Institutional frameworks for electricity supply to rural communities
A *literature review*

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July, 1995

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1 Introduction

Electricity supply to rural communities is usually an integral part of the national electricity supply industry, and at the same time, one component of a broader rural energy consumption profile. In order to analyse the nature of rural electricity supply, and the extension of that supply, it is necessary to consider both of these aspects: the role of electricity in rural energy consumption; and how rural electricity fits into the national power sector. Although the answers to these questions are intimately bound up in country specific detail, it is useful to review the international literature in an attempt to identify and understand some of the key issues which many countries face.

The principal objective of this paper is to examine the ways in which electricity supply in rural areas is organised - what structures are employed, how these organisations are regulated, and how they operate. The paper will start by briefly outlining some of the essential features of rural energy consumption which are common to many developing countries. In the light of this, an attempt will be made to review some of the international experience with rural electrification, and describe how this has influenced the formulation of rural electrification policy. The paper will then describe the nature of the broader institutional environment for electricity supply, and summarise some of the pressures which many utilities and governments are currently facing. Whatever their objectives, rural electrification policies must work within the framework of existing, or proposed, institutional arrangements. Constraints and opportunities offered by this framework will clearly shape the organisation of rural electricity supply. This paper will present some of the most common institutional arrangements which have been employed by governments and electricity supply agencies, and discuss how these have dealt with the principal policy questions. In particular, the paper will address questions concerning technology choice, finance, organisation of rural electrification projects and end-user participation.

2 The role of electricity in rural areas

Some 50% of the world's population live in rural areas of developing countries (Saunier and Mohanty, 1992) and more than two thirds of these households (around 2 billion people) do not have access to electricity. The extension of grid supplies to rural areas has been a feature of many government's energy policies over the past twenty years or more, and has been motivated on both economic and social grounds. However, a series of impact evaluations conducted during the 1980s have suggested that the actual impacts of electricity are limited in both the degree and scope of benefits. The cumulative effect of these studies has been to drastically alter perceptions towards rural electrification: it can no longer be held to be the panacea of all rural energy and development problems.

Despite this, the political pressure for rural electrification remains high, and there are clearly circumstances under which such investments can be justified. In the light of two decades of experience, it is necessary to attempt to redefine the role of electricity in rural areas, in terms of electricity as a commodity for consumption (possibly meeting some basic needs), and as an input to economic activity.

2.1 Key features of rural energy consumption

Probably the most pervasive feature of energy consumption patterns in rural areas of developing countries is the dominance of biomass fuels - typically more than 80% of primary energy

consumption (almost entirely for domestic use) comes from wood and other biomass fuels (Hurst and Barnett, 1990). The persistence of this traditional pattern is not only a consequence of low income levels combined with the low price and ready viability of biomass fuels, but is also related to expenditure decisions and the distribution of tasks within the family. For example, other priorities may take precedence over the acquisition of new appliances and a greater reliance on other fuels; in addition women, who generally collect fuelwood, may not fully control household budgets.

Although biomass fuel is largely (although not entirely) a non-monetary activity its collection is, of course, not costless in terms of time, effort and environmental damage (Bose, 1993). Concern with the 'fuelwood problem' has focused on the widening of a supply and demand gap, whereby sustainable yields of local resources are exceeded, leading to a vicious circle of fuelwood depletion, further environmental damage and greater time and effort expended on fuel collection (Ramani, 1992). Early responses tended to focus on 'technical fixes' where either the supply must be increased, or the demand contained. However, it should be noted that fuelwood shortages are more likely to be a result rather than a cause of deforestation, and solutions need to look beyond the energy context of fuelwood (O'Keefe and Munslow, 1989a).

A cross-sectional analysis of energy consumption across low, middle and high income countries suggests that a transition "from traditional biomass fuels to fossil fuels and electricity appears to be a basic feature of economic growth" (Leach, 1992: 116). Leach has also observed that at a micro-level this transition is more evident in urban than rural areas, and is highly dependent on household income as well as existing supply infrastructure. However, the concept of a transition where alternative fuels substitute for biomass may be misleading. The 'energy demand ladder' is a hierarchy of energy services rather than fuel types (Foley, 1994). Thom (1994) reports that in rural areas of South Africa, biomass fuels continue to be used for 'basic' domestic energy requirements of cooking, heating and possibly water heating, while paraffin, candles and batteries are commonly used for other services such as lighting, radio, boiling water and quick cooking. Even the poorest of rural households seem prepared to spend a significant portion of their income on fuel, principally for lighting. Although substitution may be part of a changing energy consumption pattern, multiple fuel use is clearly associated with a diversification of energy demands.

Assessments of non-domestic energy demand tend to focus on agricultural requirements, which will vary according to the type of agriculture practised. Where irrigation farming is possible, energy for water pumping can be supplied either by grid electricity or diesel, and the latter may provide the additional benefit of allowing the pumping system to be moved from site to site. Shaft power for crop processing is important and is usually supplied by electrical motors or diesel engines. High and low temperature heat is required for some crop processing, and refrigeration can be essential in storing produce before transport to markets. Many other agricultural activities, including dairy and poultry farming and on-farm maintenance, can benefit from electricity. The strong emphasis placed on energy for irrigation may understate what is possibly the most important agricultural energy requirement - traction for land preparation and transport. Although oxen are commonly used, access to a tractor provides multiple benefits in terms of haulage, transport and shaft power for pumps and crop processors (Auerbach and Gandar, 1994).

Other non-domestic energy requirements include those at clinics, schools, churches, government offices, shops and rural industry. Whereas domestic energy consumption is characterised by a

reliance on biomass, and agricultural needs by diesel, it is electricity that can most conveniently supply the energy services required by these organisations.

Rural energy consumption has to be understood, not just in terms of income levels and supply infrastructures, but also in terms of end-use requirements. A picture emerges of 'low value' (albeit essential) energy services being met by cheap or free biomass resources. Higher value requirements, in both the domestic and non-domestic sectors, are served by other fuels. This is not only because biomass simply may not be able to deliver such services, but also because of the quality and flexibility which other fuels can provide.

Electricity supply in rural areas must be placed within this context of multiple fuel use patterns. Effective demand will be strongly associated with income, appliance ownership (itself related to income) and end-use requirements. In the domestic sector, it is probable that electricity use may be largely restricted to high value services, such as lighting and peculiarly electrical services, and other requirements will continue to be met by biomass and even paraffin. For agricultural purposes, diesel may be preferred over electricity given traction and transport requirements, and again electricity use may be restricted to very specific services. Unless there is a growing commercial or industrial base in a region, the role of electricity may be limited to these high value, and low intensity, energy requirements.

2.2 The politics and economics of rural electrification

Rural electrification programmes are often caught in a conflict between economic constraints and political pressures. The micro-economic effects of rural electrification projects may severely limit a utility's ability to successfully implement and sustain a programme, just as broader macro-economic factors may limit financing options and restrict tariff policies. However, political pressures at both a local and national level will act to promote rural electrification in the face of such constraints.

Rural electrification projects are relatively expensive both in terms of initial and operating costs. Low population densities, long transmission lines and difficult topographical conditions all mean that installed costs per consumer are much higher than for urban areas. In addition, large transmission losses, high maintenance costs and low load factors all mean that the recurrent costs of supplying electricity to rural areas are again substantially higher than for urban areas (Meunier, 1990). Not only are costs high, but revenues are low as a result of low demand and slow growth in demand. This is accentuated by pricing policies with tariffs do not reflect the full costs of supply (Soldatos, 1991). Although it is common for electricity supply to result in financial savings for users (Davis and Horvei, 1994) particularly where tariffs are subsidised, many rural electrification projects are not financially viable for the utility and rely on substantial direct or cross-subsidies (Ranganathon, 1992).

Despite this, economic analyses suggest that under certain conditions rural electrification can result in net benefits (Munasinghe, 1988a). Although the results of such an analysis will always depend on the extent to which additional, non-revenue generating, benefits are incorporated, recent literature has tended to recommend cautious methodologies which tend not to include intangible benefits (Munasinghe, 1987; Pearce and Webb, 1987). Although a list of conditions under which this will occur can never be fully prescriptive, Foley (1994) suggests that those outlined by a World Bank document in 1975 have stood the test of time:

"• *the quality of infrastructure, particularly of roads is reasonably good;*
- *there is evidence of growth of output from agriculture;*
- *there is evidence of a growing number of productive uses in farms and agro-industries;*
- *there are a number of large villages, not too widely scattered;*
- *income and living standards are improving;*
- *there are plans for developing the area;*
- *the region is reasonably close to the main grid (if the demand is particularly strong, remote regions may be considered too).*" (World Bank, 1975).

Of course, these conditions are designed to select projects where capital costs are relatively low and revenues high, and suggests that rural electrification should be demand driven. The same World Bank paper suggests that revenues should comfortably cover operating costs in the first few years, recover initial expenditure in later years, and ultimately yield healthy returns. However, this scenario has not always been achieved and much of the controversy around rural electrification has concerned the extent to which additional benefits outweigh financial losses and whether electricity supply can stimulate growth and hence increase demand. The debate around the relationship between electricity and rural development will be discussed later in this paper.

In addition to these project specific factors, there are a number of macro-economic constraints which affect rural electrification. It is not only rural projects which are capital intensive, but the whole electricity supply industry requires large capital investments. It is estimated that extensions to generation capacity will account for 60% of total capital expenditures in the power sectors of developing countries during the 1990s (Moore and Smith, 1990). Although some of these expenditures may be offset by maintenance, efficiency improvements and technical change (Schramm, 1993a; Munasinghe, 1992), competing demands for capital and foreign exchange within the power sector may disadvantage rural electrification projects (Menanteau and Shunker, 1990). Given the debt crisis of the 1980s, where high international interest rates and depreciating exchange rates severely affected the financial performance of many utilities, management may be reluctant to undertake projects without the assurance of an adequate return (De Oliviera, 1991). A number of countries, particularly in Africa and Latin America, have had to curtail their original electricity expansion plans (Menanteau and Shunker, 1990). Revenue may also be restricted by pricing policies dictated by government macro-economic objectives to contain inflation. Under these conditions utilities will find it difficult to justify the implementation of an extensive rural electrification programme (McCawley, 1978).

