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Low-cost electrification for household energy

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Boiling Point

ITDG
PRACTICAL ANSWERS TO POVERTY

In this edition…

IT Consultants (ITC) is the consulting arm of the Intermediate Technology Development Group; a resumé of the work of ITC can be seen on the back page of this issue. Our theme editor for this edition is Dr Rona Wilkinson, who is Energy Programme Manager for ITC. Her work includes project management, facilitating and running workshops/training sessions, and policy advice and dissemination, within the areas of renewable energy and rural electrification – we are very pleased that she agreed to be theme editor for this edition. As this is such a new field for *Boiling Point*, most of the edition is theme material – but please don't miss two excellent articles at the end – again on important subjects which have not been addressed lately. A very practical article on making low-cost grates to improve combustion efficiency of stoves, and another article on passive solar heating of water.

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Back issues of *Boiling Point*

If you would like a copy of any back issues, please contact us. Multiple copies will be charged at £2 per copy plus postage. A detailed index of all *Boiling Point* articles is also available. *Boiling Point* appears on the CD-Rom 'Humanity Development Library', with an excellent search facility.

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Technical enquiries to ITDG

If you have any technical enquiries, ITDG's Technical Enquiry Service should be able to help you. ITDG has extensive contacts worldwide, and can respond on a wide variety of development topics. A unit specializing in energy topics is particularly able to help in the household energy field.

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Contributions to *Boiling Point*

You are invited to send articles for the next two issues of *Boiling Point*, the themes of which will be:

- **BP46: Household energy and the vulnerable.** For those people and communities who have particular needs, access to household energy may be a major factor in their lives. This edition of Boiling Point will be dedicated to looking at those problems and possible coping strategies. BP46 will look at sectors of the community for whom access to energy is a particular problem such as: the elderly who are alone; children who have to fend for themselves; people with physical and mental disabilities; those who suffer long-term illness. The edition will also look at vulnerable communities, for example: those which are particularly isolated, and for whom climatic changes have had a major adverse impact; those urban communities for whom no formal tenancy arrangements, or their status, make access to energy difficult.
- **BP47: Household energy and enterprise.** For many people, the income that they generate comes from work done at the household level. The energy involved in these enterprises can be a substantial part of their household energy needs – such as for commercial baking, food processing, crop drying, producing street foods etc. Others may make a living providing energy for household use. This edition will look at ways in which energy and enterprise are related within the household context.

Articles should be no more than 1500 words in length. Illustrations, such as drawings, photographs, graphs and bar charts, are essential. Articles can be submitted as typescripts, on disc (preferably WORD), or by e-mail.

All correspondence should be addressed to: *Boiling Point* Editor, Intermediate Technology, Schumacher Centre for Technology & Development, Bourton Hall, Bourton on Dunsmore, Rugby, CV23 9QZ, UK, or by e-mail to <elizabethb@itdg.org.uk>

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Cover photo: Installation of power lines and street lighting from micro-hydro, Peru (ITDG Peru K1.10)

THEME EDITORIAL

Low-cost electrification; the need for access to energy services

by Rona Wilkinson

Electrification à bas coût et accès aux services dérivés de l'énergie
Environ deux miiliards d'êtres humains n'ont pas accès à l'électricité pour satisfaire les besoins énergétiques de base et fournir l'énergie à des activités productives. Les systèmes décentralisés sont une autre alternative basée sur les ressources hydrauliques, solaires, éoliennes ou l'utilisation de groupes électrogènes. Leur succès est cependant conditionnné par plusieurs facteurs non techniques notamment: l'intégration avec d'autres projets de développement, l'évaluation des besoins, la gestion de l'énergie, le financement et l'appui institutionnel, la participation des communautés, la capacité à payer et le niveau des tarifs.

Introduction: Lack of access

Rural areas in developing countries have limited access to all types of services – health, clean water supplies, communication and roads. This is also true for the provision of energy services, for domestic use, communications, agriculture and income generating activities.

It is estimated that around two billion people do not have access to grid electricity; in sub-Saharan Africa, it is estimated that the percentage of the population that is connected to the grid is between 4% and 25%, and the majority of those live in urban areas.

Why electricity?

Electricity can provide some of the fundamental energy services required by rural communities:

- at a domestic household level for lighting, radio and television, ironing, fans, etc.
- at a community level for clinics, schools, shops, and street lights
- for productive end uses and income generation through milling, crop processing, battery charging, workshop services

Options for supply of electricity

Electricity can be supplied through the grid or through de-centralised schemes, where the source of the electrical power is located in a specific community or even in an individual household. In the latter case, renewable energy sources provide the most attractive means of providing this energy, through hydro, solar or wind power. However if such resources are not available, then the use of diesel generators is another option. In terms of the services provided, off-grid options are often limited to lighting and communication, especially for solar PV and systems that use batteries to supply electricity, as the amount of power they can produce is limited.

Critical success factors

There are various constraints in providing electricity to rural areas. Grid extension has traditionally been seen as the only way to deliver electricity to the population. However, low population density, hard terrain and low levels of demand make it uneconomic to extend the grid to many areas. Harper gives an example, where even though the grid has been extended to villages in Orissa, problems have been experienced with non-payment and electricity theft.

De-centralised schemes are one alternative, and there are a number of success stories all over the world, as shown in many of the articles in this issue.

However, there are a number of aspects that have to be addressed for an off-grid scheme to be sustainable and successful. These are highlighted by Costa and Eck who give an overall view of what is required for a successful de-centralised electrification scheme, drawing on their experience in North East Brazil.

These aspects for success include:

- Integration with other development projects
  As described in the article by McMenemy the most successful energy projects are those that are integrated with other development priorities and projects.- electricity tends to stimulate development projects rather than initiate them. For instance a hydropower scheme can often be built on the back of a water supply project and provide greater benefits.
- Needs assessment and energy management
  Irvine Halliday et al look at the importance of carrying out a proper energy needs assessment within a community, looking at consumption, demand and needs and also how to deal with users wanting more electricity than they can afford to pay for.
- Financing options and institutional support

Theme

Rural energy development: an integrated approach in Nepal

by C. McMenemy[1], M. Williamson and F. Vitez[2]
1 Christopher McMenemy was a geography Ph.D. candidate at the University of Cambridge, studying energy and community issues in Nepal and northern India, when he and three others were killed in a yachting accident off the Dutch coast in August 2000. At the time of his death, this article was a work in progress. It is based on the paper he presented at the World Renewable Energy Congress held in Brighton, UK, July 2000
2 Lamjung Electricity Development Company, PO Box 5926, Kathmandu, Nepal

Développement de l'énergie rurale au Népal: une approche intégrée
Cet article passe en revue l'expérience de deux récents projets énergétiques de développement au Népal. Les deux projets ont pour objectif la réduction de la pauvreté dans des zones physiquement isolées et économiquement marginalisées. Selon cet article, les effets des projets sont optimums si les besoins énergétiques de base sont intégrés avec des objectifs productifs. Afin de minimiser les risques, un effort substantiel doit être accordé aux institutions locales et régionales.

This article discusses two case studies in Nepal

- the Community Based Economic Development Project – CBED in Jumla
- the Community-Based Integrated Energy Planning Project – CBIEP in Lamjung

These projects focused mainly on the development of community-owned micro-hydro power systems (MHP- see Figure 2), which can be used for lighting, but could also be used for mechanical end-uses. (Two of the more common end uses are grinding and oil expelling.)

Theme

Project 1: Community-Based Economic Development Project (CBED)

CBED is a medium-sized development project run by the Centre for International Studies and Cooperation, a Canadian INGO based out of Montreal. The project is being conducted in three Districts in Western Development Zone of Nepal over a period of six years (1995-2001) with a budget of US$5 million. This paper focuses only on the MHP initiatives in one District, Jumla (Figure 3), which is one of the poorest areas in the country where;

- The majority of the population are poor farmers.
- The average household income is Rs. 40,000 per year (£365 or $590)
- Both assets and income are distributed relatively equitably

The goal of the CBED project is to 'build and strengthen Community Based Organisations (CBOs) so that they can develop as viable economic institutions, capable of effectively managing natural resources, improving socio-economic conditions in their communities and interacting productively with local elected officials and government agencies at the district level '

The strategy is to form organisations such as NGOs or co-operatives that can provide a link between the users and the state. To date, the project has generally been successful – the production and sales of cash crops has increased; MHPs have been built and are operating reasonably well; and numerous workshops have been held with the state and local officials; and it is well-received among villagers.

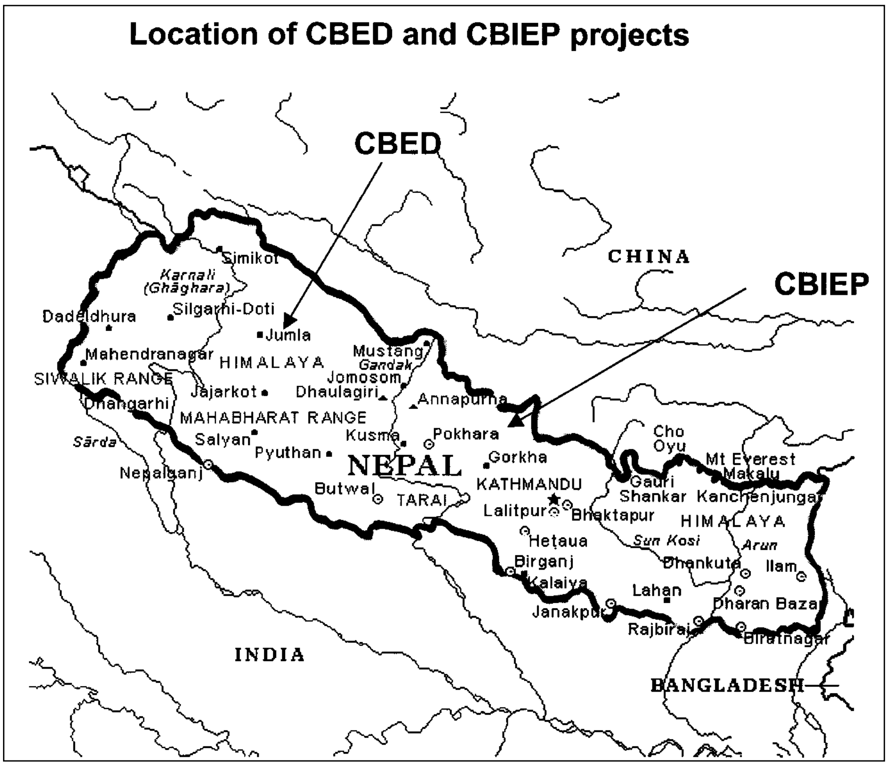

Figure 1: Map of Nepal

Project 2:Community-Based Integrated Energy Planning Project (CBIEP)

Figure 2: 10kW micro-hydro power system

The CBIEP was conducted by the Lamjung Electricity Development Company (LEDCO) in the District of Lamjung, Nepal. LEDCO is a private Nepalese company, owned by a group of investors from Lamjung District.

The social and economic conditions in Lamjung are relatively better than in Jumla (Figure 4):

- The district is fairly wealthy due to its proximity with the road, existence of army pensions and a reasonably developed infrastructure (e.g. phones, some irrigation).
- The literacy rate is 42%.
- On average people have more land per household and a large number of people are able to grow enough food for their own consumption.

The goal of the project was to implement MHP systems so that the plantsa range of renewable energy systems that could support themselves financially. Therefore, the project sought to develop an energy strategy that was integrated with local economic development objectives.

The specific goals of the project were:

- Short-term: through participatory planning, develop an energy management strategy for two Village Development Committees (VDCs) – Kolki and Ilampokhari
- Long-term: improve the ability of communities to plan for the sustainable use of local energy resources.

The project sought to achieve these goals through the establishment of Village Energy and Environment Committees (VEECs) that would serve:

- as intermediaries between the community, the state and manufacturers;
- centres of local knowledge about energy;
- long-term decision-making bodies

Discussion

Micro-hydro infrastructure has three main aims:

- providing for basic needs;
- improving economic and agricultural productivity;
- improving human capabilities through the developing of new businesses/markets

The number of failed rural energy projects is evidence that the provision of energy infrastructure alone is not enough to bring about these aims.

The questions still facing us – as implementers, planners and technologists – is; how does energy infrastructure fulfil development objectives? How do we ensure that development is positive for the greatest number?

Figure 3: The village of Huri in Patrasi, Jumla

Figure 4:

Decentralised energy development does offer rural areas benefits:

> The effectiveness of local institutions is cruicial in determining:
> - The size of the benefits;
> - How they are distributed.
>
> Clearly other factors come into play, but without a solid institutional foundation, the productiveness of systems is seriously hindered and this has a detramental effect on those who can not afford other energy.

- the only way to reach many remote areas
- environmental benefits and long-term sustainability through the use of renewable resources
- scale is often more appropriate to local needs – 100 to 150 W per household, and, with the introduction of affordable energy efficient lighting systems, future household power demand will be considerably less than this
- the rural sector provides security from markets biased in favour of urban areas
- decentralised decision making
  - use of local knowledge
  - freedom and flexibility in the hours and types of energy use, payment systems;
  - the development of local organisations adds value in itself – i.e. it builds social capital.

Of course, decentralisation also face obstacles

- financial risk and lack of capital
- lack of local experience (technical and managerial)
- collective action problems (fairness and accountability)

So, the practical challenge is first making MHP systems run, and second, ensuring that they run well.

The costs facing an MHP plant suggests that there is a break-even point where productive end-uses generate enough money that

Theme

Table 1: Impact of certain end-uses on different groups

End-Use	*Effect*	*Potential Bias*
Electrified Pumpsets	Increases agricultural productivity due to irrigation	• in favour of small farmers due to increased the labour-intensity in agriculture, especially if combined with credit and high yield seeds • large farmers may require additional
labour		
Agro-processing	Reduces drudgery due to mechanisation	• in favour of large farmers because it decreases the need for labour • may reduce workload for women, who typically perform majority of agro-processing tasks
Lighting, communication	Longer working day, greater communication with outside world, health and cleanliness	• no huge difference in benefits between households • tends to have a larger positive effect upon women and children, since they spend the majority of their time in the household • may also add to the number of domestic tasks for women
Industry and Small Business Applications	Improved productive efficiency, potential stimulation in local economy	• business owners clearly benefit from improved production and business environment. • the demand for labour may also increase due to the creation of new enterprises.

Table 2: CBED project; the role of electricityof electricity in development objectives, benefits and drawbacks

Village	*Stated development objectives*	*Stated benefits of electrification*	*Stated drawbacks of electrification*
Urthu	Road Irrigation	clean & healthy stay up later	repairing the canal, cost, irregularity of service,
and			
	Bridges	fuelwood savings (1/3 bari per day)	potential disagreements
Khalabada	Road, Drinking water	clean & healthy, literacy,time saving in domestic work	no drawbacks mentioned
Barkotebada	Road, Electricity, Drinking water	clean & healthy, wood savings, literacy	repairing the canal

Table 3: CBIEP project; Development objectives and strategy

Priority	*Participants objectives for energy development (after VEEC meetings)*	*Strategy*
Cooking	– improve health and cleanliness	combination of improved
cooking		
	in the home	stoves and forestry
management		
	– prevent further deforestation	
Lighting and	– use radios, television, and VHF telephones	all objectives must
be met through		
Communication	–	provide alternative to kerosene
or lighting	electrification. Examining	
	– provide lighting for group discussions	MHP development and grid
extension.		
Agricultural	– reduce the workload of women	both can be met through
Processing	– improve the yield from crops in order to	development of
MHP and		
	generate income	modification of existing diesel systems
Income	– encourage entrepreneurial opportunities	specifically
identified bakery ovens,		
Generation	and investment opportunities for savings	cinema halls, water
pumping,		
	and credit organisations	sawmills and marketing of non-timber forest products as avenues to generate income.

the cost of domestic – or basic needs – applications drop to a level where they are affordable for all. It is likely that certain end-uses have different impacts for different groups (Table 1).

Comparisons between the projects

The project areprojects are similar in that they sought to implement energy through community-based energy strategies, but they are different in:

- Energy was only one aspect of the CBED project, whereas it was the main goal of the CBIEP project
- the CBIEP looked at a broader range of energy technologies, whereas CBED only focused on MHP electrification as an energy strategy.

Distribution of benefits

The point is to ask how effective these projects have been in creating benefits and new opportunities. A good place to start was to ask people what they think!

In the CBED project, people were asked how electricity had fit into their development objectives, as well as the benefits and drawbacks of electrification systems, as shown in Table 2

Similarly, in the CBIEP project, people were asked to identify their specific development objectives (Table 3). Energy strategies were subsequently developed around this feedback.

Subsequently, people were asked how much they would be willing to pay for four measures needed in order to get an idea of the likely distribution of benefits (Table 4).

Table 5: Benefits of electrification; distribution within households

Lighting approximately	● CBED: The fire burns for less time since there is electric light – 20% less wood used. – Because women do the majority of the wood collection, we would expect that this results in a timesaving of 195 hours for women and 109 hours for men. ● CBED, CBIEP: Both projects indicated improved health and cleanliness in the home. This has greater impact upon women who spend more time in the house ● If the project is part of an integrated development strategy, lighting enables women's evening literacy classes, cottage industry, improved education. These were all mentioned as benefits, but are obviously NOT quantifiable. Conclusion: Generally better for women
Agro-processing	● CBED: modern grinder is 10 times faster than a traditional ghatta. Since the average household grinds 965kg of flour per year, and women do 80% of this task, it results in a potential time saving of 115 hours. Higher yield expected from automatic oil expeller. There is a minimal time saving (3 day trip to the bazaar), but potential income saving of Rs. Rs. 100 to 200 per year. Some households indicated that they would start growing oil crops if there was an expeller available, resulting in greater saving. Huge benefit that the expeller would be used by other areas, resulting in the growth of a small local industry and a lowering of cost of electricity for all. ● IEP: In Lamjung, looking at all agro-processing tasks and similar results were seen. On average, there was a potential time saving of 327of 327 hours: approximately 83 hours for men and 244 hours for women. Conclusion: Generally better for women
Others Impacts	● CBED: See that electricity stimulated new businesses in the towns (e.g. three new shops opened in Urthu since the start of electricity). In other villages, the MHP was used as a source of capital for loans – the income from the loans reduced the cost of electricity for all. ● CBIEP: the potential for entrepreneurial activities was discussed (individual renting pumping services, cinema hall, bakery oven, sawmill) Conclusion: Not conclusive, but likely to be of greater concern for men.

- to make a lump-sum payment for energy services (e.g. for installation or repair)
- for lighting
- for grinding
- for oil expelling

Not surprisingly, willingness to pay was always related to household income. Also;

- people with more income spend slightly more on energy,
- poor people spend a much higher of percentage of their income on energy services

This trend is likely to become more pronounced with increasing levels of development. If there was a greater range of services, it is likely that either the prices would be set above what poor people could afford, or richer people would have greater access to services.

