How important is modern energy for micro-enterprises?

Evidence from rural Kenya

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KIRUBI, Charles

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Approved by:

Arne Jacobson________________ Date: April 17, 2006

Assistant Professor, Environmental Resources Engineering,

Humboldt State University

Arcata, California.

Dan Kammen________________ Date: 5-10-06

Professor, Energy and Resources Group

University of California, Berkeley

Received:

Jane Stahlhut________________ Date: 5/4/06

Graduate Assistant, Energy and Resources Group

Abstract

In this study I explore the relationship between modern energy and economically productive activities in rural Kenya. Research is based on surveys done in Mpeketoni Village in Summer 2005, complimented by review of the literature. The findings reveal that access to electricity, in combination with simultaneous access to markets and other infrastructure (roads, communication, schools, etc), have contributed to robust growth of microenterprises in clear and compelling ways. For instance, productivity per worker and gross revenues per day increased by the order of over 200% for both carpentry and tailoring microenterprises.

Despite high tariffs [Ksh22.50 (US$0.30)/kWh or nearly 3 times the national grid tariff], Mpeketoni Electricity Project has demonstrated that there exists substantial unmet rural demand for electricity. My key policy recommendation is that small-scale power generation and distribution projects below a pre-determined capacity (say, 1000 kW) should be permitted to operate license-free in rural areas under a revised Electricity Power Act as is the case in India and Nepal. Removal of licensing bureaucracy for such small-scale mini-grids would make it possible for owners of diesel generators in rural areas to sell power “over-the-fence” to households and enterprises, thus increasing access to rural electrification.

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CHAPTER 1: INTRODUCTION

1.1 Research overview and statement of the problem

Broad agreement exists that for global poverty to be addressed the poor must have access to modern energy services[1]. A number of researchers claim that for modern energy to make a difference on poverty, it must necessarily contribute to "productive uses" that generate income and create jobs. IDS (2001) asserts that the "vicious cycle of poverty will only be broken by combining improved energy services with end-uses that generate cash income." Martinot et al (2002) add that applications of renewable energy that provide income generation and social benefits such as clean drinking water, cottage industry, distance education, and improved agricultural productivity, "will appeal to increasing segments of rural populations".

While these claims are compelling, data on the broader benefits of modern energy for micro-enterprises, income generation, and sustainable livelihoods for the poor in Africa is extremely limited (Meadows et al, 2003; Martinot et al, 2002). The Mpeketoni Electricity Project (MEP) in Kenya, where diesel generators and a mini-grid distribution network delivers power for use in a remote rural village, was selected for this study to explore the impact of modern energy on micro-enterprises. This particular case study was selected because it permits a direct exploration of the connections between the supply of modern energy, in this case electricity, and microenterprises for rural development.

One hypothesis was that "*modern energy plays an important role in the start-up and growth of microenterprises in rural areas*." In testing this hypothesis, I examined the relationship between rural electrification and micro-enterprise development. In other words, I was interested to understand the degree to which rural electrification may contribute to sustainable livelihoods and poverty reduction in a rural setting. Various aspects of the energy-enterprise-livelihoods nexus were examined, including the value of energy for enterprise, income and employment creation, and other development goals such as education.

The second hypothesis is drawn from the literature reviewed (see section 3.5). A key conclusion from the literature is that modern energy, in this case electricity, should

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[1] The term modern energy refers to a variety of improved energy sources e.g., liquefied petroleum gas (LPG), kerosene, electricity- whether from fossils fuels or renewables (Meadows et al, 2003)

be viewed as one of a suite of critical enabling factors that act individually and/or in concert to create a suitable environment in which micro-enterprises can operate. In other words, access to electricity is a necessary but not sufficient condition for the start-up and development of SMEs. A testable hypothesis arising from this assertion is that: "*an interactive and synergic effect exist between access to electricity, markets and other infrastructure which is essential for microenterprise development*[2]." In testing this hypothesis at Mpeketoni, I will use three metrics for which data is available: (i) markets for agricultural produce; (ii) roads; and (iii) facilities for social amenities (schools, polytechnic, and communication services)

1.2 Motivation and significance of the study

Small and micro-enterprises (SMEs)[3], also known as the informal sector, have become an integral player in the African economy. In Kenya, for instance, this sector accounted for 20% of the GDP in 1999 (CBS et al, 1999) and 64% of the urban employment by 2002 (Karekezi and Majoro, 2002). Studies in India have also shown that SMEs enable rural households to generate non-farm income which can largely contribute to poverty reduction (Lanjouw and Shariff, 2002). In general, SMEs purchase (rather than harvest or collect) their energy, including electricity, LPG, kerosene, firewood, charcoal, etc. This is true even in rural areas. Moreover, despite energy being one of the significant factors for most microenterprises, there is knowledge gap on how much energy is being consumed; neither is it systematically documented what role energy plays in diversifying production and expanding employment opportunities by microenterprises, both in urban and rural areas (Clany and Dutta, 2005). Motivating my study was the need to address this knowledge gap within the broader discourse of productive energy uses.

Another motivation is that the MEP project has been hailed as a "successful" project and selected for scaling-up into a wind-diesel hybrid energy system by the e7

[2] When two components of a production program interact to make each other viable, their simultaneous access is imperative (see Leonard, 1991)

[3] Refers to very small businesses, employing less that 10 people each, and produces goods or services for cash income (Allerdice and Rogers, 2000). SMEs are often grouped and referred by different categories and acronyms, but for this study microenterprises and SMEs are conveniently used interchangeably.

Group[4] in conjunction with Ministry of Energy (Kenya), ScottishPower Plc (UK) and Energy for Sustainable Development (Scottish Power, 2005). Thus understanding how and why the project has been "successful" and documenting its local micro-enterprise and livelihoods impacts is both critical and timely. The findings will provide policy makers, rural development practitioners and entrepreneurs with insights and lessons regarding the role and value of modern energy in facilitating and supporting the establishment and growth of micro-enterprises and how and why these can be linked to sustainable livelihoods and poverty reduction in Kenya.

CHAPTER 2. METHODOLOGY

2.1 Nature and sources of data

The study combined quantitative and qualitative methods, including surveys, electricity generation and consumptions analysis as well as changes in SMEs' productivity to analyze the social and economic significance of access to electrification in rural Kenya. The field survey was conducted in the summer of 2005 at Mpeketoni village, where a community-owned and managed diesel-powered mini-grid has been in operation since 1994. The guiding questions framing the survey were: (i) What difference did access to electricity make to the SMEs and other social institutions like schools? (ii) How did SMEs and other residents themselves assess and experience the difference? (iii) What are the policy implications for rural electrification arising from MEP experience?

Primary data was collected using participatory rural appraisal (PRA), combined with secondary electricity consumption data from the MEP's records. The PRA used a combination of techniques to collect a consistent set of data from direct observations and interviews. Semi-structured interviews with operators of SMEs and MEP management committee elicited much of the information on the impact of electricity on the startup and growth of SMEs in the village. Separate interviews with key informants (including government officials, teachers, community leaders, agricultural extension officers) provided supplementary information and helped in cross-validation of data collected from the questionnaires.

[4] A group of electricity companies in the national territories of the G8 countries. The Group supports demonstration sustainable energy projects in developing countries (see www.e7.org)

The impact of electricity was assessed using two types of SMEs: carpentry and tailoring. As the supply of electricity at Mpeketoni is very erratic, the two trades are always switching back and forth between using electricity and manual labor for their production[5].

Thus, the erratic power supply permitted me to observe and compare the production patterns of workers in the two trades as they consistently operated on two modes, i.e., “with” and “without” electricity. Unexpectedly, the frequent outages presented a unique “experimental” opportunity to observe two distinct production scenarios within the same sample group; yielding a more reliable data set used to estimate the cause-and-effect relationship between electricity and production of typical SMEs.

In other situations where the effects of “with” and “without” electricity could not be observed within the time constraints of the study (e.g., in agriculture and education), a less reliable recall method of “before” and “after,” using key informants, was applied. The possible unreliability of recall data, exacerbated by the absence of a comparable control study village, suggests that often the *directions* of (positive) changes I describe are of more significance than the absolute figures presented.

2.2 Definition of terms

In this section, I define key terms and concepts related to study of electrification and economic development in Mpeketoni Village.

2.2.1 Modern Energy

The term “modern energy” as used in the literature can be taken to refer to a variety of energy sources including liquefied petroleum gas (LPG), kerosene, and electricity, either grid or off-grid – whether generated by burning fossil fuels or by using renewable sources such as solar, biomass, hydro or wind (Meadows et al, 2003). Generally speaking, however, modern energy is most commonly associated with and sometimes (wrongly) used as a synonym for “electricity” or “electrification”. The

[5] Outages are the rule rather than the exception – lasting from a few hours to several days (Kirubi, personal observation). In Feb 2004, one outage lasted 3 weeks due to a major technical breakdown.

literature review for this study will relate to modern energy in general, while my case study will specifically focus on a rural electrification project using a diesel-powered mini-grid at the Mpeketoni Settlement Scheme.

2.2.2 Micro-enterprise

The term “micro-enterprise” refers to a very small business that produces goods or services for cash income (Allerdice and Rogers, 2000). Micro-enterprises can be identified on the basis of a number of characteristics. For example, they usually operate in the informal sector of the economy, require little in the way of initial start-up capital, and have few employees, usually defined as less than ten (CBS et al, 1999). Micro-enterprises are often home-based (Karekezi and Majoro, 2002), and as a result the employees are usually family or household members working on a casual basis (sometimes without cash wages). It is also often difficult to distinguish between household expenditure and that of the micro-enterprise. SMEs operate in a number of economic sectors, including commerce (e.g., retail and trading in new and second-hand goods, agricultural produce), manufacture (i.e., production activities), and service (including personal and non-personal services).

2.2.3 Productive uses of energy

The conceptual understanding and knowledge base linking energy and productive uses have expanded over the past decade. Traditional understanding emphasizes direct income generation as the primary goal of productive uses of energy (Barnes, 1988; Rogerson, 1997; FAO, 2000; IDS, 2001). For instance, according to Kittelson (1998) productive use is any use of electricity that helps generate income for the end-user. It may be a huge “cement factory or a tiny juice stand with an electric blender.” However, in order to respond to international development goals which go beyond income, (e.g., the Millennium Development Goals), and to also keep pace with an updated understanding of what development is, other researchers have expanded the traditional thinking to encompass the tremendous impact that energy services have on education, health and gender equality (Cabraal et al 2005; Etcheverry, 2003). For instance, Kapadia (2004) defines “productive uses” of energy to involve the utilization of energy – both electric and non-electric in the forms of heat or mechanical energy – for activities that enhance income and welfare. The activities are typically in the sectors of agriculture, rural enterprise, health and education. Examples of such activities are pumping water for agriculture, agro-processing, lighting, information and communications, vaccine refrigeration, etc. In using this definition, Kapadia is cautious that the distinction between "productive uses" and "consumptive uses" is by no means clear-cut because overlaps can occur. To permit broader exploration of the impact of electrification and economic development, including micro-enterprises, agriculture and education at Mpeketoni, this study adopts the expanded view of productive energy uses.

CHAPTER 3: LITERATURE REVIEW

3.1 Modern energy as a catalyst for micro-enterprise

Reviewed literature demonstrates that access to modern energy is a necessary but not sufficient condition for the start-up and development of micro-enterprises. Another key finding is that, while lack of modern energy is often characterized as a barrier to micro-enterprise development, removing this barrier (through, for example, energy development such as (rural) electrification) does not necessarily result in micro-enterprise development. In other words, access to modern energy is neither the only nor even necessarily the most important factor influencing micro-enterprise development. Other factors such access to finance, markets, and other infrastructure are also very important.

Support for the notion that modern energy can and does act as a stimulus for the emergence, growth and continued development of micro-enterprises is relatively strong in the literature reviewed (Fakira, 1994; Foley, 1990; Karekezi and Majoro, 2002). Fakira (1994 cited in Meadows, et al 2003), for example, claims that "energy is one of the critical resources needed to liberate micro-enterprises from low value, low productivity and low income activities." Allerdice and Rogers (2000) suggest that "access to even limited amounts of electricity for micro-enterprises in non-grid–connected areas can be important to the establishment and growth of those businesses."

Khan (2001) demonstrated the significance of better lighting for increased income-generation attributable to extension of business hours into the evenings. The author cites examples of tailors who worked for four more hours and thereby increased their revenue by 30% in Bangladesh. Opening hours for shops were also found to increase by an average of three hours a day and in terms of new businesses, Khan concluded that adequate lighting is a "deciding factor" in whether or not people opened a home-based business. Foley's (1990) study reports increased economic activity and higher living standards following electrification and concludes that "the arrival of an electricity supply in certain areas seems to be a crucial factor in precipitating decisions by local entrepreneurs to invest in a variety of productive enterprises."