Despite these micro- and macro-economic constraints, rural electrification exercises a powerful political voice (De Oliviera, 1991). Access to electricity can symbolise modernity, and this symbolism is based on the very real extent to which many 'modern' activities rely on electric power. Rural people without access to electricity are the first to recognise this, and as Foley argues:

> *"Becoming part of the modern world is, arguably what development fundamentally means. It is certainly how large numbers of people see it; and they will not be deterred from demanding an electricity supply by being told it is not economic to provide it"* (1989: 159).

Not only is rural electrification seen by local residents as a symbol of modernisation, but it is also actively promoted as an integral part of rural development strategies (Bowman and Pintz, 1990).

Munasinghe (1987) points out that rural electrification is an essential part of what may be a critical transformation: in the long run rural areas of developing countries must be able to compete successfully with imported products if they are to avoid a process of stagnation and decline.

Additional pressures may arise where an extensive rural electrification programme exists: communities who remain without a supply may be regarded, and regard themselves, as second class citizens (Bharier, 1987). Although electrification may not always be the highest development priority for rural communities, it may become the focus of attention given that other, potentially more important needs, are unlikely to be easily realised.

These local political concerns translate into broader political pressures. Rural development initiatives, for a variety of reasons, often enjoy a high national political priority, and electrification is often part of a development package. However, as pressures for rural electrification intensify, it becomes increasingly clear than governments simply cannot afford the ambitious programmes proposed (Foley, 1990). In the face of these conflicting pressures, it is common to hear calls for a rationalisation of rural electrification planning: costs must be minimised, resources allocated carefully (Foley, 1992a), links with rural development carefully constructed (Ramani, 1992) and electrification integrated into a national energy plan, thereby avoiding *ad hoc* political interference (Munasinghe, 1988a). However, Rogers (1980) contends that any rural electrification policy that does not take account of political influences will "remain on paper only".

2.3 Comparing rural electrification in industrialised and developing countries

In most advanced-industrialised countries, the electricity distribution systems are extensive and often reach even the most remote rural localities. By the late 1960s most western European states had effectively completed their electrification programmes (Foley, 1989). Although some countries had embarked on extensive programmes before the Second World War (for example in the US Franklin Roosevelt initiated a large scale rural electrification programme in 1935), it was in the 1950s and 1960s that many countries made substantial progress in extending their rural networks.

However, these results have taken time and have not been achieved without extensive political commitment, large subsidies and concomitant controversy. The electrification of southern Ontario took as long as six decades (Fleming, 1992) and it was only in 1991 that the National Rural Electrification Co-operatives Association (NRECA) in the US was abolished, along with the substantial subsidies to advance rural electrification (Saunier and Mohanty, 1992). In many cases rural electrification has relied heavily on direct government assistance (for example, in Ireland the government was prepared to subsidise connections by as much as 50% - Shiel, 1989). It has also been common for cross-subsidies from urban consumers to cover the losses incurred in rural areas - a practise that still continues, particularly where national publicly owned utilities exist (in France, electricity supply to rural communities is still cross-subsidised by as much as 30% - Hourcade et al, 1990).

However, analogies between the success of these early electrification programmes, and current prospects for developing countries can be misleading. The economic status and demographic conditions of industrialised countries were very different, when they were engaged in rural electrification programmes, from those in developing countries today. The ratio of rural to urban consumers was lower, and the rate of decline in this ratio much higher. Electricity consumption levels in both urban and rural areas were much higher, and hence the financial burden was smaller

and shared by a relatively larger and more prosperous urban population. By the standards of many populations in developing countries the rural inhabitants of industrialised were wealthy, even in the 1930s. Thus, people were more likely to be able to afford electrical appliances and machinery and so increase consumption levels and revenues to the utility (Foley, 1989). It should be noted that in the early days of rural electrification in the US, rural consumption levels were around 50 kWh/month (REA, 1966) - similar to current consumption levels in many electrified rural communities in developing countries.

Perhaps more important than these differences in population distribution and rural economic status has been the change in the economic environment and technological prospects for power utilities. The 1950s and 1960s were the 'golden age' of power utilities - "a virtuous circle of cost-cutting innovation, fast-increasing demand levels, economies of scale and generally low interest rates allowed the industry to grow rapidly at falling cost" (De Oliviera, 1991: 7). However, the 1970s proved to be a turning point for the industry. Rising fossil fuel prices led to increasing real electricity prices, and the consequences for demand forecasts were not adequately foreseen. Not only did reduced economic activity result in a decrease in electricity demand, but for many countries income elasticities of demand for electricity appear to have been permanently altered (Hansen, 1990). This led to plant surpluses in the 1980s, with further pressure on prices since large debts on sunk costs had to be serviced with lower than anticipated sales. Although fossil fuel prices have steadily declined in real terms since 1980 (in 1994 the real price of oil was around 35% of the peak in 1980 - Flavin and Lenssen, 1994), other pressures have emerged. These have included financial, technical and environmental issues: high interest rates during the 1980s imposed a heavy burden on this capital-intensive industry; a failure of technical change to produce significant cost reductions (particularly in nuclear power); and the emergence of a range of environmental issues, all of which have tended to impose additional costs on power generation.

This turning point for power utilities coincided with the completion of rural electrification programmes in industrialised countries, and the initiation of similar programmes in many developing countries (see table 1). Much of the controversy around rural electrification and the associated costs and benefits must be seen in the context of this changing environment.

Table 1: Formation of rural electrification institutions in some developing countries

Country	Institution	Date
India	Rural Electrification Corporation	1969
Philippines	National Electrification Administration	1972
Thailand	National Plan for Thailand Accelerated Rural Electrification	1973
Algeria	KAHRIF - national rural electrification plan	1974
Fiji	Public Works Dept Rural Electrification Programme	1975
Jamaica	Rural Electrification Programme Company	1975
Malaysia	Third Malaysia Plan[a]	1976
Bangladesh	Rural Electrification Board	1977
Indonesia	Rural Electrification Sub-directorate	1977
Zimbabwe	Rural Electrification Co-ordination Committee	1984

(Sources: Foley, 1989; Chullekesa, 1992; Monerasinghe, 1992; Soetendro et al, 1992)

a Although previous plans had targeted rural electrification, the third plan increased budget allocations by over 300%.

2.4 Expectations of rural electrification in developing countries

Before the status of rural electrification programmes is presented and their impacts reviewed, it is worth while examining some of the motivations which have been used to justify large expenditures on these programmes. In the past two decades, there has been a substantial change in attitude towards rural electrification, largely as a response to sobering experience, but also as part of the changing attitudes towards power utilities, their operation and organisation. Ranganathon (1992) has commented that "in the 1970s, support for rural electrification was euphoric; it was riding the crest of the cost-benefit wave and promised much" (p1). However, by the late 1980s much of the original euphoria had dissipated as countries discovered that costs had been under-estimated, utilities (and governments) came under severe financial pressure, and a series of studies suggested that many of the anticipated benefits had not been realised (Cecelski and Glatt, 1982; Fluitman, 1983; Pearce and Webb, 1985; Barnes, 1988; Munasinghe, 1988b; Foley, 1989; Kjellstrom et al, 1992; Schramm, 1993b).

There are perhaps two broad types of motivations for rural electrification programmes: those that anticipate substantial social benefits; and those that are based on economic returns. A few governments have expounded explicit political objectives (for example, rural political stability), although it is more common for a combination of social and economic justifications to be used. In fact, multiple goals are often cited for rural electrification and this has lead to conflicting objectives for utilities. Financial logic would dictate that electrification should focus first on areas of high economic potential and lowest cost. In fact, urban electrification would probably be a higher priority than in rural areas. However, other goals, such as social equity, agricultural development and so on, may require utilities to compromise their financial objectives.

Cecelski and Glatt (1982) suggest a long list of potential benefits from rural electrification. Possible social benefits include improved living standards, particularly for women; reduced urban migration; and reduced crime. Health and educational issues cover improved services at schools and clinics, lighting for evening study; lower fertility rates and reduced dependence on smoky and dangerous fires. Environmental benefits relate primarily to alleviation of pressure on local fuelwood resources, as well as reduced indoor air pollution from fires and stoves.

Potential direct economic benefits relate to the use of electricity in productive applications, most importantly irrigation, crop processing and refrigeration. Employment opportunities may increase as a result, and the operation and creation of business enterprises may improve. For users who have previously depended on alternative fuels, electricity supply is likely to provide direct financial savings. Where electricity substitutes for paraffin or diesel, it is possible that there may be foreign exchange savings on imported fuel. Indirect economic spin-offs concern the nature of the relationship between electricity and local economic growth. Where electricity acts as a stimulus to local agriculture, commerce and industry, the spin-offs in terms of value-added and job creation may be significant.

Table 2 summarises some of the principle objectives of rural electrification programmes, and the literature presents lengthier lists (for example, see Ramani, 1992). Potential benefits are numerous and diverse, and studies during the 1980s have attempted to assess the extent to which these benefits have been realised, and under what conditions they might be found. The achievements and disappointments of rural electrification programmes in developing countries will be summarised in the following two sections.

Table 2: List of potential benefits of rural electrification projects

Type of benefit	Benefit	*Mechanisms*
Social and educational	Improved living standards	*Access to appliances, time savings*
	Reduced burden on women	*Less effort spent collecting wood*
	Improved communication	*Access to television and radio*
	Household and community lighting	*Higher quality light, reduced crime*
	Improved education	*Lighting in schools, evening classes*
	Improved water supply	*Use of electric pumps*
	Greater urban/rural equity	*Increases in living standards*
	Reduced urban to rural migration	*Employment opportunities*
Health and environmental	Reduced pressure on natural woodland	*Less fuelwood collection*
	Less smoke from indoor cooking fires	*Use of electricity for cooking & heating*
	Improved services in clinics and hospitals	*Refrigerators, lighting, communications*
	Reduction in fertility rates	*Higher standards of living*
Economic	Improved agricultural productivity	*Irrigation, use of agricultural machinery*
	Increase in employment	*More businesses, growth in agriculture*
	Greater number of enterprises	*Opportunities, access to equipment*
	Financial savings to users	*Electricity replaces expensive fuels*
	Foreign exchange savings	*Electricity replaces paraffin and diesel*

(Source: Cecelski and Glatt, 1982)

2.5 Rural electrification programmes

Most developing countries have an electrification programme of some description. However, the changing environment for power utilities in general, and rural electrification in particular, have acted to limit the extent to which ambitions have been realised. Although the number of rural households with access to electricity has more than doubled over the past twenty years, this has just kept up with population growth and the absolute number of people without a supply has not declined much.

