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POVERTY REDUCTION

INTEGRATING ENERGY ACCESS AND EMPLOYMENT CREATION TO ACCELERATE PROGRESS ON THE MDGS IN SUB-SAHARAN AFRICA

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Integrating Energy Access and Employment Creation to Accelerate Progress on the MDGs in Sub-Saharan Africa

April 2012

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ACKNOWLEDGEMENTS

This report was authored by Steven Hunt and Jan van den Akker (Practical Action Consulting); Stephen Gitonga, Usman Iftikhar, Jessica Murray, Kamal Rijal (UNDP), and Jonathan Brooks, who was with UNDP till 2011. The works of the authors are greatly appreciated.

Case studies were prepared by the following authors: Kenya case study by Bhola Shrestha (GTIEA); Burkina Faso and Mali case studies by Ibrahim Togola and Pierre Dembele (Mali Folkecenter Nyetaa); Malawi case study by Tinashe Nhete (Practical Action Consulting Southern Africa); Zimbabwe case study by Tinashe Nhete (Practical Action Consulting South Africa); and South Sudan case study by Nick Allen and Dan Waddle (NRECA International). Thanks are due to all to the country case study authors.

A number of UNDP colleagues made substantive contributions to the Report as internal peer reviewers: Stephen Gitonga, Mette Block Hansen (Environment and Energy Group, Bureau for Development Policy), Paul Ladd (Poverty Practice, Bureau for Development Policy), and Leo Horn-Phathanothai and Gregory Woodsworth (Regional Bureau for Africa). Lisa Feldmann (GIZ), Anne Marije Kooijman van Dijk and Smail Khennas (University of Twente, Netherlands), who served as external peer reviewers, provided invaluable comments and suggestions. The contributions of the peer reviewers are immensely appreciated.

This research would not have been possible without the valuable contributions of key sector specialists, policymakers, programme staff, business managers, workers and others who responded to our requests for information in the compilation of this report. Their contributions are gratefully acknowledged.

Finally, critical operational support was provided by Shams Banihani and Kariny Gaugris (Poverty Practice, Bureau for Development Policy), Lance Garmer who served as the editor of the Report and Saswata Alex Majumder as the designer. Their contributions are thankfully acknowledged.

Cover photograph:

Man stands on weir next to inlet channel at micro-hydro plant in Kenya.

Photo by Zul Mukhida/ Practical Action.

Disclaimer:

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ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
AMADER	Malian Agency for the Development of Household Energy and Rural Electrification
APEC	Asia-Pacific Economic Cooperation
AREED	African Rural Energy Enterprise Development Programme
BUC	Bonny Utility Company
CBO	Community-based Organization
CDM	Clean Development Mechanism
CTC	Cutting, Tearing and Curling
EATTA	East African Tea Trade Association
EPKL	Eastern Produce Kenya Ltd.
EU	European Union
ESCOM	Electricity Supply Commission of Malawi
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTIEA	Greening the Tea Industry in East Africa project
GWh	Gigawatt hours
HDI	Human Development Index
ICT	Information and Communication Technology
IEA	International Energy Agency
ILO	International Labour Organization
KCJ	Kenyan Ceramic Jiko
KTDA	Kenyan Tea Development Agency
kW	Kilowatt
LED	Light-emitting Diode
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goals
MFC	Mali Folkecenter
MFP	Multi-functional Platform
MW	Megawatt
NGO	Non-governmental Organization
NRECA	National Rural Electric Cooperative Association
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
O&M	Operation and Maintenance
O&M&M	Operation, Management and Maintenance
PAC	Practical Action Consulting
PRSPs	Poverty Reduction Strategy Papers
PV	Photovoltaic
REDD	Reducing Emissions from Deforestation and Degradation
SAPP	Southern African Power Pool
SHS	Solar Home System
SME	Small, Medium, and Micro-sized Enterprise
UN	United Nations
UN ECA	United Nations Economic Commission for Africa
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UTKL	Unilever Tea Kenya Ltd.
W	Watt
WSSD	World Summit
YECO	Yei Electric Cooperative

FOREWORD

At the UN High-level Plenary Meeting on the Millennium Development Goals (MDGs) in September 2010, the international community adopted an action-oriented outcome document reaffirming its commitment to accelerating progress and achieving the MDGs by the 2015 target date. The momentum for such an outcome gained strength throughout the 2010 MDG Review period and was based on the fundamental belief that business as usual will not get the world to the MDGs by 2015. Rather, it was stressed that the 2010 MDG Review should be a lynchpin opportunity for a transformation of knowledge and action by providing each country with deeper analyses as to why they were making progress on some MDGs and why they were lagging behind on others – and thus as to what was working and what was not. In turn, the 2010 MDG Review was a breakthrough in garnering new evidence and knowledge about achieving individual MDGs as well as approaches that accelerate progress toward multiple MDGs.

Indeed, one of the most profound lessons emerging from the 2010 MDG Review was the realization that progress toward multiple MDGs can be achieved through, for example, investments in expanding access to sustainable energy for the poor. That is, evidence began to emerge that access to sustainable energy for the poor allows income opportunities through new jobs and enterprises, improving existing jobs and livelihoods, enabling improved health and education services and improving opportunities and quality of life, particularly for women.

