the emission factor of 0.9 $kgCO_2/kWh$, this is about 16 tCO_2/a. For one village, the revenues from CDM would be about 80 US$ per year, which corresponds to about 3600 Rs/a for the whole village. Unless implemented by an agency that bundles a large number of villages and can cover the transaction costs associated with the CDM project, financing through CDM is contributing a little, but not much. If increases in scale can however be obtained, e.g. if the Orissa Renewable Energy Development Agency acts as a bundling organisation, implementing the whole Orissa electrification plan as a bundled CDM project, the revenues could be used for the financing of the programme (and to cover transaction costs such as verification costs). OREDA would have to legally arrange the ownership of the credits. Assuming that 5,000 villages in Orissa will be electrified in a similar way as the example above, the revenues would be some Rs. 18 million per year. A training programme could for instance be financed from this revenue.

5. Is the MNES electrification plan set up for sustainability?

The Government of India plans to electrify about 25,000 villages with renewable energy by 2007. A large part of the villages is very poor with very low cash incomes. The responsibility for the implementation of this plan lies with the Ministry for Non-conventional Energy Sources, which aims at providing a 90 to 100% subsidy on the electricity systems. The policy documentation recognises the importance of sustaining positive impacts and operation and maintenance, but no provisions are made if the villages are unable to pay for the maintenance. The generation of additional income because of the electrification is projected to be sufficient to cover those costs.

This plan is evaluated above, in a roundtable meeting and in a stakeholder consultation. The results of those are in Section 5.1. Section 5.2 proceeds with a discussion of the plans of the government and suggestions on how the electrification can best be realised.

5.1 Stakeholder consultation on sustainability of remote village electrification

Stakeholders were consulted twice during the project, about best approaches for remote village electrification in general and specifically for the situation of the villages in Orissa. Firstly, a roundtable discussion was held in Delhi, India on February 1st, 2005. Secondly, in March, a number of Indian and international stakeholders was interviewed on best applicable approaches. They were asked what their current involvement in rural or village electrification was, what their opinion on the MNES plan was and what they saw as essential conditions for success, and whether they would see a role for themselves in the MNES programme. In the roundtable discussion as well as the interviews the MNES approach was discussed. The outcomes of both consultation rounds are discussed per subject below.

5.1.1 Roundtable discussion

A number of stakeholders from various backgrounds, including governments, NGOs and private parties discussed the current insights in rural electrification implementation models during the round table discussion in Delhi. Before the discussion the participants were presented with information on village electrification and the results of the survey of the five Orissa villages.

Mr. S.B. Rath of the READ Foundation gave an overview of the potential income generation possibilities and the increase in income that may provide. The current income would be around 3000 Rs, after three years this could have grown to about 7000 Rs. Growth would start slowly and hope should not be given up after one year. Socio-economic impacts could be in the field of better living standard, health, education, relief of food insecurity, impact on emotion and attitude, and women empowerment (READ Foundation, 2005).

Mr. Maharnav Patir of BASIX talks about their case in the Jharkhand region (see BASIX, 2005). He argues that a whole-livelihood approach is needed and that just giving one component is not sufficient for ensuring development. Energy (or micro-finance) is not a goal in itself but a catalyst to improving living conditions. BASIX provides support to small organizations working in livelihood improvement. BASIX's experience shows that different approaches needed for different scales (large enterprises can deal with loans, medium enterprises with Joint Liability systems and marginal farmers, such as in the villages in Orissa, by Self Help Groups).

Mr. Benudhar Sutar (WIDA), represented by Sameer Maithel (TERI), reports on the Putsil case, a village similar to the five villages in the project. The micro-hydel installation in the village has a good record in reliability of the system. Supply hours are 9 per day. The income rise was around 3000 Rs/yr per household. Much more individual access to TV and radio, and in addition, a community TV and computer were installed. Education practices have started, leisure time available, particularly for women.

Mr. Liby Johnson (Gram Vikas) highlights a number of issues that can contribute to the sustainability of rural development projects in general and rural electrification specifically. Lessons learnt in the institutional and processing fields are democracy in governance, women participation and consensus based on proportional representation. On financial issues: People have to pay until it hurts to pay. If not, ownership and responsibility are too low to make the project a success. Payment can also be done in non-cash currency; e.g. in labour. Investment in capacity building, mobilization and motivation are necessary to build confidence with the users of the energy provisions - create demand by exposure to other villages. Capacity is also important; technical; administrative and accounting; conflict resolution; and management of external contacts. It needs to be kept in mind that the villages addressed are systematically excluded from normal influence channels and programmes. A strong role for the village local organizations should be ensured (Gram Panchayats).

The main results from the discussion on the presentations are:

- In ideal cases, income can be augmented with Rs. 30,000 (about 5,000 fuel savings, rest extra income)
- For economically inactive villages, livelihood approach is needed - project should be supported by other policies and should not be a goal as such
- For economically active groups, electricity combined with training on how to use, exploit and maintain it
- Diversification of the livelihood and income generation means should be enhanced, particularly from the farm to the non-farm sector.

In addition to the above, and in the final panel session, general discussion took place on the following topics:

- *Financial implementation model*
  In general it was found that to ensure ownership, the village communities should have a strong stake in the energy supply and should take up responsibility for the operation and maintenance. However, given the limited cash income of the villages in Orissa, an almost 100% subsidy from the government on the investment seems inevitable. In addition, it was suggested that for certain technological options, the operation and maintenance costs might also have to be partly subsidised for a few years. The government states that though it will strive to ensure that the project will finance itself after the capital subsidy, there is a possibility for a temporary provision to ensure post-commissioning provisions.
- *Organisational implementation models: actors to involve*
  It is broadly felt that the government should be responsible for the programme. The possibilities of involving the private sector in a public-private partnership model are low in the case of the five Orissa villages, as this type of villages is so poor that the private sector considers them as an uninteresting market to invest in.