Table 3: Rural electrification and population data (millions)

	1970	1980	1990
World population	3,600	4,400	5,300
Developing country rural population	2,600	3,000	3,200
Number of rural residents with electricity	610	1,000	1,400
Number of rural residents without electricity	2,000	2,000	1,800
Percentage rural access	23%	33%	44%

(Source: Foley, 1994:42 with figures for China added. Figures are rounded to two significant figures)

Global totals mask the variations between countries. A number of Asian countries have made impressive progress, most notably Malaysia, Thailand, the Philippines and China. In fact, China's rapid electrification programme over the past 20 years (during which time 365 million more rural residents gained access to electricity) significantly increases world totals. If China is excluded, then current levels of access change from 44% to 33%. South Korea had effectively completed its rural electrification programme by the late 1970s (Fluitman, 1983).

Table 4: Rural access to electricity by region

Region	1970 Rural population	1970 Rural access	1990 Rural population	1990 Rural Access	Increase in population with elec.
North Africa & Middle East	77m	14%	108m	35%	27m
Latin America	121m	15%	125m	40%	32m
Africa	222m	4%	340m	8%	18m
South Asia	579m	12%	836m	25%	140m
China	675m	40%	794m	80%	365m
East Asia & Pacific	930m	25%	1,072m	45%	249m
Total	**1934m**	**32%**	**3,276m**	**44%**	**831m**

(Source: World Bank, 1995)

However, many other countries have made only limited progress with rural electrification, and much of Africa (including South Africa, which generates over 50% of the continent's electricity) has levels of rural access to electricity of around 5%. India, which has pursued an aggressive rural electrification programme has targeted pumpsets and although as many as 80% of all villages have an electricity supply a much smaller percentage of households have taken a connection.

Table 5: Estimates of rural household access to electricity

Region	Country	Year	Rural access	Region	Country	Year	Rural access
Asia	Malaysia	1990[f]	90%	Latin	Costa Rica	1986[a]	74%
	China	1990[a]	78%	America	Chile	1981[d]	42%
	Thailand	1990[a]	72%		Brazil	1981[d]	19%
	Philippines	1990[j]	54%		Central America	1986[d]	15%
	Sri Lanka	1988[a]	25%		Ecuador	1980[d]	13%
	India	1988[a]	22%		Bolivia	1981[d]	9%
	Pakistan	1986[d]	22%		Argentina	1981[d]	5%
	Indonesia	1991[h]	22%				
	Vietnam	1992[b]	14%	Africa	Egypt	1980[d]	23%
	Nepal	1992[i]	9%		Tunisia	1982[d]	25%
	Laos	1992[g]	9%	N Africa & Middle East		1987[e]	21%
	Bangladesh	1991[c]	9%	Sub-Saharan Africa		1987[e]	4%

(Sources: a Foley, 1994; b Hanh, 1992; c Rahman & Mainuddin, 1992; d Schramm, 1993; e Foley, 1989; f Monerasinghe, 1992; g Manodham, 1992; h Soetendro et al, 1992; i Acharya & Shresta, 1992; j Cabrera, 1992)

Most rural electrification programmes are implemented through the extension of the grid network to rural areas. The tendency is to extend the grid incrementally, reaching towns and settlements in order of declining capital costs. Remote areas with small populations are likely to be the last to receive an electricity supply. Unlike grid extension, the cost of installing decentralised technologies is naturally independent of the existing status of the transmission and distribution system. In many settlements it is common to find diesel generators, either for a single user, or as part of a local distribution network. Such systems may be operated by a power utility, or more commonly, by a private enterprise. Rural hospitals, government offices and police stations in remote areas will typically have their own diesel generators, often with a back-up set.

Some counties have pursued decentralised electrification as an important part of their rural electrification strategies. In China there are some 60,000 small hydropower stations (Zengguang, 1990) supplying nearly 20% of rural electricity consumption (Zizhen, 1990). In the Philippines and Indonesia, where a large portion of the rural population lives on islands, decentralised options are often the only way to supply electricity, primarily through small hydropower systems or diesel generators (Cabrere, 1992; Munasinghe, 1988b).

Photovoltaic systems are probably best used either as home-systems for lighting, radio and television, or to power special electrical services such as clinic refrigeration or telecommunications. In some countries the dissemination of photovoltaic systems to rural households has been left entirely to the private sector. For example, in Kenya neither the utility nor the state has any involvement in the photovoltaic industry, yet more rural households obtain electricity from these systems than from the grid (van der Plaas, 1994). Some programmes have aimed to support the operations of the private sector, usually through the provision of finance facilities and establishing standards in system design and installation practice. Two examples of this type of intervention are in Zimbabwe and the Dominican Republic. A $7 million grant from the Global Environment Fund (GEF) is designed to assist private enterprises operating in Zimbabwe, principally through the establishment of revolving credit funds (Flavin and Lenssen, 1994). In the Dominican Republic a combination of local entrepreneurs, foreign aid and a supportive government have all contributed to the establishment of a successful photovoltaic dissemination programme (Hansen and Martin, 1988). In Mexico the government has charged the national power utility with the responsibility of rural electrification using photovoltaic systems where necessary. The programme is heavily subsidised and there are currently an estimated 37,000 home systems installed (Foley, 1994).

The centralised or decentralised debate is a contentious one. Foley (1994) asserts that photovoltaic systems and grid extension do not compete: where grid power is possible and viable there should be no question about providing it; photovoltaic systems should be used for small isolated loads where the possibility of obtaining a grid supply is remote. Clearly grid electricity is more versatile and once installed can usually allow for any conceivable increase in demand. However, decentralised options may be attractive for a number of other reasons. Where the demand is uncertain or latent, the use of diesel generators will require a lower initial investment and hence the risk of substantial financial loss is reduced. If demand does pick up, a grid connection can be installed later and the diesel generator can be sold or used elsewhere. Small-scale hydro power, although site dependent, may provide the least cost option as well as providing a service comparable with grid supply. In addition to these economic arguments, the use of decentralised and renewable energy systems has a powerful symbolic value, and proponents argue that these technologies provide a sustainable and environmentally benign electricity supply that is more in tune with the ethics of rural development (Flavin and Lenssen, 1994). However, the symbol may not be as powerful for rural residents.

2.6 Impact assessments of rural electrification

The first attempts to synthesise the emerging experience with rural electrification in developing countries were by Cecelski and Glatt (1982) and Fluitman (1983). In his report, Fluitman was struck by the absence of tangible positive impacts of rural electrification projects and concluded that "benefits...tend to be overestimated and the costs understated" (p53). Subsequent studies have tended to support this initial conclusion. Cecelski and Glatt provided a useful framework for systematically analysing rural electrification projects and concluded that more detailed studies were required before the relationship between rural electrification and development could be properly understood. In an attempt to provide the data necessary for this type of analysis, Barnes (1988)

has probably provided the most detailed and extensive analysis of the impacts of rural electrification across a number of countries, and these results are drawn on in the following discussion. Pearce and Webb (1985) have also contributed an extensive review of rural electrification impact assessments and attempted to synthesise the results within the framework of cost-benefit analysis. Later studies by Munasinghe (1987), Foley (1989) and Schramm (1993) have reached similar conclusions to previous work, namely that electricity is unlikely to act as a stimulus to rural development, and that successful electrification projects are more likely to be the result, rather than the cause, of economic growth in rural areas.

With the exception of Barnes' study, all of these assessments are based on reviews of published literature on the impacts of rural electrification. However, since the early 1980s when studies often cited the paucity of evidence as a major obstacle to a thorough analysis, there has been an explosion of primary data collection on rural electrification projects. Many of these have been sponsored by donor organisations attempting to evaluate the effectiveness of support for rural electrification (for example, Wasserman and Davenport for USAID, 1983; Maillard and Vernot for the Commission of the European Communities, 1985; World Bank, 1986; and a series of country case studies commissioned by the Panos Institute: Shiel, 1988; Hancock et al, 1989; ENDA, 1988). What follows is an attempt to summarise the main findings of these country studies and synthesis reports.

Impacts on agriculture

Much of the controversy around rural electrification in developing countries has concerned the relationship between the availability of electricity and increased economic activity. Probably one of the most powerful arguments had been its potentially revolutionary role in agricultural development. India, for example, has targeted the 'energisation' of pumpsets as being the prime motivation for rural electrification and some 10 million pumps have been connected (Sadaphal and Natarajan, 1992), although other estimates suggest that a large number of pumpsets that have gone out of service or been disconnected. The availability of power for irrigation, it is argued, will lead to an increase in cultivated land, higher productivity and double cropping.

Barnes (1988) has found from surveys in Indian villages that the percentage of farmland irrigated, existence of double cropping and agricultural productivity all correlated strongly with access to electricity. However, a report on the same study states that "diesel engine pump-sets have almost the identical benefits of electrical ones" (Barnes and Samanta, 1987: 1157) and that other factors, namely access to credit, proximity to markets and availability of printed information, were all important. The study proposed a two stage causality scheme whereby complementary agricultural inputs lead to a change in agricultural practices, which in turn improves agricultural production. The role of electricity then is to promote the use of irrigation as one of the necessary inputs.

In the Indian case, electrification was intended as one component of the 'green revolution', and the benefits of higher yielding varieties, in conjunction with other agricultural inputs, would lead to a change in farming practices and hence greater agricultural production. Pumped water is just one of these complementary agricultural inputs and it would, of course, be unfair to attribute all of the changes which may be observed simply to the availability of electricity. Given the finding that irrigation, along with other agricultural inputs, 'causes' an increase in crop yields, the issue becomes one of comparing the costs of electric pumping with the alternatives, principally diesel pumping. Here the advantages of electricity are not so clear. Although Indian farmers may opt for electricity, subsidies tend to obscure the economic advantages or disadvantages of its use.