In 2011, building on these emerging lessons, the United Nations Energy Access Facility (UN-EAF) was launched, flowing from the recommendations of the Secretary-General's Advisory Group on Energy and Climate Change (AGECC) calling for universal access to modern energy services by 2030. In 2012, the momentum increased when the United Nations General Assembly voted 2012 to be the International Year of Sustainable Energy for All, recognizing the role that access to sustainable energy can play in promoting growth, poverty reduction and environmental sustainability and addressing climate change with the concomitant announcement by the UN Secretary-General on the launch of the 'Sustainable Energy for All' initiative. Sustainable energy access is increasingly being recognized as a central theme for the upcoming UN Conference on Sustainable Development (Rio+20). Finally, innovative groups such as the Friends of Sustainable Energy for All have emerged, with particular interest in sustainable energy as a means to promote human-centred sustainable development.

Parallel with these developments, UNDP has also emphasized in its MDG Breakthrough Strategy the critical importance of access to energy as an important means for achieving the MDGs. Such access is also a critical element of the MDG Acceleration Framework (MAF), as in many countries, energy access has been identified as the binding constraint towards the MDG achievements. In that context, the Poverty Practice in UNDP, with a generous support from the Government of Denmark, has undertaken an initiative of having country studies on the issue of linkages between energy access with employment and poverty reduction in Burkina Faso, Kenya, Mali, Malawi, studies at sub-national levels in Yei in South Sudan and a sub-regional study in Southern Africa. The idea was that all these studies would deepen the understanding of the interdependent relationship and generates new knowledge on links between access to clean energy and the potential to catalyse growth, private enterprises, employment and the achievement of a number of MDGs in sub-Saharan Africa. Furthermore, the report endeavoured to contribute to the formulation of policy options for an integrated approach to decentralized 'green' energy services, which is seen as a means to expanding the market for decentralized energy solutions and the creation of productive employment.

The present report, which reflect those studies, examined cases of energy access being "pulled" to expanding sectors, of introducing energy access in "pushing" growth and expansion of employment opportunities within a community, town or region, and of creating new jobs in the energy sector. Overall findings based on the analysis of literature and case studies strongly suggest that the role of increasing energy access is a necessary precondition for growth and employment. Expanding employment sectors, which would otherwise create new jobs, are inhibited in their growth by expensive, unreliable or insufficient energy access. Meanwhile, without energy access, existing employment and livelihoods activities remain inefficient, provide low returns and absorb crucial time in drudgery, which has a real opportunity cost in terms of output foregone. Additionally, the employment potential of the energy sector itself will not be realized while levels of energy access remain as low as they are currently in Africa.

However, crucially, the report also found that expanding energy access alone is an insufficient condition for achievement of growth, employment and the MDGs. Several steps connect energy access to employment, including the taking up of (sometimes expensive) appliances and equipment, improvements in enterprises, increased income generation – and only then eventually to expansion and hiring new employees. Furthermore, energy access is not necessarily in the short run converted into new jobs in the absence of market access, technology/skills access, access to finance and economic/social stability. Processes stimulating and supporting enterprise development can accelerate this process if combined with access to modern energy.

Based on the case studies and analysis, this report recommends policy actions under three headings to achieve universal energy access while maximizing the contribution of decentralized and renewable energies: improving policy and planning by governments; enabling private sector and community action; and coordinating action at the international level. With these policy recommendations as a guide and with support from the international community and global institutions, the report demonstrates that it is possible to expand access to energy in a different way that contributes to the achievement of the MDGs in sub-Saharan Africa.

I am sure that the recommendations of the Report contribute to our on-going work on the MDG Acceleration Framework (MAF), the issues related to Rio+20 and the development discourse on the Post-2015 Development Agenda. Our efforts would be amply rewarded if the readers find the Report useful in their areas of work.

Selim Jahan
Director, Poverty Practice
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EXECUTIVE SUMMARY

In September 2010 at the United Nations High-level Plenary Meeting on the Millennium Development Goals (MDGs), the international community reaffirmed its commitment to accelerating progress and achieving the MDGs by the target date, adopting an action-oriented outcome document. The outcome document represents a collective assessment of the situation as well as a roadmap of actions needed to achieve the MDGs, including in sub-Saharan African countries where progress has been mixed. One of the key pathways to the achievement of the MDGs in sub-Saharan countries is seen to be sustained, inclusive and equitable growth – particularly where it creates and enhances enterprises and employment in sectors that benefit the poor, raises revenue for the provision of essential social services and infrastructure and involves more equitable distribution of income, assets and resources. Evidence suggests that, while there are some challenges to sustained, inclusive and equitable growth in sub-Saharan Africa, one of the most pervasive constraints is the lack of adequate, reliable and equitable access to modern energy services.

Although energy access is not an MDG itself, it has been increasingly recognized as a crucial pillar in the achievement of all of the MDGs, most recently in a report by the UN Secretary-General´s Advisory Group on Energy and Climate Change (AGECC, 2010). The United Nations General Assembly has since voted 2012 to be the 'International Year of Sustainable Energy for All'. Sustainable energy access will be a central theme at the UN Conference on Sustainable Development (Rio+20) in 2012, at which the UN Secretary-General is expected to launch a new goal of Universal Energy Access by 2030, with secondary goals of doubling renewable energy and energy efficiency.

Access to basic energy services such as cooking and heating is essential for survival, while lighting, cooling and information and communication technology (ICTs) underpin health, education and services. Energy access is also a crucial input to a wide range of productive and income-generating activities. Few enterprises of any scale can operate without a supply of electricity, fuel and/or mechanical power with which to produce the energy services needed in appliances and processing equipment, from boilers to computers. At national scale, access to modern energy services is critically coupled to a country's economic development, yet over 1.3 billion people globally are without access to electricity and 2.7 billion people are without clean cooking facilities (IEA, 2011).