Rogerson (1997) cites evidence from KwaZulu/Natal of positive impacts of on existing SMEs that benefited from the switch to electricity including welding shops and tailors. In other sectors such as brickmaking and garment manufacturing, the availability of electricity determines levels of technology and also has strong influence on cost and levels of production. In Northern Province of South Africa, the contrast between rural SMEs without access to electricity and those in electrified industrial estates is instructive. Rural SME owners indicated that lack of electricity was among the main limitations to their competitiveness while those operating in the industrial estates mentioned the presence of electric service as one of the benefits of location in the estate, in addition to other important infrastructure available there (Rogerson, 1997).

Anecdotal evidence is commonly used to support the argument that modern energy can and does play an important role in stimulating micro-enterprise. For example, Rana-Deuba (2001) suggests that access to modern energy produced by micro-hydropower in Nepal has been found to result in or contribute to the establishment of bakeries, photo studios, battery charging, grocery stores, agricultural and saw mills and small-scale agricultural activities such as poultry farming and goat keeping. Balla (2003) reports a similar variety of SMEs established and/or expanded following micro-hydro rural electrification projects in Kirinyaga and Meru Districts of Kenya.

Dube (2001, cited in Karekezi & Majoro, 2002) suggests that the security lighting on high-masts (poles) in poor urban areas of South Africa has resulted in the urban poor setting up small enterprises in the evenings. Similarly, the Nairobi City Council in Kenya has embarked on a program to repair and install streetlights along the inner roads, walkways and slums with a view to relocating hawking businesses from the congested central business district into the outer parts of the city. Installation of streetlights has increased visibility, attracted more customers, improved security and extended the hours of operating businesses into the night, thus improving sales and profitability (Kirubi, personal observation, July 2005; *Daily Nation*, 12/16/2005).

Several case studies from Grameen Shakti's PV program illustrate well the value of modern energy to microenterprises (Meadows et al, 2003). For example, a local appliance repair shop, using solar power to undertake repairs, was reported to increase income by US$25 per day. A lamp-renting enterprise which rented out 5 solar lamps earned an extra US$12.50 a month and the operation of solar powered cellular phone system earned the owner an estimated US$30 a day extra. Extended working hours at a local barbershop using solar lighting was found to increase income by US$5 a day. In addition to these financial indicators, other direct impacts experienced by these enterprises included better work quality and efficiency, a better working environment and greater income from ancillary sales associated with attracting customers in the evenings. Other indirect impacts of these enterprises using solar systems were identified as greater customer satisfaction, increased income for workers, increased social status of owners and customers, increased living standards for locals and increased employment opportunities.

Nevertheless, there are conflicting reports and differences of opinion in the literature regarding the impact that modern energy can and does have on entrepreneurial activities, and hence its developmental importance. Several authors have offered explanations for these differences. One view is that modern energy is one of a number of critical enabling factors necessary for micro-enterprise development. For example, Barnes (1988) reports finding greater numbers of businesses in rural areas with electricity than those without it, but also highlights that there were other complimentary local conditions such as "ready availability of adequate credit finance and access to markets".

Another perspective is that while electricity is crucial to existing and well-established micro-enterprises, it is not so much a contributing factor in the emergence of new ones. Following a literature review of international work on rural electrification, Rogerson (1997) concludes that access to electricity encourages the "modernization" of existing rural SMEs but "it exerts only a modest stimulus for the growth of new enterprises." This skepticism is echoed by Wamukonya and Davis (2001) who observed that "overall, rural electrification does not seem to have had significant impact on the growth of income-generating activities in Namibia". They note that very few home-based businesses used electricity and when they did, they mainly made use of electrical "lighting only". In their view, access to finance and markets are more important for SMEs than electricity.

Other studies strongly question the developmental value of modern energy (e.g., solar PV) that provides "lighting only" in rural areas[6] Karekezi and Kithyoma (2002) have observed that, while typical solar PV systems (40-100Wp) are useful for lighting in rural SMEs, they cannot meet the "heating and shaft/motive" power needs of the SMEs, which are 100-1000 times higher. PV technology, they contend, is thus unsuitable and uneconomical for *agro-processing* activities that often represent the most attractive options for generating incomes in rural areas (emphasis added). An FAO study (2000 cited in Cecelski, 2000) on the impact of solar PV on rural development shares this view and emphasizes the need to go "beyond the light bulb" in order to have an impact on poverty reduction. While acknowledging the limitation of solar PV as an anti-poverty intervention, Jacobson (2004), nonetheless concludes that "solar PV appears to play a *small* but potentially significant role in supporting income and work related activities in rural Kenya" (emphasis added). He cites a 2003 survey (n=76 households) where 32% of the households with solar PV reportedly used "lights for income generation or work related activities." In total, 48% of the households in the same sample reported some "sort of work or income-related activity" that was supported by use of solar PV. In addition to lighting services, Jacobson further draws our attention to another important application of solar PV: supporting "connective" appliances such as TV, radio and cellular phones in rural areas. The (economic) value of information from the use of these appliances is particularly difficult to evaluate, however.

To bring better clarity and reconciliation in the energy-SMEs debate, it is methodologically insightful to bear in mind that while the term "micro-enterprise" may be useful to describe a broad spectrum of similar income-generating activities, the businesses themselves are not homogenous but often have different characteristics and

[6] Technically, solar PV can provide a wide range of energy services beyond lighting. However, due to its prohibitive cost, rural households/SMEs can only afford small systems (20-50Wp range) adequate to power a few lights, radio, and TV (Jacobson, 2004).

different needs. Consequently, it is inevitable that there will be differences in the degree to which access to modern energy affects each micro-enterprise. In fact, Meadows et al (2003) questions the validity of studying small or micro-enterprises as a group, arguing that a sub-sector approach is more useful. It may be more relevant, for instance, to look at milling, information communication and technology (ICT), carpentry or metalworking businesses (see, for example, a study on SMEs in metal work by Kabecha, 1999), irrespective of their size. According to this view, modern energy may be good for some sub-sectors, neutral for others and perhaps negative for others[7].

3.2 Barriers and enabling factors experienced by micro-enterprises

Many of the examples cited above seem to suggest a common conclusion in the literature, namely that modern energy is neither the only nor even necessarily the most important factor influencing micro-enterprise development. Rough evidence to this effect is provided by Rogerson (1997) who reports on the findings of a study which asked micro-enterprise businesses to rate the various constraints facing their businesses in South Africa. The findings showed that on a scale from 0 (completely satisfied) to 100 (completely dissatisfied), lack of electricity received a rating of only 12 and was ranked 34th out of the 46 possible business problems listed by the survey. While more contextual information is required to meaningfully interpret this ranking (e.g., quality and cost of energy relative to other infrastructural or business services), the findings are important because they reflect the value of energy as subjectively assessed by SMEs.

On the other hand, this type of ranking could also be highly misleading, underestimating as it does, the indirect value of energy. Energy, unlike water or food, is valued as a means not an end; only valuable for delivering the energy services that end-users need. Thus it is not surprising that most households and micro-enterprises rarely ranked energy as top priority compared to say water or security. A point reinforced by noting that none of the eight Millennium Development Goals (MDGs) directly refers to energy, yet energy is critical to the achievement and sustainability of all MDGs (Ogunlande, 2005; McDade, 2004). In a report to the 2005 G8 Meeting, Practical

[7] ESD (2000) contends that introduction of modern energy such as LPG to displace traditional biomass fuels may have negative livelihoods impacts on the producers and traders of the latter who are poor, mostly women, for whom there are very few alternative employment options.

Action(2005) notes that "at the individual or community level people may not express their needs in terms of demand for energy, but they do desire the services that it provides, such as cooked food, pumped clean water, lighting, heating, radio, telephone, transport, reduced drudgery and time saved." Moreover, at the national level energy is seldom the most visible issue on the national development policy agenda, yet it can help facilitate stable economic development, allow access to global markets, impact on the national and global environment and affect national budget allocations.

The international literature suggests a number of other critical enabling factors for micro-enterprises. A key enabling factor and one that is frequently discussed is access to financial resources, especially credit for raw materials, fixed assets and working capital (Rogerson, 1997; Allerdice and Rogers, 2000; Wamukonya and Davis, 2001). Indeed, it has been contended "access to credit is probably the most frequently cited constraint across the SME sector" (RWEDP, 1999 cited in Meadows et al, 2003).

In discussing the technological capability of micro-enterprises in Kenya's informal sector, Kabecha (1999) identifies and then classifies the constraints into two categories: (i) internal constraints (e.g., lack of entrepreneurial ability, historical underdevelopment of the micro-enterprise sector, entrenchment of expensive private foreign capital, lack of organization), and (ii) external constraints (e.g., technological gaps, dependence on foreign sources of equipment, low levels of education and training, limited markets for products, lack of working space and infrastructure to expand operations, lack of suitable premises, lack of electricity and water – found to impose a severe constraint on the level of technology that can be adopted, and uncertainty in the informal sector not conducive to private investment).

Lack of access to modern energy that is reliable and affordable may act in concert with and/or contribute to the occurrence of additional barriers to micro-enterprise development. For example, the benefits of ICT such as computers and the internet for obtaining information and reaching markets are restricted to users with access to an effective electricity supply (Duncombe and Heeks, 2001; Heeks and Duncombe, 2001). Similarly, getting the goods or services to the markets requires transport, which in turn requires energy. Thus, Rogerson (1997) suggests that the effect of technological constraints and inadequate infrastructure in limiting modern energy services for micro-enterprise is but one of the "myriad constraints" that confront micro-enterprises.

Access to modern energy *per se* is also not the only significant issue in considering the effect of modern energy on micro-enterprises. The energy, as well as the electric tools and equipment, need to be reliable and affordable to be effective enabling factors for micro-enterprise (Kittelson, 1998). Osunbitan et al (2000) illustrate the importance of energy supply reliability in their examination of the energy used to power machinery in agro-allied micro-enterprises, in this case cassava and palm oil processing. They found that despite the availability of electricity via grid connection in urban and semi-urban areas of Nigeria, the processing centers studied did not depend on or use electric engines because of unstable power supplies, preferring instead to rely on diesel engines. An unreliable energy service was cited by micro-entrepreneurs in Uganda as one of a number of common energy-related problems that they encountered (Meadows, et al 2003).

Others constraints included unstable voltage (which necessitates use of voltage stabilizers to protect equipment from damage during surges); non-transferable power connections (resulting in situations where new tenants inherit the previous tenant's bill); having to pay bribes to get connected to power and high tariffs. Karekezi and Majoro (2002) also report that in Zimbabwe the tariff categories for electricity supply are "particularly unfavorable" for micro-enterprises. These authors conclude that the provision of modern energy to SMEs and the agricultural sector could be enhanced by progressive policies such as liberalization of distribution and tariff setting. In the next section, I review the policy environment relating to rural electrification in Kenya.

3.3 Current rural electrification status and policy in Kenya

In 2001, Kenyan's national population was 30 million and 66% lived in rural areas with a very low ($350) national GDP per capita (Nyoike, 2004). Electrification statistics are depressing: only 15% have of the population has access to grid electricity, less than 4% have access in rural areas, and electricity consumption per capita is a mere 104 kWh (Kamfor, 2002). Started in 1973, the Rural Electrification Program (REP) is the primary means of electrifying rural areas in Kenya (Walubengo and Oyango, 1992). The

Kenya Government, via the Ministry of Energy (MoE), contracts the services of the national utility, the Kenya Power & Lighting Company (KPLC), to oversee the planning, execution, operation and management of REP countrywide (MoE, 2003). From the outset, a deliberate policy decision was made to prioritize electrification of the administrative district headquarters, public and commercial services (e.g., market centers, schools, hospitals, etc) as well as rural industries (e.g., coffee, tea and sugar factories) (Walubengo and Oyango, 1992). According to these authors, the early phase of REP was "very successful" as all the administrative headquarters, main market centers and rural agricultural factories had been electrified by early 1990s.

Despite the extensive grid network reaching majority of towns along major roads, access to electricity by the rural poor households remains a pipe dream. For decades, strategies for increasing the rate of new connections to cover upcoming towns and households have engaged the minds of researchers, policy makers, and politicians. Available data indicate that, since 1973, only about 80,000 consumers (inclusive of households, industrial, commercial and public services) had been connected by the year 2002 at a total cost of Ksh 10 billion (US$14.2million). (Balla, 2003). Funding for REP is generated primarily through a 5% cross-subsidy levy imposed on each electricity consumer. This support is supplemented by donor support, which accounts for 18% of the funding for the program. (MoE, 2003).