The second aspect of the study analysed how benefits distributed with the household, as shown in Table 5.

Table 4: Willingness to pay for services

	Average	*Amount Market Rate*
Lump Sum	Rs. 870	comparable to national expenditure on domestic energy of 1% of annual income
Lighting	Rs. 16.5 per month for 40W bulb	approximately 40% of suggested value
Grinding	Rs. 2.0 per kg of flour	Rs.1.0 at district bazaar
Oil Expelling	Rs. 33.0 per litre of oil	Rs. 18-20 at oil expeller or Rs. 60 per litre for oil in the market

Conclusions

Judging by these findings, there are three broad statements can be made:

- energy does offer benefits to the whole community –

Theme

Gaining ground in community micro-hydro power development in Kenya

by Stephen Gitonga [1], James Mureithi and Daniel K Theuri[2]
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Développement communautaire des micro-centrales hydro-électriques au Kenya
Cet article met en relief les défis à relever lors du lancement d'un projet de micro-centrale dans un pays qui ne dispose pas d'une infrastructure adaptée à ce type de projets. L'auteur souligne les aspects qui ont été couverts et ceux qui devraient être pris en considération dans le futur.

Introduction

This article is a case study of work being developed by ITDG East Africa and the Ministry of Energy in Kenya, with financial support from UNDP GEF Small Grants Programme. The project idea started with a meeting between the Ministry of Energy and ITDG staff in March 1997 as a result of the emerging potential of the micro-hydro sector in Kenya. Consequent activities, included seeking for financial support among the following components, started in May 1998:

- A feasibility study
- The installation of one micro-hydro scheme
- A database for micro-hydropower development in Kenya

The feasibility study involved identifying suitable sites country-wide for community micro-hydro power schemes. A detailed desk study of the legal statutes was important as micro-hydro power generation involves various aspects of resource management, such as water use, land use and ownership. The study included a background of the general situation of micro-hydro activities in the country.

Feasibility Study and Sites election

Criteria were developed that helped to identify sites for potential development, and assisted in prioritising the site that would be developed for demonstration. The criteria proved very important during the field visits that were made across the many rivers and rivulets; a sample is provided in Table 1.

Two potential sites for the installation of the community micro-hydro power scheme were identified from a list of over twenty. A detailed feasibility study was conducted on the two, including a social economic survey. Based on refined criteria, a site on the Jiameceu Falls on the River Tungu was selected, about 200Km north of Nairobi, and 12Km from Chuka town, close to Mbuiru village. The social survey helped the team to assess the demand and the potential load factor of the proposed scheme. Technical aspects were studied in detail to ascertain the design and the layout of the scheme. Community micro-hydro power schemes were a completely new concept in Kenya.

The most important aspects that the team considered are the commercially viable end-uses which are environmentally beneficial in a place where the river is running all the year round and the communities are not dispersed beyond the economically viable distances for a community micro-hydro power project.


credit
reference

Figure

Social mobilisation

It was important to link up community mobilization activities with the site characteristics because the community is involved in the construction, mainly by providing both skilled and semi-skilled labour. Site characteristics include weir construction, the canal, the powerhouse and the penstock. The community will take over the ownership, management and running of the scheme once completed.

Training

ITDG, the Department of Renewable Energy of the Ministry of Energy, the Nottingham Trent University UK, and the Ashden Trust initiated training courses on

Theme

Table 1: Criteria for selecting a site for micro-hydro Geographical and topographical conditions

Aspects	*Rating criteria*
Geographical location – site development can be affected accessibility etc	Very good – if there are existing roads, site accessible by vehicle Good – if site accessible only by 4 wheel drive vehicles Fair – if site accessible only by foot/draught animals Poor – if site inaccessible
Topography and site conditions	Very good – if no major costs on topography, soils and foundation Good – if the above is acceptable but with some minimal costs on site structural strengthening. Poor- if topography, soils and foundation incapable of supporting the physical structures – prone to landslides
Social economic and legal aspects	
Hydropower or diesel Site where power is supplied by diesel and micro-power can replace it	Good – if there are chances of substituting for a diesel engine Fair – if there are no existing activities involving diesel-driven machines Poor – if chances of substitution remote
End uses (local centres) Load centres or power demand areas are conducive to the establishment of micro-hydro potential sites, since without a power demand, not even the most favourable micro-hydro can be economically developed.	Good – if there is an existing commercially or economically viable end-use which is environmentally beneficial Fair – if an existing economically viable end-use is not environmentally beneficial Poor – if there are no existing profitable end-uses. Load centres include: *Community*: lighting; social amenities; community based institutions; hospitals; site schools; cattle dips; etc. *Industrial activities*: grain milling; oils pressing; weaving; ceramics; etc. – the community is expected to set its priorities, which will be accommodated in the design stage.
Remoteness in relation to grid connection Probability of connection to the national grid power	Best – if the site is good for micro-hydro, accessible, and load centres are available, but there is only a remote chance of being connected to the national grid Good – if it is good for micro-hydro, accessible load centres are available and the area is adjacent to the national grid but cost of supply is prohibitive i.e. Below 33Kv to 185 Kvs Fair – if it is good for micro-hydro, accessible and load centres available but the area is covered by low voltage grid distribution line Poor – if it is good for micro-hydropower, accessible and load centre are available, but the grid supply available at competitive costs.
Legal features	Very good – if there are no legal limitations whatsoever Good – if site is subject to permits under laws not limiting entry and rights of way No use – if site is physically available but legally inaccessible due to legal limitations like protected areas such as nature reserves, heritage sites etc.as protected by Act of Parliament
Existing structure Hydroelectric development utilizing the existing small structure (eg diversion canal for irrigation) other indirect utility, such as canals to coffee factories	Good – if there are existing structures Fair – if the existing structures need a lot of upgrading Poor- if there are no existing structures
Remoteness of the site to the community	Very good – if the end-uses are within 600m radius. Good – if the distance between power house and user is exceeding 600m and not more than 2000 metres Poor – if site distance exceeds 2000 metres
Community set-up	Good – if communities live close to each other (village concept) or there is a centralised use of power Fair – if the community set-up is highly dispersed but with centralised use No use – Where the community set-up is highly dispersed
Technical aspects of the site	
Appropriate site	Good – if water supply head and flow are sufficient for the micro-hydro development to meet the load requirement from the community. Fair – if the site has either sufficient load or flow but not both Poor – if the site has insufficient head and unreliable flow No use – if the site is not within economic distance (600 metres for the power transmission)
Relative costs of civil works to be involved?	Good – if no significant civil works needed to develop the site Fair – if minimum civil works is needed Poor – if major civil works is required

skills, technology transfer and capacity building. The training courses included participants from other countries.

Scheme Ownership and management

The result of the social mobilisation process was the formation of the Tungu – Kabiri Micro-hydro Power Project management committee. The scheme will be operated on a commercial basis through share-holding in the company with support from local government departments.

The ownership structure will fall in the following categories:

- A commercial hydropower group, comprising Mbuiru village community members, who have contributed towards the project.
- A community power company owned by community members through shares

Community contribution

The community has contributed in the following ways:

- Identification and provision of local artisans and resources
- Labour for, among other things, construction, moving building materials; blocking the river during construction; off-loading lorries. (Every Tuesday is a community working day which is costed in the project by the community members.)
- Land provided by the Government for building the power centre and canal; storage space for construction materials and equipment; a pressure lamp for night work; materials for blocking the river during the construction
- Providing finances to pay for registration and Government licences for the project
- Maintenance of the canal (to keep it wet and prevent cracking)

Impacts already achieved

- Community members have organised themselves into a commercial development group, which has initiated a project fund for activities related to the hydro scheme.
- They have acquired, from the Government, one acre of land to build a power centre where micro enterprises, served by the power from the scheme, will be located.
- The community has been empowered to put development issues on to the agenda and is looking at other development activities utilizing power from the scheme.
- The work has attracted the attention of the NGOs, government ministries, private agencies, individuals and donors. For example, two smaller schemes will be installed in Kirinyaga district through collaboration with Nottingham Trent University, ITDG, and the Ministry of Energy.
- Funding for related activities, such as a turbine manufacturers' training ,in collaboration with the Renewable Energy Department, ITDG and Jomo Kenyatta University of Agriculture and Technology and Nottingham Trent University, have been obtained.
- The scheme has become a centre for education on energy and environment for local schools.

Use of micro-hydro power

The scheme will contribute significantly in raising the income and improving the livelihoods of the Tungu – Kabiri river communities. The 18KW scheme will help alleviate environmental problems associated with biomass and diesel fuel use by

- Water pumping (commercial)
- replacing the use of firewood by utilizing ballast load heat from the scheme to cure tobacco
- replacing the diesel engine currently in use for maize grinding by hydro power.
- replacing kerosene for lighting. The community will not benefit at present from a power-distribution system (especially for .lighting their homes) but will use the energy by charging batteries for both lighting and running their radios or TVs.
- Agro-processing

Lessons and recommendations

In a country where there is no micro-hydro power infrastructure, the following were found important factors to consider:

- The level of involvement in micro-hydro power development
- The potential for micro-hydro power development, ascertained by carrying out a pre-feasibility study
- The legal statutes and procedures
- The policy aspects in the country that may affect micro-hydro power development
- A lobbying process to policy makers, development organizations, donor and support organizations and the to community groups to create awareness of the role of micro-hydro power in development
- A set of criteria for site selection during the initial stages of the initiative
- A pilot scheme to demonstrate the technology
- A mechanism to create the capacity for manufacturing components such as turbines
- Training of potential micro-hydro experts during the pilot scheme.

credit

reference

Figure

Tariffs for rural grid electrification

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Tarifs pour l'électrification rurale à partir du réseau
Des variations significatives caractérisent les voies selon lesquelles les différents coûts pour la consommation d'électricité sont établis: coût pour le raccordement initial, charge fixe et charges basées sur la quantité d'électricité consommée. L'auteur soutient qu'il serait plus équitable d'instituer des tarifs, pour les populations pauvres, qui ne couvriraient que les coûts d'approvisionnement. La réussite de ces structures tarifaires dans plusieurs pays montre que cette méthode doit etre considérée comme une mesure politique visant à atteindre des objectifs techniques, financiers et sociaux clairement définis.

Charging for electricity

It is now generally accepted that charges for electricity should fully cover the capital, operating and expansion costs of the company supplying it. Within this framework, the way these charges are levied and the levels of charges within successful rural electrification programmes show major variations. Many electric companies charge new customers an initial connection fee. In addition to this connection charge, many also impose a fixed minimum charge, even for people using very small amounts of electricity. The great majority of consumers also pay a charge based on the amount of electricity they use; this is called an energy-, unit-, or kWh (kilowatt hour) charge. (A kilowatt-hour is the amount of electrical energy given out when a kilowatt of power is used for one hour.)

Connection fees and fixed or minimum charges

The connection fee is designed to pay back some or all of the initial investment made by the electricity company in the construction of the distribution system. The connection charge usually includes the cost of electricity connection up to a certain distance, often as little as 10 metres, from the nearest line. New consumers further from the distribution line are obliged to pay the additional costs involved in their connection.

The connection fee is often accompanied by a 'security deposit' to cover one or more month's bills. The security deposit is, in principle, repayable when the consumer leaves the dwelling, but since a new deposit has to be paid for the next connection, it is, in effect, a permanent payment to the supply company. A monthly minimum charge, which may or may not allow a certain amount of electricity to be used, is also levied by most utilities.

Benefits to the electricity company
The connection fee and minimum charge provide assured and early money to the electric utility on its capital investment in supplying electricity. Immediately a consumer pays the connection charge, part of the capital investment is repaid. Thereafter, with a minimum monthly charge, there is a guaranteed return to the utility that does not depend on the level of electricity consumption.

High initial payments – a major barrier to the poor
One of the major disadvantages of the initial charge system is that poor rural families often find it difficult to raise the necessary cash at the same time as they have to pay for house-wiring and electrical appliances. High initial charges can, in fact, be a major barrier to rural people taking a supply (Figure 1). Surveys in different developing countries have often found that the initial payments demanded by the utility are too great an obstacle for a high proportion of potential rural consumers to overcome. In cases where electricity is subsidised, initial charges can prevent poor families from having the low-cost electricity which the rich can obtain because they can afford the initial payment.

Unit charges

In many countries, there are strong pressures in rural areas to set charges for each unit of electricity at levels well below the supply cost. In some cases, charges are just a few cents per kilowatt-hr compared with actual costs of up to 20 cents/kWh or more. The main reason used to justify these low rural tariffs is that 'rural people are too poor to pay the true price of electricity and that they should be provided with a subsidised supply.'

Subsidised unit charges – a questionable practice
This is highly questionable. The people who connect to the electricity supply are spending significant amounts of money on electricity-using services. Obtaining a grid supply represents a major


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Figure 1: Initial charges may be a major barrier, even to those close to a grid supply

step upward in living standards, even if they continue to pay out the same amount of money. The amount of money spent previously on batteries and kerosene would be more than enough to provide the household with a level of service considerably higher than obtained before electrification. Put simply:

One kilowatt hour of electricity from an incandescent bulb is equivalent to the amount of light coming from 12 litres of kerosene used in a kerosene wick lamp.

A kilowatt hour of electricity used in a power tool produces the equivalent of a man working for two days without the power tool.

Cost of electricity from batteries

Electricity from dry-cell batteries costs at least $100 per kWh or more. When car batteries are used, the cost is likely to be in the range $3-4/kWh. Where people depend on small-scale private suppliers (non-grid), the effective rate for restricted evening supplies can be as high as $1/kWh. Even in the poor outlying islands of the Philippines, consumers have shown they are prepared to pay rural electric co-operative tariffs in the range UScents15-20/kWh. Writing of car battery users in Uganda, an ESMAP study remarked that 'Non-grid households pay cash for every kilowatt-hour they consume, they never default, and they pay on time at 30 times the grid-connected fee' (ESMAP (1998a).

Grid electricity gives good value to the consumer

At these, and indeed higher, price levels, electricity from the grid therefore represents extremely good value for consumers who have been using kerosene or batteries. Not only is the electricity much cheaper, it is far more effective and versatile than the energy sources they have been using previously.

Electricity should cover supply costs

The case for setting electricity tariffs at levels which are sufficient to cover supply costs is fairer to poor people because, where electricity is supplied at less than its cost, it is the better-off consumers, rather than the poor, who benefit the most. In addition, there is a risk to the electricity supplier that it will not be able to stay in business.

Tariff structures

A wide variety of tariff structures (ways for charging for electricity) are used throughout the developing world. In Costa Rica, there are sixteen different consumer categories with substantial differences between their charges. In the Philippines, the system is much simpler and there is little difference between consumer categories.

Charges also vary with the amounts consumed. Two opposite approaches are in common use. One, which is used for example in Costa Rica, is the rising block tariff, which charges progressively higher rates for increasing consumption. The other, the declining block tariff, charges progressively less per unit for higher consumption levels.

Rising block tariff

The rising block tariff assumes that those using the largest amounts of electricity are better off and more able to contribute to the running costs of the utility. This tariff is, in effect, a subsidy from the heavily consuming, and presumably better-off, customers to the poor. The rising block tariff, by acting as a progressively stronger deterrent to increased consumption, can be a useful component in an energy conservation strategy.

The element of fairness of the rising block tariff system is seen most clearly when a lifeline tariff at a specially low rate is provided for the first block of consumption. This allows poor people, who would not otherwise be able to afford it, to benefit from an electricity supply. However, since it is the initial block of consumption, enabling people to shift to electricity from expensive and inefficient kerosene lamps and batteries which provides the greatest benefit to consumers, even at UScents20/kWh, poor consumers are benefiting greatly from an electricity supply, so subsidising these benefits is unnecessary. Equity (fairness to all) is more likely to be served by using the same resources to reduce or eliminate the connection fee.

Declining block tariff

The declining block tariff is based on commercial logic. The fixed costs to the supply company are the same whether a consumer uses a small amount of electricity or a great deal per month. The cost of supplying each kilowatt-hour therefore goes down with increasing consumption. Where there is more energy available in the supply system than is needed, the reducing price encourages increased consumption and therefore profit, but lowers the incentive to energy conservation among large consumers. On the other hand, where there is a shortage of available electricity the declining block tariff gives the wrong price signal to consumers.

Single price per kilowatt hour

The simplest tariff of all sets a single price per kilowatt hour to cover the electric company's full operating and capital expenses. As well as its simplicity, this has a number of important equity advantages. It completely removes the problems created by the connection fee and initial deposit system, so that poor families are not barred from obtaining a supply. It also means that the capital investment and fixed charges for the network are shared between users in proportion to the use they make of the system. This system is coming into widespread use in South Africa where it has the additional advantage of being ideally suited to the system of prepayment cards promoted by the national utility, Eskom.

Theme

Load-limited tariff
Another approach sometimes used is the load-limited tariff. This requires a specially designed connection into the house which only allows a certain level of current to trickle through to the consumer. A two-amp connection, for example, will only be sufficient for lighting and TV; if the consumer tries to operate a kettle or electric iron, the connection will cut out. The consumer pays a fixed fee, based on the level of electricity they are allowed, irrespective of the amount of electricity consumed.

The advantage of the system is that the amount of energy used does not have to be measured and bills do not have to be sent. The disadvantage is that there is no incentive for the consumer to switch off appliances or economise in any way. The higher the allowable electrical load, the greater the amount of electricity the consumer can use. One problem is that there is little to prevent consumers bypassing the system and using whatever appliances they wish, while paying the fee for the lowest level connection. This tends to make most electrical supply companies rather wary of the load-limited approach. It has, however, a long record of use in some countries, among them Zimbabwe, and may deserve to be considered in some cases.

In summary

The successful application of quite different tariff structures in various countries shows that there is no one universally applicable or 'correct' system. The particular method adopted should be seen as a policy measure adopted to achieve a clear set of technical, financial and social objectives. The most important objective has to be a structure that allows the electric utility to cover its full operating costs and pay its debts. Once the objectives have been clearly defined, the technical exercise of developing the most effective tariff structure to achieve them can be undertaken.

Gerald Foley has been involved in energy and development issues since the late 1970s

Theme

Fuel for lighting; an expensive commodity

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This article was adapted by the editor of Boiling Point from the article 'Fuel-based light; large CO2 source, which appeared in IAEEL newsletter 2/99 – The web address for the original article is: http://195.178.164.205/IAEEL/iaeel/newsl/1999/tva1999/NatGlob_a_2_99.html This article presents preliminary results of a forthcoming study being conducted for the International Energy Agency. Readers interested in copies of the final report are welcome to contact the author.