Sub-Saharan Africa has the lowest rates of electrification and access to modern fuels in the world, at 26 percent and 21 percent, respectively (UNDP/WHO, 2009), while no data is available on mechanical power. In surveys of African business leaders, availability, reliability and affordability of energy consistently come out among the most important constraints on expansion of enterprise activities (CGDEV, 2009). These activities drive the employment growth that the Africa Commission 2009 report 'Realizing the Potential of Africa's Youth' shows is so strongly linked to achievement of the MDGs. However, the nature of the interdependent relationship between energy access and employment has not yet been well understood. This study seeks to start to address this gap.

With increasing awareness of the issues of climate change and high oil prices, a confluence of political, social and economic drivers has stimulated the development of energy technology approaches that diverge from the grid-based, fossil-fuelled models dominant to date. New off-grid, decentralized energy options are increasingly available, often using renewable energy resources including solar, wind, small hydro and biofuels. The emergence of such technologies has also been linked internationally with the creation of new 'green jobs', along with grid-based renewables, energy efficiency and other environmental technologies. Decentralized energy options are also considered by many to hold particular potential in sub-Saharan Africa, where most people have no access to modern energy services and will continue to be dispersed far from the reach of the grid for the foreseeable future. However, despite some good examples of success in sub-Saharan Africa and the potential for replication and scaling-up, these innovations remain 'islands of success'. This report presents the latest understanding of the impact and potential of decentralized energy technologies in Africa with respect to economic development and employment.

The study has analysed a series of expanding employment sectors in Africa that rely on energy services, including the tea sector in East Africa and the mobile phone sector, with a focus on southern Africa. Analysis of these sectors has revealed that, while their growth is driven by sector-specific market factors including natural resources, available skills and capital, and strong export and local demand, the speed and extent of that growth is critically coupled to the quality, price and availability of energy access to these sectors. In the case of the eastern African tea sector, the application of small-hydro power has substantially reduced the cost base of tea production, compared with the diesel backup required to maintain supply within an unreliable and expensive grid system. Energy access is shown to be 'pulled' to such expanding sectors. When this happens, new opportunities also emerge for multiplier effects, such as the expansion of communications-based products and services offered in southern Africa, which, in turn, is based in rural areas on the decentralized powering of mobile base stations and the charging of handsets.

The introduction of energy services within a community, town or region has also been assessed to measure the impact of introducing energy access in 'pushing' growth and expansion of employment opportunities. Case study analyses that focused on mini- and off-grid solutions to energy access included the rural electrification of the town of Yei in South Sudan and the introduction of multi-functional platforms in western Africa. The results of this study suggest that the introduction of electrical and mechanical power supplies may create relatively few new jobs in the first few years, mainly in the provision of the service itself. Introduction of such energy services, however, contributes strongly to improving existing employment as well as reducing opportunity cost in basic household or processing activities, particularly for women. In the longer term, virtuous circle effects in job creation and business activity are expected, although a wider sample and longer-term study would be required to confirm these effects.

Creation of new jobs in the energy sector itself has been found to be a relatively under-appreciated but important feature of the contribution of energy access to growth and employment. In developed countries, with saturated energy markets, employment is dropping in the energy sector as a whole (except in the newer and expanding renewable energy subsector). With the very low levels of energy access in Africa, huge potential for job growth is shown over the coming decades in expanding energy access for domestic use and possibly in exporting low-carbon fuels. Case studies of the charcoal sector in Kenya have highlighted the existing role of traditional bioenergy sources as the second largest rural employer, while a case study of the bioethanol sector in Malawi assesses the potential of biofuels as a new driver for rural employment. With respect to electrification, the formal energy sector continues to significantly underperform in sub-Saharan Africa. The new decentralized renewable energy subsector has important potential to fill some of this gap in increasing energy access and, as this supply sector grows, it can in turn be expected to create new green jobs on the continent.

In the course of this research, then, it has become clear that increasing energy access is a necessary precondition for growth and employment. The correlation among these three factors is clear and shown via some analyses presented, with the correlation being particularly strong at the transition between low and medium national Gross Domestic Product (GDP) and employment levels. The growth of expanding employment sectors, which would otherwise create new jobs, is inhibited by expensive, unreliable or insufficient energy access. Meanwhile, without energy access, existing employment and livelihoods activities remain inefficient, provide low returns and absorb crucial time in drudgery, which has a real opportunity cost in terms of output foregone. Additionally, the employment potential of the energy sector itself will not be realized while levels of energy access remain as low as they currently are in Africa.

However, crucially, the study has also found that expanding energy access alone is an insufficient condition for achievement of growth, employment and the MDGs. Several steps connect energy access to employment, including the taking up of (sometimes expensive) appliances and equipment, improvements in enterprises, increased income generation and only then eventually to expansion and hiring new employees. In some cases, the net effect of growth can be net zero job creation (AfDB/AUC/UNECA, 2010). Growth (driven by mechanization) can lead to fewer opportunities for job seekers in certain sectors or type of jobs, while, on the other hand, increased business viability may lead to more employment opportunities or to the creation of new skilled and unskilled jobs. In all cases, variability in the employment intensity of growth sectors, as well as accessibility of new employment opportunities to poor people, govern the employment impact of any growth created or supported by energy access. It is further seen that, in the short run, energy access is not necessarily converted into new jobs in the absence of market access, technology/skills access, access to finance and economic/social stability. Processes stimulating and supporting enterprise development can accelerate this process if combined with access to modern energy. The experience in Mali with linking rural electrification to development of productive uses is analysed for lessons in this regard.