Another major policy concern is that despite a steady growth in revenue for REP, new connections have slowed or stagnated. For instance, despite a staggering five-fold increase in revenue from Ksh200 million (1993) to Ksh1 billion (2001), the number of new connections remained relatively constant. In other words, the cost per connection in 1993 was about Ksh40,000 while in 2001 it had risen to Ksh200,000 (Karekezi et al, 2003). A Rural Energy Task Force appointed by the MoE in year 2003 sheds considerable light on the challenges facing REP and how they could be overcome. The Task Force identifies lack of appropriate and effective institutional framework, high operating costs, and high capital costs as the three key constraints to accelerated rural electrification in Kenya (MoE, 2003).

The current arrangement whereby REP is managed by the Permanent Secretary[8] in the MoE, supported by a committee comprising members from MoE, Office of the President, Ministries of Finance and Planning, and KPLC, is one key institutional weakness (MoE, 2003). The Task Force claims that the Committee has not been effective as it lacks well-equipped full-time technical staff and a secretariat to manage the REP. To address this institutional weakness, the Task Force recommends creation of an autonomous body, such as a Rural Electrification Agency, to be directly and fully responsible and accountable for the REP.

Prohibitively high operating cost is another key constraint. Under the contractual agreement signed in 1973 between the KPLC and the Kenyan Government, the latter owns assets created through the implementation of rural electrification[9](MoE, 2003). The Government is also required to underwrite any operating losses attributable to rural electrification incurred by KPLC. As proportion of total REP resources, the losses have dramatically grown from 14% (1973-83 period) to 54% (1999-2002 period). This analysis makes it evident that the bulk of REP funds are significantly depleted by KPLC operating losses; leaving very little for system expansion. Moreover, the Task Force claims that the operating losses are inflated. To address the operating losses problem, the Task Force recommends that REP assets be transferred to KPLC and REP tariff be (marginally) adjusted to cover the losses. Hypothetically, if the REP assets had been owned by KPLC between 1998 and 2002, and if the losses for the same period had been covered by the tariff, the Task Force estimates that this would have resulted in a tariff increase of only Ksh0.20 per unit or 2.5% of the current average tariff of Ksh8 (MoE, 2003).

Except for a few isolated diesel stations in northern parts of the country, REP is primarily implemented by capital-intensive grid extension. On average, it currently costs Ksh1.0 million (US$13,333) to construct one kilometer of an 11kV or 33kV line while the average cost of connecting a rural customer is Ksh80,000 to 150,000 (US$1066 - 2000) (MoE, 2003). The diesel stations are equally prohibitive requiring approximately

[8] Permanent Secretary is the chief executive government officer heading a ministry in Kenya.
[9] The report does not specify the assets in question. But from the report context, it can be inferred assets refer to the distribution network serving REP customers in addition to stand-alone diesel generators installed in the remote districts.

Ksh500,000 (US$6666) initial capital costs; while their operating costs [Ksh39 or US$0.52/kWh] is more than double compared to the hydro-based rural grid [Ksh16 or US$0.21/kWh]. To reduce capital costs, the Task Force recommends diversification of REP energy sources portfolio to include small hydro, solar, wind, and biomass.

The current energy policy and legal framework embedded in the Electric Power Act (EPA) of 1997 is also considered a serious impediment to accelerated rural electrification. EPA is the legislation governing the generation, transmission and distribution of electrical energy. The Act's main thrust is liberalizing the electricity power sector by attracting private investors into the electricity market. Independent power producers (IPPs) can and do generate electricity and sell it to KPLC for distribution. However, a number of authors have identified a couple of material weaknesses in the Act which impact negatively on rural electrification (Balla, 2003; Nyoike, 2004; Karekezi et al, 2003, EAA[10], 2002).

First, the de facto distribution monopoly enjoyed by KPLC limits the potential of increased rural electrification. By virtue of KPLC holding distribution licenses covering most of Kenya, if not the whole of it, this implies that no other entity can establish a rural mini-grid or decentralized system without express permission of KPLC. KPLC was only recently salvaged from near bankruptcy by the State (Karekezi et al, 2003). In effect, it is likely to take a while for the utility to upgrade its overloaded distribution system before embarking on expansion of its rural electrification program. Second, not only are the prescribed licensing procedures bureaucratic, cumbersome, centralized and expensive, they also fail to differentiate between small-scale (e.g., <1000kW) and large scale generation (EAA, 2002).

UNDP (2002) reports additional weaknesses in the EPA (1997) revealed by the implementation process of micro-hydro schemes in Kirinyaga and Meru, jointly done by MoE, Intermediate Technology Development Group (ITDG)[11] and local communities. The Act permits only one standard for electricity accessories which would be wasteful for minigrids. Moreover, the Act neither encourages competition in tariffs nor provides incentives to attract IPPs to rural areas. The good news is that remarkable progress is

[10] EAA has since changed to ESDA (Energy for Sustainable Energy Africa).
[11] ITDG has since changed to Practical Action.

being made in revising the Act. Drawing from the Kirinyaga and Meru experience and the recommendations from the Task Force on Rural Energy, the proposed Sessional Paper No.4 on Energy (2004) will, when passed by Parliament, dramatically transform the REP (GoK, 2004). First, a Rural Electrification Agency (REA) to mange REP will be established while DG minigrids, powered by a wide range of renewables and/or diesel, are permitted. Second, the need for electrifying productive uses such as irrigation and off-farm income generating activities is made more explicit. With respect to incentives for DG minigrids for rural electrification, a one-off financial subsidy will be provided to support communities or the private sector.

Despite the reported progress on the policy front, my key claim is that licensing barriers, among others, have discouraged investments in small-scale mini-grids in rural areas, hence contributed to slow rural electrification[12]. Thus, the question at this juncture is what policy implications for revising the EPA, particularly on licensing, can be drawn from the MEP's 'success' story? We turn to this question later in section 5.8.

3.4 Key findings and conclusions from the literature review

In terms of linkages between modern energy and micro-enterprises, the literature reviewed in the study highlight a number of important findings. First and foremost is that modern energy can, but does not necessarily, affect the emergence, development, productivity and efficiency of micro-enterprises. Secondly, while lack of modern energy is often characterized as a barrier to micro-enterprise development, removing this barrier (through, for example, energy development such as (rural) electrification) does not necessarily result in micro-enterprise development.

Modern energy should, therefore, be viewed as one of a suite of critical enabling factors that act individually and/or in concert to create a suitable environment in which micro-enterprises can operate. This suggests the importance of assessing the significance of modern energy in relation with the presence or absence of other enabling factors needed for micro-enterprise development. The importance of integrated infrastructure

[12] Licensing barriers to mini-grid is of course only part of much broader set of complex and interrelated power-sector reform processes underway in Kenya. Other notable factors include privatization, poor sequencing of reforms, misappropriation of rural electrification funds, political interference, low priority for the poor, etc (see Karekezi et al, 2003; Marundu and Kayo, 2004; Wamukoya, 2003; Nyoike, 2004; World Bank, 2000 and others for detailed discussion).

planning and development particularly in rural areas to achieve and sustain economic development is another recurring theme in the literature. Despite the creation of a REP nearly 4 decades ago, the rate of rural electrification (4%) in Kenya is dismal. Clearly, myriad factors (e.g., power-sector reforms, mismanagement, underfunding, corruption, etc), account for the slow rate; and licensing barriers to DG is but one of the important policy constraints. Before turning to policy lessons from MEP, a brief geographical and historical background of the study area is in order.

CHAPTER 4: BACKGROUND TO THE PROJECT

4.1 The Study area

Geographically, the Lake Kenyatta Settlement Scheme 1 at Mpeketoni is located west of Lamu Island in Lamu District, Coast Province of Kenya. Figure 1 shows a map of Lamu District, indicating Mpeketoni located in the southern part of the district. Mpeketoni is part of a resettlement program initiated in early 1970s in an area with high agricultural potential. Mpeketoni is the largest town and is surrounded by many smallholdings and villages. The physical land area is 14,224 ha with population of 28,000 in 1997 rising to over 31,000 by 2004. Ecologically, the area experiences bimodal rainfall at an average of 1000mm per annum with long rains from April to August and short rains from October to December[13]. January to March are the hottest and driest periods with temperatures reaching 32^{o} C. Vegetation is mainly cultivated farmlands with patches of bush and savannah grassland with red loams and sandy soils (Illy et al, 1997).

The area has low altitude of 4-17m above sea level and is generally flat with the highest point at Bomani Hill at 29 m above sea level. Other key physical features include a lake ($2km^2$) and sand dunes along the shores of the Indian Ocean. Administratively, the Scheme is located within Mpeketoni Division which is further sub-divided into 3 locations (Mpeketoni, Baharini and Mkunumbi) and six sub-locations –which are small manageable village blocks.

[13] Rainfall pattern in Kenya is bi-modal, i.e., two rainy seasons per year characterized as short and long-rains based on the amount of precipitation received.

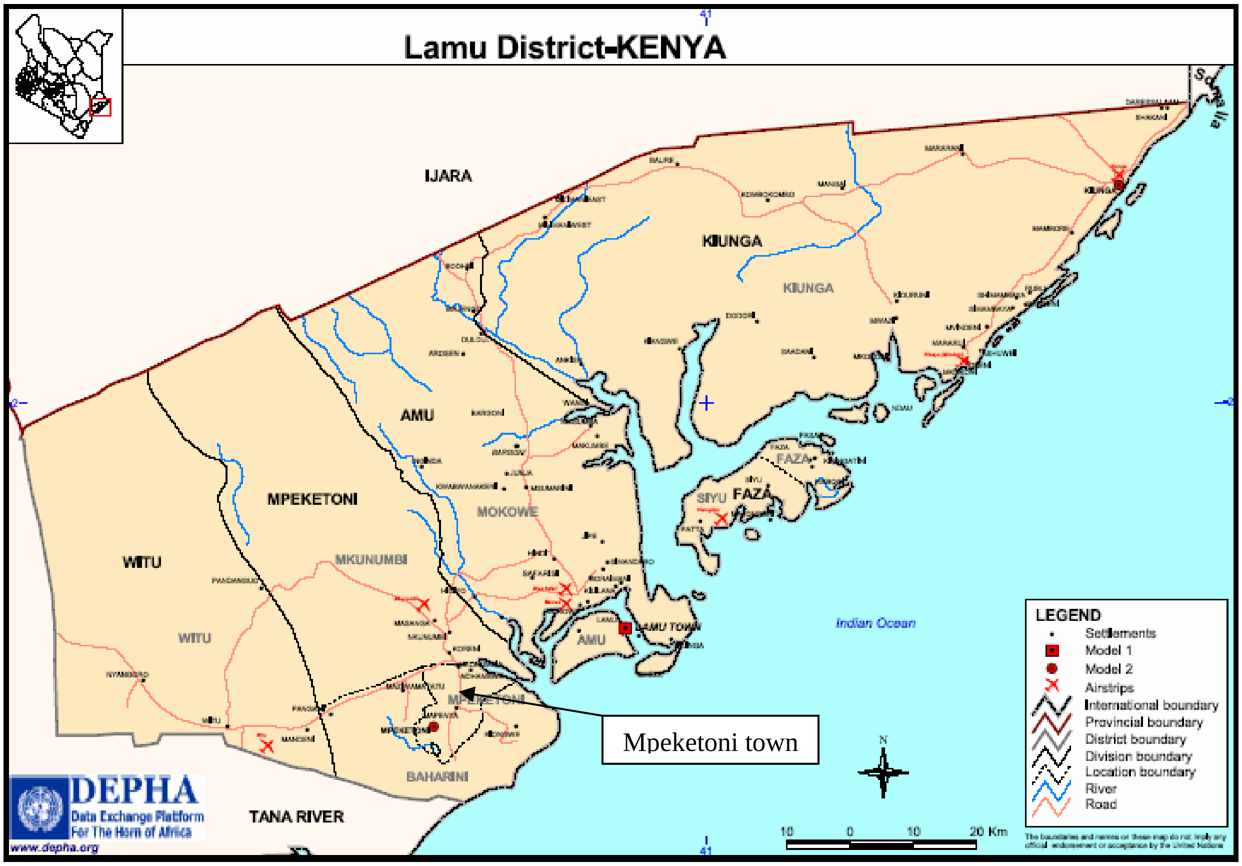

Figure 1: Map of Lamu District (source: Data Exchange Platform for the Horn of Africa (DEPHA), www.depha.org.)