A number of possibilities exists to increase private sector involvement in the electrification of very poor remote villages. The government could design a policy for public-private partnership, where it would take care of private investment risk. It could also be done through a tendering process. The private sector could also contribute in a non-financial form.

Community ownership of installations, especially when combined with promotion of livelihoods through additional income generation activities, is seen as an advantageous approach to village electrification. For NGOs the programme is too large to manage, but they could play a role in this part.

The effect of village electrification on income generation and timeframe for implementation

The provision of electricity enables the initiation of livelihood activities, which could lead to additional income generation of Rs. 3,000 (in very basic conditions) to Rs. 30,000 (in very favourable conditions) per household per annum. The perspective to generate income from the energy services varies greatly, and income generation will not start immediately. Villagers need time to accustom themselves to the new possibilities. After commissioning and depending on the circumstances, it is judged that villages need several years to generate sufficient additional revenues to ensure self-sustenance of the energy system.

It was recognised that the timeframe between the initiation of the project and the commissioning of the energy system can be two to three years, if community mobilisation is included.

Summary paper

The outcomes of the roundtable were summarised in a one-pager, which is in Annex II. This piece of paper was distributed during the rural energisation session at the Delhi Sustainable Development Summit 2005.

5.1.2 Stakeholder interviews

Stakeholders were interviewed on the their experiences in remote village electrification, best applicable approaches for village electrification in general and for village electrification in Orissa. Annex III gives the questions and an overview of stakeholders consulted. The outcomes of the interviews are summarised below.

Financial implementation models

The interviewees agree that ownership is of utmost importance for success of village electrification projects. Ownership strongly influences the way in which installations are operated and maintained. Bad operation and maintenance are seen as important points in which electrification projects can succeed or fail. Impacts of the projects are low when maintenance is neglected. In order to increase the sense of ownership and feeling of responsibility, it was felt that systems best not could be subsidised, or at least not over-subsidised. Furthermore electrification in general leads to income generation, which decreases the need for subsidies over time.

One of the interviewees, a representative of a commercial PV system provider, has had bad experiences with subsidised electrification schemes in the past. He claimed that after-sales in subsidised schemes, just like theft, selling of systems on the market, external operation and maintenance and need and user assessment for the systems may form a problem. Furthermore in a subsidised scheme one supplier often has a de facto monopoly position. This may lead to market distortion and an increase in price, as donor organisations will pay anyway. The interviewee furthermore mentioned the preference of donor organisations for new but still unproven technologies, which was observed by him.

One option for financing electrification is micro-credits. One of the interviewees argues that regional banks or micro-credit organisations could have a role in public-private partnerships. Commercial financial institutes will probably not be involved in financing village electrification in India, as commercial institutions have no access to subsidised funds.

Opinions on the usefulness of micro-credit differ. One of the interviewees is strongly against micro-credits as its use increases transaction costs. Furthermore as governments often agree to take the risk in micro credit financing, the use of micro-credits sometimes forms hidden subsidies.

As the villages in Orissa are very poor the interviewees agreed that subsidising is probably a necessity for village electrification. The following options were mentioned:
- Cost sharing within sponsors and customers.
- The use of separate tendering procedures for supply, installation and after-sales.
- The capital cost of replacement of installations if necessary, should also be covered in a rural electrification programme.
- Subsidising in interest rates and longer payback periods.

Organisational implementation models: actors to involve
One of the interviewees is a strong believer in commercial supply of rural electrification systems. According to this stakeholder sales should be left to commercial actors, including local dealers. Public funding can then best be used to develop local dealership and to increase sales dynamics.

Another commercial organisation feels the implementation of an electrification project should include post-commissioning and installation of the system. Bad after-sales and maintenance or often mentioned as points on which electrification projects can fail. In order to enable proper installation and after sales, fixed prices should not be set too low. Another interviewee mentioned that in installation and after-sales local dealers could best be involved as this leads to capacity building.

The effect of village electrification on income generation
In general, all stakeholders interviewed agreed that electrification could increase incomes. One interviewee argued that possibilities for income generating activities partly depend on the coherency of the village and the presence of literate individuals. The same interviewee mentioned the remoteness of markets as one of the main causes for electrification programmes to fail. It was also argued that solar home systems could have a positive impact on income generation as the systems are sometimes used at night for commercial activities.

System size
The interviewees do not agree on the optimal size of the systems supplied. The one feels that systems should generate enough income to cover the power costs. Another argues that when finance is tight, individual households and also villages would be best off if first a smaller system is used. Another again explicitly states that the provision should be demand-driven and that electrification aimed at one-lamp systems are not sufficient. This is contradicting the claim by the former comment, which argues for starting with smaller systems and generate demand for larger.

Village electrification plan of Government of India
At the end of the interview, the Government of India village electrification plan was discussed, focussing on the situation for the remote, very poor villages. The possible role of the stakeholders within the plan was also discussed. Almost all interviewees were critical on the plan.

Main critiques included:
- Too much subsidised, no room for commercialisation and private sector, market monopolies should be avoided.
- No provisions for accounting or to combat corruption.
- Insufficient operation and maintenance provisions.
- Costs of replacement can be very high, which is not covered.

- If the equipment supply is tendered out, explicit attention to after-sales aspects should be given.

The private sector (financial and energy sector) indicated low interest for participating in the programme, as a supplier or in a public-private partnership context. Banks have no access to subsidised funds, it will be therefore be very difficult for banks to work with subsidised interest rates or government guaranteed pay back times. PV system suppliers indicated that participating is only worthwhile if a large part of the village is electrified and therefore a significant market is created. Another comment was that the plan works with too low, fixed prices. It was also highlighted that earlier experiences learn that the subsidies from the Indian government can arrive late and as margins are low, this might become a problem if a supplier participates on a large scale.