Case study analysis in this report has highlighted the following factors that sector actors have identified as key competing barriers and drivers to scaling up energy access, particularly via decentralized and renewable energy options, and to maximizing its contribution to employment generation.

Barriers	Drivers
High upfront investment cost of decentralized energy technologies combined with limited affordable financing available to project developers.	Low reliability, high cost to business consumers and low coverage of grid power systems drive decentralized renewable options.
Limitations on technical and management capacity in place within local/national public and private institutions to operate, manage and maintain energy systems.	Availability of key resources, including renewable energy resources, land availability and year-round growing conditions, offers a comparative advantage.
Lack of market maturity and purchasing power at consumer levels, particularly in dispersed rural communities.	Strong unmet demand for energy services coupled with improving decentralized technologies.
Inadequate national energy policies, regulations and institutional structures integrating decentralized renewables and linking energy planning with other sectors.	Growing recognition of need to reduce fossil fuel dependency in the face of high oil prices, as well as of the importance of expanding energy access to development.
Energy access has not to date been a major priority of the donor community, e.g., limited integration of energy into the MDGs remains a barrier.	Recent increase in availability of climate-related and donor finance for low-carbon and climate-resilient development that prioritizes renewables.

The International Energy Agency (IEA) estimates that an annual investment of USD 48 billion, or a total of USD 1 trillion, is required to achieve the UN Secretary-General's goal of universal access to modern energy by 2030 (IEA, 2011). This is around 3 percent of expected global investment in energy by 2030. Investment in electricity makes up USD 641 billion of the total required, with the IEA estimating that sub-Saharan Africa needs 60 percent of this investment. IEA analysis of the most cost-effective way of achieving universal energy access in sub-Saharan Africa concludes that 70 percent of new connections in rural areas will be via decentralized options, i.e., mini- or off-grid. Achievement of clean cooking goals also emphasizes off-grid biogas, improved cookstoves and liquefied petroleum gas (LPG).

Based on the case studies and analysis conducted, this report recommends the following policy actions under three headings to achieve universal energy access while maximizing the contribution of decentralized and renewable energies:

Improving policy and planning

- Governments need to prioritize energy access as part of national development priorities, set national targets for universal energy access and establish plans, institutions and an enabling environment to deliver them.
- Governments should integrate decentralized renewable energy into their energy policies and planning alongside conventional grid extension, with clear interim goals for progress that are monitored.
- There is a need to integrate energy planning with planning in other sectors and to target energy access support to all geographical areas with economic and/or employment potential that can enable multiplier benefits.
- Policy guidelines are required for the sustainable development of the biofuels industry because of its broad linkages and impacts on environmental, economic and social pillars of development. This is required before realization of its employment potential and its potential to meet domestic energy service needs, import substitution and export markets.
- Targeted direct support, including subsidies and incentives, can be warranted in developing energy delivery subsectors, including decentralized renewables or an employment growth sector pulling energy.

Enabling private sector and community action

- Conditionally target energy access support to private subsectors and communities with employment growth potential, encouraging private sector participation within a market structure, including incentives to reach poorer consumers.
- Build capacity in decentralized and renewable energy supply chains that provide technology and after-sales services, recognizing also the role of industry associations and academic and vocational training institutions.
- Promote community marketing, awareness creation, and capacity- and confidence-building with regard to decentralized energy options.

- Energy initiatives should incorporate end-use support (in terms of capacity and market linkages as well as finance) to households and businesses to ensure employment connections are made.

Co-ordinated action at the international level

- There is a need for more explicit recognition of the importance of energy access in underpinning growth and development, coupled with a process translating this into expanded and improved programming. This programming should balance on-, mini- and off-grid approaches as well as cleaner cooking and mechanical power; it should also maximize employment impacts. The launch of the UN Secretary-General's 'Energy for All' initiative at Rio+20 offers a promising opportunity for this.
- Increased concessional support from the international community to developing countries in sub-Saharan Africa for creating energy access remains essential, especially in the difficult areas that do not initially offer an adequate commercial return. These financing requirements can be partially met by official development assistance (ODA) as well as climate-related (carbon) finance. However, the use of such funding to stimulate additional private-sector investment in expanding access (e.g., through results-based financing or loan guarantees) will also be essential in closing the funding gap.
- The international community should enhance collaborative mechanisms for research and development, as well as knowledge exchange and transfer, regarding decentralized energy technologies in order to expand applicability and reduce costs. Such mechanisms must develop a pragmatic approach to intellectual property that retains value created while accelerating the spread and uptake of beneficial technologies at affordable costs.

1. INTRODUCTION

1.1. The Millennium Development Goals

At the United Nations Millennium Summit in September 2000, world leaders agreed to a set of time-bound and measurable goals for combating poverty, hunger, illiteracy, gender inequality, disease and environmental degradation. In summary, the eight Millennium Development Goals (MDGs) upon which they agreed are:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop global partnerships

A recent review of progress on the MDGs (UN, 2010) summarizes progress on achievement of the goals:

> "There have been noticeable reductions in poverty globally. Significant improvements have been made in enrolment and gender parity in schools. Progress is evident in reducing child and maternal mortality; increasing HIV treatments and ensuring environmental sustainability. At the same time that the share of poor people is declining, the absolute number of the poor in South Asia and [s]ub-Saharan Africa is increasing."

In sub-Saharan Africa and southern Asia, the share of people living on less than USD 1.25 a day fell from 58 percent to 51 percent between 1990 and 2005. Although the number of poor people alarmingly increased from 877 million to over one billion in 2002, mainly because of high fertility and population growth rates, the trend abated by 2005, when the number of poor people fell to 984 million.

