DECENTRALISED RURAL ELECTRIFICATION: THE CRITICAL SUCCESS FACTORS
[EXPERIENCE OF ITDG[1]]

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Summary

Rural areas of poorer countries are often at a disadvantage in terms of access to all types of services – roads, health facilities, markets, information, clean water. The high cost of providing these services in remote areas has led to new approaches being tried, based on self-help and the private sector rather than traditional government-led solutions. Energy services for household, agriculture and production are no exception. In the case of electricity, which has the potential to improve productivity and provide considerable welfare benefits (lighting, entertainment, etc.) traditional grid extension is no longer seen as the only solution. Decentralised supplies, whether at an individual household level or at community level, are now an established, cost-effective alternative for the two billion rural people who are currently without access to mains electricity.

In many cases renewables provide the most financially attractive means of providing that energy. Supplies may be of a similar standard to grid supplies (mini-grids supplied by diesel or micro hydro) or they may be low voltage household supplies (PV, battery charging).

This review of recent practice draws on ITDG's twenty years experience of supporting off-grid solutions in Sri Lanka, Nepal, Zimbabwe and Peru in particular, and on work by other organisations in other countries, such as Indonesia, Kenya, Vietnam, South Africa. It draws out the generic issues which are likely to be important in any country, but we also include others which are more context-specific on:

- **Financing**
- **Institutional support**
- **Ownership**
- **Management**
- **Local Participation**
- **Energy Management**
- **Standards**
- **Market**

ITDG is privileged to have worked with organisations in many different countries, particularly on community micro hydro-electric programmes, more recently on household PV systems, and we acknowledge the many innovative companies, governments and NGOs from whom we have learned.

INTRODUCTION

In a globalised world, access to electricity is almost taken as a basic human right. It is certainly a symbol of development. It provides at the least the social benefits of improved lighting and communication – radio and t.v. -- and in other cases greatly improved productivity with electrical appliances and machines. For many rural people, around two billion people in fact, this is still a dream. But the world is changing. No longer do cumbersome cash-strapped utilities have the monopoly on electrical supplies. Many new models are being tried out, and for practical reasons decentralised solutions are often the most cost-effective. Where renewable energy sources are available – solar, small hydro, biomass, wind – they can often provide remote communities and businesses with the most reliable and affordable source of electrical energy. This paper discusses some of the issues that have proved to be critical in practical experience of off-grid approaches over the last few years.

1. Energy services -- Electricity provides only some of the rural energy needs of remote communities. It can usefully substitute for candles, kerosene or batteries used for lighting, radios and television, and power machines and appliances to increase the productivity of production activities. It is rarely used to substitute for thermal applications like cooking.

Typical rural electricity applications include: radio/t.v.; lighting; fans and refrigerators; ironing; clinics, schools, shops, street lights; workshops; crop processing.

[1] ITDG is an international NGO with offices in Kenya, Nepal, Peru, Sri Lanka, Sudan, Zimabwe and UK. It has been working on rural energy projects of various kinds for 25 years.

In general, even with grid electricity it is rare for electricity to be used for cooking (other than heating small quantities of water). Off-grid (decentralised) electrification is often limited to lighting and communication (radio/TV) especially for solar PV and household battery-based systems. The other services will often not be met or will continue to be met from other energy sources, such as wood, kerosene, Liquid Petroleum Gas or diesel engines. The reason for this is the cost – of both the electrical appliances and the running costs (although there are means of reducing costs, as shown below).

The benefits of electricity, as compared with other forms of energy, are its versatility and convenience. Electricity can stimulate development that is already taking place. It will not initiate development. Communities which are very poor, with very little economic activity, are unlikely to derive much economic benefit from an electricity supply, although they may derive substantial social benefits from better lighting and communication. The World Bank's suggested *pre-requisites* for conventional grid extension provide a useful guide. Communities should have:

- some existing infrastructure investments (water, roads)
- access to markets
- growth in agricultural output
- growing number of productive uses
- improving living standards and income
- existing development activity in the area

More detailed socio-economic indicators based on these criteria have been used to prioritise villages to be electrified in Thailand:

- proximity to distribution network/other electrified villages
- proximity to good roads
- village size
- number of initial consumers/connections
- existing rural industry (use of rice mills, power tools, pumps etc)
- number of commercial establishments
- existing public infrastructure facilities
- Similar indicators have been used in other countries, such as Zimbabwe and South Africa.