The Dutch government had no interest as they are pulling out all development assistance to India.

5.2 Recommendations on sustainable implementation models

Based on the discussions above, and notably while keeping the key aspects of a sustainable electrification project in mind, we propose here an implementation model that could be able to serve even the poorest of the poor; i.e. the type of villages that were surveyed in this study. The key aspects are to ensure ownership, to ensure affordability, and to ensure that positive impacts are sustained. Assumptions are that the cash income for the villages is very low, that a level of income generation can be achieved, but that this can vary between villages, and that the technology that is supplied is desired by the inhabitants, and can be used to obtain the extra income generation. Before explaining the model for low-income villages, we will first indicate the underlying assumptions and will also give the situation in the case that the villages are more in the middle-class, and a more commercial model can be followed.

The model we propose for the low-income communities is not a public-private partnership model in the strict sense of the word. Though private and public sectors play a significant role, it is possible that they are not in a symbiotic state in the model. The relationship boils down to the government (both national and the local panchayat) hiring services of the private sector to provide the villages. This goes for the equipment supplier, the consultant, and the financial sector. It is possible, however, to change the model slightly to oblige the local private sector, which is taking care of the operation and maintenance to make small investments in order to enhance income generation. If this can be agreed, and the implementation model gives the flexibility to do so, it would be a public-private partnership in the strict sense of the word.

We emphasise the totally different situation between the remote villages with a middle class and the villages with only very poor people. The former group is interesting for the private sector as the risk that the electrification project will fail is low here, and chances are high that a local market will be created which offers opportunities for the private company involved. Therefore, there is scope for public-private partnerships for this class. For the poorer villages, this is different. The income is so low that it will take a lot of time to grow to a level where the village communities can afford the operation and maintenance costs. Moreover, the fact that the villages are so poor is partly due to their remote situation (far away from markets), the low level of literacy and education, and potentially a lack of ideas and entrepreneurship. The potential for income generation for this group is therefore low, and it may not be interesting to invest in. The Government of India should make a clear distinction between the middle-class and low-income groups. A one-size-fits-all policy in the subject of village electrification will still deprive the poorest villages from electricity, as the implementation model will not be adapted to their needs.

5.2.1 Assumptions on electricity in India

Below, the models for the middle-income villages and the poor villages will be explained. We start, however, with contemplating on the energy situation and the electricity price developments in India. The current situation is that the Indian urban dwellers get electricity quite cheaply, because of the conveniently dense concentration of the people in the urban and suburban areas. These are also the areas where people have a higher ability and willingness to pay for electricity. The rural areas, quite to the contrary, face higher electricity generation and distribution cost because of low population densities, and complex landscapes. These people also have the lowest incomes and the lowest ability to pay for the electricity - especially against the high prices. A kind of cross-subsidy should take the form of an ‘energy access deficit charge’ for the urban areas. Cross subsidising would have to involve the same company and as the electricity sector in India is liberalised, this is hard to achieve. The energy access deficit charge can only be realised by feeding in on electricity tariffs, so not on stand-alone generation where the owner of the installation is the village community. It will therefore only be applied to the middle-income remote villages in the implementation models that are proposed below.

The current general situation is explained in Figure 5.1. This figure, especially increasing the converging of ability to pay and electricity cost, represents the higher objective and the leading principle for the models proposed below:

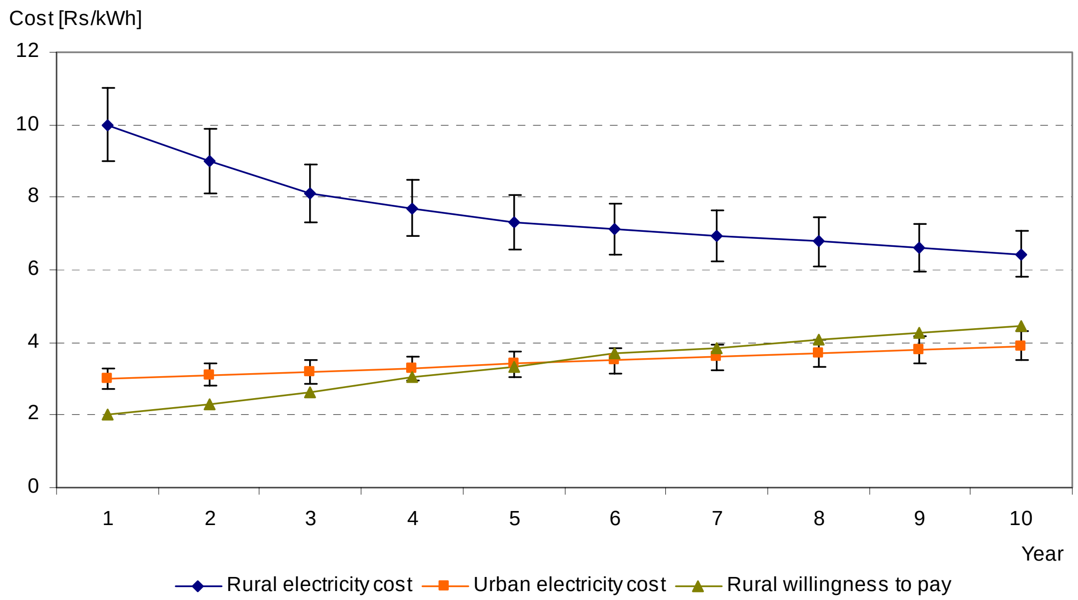


Figure 5.1 *Desired cost development for electricity in the rural and the urban context.*
Note: Also depicted is the willingness to pay of the rural population. The idea is that with the provision of electricity, both ability and willingness to pay in rural areas goes up. The willingness goes up because of the affection with the service, and the ability to pay goes up because of the additional income generation thanks to the access to energy. It is assumed that the willingness to pay of the urban areas equals the cost of electricity there. As a leading principle, the willingness to pay never exceeds the cost of electricity. The numbers on the y-axis are rough assumptions and should be regarded indicative.