The year 2010 was critical for the MDGs. With less than four years remaining until the target date of 2015, there is a growing realization that, without accelerated effort, the MDGs will be missed in some countries, with a large concentration of these in sub-Saharan Africa. The year 2010 was also important in that it provided the setting for a comprehensive review of progress on the MDGs that included addressing new challenges and realities, such as the global economic and financial crises and climate change, as well as new evidence on policy innovations to accelerate progress toward the MDGs.

1.2. Energy and the MDGs

Although no MDG pertains specifically to energy, access to energy services is now widely recognized as a prerequisite to the achievement of all eight MDGs. This was first officially recognized at the World Summit for Sustainable Development (WSSD) in Johannesburg in 2002, and the recent Secretary-General´s Advisory

Group on Energy and Climate Change (AGECC, 2010) report has reinvigorated commitment to addressing the issue of energy access at the highest levels. At one point, a proposal was put forward for an international commitment to "universal energy access" by 2030 and discussions were started regarding policy, planning, financing and action to achieve this. These efforts indicate the international community's increased recognition of the contribution of energy to achieving the MDGs.

During the UN High-Level Plenary Meeting in September 2010, a follow-up resolution to the outcome of the Millennium Summit was adopted. In this additional document,[1] several issues relating to energy access and security, clean and renewable energy, and other areas are set forth, emphasizing the importance of energy for sustainable development.[2]

The year 2012 was designated by the 65th United Nations General Assembly as the international year of "Sustainable Energy for All" in order to galvanize international support for achieving universal energy access, doubling energy efficiency and doubling the renewable energy share in the energy mix by 2030.[3]

Energy services such as cooking, water heating and space heating are increasingly recognized as essential for survival, while lighting, cooling and ICTs underpin basic health, education and communications services. At the same time, energy services can clearly be seen as essential inputs into the operations of the vast majority of private enterprises, from the smallest stall, farm or workshop to the largest factory, mine or office. A key complexity in energy and development discourses is the wide range of services that are 'derived' to a greater or lesser extent from energy sources and their respective interactions with the range of MDG goals. Table 1 attempts to map the full range of energy services against the MDGs.

However, in spite of the recognized importance of energy services and their connection with development outcomes, international institutions have generally preferred to set targets for energy around access to energy supplies (from which, in turn, services can be derived). The three key supply dimensions around which targets have so far been expressed are fuels, electricity and mechanical power. A prominent World Bank-UNDP report has recommended the following energy targets for 2015, necessary for meeting the MDGs (World Bank/UNDP, 2005):

- Enable the use of modern fuels for 50 percent of those who presently use traditional biomass for cooking and simultaneously improve the health and environmental sustainability of the use of traditional biomass
- Ensure reliable access to electricity to all urban and peri-urban areas
- Provide access to modern energy services (in the form of mechanical power and electricity) at the community level for all rural communities.

1 Available at *www.un.org/en/mdg/summit2010/*

2 Paragraph 46 mentions "the importance of addressing energy issues, including access to affordable energy, energy efficiency and sustainability of energy sources and use, as part of global efforts for the achievement of the Millennium Development Goals and the promotion of sustainable development."