4.2 Project history, current status and customer base

The idea of starting a community owned and operated electricity company at Mpeketoni Settlement Scheme was conceived in 1991 in partnership between the Mpeketoni Jua Kali Association and the German Assisted Settlement Project (GASP) via GTZ (German Technical Cooperation Agency). The initial capital cost (in constant 2005Ksh)[14] was Ksh2.7 million (US$36,000). GASP contributed Ksh1.8 million (US$24,000) and the Mpeketoni Jua Kali Association, in conjunction with other community members, raised Ksh0.9 million (US$12,000). The contribution by the community was mobilized as equity capital through selling of shares to individuals, who became the shareholders of MEP. The project was commissioned in 1994.

[14] Money values are in constant 2005 Ksh and Exchange rate: US$1 =Ksh75 (August 2005). I maintain this conversion throughout the paper, unless otherwise indicated.

MEP has a simple management structure. At the top are the shareholders who elect an executive committee of seven members. They have an accountant-cum-manager who is responsible for accounting and administrative issues. Reporting to the manager are two technicians, who operate and maintain the gensets, and one night security watchman. There is also an internal audit committee for strengthening financial oversight. Meter reading is done using hired casual labor while the accountant is responsible for processing monthly bills and collecting payments. MEP operates for 18hrs per day: 5am to 12am.

The present mini-grid operates using three Deutz-brand generating sets: 150kVA, 57kVA and 60kVA (Figure 2). A pre-feasibility study commissioned by Scottish Power (2005) established that the system is designed such that the 2 smaller gensets (57kVA and 60kVA) are manually synchronized and used as backup when the 150kVA fails. However, synchronization has been problematic and the load has continued to increase, with peak loads sometimes reaching 200kW[15]. Electricity is transmitted without transformers (at 415VAC-three phase and 240VAC-single phase), leading to power surges which can be destructive to electronic equipment.[16]. The study estimated the distribution system is 6km (3,152m of 75mm conductor and 15,882 of 50mm conductor). The main weaknesses identified with the system design include lack of service parts for the aging Deutz gensets, faulty power correction unit, use of different-sized transmission cables, poor earthing, voltage drops, leaning poles and sagging cables, automation of control systems and air and noise pollution (gensets are located near residential area). The study concludes "each of these items contributes to the poor performance of the system and increases the hazards to the operators and users of the electricity generated."

[15] This refers to frequent instantaneous sharp loads attributable to frequent turning on and off of electric motors particularly for milling and welding. Otherwise, average peaks are much lower at 50kW max (Figure 6).

[16] Fuses had been installed to in the system to prevent surges from destroying equipment but were later removed due to their frequent blow rate (sub-standard). Complaints of damaged equipment are common from customers (Scottish Power, 2005).

Figure 2. **MEP generators and transmission line at Mpeketoni village** (Photos: courtesy of ESDA)

Figure 3 below provides an overview of power generated, sold and the distributional losses by MEP from 1994 to 2003. There was a dramatic growth in generation and sales of over 300% between 1994 and 1995. A steep increase in price, coupled with severe capacity constraints, started to slow down new connections as early as 1997. Nonetheless, the average growth in both generation and sales remained high at nearly 50% per year. As shown in Figure 4, the cost of power has steadily increased by nearly 28% per year from Ksh11 (US$0.15)/kWh in 1994 to the current Ksh22.50 (US$0.3) per kWh, which is approximately 3 times the average national grid tariff of Ksh8 (US$0.11)/kWh (MoE, 2003)[17]. The increase, according to MEP, is primarily due

[17] The Ksh10/kWh tariff is exclusive of a cross-subsidy which Mpeketoni customers would enjoy if they were connected to the rural electrification program, meaning they are effectively paying much more that 3 times. On equity grounds, innovative ways should be found to extend the publicly-funded cross-subsidy to community owned mini-grids. One way would be to provide them with a one-off financial subsidy to enable them procure and install high-quality the systems as recommended by proposed Sessional No. 4 2004 on Energy (GoK, 2004). Another would be to waive and/or reduce import duties on spare parts. For instance, as part of scaling-up the generation capacity, the PS, MoE, has pledged to support MEP with two gensets (250kVA each) to replace the current old ones (MEP, ESDA officials, personal comm.).

to corresponding rise in cost of diesel from Ksh27 (US$0.36)/liter in 1994 to Ksh65 (US$0.87)/liter by early 2005 or 24% average price increase per year.

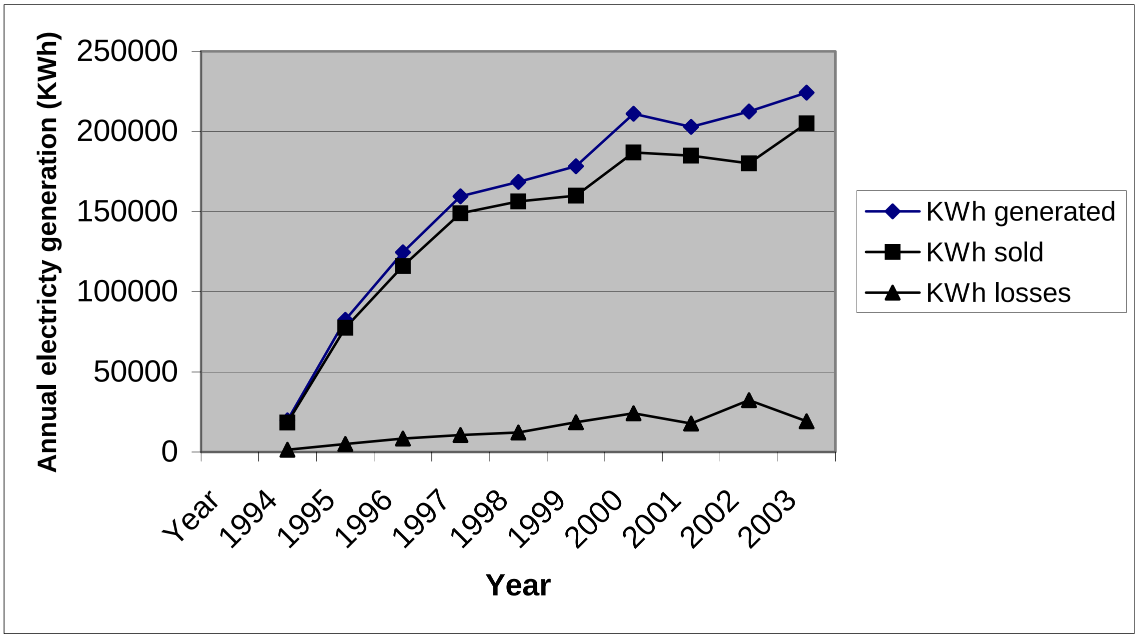

Figure 3. MEP annual electricity generation, sales and loses

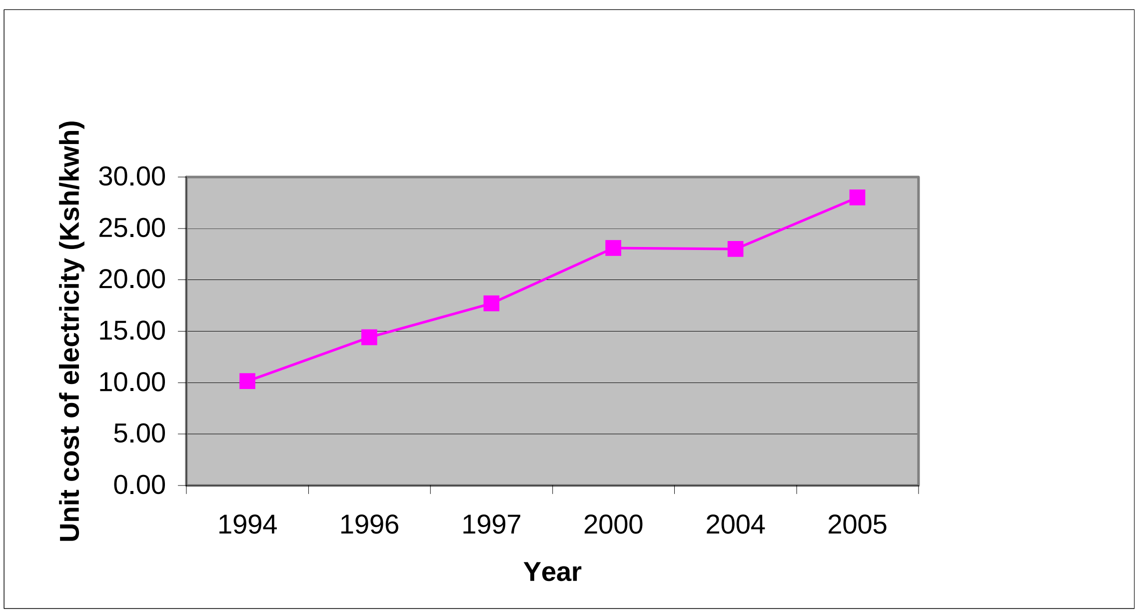

Figure 4: Trend in cost of electricity to MEP customers (cost adjusted to constant 2005 Ksh)

This high cost of electricity, the relatively high connection charges of Ksh10,500 (US$140) (at time of study), and the limited mini-grid capacity to serve more customers have reduced its ability to grow with hundreds of new connection applications pending at the MEP office. An important insight is that the Ksh10,500 connection fee is nearly the price of 20 months of power for the lowest level of users, mainly households[18]. MEP has two tariff rates divided into single-phase and three-phase. Single phase customers, representing over 90% of all connections, are levied a service charge of Ksh250 ($3.30) per month in addition to their consumption charges. Another important finding is that only 10% of MEP customers have three-phase connection, yet they provide the critical anchor loads. These customers are levied Ksh500 ($6.70) monthly service charge in addition to their consumption charges. MEP further imposes a fine of Ksh200 ($2.70) for any late payment.

MEP is literally the life-line of the local economy, with a very diverse customer base as summarized in Table 1 below. The data in Table 1 allows some important observations to be made. First, the use of power by most customers is limited to a relatively small time each day, ranging from 6 to 9 hours. This is perhaps a deliberate response to saving costs and/or just the nature of their business operations. Second, the top eleven single customers with consumption above 100kWh/month [ranging from the secondary school (2700kWh/month to post office (125kWh/month)] account for nearly 40% of the power produced, indicating that they provide strong anchor loads[19]. For instance, Mpeketoni Secondary School, the largest single customer (2700 kWh/month), consumes approximately 45% of total demand by all households (6060kWh/month). Third is the wide variation in consumption across the households, i.e., the average demand per household is approximately 143kWh/month, 60kWh/month and 24kWh/month for high-, medium-, and low-demand households respectively.

[18] For customers that use <100kWh per month (170 out of 240), Scottish Power (2005) recommends use of a single tariff and load limiters and do away with individual meters. This could reduce both the costs of meter reading and installation costs. At time of study, MEP used 2 casual laborers for meter reading at a cost of Ksh200/person/day for 2 days/month. This works to Ksh800/month or Ksh4 per customer (there are 224 customers in total). The customers with the lowest use levels pay an average of Ksh525/month. Eliminating meter reading would therefore have a negligible saving of < 1.0%. However, I did not establish how the Ksh10,500 connection fee is determined. Balla (2003) noted the used of single-tariff enhanced access to low income SMEs in the Tungu Kabiru (Mbuiru) community micro-hydro project.

[19] TSS ginnery has its own genset in addition to being connected to MEP. The genset supplies power for cotton processing and MEP power is used for lighting and other low loads (Scottish Power, 2005).