Keeping this ‘idealised situation’ in mind, which should be the aim of the electricity situation in India, below we introduce two models for middle-income remote villages, and low-income remote village communities.

5.2.2 Middle-income remote villages

Taking the perspective of the Indian government, an implementation model based on the services by an energy service company (ESCO) is most attractive because a capital subsidy will not be needed and the spending could be kept to a minimum.

In that case, the villagers will pay per kWh electricity used. The government will in the best case only facilitate market access or flanking income generation activities, or in a sub-optimal case also subsidise electricity costs. If the systems are not metered, the use can be estimated. Assuming that - analogue to the telecom situation in India - an 'Energy Access Deficit Charge' is heaved on the urban electricity provision and this tax is used to fund the Government's electrification programme, the costs could be kept low as well. The development of spending of the Government on one village would then look as in Figure 5.2 (electricity costs are all indicative):

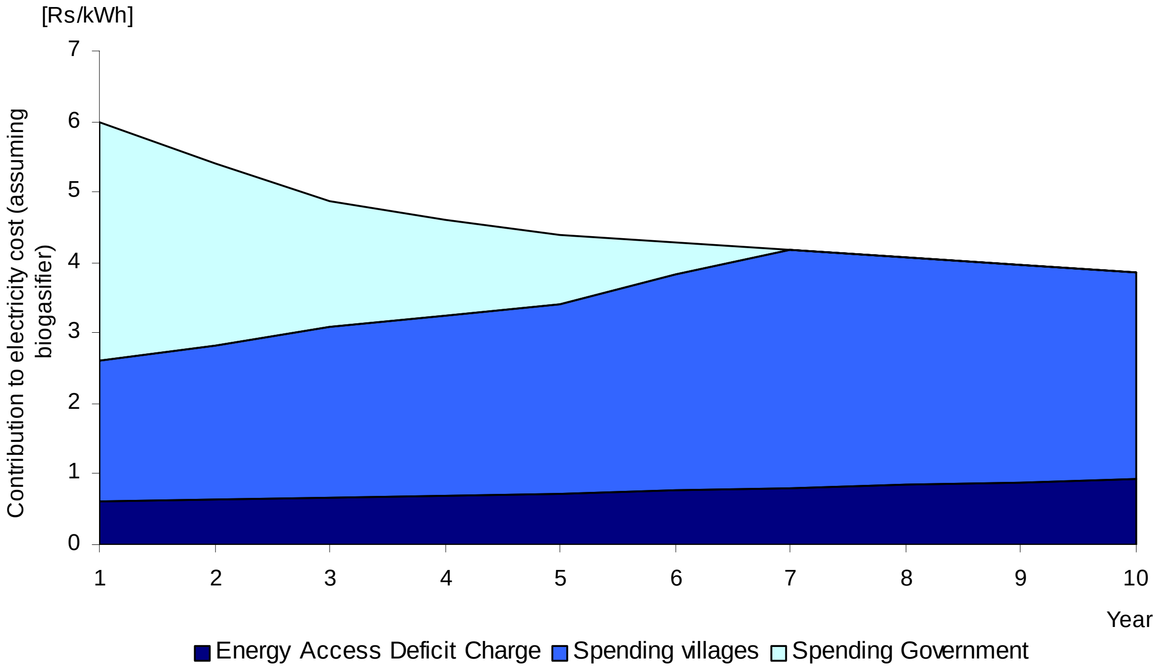


Figure 5.2 *Development of electricity cost and spending over the period of a project.*
An 'Energy Access Deficit Charge', analogue to the telecom charge that is applied in India, is anticipated to be about 10% of the urban electricity costs. This is used to finance part of the rural electricity provision. The costs of electricity indicated here are general assumptions. At the start of the project, the government would still finance the larger part of the electricity cost, and the villages only a small part, according to their ability to pay. Quickly, however, the ability to pay increases and leads after several years to the ability to afford the electricity tariffs - while the revenues from the Energy Access Deficit Charge increases slightly because the urban electricity prices are assumed to rise slightly.

This model follows the public-private partnership model. The partners are the Village Electricity Committee, the government and the ESCO. Potentially, there is a bank or a micro-credit facility involved to manage the finances. The government needs the ESCO to fulfil its needs, and the ESCO needs the government to facilitate the market that will eventually be lucrative. Ownership and post-commissioning are arranged for in this model, as is affordability as the villagers have sufficient income to be able to afford the service.

5.2.3 Low-income remote villages

In the case of the very poor, tribal villages (of which an estimate of 11,000 still needs electrification) a capital subsidy is unavoidable as the village inhabitants cannot pay or keep savings for even 10% of the installation costs. The field surveys in Chapter 3 also pointed out that even the operation and maintenance costs could be too high to be covered by the village population, even if the whole community is involved and a VEC or SHGs are in place. The studies by the READ Foundation and BASIX and the discussions during the Roundtable on Village Electrification showed that sufficient income generation could be achieved to cover these O&M costs. It was already suggested at the roundtable that the Government should therefore also subsidise part of the O&M costs, though with a timeframe on it.