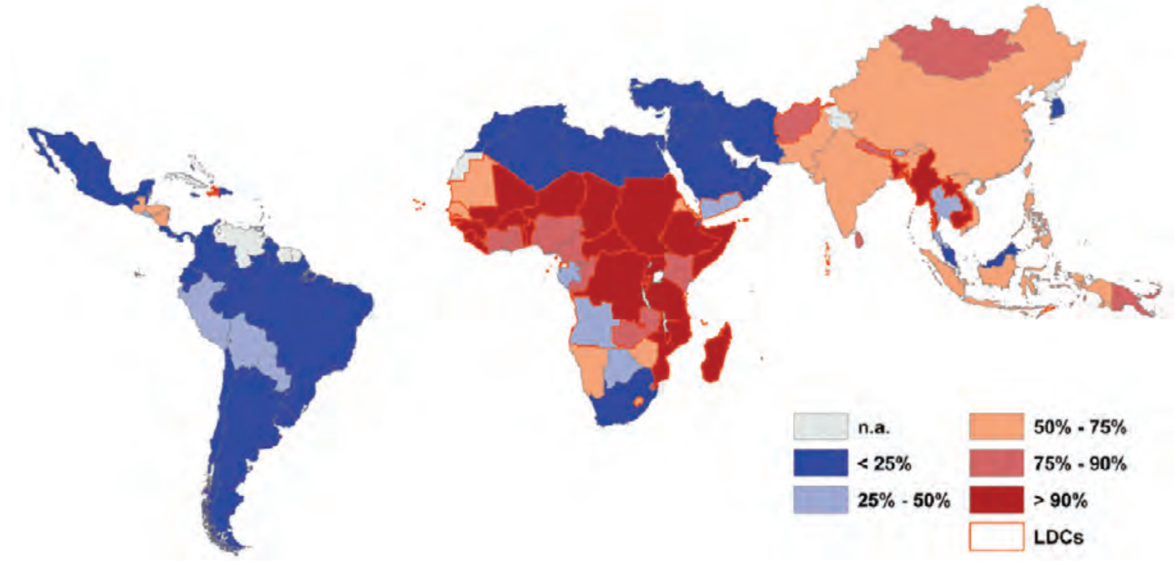
3 See *www.sustainableenergyforall.org*

Table 1: Energy services contribution to the MDGs

MDG	Energy Service					
	ES1. Lighting	ES2. Cooking and water heating	ES3. Space heating	ES4. Cooling	ES5. ICTs	ES6. Earning a living
1. End poverty and hunger	Increased productive time at night for work and sales; reduced money spent on low-quality lighting	Reduced time lost gathering wood, increasing time available for other productive activities Food can be cooked safely	Reduced time lost gathering wood, increasing time available for other productive activities	Reduced food waste and increased incomes for producers	Information enables better market prices for producers ICTs support economic growth	New and improved income gathering
2. Universal education	Children allowed to study at night Rural schools and colleges attract teachers	Less time spent collecting wood means more time for education	Less time spent collecting wood means more time for education	—	Access to educational software and information from global sources	Children released from earning into learning
3. Gender equality	Women's domestic burden reduced by improving lighting	Reduced burden on women to obtain cooking fuels	Reduced burden on women to obtain cooking fuels	—	Equal access to information, including information on government programmes	Broader income-generation opportunities for women, decreasing the importance of physical strength
4. Child health	Reduced deaths and injuries from unsafe lighting; less lung damage from sooty flames	Reduction in smoke inhalation-related diseases among young children	Reduced child deaths due to cold-related illnesses	Vaccine refrigeration enables inoculation	Information about child health care options more available	Higher incomes linked with improved health
5. Maternal health	Improved lighting for clinics, essential for safe night births and treatment	Increased birthweight of children without smoke. Hot water available, essential for childbirth	Improved comfort and health of mother in pregnancy and childbirth	—	Information about health care options more available	Higher incomes linked with improved health
6. Combat HIV/ADIS	Improved lighting essential for clinics	Needles can be sterilized	—	Liquid anti-retroviral can be refrigerated	Information about protection and health care options more available	—
7. Environmental sustainability	Lighting is an ideal end-use for renewable electricity	Improved practices reduce deforestation and emissions	Improved practices reduce deforestation and emissions	—	Monitoring and communication of environmental impacts is possible	—
8. Global partnership	—	—	—	—	Communications enable dialogue, information exchange and partnership	—

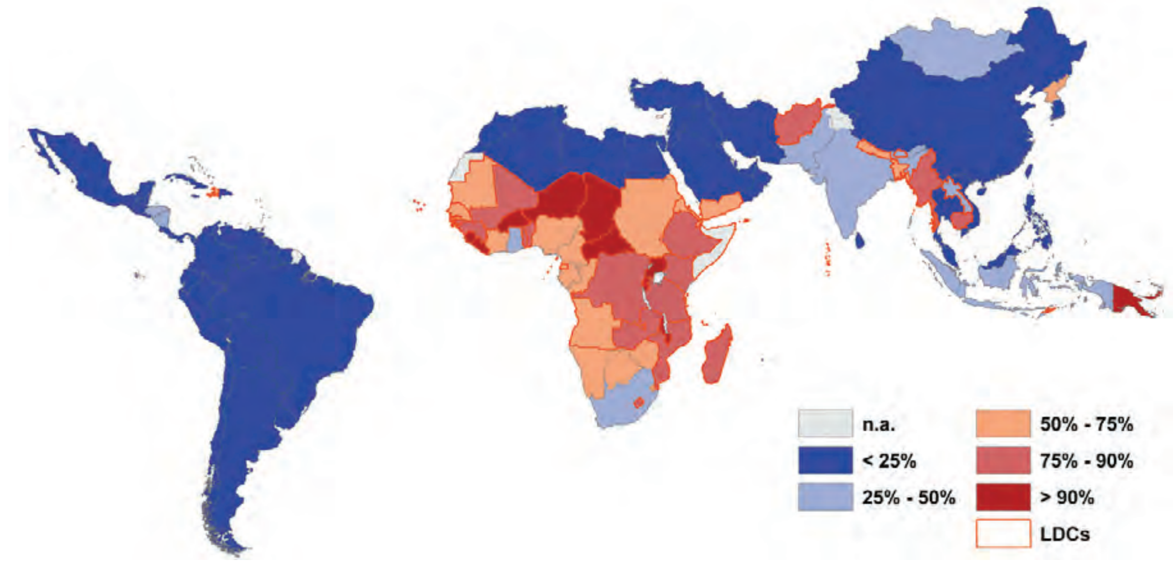
Source: Practical Action, 2010.

Figure 1: Share of people without access to modern fuels in developing countries



Source: UNDP/WHO, 2009.