Table 1: Electricity demand summary at Mpeketoni

Customer type	Estimated no. of customers	Load (kW)	Total load (kW)	Hours /day	kWh/day	Estimated use (kWh/month)*
High-demand households (>89kWh/month)	23	0.6	13.8	8	110	3300
Mpeketoni Sec. School	1	10	10	9	90	2700
Retail shops	40	0.25	10	6	60	1800
Low-demand households (0-21kWh/month)	60	0.1	6	8	48	1440
Medium-demand households (22-88kWh/month)	22	0.25	5.5	8	44	1320
MEP posho mill	1	8	8	6	48	1200
TSS cotton ginnery	1	5	5	9	45	1125
Petrol stations/welding shops	6	1.2	7.2	6	43	1075
Bar, lodging, restaurant	4	1.2	4.32	6	26	780
Repair shops	24	0.2	4.8	6	29	725
Mpeketoni hospital	1	3.5	3.5	8	28	700
Posho mill 1	1	4	4	6	24	600
workshops (woodworks/carpentry)	2	1.8	3.6	6	22	550
Big hotel	1	1.5	1.5	9	14	420
Posho mill 2	4	4	4	4	16	400
Tea/coffee café	20	0.1	2	6	12	300
Mosque/church	3	0.6	1.8	6	11	270
Big garage	1	1.3	1.3	8	10	250
Catholic church	1	1.5	1.5	6	9	225
Telekom	1	1	1	8	8	200
Non governmental organisations	2	0.5	1	6	6	150
Mpeketoni Youth polytechnic	1	0.8	0.8	6	5	125
Post office	1	0.8	0.8	6	5	125
Police station	1	0.5	0.5	6	3	90
Bank (Kenya commercial Bank Ltd)	1	0.5	0.5	6	3	75
District Officer office	1	0.5	0.5	6	3	75
Total	**224**	**50**	**103**	**175**	**722**	**20,020**

*A month is assumed to be 25 days for public offices which normally don't work over weekends (such as post office, DO's office), and 30 days for SMEs.
Source: data adopted from Scottish Power (2005).

MEP customers can be further ranked by monthly consumption as shown in Figure 5[20]. One striking observation is that the three grain mills in town consume slightly less (2200kWh/month) than the demand by both the 60 low-, and 22-medium-demand households combined (2760kWh/month). Results in Table 1 and Figure 5 are consistent with an important point made earlier in the literature that SMEs have higher intensity of energy use than households (see Karekezi and Kithyoma, 2002; Mapako and Mbewe, 2004, TERI, 2003). The data further amplifies the important benefits of going "beyond the light bulb" by targeting SMEs which provide better anchor loads, thus improving the techno-commercial viability of rural electrification – either via grid or off-grid.

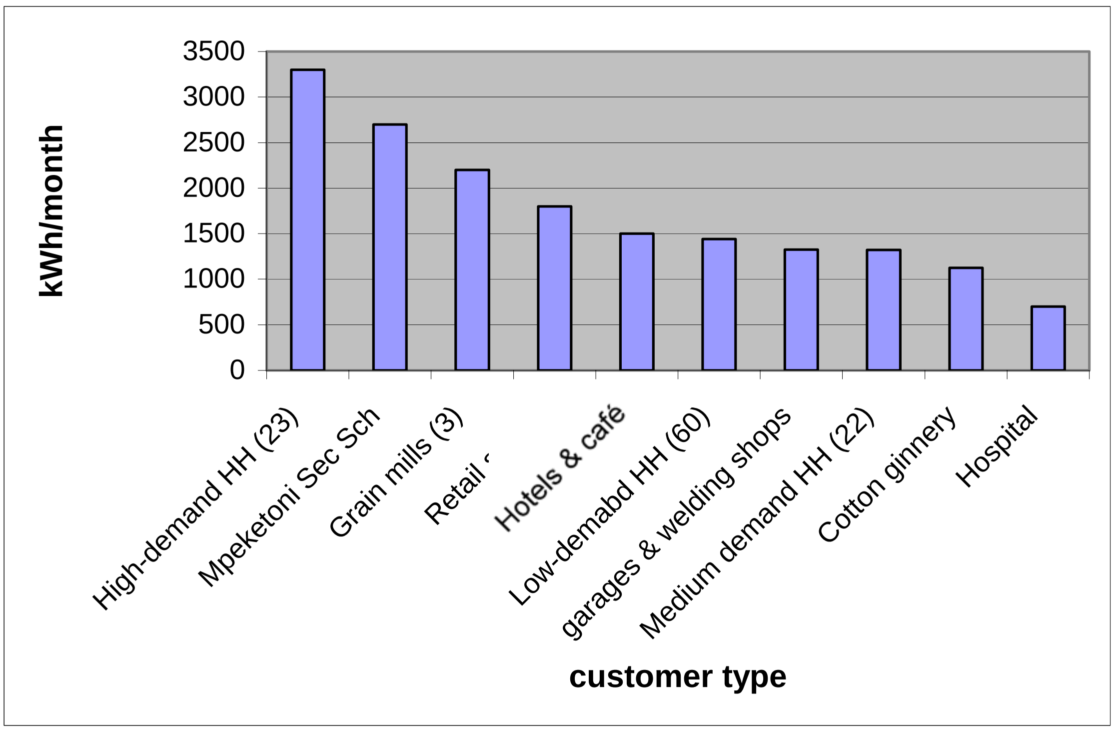

Figure 5: Electricity enduses by customer type

The distribution of load in Figure 5 has serious implications on both administration and unit costs of service delivery because each customer, irrespective of load, is connected to a meter. This being a community owned and run project, it is much more convenient and cost effective to encourage and/or enforce end-use efficiency

[20] Data extracted from: Scottish Power, "Prefessibility Study: Mpeketoni wind project Kenya, 4th April, 2005

measures in a few heavy consumers such as Mpeketoni Secondary, grain mills or TSS cotton ginnery than dealing with hundreds of low-load households scattered in town. Multiple peak loads are experienced throughout the day but the critical peak occurs between 5pm-9pm (Figure 6). This can mainly be explained by the typical trend of customers, particularly the school, turning on their lights and other devices in the evenings.

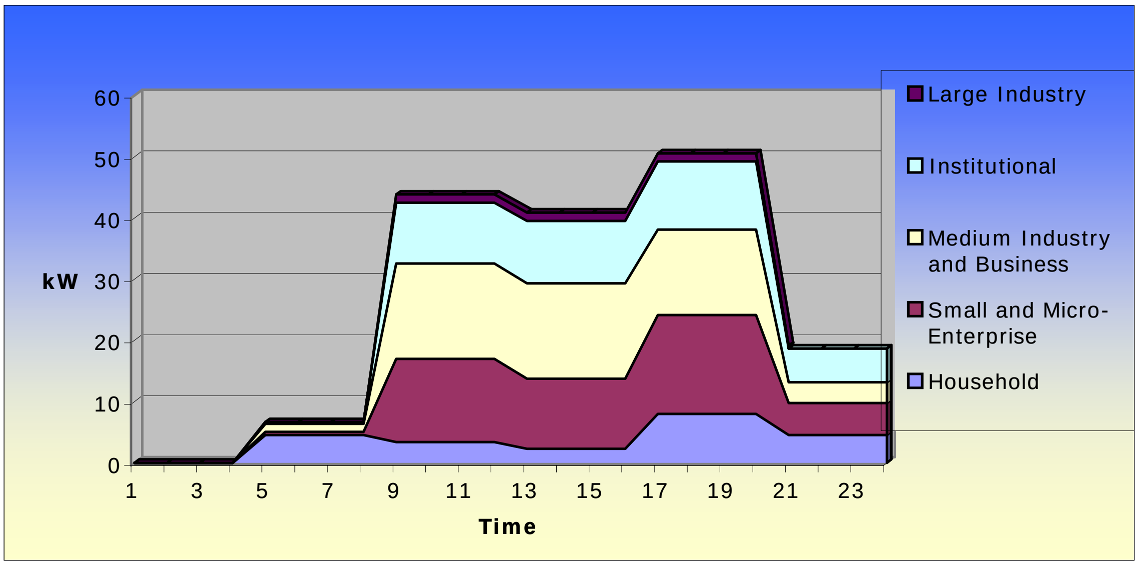

Figure 6: MEP daily load profile
Source: Scottish Power (2005).

Also, grain mills reported brisk business after 5pm because parents tend to send their children to the mills after school's hours. MEP has for instance attempted to work out a negotiated operating schedule as a pragmatic way of re-distributing the peak loads, hence improving quality of service to as many customers as possible, especially in the evenings. One possibility is to discontinue milling past 6pm and advice customers to deliver their grains much earlier in the day. The mill operators have accepted the idea but implementation has not been without hitches. As expected, it will take a while before all their customers make this "cultural" change of not expecting milling services in the evenings.

In spite of high tariffs, MEP boasts over 90% timely repayment rate. However, the inability to make new connections and meet the high and growing demand for power results in substantial opportunity cost in lost revenues; a crisis that threatens MEP's sustainability. Hence the motivation to appeal for assistance from the Government, via the Ministry of Energy, to enable MEP to expand the system, supply new customers while improving the quality and reliability of power supply. Having discussed the historical and current status of MEP, I now turn to my key question of this study: how important is modern energy for stimulating growth of micro-enterprises and rural development?

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Impact of electricity on micro-enterprises

An attempt was made to investigate both the qualitative and quantitative impact of electricity on the production of various micro-enterprises at Mpeketoni. Observations were made and questions were asked to elicit data on production of both carpentry and tailoring businesses during the “with” and “without” electricity scenarios. Using this criterion, twelve carpentry artisans and five tailors were selected to provide a comparative assessment of the impact of electricity on the productivity of micro-enterprises. Three production efficiency indicators, namely increased productivity per worker, price reduction per unit and increase in gross revenue per day were used to estimated the impact of electricity on micro-enterprises (Tables 2 and 3).

I found that introduction of modern technology in form of machinery and tools provided the most dramatic and significant beneficial impact of electricity on micro-enterprises studied at Mpeketoni. The productivity per worker increased, both in the quantity and quality of products made, leading to increase in volume of sales, hence higher gross revenues per day. Taking a typical carpentry workshop (Table 2), productivity per artisan increased by a simple average of 243% while increase in gross revenues ranged from 30% to 480% with an average of 213% per day.

Table 2: Effect of electricity on productivity in carpentry workshops at Mpeketoni

	Production with electricity (n=12)		Production without electricity (n=12)		Efficiency indicators		
Typical carpentry product	**Average production time per unit per artisan**	**Average unit price (Ksh)**	**Average production time per unit per artisan**	**Average[21] unit price (Ksh)**	**Increase in productivity per artisan**	**Price reduction per unit**	**Increase in gross revenue per day**
Stool	2 hrs	300	6 hrs	400	300%	25%	167%
Bed (6x4 feet)	1 day	4000	2 days	4500	200%	11%	311%
Sofa set	2 days	7000	5 days	9000	250%	22%	151%
Door (6x3 feet)	1 day	2000	2.5 days	3500	250%	43%	137%
Window (3 x 3 feet)	0.5 day	2000	1 day	2500	200%	20%	480%
Coffee table	1 day	1500	3 days	2500	300%	40%	213%
Wardrobe	6 days	13000	12 days	18000	200%	28%	30%
Wall-unit	12 days	20000	N/A	N/A	N/A	N/A	N/A
Average % change					**243%**	**27%**	**213%**

Exchange rate: US$1 = Ksh75 (August 2005)

N/A = carpenters indicated that it was "not possible" to make wall-units without electricity because electric machines are necessary to form the "complex" designs demanded by upmarket customers.

Table 3: Effect of electricity on productivity in tailoring shops at Mpeketoni

	Production with electricity (n=5)		Production without electricity (n=5)		Efficiency indicators		
Typical tailoring product	**Average production per tailor per day**	**Average unit price (Ksh)**	**Average production per tailor/day**	**Average price per unit (Ksh)**	**Increased productivity per tailor**	**Price reduction per unit**	**Increase in gross revenue per day**
Men pair of trousers	8 pieces	500	3 pieces	600	270%	17%	367%
Men suit	1.5 piece	1700	1 piece	2000	150%	15%	28%
Women dress	6 pieces	200	4 pieces	250	150%	20%	80%
School uniform	10 pieces	150	4 pieces	200	250%	25%	350%
Average % change					**205%**	**19%**	**206%**

[21] This reflects the current price of a product made without electricity. It turns out that micro-enterprises still make and sell products without electricity owing to frequent and often pro-longed blackouts. This permits direct comparison of data for the 3 selected indicators (see methods section 2.1)

Of note also was the average 27% reduction in prices per unit despite the reported superior quality of products made using electricity vis-à-vis those made without. It turns out that workers are paid on piece wage and because electricity enabled them to make more products per day than they could previously, it was more profitable to lower prices, leading to higher and faster sales.

Another added advantage was the ability to make more sophisticated and custom-made products targeting the upmarket clientele such as salaried employees like teachers, bankers, and other civil servants working in the area. A wall-unit, a custom-made and high-cost (US$250 per unit) piece of furniture used to store a wide variety of household items such as cutlery, utensils, TV and video, etc., is a good example of upmarket products that could not be made without electricity (Table 2). Thus lack of power deprives micro-enterprises of additional income by limiting the quantity, quality and variety of products that artisans can make. Moreover, making of superior quality products at competitive prices has enabled the micro-enterprises to access more lucrative external markets in Lamu town and Mombasa City.