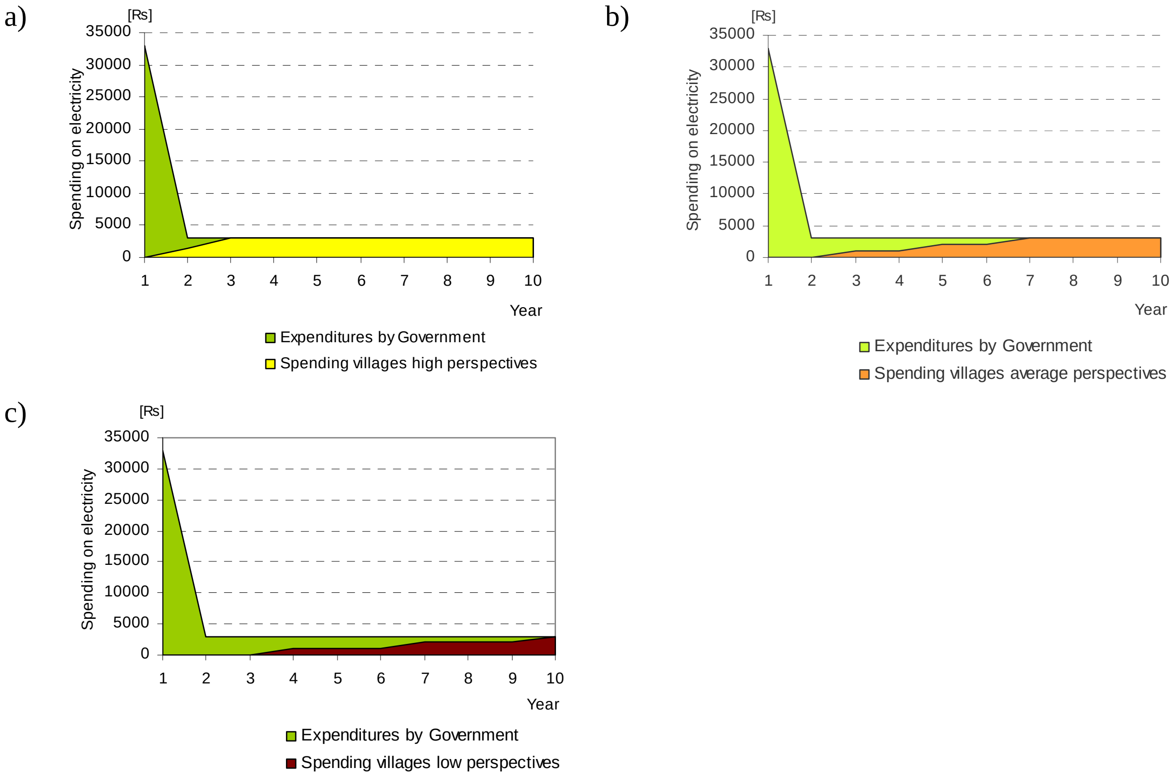


Figure 5.3 *Electricity expenditure developments in the electrification model*

The figure concerns electrification of remote, poor communities, assuming fictional capital and O&M costs. (a) the development in the case of poor communities that have good prospects on income generation to cover the O&M costs, e.g. because they have good access to markets. (b) average villages, and c) villages with low prospects for income generation.

We propose to survey the poor, remote villages on perspective for income generation before electrification is taking place, which will have to be done anyway to determine the energy needs. Based on current income, the activeness of the inhabitants, the access to markets and the ideas that exist on starting businesses, the prospects on income generation should be estimated into three groups: (a) high perspectives, (b) average perspectives and (c) low perspectives. Each group would have a different period in which their O&M costs will need to be covered. There will be a 100% subsidy on the systems. This may be compensated by lower subsidies (e.g. 80%) on richer other villages.

This model addresses the issue of affordability, as this is the main bottleneck in the villages we talk about. The post-commissioning is also taken care of, as the panchayat will contract an O&M provider, who could also and ideally play a role in market and business development and who can train people from the village in daily maintenance of the systems. Ownership is the weak point. A capital subsidy on the installations *and* subsidised O&M costs in theory are devastating for the sense of ownership of the villages.

The proposal therefore includes a provision for a village bank account, which is also fed by a fee that one of the village inhabitants will collect, depending on the ability to pay. The bank account for the village will also be used by the government to provide the payment for the installation and the O&M costs and will be used by the panchayat to pay for the O&M, the installation, and other issues that may come up and that relate to the energy provision. Training on business development or on optimal use of energy for instance could be funded from this as well. In that way, the responsibility and therefore the ownership is transferred to the village itself. Each village - depending on how prospective they are rated - will have an O&M funding period of e.g. 2, 6, and 9 years, where also a stepwise decrease in funding could be envisaged. This can also incense the village inhabitants to look for income generation activities as otherwise they will lose their highly desired energy provision.

Because of the stepwise process, the involvement of banks, equipment and O&M suppliers, the panchayat and even a state nodal agency to do the auditing, the construction is quite complex. This could be a disadvantage. However the advantage is clear: the energy will be provided in a sustainable way to the poorest of the poor. In addition, each participant remains doing their core business, which decreases risk of failure because of non-delivery of the tasks. The bank sticks to banking, the equipment supplier supplies equipment and emergency O&M, the operators of the systems do the daily O&M, and the government is a mere facilitator. Again from the government perspective, the expenditures will be high, but predictable. The theoretical development of the expenditures is indicated in Figure 5.3, where the three perspectives groups are distinguished.

The ‘high perspectives’ villages involve communities that can generate more income right away and could only need government support for the O&M costs for two years, wherein already a gradual abolishment is foreseen. The middle panel shows an average group, which would not be able to generate income so quickly, but which can grow into economic activities once electricity is provided. The last group has very low perspectives. Though a theoretical timescale of 9 years is given here, it may well be that these villages will never be able to afford the electricity cost. The government should keep this in mind.