Combustibles pour l'éclairage domestique: une marchandise onéreuse
Environ un tiers de la population mondiale utilise des combustibles pour l'éclairage particulièrement les populations pauvres. A cause de son faible rendement, il est pénible de lire ou de travailler à partir d'un éclairage à base de combustible. Une lampe à kérosène fabriquée localement ne produit que le centième d'une lampe à incandescence de 100 W. L'éclairage à base de combustible est plus onéreux pour une qualité de service nettement inférieure. En outre la qualité de l'air dans les foyers est affectée négativement.

For the world's two billion users of fuel-based lighting, the cost of lighting their homes rivals that of affluent households who enjoy the vastly higher levels of quality, safety, and services provided by electric light. According to the World Bank, 24% of the urban population and 67% of the rural population in developing countries are without electricity today.

Unlike heating or cooking, lighting is one of the energy end uses that is often associated exclusively with electricity. But the reality is different: In fact, about a third of the world's population uses fuel-based lighting. The extent of rural electrification varies widely from country to country, e.g. about 90% of the population in Africa is not served by grid electricity, versus 20% in Mexico. Some countries (e.g. Burundi and Rwanda) have barely passed the 1% electrification threshold. While the levels of illumination provided by flame-based lamps are far lower than with modern electric lighting, the efficiency of fuel-based light production is also low. The result is a substantial amount of fuel used with poor lighting received in return (Figure 1).

credit

reference

Figure 1: Efficiency of fuel-based light production is low

In some instances, the rate of electrification is high, and one could argue that fuel-based lighting energy use is a temporary problem. Yet, in Sub-Saharan Africa the rate of electrification has been only 25% of the birth rate over the past 20 years (i.e. 55million out of 220 million people). An estimate for Kenya projected rural growth of 65 000 to 85 000 households in 1996, of which only 4000 to 8000 would have electric grid connections. In South-east Asia, the net effect of new electrification and population growth was an increase of 250 million people without electricity during the two-decade period of 1970 to 1990. However, in China, the opposite effect was seen (electrification exceeding population growth). At best, population growth balances efforts at electrification; at worst, population growth may result in an increase in the number of people without electric light.

The state of affairs concerning fuel-based lighting is worrisome. Oil import dependency is generally high in developing countries, and it drains valuable hard currency. Because it is inefficient, fuel-based light is hard to work or read by, imposes a high cost on very poor households, and seriously damages indoor air quality. Further complicating the picture, subsidized kerosene intended for domestic lighting sometimes finds its way into vehicles, which creates additional environmental consequences. Meanwhile, electrification (for lighting and other energy services) has its own problems, not the least of which is the extraordinary cost of electric transmission and distribution costs and low system efficiencies associated with providing centralized power generation in such conditions. A further limitation is the high cost for families buying electrical appliances and setting up electrical circuitry in their homes.

The world of fuel-based lighting

There are a wide variety of fuel-based light sources, including candles, oil lamps, ordinary kerosene lamps, pressurized kerosene lamps, biogas lamps, and propane lamps. According to most studies, ordinary kerosene lamps are the most common type of fuel-based lighting in developing countries. The more efficient kerosene lamps tend to increase both light output and fuel consumption, whereas an efficient electric compact fluorescent lamp provides an eight-fold reduction in primary energy consumption compared to standard incandescent light sources.

According to a 1995 study, typical household kerosene lamp use is 3 to 4 hours per day, with weekly fuel consumption of about 1 litre. Typical light outputs are 10 to 15 lumens for locally-made lamps and 40 to 50 lumens for store-bought models. Placed in perspective, the lower end of this range corresponds to about 1% of the light produced by a typical 100-watt incandescent lamp.

A study conducted by the joint UNDP/World Bank Energy Sector management Assistance Programme (ESMAP) found rural households spending as much as US$10 per month on lighting from candles, kerosene and dry cell batteries (1). This operating cost is similar to that paid by industrialized households with two dozen bright electric light sources throughout their home.

Many suppliers of energy-efficient lighting equipment have not found the rural markets in developing countries worth exploring. However, the large amounts of money spent on lighting fuel indicates that there is a considerable potential for spending money on alternatives, for instance PV-based lighting solutions; this was verified in a field test by the World Bank.

How much energy?

We could find no estimate of the global lighting energy use associated with fuel-based lighting. A very approximate one is developed here, attempting to capture the uncertainties by considering a range of values for important factors that are not well known. We assume:

- a non-electrified population of 2 billion
- the kerosene lamp as the reference light source
- the penetration of lamps as between one lamp per six people and one per two people
- the fuel consumption at 0.04 to 0.06 litres per hour
- the daily usage at three to four hours

We have estimated only the household contribution to fuel-based lighting, lacking sufficient basis for assumptions necessary to evaluate the service and industrial sectors. The pressurized kerosene lamps used in businesses have a much higher hourly fuel-use rate. The energy requirements for households who use fuel-based lighting as an alternate light source (e.g. during blackouts) have also not been estimated.

The main findings, including ranges of uncertainty, are:

- Between 15 and 88 billion litres of are consumed each year to provide residential fuel-based lighting in the developing world.
- The primary energy consumed for this fuel-based residential lighting is between 13% and 78% of that used to provide the approximately 400 TWh of electricity consumed for residential electric lighting globally.
- The cost of this energy ranges from $15 to $88 billion/year (assuming a kerosene price of $1/ litre), or $44 to $175 per household.

The amount of light (measured in lumen hours) is approximately 1/1000th that enjoyed by households in the industrialized world (more sources; more efficient sources). Within developing countries, the amount of fuel used in the country to provide fuel-based lighting energy can even be large compared to the amount of energy consumed to provide the electricity used for all purposes. One study noted that kerosene accounted for nearly 60% of the total energy requirement for lighting in India's household sector in 1986. According to our estimates, fuel-based lighting in Brazil consumes 40% as much energy as that required to produce the electricity used for lighting in the country.

Towards better lighting services

Among the more startling implications of these findings is that users of fuel-based lighting in the developing world spend as much or more money on household lighting as do households in the industrialized world, but receive a vastly poorer level of service. On a percentage-of-income basis, households in developing countries spend many times more for lighting than their counterparts in the industrialized world.

Some argue that the problem of fuel-based lighting is not a priority, given the environmental impacts and costs of other end uses, such as cooking. However, few would dispute that improving the quality and quantity of light available to households in the developing world would yield dramatic social and health benefits.

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Dr. Evan Mills is a scientist at the Lawrence Berkeley National Laboratory, specializing in energy end-use efficiency and energy policy.

Demand side management for rural Nepal

by Dave Irvine-Halliday[1], Stewart Craine[2]
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Gestion de la demande pour le milieu rural népalais.
La plupart des problèmes liés a l'électrification rurale au Népal sont dûs a l'absence d'évaluation de la demande. La capacité à payer pour l'installation des micro-centrales dépend du revenu. Une solution pour abaisser les coûts serait de diminuer l'énergie allouée aux foyers par l'introduction de lampes compactes fluorescentes ainsi que des chargeurs de batteries. Un nouveau point d'entrée pour l'éclairage en milieu rural est les diodes émetteurs de lumière (White Light Emitting Diodes) qui procurent suffisamment de lumière pour la lecture. Dans quelques zones, des technologies utilisant des pédales mues par la force humaine peuvent produire suffisamment d'énergie pour alimenter des lampes. En moyenne, il faut pédaler 30 minutes pour recharger une batterie qui peut fournir 4 heures d'électricité.

Nepal has a long history in rural electrification, particularly through the efforts of a mature micro-hydro industry. However, in recent years, there has been a slowdown in the number of plants being installed throughout the country. The general conclusions that have been reached include:

- micro hydro plants (MHPs) that have only lighting as an end use are not financially sustainable, particularly in the more remote districts
- ongoing technical support is crucial for sustainability;
- training for developing technical and managerial skills is important;
- not all systems have been been properly designed

Many of these problems result from a focus on the supply of power without analysing the demand. The willingness to pay for MHP systems varies throughout the country, from 15 NRs/month in the most remote and poor districts to about 200 NRs/month in the richer districts. Although these figures are approximate, at a capital investment of about 14,000 NRs (US$200) per household, it is clear that it will take many, many months to recover the initial investment if there are no other income-generating end uses for the MHP.

One solution is to reduce household power consumption, allowing the power generated to be shared among more households. Several innovative projects are now under way which focus on this approach.

Compact fluorescent lamps (CFLs)

A recent project by Ghanashyam Ranjitkar (ITDG/Energy Systems) and Nigel Smith (Nottingham Trent University) introduced the pico power pack to be used with CFLs. Household consumption was limited to 40W, allowing only the use of one 15W CFL and one 25W bulb, allowing more than twice as many households to be connected. A DANIDA-funded research program will soon be undertaken by Mr Ranjitkar and Stewart Craine (LEDCO/AVI) to assess which CFLs are most suited to run from micro and pico hydro systems. DANIDA is very interested in this research, as its five year Energy Sector Assistance Program has just started, with one component involving the promotion of micro hydro systems. The results of this research will be used in an upcoming AusAID project for 150 households to demonstrate the cost-effectiveness of a 5kW pico power pack and CFL lamps.

A lease-purchase agreement for the CFL lamps will most probably be created between a local entrepreneur and the electricity users, combined with a service fee so that the entrepreneur is responsible for maintaining the power supply and transmission lines. LEDCO, a community based electricity development company, will support the entrepreneur at a district level, and Energy Systems will assist LEDCO with the design and implementation of the scheme. This will ensure ongoing technical support and a framework for expansion if the capital cost reductions of at least 50% are realized. It is hoped that this project will illustrate the advantages of CFLs for rural electrification.

Battery charging and micro hydros

LEDCO has also completed a study on using a hybrid system for rural electrification. Overnight energy from the micro hydro is stored in battery banks in a nearby second village and used later for small DC fluorescent tube lights. From 6am to 10pm, the power is diverted to the original village for lighting and agro-processing activities. The result is a system with a plant factor over 80%. If the battery banks are added to a CFL system similar to that described above, over 200 households can be supplied from a 5 kW pico hydro. Using standard bulbs and 100W per household, a 20 kW plant would be required, costing approximately 2,800,000 NRs (US$40,000). The capital costs are at least 30% less than a conventional bulb-lighting plant. This design is most useful

Theme

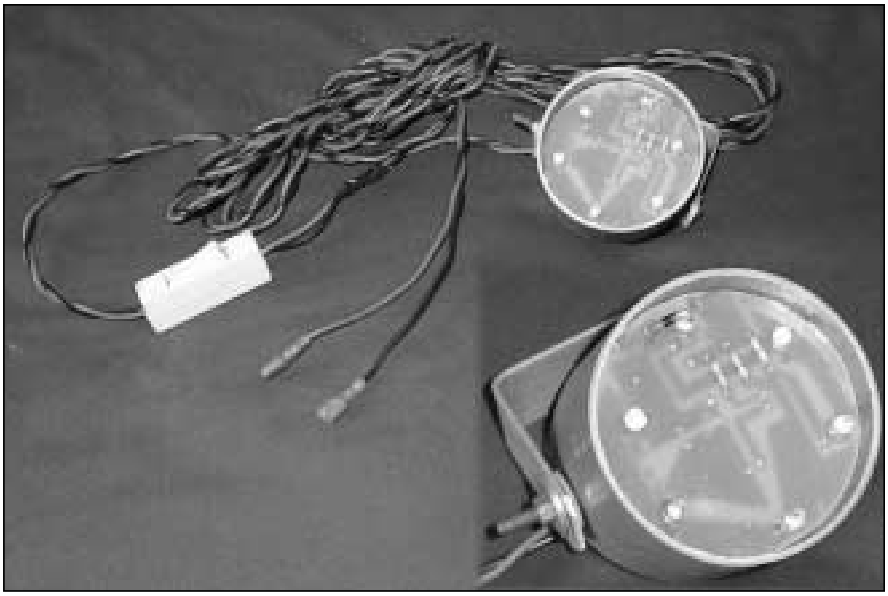

Figure 1 – A digital picture of a 6 cluster WLED lamp.

when only a small amount of power can be developed from a small stream located within 2km of one or more rural villages.

Traditional water-driven grinding mills (ghattas) are also are cheap source of power. A 10-year GTZ programme has concluded that improving the efficiency of ghattas is economically and technically sustainable. The electrification of improved ghattas takes advantage of existing infrastructure and community practices, which should increase the chances of sustainability. The daytime load is already used for agro-processing, so the plant factor will be over 50%. These ghattas can provide electricity via a transmission system, or can also function as a battery charging station.

White LED lamps – a new low-cost entry point for rural lighting

The Nepal Light Project (NLP), led by Dave Irvine-Halliday from the University of Calgary, recently completed the world's first permanent installation of large-scale rural lighting using white LED lamps. These lamps consist of a cluster of white light-emitting diodes (WLEDs) mounted on a printed circuit board, with very simple electronics to complete the circuit. While the light emitted does not project as well as a 15W bulb, it is more than sufficient for moving, cooking and reading, which are the primary activities of rural people during the early morning and evening hours. The NLP was generously supported by Nichia of Japan, the leading manufacturer of WLEDs.

Each lamp requires around 0.4W, since there are 6 WLEDs in the cluster. The diodes are rated at having a life of 100 000 hours, which is 45 years if used 6 hours a day. This recent innovation represents a new low-cost entry point for rural lighting. The cost of these diodes is decreasing as rapidly as the efficiency is increasing, and some companies are already selling WLED lamps. One such lamp from the Kathmandu company, 'Pico Power Nepal' is shown in Figure 1.

Case study 1: White LED lamps in Kavre district

The first NLP project, run in collaboration with the Nepal Schools Project, completely and permanently lit up the villages of Thulo Pokhara (23 homes, completed 15 July 2000)) and Raje Danda (31 homes, completed 17 July 2000) in the middle hills of the Kavre district.

In some areas of Nepal, pico hydro, solar or wind power are not viable energy sources, so human-powered technologies are used to fill this niche. In this case a dynamo is rotated at a comfortable speed via a pedal generator, making it suitable for young children to operate while the parents are involved in more pressing activities (Figures 2 &3). Each home received one 12 Volt sealed lead acid battery and a 6 cluster WLED lamp and time-shared a pedal generator with between six and eight other homes since there are four pedal generators per village. On average, the user will pedal for around 30 minutes to recharge a battery that has provided 4 hours of light (Figure 2). Each lamp draws only 40 mA. By September 2000 the pedal generator set-up will be changed to allow 4 batteries to be charged simultaneously. The life of the SLA is expected to be many years, as they will be recharged every day at precisely the voltage recommended by the manufacturers. The average cost per home for

Figure 2: A villager in the village of Raje Danda charging his battery first thing in the morning.

Figure 3: Children, pedal generators, batteries (in the white boxes by the wall) and a powered up 6 cluster WLED lamp held by one of the children – Thulo Pokhara village

credit

reference

Figure 4: Three proud pedal generat or custodians in the village of Thulo Pokhara.

these first two villages was approximately $69.00US. It is confidently predicted that this cost will be reduced significantly in the future due to:

- more selective choice of pedal generator manufacturer
- lowering of WLED prices
- increasing the number of homes time-sharing a pedal generator due to parallel charging of batteries
- reducing the Ah of the battery and the sharing of batteries between 2 to 4 homes.

Case study 2: White LED lamps in Jumla

The second NLP project involved the relamping of a village that was testing a pilot 200W low head pico hydro turbine that was running 160W of bulbs in the district of Jumla. Jumla is extremely remote, being 6 days walk from the nearest roadhead, and extremely poor. Lighting is currently from sap-filled sticks that emit a lot of smoke when burnt, adding to already substantial health problems. Kerosene is too expensive as it is transported in by air. Twenty-eight households were connected, using a total of 80 lamps. The turbine has an output at 220V AC to allow for long transmission distances. Average household consumption was a tiny 2W per household. The WLED lamps were designed to be compatible with existing batteries and converters and cost about US$20 each. This project was undertaken in collaboration with LEDCO, Energy Systems, Pico Power Nepal and the Karnali Community Skills Training project in Jumla, a United Missions to Nepal initiative. Plans are under formation for the extension of a nearby 8 kW micro hydro to the 600 surrounding households, which will increase the income for the plant by over 500% at a level that is affordable for everyone.

Summary

Figure 5 shows the approximate costs of the systems described in this article. It is clear that an investment in energy efficient lamps and demand side management is an important step towards providing the most economic and easily maintained rural lighting system. The onus is now on the development agencies to ensure the income-generating schemes they propose justify the larger plant they often require, and not to assume that economic development will take place once access to electricity is ensured.

Dave Irvine-Halliday is professor at the University of Calgary. Research fields: Networking fiber optic current sensors; Fiber optic gyroscopes for horizontal drilling; Biophotonics – optical behavior of stressed tissue; Pico Power White LED lighting for developing world

Stewart Craine is an AVI volunteer working for 2 years with a Nepal hydropower company, LEDCO. His background is in civil engineering and mathematics. The focus of his placement is to optimize rural energy solutions for villages that will not be connected to the national grid in the near future.

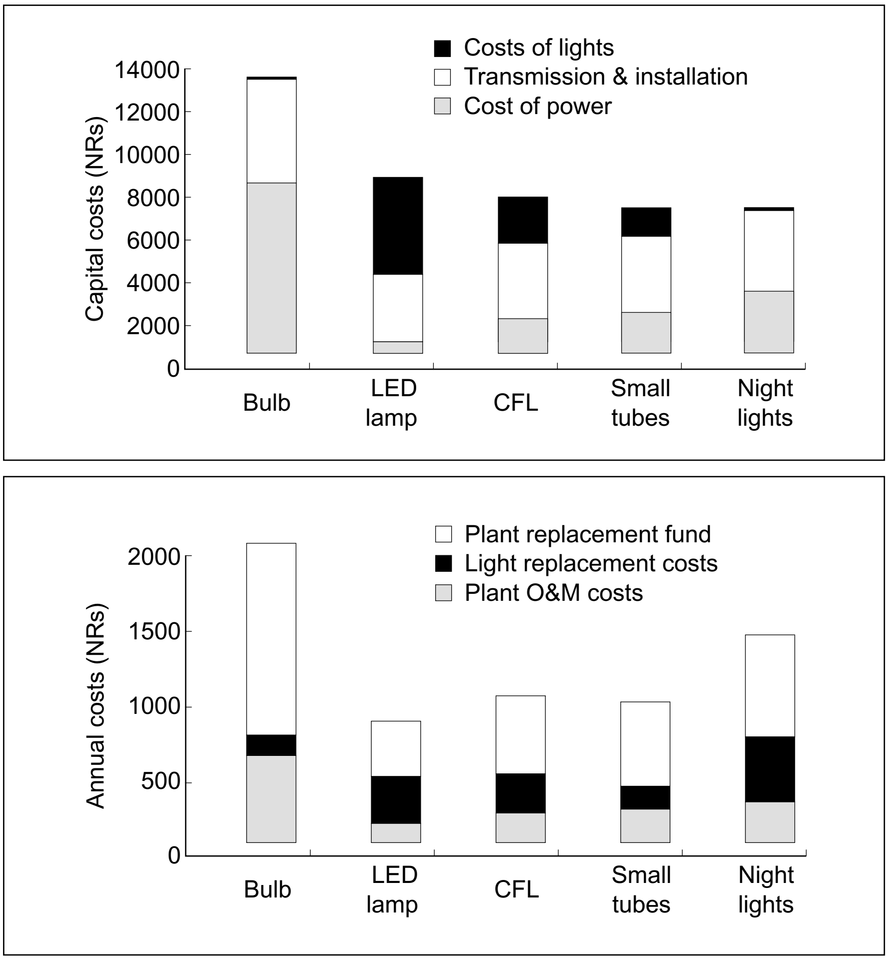

Figure 5: approximate costs of lighting systems

‘Micro-privatising’ rural power distribution – mass produced community development in Orissa, India

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Micro privatisation de la distribution d’énergie en mileu rural
Cette initiative pourrait améliorer l’offre, actuellement défaillante, d’électricité a Orissa en Inde. Parmi les principales mesures, il convient de relever : une gestion plus efficace quand elle est prise en charge par une organisation intéressée aux résultats et ayant des responsabilités et des primes clairement définies. Les groupements communautaires ne devraient pas etre assujeties à des responsabilités complexes et différentes. Les intéressés devraient être motivés par la possibilité de réaliser des bénefices perçus selon des règles établies et si nécessaire les bénéfices pourraient être fractionnés.