Figure 2: Share of people without access to electricity in developing countries

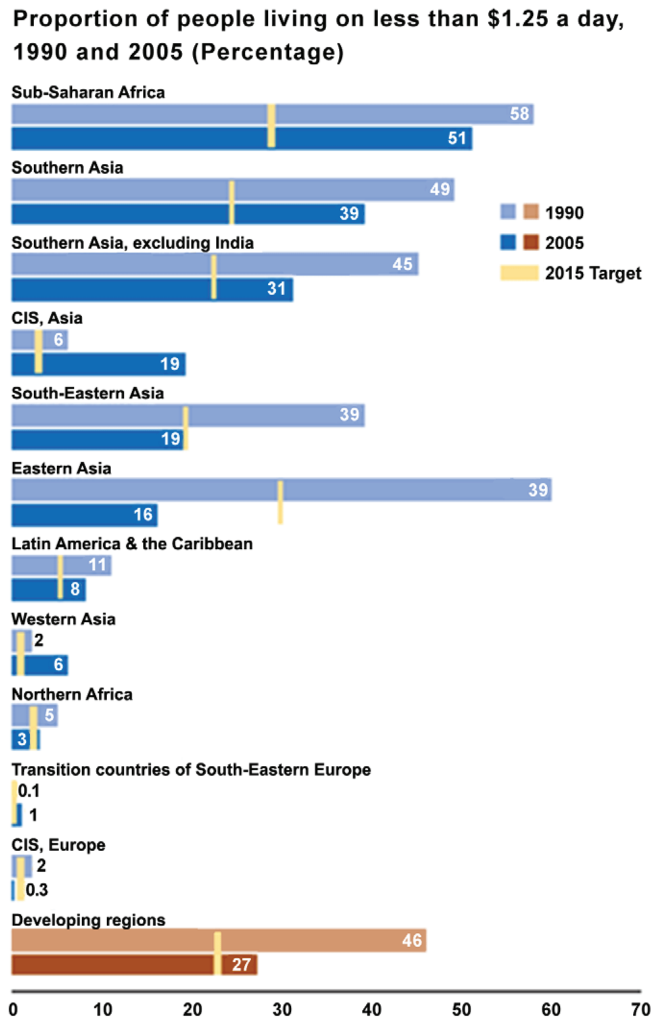


Source: UNDP/WHO, 2009.

Relevant data collection by international institutions such as the IEA to date has focused on electricity access and consumption of modern fuels, although recent reports such as 'The Energy Access Situation in Developing Countries' (UNDP/WHO, 2009), the 'Poor People's Energy Outlook' (Practical Action, 2010) and the IEA's own World Energy Outlook chapter on energy poverty (IEA, 2010) have attempted to present data incorporating mechanical power, wider health and development connections, as well as at the level of energy services access. Whatever data is used, however, it is clear that sub-Saharan Africa is furthest behind in all dimensions of energy access. Figure 1 illustrates the high proportion of people without access to modern fuels (defined as using fuel-wood and charcoal) in sub-Saharan Africa as compared with other developing regions, while Figure 2 presents the share of people in the region without access to electricity. The latest IEA World Energy Outlook report (2011) states that 69 percent of sub-Saharan people have no access to electricity (465 million in rural areas and 151 million in urban areas) and 78 percent have no access to clean fuels (476 million in rural areas and 177 million in urban areas).

The low energy access rates in sub-Saharan Africa are correlated with challenges in meeting one or more of the MDGs, including the goal on eradicating poverty (see Figure 3). Lack of energy access contributes directly to this by degrading people's ability to meet their basic physiological needs and by disrupting energy's underpinning contribution to basic education, health care and communications services, as presented in Table 1. Energy poverty itself can therefore be seen as a form of poverty that contributes directly to the missing of the MDGs. However, this study focuses on the contribution of energy to people's ability to work their way out of poverty.

Figure 3: Achievement of the MDG goal on eradicating poverty



Source: UN, 2010.

1.3. Employment and the MDGs: the role of energy

The recognition that employment and decent work are the main route for people to escape poverty led to the inclusion in 2005 of a new MDG Target (1.B): "achieving full and productive employment and decent work for all, including women and young people". This target around 'decent work' encompasses enhancing the quality of employment alongside creating new jobs. This recognizes that it is not only the number of jobs, but the nature of them and their security, that affects their contribution to people's livelihoods and ultimately achievement of the MDGs.

The 2009 Africa Commission report 'Realising the Potential of Africa's Youth' highlighted the importance of private-sector-led growth, the growing African youth population and improved competitiveness of African economies as critical opportunities to accelerate progress on the MDGs. The report identifies five key areas for attention with respect to increasing growth, employment and competitiveness, namely:

1) Benchmarking African competitiveness
2) Access to investment finance and capacity development for small and medium-sized enterprises
3) Unleashing African entrepreneurship
4) Access to sustainable energy
5) Promoting post-primary education and research

This positions energy access, and in particular 'sustainable' energy access,[4] as one of five key requirements for boosting employment in Africa. This positioning is reinforced by surveys of African business leaders, who consistently cite availability, reliability and affordability of energy among the most important constraints on expansion of enterprise activities (CGDEV, 2009). The prevalent lack of energy access in sub-Saharan Africa is therefore seen as a critical restriction on business development and employment creation in the region.

The reason for this low level of energy access is that conventional power grid and fuel distribution systems only reach a small percentage of the population, usually in urban and peri-urban areas. While conventional strategies such as these for increasing energy access will continue, there has also been a rapid expansion in recent years of a new breed of energy access products and services. Decentralized energy options, often using renewable energy resources including solar, wind, small hydro and biofuels, have become more available, efficient, effective and cost-effective in recent years. They offer new opportunities to increase energy access, particularly among dispersed rural populations living far from the grid, and have been widely connected internationally with the creation of new 'green jobs' and with other environmental technologies, such as on-grid renewables and energy efficiency. In so doing, they potentially support rural growth and expansion of employment opportunities on the demand side while creating a new industry with potential employment impacts on the supply side.

Despite good examples of success in decentralized energy services in Africa and the potential for replication and scaling up, these innovations remain 'islands of success'. A gap in knowledge and practice remains regarding the extent to which decentralized and renewable energy solutions can contribute to expansion of energy access at scale and in particular regarding their potential contribution to employment and development in sub-Saharan Africa.

1.4. Objective and design of the study

As part of the 2010 MDG Review process, UNDP commissioned Practical Action Consulting (PAC) to carry out an analytical study on the integration of clean decentralized[5] energy solutions and employment creation. In particular, the study assesses the degree to which the following two pathways function:

4 'Sustainable energy' is defined here as encompassing renewable sources of energy (e.g., based on solar, wind, hydro, geothermal and sustainably grown biomass) as well as efficiency improvements in the use of energy carriers.