Venkataraman (1990) reports that electric pumps do not have a clear economic advantage over diesel systems, although a study commissioned by the International Labour Office (1986) concluded that electricity had the edge over diesel, even if tariffs were to be based on real costs. However, diesel pumps have other advantages in that they require a lower capital investment and can be moved from field to field (Cecelski, 1992). Smith (1993) has gone further than comparisons of individual installations and has suggested that there are huge costs borne by the rest of the Indian economy due to power cuts, which may be partially attributable to the high priority placed on rural supplies. In direct contrast to these results, Ranganathon (1993a) asserts that where rural electrification is planned on a cluster basis, the "benefits in terms of the value of increased agricultural production far outweigh the costs" and that "electricity is also cheaper than the diesel alternative, at unsubsidised prices" (p143).

Much of the literature on agricultural impacts is focused on the Indian experience, for the obvious reason that this country has had an extensive programme to supply electricity for water pumping purposes. However, irrigation may play only a very limited role in other countries' agricultural systems. Rainfall patterns, choice of crops and ground water potential may mean that irrigation is either unnecessary or inadvisable. In conclusion, electricity may have substantial benefits due to higher agricultural productivity, but this depends not only on agricultural potential, but also the availability of complementary inputs, credit and proximity to markets. In addition, the advantages of electricity over diesel are by no means overwhelmingly apparent. Fluitman comments that "the dissatisfaction of the farmer with the quality of supply is reflected in the phenomenal growth of diesel pump sets in the last 15 years despite their high costs and the heavy subsidy given for rural supplies" (1983: 13).

There is very little attention given in the literature to agricultural uses of electricity other than irrigation. Pearce and Webb (1985) comment that the impacts of electricity on agriculture will vary from country to country and that there are no general results relating to improved productivity. However, they also state that there is more evidence for the significance of "backward and forward linkages from agriculture" (p10), in particular there are gains to processing industries which substitute electricity for alternative power sources.

Impacts on small-scale industry and commerce

Clearly there is no doubt that electricity is essential for many industrial activities. However, the question is whether rural electrification will bring about the development of rural industry, either by the creation of new enterprises, or through a productivity increase in existing industries.

Using cross country comparisons in India, Indonesia and Colombia, Barnes (1988) has found that, in general, the impact of electrification on rural industry and commerce is significant. Rural enterprises often operate on small margins and access to electricity may mean the difference between bankruptcy and survival. His principal findings are that the number of businesses in areas with electricity is higher, that the increase in the number of enterprises is likely to be higher, and that almost all businesses, either new or old, quickly adopt electricity. A consequence of this increased level of business activity is that non-agricultural employment is higher, and although labour productivity is higher in electrified enterprises, there is no evidence to show that employees are being put out of work by machines. However, Barnes comments that the level of rural industrial activity remains low and that "the expectation that electrification will lead to an explosion of business activities is likely to remain unfulfilled" (1988: 90). The nature of business activity is also likely to be limited to trade and services, with little manufacturing activity (ILO,

1986). Over all the findings are positive, but this must be tempered by the possibility that electrified areas are likely to be more dynamic than other areas for reasons other than simply the availability of electricity. In fact, the causality may just as well be reversed since higher levels of business activity are likely to make an area more attractive to rural electrification planners.

Other studies have found either no evidence for substantial increase in business activities as a result of electrification (for example in Malaysia: ILO, 1984), or only limited impacts (for example in Peru, Valencia et al, 1990). The substance of the conclusion reached by most observers is that "rural electrification can accelerate rural development, if other favourable conditions are present, but has a limited role as a single catalyst" (Jechoutek, 1992: 115).

Social, political and environmental impacts

Most studies attempt to evaluate the social and economic impacts of electrification separately, ignoring the possibility of relationships between the two. Be that as it may, it is a commonly used framework and useful, at the very least, for structuring an analysis. Whereas changes in productivity, employment and size of a local economy can be measured (with at least some degree of certainty), social impacts are significantly harder to quantify. Returning to the list of anticipated benefits, in addition to those concerning agricultural, industrial and commercial development, Schramm (1993) lists the most imported goals cited as being:

"• *To improve the quality of life...particularly for women.*
- *To improve the standard of living of the poor.*
- *To stem migration from urban to rural areas.*
- *To improve security, political stability and/or regional imbalances.*
- *To redress urban/rural bias.*
- *To reduce deforestation by replacing firewood or charcoal*" (p504).

The mechanism by which the quality of rural life may be improved is essentially through greater access to a range of appliances. Since most appliances are likely to be used primarily for domestic chores in the home, it is likely that they will impact mainly on women. Appliance ownership is the key here, and although it is commonly assumed that the majority of rural households only use lights and possibly a radio, Barnes (1988) has found that ownership of a far broader range of appliances was common in all three countries studied. Lights, radios, televisions, fans, irons and sewing machines were found in many houses. However, as might be expected, appliance ownership was closely associated with income.

Household and communal lighting has been found to be an important benefit of rural electrification. All households with an electrical connection use electric lights and this is often held to be one of the most important benefits of electricity. In northern Botswana, residents were particularly concerned with the need for streetlighting, partly to prevent crime but also to be able to see elephants at night! (Borchers et al, 1994). Although this latter concern is unlikely to be prevalent in many rural areas around the world, streetlighting is still commonly held to be an important use for electricity.

Cecelski (1992) reports that a Thai study has found that the labour saving effects of rural electrification during the peak agricultural season where by far the largest quantifiable benefit. This was largely related to the availability of domestic lighting, allowing women to work later. However, she also comments that although "household and non-household extensions of working

hours due to improved light represent real productivity gains...some health and other costs of longer working hours must be counted as well" (1992: 154).

Rural electrification is often stated to have perverse distributional impacts. That is, wealthier households are more likely to be able to afford a connection and to purchase a wider range of appliances, and so will benefit more than poorer households. Although rural electrification may have rural/urban equity benefits, the available evidence does not support the conclusion that rural electrification specifically benefits the rural poor (Pearce and Webb, 1985). This result has particular significance for subsidy policies. However, where electricity substitutes for more expensive fuels, in particular candles and paraffin for lighting, even the poorest households are likely to receive some savings in their monthly energy expenditure.

There does not appear to be much effect on rural-urban migration, although Barnes (1988) has found that rural electrification may affect seasonal intra-rural migratory patterns. Employment opportunities elsewhere were found to be the most over-riding consideration affecting a decision to move, and since rural electrification was not found to generate substantial numbers of jobs, its effect on this decision was minimal.

The impact on deforestation is likely to be minimal, given that the primary causes of this are usually not related to fuelwood collection, and only a very few households in electrified villages are likely to have purchased an electric stove (Barnes, 1988). Other fuels, primarily biomass and paraffin, continue to be used for cooking, space heating and water heating.

It is worth while making a particular note of the relationship between electricity and education. It is not uncommon to find a strong relationship between access to electricity and higher levels of literacy (Barnes, 1988). However, these two variables are also associated with income, and it is quite possible that wealthier households who can afford a connection are better educated in the first place. Barnes concludes that although causality cannot be determined, the results suggest that electrification and educational programmes are complementary and that electricity can, at the least, facilitate the effective implementation of literacy projects.

The supply of electricity to rural schools, clinics and hospitals is often a high priority for governments (for example, the new South African government has targeted the supply of electricity to all rural schools and clinics as a key energy policy objective - ANC, 1994). This type of policy is advocated is for the simple reason that the benefits are likely to be high, and to be evenly distributed in the community.

Evaluation techniques for rural electrification projects

Cost benefit analysis has often been proposed as an appropriate tool to judge the value of individual projects (Fluitman, 1983; Pearce and Webb, 1985; Munasinghe, 1987; Schramm, 1993). Pearce and Webb (1985) conclude that the existing evidence indicates that rural electrification is neither 'special' nor 'different' enough to warrant rejecting the use of standard rate of return selection criteria. Given the uncertainty surrounding the existence of many of the social impacts and the ambiguous nature of rural electrification as an economic stimulus, it is usually recommended that benefit capture be restricted to fuel expenditure savings and the estimation of the "consumers' surplus" (Munasinghe, 1987). However, Schramm (1993) reports that although many project appraisals estimate reasonably high rates of return for projects, it is uncommon to find ex-post evaluations where the actual return was as high as that estimated. This

result seems to confirm Fluitman's tentative conclusion in 1983 that costs were typically underestimated and benefits overestimated.

Given this emerging consensus on the limited impact of rural electrification, it is at least refreshing, if nothing else, to hear the alternative view presented. Ranganathon (1993a) argues that electricity does not only act as a commodity for consumption and as an input to production, but that it also has an important role as part of infrastructure provision and as a mechanism to meet basic needs. Building on Hirschman's (1958) notion that investment in infrastructure can induce development through external economies and secondary benefits, Ranganathon suggests that in areas where the potential for growth is high, rural electrification can lead to substantial long term returns. Given the uncertainty around the form, timing and extent of this induced development, cost-benefit analysis is an inadequate evaluation tool. Strategic planning techniques which give due weight to the 'future options' associated with investments in risky projects may be more appropriate (these techniques are commonly associated with R&D investments (Mitchell and Hamilton, 1988), and the returns from R&D are in some ways analogous to the long term benefits from rural electrification).

Although electricity is commonly seen as a lower priority than other services such as water, health and education, many governments are committed to rural electrification as a redistributive policy, independent of its role as an input in production. If this political commitment is evident (and usually it is a precondition for the success of rural electrification programmes), then conventional economic selection criteria will be inappropriate and economic analysis should focus instead on cost minimisation. Pearce and Webb (1985) recognise this and comment that political considerations may require substantial changes to project appraisal methodology.