Background

The electricity industry in Orissa State (population 35 million people) of India has been restructured and privatised. Generation, bulk, and regional distribution have been split into different businesses, Indian and multinational capital companies have taken over ownership, and the institutional stage would appear to be set for profitable growth and development.

But all this in itself makes little difference to what actually happens at the village level. Most of Orissa’s 39,000 villages are nominally ‘electrified’, but over a quarter of all the power that is supplied to them is stolen, and in some rural districts less than a fifth of that part of the power that is invoiced is ever paid for. Meters are absent, broken or unread, bills are wrong, undelivered or ignored, and field staff respond only to threats or to bribes. Transformers are burned out because transmission cables are shorted and the loads are unknown, and they remain un-repaired because they will only be blown again (Figure 1). Power may only be available for a few hours a day, or a week, and widely varying voltages frequently damage consumers’ appliances.

`The tariffs for small domestic consumers, and for irrigation pumps, are in any case set well below the marginal cost of power to the distribution companies, but it is intended that the losses should be cross-subsidised from the profits on power supplied to industrial users. The companies can never make a profit on rural power, but in the present circumstances their losses are such that it would make more sense to withdraw altogether. This is not permitted by the Government Regulator, and it is said that the private owners of at least one of the four regional distribution companies in Orissa are considering cutting their losses and returning the whole business to the State. This would undo the whole restructuring process, which is being presented as a model for the rest of India. The power is not worth paying for, and therefore is not paid for; the vicious circle spirals downwards, and there appears to be no remedy.

credit

reference

Figure 1: Semi-derelict sub-station

Micro-privatisation; a new approach

A new micro-privatisation initiative, however, appears to have the potential to make an improvement. A study by the Xavier Institute of Management (XIM) in Bhubaneswar found in 1996 that in a few villages the people themselves had got together in an effort to put things right. They were informally collaborating with the local linesmen, often with informal inducements, to control unauthorised power use in their villages(Figure 2), and to facilitate meter reading and bills collection, in return for improved power supply. In one case the village people had even paid for a new transformer.

We concluded that it might be possible to learn from these informal initiatives, and actively to promote similar local groups to take over the village level distribution task from the power supplier. Several attempts were made

credit

reference

Figure 2: Illegal ‘hook up’ to electric supply

to persuade DfID and other donors to fund a small experiment, without success. In 1999, however, when the privatisation of the regional distribution companies had been completed, the management of BSES, the owners of WESCO and two others of the four companies, agreed to finance XIM to undertake a pilot experiment with 100 villages in Bargarh in the North Western part of the State. They did this without any donor support, and not out of ‘social responsibility’. They realised that this form of community development might be a good investment.

In the event, it has been exactly that. Cash collections from the 100 villages increased from about $34,000 in the period from August 1998 to February 1999, to $71,500 in the same period a year later, after the committees had been formed. The extra collections covered the cost of XIM’s work, at $275 a village, in about five months. Payment to XIM is in any case strictly by results, as a proportion of the increased collections.

The ‘community enterprise promotion’ procedure

This success has achieved by following a more or less standardised procedure. After some false starts with NGOs and other inappropriate intermediaries, the following system was evolved:

- A team from XIM explains the potential benefits to village meetings.
- After a maximum of three meetings the villages form committees, including the linesman as an ex officio member, and appoint a Village Contact Person (VCP) from among themselves.
- The XIM team helps the committee and the VCP to collect together and present their grievances to a WESCO management representative.
- WESCO and the committee, with mediation from XIM, settle (in a maximum of 10 days) billing errors, long overdue amounts for undelivered power and so on.
- Committee persuades (by example) consumers to pay first instalment of reduced overdues, as agreed.
- The WESCO representative agrees with VCP on a cash collection day, comes to village and takes cash.
- Illegal consumers are persuaded by committee either to unhook or to accept legalisation, to pay a $10 connection charge and receive a meter.
- WESCO implements supply improvements as necessary (reduced illegal load and reduced consumption because of metering often make this unnecessary).
- WESCO pays the VCP a fee for each meter reading and each bill delivered, amounting to about $5 a month for a typical village. This is an appreciable sum for an otherwise un- or under-employed person.
- Consumers continue to pay regularly at monthly collection days.
- XIM provides advice on a declining basis, which is terminated after about one year.

As a result of this initial success, XIM have been contracted to provide the same ‘treatment’ to a further 3000 villages. It is envisaged that the process will be extended throughout the State, at as fast a pace as XIM and its collaborators can manage. Other States are also showing an interest, as their power industries are restructured.

Lessons learned

The same approach can also be applied to the tens of thousands of small lift irrigation points in Orissa and elsewhere, and indeed to almost any situation where the large-scale provider of a public service is failing to deliver the service to small communities. This undertaking, which has already proceeded beyond the experimental stage, is only one example of the micro-privatisation approach which is already being applied to the delivery of primary health care, education, post office, telecommunications, transport and many other public services.

The experience is barely one year old, and much remains to be learned. A number of important lessons have however already evolved:

- Community management can best be promoted if the endeavour is paid for and driven by a results-oriented organisation which has a vested interest in success.
- The promotion organisation should be organised like a marketing business, with clear

Theme

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News from Headquarters

HEP-Meeting 2000

The HEP-meeting 2000 took place at GTZ-HQ in Eschborn, Germany, from September 4-6, 2000. Most of the participants came from all GTZ-supported household energy projects (ProBEC, Southern Africa, Ethiopia, Burkina Faso, Senegal), the rest were supra-regional staff of HEP, and some associated experts.

Workshop objectives were defined as followed:

1. Recent approaches for dissemination of HE-technologies (applied by completed and ongoing projects and programmes) were outlined, and evaluated with regard to criteria for successful and sustainable strategies.
2. The different elements of national HE-measures to establish successful and sustainable structures were outlined and compared to experiences from regional programmes.These comprised:
   - advice to and sensitisation of decision-makers,
   - capacity building (national, governmental, non-governmental and private partners)
   - information exchange and networking among the actors engaged in the HE-sector

   Their transferability was assessed, and differing features were identified. Feasible adjustments and modifications, which may contribute to future work and activities, were highlighted.
3. Based on the present role/ functions of supra-regional HEP activities vis-à-vis individual projects and programmes, the future expectations of HEP and HEP-related services on the Planning and Development Department beyond the year 2001 were defined.

The participants presented their experiences regarding the above listed issues, and identified constraints and opportunities in working groups.

The workshop report presently is in preparation, and conclusions and results of the meeting will be published in BP 46.

Extension Course on household energy for decision makers

The extension course – first designed in November, 1999, for the GTZ-supported Household Energy/Protection of Natural Resources (HEPNR) project in Ethiopia – is now available in non-country-specific English and French versions. Prior to conducting the course in certain countries, the material has to be adapted to the specific situation of the country / region. Facts and figures on the countries house-

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Figure 1: Working groups on sustainability in household energy-related strategies; venue Addis Ababa

hold energy situation have to be collected, analysed and included into the course structure. The course may also be adapted easily to the participants' specific background and fields of interest.

This course has been developed to raise national experts' awareness of household energy related problems, and possible solutions. It should contribute to putting household energy issues on the political agenda.

Target groups are decision makers at different levels, who work in different sectors with a wide array of different professional backgrounds related to HE-issues. Potential users are all projects, national institutions/organisations, and NGOs lobbying for improvement of HE-related problems, which are in a position to invite decision makers.

The 3-days-course is structured as follows:

The first day is dedicated to problem analysis, the second to the comparison of different strategies, and the third to discussion of implementation strategies for household energy programmes. The problem analysis starts from a country specific introduction to the household energy situation, followed by a discussion of problems at micro (household) and macro-economic levels. Supply enhancement, inter-fuel substitution and demand management are presented, and addressed as the three major strategies for tackling HE-related problems. A computer-based model simulation, adapted to the specific situation of the country in question is used to compare the impact of different strategies. The closing part of the course addresses measures needed for successful implementation of household energy projects/programmes.

The methodological approach of this three-day course relies heavily on visualisation (either through PowerPoint slide presentations or transparencies). Equally important, however, are in-depth discussions following each presentation. Group work, especially regarding the case study model simulation, is considered essential to increase ownership of the information gained.

A manual is provided for the organiser of such a course. Exemplary talks and all PowerPoint charts are presented with additional comments and hints for the trainer. All parts are specially identified, where adjustment to specific country data is required.

As yet, two courses have been conducted (Ethiopia and Mauritania), the feed-back on which has been exceptionally positive. For more information please contact the HEP at GTZ/Eschborn.

Box 1: Need for differing dissemination strategies in different areas

In the Mzuzu area of Malawi, where fuelwood is generally collected and no marketing channels exist, the introduction of biomass energy conservation (BEC) measures has so far followed a self-help approach. On the other hand, stove makers in Mulanje district in the country's south, where households are increasingly forced to buy fuel wood, have charged their customers a fee right from the outset. In Mozambique, the stove prototypes selected for dissemination are made by artisans who definitely expect a return from their product. The same applies to metal stoves being introduced in Zimbabwe. These few dissemination strategies suggest that varying degrees of commercialisation occur as one moves from mud/clay stoves to portable and metal stoves.

credit

**Supply enhancement as the easiest way out…
Plant and forget?**

- Supply enhancement requires certain political, legal, and economic remifications, which may take years to achieve,
- supply enhancement is dependant on comprehensive land-use planning innitiatives,
- supply enhancement relies on minute control, public awareness, and capacities for forest management,
- supply enhancement takes time…

…and can therefore be no single patent remedy for Ethiopia's problem, although it has to be part of an integrated strategy! No single, isolated approach will solve the preblem.

reference

Figure 2:

Studies on the communication situation in the household energy sector – HEP Sahel

An analysis workshop for three communication studies on HE-related issues in Senegal, Niger and Mauritania took place in March in Ouagadougou. Meanwhile, three more studies on that subject have been finalised for Burkina Faso, Chad and Mali, and the respective results were analysed in Dakar. Each series of studies was coordinated and backstopped by an additionally contracted expert in order to guarantee both common methodology and approach for these studies. Having sent draft versions to local stakeholders, their feedback was included in the final version. Based on results of the study, country-specific proposals for the implementation of the recommendations are presently being developed. These proposals should be integrated into strategies and action plans to improve communication in the household energy sector. In Mauritania, an action plan was elaborated for the household energy sector early in 2000, including the improvement of communication.

Dissemination experiences by ProBEC:

The regional approach of ProBEC (Programme for Biomass Energy Conservation in Southern Africa) has shown clearly the need for adjustment of dissemination strategies to the socio-economic characteristics of the concerned households and communities. The situation may not only vary from country to country, but even from one community to the other as shown in the examples in Box 1 .

The above experiences were reflected in a regional workshop on improved stove design and dissemination strategies, which was organised by ProBEC with support from Edwardo Mondlane University in April 2000, in Maputo, Mozambique. The workshop's purpose was to update the skills of BEC experts in Malawi, Mozambique and Zimbabwe in designing, constructing, and producing efficient stoves for burning biomass.

The workshop's focus was on introducing fuel-efficient biomass-stoves to a given community, which by nature is a needs-oriented approach. Stove users demand high quality services adapted to fit the socio-economic framework, which varies by region, and affects the choice of stove design and construction pattern. The workshop additionally addressed physical design parameters that are necessary to ensure energy efficiency, and/or smoke removal. Stove design and construction are balanced between socio-economic considerations on one hand and physical principles on the other. Also, aspects of kitchen management techniques and practices that have a bearing on BEC were covered. Dissemination strategies for improved cook stoves, which depend on the types of stoves selected, the economic situation of the users, and socio-cultural traditions, were discussed. Further topics were firewood management and alternative fuels, as well as dissemination strategies. The main emphasis was laid on stoves for household use, but the subject of stoves for large-scale use (institutions, small business) was also covered.

Each workshop participant outlined a strategy for the selection / design and introduction of improved stoves in her/his project, as one of the workshop's major outcomes. Guidelines for the selection / design and introduction of improved stoves and kitchen management techniques were documented, and a pool of regional experts for the full range of issues outlined above, was established.

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Figure 3: Maufacture of stove liner

The Women and Energy Project (WEP) in Kenya

(Summarised from abstract by Vivienne Abbott)

A recent post-project study commissioned by GTZ examined the sustainability of, and drew lessons from, the Maendeleo Stove dissemination in Kenya five years after the end of the Women and Energy Project (WEP). The WEP developed an alternative dissemination approach, known as the 'semi-commercial' approach. It involves commercial manufacture and selling of the technically important inner part of the stove, the liner, associated with a significant extension component in order to train the user to build the stove's body around the liner. The WEP eventually abandoned the approach in favour of a fully commercial dissemination. The transition was not easy, and the problems associated with the transition are outlined in the study. The WEP ended before the transition was considered complete. Activities have continued at a reduced level.

Supporting producers within the framework of the Improved Stoves Project – GTZ, Mali

Since 1984 GTZ has supported activities to introduce and stabilise the production and dissemination of improved cooking-stoves in Mali through the following phases:

1. Technical training of producers (traditional blacksmiths), and creation of demand through PR and project-based marketing,
2. organisation of producer associations or cooperatives, and management training to take over the marketing,
3. consolidation and extension of the network through creation of new associations in all regions and secondary towns.

Sustainable production and dissemination of improved cooking-stoves were the primary, long term objective of GTZ's support activities, with transformation of traditional craftsmen into modern entrepreneurs or business groups as secondary, supplementary objectives.

Support measures of the project included:

- technical training and refresher courses in stove production
- assisting associations with registration procedures
- management training combined with literacy training
- creation of revolving funds
- supporting the producers in optimising material supply
- supporting the associations in administrative questions (elaboration of annual balance sheets)
- assisting the foundation of a National Union of Blacksmiths, composed of local associations.

Results and lessons learnt from the project:

Regarding the first objective, production and dissemination seem to be well implanted in Mali, and a long-term demand has been created. This could not have been achieved alone by the GTZ-supported project, but only with substantial contributions of other projects. Those new associations which were among the first associations to be set up, and which therefore finished the entire management training cycle, are now well established and have enough orders to last. However, for those which came into contact with the project later, the training and learning phase was too short to allow consolidation. This was partly due to the fact that the follow-up phase of the project (1998-2000) lacked funds, and management training was hampered by poor co-ordination of too many actors.

Lessons learnt

- Strict separation between a project approach (e.g. for research and development), and a commercial approach for already tested equipment.
- Planning should define rigorous quantified objectives. Significance of publicity measures (e.g. radio and TV spots and price changes) should be tested to determine how much consumer demand can be increased.
- Training for producers should be based on social surveys in the region.
- Business plans should be established for each product and producer.
- Integration of small-enterprise promotion and micro-finance programmes should be planned by the project.
- Publicity measures may be subsidised in the beginning, but should be integrated in the cost structure of the producers and retailers, as soon as the market reacts to the promotion.
- Regular meetings between promoters, producers and retailers are useful for evaluation, and should culminate in the creation of associations.

HE/PNR Ethiopia:

(Summarised from abstract by Samson Tolessa)

At present the GTZ-supported Household Energy / Protection of Natural Resources (HE/PNR) Project is a major project addressing household energy efficiency in Ethiopia. The project promotes dissemination of the improved biomass 'injera' stove in three Regional States with a commercial dissemination approach, involving the private sector. Potential individual stove producers receive training courses for stove production and management, technical support in form of material, assistance and supervision, and are supported by the project with market promotion and advertising activities.

It is estimated that the 30 producers promoted by the project until 2000, annually will sell and install 30 000 stoves. The annual biomass savings would approx. amount to 17 500 tonnes. The annual energy expenditure savings of the households, calculated with the current average fuel wood price of 0.35 ETB/Kg, would be about 6.3 million ETB (1US$=8.15ETB 1 Euro = 7,107 ETB). Related to savings in forest area of the high yielding Eucalyptus, this would be equivalent to 2250 to 3000 hectares per year.

Electricity for the Urban Poor

by K.Krishna Prasad, Editor, Energy for Sustainable Development, Eeg 2.20, Faculty of Electrical Engineering, Eindhoven University of Technology, P.O.Box 513, 5600 MB, Eindhoven, The Netherlands

Electricité pour les populations urbaines défavorisées
La pauvreté est la raison principale explicative de l'absence d'électricité. Dans ce cas, pourquoi les populations pauvres urbaines n'optent pas pour l'électricité qui revient moins chere par unité de lumen que les lampes à kérosène. Cet artcle propose, pour la fourniture d'électricité, la création de petites compagnies d'électricité qui agiraient comme intermédiaires entre les ménages pauvres et les grandes compagnies d'électricité. Le principal problème est que cette méthode n'est pas efficace pour cette population.

Introduction

The main reason for people being without electricity in rural and urban areas is rooted in the same problem; simply stated, they are poor. Broadly speaking, in India, 75% or more villages are electrified, but only 30% or less of rural homes have electric lights. As a rule every urban area is electrified, but roughly speaking about 30% of homes, primarily the so-called slum dwellings, have no electric lights. In urban areas one is reminded of the lament of the poet Coleridge's Ancient Mariner: 'Water, water everywhere, but not a drop to drink.'

Kerosene, sold in small amounts is, in some ways, is a blessing in disguise. If people do not buy, they will not have light. With electrification, there is really a problem of collection of bills from electricity customers; cutting electricity for the individual defaulter is tricky. It can be done, but the cost of doing it may well be higher than what the individual family owes

But we will look at the problem from another angle. It does not require much fancy calculation to establish that the electricity is cheaper than kerosene per lumen of light apart from its comfort and cleanliness. Yet people have not opted for electric lights. The big question is: **WHY?**

Constraints

Theoretically the principal constraint pertains to the initial cost. However, there are several contributory factors.