A similar pattern is observed for the tailoring shops (Table 3) where average increase in productivity per worker was in the same order of magnitude (205%), prices dropped by about 19% while increases in gross revenues ranged from 28% to 367%, with an average of 206% per day. The impact of access to power can further be appreciated when one considers the time and effort required to iron a piece of clothing. It takes 30 minutes to iron a typical men's coat using an electric iron-box but 1.5 hours to do the same job with a charcoal iron-box, exclusive of the extra time and effort taken to prepare and light the latter. Put differently, the 1.5 hours taken to do a coat with a charcoal iron-box is enough to make one pair of men's trousers using an electric machine. In other words, for every 3 coats ironed using charcoal, the tailor forgoes 2 pairs of trousers he would have made with power. At a unit price of Ksh500 (US$6.7) per pair of trousers, this, translates to an opportunity cost of Ksh1,000 (US$13). Other advantages include more convenience and superior quality associated with an electric iron-box vis-à-vis a charcoal one.

5.2 Impact of electricity on agriculture and agro-processing activities

Interviews with over fifteen farmers helped to probe and document their distinct experiences "before" and "after" electricity was installed. Their views were corroborated and tri-angulated by additional interviews with a set of three key informants who played central, albeit different, roles in setting up and coordinating the Settlement Scheme: (i) the first District Agricultural Officer (DAO); (ii) the first Government Administrative Chief and his Assistant; (iii) a cross-section of professional employees[22] attached to GTZ/GASP. At the start of the Settlement scheme in 1972, each family was allocated 20 acres of land and, without the advantage of tractors, the early settlers relied exclusively on human labor using the traditional hand tools of axe, hoe and panga (machete). There is unanimous recollection that reliance on manual labor to clear and convert a 20-acre bushland (Figure 7) into a farm was an uphill, if not impossible, task. Recalls the DAO:

> "*Farmers complained the land was overwhelming and we reduced it to 10 acres per family. We encouraged them to work co-operatively and first clear only a small portion to cater for their subsistence. Nearly 50% of the early settlers abandoned their farms and returned to where they had come from. One farmer from Kisumu sold his 10-acre farm for Ksh100 – barely enough for fare back home*[23]!"

The first two tractors appeared in 1988 and, despite a low cost of diesel at Ksh80 (US$1.10) per liter, they were rented out to farmers at high cost of Ksh2,300-4,000 (US$31-53) per acre (in constant 2005Ksh). Moreover, due to the limited number of tractors, farmers had to wait for weeks or months before their land could be cultivated. Such inordinate delays made it extremely difficult for farmers to plan, plant and harvest on time resulting in huge losses taking into account that farming at Mpeketoni is 100% rain-fed. "I was compelled to buy my own tractor when by the time I found a tractor for hire, the season was over and rains stopped. I lost that season completely," recalls one farmer who is also a founding member of MEP.

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[22] Include teachers, surveyors, planners, etc. All the interviewees, though originally from different parts of Kenya, have purchased land and settled at Mpeketoni for periods ranging from 12 to 30 yrs.

[23] Quotations are paraphrased translations from unrecorded interviews conducted in *Swahili* or Kikuyu. A ten-acre farm at that time (early 1970s) was valued at approximately Ksh5000 (Okoth, Lands Officer, Mpeketoni, personal comm.). This claim obviously discounts other dynamics that might have led to this drastic action, but taking into account the regularity with which similar frustrations were (independently) expressed, I found it useful and credible in highlighting the farmers experiences. (Nb: In constant 2005 Ksh, Ksh100 (1974) = Ksh4,000 and Ksh500 (1974) = Ksh21,000.

Within a few months after MEP was commissioned in 1994, there were over ten tractors at Mpeketoni. But what has electricity got do with diesel-powered tractors? It turns out that electricity made it possible to start garages for repair and maintenance of tractors while previously simple repair and welding jobs could only be done in Mombasa, 450 km away. Therefore, the availability of garages with electricity for maintenance was an important complimentary infrastructure that has dramatically boosted agricultural production in this area.

Figure7: Typical farm today with harvested simsim and mango trees (inset – bush that early settlers had to clear before they could start farming).(Photo: courtesy of ESDA).

More importantly to the farmers, the tractors are available on demand without the previous constraints of advance booking and/or queuing for service. The multiplier effects of improved farm production combined with local agro-processing has transformed the fortunes of local farmers, catalyzed trading, and boosted the generation of non-farm income in this small remote town. Major cash crops grown include cashew nuts, cotton, maize, bananas, bixa and simsim (Figure 8).

Figure 8: Variety of cash crops grown and marketed at Mpeketoni {(a) Cashew nuts drying (inset- raw nuts on a tree); (b) Cotton before processing at ginnery (right) (inset – recently harvested cotton); (c) Bixa middleman with bixa seeds (inset –bixa seeds ready for harvesting); (d) Banana farmer next to a generator pump and well (inset-banana plantation)} (Photos: courtesy of ESDA)

Access to electricity has boosted agriculture in other ways, too. The ability to process the maize in the local mills gives them competitive advantage when selling to the external markets at prices far better than they would previously fetch without milling. For example, for every 10kg of maize, one gets 2kg of chaff as a by-product of milling. The chaff, a valuable animal feed particularly for cows and poultry, retails at Ksh10/kg (US$0.13/kg). This is an extra stream of revenue available to farmers which would not have been possible without mechanical milling, whether provided by electricity or diesel-powered gensets[24].

Storage of perishable farm produce was a constant headache for local farmers and traders. Without electricity, perishable produce such as milk and meat were the least valuable products and farmers could only hope to get throw-away prices or literally throw them away when spoilt due to lack of cold storage.With electricity and availability of cold storage, the farm-gate price dramatically increased by 400% from Ksh10 to Ksh40 per liter within a couple of years. Also, the market for meat increased with numerous butcheries opening up, mainly due to availability of refrigeration. It is not surprising that animal production for both milk and meat are key sources of income for local farmers. The findings at Mpeketoni demonstrate the powerful synergy between access to both electricity and markets in stimulating agricultural-related SMEs.

5.3 Impact of electricity on education services

Availability of quality education is a crucial factor in determining not only the economic well-being of a country but also the general welfare of a society. This is even more critical in a remote rural village like Mpeketoni whose children have to compete for placement in universities, colleges and jobs with their counterparts in the urban and more resource-endowed areas of Kenya. Conscious of this fact, parents demanded that from the outset, Mpeketoni Secondary School be given the first priority to electricity in 1994. Figure 9 shows the trend in academic performance in Kenya Certificate of Secondary Education (KCSE) national exams for 15 years from 1989 to 2004. Aware that improved performance in a typical school is influenced by many factors, besides connection to

[24] A related observation by Pandey (2004) in Nepal claims that, for crops like mustard seed, mechanical milling increases yields by >30% of the of much valued cooking oil over the traditional wooden *kol*.

electricity, I asked the Deputy Principal to account for the positive correlation between access to power and improved performance as can be inferred from Figure 9[25]. The Deputy Principal, who has been at the school since 1991, recounts:

> "*Before we got power, water was an even bigger problem. We had no piped water and students would spend 2-3 hours daily in the evenings hauling water with ropes and buckets from deep boreholes while others walked far way in search of water. Hygiene was very poor and students, particularly girls, were reluctant to take part in sports because showering was a nightmare.*"

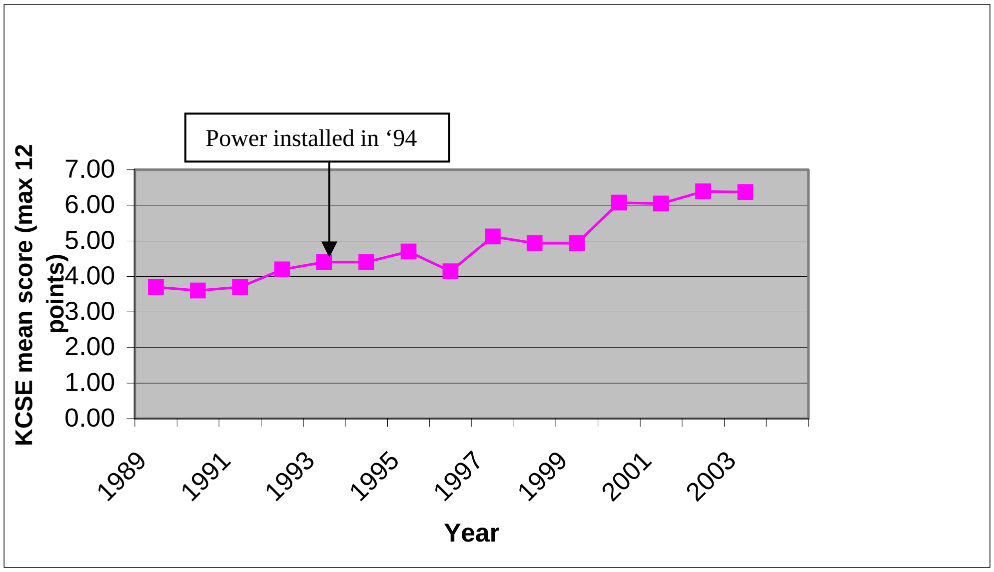

Figure 9: Trend in academic performance at Mpeketoni Secondary School
(Source: Mpeketoni Secondary school, 2005).

He adds that toilets would never be cleaned due to lack of water while water borne diseases especially skin infections, typhoid and cholera were particularly common due to poor hygiene, resulting in rampant absenteeism from school by both students and teachers. What difference did power make? He continues:

> "*Obviously our first priority when we got power was water pumping and lighting. The 2-3 hours previously dedicated to gathering water are now dedicated to evening study, with better lighting and huge cost savings in*

[25] Other factors might be hiring of more and better trained teachers, improved access to library resources, improved students' discipline, etc. Indeed, the Deputy Principal acknowledged that access to power both at the school and in the village had partly contributed to higher retention rate of more trained teachers since they could enjoy better social amenities such as lighting, TV, ironing, etc., like their peers in other urban areas.

> *kerosene bills when we switched from hurricane lamps to electricity*[26]. *Previously common water borne diseases have been eradicated.*"

According to the Deputy Principal, notable academic improvements have been in science subjects because of electrified laboratories. More importantly, Mpeketoni is one of the very few schools in Kenya offering computer courses to students. Having their own computers and photocopying machines has dramatically improved the efficiency of processing information, particularly exams, at the school. This would not have been possible without electricity[27].

Another way of assessing improved academic performance at the School is to track the number of students it sends to universities. Within the Kenyan education system, the number of students a typical secondary school is able to send to the highly competitive public universities is a highly valued metric of academic performance. For Mpeketoni Secondary, the number of students admitted to public universities doubled from 2 per year between 1991 to 1993 to an average of 4 per year between 1994 to 2005, in addition to other admissions in diploma colleges[28]. School enrolment has also gone up by 60% from 300 to 480 students in addition to much higher retention and completion rates particularly for girls. One can therefore make a (*prima facie*) plausible connection between access to electricity and improved academic performance at the School. Further research is, however, needed to provide a more nuanced understanding of all the different dynamics influencing the noted improved performance.

Further evidence of the direct impact of electricity can be observed at Mpeketoni Polytechnic. Without electricity, the Polytechnic could only offer very limited technical trades in carpentry but now they offer a wide variety of courses including engineering and metal works. The polytechnic is a critical source of practical know-how and skills for

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[26] Pandey (1997) has also noted that switching from kerosene to electric lighting (partly) contributed to improved academic performance in the rural-micro-hydro-powered-villages of Nepal.

[27] The school has purchased some computers whiles others have been donated by various organizations. It is common to find donors and NGOs donating computers to schools in Kenya. For instance, an NGO known as Computer Schools for Kenya, based at Starehe Boys Center, Nairobi is at the forefront of this initiative. But for a school to be eligible for this computer project, it must have access to power.

[28] Lack of data prior to 1991 did not permit a longer-time comparison for the "without-electricity" scenario. Moreover, the education system changed from 7-4-2-3 to 8-4-4 in 1989 (reflecting the number of years spent at primary, secondary, high-school and university, respectively. In the previous system, after secondary school, students joined high-school while in the current system, they join university), thus further limiting direct historical comparisons of academic performance between the "with" and "with-out" electricity scenarios.

hundreds of youth who find employment in local SMEs. Results of this survey show that over 70% of the youth employed and/or self-employed at the Mpeketoni Juakali (open-air informal) sheds reportedly acquired their training at the Polytechnic.