Proposition: Electricity is highly desired by rural communities and will form an important component of rural energy supplies, provided that the conditions exist for other development activities. Social benefits may be more significant than economic benefits for poorer people.

2. Financing -- Rural electrification is not the sort of investment that is going to attract private investors looking for somewhere to maximise their return. True, there are examples of where state-provided schemes have been taken over by private investors and run profitably by cutting costs (particularly of staffing) and adjusting tariffs (recent experience in Nepal). However, most of these schemes have been purchased on very favourable terms from the utility. Private developers have mostly been motivated by providing power for their own productive uses (e.g. agro-processing of various types, workshops, shop lighting) or as a public service, to provide domestic electricity to the community at low marginal cost.

Private finance is more commonly a loan component complementing a mix of government grant/subsidy and local equity capital. Where such private sources of credit are not available there can be a role for the development finance institutions (e.g. an innovative approach adopted by the Inter-American Development Bank in Peru[2]) to provide bank guarantees or credit packages specifically for community micro-hydro. There is currently little interest from conventional banks, but they may be encouraged to lend at least a proportion of the capital if the schemes are "accredited, or supervised" by an intermediary agency - as they are in Sri Lanka. If credit is needed for individual household connections the most effective way to supply it is to build it in to a higher tariff (as in South Africa) or by supplier credit or micro finance scheme (e.g. for solar home systems). Poorer consumers will prefer flexible tariff arrangements, with low standing charges. Pre-payment metering (pay-as-you-go) is often preferred to conventional metering.

Rural electrification is subsidised in many countries, but the subsidies should be "smart", that is they should not be open-ended, they should be transparent and they should be available to the users (not suppliers) for the initial capital cost, not running costs.

Proposition: The capital cost of decentralised rural electrification is best met in the medium term from a mixture of local equity capital (community or private), and a loan component from a bank or other conventional credit organisation, at commercial rates backed if necessary by loan guarantee funds. Subsidies should ideally only be used where there is a possibility of their being phased out.

[2] The credit scheme in Peru consists of a revolving fund, providing loans to isolated communities for small hydro schemes – to normally about 25% of the capital cost. 18 schemes have been built to date, totalling 800kW, supplying 12,000 people, total investment approx $2.5 million.

3. Institutional Support – The business objectives of electrical utility companies generally do not encourage them to invest in rural schemes with low levels of demand. In any case they are rarely well placed to work effectively with rural communities in a supportive manner. It is suggested that there is a need for institutional support at the national and local level, but most particularly at an **intermediary** level.

- **The National Level** where the formulation of policy and plans for rural development provides the legal and regulatory framework within which the sector will develop. Policies such as import restrictions on generating equipment, fuel pricing, fiscal incentives for rural investment etc may be relevant. Legal restrictions on the independent generation and sale of electricity may need to be lifted. Flexibility in tariff setting may need to be sanctioned. Targets for the coverage of electrification by grid extension and decentralised schemes are also needed at this level to stimulate and focus activity. Rural communities need to know when, if at all, they can expect to have access to grid extension

- **The Local Level** where village and district rural energy supplies are implemented. Suitable owners may be community based organizations, electrification co-operatives supported by local NGOs, or branches of national NGOs. In Peru the micro hydro schemes are owned by the community but operation and maintenance is contracted to a private service company. In Sri Lanka the Electricity Consumers Society own operate and manage. All sectors of the population need to be involved in planning from the outset if the community is to own or manage the scheme. As electricity is new to such communities an intermediary can provide useful help in planning. Guidelines for developing a range of options and arriving at a consensus on the scope of electrification and on tariffs, have been developed and used successfully in Sri Lanka, Nepal, Zimbabwe, and Mexico.
- **The Intermediary Level** which 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.