The first group pertains to the question of safety

- For grid electricity, it is required for one to use 'licensed' electrical contractors to draw the lines from the mains to the house. There is no possibility of using the 'informal sector' as one is accustomed to for buying kerosene lamps.
- Further, housing is required to meet some standards. Slum dwellings rarely meet these. In fact, those living there are labelled 'illegal' squatters.

The second set of constraints are associated with the use of decentralized electricity production

- Solar Home Systems, using solar photovoltaics, at current costs, are seen to be a viable option for only isolated communities. It is seldom the case that urban slums will qualify on that basis.
- Biomass-based systems are not feasible due to the lack of an available resource.

The third set of constraints is concerned with the payment for electricity

- Electricity cannot be bought as one does with kerosene from the proverbial street-corner shop. There is a gigantic bureaucracy of the utility company to be dealt with.
- Metering electricity for a small consumer with a connected load of the order of 100 watts or less is prohibitively expensive.
- Conventional methods of billing and collection of tariffs simply makes the cost higher.

The last constraint – the constraint of all constraints

This has to do with the utilities themselves. They are under great pressure in almost every developing country to do without government handouts. This is exacerbated by an enormous scarcity of electricity generation capacity leading to power shedding and rationing. Expansion of capacity can occur only through investment by international sources – either private or agencies such as World Bank – that need to be assured of adequate rates of return. Under these conditions it is hard to expect the utilities to invest either effort or cash to assist te poor and needy.

Possible ways to get around the constraints

The key to progress lies in the slum dwellers forming an association – for lack of a better name, let us call it a small **utility company**. This brings us to that famous catch-phrase, that is so popular in development discussions, *institution building.*

One can visualize a series of tasks for our **utility company**.

- It will have to negotiate with the **utility company** to set up a transformer station with a meter and will pay for the electricity used by the households in the area.
- It will negotiate with the licensed electrical contractor to lay the necessary lines from the substation to a group of houses as would happen in a high-rise apartment complex. Such an approach can lead to some cost reductions.
- It will need to investigate technology modifications – for example use of moulded plas-

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tic wiring – to fulfil the building codes but yet meeting safety requirements. This can also lead to cost reductions.
- It will have to bill and collect the tariffs from the users.

The last item is going to prove the most complex since it will determine the sustainability of our **utility company**. Over the years there has been enormous work done on the costing involving capital, operation and maintenance, metering, billing and collection of tariffs. We will not go into details of these things but satisfy ourselves with presenting various cost elements.

The capital costs of our **utility company** are:

1. Setting up the sub-station;
2. Laying the lines;
3. Connection to the houses including light fixtures and lamps. The latter should obviously be the compact fluorescent variety.

There will be the inevitable maintenance costs both at the sub-station level and the consumer level – for example replacement of lamps (hopefully these need be only once in a couple of years or less).

Finally there will be the **utility** charges.

All these costs have to be recovered from the users in the long run through a 'billing and collection' system. Since metering is not an option, current limiters as described by Nafziger (1996) could be a useful approach. The amount of money to be collected is simply determined by the size of the current limiter.

Policy issues

The fundamental assumption here is that some outside institution/agency is interested in providing electric lights to these slum dwellers. How should it start?

In the case of electrification, the interested institution has to be armed with the money or a clear assurance of it (from one source or another) when needed, before initiating a discussion with representatives of slum dwellers. A question of consequence is the financial participation of the slum dwellers in the **utility company**. The approach in this context would be to raise the issue of the money saved on kerosene during the discussions.

A profile of the slum needs to be drawn up. Size of the slum determines the size of the sub-station. A slum of 1000 households will obviously use enough electricity to be worthwhile for the **utility** but will demand greater skill from the **utility company** in tariff collection from its customers. Another tale again from rural India shows the possibilities for dealing with its customers. Rice transplantation in India is invariably carried out by women. A leader of the women negotiates with the landowner the wages involved. On completion, the terms and conditions of work are presented to the entire group. Once these are accepted the work is begun and completed in time (Reddy 1990). The point here is that one can make use of the leadership qualities among the poor. One idea could be to borrow the practice of Grameen Bank in Bangladesh by creating the equivalent of so-called 'lending circles' comprising of five or so households to achieve the desciplined payment of electricity charges.

One more level of participation from slum dwellers could be envisaged. Presumambly there will be electrical contractors who are enlightened enough to train young people to carry out the diverse tasks involved in setting up the lines and connections to individual dwellings. This has been done in rural Ladakh, India in connection with PVSHS lighting (Roy 1996).

Conclusions

This short note is an attempt to suggest an approach to providing elecricity to the urban poor. The main point is that the normal method of providing electricity to users is a non-starter for this group. There have been successful examples of implementation of a diversity of projects that have helped poor people to better their lives. It is simply to integrate them into the project that is of interest here.

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Windpower: Small is beautiful

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Theme

Windpower works!

Windpower has become an important renewable energy source in recent years. Large wind turbines are the fastest expanding sector of the energy business in the industrialized world. Every year the wind turbines grow bigger, and the cost of wind-generated power grows smaller. But what about small wind turbines? They are more expensive in terms of each unit of energy that they can produce. But they have a role to play, especially for electrification of remote areas.

Windpower can supply a house with electricity. I know this because my own home is powered by the wind, and has been for over twenty years. I live in a windy location on the coast in Scotland, and I use batteries to store electrical power until I need it. In the beginning, I was very happy to have one or two little 12 volt lamps. Now our home has all modern conveniences, including TV, computer, etc… all powered by the wind. My neighbours use windpower too.

credit

reference

Figure 1: Windpower is useful in isolated windy locations

L'énergie éolienne: "small is beautiful"
Les petits aérogénérateurs ont un rôle à jouer particulièrement pour l'électrification des régions isolées. La technologie est relativement simple et les aérogénérateurs construits localement sont moins chers, souvent fonctionnnent mieux et ont une durée de vie plus longue que les machines importées. La qualité du produit est importante mais une technologie complexe n'est pas nécessaire. L'énergie éolienne peut être une réussite si les aspects suivant sont pris en consideration: un site venteux, une concepton fiable, un savoir faire local permettant des coûts bas et une bonne maintenance, une source d'énergie (solaire, diesel ou même lampes à kérosène) d'appoint lors des périodes de vents faibles.

Other options compared

To be honest, I would rather have a micro-hydro system. A micro-hydro system can be much more cost-effective than a wind generator. The wind comes and goes, but a reliable supply of water flows on, day and night. If I had a good stream of water, I could have power direct from the micro-hydro, and never need to use batteries again. But there is no stream of water – just plenty of wind.

Solar systems will work almost anywhere. Photovoltaic (PV) panels simply need to see the sun and they work. Windmills are not so easily satisfied. In most places there is not enough wind to make windmills worth having. Windmills need to be on hills, open plains or coasts where the wind is stronger and more regular. They need to be on tall towers to avoid the effects of trees and buildngs. Then windpower can be much cheaper than solar power, and it also works at night! Here on the Scottish coast it is cloudy and windy, so we harness the wind.

Wind and solar work well together (hybrid system). When there is no sun, it will often be windy, and so windmills can make a good back-up for solar systems. When there is sun, PV charges the batteries the same amount every day. In windy weather there is often a big surplus of energy. Windy weather can be a good time to 'equalise' the batteries by deliberate overcharging. On the other hand, here in Scotland I have started to use PVs as a back-up for my windmill. We run short of wind power in the summer when the sun is strongest.

Hybrid wind and solar systems can function with smaller batteries than sun or wind alone. Other sources can be used in hybrid systems: hydro, biomass, even diesel power can be a good choice if necessary.

Economics

Renewable energy equipment from western manufacturers is expensive. Developing countries may not have the capacity to produce PV technology, but small windmills are a relatively simple technology. Our experience here at Scoraig has been that correct design is more important than complicated engineering. Locally built windmills are cheaper, and usually work better and last longer than expensive imported ones. But it has taken time to develop the simple, rugged design. In recent years I have had opportunities to transfer this technology to the developing world. Quality is important, but high technology is not necessary. Small windmill production could be a perfect example of Schumacher's principles: a local solution to a local need, bringing power to the people.

Figure 2: Quality is important in wind turbine manufacture

Cost of small wind turbines is not proportional to size, as is the case with an array of PV panels. Larger units are more cost-effective in terms of electricity production. But smaller units are more affordable, and much more popular. Where a single family is concerned, a small unit is appropriate. Where village electrification is concerned, larger units, combined with PV, can offer better economics. In all cases, the results will depend on choosing a windy site.

Specifying wind turbines

Windmills are usually chosen by power output. Most people assume that a windmill with higher power rating will give them more power. It seems logical. But life is not that simple. Most of the time, the wind is not strong enough to enable the full rated output. Under these normal circumstances, the output will depend on two things: wind speed and rotor size. A windmill with larger rotor blades will produce more power on average than a windmill with a smaller rotor. The average power determines the monthly energy output.

For example, consider two windmills which cost the same to buy. In one case the rotor diameter is 1.2 metres, and the rated power is 400 watts. In the second case the rotor diameter is larger: 1.7 metres, but the maximum power is only 200 watts. Most customers will buy the first example, because they feel that it will give them twice as much power. But the rotor is so small that it takes a very strong wind (35 mph) to reach 400 watts. This will very seldom occur, in reality. Instead the second machine will produce more power, because the area of wind it sweeps is twice as large. (Area depends on the square of the diameter.) This windmill reaches its rated output of 200 watts at only 22 mph, while the smaller, windmill is ony producing 100 watts. Most of the time, the larger windmill outperforms the smaller one. Nameplate rated power is not very important.

Figure 3: Erecting towers is not as simple as it looks

Siting wind turbines

Windspeed is critically important. A 25% higher windspeed gives almost twice the power output. On most sites it pays to erect a tall tower for the windmill, so as to catch a better windspeed. The cheapest tower is a steel water-pipe, guyed with fencing wire. Safety is vitally important, too. Erecting towers is not as simple as it looks. Windmill towers can fall on people. And, in areas with grid electricity, care must be taken to avoid high voltage powerlines.

Predicting the electricity output

It is very difficult to predict how much energy a windmill can produce on a site. The correct way to do it is to measure the windspeed over a whole year, and then analyse the data into a frequency distribution. If we know how much power the windmill can produce at each windspeed, and we know how many hours the wind blows at this speed, then we can predict how much energy we shall accumulate over the year at each windspeed. This process is very expensive and time-consuming. At the end we are relying on data for the windmill which may not be accurate. Nobody uses this process for small windmills.

It is actually cheaper to erect a small windmill on a site and monitor its output over a year. The output can be recorded with an *amphour meter* or a *data logger*. Or we can connect a typical household to the system and see if it meets their needs. This is probably the best proof of success, and the family in question will be the best advertisement, when it comes to selling windmills to their neighbours.

As a rough guide we can say that a good site has average windspeed in the range 4-6 metres/second (9-13 mph). A windmill with a 2-metre diameter rotor will produce 40-120 watts average power output. There are

Management of sustainable photovoltaic solar energy in the semi-arid region of the State of Pernambuco, Brazil

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Gestion de l'énergie solaire photovoltaique (PV) dans une région semi aride de l'etat du Pernambouque au Brésil

Ce projet situé dans le milieu rural du Nord-Est du Brésil a identifié les éléments suivants à prendre en considération. En ce qui concerne l'offre une centrale pour la fourniture de services, la promotion du solaire PV, des compagnies pour la distribution, des progammes de formation, financement des coûts initiaux, liens entre fourniture d'électricité et développement économique et social. Du côté de la demande : habitudes de consommation des ménages ruraux, projections de la demande, un plan énergétique détaillé pour déterminer les resoources requises et la participation des communautés.

Introduction

In the rural areas of Northeast Brazil, less than 20% of rural properties receive grid electricity (1). The extension of the distribution network to attend this population, estimated at more than 20 million, may not be the best option for satisfying the energy needs of these regions, which are characterized by low population density, difficult access and low electrical energy demand.

Renewable energy sources: solar and wind, offer many advantages in rural areas, because they are locally generated, are produced on a small scale, are non-polluting and are environmentally friendly. Among the technologies that make use of renewable sources of energy, solar photovoltaic systems are among the best for offering economical electrical energy. The use of solar energy, a natural and abundant resource in the this region (2), can influence the socio-economic, commercial and agro-industrial development of rural communities, bringing about the following benefits:

- With lighting it is possible to augment the hours of work and study
- The opportunities for education increase with access to radio and television

Figure 1: Opportunities for education increase with more time for study

- Health conditions improved by:
  - having a cleaner source of lighting
  - for refrigerating vaccines and medication
- Reducing the isolation of the communities, because with electricity the use of radio-communication systems and telephones is possible,
- Electrical energy can stimulate productive activities such as: pumping water for irrigation; crop processing; conservation of harvests; production of arts and crafts etc.

Another relevant aspect of photovoltaic technology is that it integrates well into the economy of the local community, which can operate, maintain and repair the equipment.

Rural electrification in the state of Pernambuco

Pernambuco has an area of 101,023 square kilometres; its rural population (a quarter of the total) is 1,922,216 inhabitants, which consumes about 374 GWh of electricity. Situated in the north-east region of Brazil, the state of Pernambuco (Figure 2) presents four well-defined ecosystems: the coast; the mata – a zone between the coast and barren area, characterized by great fertility and abundant vegetation; the agreste – a semi-arid zone; and the sertão – an arid zone.

The rural sector of Pernambuco is characterized by small villages, supported by small family farms that use little technology, and only a few of which are electrified. A development model for this region must seek the following:

- improvement of the quality of life and well-being of the population
- strengthening of organization through associations or cooperatives
- participation of the whole community (children, adolescents, adults, women) in the productive and social process
- creation of a new technological model that allows the com-

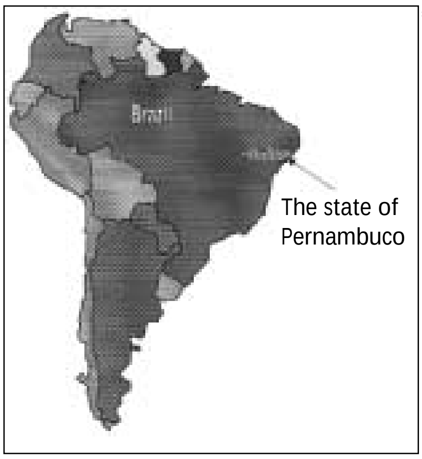

Figure 2: Map showing location of Pernambuco.

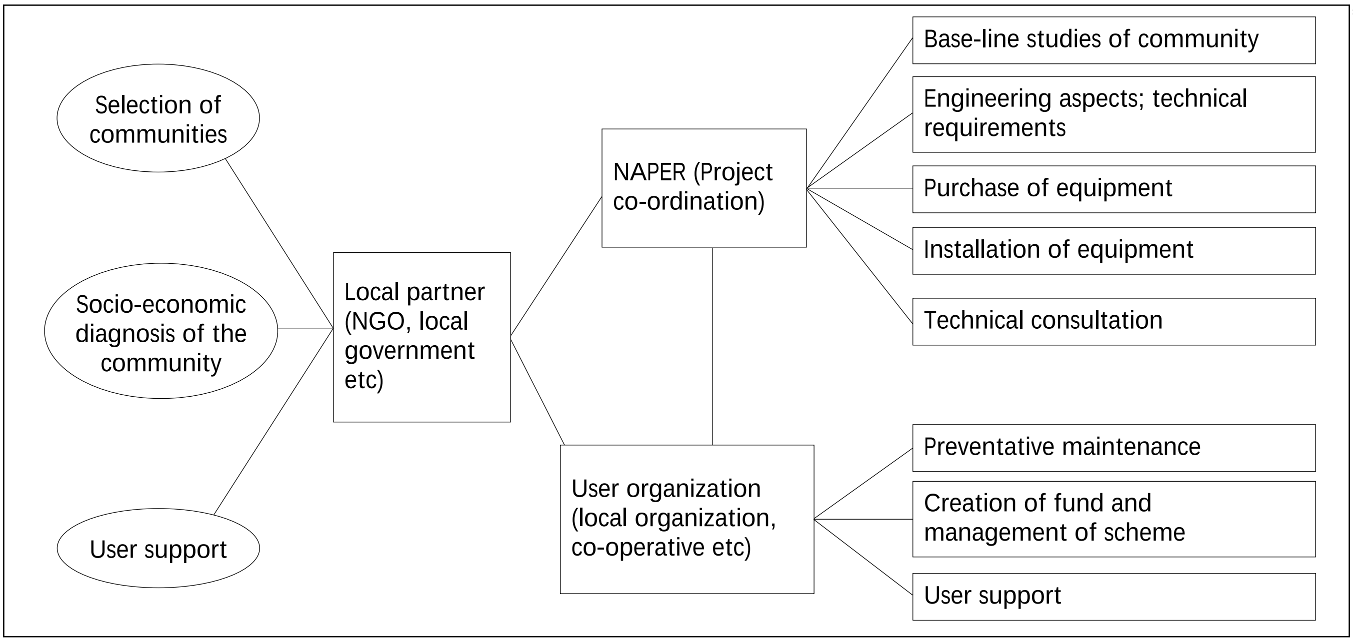

Figure 3: Participation and responsibilities in rural photovoltaic electrification

munity both to own and understand the technology.

- To implement a sustainable programme of rural electrification with photovoltaic systems. This strategy would look at both supply and demand (3).

On the supply side, the strategy should consider:

- the necessity for a central supply of goods and services
- the promotion and propagation of photovoltaic electrification
- the existence of firms for the commercialization and distribution of equipment, systems, replacement components and maintenance services
- the existence of training programs
- programmes for financing the set-up costs (principally for the purchase of equipment)
- the establishment criteria linking electricity supply to programmes of economic and social development at the local and regional levels
- evaluation of solar insolation (the amount of sunlight)
- identification and socio-economic profile of the non-electrified residences and rural communities

Figure 4: Photovoltaic technology is a good option for rural communities

The demand side should consider, for example:

- the consumption patterns and amount of energy used by rural households
- the demand projections, both at the level of basic needs and at the level of productive needs;
- an integral energy plan with the community, to establish the level of energy resources and technologies needed to ensure an adequate supply
- the participation and inclusion of members of the community in the various stages of the project.

The strategy should lead a programme that includes the objectives and methods needed to satisfy the energy needs of the rural communities effectively (4) both for subsistence and for economic development. These should be within the technical and social limits of the community.

Participative methodology

The Nucleus for the Support of Renewable Energy Projects (NAPER) has developed, during recent years, a participative methodology for implementing projects for residential solar electrification. The equipment is expected to last for at least the life of the photovoltaic generator; estimated at 20 years (5).