2.7 A reassessment of rural electrification rationale

Despite the ambiguity in the evidence for rural electrification, it is intuitively apparent that there is some kind of a connection between electricity and economic growth - the problem has been to specify this connection and assess its value against the associated costs. Complications are evident not only in the time lags which may distance the returns from the time of implementation, but also in the influence that electricity may have on the subsequent path of development. Although other energy supplies may be able to meet immediate needs adequately enough, it is quite likely that access to electricity will influence decisions (such as technology choice) which will have far reaching and long term implications for the development of a rural area.

Foley concludes that "none of the developments or changes associated with rural electrification will take place unless the basic economic and other necessary preconditions are already present" (1992a: 146). There is a sense in which this comment is consistent both with Ranganathon's view that electricity can play an important role as infrastructure, and the new orthodoxy in which tangible benefits should outweigh real costs, and that electrification should be demand driven. Rural electrification cannot be seen outside the socio-economic environment in which it is placed: "in short, the context is everything" (Foley, 1992a: 146).

Overall, the impact studies of the 1980s have dampened the euphoria previously associated with rural electrification. Not only has the value of rural electrification been challenged, but the ability of utilities to sustain such programmes has been questioned. A number of World Bank studies have reviewed the performance of the power sector in developing countries and come to the

conclusion that, measured in both financial and technical terms, performance has been declining[1] (Schramm, 1993c; World Bank, 1992; Mason et al, 1988). Although part of this can be attributed to the changing nature of the economic and technical environment for the power sector (the end of the 'golden age'), assessments have also pointed to managerial and institutional failings within the sector. Or at least, it is in these areas that solutions are sought.

A decade of reflection and assessment may have sharpened our understanding and eliminated some misconceptions, but many of the old questions remain. Given the sobering assessments of the limitations of rural electrification, and the realisation that site specific conditions are of critical importance, where does this leave rural electrification? After all the evaluation and review, what is the role of electricity and how can impacts be maximised? What are the least cost strategies, and how are these related to technology choice? Given the political commitment to rural electrification, how best is it carried out and what institutional and financial arrangements are most appropriate?

If the economic benefits are dependent on the context, then it seems essential that planning of electrification programmes is closely associated with rural development strategies. This is not a new theme and actors in both the electricity supply industry and rural development organisations have been encouraged to co-ordinate their efforts (Hulsher and Hommes, 1992). One of the problems here may be the essential differences in structure between a centrally planned electricity supply system, and a rural development framework that is largely decentralised and people focused (Romani, 1992).

If least cost planning approaches are required, then an 'integrated energy planning' strategy would be appropriate (Eberhard, 1993). Munasinghe (1991) has proposed that integrated energy planning should occur at a national, rather than a local level. This idea is primarily aimed at developing national energy policies which are consistent with each other, and mutually reinforcing. Although this may make integrated energy planning at the local level easier, it is not sufficient to ensure that it takes place. Such techniques require extensive site specific data, close co-operation between a wide range of agents, and multi-disciplinary planning teams. In the end, the difficulties of operating in remote rural areas with limited information, funds, time and skills, may make this approach impractical. If there is a commitment to exploring alternative methods of supplying electricity to households, a starting point should be an analysis of end-use patterns. Evidence points to the fact that many of the loads used by rural households are of a low energy intensity and could feasibly be met by solar home systems. Where loads are greater, diesel generators present a tried and tested technical solution that may adequately meet the needs at considerably lower capital cost.

By combining an analysis of energy demand with supply options, it may be possible to define an energy supply typology of rural areas. In small towns and larger settlements there is likely to be adequate demand for an electrification project to be a financially viable proposition to the utility. In addition, there are areas where adequate demand may exist, but the costs of supply mean that the project requires some kind of financial support to be feasible. These type of areas would probably yield a positive economic net present value. There will also be areas which the government has identified as being potential 'rural growth points', and where a package of development initiatives

[1] This World Bank view is not completely accepted by other observers. De Oliviera (1992) reports on an international study aimed at evaluating utility performance in terms of a wide range of indicators. Although many utilities have suffered a decline in their financial positions, other indicators suggest that the picture is not quite as bleak as the World Bank would have it.

are planned. For example, Zimbabwe has planned rural electrification on the identification of such growth sites (Majero, 1994). Electricity is likely to be part of such an integrated development package, and yet the project would require some form of subsidisation. Lastly there are areas where high costs and limited demand means that the expense of providing a supply cannot be justified. In these cases, there may be scope for the provision of a lower quality supply at lower cost. For example, diesel generator might be installed for essential loads; or small photovoltaic systems used in some households. In all cases, least cost supply principles should apply, and the choice of technology (grid, diesel-engine generator, micro-hydro etc.) will depend on cost, supply requirements and institutional mechanisms.

Lastly, if social benefits exist, but are related to levels of access and appliance ownership, then new connection policies and strategies to promote accelerated appliance acquisition will be required. Rural electrification agencies have often operated against targets which have measured success not by the impacts of electricity, nor even the financial viability of their operations, but in terms of fixed and easily measurable quantities which may have very little to do with maximising the type of benefits discussed in the literature. For example, programmes commonly aim to 'electrify villages', where this may mean that only a handful of residents in a village actually use electricity. Alternatively, the number of 'pumpsets energised' may be the required target, with little concern given to the maintenance and operation of old pumpsets, or the use to which new pumpsets are put. Ever where programmes have aimed to maximise the number of household connections, this may be at the expense of selecting areas of maximum economic potential. Although rural electrification projects generally make a financial loss for the utility, and this may or may not be recompensed by public funds, there seems to be little concern with building up loads through higher connection rates, access to appliances, or productive uses for electricity.

Many of the problems relating to successful implementation of rural electrification are associated with the institutional arrangements available. Ownership, regulation and the relationship with the state will be critical factors in determining the nature and content of a rural electrification programme. Section three will explore institutional arrangements for rural electrification, and the concluding section will attempt to identify some of the important policy questions that need to be addressed.

3 Institutional arrangements for rural electrification

Considerations of the 'why' and the 'when' of rural electricity supply naturally lead to questions of 'how'. Generalisations are difficult since the implementation of rural electrification projects is intimately bound up in the structure and nature of the national electricity sector. Institutional arrangements for rural projects must dovetail with the national electricity supply industry, and in recent years there have been growing pressures for institutional reform in this energy sector. This section of the paper will attempt to describe these pressures and to outline some of the institutional options for grid and off-grid electricity supply to rural areas. Lastly, some of the impacts of these on financing options and project implementation will be discussed.

3.1 The pressures for institutional reform

The World Bank's assessment of power utility performance, measured in terms of financial and technical indicators, is that performance has seriously declined since the early 1970s. An examination of financial parameters, such of return on assets, debt-service coverage and self-financing ratio, indicates a steady deterioration in performance from the mid-1970s to the late 1980s (Schramm, 1990). Similarly, high system losses, unreliable service, low labour productivity and slow receipt of revenues, all indicate a similar trend (Schramm, 1993a).

The reasons for this decline in performance have been cited as being 'first, exogenous factors beyond the countries' control, such as world oil prices, access to foreign loans, interest rates and inflation; second, misguided national policies on pricing, investments, institutional development, and methods of governance; and third, enterprise-related factors, including management, technical, operational, and financial problems' (World Bank, 1992: 4). Much attention has focused on dealing with the second set of reasons, presumably because exogenous factors are beyond the control of utilities and the World Bank, and institutional reform is seen as the key to dealing with enterprise related problems.

The pressure to promote institutional reform, based on an assessment of performance, has been compounded by estimates of the size of the required investment in developing countries' power sectors, and the perceived inability of traditional sources to meet this need. One of the proposed solutions has been to encourage private sector participation, particularly in generation (Glen, 1992). This strategy in turn requires certain institutional reforms.

It should be stressed that much of the analysis of utility performance in developing countries has been undertaken from the perspective of a lending organisation, i.e. the World Bank. MacKerron (1993) points out that the concern with financial viability "is an accurate reflection of their desire to be repaid" (p162). Utility management and governments may have other, equally legitimate interests. Management may also be interested in financial performance, but is likely to have a greater focus on technical performance and system growth. Governments may be more interested in social and macro-economic impacts, as well as environmental concerns. If these other perspectives are incorporated into the analysis then it becomes apparent that in many ways, particularly in some social and technical areas, performance has been constant or has actually improved (MacKerron, 1993).

The pressure for institutional reform has in some senses been intensified by developments in industrialised countries, particularly in the UK, but also and to a lesser extent in the US where the

introduction of legislation (PURPA[2]) has required utilities to purchase privately generated power at avoided costs. McGowan (1993) suggests that there are two mechanisms for the transfer of experience in industrialised countries to developing countries: "the North as a model for the South" and "the South as a market for the North". In the first case, recent experiences in countries such as the UK, US and France inform the debate around the restructuring of power utilities around the world. Although agencies such as the World Bank do not offer Northern models uncritically, they are undeniably a major source of ideas for change. In the second case, investors and utilities, particularly from European countries may find business opportunities in marketing their experience. Although power markets in developing countries have always been an object of international participation, recent developments are tending to further opening up this market. Not only are consultancies able to sell their expertise in managing change, but increasingly utilities are seeking to diversify their revenue bases (McGowan, 1993).

De Oliviera and MacKerron (1992) examine the UK privatisation experience in the light of suggested reforms in developing countries, and conclude that a focus on ownership as a means to promote competition and hence efficiency may be misdirected. Not only are there severe limits to the extent to which competition can be introduced, but that the process of encouraging competition requires careful management. Although private sector participation may help solve the acute financial crisis facing developing countries' utilities, it will not necessarily be the central issue in achieving better performance. In a similar vein, Munasinghe and Sanghvi (1989) suggest that the potential benefits of increased competition in power generation may be frustrated by regulatory shortcomings.

These conclusions based on recent experience can be supported by valid economic arguments. In many developing countries, the electricity supply industry retains features of a natural monopoly and there are considerable economies of scale and scope to be maximised through the retention of a vertical monopoly (Teplitz-Semblitzky, 1990). A study on the performance of isolated diesel generators has suggested that the principal reasons for poor plant performance centre around managerial autonomy and concluded that solutions which address institutional reform should be directed at clarifying power sector development objectives, government-utility interactions as well as sector organisation and utility management (World Bank, 1991). However, Barnett (1993a) has suggested that this interpretation may underestimate the need to concentrate on the long term development of local human capabilities. Pachauri (1993) suggests that proponents of major structural changes in the power sector of developing countries do not always appreciate the political complexities of these changes.