The above model has the following actors and roles:

- Surveying consultancy/NGO: will establish the ‘perspective rating’ of the village and will perform the initial survey. Will also inform the village of the possibilities for income generation.
- Village Electricity Committee/Panchayat: is the owner of the systems and the receiver and spender of the subsidies. Responsible for basic O&M.
- Bank: will keep the bank account, on the name of the village electricity committee or panchayat.
- Central government: will provide the earmarked capital subsidies to the bank account and will do the regular O&M payments.
- Installation company: will install the systems, receive the money from the village bank account, and will also perform training in simple daily maintenance, and in potential activities to be exploited (follow-up from the surveying).
- State nodal agency: will perform monitoring, and will do the accounting and auditing of the electricity provided.

We feel that the difficult circumstances in the low-income village communities do enable this model is the best model that completely fulfils the requirements that were posed in Chapter 2: affordability, ownership and post-commissioning provisions. The uncertainties remain in the technology, the level of O&M costs, and in the ability of the village communities to develop enterprises and generate extra income.

The model in the way it is posed above assumes that the income generation activities are the responsibility of the villages. The incentive to take that responsibility is given by the decreasing provisions for operation and maintenance from the side of the government. The risk is therefore with the villagers. An alternative model could be that the installation company is obliged to make small investments in the villages, in order to facilitate extra income generation in a more progressive manner. In that case, the risk would be with the installation company and the model would qualify as a public-private partnership, as the private partner would then run a financial risk if the project does not succeed. The question is one of conviction and of pragmatism: is the risk for income development small enough to be taken on by the private sector on a small scale, or is it better off with the villagers themselves? We do not attempt to answer this question, as there is something that can be said for both cases, but we do point out that the model introduced above can serve both perspectives.

5.3 Differences with the MNES-RVE and VESP plans

The model proposed in 5.2 bears similarity but is not the same as the MNES plan as presented in Chapter 4. The similarities are that both models foresee (probably inevitable) capital subsidies, some degree of training, and a strong involvement of the user's organisation. The main differences are in the following:

- Differentiation between villages, which may be able to afford an ESCO model, between high, middle and low-perspective villages.
- Financing of O&M costs by the government, but with a fixed timeline, in addition to the capital subsidies planned.
- Active stimulus for income generation.
- MNES sees much cooperation between users and implementing agency, which is less in the proposed model; that sees more cooperation between the users and the private sector. State government is responsible for the revenue subsidy if required.
- Implementing agency's role more limited in TERI/ECN model; restricted to monitoring and auditing.
- Potentially a mutually dependent relationship between the public and the private sector.

6. Conclusions

The implementation model that the Government of India currently aims to use for electrifying its remote villages with renewable electricity is inappropriate for a large number of the target villages. The planned uniform policy of capital subsidies of 90 to even 100% will over-subsidise many and under-subsidise the most needy. This conclusion stands out after the project team of ECN and TERI examined international experience, did a detailed survey in a number of poor and remote tribal villages in Orissa, and consulted a number of stakeholders.

The objectives of this report were to provide insight in the sustainability of implementation model currently anticipated by the Government of India for 25,000 remote villages, and to propose an alternative model, which, based on a review of the village situation and on a general review of Indian and international programmes and projects for electrification, would ensure a higher degree of sustainability.

A review of international and national initiatives for remote village electrification indicates that the project will only work if affordability, ownership and post-commissioning are given appropriate consideration. These variables, however, can be in conflict with each other. Especially affordability, which is a relative term as it depends on a highly variable ability to pay of village inhabitants, is often inversely correlated with the creation of a sense of ownership and with proper - but costly - post-commissioning.

In general, literature teaches us that capital subsidies are considered a risk for electrification projects. Private sector involvement is regarded as a good thing, preferably in a public-private partnership where a symbiotic relationship is developed in the fulfilment of the project goals. However, the affordability is at stake, as the involvement of corporations requires prospects of financial viability and a market.

It is concluded that an ESCO model, where the Government of India gives revenue subsidies for a given number of years and where it is expected that both the costs for decentralised electricity goes down, because of scale and learning effects, and the ability to pay goes up, would be most appropriate for villages already capable of paying some of the electricity costs in Rs per kWh, the so-called ‘middle-income villages’. Possibly, an ‘energy access deficit charge’ on electricity for urban areas could be used to cross-subsidise the more expensive electricity in rural areas.

This model would however lead to a problematic situation for electrifying very poor, tribal villages, such as those studied in Orissa in this report. The present plans of the Government of India are also insufficient, as it was concluded that present cash incomes in the villages are too low to even cover operation and maintenance costs for electrification and provisions for ownership enhancement and post-commissioning seem insufficient. The private sector would therefore probably not invest in this area and the government programme will also not yield the desired results. The extremely low incomes demand a tailor-made approach to ensure that the affordability question is solved, which in our view must involve capital subsidies.

We propose to grant the initial capital subsidy and also provide a revenue subsidy for a fixed and pre-determined period of time. If these subsidies are not given, the villagers cannot afford the electricity provision. Both subsidies should be transferred - earmarked - to a bank account operated by the Village Electricity Committee, which should also contribute a small internal fee itself. The operation and maintenance should be performed by local people in conjunction with a company representative in or near the villages.

The same private company responsible for the execution of the operation and maintenance should provide training and support with the setting up of small businesses and other economic activities, which would eventually lead to extra income generation and would in the long run enable the villages to afford their own electricity. Differentiation between the villages in most and least prospective for economic activities should result in differentiation of the maximum period of revenue subsidies for the villagers. An important task is also auditing and monitoring, which could be done by a state nodal agency.