In this process of electrification, the users are expected to understand and service the technology. Since communities do not have technical expertise at the start, they need a technical team that will have an important role in the designing, installation, training and supporting the installations.

The Program of Rural Electrification with Solar Photovoltaic Energy – PERESF, developed and coordinated by NAPER, is a model for other programmes that use solar electricity in rural areas. With the financial support of the Program to Combat Poverty of the State of Pernambuco –

Rural electrification in Nepal: Experiences of an integrative social contextual approach

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Electrification rurale au Népal: Expériences d'une approache sociale intégrée
Au Népal les projets d'électrification ne sont plus limités aux aspects techniques. Le besoin d'associer les communautés est devenu un facteur important pour l'amélioration du niveau de vie. L'énergie hydro-électrique est utilisée pour alimenter de petites unités industrielles. A travers plusieurs études de cas, l'auteur considère que l'approche à privilégier doit concilier les ressources naturelles nécessairs au fonctionnnement du système électrique et le potentiel culturel, social et économique des communautés et des individus.

Introduction:

The word 'electrification' conjures up bright lights and urban expensive high technology powered gadgets, often considered as an unlikely intervention for the poor. This has led to the slow rate of high-grade energy technology intervention in remote or rural areas of developing countries, where over two-thirds of their total population live. However, there have been successful cases of bringing in electrification, in the form of micro-hydro plants (smaller than 100kW usually), solar or biomass options to light up rural areas. Apart from lights and domestic usage, they provide energy to power small scale industries as well. Nepal has had almost a two and a half decade of historical experience in bringing electric power to its villages, initially with mechanical systems to run milling machines and later when electrification came in the 1970s. Some systems are as remote as 7 days walk away from the main roadhead.

In Nepal, electrification projects are no longer seen as technical interventions alone. Practitioners and critics conclude that 'electricity if targeted at the poor alone' would not be a realistic approach. This is often because the poor alone cannot risk the heavy financial investments that are required to build and maintain an electrical system. In addition, the lack of proper feasibility studies, quick assessments, and non-participation of the beneficiaries has led to failures in some cases. However, alternative approaches are widely applied in electrification development interventions. The need to get communities actively involved is becoming a crucial factor for sustenance and improved livelihoods. This article is based on some of the Nepali experiences in the micro-hydro sector.

A wider social strategy for intervention:

In Nepal, organisations and individuals working in the field of rural electrification has realised that the only way to be successful, while keeping in mind the poor, is to integrate technology within a wider social strategic approach. Participation of communities are key to understanding and implementing projects.

Often, energy constraints are about the same for both the rich and the poor. The wider social approach does not consider them as separate entities but that they are bound to each other in complex relationships that need to be fully understood. Therefore, thorough investigations and full participation by all sections of the community is increasingly becoming prominent. Often, participation is achieved through a series of meetings, group formations, exposure trips and training for women, men and unemployed youths. In fact, electrification could reach the poor by maximising and tapping the potential of the richer sections of the community. One of such example is the case of Tikhedhunga presented below.

Within the integrative social context, the intervention approach takes into consideration all members of the community and how the benefits could be widely and equitably distributed. In many projects, benefits are largely unequal between the rich and poor, a major point of contention for the critics of rural electrification projects. To make this

In Tikhedhunga village, Kaski district, Nepal where the Annapurna Conservation Area Project (ACAP) works, a 40kW micro-hydro scheme provides service to several lodges and 102 houses. The locals had participated fully and provided active contributions in cash and kind to build the scheme. An elected Village Electrification Committee manages the scheme on behalf of the community. In this village, they have decided that the lodge owners, who have more income (this village falls under one of Nepal's famous trekking circuits) should pay almost double the tariff than ordinary households (Figure 1). Power is used continuously by lodges during daytime to cook with electricity while households can light up their homes during the night.

This example shows a good case of cross-subsidising the poorer members of the community by the other group of higher income earners. The chances of the price of electricity to remain stable and affordable are higher and will have a greater positive impact for the poorer households who may otherwise by themselves be unable to risk the technology and would have had to continue living in darkness.

Theme

credit

reference

Figure 1: Electricity used for showers in tourist lodge

possible, poorer sections of the community are all included to meetings and given equal opportunities to be members of the Village Electrification Committee. For example, in the successful community mobilisation process implemented by the Rural Energy Development Project (REDP), a UNDP project there are many cases where both poorer men and women have been actively participating in the decision making processes by forming their own social groups. They are allowed equal rights to attend trainings and start income generation activities or engage in-group saving and credit schemes. It is not necessarily only with lighting that communities benefit. Sometimes, as in the following REDP case, micro-hydro plant succeeds because of the integration of resources, both human and natural.

Gaining Equity with informative choices and rightful participation

While considering the wider intervention approach, the issues of equity and right informative choices comes uppermost in successfully integrating the poor. Theoretically, the benefits of electrification to all sections are almost the same; however, their capability to utilise it may not be. In many schemes for example, equal participation of all members of the community is made compulsory but the benefits do not accrue to the same. Some electrification plants in Nepal show this gap primarily because issues like information on usage of electricity, tariffs etc are not discussed properly with the poorer sections of the community. The fact that they are less educated makes the informative process a top-down one in many instances. Equity is possible only by including the poor, especially women, to participate actively in the provision of all informative processes. The following case gives a general picture of the benefits women accrue from an electrification scheme.

The right information and choices based on it have been crucial to the promotion of benefits to the poor. Information sharing can lead to communities valuing the range of option. In Nepal's remotest areas where the government body Remote Area Development Committee (RADC) works, micro-hydro was their main concentrated energy program to replace expensive kerosene or inefficient lighting woodfuels. However, in recent times, they have also taken in solar panels as another option to make it more cost effective and according to peoples needs, mostly for lighting purpose only. Beneficiaries therefore were therefore provided with a wider informative choice. In Ghandruk village where the community successfully runs a 50kW scheme, it has been now realised that initial phases had not concentrated on providing equal information to all members of the community. Today, even if there is equal participation in terms of labour provision and meetings, poorer people have not been able to access more electricity as the richer people (who often owns lodges) have already used up majority of the limited power supply.

The way forward:

Although, low cost electrification schemes have often been placed to be the right alternative to fossil fuels and expensive grids, the lack of incentives - financial,

Garlic farming in Pinthali village

The 11 community male and female groups from Pinthali in Mangaltar VDC, Kavre Palanchowk, are not only proud of the effort in bringing electricity to their village but also an added pride comes with the usage of the same water canal for irrigating land. The land earlier used for vegetable farming did not bring them income as cultural practices disallowed them to sell vegetables. Therefore, the villagers decided to shift to garlic farming and the impact has been found to be extremely positive. Ran Singh Lama, the Chairman of the Working Committee explains: ''Today, about 76,302 sq.m of land has improved with additional irrigation from the canal. This has added 90,000kgs of garlic growth each year and brings a profit of at least 1.5 lacs (US $1- approx. Nepali Rupees 72)''. Nearly 80 per cent of the people from the village benefit from this activity. Mr. Salaam Singh Lama, another village leader praises the efforts of all the villagers particularly the community mobilisation processes to have made it a success. To improve this system, the Pinthali farmers have recently started to cement 1km of the canal. Thus, electricity and an economic gain can sometime come hand in hand, if people are involved as well as committed towards effective results.
(Source: REDP, 2000)

Theme

Benefits to women from a micro-hydro scheme

In the village of Harichour, Baglung district, Nepal an enterprising MHP entrepreneur, Capt.Ganesh Bahadur Khatri has been operating a 25kW micro-hydro plant for over 15 years. The mill serves about 380 households during the daytime and electricity is provided to 215 households in the evenings for about 5 hours. The impact has been positive especially to women. Prem Kumari, a user, feels that the replacement of unhealthy kerosene lamps has created a favourable impact especially for the children who can now study with better lighting. Also, the health centre for women had benefited largely with lights as emergency cases in the evenings could be treated well.

The accessibility to the electrically driven mill has provided a big difference to women's lives. While before, women had to walk about 1 hour to grind grains in the traditional water mill, it has been now reduced to a 5 minute one. Hira Gauchan, another user pointed out that they have more time now than before when they had to grind at least 4-8kgs of grain every morning. The mill facility has also made it easier on poorer women who were hired to grind grains by the richer houses. According to these poorer women, this time saving has allowed them to work in other productive activities. Time is equated with money and often women preferred to work and earn rather than rest.

Women also felt that the television has become an important medium for gaining access to information about political, social, cultural and economic issues. This has helped them widen their understanding particularly because they did not travel out of the village.

structural or institutional makes it a difficult proposition to follow. An integrative social approach shows promise and furthering it will only be possible with the support of all stakeholders. The key point in the participation process to gain equity and enhance information sharing is that of transparency. Often, communities feel that they are not provided all the right answers or informed inaccurately. Practitioners should learn to be open about the processes and its mistakes and also simultaneously create room for the communities to be transparent themselves. Open meetings involving the poor and women are crucial if equity is to be assured.

In conclusion, a gradual holistic approach not only in terms of natural resources as electrical systems demand (such as water for hydro or light for solar) but by linking it up actively with individuals or communities social, cultural and economic potential should be the way forward. Continual assessment with communities and partners are required and equal opportunities prioritised. Low cost electrification technologies and their intervention must be continually assessed, researched, developed and disseminated. To lift the poorest of the poor out through electrification is no doubt a difficult proposition. However, to try to get there by using an integrative social approach through the right informative processes are showing positive results. A clear analysis of time, place and build up of expertise will lend a hand to improved access to electricity for all.

Thanks to Mr.Satish Gautam, REDP & Mr.Tej P.Rimal, Former ACAP Alternative Energy Officer for providing information.

Kavita Rai trained in Anthropology and worked as a social scientist with

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Development Consultant with interests in energy issues.

Non-theme

Income from micro-hydro: Jogbudhha VDC, Dadeldura, Nepal

Jaya Bahadurs' case comes as one of the many in Nepal's micro-hydro interventions. This particular one comes from the efforts of the REDP, who has worked in Nepal since August 1996 concentrating its efforts in 15 districts. REDP uses energy as an intervention strategy to build up community groups as well as working with local governmental institutions. Its fully integrative method aims not only to lift people out from the reaches of poverty but also to help them create sustainable strategies. Jaya Bahadur (JB) is one such case amongst many.

JB hails from Jogbudhha VDC in Nepal's remote western district of Dadeldhura. Before REDPs intervention in his village, he had to move to India to earn cash for six months. However, from July 1997, he got involved in the REDP community mobilization programme. Soon, the community decided that he be sent to a one month operators' training and was employed as the operator for the 4 kW ShanKhola Jal Vidhyut Pariyojana (Village Electrification Programme). With a regular salary of Rs 800 per month (about US$12), Jay is happy that he has cash for daily use and has kept aside his thoughts of going to India seeking temporary jobs. Today, JB is no longer just an operator as he also manages successfully his own community group. Where prestige is reigned supreme in Nepal's villages, he says his social standing has considerably increased. Within his group, he helps all the other members, poorer then himself to attain loan from the groups' saving credit scheme.
(Source: REDP, 2000)

From candles to compact fluorescents

by Kathleen Forssman, Account Director, Simeka TWS Communications, South Africa. Tel: (27 11) 712-9600, on behalf of Barry Bredenkamp, Programme Manager: Efficient Lighting Initiative: South Africa. Tel: (27 12) 427 2619.

De la bougie à la lampe compacte fluorescente

Cet article décrit un programme en Afrique du Sud dont l'objet est de diminuer les coûts associés à l'énergie domestique, créer de l'emploi et préserver l'environnement. Ces objectifs seront atteints à travers une planifcation intégrée des ressources, l'information du consommateur, et un apport technologique. L'auteur aborde l'utilisation des lampes fluorescentes compactes ainsi que d'autres mesures visant à économiser l'énergie.

Eskom's (South Africa's electricity supplier) Efficient Lighting Initiative (ELI) programme seeks to find solutions to link household energy initiatives with other development objectives.

The objectives of the ELI project are as follows:

- The lowering of household energy costs, so that less money needs to be spent on energy, particularly by poor people
- The creation of employment and economic benefits arising from a robust, energy efficient lighting market
- The conservation and preservation of the environment through its ELI programme.

Non-theme

The ELI Programme

Bonesa, the company formed to implement the Efficient Lighting Initiative and which falls under the Eskom Enterprises banner, promotes efficient, affordable and environmentally friendly lighting technologies.

The initiative is being funded by Eskom and the International Finance Corporation (IFC), with the latter supporting the project to the tune of $2,5-million (R15-million) and the former contributing an additional $8million (R48-million) to the programme over a period of three years.

IFC funding will be used to bring efficient lighting technology to newly electrified consumers. This will not only assist in reducing greenhouse gas emissions, but also in reducing the electricity bills of low-income groups in South Africa.

The partners will be working closely with stakeholders – including manufacturers, suppliers and retailers - to find additional funding and resources in order to achieve government-led efficiency targets; megawatt reductions to avoid the construction of additional power plants, improved environmental benefits and an increased number of energy saving lamps in the market.

The use of compact fluorescent lighting (CFLs) and other energy efficient technologies will benefit the country's citizens in terms of comfort, affordability and energy savings. CFLs are essentially lamps that use up to 75% less electricity, but produce the same amount of light as a regular light bulb. CFLs are filled with gas, and they glow brightly when electricity passes through them. When using CFLs, a homeowner feels safe as the home is surrounded by light. This technology also makes electricity more affordable for the South African consumer.

The ELI project will mean savings for individual consumers, and it will also assist in boosting the South African economy by providing savings for the country as a whole. By using electricity more efficiently, energy will be freed up for growing demand elsewhere.

All Africa Games Village provides a showcase of energy efficiency

One project using energy efficient measures is the design of the All Africa Games Athletes Village, where the athletes' village led the way in terms of energy saving measures.

This 75 000 square metre village of nearly two thousand units, situated adjacent to Johannesburg's sprawling Alexandra township, is now being utilised for low-cost housing, provides a range of cost-saving energy efficiency measures.

With each unit containing 60 watt equivalent CFLs with a wattage of 13W for internal lighting, the electricity cost saving to residents is an impressive statistic on its own as each house contains four lamps - amounting to 7200 lamps in the 1800 units - which would normally have meant a significant electricity expenditure to the homeowners.

Eskom's Hartbeespoort project

A Local Integrated Resource Plan is being implemented in the Hartbeespoort area to investigate resource availability (Figure 1), water and waste management and primarily electricity. The initiative is a joint venture between the local municipality, Eskom and the University of Pretoria.

Professor Holm, Head of Research and Postgraduate Studies of the Built Environment, in the University of Pretoria, says: 'Although it is still early days, we can say with confidence that the project at Hartbeespoort will result in savings in electricity consumption of between 40 and 50%. This has been achieved through the implementation of a few, simple and inexpensive measures.'

Dr Steve Lennon, Senior General Manager, Technology, Eskom, adds ‘Savings have numerous benefits for consumers, the utility and the country as a whole. The community benefits from reduced electricity bills, South Africa as a country reaps savings through better utilisation of resources (which in turn spares the cost of building or extending expensive power infrastructure), and there is less of a burden on the natural environment…’Eskom has high hopes that, in the long run, the measures run at the Hartbeespoort pilot can be extended to other communities throughout South Africa.

Says Barry Bredenkamp, product development co-ordinator, Efficient Lighting Programme, Eskom: ‘It is human nature to emulate successful enterprises, so we selected this area to serve as a role model. Hartbeespoort is an area where the existing power infrastructure is under strain and it is hoped that the project will facilitate better use of resources, show cost savings and will set a precedent for other pilots in the future.”

The basic tools for reducing power consumption are awareness and technology, to assist residents to turn their awareness into action. Eskom has made CFLs available to the residents throughout the municipality. To date, 3000 CFLs have been sold to just over 2000 households, which is believed to be the South Africa record.

Awareness of the availability and advantages of CFLs was promoted through partnership initiatives including lighting companies, both of which were offered CFLs at reduced prices and also contributed to the customer education drive in the area. CFL advertisements, funded by the suppliers, were placed in local newspapers.

Several information centres were set up at areas where residents pay their bills. Information on how to reduce energy expenditure is readily available.

Energy-efficient homes

Thirty local households were selected as test cases to measure energy efficiency. This was done without sacrificing the relative comfort levels of the homes involved. The project used these houses as test cases, measuring the efficiency of their power use and the comfort level of the homes, and providing advice that would enable householders to reduce the power consumption while maintaining comfort levels. As part of the project, designs for energy-efficient low-cost housing are being developed. Low-cost housing is in the pipeline for the Hartbeespoort area sometime soon.

Other houses are fitted with small monitors that measure the power use, and can be read from outside the home, without disturbing the householders. “I believe this is the first time this system has been used in South Africa,” says Professor Holm. “The results proved very helpful - and we were able to provide the residents with a detailed account which specified where and how they were using electricity, feedback they could put to use to improve their consumption.”

Education in schools

School children have visited the information centres, where they receive Eskom kits intended for use in science and environmental awareness classes. These kits include imitation geysers and measuring instruments, to which any appliance can be attached. The instrument will give a reading showing how much power the appliance uses, and even how much it costs.

‘School children will talk to their parents about what they’ve learnt,’ says Professor Holm. ‘But of course, they are also the energy users of the future, and our aim is to make them more discriminating users of energy and purchasers of appliances.’ Three schools in the Hartbeespoort area will be integrating these kits into their teaching syllabus in 2000.

Kathleen Forssman is an Account Director at Simeka TWS Communications, the largest public relations company in South Africa, which specialises in strategic consulting and media relations.

Figure 1: Dams and rivers provide water and energy solutions for Africa

Non-theme

Consumer response to mobile solar water heating in the low-income sector, South Africa

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Non-theme

Introduction

15.5 million people in South Africa live without indoor water and modern electric or gas geysers in their homes. The absence of such plumbing, as well as the cost of the systems themselves, generally precludes a fixed water heating system for this population. As a result of this situation, water most often is heated by burning traditional fossil fuels indoors, and at very low efficiencies.

This article presents a summary of results of a small consumer acceptance survey of mobile solar water heaters, conducted by IIEC-Africa during December 1999. The survey was conducted in Ivory Park, a low-income township in Midrand, North of Johannesburg. IIEC chose to test mobile solar water heating devices for their potential benefits, which include zero operating costs, and zero emission characteristics. IIEC focused on consumer response as an unexplored feature of market change in the solar arena.

Objectives

The primary objectives of the study were to profile energy use for residential water heating amongst low-income households of South Africa, and collect consumer response to passive, mobile, solar water heating devices.

Warm water is essential for the preparation of many staple foods, and even more relevant to proper hygiene. The fuels used to meet these water heating needs have direct impact on the health of their users, as well. When fuels are burnt inside the home, air quality and safety deteriorate. Fires are a frequent event in such households, as is paraffin poisoning. Smoke causes respiratory and eye, nose and throat ailments. The carbon monoxide from poorly designed and serviced stoves deteriorates brain functions, impacting productivity, and the ability to learn.