Although the exact nature and content of optimal institutional reform is not clear, most observers agree on the need to (1) attract some form of private participation in power generation (principally to resolve the finance crisis); (2) redefine relations between utilities and the state, working towards some form of 'arms length' regulation; and (3) reform pricing policies to make tariffs reflective of costs and so ensure financial viability for utilities. Solutions need not be as radical as breaking up the industry into separate components or privatising parts of the industry. In the 1994 World Development Report, the World Bank has proposed that three principles should govern the adoption of institutional reform: the promotion of commercialisation; increased competition; and user/ stakeholder participation. These principles are essentially aimed at improving the financial position of utilities through the introduction of market forces and a move towards clarified and transparent systems of accountability. However, Barnett (1994) has pointed out that long term

[2] PURPA: Public Utilities Regulatory Policies Act

success (and not only in the electricity sector) depends on the ability of institutions to manage technical change. Although some of the capacity to do so will depend on exogenous factors, it is essential that the need for a proactive policy is recognised, requiring substantial investment by the industry in building human resources (Barnett, 1993b). Whether these concerns will be adequately addressed in the current debate on reform remains to be seen. However, institutional change is now on the agenda, and governments and utility management are having to address issues of ownership, governance and regulation.

3.2 Institutional options for rural electrification

Since rural electrification must fit into the broader structure of the electricity supply industry, it is worthwhile briefly examining some of the institutional arrangements in place. In general there are four categories of structure and governance in the power sector: public ownership and public operation; public ownership and private operation; private ownership and private operation; and community and user provision (World Bank, 1994). The dominant structure found in most countries has been a publicly owned monopoly, although almost all countries will have had some history of privately owned generation plant. In some cases (such as France), the industry is vertically integrated with all the functions of generation, transmission and distribution in one organisation. However, it is common for distribution to be controlled by second tier or local agencies (as in South Africa). For larger countries, often with a federal political system, each state will typically own its own electricity utility which may generate power, or purchase some of it' requirements from neighbouring states or the federal generator (India is an example of this). It is not uncommon to find private participation in the power market (as in the US), although in some cases this is prohibited by law. Recently, pressures to allow private participation, particularly in the generation market, has resulted in the growth of co-generation, privately owned power stations, and BOOT[3] arrangements.

With the recognition that the natural monopoly elements of power supply are essentially restricted to transmission and distribution, efforts have been made to introduce competition in both the generation and retailing of power. Given the close association between retailing and distribution, it is less likely that competition can be introduced at the lower end of the supply chain, although separately constituted and separately owned regional franchises are possible. It is in the generation of power that most attempts have been made to introduce private participation. India has attempted to attract privately owned new generation capacity, although Ranganathon (1993b) points out that this may be less to do with a desire to introduce competition than to mobilise capital resources.

In many public utilities, the roles of owner and manager tend to overlap (World Bank, 1990), and there has been much attention paid to the adverse effects of direct government interference in utility operations - the so-called 'command and control' situation. Although technically a publicly owned utility does not need to be regulated - it can simply be instructed - there is a growing recognition of the need to establish an arm's length relationship between the government and utility management. The use of a separate state body, namely an industry regulator, can be an effective way of doing this. Where utilities are privately owned, or even structured as a public corporation, regulation tends to focus on price controls, either through rate of return or price capping constraints (as in the

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[3] Build, Own, Operate and Transfer: where private participants finance, construct and operate a generation plant with the intention that, at some later stage, the public utility will take over the station.

US and the UK respectively). These arrangements leave the operation and investment planning entirely up to the utility (although rate of return regulation requires reviews to determine whether new investment can be included in the asset base). The public utility Electricite de France is organised like an industrial corporation and regulation is effected through a 'contract plan' - a negotiated agreement between the utility and the state that sets out the responsibilities and obligations of the two parties. Although this may appear to resolve the conflicts associated with ownership and regulation, negotiation of the contract may not be easy (World Bank, 1992). In other words, the problems of conflicting objectives associated with 'command and control' systems do not go away merely by formalising the relationship in terms of a contract. In countries where the electricity supply industry is still growing rapidly, either in terms of power output or number of connections, the government may have a legitimate concern to ensure that power sector development proceeds according to policy. In these cases regulation restricted to price controls may be inadequate.

Rural electrification occupies a rather special place in the organisation of power systems. Foley (1992b) asserts that rural electrification invokes conflicting interest within utilities: financial and technical logic dictates that utilities will be averse to rural projects, whereas political pressure requires them to act. Not only is there the perception that rural projects will result in financial losses but they also make heavy demands on technical and administrative resources. In addition, Mason (1990) argues that centralised utility structures are inappropriate organisation forms for the implementation and operation of small scale rural projects, partly because utilities' first priorities will tend to be generation, transmission and urban operations.

It is commonly argued that the solution to the institutional dilemma faced by utilities is to separate the rural electrification tasks from the rest of utility operations. This separation of functions, it is claimed, will resolve the underlying conflict, as well as make subsidies and the real costs of rural electrification transparent. In this view, essential features of any rural electrification agency are that it should enjoy substantial support from the state, yet retain financial and managerial autonomy (Foley, 1992b; Wade, 1990).

Experience indicates that most rural electrification projects are implemented in one of the following ways: as part of the normal operations of a public (or private) utility; by a separate rural electrification authority within a public utility; by an independent public agency; by local co-operative structures; or by small-scale private enterprises. The first option suffers from the autonomy problems discussed above but may be the easiest way to mobilise the substantial resources which utilities have at their disposal. The second option, where the utility establishes a special division within its organisation, is arguably the simplest and most effective arrangement. It has been tried with success by a number of countries, including Ireland, Algeria and Malaysia. However, the close links with the utility may compromise the requirement that the agency exercises financial and managerial autonomy.

The establishment of a separate rural electrification organisation should resolve the question of autonomy, but might raise problems concerning access to adequate technical and managerial resources. This option has been used in Thailand where a separate public utility is responsible for the distribution of electricity to all non-urban sites. It is not necessary that such an independent agency be responsible for all the functions associated with planning, finance, implementation and operation of rural electrification projects. In India the Rural Electrification Corporation (REC), a federal organisation, is responsible for the financing of projects, which are undertaken and operated by state utilities. Similarly in the US, the Rural Electrification Administration (REA) acted

primarily as a finance institution which channelled low interest loans to co-operatives as well as state and private utilities (REA, 1966).

Bose's analysis of India's rural electrification institutions demonstrates that the establishment of a separate rural electrification organisation is insufficient to ensure that it will operate as an autonomous body. She comments that in India "the REC has become increasingly mired in dependency on central government funding, the predominance of politically preferred programmes to economically sound ones, and a false system of performance evaluation that focuses on budget maximisation and enumerates an undefined concept of 'electrified villages' instead of providing electricity to households" (1993: 95).

The use of rural co-operatives to further electrification is best demonstrated by experience in the US. Farmers were encouraged to organise electricity co-operatives and initiate the process of designing a system and obtaining a loan (on concessionary terms from the REA). Co-operatives were explicitly excluded from regulation by state commissions (REA, 1966). The American experience has inspired a number of countries to adopt this model (with encouragement from the umbrella body of US co-operatives, the NRECA), with varying degrees of success. The Philippines is an example where rapid rural electrification has been achieved, and much of it through the use of co-operative structures (Santos, 1990). However, political pressure has encouraged over-ambitious projects and kept tariffs low, resulting in financial difficulties for the National Electrification Administration, as well as for a number of co-operatives (Foley, 1992b). Bangladesh has also followed the US system, evidently with considerable success. However, attempts in other countries have not always met with the same promising results (Foley, 1992b).

It is not uncommon to find local entrepreneurs operating a limited local network, powered by a diesel generator. For example, it is estimated that there are some 18,000 privately operated small rural supply networks in Indonesia (Foley, 1992b). Not only does this represent the mobilisation of substantial resources, but it also indicates that electricity supply in rural areas need not be a loss making business. However, the need to ensure adequate safety standards, and legal recourse against abuse of monopoly power suggests that some form of regulatory framework is required.

Emerging from this quick overview of institutional arrangements is the sense that there are a wide variety of options which have been used in different countries. Although much of the literature focuses on the need to establish autonomous agencies that have the commitment and resources to fulfil their tasks, it is not obvious that this is always possible. The contribution of state funds to finance projects appears to be necessary, yet encourages financial dependency on the state which tends to undermine institutional autonomy.

The pressure on many utilities to curtail their electrification activities and concentrate, at least in the short term, on maintenance and improving technical and financial performance, is likely to limit the ability of utilities to directly embark on rural projects. Institutional reform, and the promotion of private participation, will influence how rural electrification gets organised and implemented. However, it is impossible to generalise and individual countries will seek different arrangements depending on the current status and structure of their electricity supply industry, and the extent of the commitment to rural electrification.

3.3 Institutional options for off-grid electricity supply

Rural electrification generally refers to grid extension, and if viable and reliable, grid supply is likely to be a superior technical option. However, given the high costs associated with this option, decentralised technologies need to be considered. There are essentially two types of decentralised systems: those which can provide a similar level of service to grid supply (such as diesel generators or micro-hydro); and those that can only meet low intensity loads, usually through wind or solar systems. Although both wind and solar are relatively mature technologies, it should be emphasised that "some of the most crucial energy needs...cannot be readily addressed with these two technologies. Wind and solar technologies used in the developed world often do not seem to match well with needs in rural areas of [less developed countries]' (Wyatt, 1988: 43).

Diesel generators have the advantage that they require a lower capital investment and are flexible in that they can be run for varying lengths and times during the day. However, operating expenses are high and regular maintenance is essential. They are commonly used to meet targeted loads, such as those at a hospital, police station or private house, or used in conjunction with a mini-grid. In general, it can be shown that for relatively small, isolated loads with low load factors, diesel generators will be a lower cost option than grid extension (see for example Sinha and Kandpal, 1991). Of course, whether a project is financially or economically viable will depend on tariff policies and consumers' willingness to pay for the power. It should be noted that straight forward cost comparisons tend to overlook the 'transaction costs' and difficulties associated with establishing and maintaining decentralised systems.