  In Sri Lanka and Zimbabwe, for example, this role has been filled NGOs such as ITDG, backed by a national Energy Forum, with members from industry, consultants, government and NGOs. Such groups can play an important role in informing government policy from their understanding of the perspective of user groups, community organisations, local manufacturers, NGOs, financial institutions, and other actors.

The role of the intermediary level institutions includes:
- 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
- Support and advice to manufacturers,
- Facilitating financing,
- Information brokering – e.g. preparation of "Yellow Pages" in Sri Lanka,
- Providing simple guidelines for working out energy service needs, and presenting the technical options available with their costs, benefits, advantages and disadvantages,
- Facilitating 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,
- Setting the framework for tariff options,
- Promotion of rural electrification and electricity use,
- Co-ordinating Research and Development.

Proposition: Successful decentralised rural electrification requires a co-ordinated institutional approach with an enabling policy environment created by government, suitable local organisations supported by a regional or national intermediary body, which is charged with a variety of co-ordinating functions.

4. Ownership and Management – Electrical supply systems should ideally be owned by those with the most important stake in their success. For instance public or national utility ownership of decentralised electrification schemes may make sense for larger towns or district administrative headquarters. Such schemes may also be suitable for private development and operation particularly where there is potential for integration with the grid. Private ownership may be appropriate where there is a major industrial load that provides the major energy demand for the plant - examples include grain mills, textile mills etc, where excess power can be sold to the neighbouring community. Community ownership may be most appropriate in the majority of villages and small towns which are beyond the reach of the main grid and where the loads are poorly developed. The management of these schemes may be contracted out (as in Peru) or handled by the community (as in Sri Lanka). Ownership may also be franchised by the utility or the State to a

commercial operator as in Mexico, but to continue to be ultimately owned by the State. For household schemes such as PV-powered lighting and radio then individual ownership is normal, though leasing arrangements are also being tried.

Proposition: A variety of ownership and management options may be considered depending on the context.

5. Local participation - Community participation is now widely accepted as a pre-requisite to ensuring equity and sustainability of local infrastructure investments, such as water supply or rural 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, chamber of commerce, etc). There has been more success where intermediary organisations have helped the local planning process.

In small private schemes the equipment supplier may provide all the technical advice and support (Nepal), or the engineering and supervision may be the subject of a separate contract (Peru). Practical planning guidelines for community electrification schemes have been developed in Peru, Sri Lanka and Zimbabwe and there has been useful experience in many countries that could usefully be shared. It has been found that the planning of electrification by a community is best facilitated by someone who can explain the options in simple terms, as un-electrified communities will normally not be familiar with the technology or the implications of the choices. The materials used to present the technical options are best produced in the local language in a form that is suitable to the culture, and should be neither too complex nor patronisingly simplistic.

External assistance is also likely to be needed for the design and management of electrification schemes and the presentation of proposals for funding to appropriate sources of finance.

Proposition: Community participation in planning for electrification is likely to lead to more successful and sustainable schemes. Careful preparation is needed and locally appropriate guidelines prepared, and an external facilitator is recommended.

6. Energy Management - In communities that have been electrified, electricity becomes the most important source for energy services, such as lighting, radio and motive power for small enterprises, though it is common for fuels like kerosene to continue to be used. Its role in improving productivity is particularly significant. Decentralised schemes are often limited by the peak demand they can supply, so energy management measures to spread the load over time are desirable (demand side management). Successful methods include:

- *Demand limiters*. Electronic cut-outs which limit the power demand of each consumer, combined with a fixed monthly tariff, according to the maximum demand. These serve to reduce the cost of bill collection and metering and to reduce pilferage. Used successfully in India, Nepal, Zimbabwe and South Africa.
- *Time diversity for high load uses* - e.g. welding in afternoon only (Peru); off-peak water heating for bathing or cooking.
- *Pre-payment metering* both reduces meter reading costs and permits pay-as-you-go, which is often preferred by people whose sources of income are irregular or uncertain.
    - *Heat storage cookers* (Nepal and elsewhere). Low power cookers that store the heat over several hours (in hot rocks or water) and make it available at high intensity for short cooking periods. Such cookers are particularly well matched to 'run of river' hydro schemes, where the marginal cost of off-peak energy is very low. Technically very successful, these cookers have an initial cost that may be too high for very poor users.