IIEC collected the following information to reach the primary objectives:

- Baseline information relating to residential water heating;
- Consumer responses to mobile solar water heating devices and their features, as well as information on conditions under which consumers would use solar water heaters;
- Data regarding the conditions under which households that own more than one water heating device would tend to use solar water heating devices; and
- Data on consumer willingness to pay for such devices, needs in terms of consumer finance, and conditions under which that willingness might change.

Background of Ivory Park

Of the estimated 292 000 people living in Midrand, about 233 000 (80%) live in households located in Ivory Park. The energy consumption patterns in these households are typical of many low-income developing communities, i.e. they use a wide range of energy sources, including electricity, in an inefficient manner, and in ways that are detrimental to their health and the local and global environment. Household energy use in Ivory Park is one of the major contributors to local air pollution, primarily due to the burning of low-grade coal for heating and cooking purposes. The preferred use of low-grade coal is due to the low cost of this fuel [1]

Methodology and sample

(a) Household Selection

Thirty households participated in the survey. Though the group contained participants from both formal houses on formal stands (a brick house on a designated, registered lot) and informal houses on formal stands (i.e., a shack on a designated, registered lot), it did not include any informal houses on informal stands (i.e., shacks on an unregistered lot). The households also mirrored the township's varying income levels, diverse energy use patterns and range of water supply sources (i.e., water available on stand and inside the house).

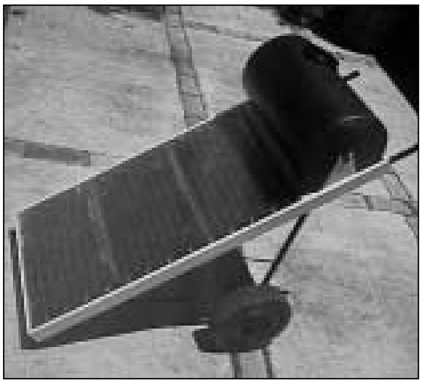
The ideal desired sample of households were those that varied in terms of energy profiles, income, number of residents, home structures, age and gender.

b) Equipment Selection

The selection criteria for the equipment used for the study was commercial availability, ease of use of the equipment, sturdiness and affordability. IIEC also gave preference to devices that were locally manufactured. IIEC selected three different devices and tested each of them over a period of three weeks. IIEC obtained thirty devices in total; ten of each of the selected products. The devices obtained were:

- A 'wheel barrow' type solar water heater, purchased at a cost of R766 (± $120 US) per unit at the time of the study (December 1999). This device has a filling aperture at the top of the device near the handles. Water runs through a PVC zigzagging pipe in the body of

IIEC-Africa



reference

Figure 1: The Wheel Barrow Type Device

the 1 metre long device to heat, and continues to heat in the holding tank (25-30 litre) whilst the device in strong direct sunlight. The device stands at a permanent angle of 45 when on flat ground, and has two wheels for ease of mobility. A tap at the bottom of the holding tank supplies water from the filled device.

- A soft tank shower at a cost of R60 (± $10) per unit. This shower also known as a 'pillow case' device or 'bladder', is made of black soft plastic sheeting on the one side and a transparent plastic sheeting on the other side. It has a short transparent plastic outlet pipe with a small red shower-head at the end. To open and close the shower, the user pulls the shower-head vertically up and down. The volume is 18 litres.
- A third device, almost identical to the solar shower but with a different aperture device, R70 (± $11 US).

credit

reference

Figure 2: Soft tank shower

Study methodology

IIEC designed a survey tool to gather information from the community and relied on structured face-to-face interviews to gather data. IIEC's rationales for relying on interviews were: the multiple languages of the community; the high degree of illiteracy in the target community; and cultural issues such as unfamiliarity with answering surveys.

Before distributing the solar geysers, IIEC interviewed study participants to gather information on residential energy use and water heating. These interviews provided IIEC with a baseline against which to compare participant's responses to the solar water heaters. The baseline interview sought data (both hard facts and perceptions) of fuel use. Thereafter, each participant was interviewed once a week on their use of that week's solar water heating device.

Summary of findings

(a) Baseline Information Data

The baseline interview indicated that:

- All participating households use hot water for bathing and most also for cooking. A small percentage uses hot water for laundry.
- Although the households were electrified, only 13% of the participants use electricity as their sole fuel for water heating. Twenty percent rely solely on paraffin for water heating, and the remainder (67%) use a mix of fuels to meet their water heating needs.
- Few of the formal households have electric water heaters/geysers installed. The few households that have these installed do not use them often, or at all, because of the high cost related to their use.
- Households use various appliances such as electric kettles, ordinary kettles and pots to heat water on either electric, coal or paraffin stoves. None of the households used gas.

The survey further indicated that:

- Participants welcomed the energy savings associated with mobile solar water heating devices.
- The devices met almost no resistance in terms of the cultural or status perceptions,
- Many participants were unimpressed with the low volume device. They found the time/volume trade off unappealing.
- Participants indicated an interest in purchasing the higher volume system "wheel barrow" through a financing mechanism. The commonly mentioned financing mechanisms were through savings clubs, credit with national chain department stores and lay-away programmes at preferred stores.
- Survey participants offered few comments on design or features of the systems tested.
- Solar water heaters meet many, but not all water heating needs in low-income households surveyed.

Conclusion

Solar thermal devices make use of the sun's radiation in a direct heat transfer format. Simple devices such as solar cookers and mobile solar water heaters require the most minimal acquaintance to the product, and in most cases are self explanatory. No technical training or literacy is necessary to use them effectively. Like solar-electric systems, solar thermal systems require an adequate duration and strength of irradiation to supply service.

Due to their simplicity, utility, and low generating costs, simple, low-cost solar water heaters offer

Clay Grate Development in Chibau Khera

by Jon Rouse, Water, Engineering and Development Centre (WEDC) Water, Engineering and Development Centre (WEDC), Loughborough University , Leicestershire LE11 3TU, UK. Email jonrouse@iname.com

Introduction

This article describes the design, testing, manufacture and promotion of a clay grate. The grate was developed earlier this year as part of an improved stove for a project in Uttar Pradesh, India. The project itself is outlined briefly, but the article concentrates on the ideas behind the development of a cheap alternative to the steel grate, and various aspects of its development, manufacture and potential.

This is not about a 'model project', or even a project that will necessarily succeed, but the story-so-far on one aspect of a simple, small scale, participatory, village-based project. The project is being continued by the Indian Institute for People's Action and Development Systems (IPADS) in a village called Chibau Khera in Mohan Lal Ganj, near Lucknow.

Traditionally, women in Chibau Khera use a simple U-shaped mud stove for all cooking activities, fuelled by wood and dried-dung. While these stoves are free, familiar and easy to construct, they are not efficient and are very smokey. Women complain of health problems relating to smoke, affecting their eyes and respiratory systems. Wood collection is also said to be an arduous task.

The IPADS project sought to respond to the stated needs of the village women by designing a more efficient and less smokey cooking stove affordable to all, encompassing as many of the positive aspects of their traditional stove as possible. Lessons from a previous (failed) stove project were taken on board, and the programme was designed with local sustainability in mind.

A potter in Chibau Khera lent us a piece of land to be used as a 'village laboratory'. This constituted a stove development, testing and demonstration area, although it was simply an area of ground under some trees. However, what the 'laboratory' lacked in terms of 'facilities' it made up for in the fact that it was public. As such, it attracted much interest in the form of spectators and curious children. This led to considerable participation giving the villagers an opportunity to air comments, discuss scepticism as well as get involved and make suggestions. This raised the profile of the stove, and helped relationships to develop between the field workers and the villagers.

The stove developed was named the 'Mina Stove'. It is a simple two-pot mud stove, shown in use in Figure 1, and in cross section in Figure 2.

credit

reference

Figure 1: The Mina Stove

The Mina stove

No chimney was included in the stove due to cost and difficulty of procurement. This compromises the pursuit of clearing the kitchen environment of smoke, but in this case the 'technical ideal' had to be sacrificed in the interest of user needs and means. However, the stove was made considerably less smokey than the traditional by the inclusion of a grate and firebox air holes (to provide primary and secondary ventilation respectively), which aided cleaner, fuller, combustion. The firebox opening was shaped in such a way as to minimise heat loss whilst enabling the insertion of chapattis for baking. The double pot-holes were a feature welcomed by all users, as meals usually consist of at least three separate dishes.

Cooking tests, conducted by village women, were used to compare the U-shaped and Mina stoves for cooking a typical family meal. In these tests, the Mina stove burned 0.5kg (25%) less wood and cooked in 30 minutes (40%) less time than the traditional. In addition, the Mina stove produced considerably less smoke (visible emissions down by more than 50%) and was easier to light and control. Figure 3 shows a woman cooking the meal on the U-shaped stove during a test. Many people came to watch the testing in progress, which were followed by an announcement of results and a very good meal.

After the demonstrations and the resultant good reputation the stove gained, many people were

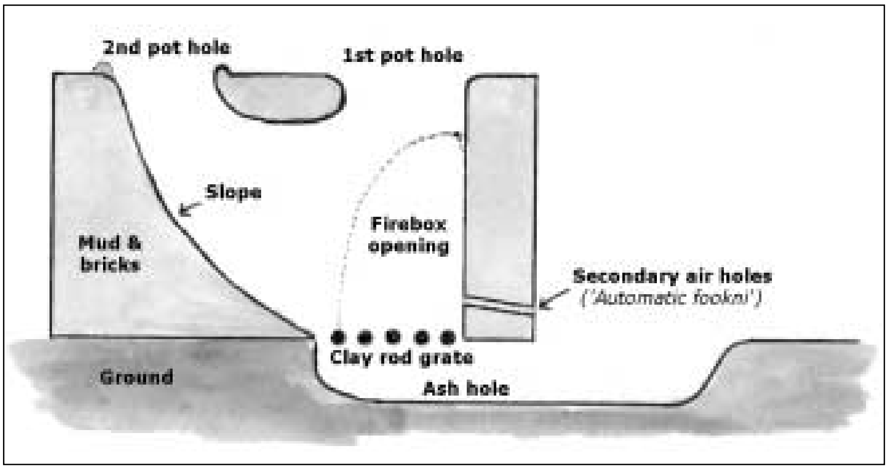


Figure 2: Cross-section of Mina stove

keen to adopt this stove and asked for one to be built in their homes. Some villagers have been using the stove for three months now and are very enthusiastic about the improvements. Cost, however, remained an issue for the poorer villagers. Steel grates are the most expensive component of the stove, costing around Rs25 (US $0.55). This is a significant sum for many of the villagers, equal to a full day's pay. As such, the project set about devising a cheaper, locally producible alternative to the steel grate.

The Baked Clay Grate

In the intervention village there is an abundance of clay and potters. One of these potters volunteered his services to help develop a clay grate. Clearly, clay is not as strong a material as steel and the possibility of breakages needs to be considered. It is unlikely that an entire grate would break at one time, so it seemed wise to design the grate in such a way that individual elements could be replaced when broken.

The final design consisted of 5 baked-clay rods of diameter 25mm arranged side by side with 10mm gaps between rods, as in Figure 4. In terms of stove performance there is no noticeable difference between clay and steel grates.

Note that the rod supports do not constitute a separate component of the stove, they are simply moulded into the mud in the ground. These can be formed using a wooden mould, easily and cheaply prepared by a local carpenter as in Figure 5.

How strong is it?

Tests have shown that the rods comprising this grate are surprisingly robust. Cooking 'simulations' were conducted involving heating the rods to high temperatures and 'spilling' hot and cold liquids onto them to see if they fracture, as well as testing their resilience to shocks through knocking. The rods survived more abuse in all these tests than they are anticipated to encounter in normal household use.

The grates have also been used for household cooking. Repeated cooking over a number of weeks did not result in any damage to the rods in one household. However, it is clear that longer tests are required. As such, 25 households are presently using the clay grates for everyday cooking. The grate will be evaluated, based on the results of these tests, later this year.

How cheap is it?

In Chibau Khera, one of the potters is now manufacturing the rods for Rs1 each, which includes the clay, labour and baking. The cost of the entire grate will therefore be around Rs5 (US$ 0.10). This is about 20% of the cost of a metal grate, and as such needs to last over 20% of the life of a metal grate in order to be directly economical. Of course, even if the direct economics of this did not 'work out', the lower cost could be seen as a way of spreading payments for a grate. This is a potential area for future research.

Mixed reactions

The stove performs well in tests and it makes the Mina Stove financially accessible to some of the very poorest and remotest villages. However despite the successful tests and demonstrations, many villagers have opted to buy metal grates. People doubt the strength of the rods, particularly

Figure 3: Woman cooking a meal during a stove test

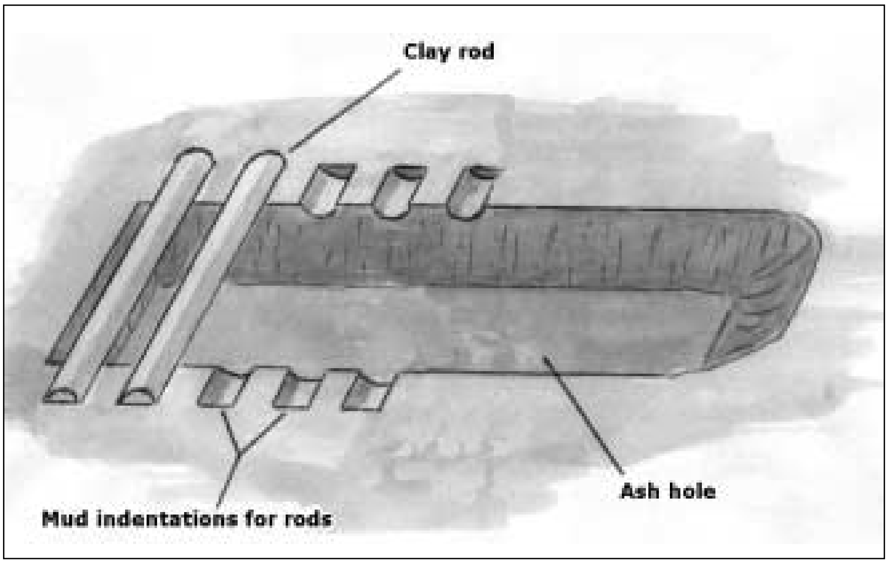


Figure 4: Final design of baked clay grate

in the longer term. Some of the sceptics are themselves potters and it is important to respect and be open to their wisdom and doubts.

There may be other less obvious reasons for people's reluctance to use the grates. By virtue of the publicity they have received in the village - as a 'cheap alternative' - the grates may now have something of a stigma attached them. It is possible they have become a 'poverty indicator' in the minds of villagers. In contrast, the metal grates may indicate affluence. These attitudes may be held sufficiently strongly to mean that even the poor are prepared to pay the extra for a metal grate, though this has not been confirmed. This example highlights how the manner of introduction of a technology may affect people's response to it.

There are also village politics worthy of note, including a longstanding argument between an influential government representative and the potter. This may be affecting people's attitude towards the potter's business pursuits. Finally, it is important to note that this village is not among the poorest in the area, and that uptake rates may be different in a lower income context where people could not consider a metal grate.

Figure 5: Rods in position in a stove, forming the grate over the ash hole.

Other benefits

There are likely to be a number of indirect benefits of using this grate. Firstly, the manufacture of the rods can provide extra income for one or more of the potters. In Chibau Khera, the potter selected for manufacture was one who had been unendingly helpful and generous to the project team and our work. This was a way of giving something back to him. Secondly, the fact that components are locally made means supply problems are less likely, and that prices may be lower than if transport costs were incurred. When replacements rods are required they can be procured easily in-village. Travel outside of villages can be time consuming and expensive. Finally, the manufacturer is likely to constitute an in-village publicity representative for the new stove and grate. It is in his or her business interests for people to use the new stoves and grates, as that generates business.

Conclusion

This concludes the story, so far, of the clay grate in Chibau Khera. The results of the longer-term tests presently underway are required before the next step in its development or promotion can be decided. In addition, the obstacles to dissemination of the grates need to identified and better understood before moving forward.

To date, the project has been a great success. The objective of developing and popularising an improved stove in the village has been realised. Many people are willing to pay for the stove components, and a woman has been trained and is working in their construction. The whole manufacturing process can be carried out at village level using local materi-

What's happening in household energy?

in association with the Household Energy Development Organization's Network (HEDON)

HEDON website has moved

It can now be found at http://www.ecoharmony.net/hedon/news.htm

The Shell Sustainable Energy Programme

The Shell Foundation is a charity registered in the UK and established in June 2000. One of its programmes is the Shell Sustainable Energy Programme, which will support projects that tackle two fundamental energy-related issues:

– the environmental impact of our global dependence on fossil fuels; and
– the link between energy and poverty in developing countries.

The Sustainable Energy Programme will provide grant funding and other forms of support to groups working in the public interest.

The programme will:

– concentrate on issues where focussed effort will bring significant results;
– work closely with grantees and funding partners to develop projects that deliver observable benefits and use methods applicable elsewhere;
– help grantees communicate their results and lessons learned to key audiences for wider benefit.

In developing countries the programme will give priority to projects whose principal focus is tackling the link between energy access and poverty, but which also deliver environmentally positive outcomes.

Details: Shell Foundation, Shell Centre, London SE1 7NA, UK

Information on ITDG programmes can be found on the inside back cover, and GTZ programmes are described on the centre pages

Tel: +44 (0) 207 934 27 27; Fax: +44 (0) 207 934 66 25:

Email: info@shellfoundation.org

Traditional household fuel use in developing countries

Funding from the Shell Sustainable Energy Programme will be used to support detailed quantitative analysis, policy assessment and communication of the results of a seven-year, six-country (India, China, Thailand, Brazil, Kenya, and the USA) study. This will be carried out under the direction of Professor Kirk Smith, University of California, into the health and environmental effects of traditional household fuel use in developing countries. Among the variables measured (across 60 fuel-stove/field site combinations and a dozen charcoal kilns) on a strictly comparative basis were energy efficiency parameters, emissions of health-damaging pollutants as well as all major greenhouse gases. Analysis of this unique database will allow calculation of greenhouse gas and health-damaging pollutant inventories, the assessment of implications for i) potential substitutions/ switches of fuels and/or stoves; ii) possible changes to improve health or reduce greenhouse gas; and iii) the interactions of health-damaging pollutants and greenhouse gases with stove parameters such as efficiency and power. Grantee: School of Public Health, University of California SEP Grant: $120,000

Project Gaia

(see BP no.43 page 28 - 'A new clean household fuel for developing countries')

Project GAIA are introducing methanol with a cheap non-pressure stove, which can be used interchangeably with ethanol, as a domestic fuel in developing countries is working to get a 50-ton per day local methanol plant installed in an African country to use flared natural gas.