Discussions on the best implementation model are still ongoing. It is certain that the preferred model is dependent on the local circumstances, which vary greatly even in the portfolio remote villages identified by the Government of India. We plead for a differentiated approach. Conditional criteria for villages that determine their associated implementation model are still to be developed. This study has made another step in this direction.

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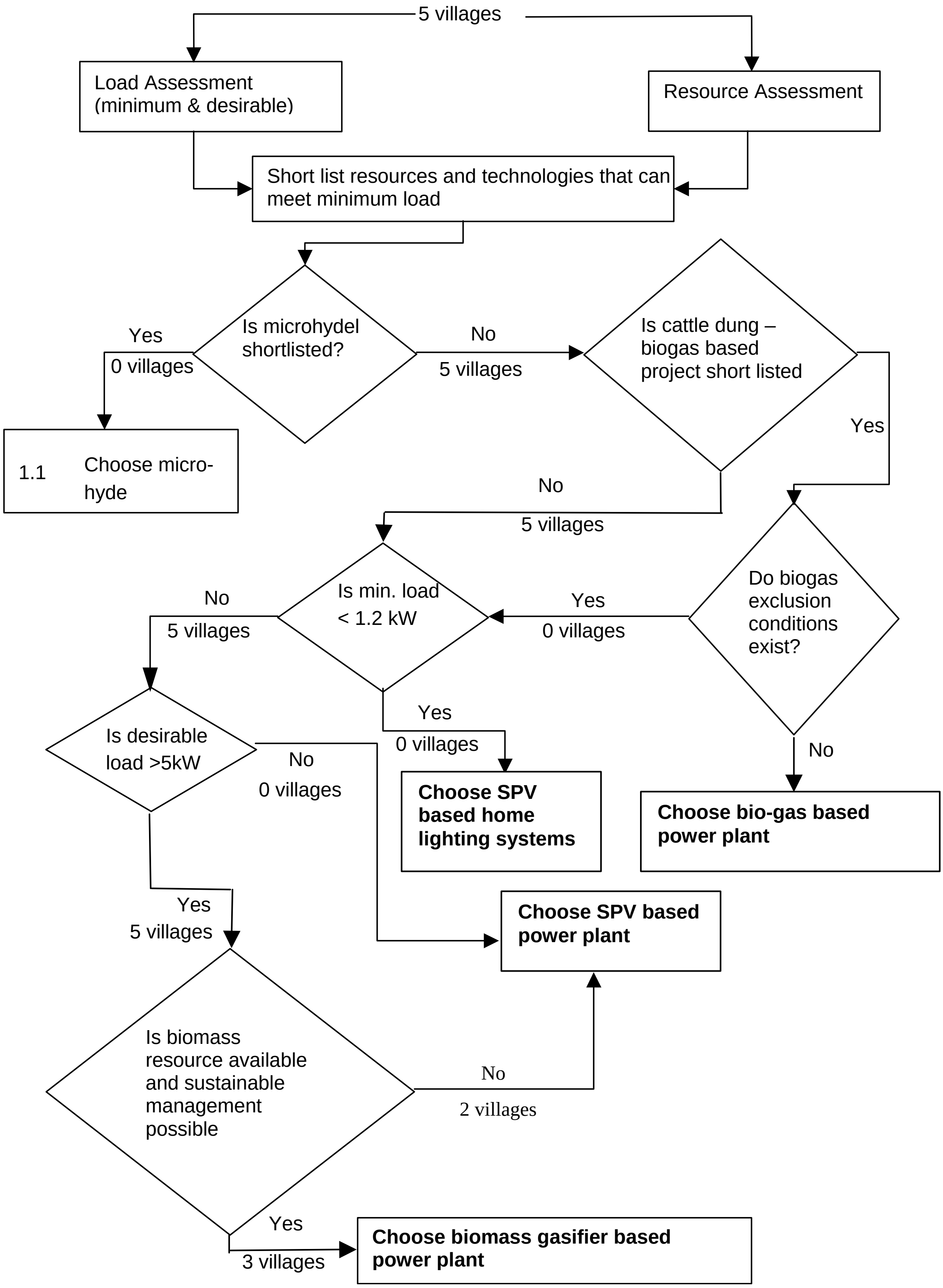
Appendix A Technology decision tool



Appendix B Roundtable discussion note

The Roundtable on Sustainability of Remote Village Electrification Projects

On February 1st, in the run-up to the Delhi Sustainable Development Summit, around 30 representatives from government, NGOs and the private sector gathered to discuss the current insights related to the implementation issues of village electrification. This note discusses the outcomes of the meeting and is published exclusively for DSDS participants.

The Ministry for Non-conventional Energy Sources (MNES) of the Government of India aims to provide electricity to about 25,000 unelectrified remote villages in India based on renewable energy resources. The majority of the villages are tribal villages in the east and northeast of India. Initial surveys indicate that energy provision can be based on biomass, solar and micro-hydel resources. In the case of the biomass option, the biomass supply should be done in a sustainable manner. The tribal villages typically have a strong sense of community, which is beneficial for building community stake and thereby ensuring effective electrification. However, the purchasing power of the villages is very low with cash incomes being as low as Rs. 3000 - 5000 (US$60 - 100) per household per annum. This poses a major challenge to make these projects viable. Regarding the implementation model, which can be defined as the total of provisions and policy leading to the realisation of a certain goal or operation, much is still open.