Micro-hydro systems can only be used where adequate water resources can be utilised, and load/speed management can present technical problems. However, the institutional arrangements for their establishment and operation are not dissimilar to those for diesel, perhaps the only difference being the absence of the need to ensure reliable diesel fuel supplies.

Photovoltaic systems have the obvious drawbacks of being expensive and for all practical purposes are restricted to serving very limited loads. They occupy a certain niche market, which essentially covers low intensity, high value loads. Much of the recent literature has focused on their role as home lighting systems in remote and isolated communities. The nature of the capital investment required means that although there are no economies of scale, it is possible for single households to afford their own system. Wind generators are particularly sensitive to local wind conditions, and the costs exhibit similar features to photovoltaic systems.

It is common for the utility to own and operate diesel generators and local mini-grid networks. However, it has been suggested that centralised utility structures are inappropriate institutional forms for decentralised technologies. Arguments tend to be based either on observations of the inefficiency of utilities in dealing with decentralised projects (Mason, 1990), or based on a perception of the type of structure that 'fits' with rural development practice. An example of this latter argument is given by Ramani's assertion that "the prospect of megalithic utilities...remaining in near total control of decisions on rural electrification is inconsistent with the vision of decentralisation and participation advocated under rural development" (1992: 49). However, advocacy of decentralised solutions is often conditioned by a recognition of the need for the existence of a national plan and supporting institutions coupled with adequate credit and other complementary inputs (Mendis, 1992).

The possibility of private participation in rural electricity supply is probably very different from that currently being promoted in the power sector of developing countries. The large scale investments required for power generation attract investors who would be unlikely to want to participate in rural distribution schemes. However, there appear to be many opportunities for local entrepreneurs to initiate and operate localised electricity supplies. Many of the advantages of centralised organisation of grid systems do not appear to apply to decentralised diesel generators and privately owned diesel generators are common in most rural areas. Although these are usually used to meet the owner's needs, there are also many examples of local distribution systems powered by privately owned diesel engine generators.

Dissemination strategies for photovoltaic systems are more contentious, and enthusiasm for the technology has often tended to overlook its limitations. It has been argued that at least a portion of the subsidies available for grid extensions should be made available for photovoltaic systems. However, this ignores the fact that, unlike household photovoltaic systems, grid electricity can supply a wide range of services. The use of subsidies for what essentially amounts to household lighting and television may not be justifiable, particularly when only the wealthiest portion of the population is likely to utilise the subsidy. However, these arguments can also be made against subsidies for grid extension and the issue is not easily resolved.

Institutional options for the dissemination of photovoltaic systems include direct utility involvement (as in Mexico), the use of local finance co-operatives and private retailers (as in the Dominican Republic), or total reliance on the private sector (as in South Africa). The role of the state and the choice of any one, or combination, of these arrangements will depend not only on existing local institutions and capabilities, but also on the role that is expected of photovoltaics. If the technology is envisaged as an essential feature of a rural electrification programme, then it is likely that considerable state involvement will be required. However, if policies assume that the benefits of intervention in the dissemination of rural photovoltaic systems are unlikely to outweigh the costs, then state involvement may be limited to research assistance and promotion of technical standards and codes of practice.

There has been considerable development assistance for renewable energy in general, and photovoltaic systems in particular. However, the record to date has been poor (Foley, 1993). Kozloff and Shobowale (1994) have examined the role of development assistance for renewable energy in the light of the current climate favouring substantial institutional reform and it is worthwhile repeating their conclusions:

> *"1. Development assistance that is part of a comprehensive strategy for commercial development is more likely to result in technology diffusion than 'one-off' projects.*
> *2. Growing private participation in power sector finance and management...is unlikely to boost the market share of renewable electric generation.*
> *3. Improving local capacity for commercialising renewable technologies is critical for stimulating sustainable markets.*
> *4. Local conditions determine what institution is most appropriate to deliver renewably-generated electricity services.*
> *5. Even if renewable energy assistance projects are well-designed to address other barriers, project funds may well be squandered in countries with severe power-sector distortions."* (p41-44)

These conclusions suggest that although institutional arrangements may be the key to effective intervention in renewable energy, solutions cannot not be prescriptive, and must take account of a wide range of factors, including capacity building, commercial development and the need to integrate renewable energy with other energy policies.

3.4 Financing rural electrification

Financing options for rural electrification have to be seen in the context of (1) the necessity of subsidies to ensure financial viability; (2) the history of impact assessments; and (3) financing options for the entire power sector of developing countries.

The high capital and operating costs of rural distribution systems combined with low revenues means that subsidies are often required. These may take the form of direct grants from the state or foreign donors, or loans on concessionary terms. Pricing policies, which have tended to keep rural tariffs below costs, mean that it is common for projects to require further subsidies to cover operating costs. Utilities are often forced to use cross-subsidies from urban consumers to cover these operating losses. Where the losses are small relative to the urban surplus, these cross-subsidies may be sustainable. However, Menanteau and Shunker (1990) assert that the rural electrification financial burden has undermined the financial health of many utilities. In many cases, the use of cross-subsidies, particularly from non-domestic consumers may be in conflict with general pricing policy. Most analysts accept the need for life-line tariffs for the poor, but suggest that these special tariffs have tended to apply to people who should not qualify for subsidies. An interesting solution is the use of a straight-line tariff (i.e. a single unit energy rate with no fixed charge) where low consumption consumers are subsidised by those using more electricity (Pickering, 1994). If designed carefully, the tariff can yield sufficient surplus from high-level consumers to balance the deficits from low-level consumers.

Apart from the need to obtain subsidies to cover operating losses, there is the need to raise finance to cover the capital costs of rural project. Recognising that finance for rural projects requires concessionary terms, it has been common for states to establish special financing agencies. These organisations can then lend to utilities and co-operatives at rates which may even be below that used to finance national debt (after 1944 in the US, the REA was awarded loans at 2%, compared with 2.5-3% on government long-term debt - REA, 1966). However, given the overall effect of impact evaluations during the 1980s, it has become harder to justify these generous financing arrangements. There was a time when finance for rural electrification was relatively easy to obtain: they were big, visible projects with great promise - the type of projects which both governments and foreign donors like to support. However, rural electrification no longer enjoys this type of prestige, and more emphasis is now placed on consolidating existing infrastructure and improving utility technical and financial performance.

Institutional arrangements for grid based rural electrification facilitate easier access to subsidies (particularly cross-subsidies from urban consumers) and concessionary finance. Since photovoltaic dissemination is usually concentrated in the private sector, utilising a network of retail agents, access to credit, even on market terms, is difficult. Although there are clearly other important technical and institutional issues at stake, probably the first hurdle to an accelerated photovoltaic dissemination programme is access to adequate credit. It has been suggested that some of the institutional changes currently being proposed may have the effect of promoting the use of photovoltaic systems. For example, Sinha (1994) notes that in India the greater emphasis now placed on private participation in electricity systems, together with a shift away from direct

subsidies for rural electrification towards concessionary finance (which photovoltaic systems would presumably qualify for), means that solar and wind technologies are likely to play a greater role in rural electricity supply. However, Kozloff and Shobowale (1994) indicate that this optimism may well be misplaced.

The power sector of developing countries has always tended to account for a large portion of fixed investment and foreign debt (Barnett, 1993). Although electricity demand in industrialised countries is growing fairly slowly, the demand growth in many developing countries continues to be high - with an associated demand for investment in generation and transmission facilities. The World Bank estimates that close to $100 billion will be required per annum during the latter half of the 1990s, with China and India accounting for almost one half of this (Moore and Smith, 1990). It is typical for around 50% of power investment to require foreign exchange (Barnett, 1992). However, since the early 1980s, private foreign credit for the power sector has declined drastically to less than 10% of its peak in 1981 (Schramm, 1990), although multi-lateral and bi-lateral finance has remained constant at around $5 billion per annum. Clearly there is a large estimated shortfall between requirements and sources. This has tended to concentrate policy on the need to mobilise resources, particularly from the private sector. In this context of capital scarcity, rural electrification projects will find it harder to attract finance.

Financing options for rural electricity supply are closely linked with the institutional arrangements in place. Publicly owned utilities often raise finance with state guarantees. This option is not available to private sector enterprises. Small decentralised systems supplied by local entrepreneurs are often faced with a particularly acute finance problem. Terms and conditions tend to be far tighter that those faced by large investors in centralised power infrastructure, and on-lending to end-users, if available at all, is usually on very expensive hire-purchase terms.

An excèption to this general situation is the renewed interest from development assistance agencies in supporting decentralised power options, particularly renewable technologies. Examples include FINESSE in South East Asia and Southern Africa, as well as GEF grants for photovoltaic dissemination. The FINESSE programme is intended to be a pre-investment phase to assess markets and stimulate interest in private sector investment in small scale electricity supply, including photovoltaic systems (Yager, 1994). GEF grants have aimed to provide seed money for revolving credit funds for household photovoltàic systems (although the impact on CO_2 abatement is likely to be minimal).

An area of particular concern is finance for appliance acquisition. Utilities' responsibilities have traditionally stopped at the meter, and wiring and appliance acquisition has been left to the household, farm or business. However, there are a number of precedents which indicate the scope of opportunities here: in the US the REA was mandated to provide loans for the purchase of appliances and electrical equipment, and co-operatives would lend to individual members for this purpose (REA, 1966). In South Africa, a municipal distribution agency has a policy of supplying a hot-plate to all newly electrified consumers, and recovers the cost through the connection fee (Horvei and Dahl, 1994). Since the financial viability of rural electrification projects as well as the scale and scope of social and economic impacts tend to be dependent on access to end-use equipment, rural electrification programmes need to begin to address this issue.

3.5 Technology choice, dissemination and participation

The first and foremost concern regarding the choice of technology is the decision to opt for a centralised or decentralised supply option. Although costs and site specific factors will be important determinants, the influence of different institutional forms should also be recognised. Large scale utilities are likely to want to keep to their core business of distributing power generated at large stations. Technical staff and operating/maintenance teams will be more familiar with grid extension systems and a programme which utilises decentralised technology may require substantial changes within the organisation. In this sense, the decision to opt for decentralised technology has a knock-on effect on the institutional forms which can be, and are best, employed to implement and operate the installations.