This will be preceded by or done concurrently with, a 1,000 stove market pilot study. The GAIA project is seeking interest in such pilots in other countries. Contact Andy Stokes, Stokes Consulting Group, Naples, Florida. Tel: 941-775-3439 Fax: 941-775-3438 Email andystokes@aol.com

Bonesa and the Nelson Mandela Children's Fund - Lighting Up South Africa

(see 'From candles to compact fluorescents' - this edition)

The provision of electricity and energy saving lamps is bringing health and other social benefits to South Africans. Eskom's electrification drive means that homeowners can reduce or eliminate the use of coal, wood and dung for cooking and heating, the burning of which is a leading cause of respiratory illness among South African children.

In addition, Bonesa's ELI is helping homeowners save money and energy, as compact fluorescent light bulbs (CFLs) are considerably cheaper to run than conventional light bulbs. Energy savings mean that South Africa's power plants do not need to work as hard, saving precious resources and protecting the environment.

Figure 1:

Bonesa and the Nelson Mandela Children's Fund (NMCF) have joined forces to promote the use of energy efficient lighting technologies. Approximately R1.00 from the sale of each CFL over the duration of the programme will be donated to the NMCF for use by the fund and the Nelson Mandela Foundation."

Contact: Kathleen Forssman (see linked article for contact details)

9th International Conference on Indoor Air Quality and Climate Monterey, California, June 30 - July 5, 2002

Indoor Air Pollution from household biomass and coal combustion is a major contributor to poor health (it has been estimated to account for nearly 2 million excess deaths per year) and this is gradually gaining recognition in international circles. Although this conference will not be dedicated to indoor air quality issue in developing countries it is sure to be a major area of discussion. Call for Abstracts will be issued in the Spring of 2001 and will be due in the later part of the year. More information can be found on the website: www.indoorair2002.org

eco Ltd is a small private consultant firm based in London that brings together energy, sustainable development and information technology. The company focuses on project, market, and business development. eco Ltd. aims to empower local communities and organizations, has extensive experience in renewable energy, project development, project management, and in information technology, and is sponsor of the HEDON internet pages (www.ecoharmony.net/hedon).

Further information: visit ecoharmony.com or contact:

Grant Ballard-Tremeer, tel +44 (0)20 7386 7930

fax +44 (0)870 137 2360, email grant@ecoharmony.com

Aprovecho institute

(see also 'Publications)

Aprovecho Research Center has been working with Trees, Water and People to introduce more efficient griddle type stoves in Honduras and Nicaragua. The stoves are based on Dr. Larry Winiarski's Rocket stove principles using an internal chimney above the combustion chamber to promote clean combustion. Wood ash is a great natural insulation and is used in the many variations of Aprovecho's stoves. HELPS International is beginning to disseminate a poured cement griddle type stove later this year in the highlands of Guatemala. It includes the Rocket elbow and uses wood ash or pumice rock to keep heat from the high mass of the stove body. The small fire, well inside the cast cement stove, is designed for safety. The stoves are poured into fibreglass moulds made in Guatemala City and available to village craftspeople.

Contact: Dean Still, Appropriate Technology Coordinator, Aprovecho Research Center, 80574 Hazelton Road, Cottage Grove, Oregon 97424 USA. (541) 942-8198 apro@efn.org

Some candles emit dangerous levels of lead

(Abridged from Unisci: http://unisci.com/aboutunisci.shtml; 07-Oct-1999)

A University of Michigan School of Public Health study of candles shows that some candles on the market today are made with wicks that have either lead or lead cores that emit potentially dangerous levels of lead into the

Figure 3: Cast cement stoves, insulated with wood ash, that Aprovecho and HELPS International have co-designed in Guatemala.

air. Not all candles are made with wicks that have metallic cores. The practice is primarily used with candles that are needed to burn longer, such as scented or ceremonial candles. A metal core is used to provide rigidity to the wick

The study is by Jerome Nriagu, a professor of environmental health sciences, who examined lead emissions from 15 different brands of candles made in the United States, Mexico and China. Nriagu found that metal cores in Chinese candles were made of either pure lead or lead alloy. After burning the candle for one hour, the lead levels in the air of an enclosed space were estimated to range from 0.04 to 13.1 micrograms per cubic meter, which compares to the U.S. Environmental Protection Agency recommendation of 1.5 micrograms per cubic meter for ambient air. After five hours, the lead levels had risen to an estimated 0.21 to 65.3 micrograms per cubic meter.

Regular exposure to lead in this manner in confined spaces could pose health risks to people with weak immune systems, especially children and the elderly. Some of the most damaging neuropsychological effects of lead poisoning of young children include learning disabilities, reduced psychometric intelligence and behavioral disorders. These effects have been associated with long-term low-level exposure to lead and are believed to be irreversible.

ITDG energy news

IT Consultants (ITC) is the consulting arm of the Intermediate Technology Development Group. In this edition of ITDG energy news we look at their role within the ITDG 'family'.

IT Consultants

IT Consultants (ITC) is the consulting arm of the Intermediate Technology Development Group and provides high quality, independent and professional advice to governments, NGOs, aid agencies and the private sector. It has three main Programme areas:

- Energy and Environment, where the specialisation is in decentralised rural electrification, industrial and household energy (cooking, lighting, communication), and renewable energy services.
- Manufacturing and Enterprise Development with the focus is on small and medium enterprises, helping to stimulate innovation and improve productivity.
- Natural Resources sector where the concentration is on issues surrounding sustainable livelihoods, such as income diversification, access to markets and services, and community-based natural resource management.

The Energy Programme has a proven track record of managing complex, multi-disciplinary international projects and has worked on Renewable Energy policy and strategy issues in Europe as well as Africa, Asia and Latin America.

The approach that it takes is to identify users' needs and opportunities for technology change, managing that change and providing support to local institutions to ensure sustainability. Activities include: energy needs assessment; demand surveys and market studies; resource assessment (for example, hydrological studies, wind monitoring, solar energy assessment and biomass surveys). Feasibility studies cover the technical, social and economic aspects of biomass, solar, wind and hydro use; technology development and adaptation to local socio-economic contexts; policy analysis, institutional development, strategic planning and action plans.Training courses are run in all aspects of rural and renewable energy, both general and technology specific. Specialist technical support is available for practical project design, implementation and evaluation to implementation programmes incorporating rural and renewable energy. The case studies below give typical examples of the work of ITC.

In both countries, there has been a strong emphasis on building partnerships with local stakeholders. In India, the team is working with potteries in Khurja, which is the largest ceramics cluster in India, with about 500 firms. The team is now working very closely with existing institutions in the region, including the Khurja Pottery Manufacturers Association (KPMA), the Central Glass and Ceramics Research

Case study 2: Mechanisms to improve energy efficiency in small industries

This project aims to improve the efficiency of energy use in small industries in Ghana and India, focussing on timber processing firms in the former, and ceramics firms in the latter.

As well as considering technical mechanisms, the project will also aim to develop market and policy mechanisms necessary for sustainable implementation of technical interventions. The project is also exploring the linkages between energy efficiency interventions and poverty alleviation of the workforce and local populations.

This is a two-year project, funded by the UK Department for International Development (DfID), under the Engineering Knowledge and Research programme. The project is due to finish in March 2001.

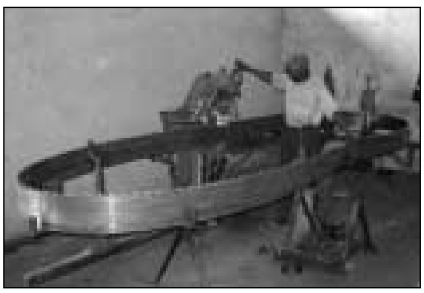
Case study 1: Renewable energy training packages in Vietnam

A project to prepare training and extension materials to support off-grid rural electrification

There are currently a number of initiatives taking place in Vietnam to electrify rural areas through grid extension. The target is to electrify 70% of all households by 2010. However, it is estimated that there will still be over 3 million households that will not have access to electricity by 2010. There are many communes in Vietnam that are too remote and dispersed for grid extension to be economically viable. De-centralised rural electrification schemes are therefore a feasible option. One of the identified needs was the requirement to train different levels of government and rural communities so they can evaluate the different energy options for decentralised electrification. They would then choose the most appropriate generation mix and type of supply (whether for a private household or at community level), to provide the energy services required by rural communities.

Stephen Ward, ITC

Figure 1: Renewable energy expert from the Hanoi Renewable Energy Research Centre demonstrating the effect of a higher efficiency water turbine, as part of a training session



Stephen Ward, ITC

Figure 2: Sawdoctor sharpening saw blade in Forest Africana Sawmill, Kumasi, Ghana3

Boiling Point is a technical journal for those working with stoves and household energy. It deals with technical, social, financial and environmental issues and aims to improve the quality of life for poor communities living in the developing world.

Contents

Theme articles

Theme articles

Our mission is to build the technical skills of poor people in developing countries, enabling them to improve the quality of their lives and that of future generations

ITDG PRACTICAL ANSWERS TO POVERTY

Intermediate Technology Development Group Ltd., Patron: HRH The Prince of Wales, KG, KT, GCB
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PRORURAL, 126 systems for rural domestic use and school electrification in communities of the semi-arid region of Pernambuco have been installed in the last two years.

To ensure the sustainability of these installations, NAPER has assisted local partners in promotion of the following;

- Selection of non-electrified communities
- Characterization of socio-economic and energy-related factors with the families and the community;
- Promotion and propagation of solar photovoltaic energy at municipal level meetings organized for this purpose;
- Technical and economic specifications of the project;
- Education on photovoltaics for members of the community;
- Participative installation of the equipment;
- Community management of technical assistance and replacement of parts (creation of community fund);
- Support for the project.

The diffusion of photovoltaic technology in the rural environment is a complex task, as verified by NAPER in recent years, involving problem solving for technical, economic, infra-structural and social issues. Various entities and organizations have participated in the different stages of PERESF. Figure 3 shows an organizational diagram of this programme, defining responsibilities.

Two critical aspects, observed throughout this work, relate to training and technical assistance.

- The training of both the users and the community association have allowed the technical, financial and administrative management of the installations (creation of the community fund), to be done by members of the community.
- Regular preventive maintenance, and in some cases, corrective maintenance, can and should be done by members of the community, who receive the requisite training. Solar electricians, (two or three members of the community) receive adequate information and training to provide technical assistance for the equipment installed in the community in which they live.

Conclusion

Although there are rural electrification programmes dealing with the extension of grid electricity (which ought to be encouraged), they are not always appropriate, even in the long-term. Other options should be considered, such as the utilization of existing renewable energy resources: solar energy, wind energy and biomass energy. These sources of energy offer many advantages; use of local manpower; they are environmentally friendly; they provide economic production of useful energy on a small scale.

Photovoltaic technology is one of the best options for supplying electricity to rural communities, being widely used in various countries. The initial investment makes the purchase of a photovoltaic system for residential use, impossible for the majority of families living in rural areas with low monthly incomes equal to or less than the minimum wage. Adequate financial plans that favour long term repayment (low interest and long term loans) at rates which can be met by rural dwellers can stimulate a greater diffusion of this technology.

The ability to pay will be similar to the monthly costs of purchasing the energy that can be substituted by photovoltaic electric energy for lighting and communication. Therefore, the monthly repayment should be similar to the costs that will be avoided, for example, for the purchase of kerosene or diesel fuel for illumination, the purchase of batteries and/or recharges for the functioning of radio and television.

Two other aspects deserve mention:

- For most people, electricity is a new factor in their lives and extensive information and education is needed in the rational use of solar electricity.
- If this is not considered, experiences in other countries have demonstrated that incorrect installations, lack of replacement parts, or the omission of simple maintenance operations, can put the residential photovoltaic system out of service within a few months.

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a superb service to consumers. To date, however, both suppliers and government policy have largely overlooked this serviced market. Survey participants, were prepared to seek these devices through existing commercial avenues, as long as standard consumer finance was possible. None were aware of the devices before the survey. The bladder devices are well-hidden in the camping section of stores. Meanwhile consumers bath via a splash-bath from small buckets and await affordable and accessible water heating solutions.

The report compiled by IIEC on this work has several recommendations following the results obtained. For more information contact IIEC-Africa.

Winrock International commissioned and sponsored this study with generous support from the US Agency for International Development. IIEC gratefully acknowledges the collaboration of the Midrand Eco City projects, and of the survey participants.

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Ketlametswe Manyaapelo holds a BSc Ed degree from the University of Bophuthatswana and a Certificate in Energy Policy Planning and Management from the Minerals and Energy Education and Training Institute. At present she is a Co-ordinator of the Eco Home Advisors Programme at IIEC-Africa., which aims at improving the quality of low-cost housing in South Africa through the promotion of passive solar design principles. She has previously worked for the national government Department of Minerals and Energy as an Energy Efficiency officer.

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24 hours in a day, so this equates to

1-3kWhours/day on average. 1 kWh equates to charging up two car batteries, or providing 200 watts for lighting for 5 hours in the evening. A smaller windmill with 1.4 metre diameter would only give half this much power because its rotor area is half as large.

Life is never simple

Why are there so few small windmills to be seen? Living with windpower is not simple. Windpower is not reliable. Even on good sites, there will be periods of several days when the wind is too low to be useful. At other times there will be so much wind that we cannot use all the power. Windmills themselves are notoriously unreliable machines. Breakdowns have traditionally been the norm.

These problems can be overcome. Windpower can be very successful. The following factors will help:

- A windy site for the windmill is essential
- A reliable design with minimum of breakdowns
- Local know-how, for low cost manufacture and prompt repairs
- A backup supply for times when the wind is low (PV, diesel, or even kerosene lamps)

Small battery-charging windmills can be produced in village workshops, and used to produce electricity without environmental damage. That’s a job worth doing!

Hugh Piggott is a freelance renewable energy system designer, with long experience of domestic wind and hydro turbines. Author, teacher, consultant, salesman, and mechanic.

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Rural Electrification schemes do require support at national, local and intermediary level. McMenemy supports this assumption in his paper and looks at how energy projects have a greater chance of sustainability if concerted effort is placed on developing and supporting Institutions at all levels.

- Community participation
  The ownership of the plant can be by the community, by a small private business or through an individual. The management, operation and maintenance of the scheme is vital. Rai gives examples of good community participation in Nepal and highlights the importance of involving all members of the community. Gitonga et al give a detailed case study of the steps involved in setting up a community hydro scheme in Kenya

Harper makes an interesting comparison by looking at how community participation in grid connected villages has led to increased access to supplies

Ability to pay and tariff levels

The amount that the community is able to pay is crucial in ensuring the sustainability of the scheme. Mills sets the scene by discussing how much is already spent on lighting in rural areas, with the conclusion that electricity is safer, cheaper and a higher quality light than traditional fuel alternatives. Prasad adds an interesting discussion point by agreeing that electricity is cheaper but asking why people still do not opt for electrical lighting.

Foley discusses various tariff structures that have been used and Forssman illustrates the importance of appropriate end use appliances such as energy efficient lightbulbs.

The articles all highlight the need for access to energy services in the developing world, and Piggott turns it full circle by talking about his de-centralised electrification scheme in the Western World, the steps he took and the reasons why it is successful.

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Institute (CGCRI) and the Petroleum Conservation Research Agency (PCRA). The latter two have lent their resources to the project, and PCRA staff have just completed energy audits of 13 firms who have expressed interest in being involved in the project. The next step will be the visit of UK and US ceramics experts who will be working with the owners of firms and local institutions to implement measures, and build capacity.

The project in India has highlighted the export market as being a major driver quality improvement in this sector. Quality, in turn, is very closely linked to improvements in productivity and energy efficiency. At the same time, ethical and fair trading initiatives provide an opportunity to link exports directly to improvements in working conditions. To this end, a funding proposal has been submitted to develop an initiative that will link energy efficiency improvements directly to benefits for workforce via the export market and fair/ethical trade.

In Ghana, to focus has shifted slightly to look at the potential for maximising recovery of logs, as this is the largest source of wasted energy. A sub-sector analysis of the forestry sector has been completed, and this has highlighted a number of key opportunities for intervention. The next phase is to explore mechanisms for firms to add value to timber processing, such as T&G, kiln drying, mouldings and other products.

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als, and this has introduced incentives for its local and inter-village dissemination.

This is, however, a small success in terms of the project as a whole. No stove project is successful until the stoves are being widely accepted and used as well as easing people's problems. The clay grate is a way of making this stove more financially and logistically accessible to a greater number of, particularly poorer, people.

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rich/poor and men/women – and there is great potential to realise positive development centred upon energy intensification

- there is a risk that benefits will be appropriated by richer households, for the simple reason that rich households have the money to spend.
- before we can talk about distribution and equity, we also need to ensure that systems do indeed function. In remote areas and low-income areas, this is still a major challenge.

Three key lessons to ensure that energy remains accessible to all

- Decentralisation means that communities will have to assume financial responsibility – when something breaks, it is up to the community to find the money to replace it. This has implications:
- Because everyone has to pool together, the participation of poor households may be limited – clearly, users will only contribute what the poorest can afford.
  - households may divert money from other essential areas – e.g. education – due to social pressure. The solution is to ensure that MHPs have other areas for income generation:
  - productive end uses should exist which will generate economic linkages between energy and MHP. Of course, this also maximises the breath of the development impacts of the system.
  - the implementation strategy and the organisational structure will determinewill determine whether the system will function well. Where linkages are generated, it is more likely that systems will be used for some sort of income generation, although it is not possible from this data to say who will benefit.
- The introduction of MHP is often technically new and challenging in remote rural regions. Often people do not know how to fix or manage the systems so the most educated, which is usually the most wealthy, have the say in decision-making. Less educated people – the poor and women – are limited in their participation because they cannot read or write. If the women are omitted from decision-making and the poor contribute a greater amount of their income to energy services, then it is fairly obvious who will suffer. The solution to this is to provide training to the greatest number of people – i.e. generate human capital. This ensures that everyone has a say in decision-making and that everyone understands the operation of plants.
- While decentralisation does offer the benefits of economic efficiency and appropriateness, it also offers an opportunity for opportunism – for example, outright pilfering of funds. The only solution to this is to ensure that linkages and enforcement mechanisms exist between the state and local organisations.

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responsibilities, measurable results and clear rewards.

- Traditional NGOs and their staff lack the skills and the attitudes which are necessary to achieve rapid and sustainable results.
- Community groups should be expected to perform one clear and simple task; they should not be burdened with a range of complex and different responsibilities.
- People should be motivated by the anticipation of real benefits to themselves, and the benefits should be delivered as promised, if necessary in small increments, and without delays.

(See Harper, M., “Public services through private enterprise – micro-privatisation for improved delivery”, 2000, Sage Publications New Delhi and ITDG Publications, London, for further examples of the same approach)

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