The participants of the Roundtable found that community ownership combined with promotion of livelihoods through additional income generation activities would contribute to sustainability in a positive way. Based on the case study of a cluster of five Orissa villages within the VERI[1] project, and the papers presented, the following emerged in the discussions:

- In order to ensure ownership, the village community should have a strong stake in the energy supply and should take up responsibility for the operation and maintenance. However, given the limited cash income of the villages, an almost 100% subsidy from the government on the investment seems inevitable. In addition, it was suggested that for certain technological options, the operation and maintenance costs also may have to be partly subsidised for a few years.
- The provision of electricity enables the initiation of livelihood activities, which could lead to additional income generation of Rs. 3000 (in very basic conditions) to Rs. 30,000 (in very favourable conditions) per household per annum.
- It was recognised that the timeframe between the start of the project initiation and the commissioning of the energy system can be two to three years, if community mobilisation is included.
- The perspective to generate income from the energy services varies greatly, but income generation will never start immediately. Villagers need time to accustom themselves with the new possibilities. After commissioning and depending on the circumstances, the villages need several years to generate sufficient additional revenues to ensure self-sustenance of the energy system.

There was discussion on the possibilities of involving the private sector in a public-private partnership model. However, research indicates that the villages are usually so poor that the private sector considers them as an unviable market to invest in. It would help if the government could design a policy for public-private partnership, where it would take care of private investment risk. This could be through a tendering process. The private sector could also contribute in a non-financial form. The complexity of the challenge appears to require a tailor-made solution for each type of village or technology, but the scale of the programme calls for a degree of uniformity. Making use of the inputs of this Roundtable, the VERI project will provide a report detailing potential directions for an apt implementation model towards the end of March 2005.

The project thus aims to contribute to the development of the government's remote village electrification programme.

Delhi, February 2nd, 2005

[1]**VERI project information:** The Roundtable on Sustainability of Remote Village Electrification Projects was organised on February 1st, 2005, by TERI as part of the project 'VERI - Village Electrification through Renewable energy in India', funded by the Royal Netherlands Embassy and co-funded by the Energy research Centre of the Netherlands (ECN). The project aims to assess implementation models for remote village electrification on sustainability in the framework of the government village electrification programme. Requests for information or contributions and feedback are more than welcome with Heleen de Coninck of ECN (deconinck@ecn.nl) or K.J. Dinesh of TERI (kjdinesh@teri.res.in). Speakers included Mr. S.B. Rath of READ Foundation, Mr. Liby Johnson of Gram Vikas, and Mr. Ashok Singha and Mr. Maharnav Patir of BASIX.

Appendix C Summary of stakeholder consultation

Below, the questions sent to the interviewees in advance of the interview are listed. The interviews themselves were conducted by phone or in a meeting, where the questions below were not followed exactly, but used as a basis for the conversation.

1. Questions on general requirements for village electrification
   a. What is the role of your organisation in village electrification?
   b. Does your organisation aim at collective or individual provision of energy?
   c. What in your opinion would the electricity mainly be used for?
   d. Do you believe that the electricity provision will have a significant positive impact on the income generation in the village as a whole or in the individual household? Is this significant enough to make the provision worthwhile?
   e. In your view, which of the elements of an electrification implementation plan are *essential* to make village electrification successful and sustainable in the longer term?[5]
   f. Which elements do you think can make a village electrification programme fail?
   g. Do you think that you can extrapolate your experience in village electrification to other areas and other circumstances?

2. Questions on Government of India specific programme

   The Government of India plans to electrify ca. 25,000 villages with renewable energy by 2007. The villages are usually very poor with very low cash incomes. The responsibility for the implementation of this plan lies with the Ministry for Non-conventional Energy Sources, which aims at providing a 90 to 100% subsidy on the electricity systems. The policy documentation recognises the importance of after-sales and operation and maintenance, but no provisions are made if the villages are unable to pay for the maintenance. The generation of additional income because of the electrification is projected to be sufficient to cover those costs.

   What is your opinion on the plan? Does this plan seem sustainable to you? What do you feel should be changed or improved in order to make it work better?

3. Questions on own role in Government of India plan
   a. Under which conditions would you play a role in the Government of India programme?
   b. Would you prefer being involved in a public-private partnership?
   c. What role would you play?

[5] For example:
- Village should accept the electrification as a community
- Electrification on an individual basis
- Establishment of a Village Electricity Committee
- Beneficiary (i.e. village community or individual) should have a strong stake in the provision of electricity
- Private sector partnering in the electrification programme
- Financial sector partnering in the electrification programme
- Beneficiary should contribute to the purchase costs of the system
- Beneficiary should take care of the O&M costs
- O&M to be done by an energy service company
- Local NGO involvement
- Training on the spot.

Table C.1 *Overview of stakeholders interviewed*

Stakeholder group	Name organisation	Role in electrification
Government	Ministry of Foreign Affairs, Directorate General on International Cooperation (DGIS), the Netherlands.	Active role in the Global Village Energy Partnership. Active partner in a joint implementation programme.
	Ministry of Non-Conventional Energy Sources, India.	Implementing pilot programme which should eventually lead to electrification of 25,000 remote villages in 2007.
	Ministry of Power, India.	Responsible for the aim of the Government of India that by 2007, all villages and hamlets should be electrified, and by 2012 all households.
Financial sector	Rabobank India.	Involved in financing of renewable energy projects. Not involved in electrification programmes or projects.
Producer/ supplier	Shell Solar, Singapore.	Producer and supplier of solar home systems. Active in many countries including India and Sri Lanka. In India the approach consists of selling SHSs door-to-door, installation and maintenance. Shell Solar's market consists of middle class average income populations, not the poorest of the poor.
	Free Energy Europe (FEE), Netherlands.	Producer and supplier of solar home systems. Active in Africa, Latin America and south Asia, currently not active in India.
	National Thermal Power Corporation (NTPC), India.	Currently conducting a number of pilot projects with biomass installations. Mandate is 100 this year.
	DesiPower/Development Alternatives, India.	Development Alternatives would be interested in investing in villages that would have perspective in income development, as that is their core business.