It is common for public corporations to operate on the basis of centrally planned targets, which may have emerged from a greater or lesser degree of consultation with local agencies. Of course, measurable achievements against targets have the advantage of facilitating evaluation - qualitative effects being much harder to capture. However, it has been pointed out (Bose, 1993) that target chasing can lead to perverse results: targets are based on indicators of achievement, but indicators may become distorted reflections of achievements.

Decentralised technologies, particularly where they are distributed though decentralised agencies, are less amenable and less subject to target setting. The process of dissemination or diffusion of the technology is more complex and less easily directly controllable. In reviewing the diffusion of energy technologies in rural areas of developing countries, Barnett (1988) has identified a number of factors which influence the process. These include the roles of the market and the state; the level of end-user participation; the actual performance of the technology; the effects of different interest groups; the extent of financial returns to both suppliers and users; macro-economic policies affecting finance, subsidies and taxes; transaction costs relating to the establishment of distribution and maintenance networks; and finally the extent to which monitoring and evaluation is carried out. This analysis suggests that the mechanisms whereby decentralised technologies are adopted are complex. There are some instruments which can be employed to encourage an increased pace of diffusion, yet many strategies will have to focus on dealing with constraints. In particular, there appears to be a substantial effort required to establish the financing and institutional arrangements for dissemination which can then be exploited at minimal marginal cost.

Where dissemination is driven by the private sector with minimal state intervention, the market itself ensures a level of participation embodied in the interaction between buyer and seller. Market mechanisms will also operate to ensure that financial returns are adequate, i.e. that a bargain is struck whereby both parties benefit. However, where price distortions exist, the market may fail to ensure that some technologies compete on an even footing. Decentralised technologies may offer unique opportunities for establishing efficient and locally organised operations, but there may be difficulties where weak institutions exist (Kozloff, 1994).

It is common to hear calls for effective community participation in state aided, or utility planned, electricity supply strategies (for example, De Beer and Swanepoel, 1994). The rationale for this is partly to ensure adequate integration with local developments (Sinha et al, 1994), but also to facilitate a dialogue between end-users and suppliers (O'Keefe and Munslow, 1989). One of the strengths of co-operatives is that they are supply organisations, as well as institutions which represent end-users' interests. However, voluntary participation by local communities in utility operations can occur, and can lead to substantial cost reductions (Chullakesa, 1990).

4 Conclusions

The starting point of any analysis of rural electrification must be an attempt to address the role of electricity in rural areas: how electricity fits with rural energy consumption patterns, its role in the local economy, and its contribution towards rural development programmes. It has often been noted that the demand for electricity is derived: its use is a means to an end, rather than an end in itself. An analysis of end-use requirements, in both domestic and non-domestic rural activities, reveals important insights into the role of electricity. Its impact as an economic agent, that is as a productive input and as part of an area's physical infrastructure, has been shown to be highly dependent on existing levels of economic activity and the presence of complementary inputs. In the domestic sphere, electricity is particularly important in powering 'high value' energy services. However, the scope and extent of benefits will rely critically on the removal of constraints to access, in particular barriers to connection and appliance acquisition. In addition to the utility of electricity, it has an important symbolic value: access to electricity is synonymous with entrance to the 'modern world'. This is closely linked with the very real role that electricity has in opening opportunities in terms of household welfare and economic development.

Electrification programmes have often been criticised for their failure to adequately take account of rural development initiatives and the dynamics of household energy transition. Since the organisation which is usually responsible for project planning and implementation is a power utility, the source of these two problems may be found in the institutional set-up. Power utilities are primarily concerned with supplying electricity and may find that involvement in rural development initiatives and consideration of 'integrated energy planning' strategies is beyond their capabilities.

Despite its reputation as an expensive way of achieving limited results, rural electrification will remain an important part of many countries' energy policy objectives for the foreseeable future. However, experience has shown that the development and implementation of programmes is caught between opposing economic and political forces. A response to this dilemma has been a tendency to move towards treating electricity as a commodity, and hence electrification as a demand driven process. However, it may prove naive to expect governments to abdicate their role in promoting what may be a key development objective, in favour of the market. Access to affordable energy services will remain a key policy theme, and interventions are likely to attempt to address particular constraints to access, such as connection policies and rural credit.

However policy objectives are formulated, their implementation must work within an existing, and evolving institutional framework. Largely unrelated to rural electrification issues there are pressures to reform the electricity supply industry. International lenders perceive an urgent need to restore the financial health of utilities, improve technical performance and develop ways to meet the projected levels of investment required to meet increasing demand. This perception is often shared by utility management and governments, and is focusing attention on issues of privatisation (and other forms of private participation), tariff reform, utility autonomy and re-regulation. Rural electrification may not occupy centre stage in these debates, but will be profoundly affected by the consequences of reform.

A key issue is the choice between decentralised and centralised electricity supply technologies. Although this choice will be affected by the technologies themselves, the demand for energy services and site specific conditions, it will also be conditioned by the existing institutional framework. If decentralised solutions are to become an integral part of rural electrification, then it

will be necessary to understand how utility structures can cope with these solutions, and how other institutional forms may be employed.

Related to the use of decentralised technologies is the potential role of the private sector. Financial constraints within the power sector, as well as a growing pressure towards private sector participation, make it necessary to consider alternatives to the traditional public utility. However, successful private participation in rural electricity supply is likely to be very different to that presently being seen in the investment in new generation plant. Given the likelihood of financial loss on rural projects, there is a disincentive for private investors to participate in this section of the industry. If rural distribution operations are privatised, considerable incentives are likely to be required to induce further investment. However, other opportunities exist, particularly in the development of small, locally based and locally owned enterprises. This includes small businesses, co-operatives and community managed systems. The experience of these types of operations is vary variable and success may be critically dependent on supportive public policy. Particular issues include access to finance as well as the development of technical and managerial skills.

In summary, institutional options for the supply of electricity to rural areas will be affected by the prevailing assessment of the role for electricity, and the existing institutional frameworks. Those options employed will have knock-on effects on the design and implementation of rural electrification programmes, including financing, technology choice, and user participation.

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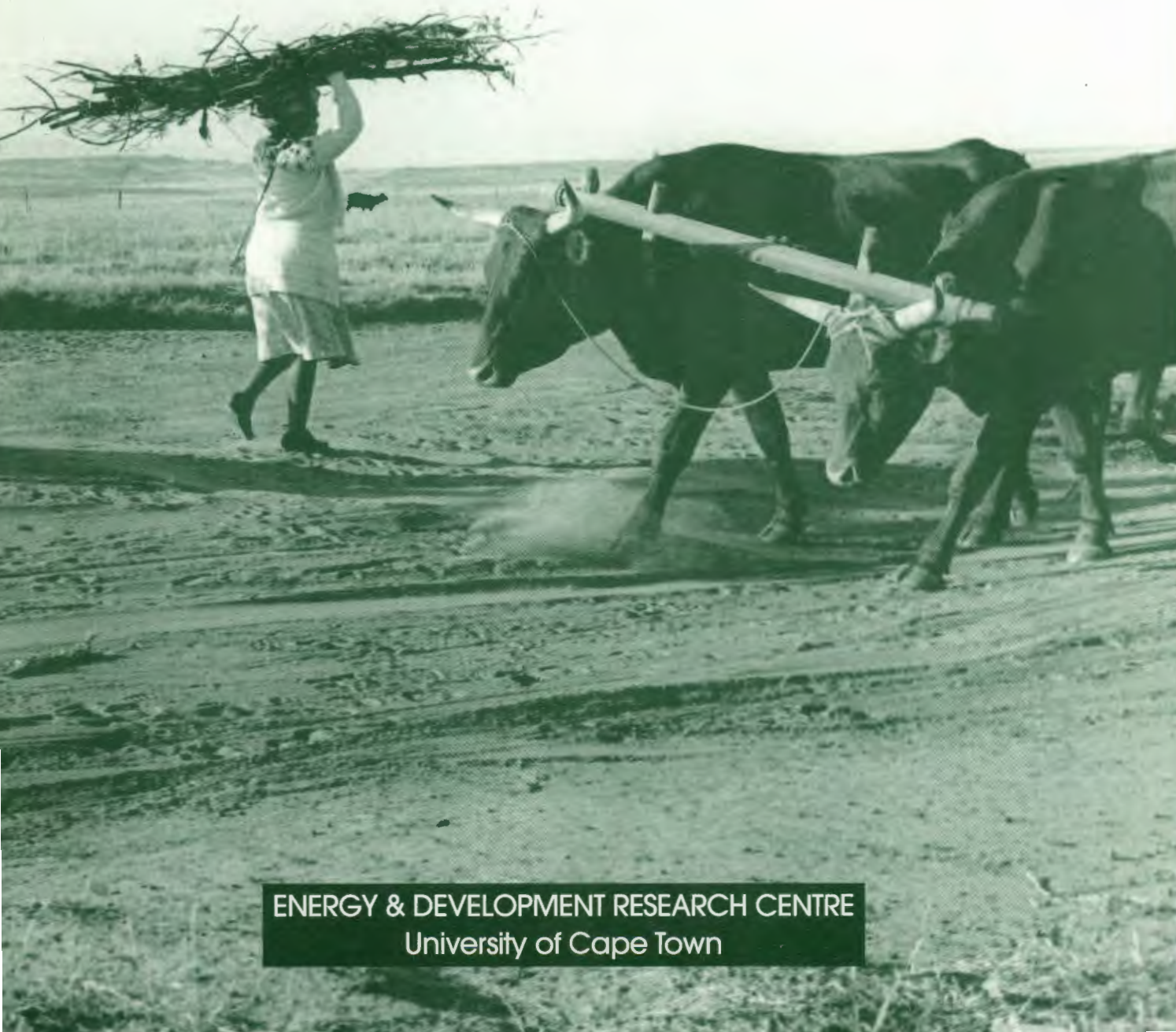

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