Another relevant observation made was that failure to connect electricity to local primary schools has had its drawbacks too as explained by the Assistant Education Officer (AEO) and other teachers. Lack of electricity has made it impossible for the schools to use mass media for supplementary teaching purposes. Despite glaring inequalities in access to learning resources (*Daily Nation*, Jan, 2006), schools in Kenya take standardized national exams. The examination system, as currently designed, is therefore, heavily biased against children from rural and remote areas such as Mpeketoni as noted by teachers and AEO:

> *"In national examinations, students get tested about what is assumed to be 'common knowledge' by examiners living in cities like Nairobi. For instance, last year (2004) there was a question on the colors and the workings of traffic lights. How can this be common knowledge in places like Lamu without roads, let alone vehicles? We find TV as the only medium for exposing our students to such ideas."*

To address this issue, Ngoi Primary, a remote school with 153 pupils in Mpeketoni, has committed a Ksh100,000 ($1300) grant from the Constituency Development Fund (CDF)[29] for the installation of solar electricity to enable it enrich learning by using mass media as teaching aids with effect from 2005[30]. In addition, severe shortage of teachers in rural and remote locations like Lamu is a perennial problem. The AEO is optimistic that availability of power would enable teachers to provide extra teaching in early mornings (6-7am) and late evenings (6-9pm) to make up for material not adequately covered during normal teaching hours due to lack of teachers.

[29] CDF is a grant from the Kenya Government allocated annually to every constituency represented in Parliament to meet local demand-driven development projects. It started in 2003 and was created by an Act of Parliament.

[30] The views of Lamu AEO, combined by the high investment in PV at Ngoi Primary, contradicts Nakhooda (2003) who claimed that "electricity makes little impact" on primary education in Kenya and Uganda (p.87). This is probably because the author restricted her investigation to lighting needs only, thus missing the use of electricity for powering electronic teaching aids.

5.4 Impact of electricity on banking and communication services

The growth and vibrancy of the local trade and commerce at Mpeketoni is reflected by the presence of a Kenya Commercial Bank branch, Postal Office and an up-coming Teachers savings and credit organization. These commercial facilities are not only connected to electricity, but were found to use electronic equipment such as computers, printers, photocopiers, etc. This further demonstrates the vital role that MEP is playing in creating an enabling environment for better business service delivery, particularly in a rural setting. Internet services are easily available at the local postal office at a competitive price of Ksh1(US$0.013)/minute, which is comparable to big cities like Nairobi and Mombasa (Kirubi, personal observation, July 2005). It is remarkable that MEP officials are able to shop for and purchase spare parts for the generators on-line from Europe and South Africa. This indicates the difference availability of power can make in communication and transaction costs as well as enabling remote villages enjoy and access opportunities that were unthinkable a few years back.

The Celtel mobile company has installed a base station locally using their own diesel generator, while MEP has turned down an application for power from Safaricom Ltd (a competing mobile phone company that is keen to enter the market) due to power generation capacity constraints. This is one of the many applications for power from corporate and major private investors that MEP is turning down daily due to limited power supply. It is apparent that MEP and Mpeketoni town have come of age – they are getting noticed and attracting investors. However, with lack of resources to expand and grow, MEP is becoming a classic victim of its own success. These capacity constraints are severely inhibiting the phenomenal potential for wealth and income generation for the local community.

5.5 Impact of electricity on women

Women deserve special mention not only because they constitute the bigger population at Mpeketoni but also because they bear a disproportionate burden of household chores, particularly in Africa. Thus, other factors being equal, an intervention that contributes to a reduction in women’s physical burden and frees time for more productive tasks is welcome. For example, without electricity, it took half a day to grind 10 Kg of maize using hand and big sticks, enough to feed a typical family of 5 for 4 days in this village where ground maize (*muthokoi*) is a significant part of the staple diet. Besides the poor quality of hand-ground maize, this is a women-only job according to culture and 6 hours spent on this chore represents an opportunity cost of Ksh150 (US$2)- the alternative income a woman could earn if she sold her labor elsewhere. Moreover, hand-grinding, unlike mechanical milling, does not yield the valuable animal feed. The lack of electricity had other drawbacks too as recounted by one woman who has lived here since the early 70s and is now a committee member of MEP:

> *"Before electricity, we looked bad and poorly groomed because there were no hair salons. The nearest was in Mombasa 450 km away. Delivery was the biggest risk for women since maternity services at the local clinic could only be offered using kerosene lamps and dry-cell flash lights."*[31].

With electricity, over 20 hair salons emerged each employing about 5 girls – creating approximately 100 jobs for women. Tailoring and dress-making shops are other sources of non-farm income for women. With electricity, both their quantity and quality have dramatically improved, enabling them to sell not only locally but also in Lamu and Mombasa where they fetch bigger and more lucrative tourist markets.

Cecelski (2000) has noted that cooking is women's most important energy need in terms of time and effort. However, electricity at Mpeketoni is too costly to be used for cooking not only by households but also by hotels. Nonetheless, women still valued electricity in their households for other purposes: "even if power is too costly to cook with at home, we are able to watch TV, charge our mobile phones and stay connected!" In addition, several self-help women groups have put up rental houses in town which are connected to electricity where they generate more rents than would be possible without electricity.

[31] Quotations are paraphrased translations from unrecorded interviews conducted in *Swahili* or Kikuyu. A nurse I interviewed at the village corroborates this observation on the high risk and inconvenience of maternity services without electricity. It was further established that the local health center, like the secondary school, enjoys first priority to power unless there is total breakdown at MEP.

5.6 The interactive effect between access to electricity, markets and other infrastructure vis-à-vis microenterprise development at Mpeketoni

I have so far explored what difference access to electricity made by way of stimulating agriculture and SMEs at Mpeketoni, holding other factors equal. The assumption in the foregoing analysis is that electricity was "sufficient" in and of itself in making the noted difference. According to the literature, however, electricity cannot take all the credit; its access is a necessary but not sufficient condition for supporting SMEs. To explore this claim, I turn to the second hypothesis: "*an interactive effect exist between access to electricity, markets and other infrastructure which is essential for microenterprise development*." In testing this hypothesis at Mpeketoni, I will use three metrics for which data is available: (i) markets for agricultural produce; (ii) roads; and (iii) facilities for social amenities (schools, polytechnic, and communication services).

My study finds that a powerful synergy and interactive effect exist between access to electricity, markets and roads to facilitate the desired growth of SMEs in rural areas of Kenya. Another key component appears to be a strong local economy. That is, access to agricultural markets means that local artisans can sell their goods to local farmers who have money to buy. In practical terms, access to electrification is only one piece of the complex puzzle of achieving rural development. This conclusion is consistent with other findings reviewed in the literature (see Wamukonya and Davis, 2001; Barnes, 1988).

Starting with agriculture, cotton is considered the highest income earner for Mpeketoni. But due to low prices, many farmers interviewed indicated they had stopped and/or reduced planting cotton in favor of other crops such as cashew nuts, maize, bixa, bananas, mangoes, oranges, water melon, etc (see Figure 8). The feasibility report by Scottish Power (2005) indicated a dramatic 300% drop (i.e., from 3000 to 1000 tons/year) in cotton production between 1998 and 2004. The same report adds that cashew nuts are the second highest income earner, with Mpeketoni the lead producer in Coast Province at approximately 2000 tons/year. The estimated potential for cashew nut production at Mpeketoni is 7000 tons/year, with a market value of Ksh350 million (US$4.5million). What's more, about four to six cashew nut companies (some all the way from India) send representatives to Mpeketoni for up to eight months to purchase nuts from farmers. Maize, bananas and vegetables find ready market in the Lamu Island (65 km away) and

Mombasa City (450km away). A conservative figure of income from agriculture alone is Ksh220 million (US$2.8 million) per year.

Another major advantage with Mpeketoni is the combination of favorable weather and availability of big farm sizes (10-15 acres/farm) which enables farmers to grow a wide variety of cash crops. For instance, interviews with 56 farmers conducted by the ESDA team revealed 70% of them grew more than one crop (Table 4). Such diversification not only boosts farmers' income but more importantly acts as a vital hedge against multiple risks and vulnerabilities that they face – ranging from vagaries of weather to price fluctuations as previously noted with cotton.

Table 4: Variety of crops grown and income earned by farmers at Mpeketoni

Crop	% of farmers growing the crop[32] (n =56)	Average income/acre /year (Ksh)	Average income/acre /year (US$)
Bixa	2%	-	
Cotton	45%	5,602	73
Maize	91%	6,469	84
Mangoes	7%	6,000	78
Cashew nuts	14%	11,285	147
Simsim	14%	4,285	56

Source: Data from Scottish Power (2005) Annexes.

The road infrastructure is one of the major "footprint" of the GTZ/GASP project at Mpeketoni. To improve accessibility and mobility, GTZ/GASP cleared the bushland (see Figure 7) by constructing three categories of roads between 1999 and 2004 (Apindi and Onyango, 2004). These three categories include cutlines, field roads, and gravel roads. Cutlines are 2 m wide paths cleared by bulldozer in the thick bush to facilitate the demarcation of the settlement scheme and the movement of settlers into their plots. They also serve as fire breaks, thus protecting the farms from fire hazards from the adjacent pockets of natural forests. Field roads are 10 m wide roads that are bush cleared, shaped and compacted. They have road reserves of 20 m for the development of other services like water, telephone and electricity. Gravel roads are field roads that have been graveled with 15cm thick compacted gravel. Table 5 is an overview of categories of roads

[32] The sum total for this column >100 because 70% of farmers reported growing more than one crop.

constructed by GTZ/GASP in both Mpeketoni (as known as Lake Kenyatta 1) and another settlement scheme (Witu 1), also in Lamu District.

Table 5: Roads constructed in settlement schemes by GTZ/GASP

Settlement scheme	Cuttline (Km)	Field road (Km)	Gravel road (Km)	Total road network (Km)
Mpeketoni (Lake Kenyatta 1)	9	200	66.4	275.4
Witu 1	146	132	11	289

Source: Apindi and Onyango, 2004

It is useful to point out that both Mpeketoni and Witu 1 roughly share some important characteristics[33]. First, both are settlement schemes, with comparable road networks supported by the same organization between 1999 and 2004[34]. Second, both schemes have access to electricity – although Witu 1 has an added advantage of being connected to cheaper and more reliable electricity from the national grid. Another advantage for Witu 1 over Mpeketoni is that the township is situated along the busy Lamu –Mombasa highway and it is much closer to two big markets at Mombasa and Malindi towns.

On the bases of the above advantages, one would therefore expect Witu 1 to have a comparable, if not more robust, internal economy like Mpeketoni; characterized by a multiplicity of SMEs that provide products and services to local residents. But that is not the case. The key limiting factor, according to both Nyange and Onyango and other informants, is the low level of agricultural productivity and diversity which have severely stifled market dynamics. It turns out that despite better location on a busy highway and access to cheaper and more reliable electricity, Witu1 cannot support similar levels of agricultural and SMEs productivity and diversity like Mpeketoni does because it is much

[33] I did not visit Witu 1, and my discussion here is based on interviews with Mr. Nyange (first District Agricultural Officer in charge of starting the settlement schemes) and Mr. Patrick Onyango who heads a Capacity Building Project to support local groups and entrepreneurs in both schemes.

[34] However, there is notable difference in distribution of road categories. The report is silent on the criteria used to determine the distribution and what implications this might have for agricultural productivity. More research is needed to clarify this.

more arid[35]. The fact that a more accessible location and access to cheaper and more reliable electricity cannot compensate the absence of vibrant agricultural-based markets at Witu 1 is very instructive.

This finding makes a strong case that a powerful synergy and interactive effect exist between access to electricity, markets and roads to facilitate the desired growth of SMEs in rural areas of Kenya. The vibrancy of the local economy is another important driving factor. That is, access to agricultural markets means that local artisans can sell their goods to local farmers who have money to buy. Other factors equal, the absence of (agricultural) markets at Witu 1 seem to render the presence of both better road accessibility and cheaper electricity "less effective" in promoting the start-up and growth of SMEs.

The Mpeketoni case study further demonstrates that facilities for social amenities (e.g., schools, polytechnic, hospital), have a win-win interactive effect with access to electricity in a variety of ways. First and foremost, Mpeketoni Secondary School provides both the largest market for power as well as essential anchor loads. Second, without electricity, the Polytechnic could only offer very limited technical trades in carpentry but now they offer a wide variety of courses including engineering and metal works. This has simultaneously increased both the demand for power and enrolment for vocational training[36]. It is therefore fair to conclude that the Polytechnic has provided the seedbed for imparting vocational skills into the local youth, and access to electricity has added enormous value to the training process. The skills were reportedly essential for doing well in the SMEs sector, in addition to helping create employment for the local population.