Energy planning needs to take into account the reality of diverse sources of supply for different purposes. The costs of different supply options depend on the context (end uses, size of community, local technical skills, potential for expansion, socio-economic context etc). For example household PV systems may be more expensive than a diesel generator on a lifetime costing basis, but the costs of electricity distribution from a diesel to more remote houses may mean that for them, PV would be cheaper (with a more limited service).

Scope for cost reduction -. There can be considerable scope for reducing costs and improving the financial performance of electrification schemes. The initial cost of household connections can be reduced by a number of means, such as simple wiring looms with connection boards, as in South Africa and Nepal. The cost of meter reading and billing can be reduced by means of simplified fixed (maximum demand) monthly tariffs. Tariffs should be such as to provide a reasonable return on investment, so they may need to be higher than for grid-connected consumers. Some flexibility in setting tariffs to reflect costs is required.

Proposition: It is most important to provide a framework which will allow rural users to articulate their own demand patterns and to decide how these can best be met from a range of energy supply options.

7. Standards The setting of appropriate technical standards is an important aspect of quality control. Without such standards the lowest capital cost is likely to dominate, with unacceptable compromises in safety and reliability. Some element of consumer protection is needed if the market for off-grid systems is to grow. There are opportunities to reduce the cost of distribution in comparison with conventional electrification, without compromising safety or reliability (experience in South Africa, Nepal, Peru), but there is a need for a national authority to co-ordinate and set the standards and to train and accredit suppliers and consultants. Associations of manufacturers can have a useful role in setting standards and quality assurance procedures.

There is also a need for standard contracts and legal agreements, particularly for small projects, where project administration and management costs are a very significant proportion of the total. There are plenty of examples of suppliers having no obligation to supply spare parts or technical support.

8. Market aspects - The experience of most countries is that the market for decentralised rural electrification installations of all types has required *initial stimulation* to make it attractive to developers, consultants, manufacturers and financiers. The initial attraction for private developers may be in relation to specific productive end uses - e.g. grain milling in Nepal and Zimbabwe where the power unit is also used for battery charging or for domestic electricity supplies. PV schemes may also be attractive for loan financing on an individual basis, since the equipment may be removed if payments are not made. However, except in wealthier areas with an income per head of more than say $1000 per year, community electrification on its own is generally not an attractive investment unless supported by an element of grant subsidy.

Recent experience of the privatisation of some schemes in Nepal into the hands of private entrepreneurs, is that the new owners have made them profitable by reducing costs, such as staffing levels, and raising tariffs. The advantage in these cases is that the load had already become established following installation by the state.

CONCLUSION

Rural electrification is highly desired by rural communities. It has developmental benefits in the right circumstances (co-ordinated with other development activities) and its expansion is a political priority. A target of facilitating wide coverage of basic lighting and radio supplies (e.g. through low cost solar PV) should be complemented by higher power (diesel/micro hydro) systems for areas with higher potential demand. Conventional centrally-managed approaches have been expensive and unsustainable. Attention is needed to ways of reducing the capital costs and of managing the schemes so that they cover their costs to the greatest extent possible, with greater degrees of local ownership and management. In the last few years successful initiatives in different countries have explored new methods of extending electrification to the rural population at least cost, and making use of available renewable resources. This experience should be shared to make best practice available to all. ITDG wishes to link its various technical information networks to other networks, to share this type of experience in the interests of the currently unserved 2 billion potential rural electrification consumers.