Expenditure on information communication services (e.g., telephone) can be an effective proxy for estimating the size and vibrancy of a local market. To estimate this for Mpeketoni, sales of cell phone air time spanning 10 months were collected from three out of many airtime shops in town. Results show that the size of local cell phone market

[35] A further supportive piece of anecdotal evidence is that, while driving on the Mombasa-Lamu highway, one can easily notice that the number of retail shops and hotels at Witu 1 township are hardly 10 compared to over 50 in Mpeketoni.

[36] In view of the current capacity constraints, increase in power demand may be viewed negatively. However, this is only a temporary setback, which is being effectively addressed by the on-going e7 funded expansion initiative.

(approximately Ksh1.5 million or US$20,000) per year) is an important source of revenue for local SMEs. Granted traders flocking in and out of Mpeketoni reportedly purchase a significant proportion of airtime, these transactions act as vital means of income transfer from outside sources into the village. It also worth noting that the estimated air time market value accounts for only less than 1% of the annual agricultural income (Ksh220 million or US$2.8 million) at Mpeketoni (Scottish Power, 2005). Currently, this market is the "monopoly" of one cell phone company (Celtel Kenya Ltd), thanks to power constraints at MEP which have locked out the competing company – Safaricom Ltd. Probing further, the retailers indicated that the noted high cell phone traffic is correlated with harvesting and marketing seasons which vary from month to month due to the wide variety of crops grown and sold (see Table 4). Also of note is lack of other essential commercial services – including banking - at Witu1 vis-à-vis Mpeketoni which has three banks (see Section 5.4).

Road traffic is another insightful proxy of the robustness of a rural market. While most rural markets in small towns in Kenya operate on designated days (often once a week), Mpeketoni markets operate seven days of the week[37]! The town is the destination of 2-3 sixty-seater passenger buses per day – one from Lamu Island and two from Mombasa City, exclusive of other smaller-car vehicular traffic.

Taken together, the foregoing empirical evidence substantiates the hypothesis that an "interactive effect" exists between access to electricity, roads and other infrastructure services vis-à-vis SMEs growth and development. This study makes it clear that in order for rural enterprise to take root and thrive, an assortment of infrastructures, services and markets must be available, at least locally and further afield. This finding has important policy implication for rural electrification, i.e., the policy should aim at providing a "suite of well-integrated enabling factors," not merely electricity, in order to spur the start-up and growth of SMEs in particular and poverty reduction in general. But what does this finding mean from a practical perspective? Does it suggest that electricity planners should focus on delivering services first to areas where complimentary infrastructures

[37] Based upon my personal life experience in rural Kenya and corroborated by Prof David Leonard of Political Science Department, UC Berkeley (personal comm).

already exist? How about equity issues implicit in such a policy? These are complex and broader questions beyond the scope of this study.

However, as policy reforms take root and funding for REP increases, both the Task Force on Rural Energy and Sessional Paper No. 4 (2004) on Energy have strongly recommended that access to modern energy should go beyond households to include more of agricultural and off-farm economic activities. As pointed out earlier, Walubengo and Onyango (1992) were the early proponents of deliberately skewing rural electrification in favor of industries, commercial and public services. I would add that the envisaged integrated approach does not have to aim at simultaneous provision of electricity and other complementary infrastructure. The package of infrastructure could be provided in a phased and coordinated rather than in an arbitrary manner as has been the practice with many rural electrification projects[38].

Moreover, the challenges of rural electrification are not unique to Kenya. For instance, to add economic value to an extensive rural electrification program underway in South Africa, ESKOM (South African electricity utility company) has established an SME promotion initiative as part and parcel of its rural electrification (Borchers and Hofmeyr, 1997 cited in McAllister, 2002). In a review of the relationship between electrification and productive enterprise in rural South Africa, McAllister (2002) reaches a crucial conclusion that resonates very well with my findings at Mpeketoni: "when provided together with basic social services such as health and education and physical infrastructure such as communication and transport, electrification is more likely to have a substantial positive effect on rural economic development." In other words, access to electrification - important as it is - addresses only one piece of the complex puzzle of the socio-economic limitations facing rural Africa. There is great need for additional studies that seek to identify the broader set of processes and factors – including access to credit,

[38] Political interference is largely to blame for the arbitrary manner in which the rural electrification has been implemented in Kenya. Hence the recommendation for an autonomous rural electrification agency that would develop a criteria for electrification (MoE, 2003; Walubengo & Onyango 1992). In my view, publicizing both the criteria and a schedule of areas to benefit annually would raise awareness and provide critical public oversight and accountability as target communities, local elite and politicians have incentives and information to ensure their villages are not short-changed and/or "by-passed". Public information disclosure has been effectively applied in other sectors to enhance accountability and oversight. For example, wide publicizing in the print and electronic media of funds allocated to each school under the free primary education and that allocated to each constituency under the CDF has enhanced accountability across the country.

community dynamics[39], rural elites, financing, government policies, security, donor support, etc – that come together to shape and determine the productive uses of rural electrification.

As earlier pointed out, the Task Force on Rural Energy has recommended adoption of distributed generation (DG) using a wide range of renewable energy technologies in an effort to address the prohibitive cost of grid extension to rural areas. Implementation of such a recommendation calls for the enactment of requisite and supportive regulatory policy framework. The next section examines the policy lessons that can be drawn from MEP to inform the regulation and licensing of DG in Kenya.

5.7 Regulatory policy implications of MEP's experience

Distributed generation (DG) is yet to be tried on a large scale in rural electrification projects, much less on a community-based approach in Kenya. For instance MEP is the only diesel community-based mini-grid in Kenya while three others are much smaller (about 5kW) and hydro-based (Balla, 2003). The latter are relatively new (started in 2001/2) and still under development, hence everyone – communities and policy makers alike – is literally on a very steep "learning curve" as far as DG is concerned. It is evident there are many barriers—technical, financial, regulatory, and institutional—that need to be addressed adequately. A clear and well-established framework is required to design, implement, and mainstream such schemes. I wish to restrict myself to licensing as one critical piece of the envisaged wider regulatory framework.

I find the rich experience with DG in India and Nepal highly germane to Kenya in four principal and innovative ways. First, the Indian Electricity Bill (2003) is highly pro-DG and makes specific reference to ‘‘permitting stand alone systems including those based on renewable sources of energy (and other non-conventional sources of energy) for rural areas’’ (Clause 4, Electricity Bill 2003, cited in Chaurey et al, 2004). Second, the Bill is explicit about the "central role" of local stakeholders (NGOs and village institutions) in the management of local electricity distribution. Third and most

[39] My informants repeatedly claimed that the presence of "enterprising" Kikuyus and Kambas in Mpeketoni compared to the "non-farming" coastal communities at Witu 1 could also partly explain the faster growth in the former than the latter.

important, it permits *license-free* generation and distribution in rural areas (emphasis added). Similarly, Pandey (2004) reports that in Nepal, the Government *delicensed* micro-hydro projects up to 100kW allowing rural people to generate their own electricity and sell "over-the-fence" to their neighbors (emphasis added). This policy is partly credited for rapid and successful deployment of micro-hydro systems that connect between 110,000 to 170,000 rural people.

The fourth point is about the benefits of leveraging indigenous expertise and experience in form of village electricity committees (VECs). For instance, Harper (2000, cited in Chaurey et al, 2004) indicates that the VECs in the State of Orissa in India have clearly shown that it is possible to improve the "operational and commercial viability" of the DG scheme if community is made an important stakeholder. The VEC is a committee of consumers from the village, supported by technical staff, acts as a "Consumer Care Center" in the village and facilitates interaction, education, grievance redress, bill distribution, metering, and cash collection. For all intents and purposes, the MEP Executive Committee has been functioning like the Indian VECs, and so have the other self-help groups managing the pico-hydro projects in Meru.

My key policy recommendation, therefore, is that small-scale power generation and distribution projects below a pre-determined capacity (say, 1000 kW) should be permitted to operate *license-free*. Citing bureaucratic red-tape with the current efforts for scaling-up MEP, Jonathan Cohen of ESD has echoed the urgency for re-examining the licensing procedure for mini-grids[40]. Karekezi, a leading energy policy analyst and a member of the Task Force on Rural Energy strongly shares these views[41]. Karekezi further points out that there exist hundreds of diesel generators in different parts of the country used either as power back-ups (by schools, hospitals, NGOs, churches, etc) or for saw milling and/or irrigation. They are often, under-utilized, particularly at night when power is needed most by households and other enterprises. In the absence of the current inhibitive (licensing) regulations (see section 3.4), Karekezi contends the owners of such generators would find it economical to sell power "over the fence" to neighboring

[40] Jonathan Cohen (email communication). Cohen is the team leader of the ESD team advising the Kenyan Government and e7 on how to scale-up MEP into a diesel/wind hybrid system.
[41] Karekezi, Stephen (personal communication, July 2005)

households and enterprises as reported in Nepal, thus increasing access to rural electrification.

In my view, despite the limited experience with DG in Kenya, the MEP project- combined with the three micro-hydro schemes in Kirinyaga and Meru South Districts- are beginning to "demystify" DG; and letting both the communities and policy makers "learn by doing." That is as it should be. This observation is collaborated by both UNEP (2002) and Balla (2003) who have documented the vital lessons from the implementation process of the micro-hydro schemes in Kirinyaga and Meru Districts. These lessons have fundamentally shaped the new Sessional Paper No. 4 (2004) on Energy (see section 3.4). In short, the Kenyan rural people, like in India, Nepal and elsewhere, are demonstrating they have the potential and know-how to be energy service providers. Thus, in addition to the commendable policy reforms articulated in the Sessional Paper No. 4, I would strongly suggest taking a step further: permitting license-free operations for small-scale mini-grids. Next section presents a summary of my key findings, policy recommendation and ideas for further research.

CHAPTER 6: KEY FINDINGS AND RECOMMENDATIONS

6.6 Key findings

i) The findings at Mpeketoni reveal that access to electricity; in combination with simultaneous access to markets and other infrastructure (roads, communication, schools, etc), have contributed to robust growth of SMEs in clear and compelling ways. For instance, productivity per worker and gross revenues per day in Mpeketoni increased on order of over 200% for both carpentry and tailoring SMEs as the result of access to electricity. Strong linkages to poverty reduction via job creation, income generation and improvement in quality of education were also noted. The key lesson is that rural electrification should be delivered in projects that are designed to provide a "suite of well-integrated enabling factors," not merely electricity alone, in order to spur the start-up and growth of SMEs in particular and poverty reduction in general.

ii) Despite high tariffs [Ksh22.50 (US$0.30)/kWh or nearly 3 times the national grid tariff], MEP has demonstrated that there exists substantial unmet rural demand for electricity. With lack of resources to expand and grow, however, MEP is becoming a classic victim of its own success. The power capacity constraints are severely inhibiting the phenomenal potential for wealth and income generation for the local community. Therefore, the ongoing joint efforts by Kenyan Government, the e7, Scottish Power, Energy for Sustainable Development (UK) and Energy for Sustainable Development are worthwhile and overdue.

6.2 Policy recommendation and ideas for further research

i) The key policy recommendation is that small-scale power generation and distribution projects below a pre-determined capacity (say, 1000 kW) should be permitted to operate *license-free* in rural areas under a revised Electricity Power Act as is the case in India and Nepal (see Section 5.8). Removal of licensing bureaucracy for such small-scale mini-grids would make it possible for owners of diesel generators in rural areas to sell power "over-the-fence" to households and enterprises, thus increasing access to rural electrification. Further research is however needed to better understand the pros and cons of private vis-à-vis community-owned and managed mini-grids.

ii) The circumstances under which private and/or community-owned and managed electricity projects become successful require further study. How unique or representative is the Mpeketoni case study? As energy policy analysts increasingly advocate for more private and/or community-based distributed generation, we need nuanced understanding of the multiple dynamics that would enhance and/or constrain success of such projects. For instance, the "common property resource" theory has been widely used to understand the governance and management of man-made or natural commons such as irrigation canals, forests, fisheries, etc. How relevant is CPR theory in understanding the governance of village-scale power projects in Kenya? In addition, comparative analysis is highly recommended to illuminate under what conditions such projects succeed or fail.

iii) There is great need for additional studies that seek to identify the broader set of processes and factors – including community dynamics, rural elites, financing, government policies, security, donor support, etc – that come together to shape and determine the productive uses of rural electrification.

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