5 Defined here as mini-grid and off-grid solutions providing any energy supply or service from renewable sources of energy (such as solar, wind, hydro or sustainable biomass), cleaner use of fossil fuels (such as LPG for cooking), or hybrids of one or more renewable source with fossil fuels (e.g., wind-diesel hybrids).

- **Access to energy services → employment → human development and MDGs** as a direct effect resulting from jobs created from provision of energy services on the supply and demand sides
- **Access to energy services → growth → employment → human development and MDGs** as an indirect effect resulting from the increased economic activity that access to energy services can facilitate

The study seeks to better understand the relationship between access to modern energy services[6] and growth in private enterprises, employment and the achievement of a number of MDGs. It is hoped that expanded knowledge of these links will enable policy makers and practitioners to formulate policy options simultaneously addressing the linked objectives of expanding access to modern energy services, stimulating business development and employment creation and accelerating progress toward the MDGs.

Although the connection between energy and income-generating productive uses has been widely recognized for some time (e.g., Cabraal et al., 2005), there has been little research on the nature and the dynamics of the relationships among energy, growth and employment. This study seeks to build up a conceptual and practical framework for the connection among these factors, based on analysis of a series of case studies in sub-Saharan Africa.

The first stage of the research consisted of a review of the status of access to energy services, growth and employment in Africa via analysis of available literature on the subjects. This overview considered available data and statistics, discourses and available frameworks defining each element as well as those linking one or more. This led to the development of a preliminary conceptual framework linking the role of access to energy services with income generation, employment creation and key MDGs.

A series of case studies was then conducted by regional specialists who considered cases in sub-Saharan Africa that were relevant to different aspects of the key questions of the study. The cases were selected to cover a range of contexts in western, eastern and southern Africa, a spread of energy access services and technologies, and a spread of examples across the following three categories:

- **Demand Pull:** in which a successful employment-intensive sector has emerged, enabled by various forms of energy access at different stages in the value chain
- **Supply Push:** in which a specific kind of energy access has been introduced in a particular geographical area, contributing to a series of different employment-creating value chains on the demand side
- **Energy Sector:** in which the energy supply sector itself can be seen to be a significant employer, not linked to any productive use of the energy itself

Data collection focused on building up evidence of the nature of the connection between energy access and employment, using a market-mapping process as the basis to enable visualization of the full extent of each market system. To this was added an assessment of the role of energy access throughout the system, the employment impacts of the case, the drivers and barriers for scale up and the emerging policy lessons from the case.

6 Defined here in terms of supply access as having a connection to adequate, clean, convenient and reliable sources of electricity, household fuels (notably for cooking) and mechanical power for productive uses. A definition of 'total energy access' describing minimum levels of energy service use rather than supplies is also proposed in the *Poor People's Energy Outlook 2010* (Practical Action, 2010).

The subsequent analysis of the role of energy in employment impacts in each case was conducted within the context of the preliminary conceptual framework. However, the framework was itself also updated and improved on the basis of the emerging evidence from the cases, as presented in Chapter 2. Analysis of the case studies using the final conceptual framework is presented in Chapter 3, while the full text of the case studies is provided in the Annex.

In Chapter 4, Conclusions and Recommendations, the barriers and drivers cited in each case are brought together and analysed for commonalities and variations among contexts, technologies and sectors. In particular, relevant policy, regulatory, financing, infrastructure, capacity, informational and cultural constraints to scaling up of decentralized and renewable energy solutions were assessed. Recommendations were then derived from the above data collection, conceptual framework and analysis of drivers and barriers. These recommendations address how modern energy access can be maximized and how such access can most affect employment and development.

2. ENERGY, GROWTH AND EMPLOYMENT: AN OVERVIEW

This chapter provides a short analytical overview of linkages between energy access, economic growth and employment. It puts forward working definitions of each term along with an update of the status of each factor in sub-Saharan Africa before reviewing the conceptual linkages between each.

2.1. Energy and development

2.1.1. Defining energy access

Energy access is characterized by various dimensions of need and various resources and technologies that can meet these needs. Several groups have attempted to define energy access in recent years, including Columbia University (2010), OPHI (2010) and Practical Action (2010). In general, definitions of energy access can focus on point of use and the energy services that people enjoy directly (e.g., light) or they can focus on the energy consumed in terms of energy carriers (e.g., electricity) that are the inputs to a range of energy services. Generally, the latter are easier to measure and aggregate, while the former relate more closely to the development benefits accrued from use of energy. In practice, both have value and can be applied separately or together, depending on the resources available and the level of detail required.

Some energy needs can be regarded as fundamental, i.e., as associated with human survival, including space heating and cooking of food. Basic energy needs have been defined to include the functions mentioned above and, in addition, energy for basic services, such as health, education, communication and transportation. A third level of energy needs is for productive uses and income generation. Another level could include increased energy requirements for cooling and heating (space and water), private transportation as well as a range of domestic appliances at the household level (such as radio/TV/hi-fi systems, refrigerators, washing machines, etc.) and at the community level (such as street lighting) (AGECC, 2010).

In practice, all energy services have consumptive qualities (i.e., their use is an input to basic human life and well-being) as well as potential productive application. For example, lighting can simply enable a family to play a board game together at home at night or walk home in safety, whereas lighting can also enable later opening of a shop or stall, home study or later production in a workshop. There are, however, some specific energy services more strongly linked to income generation, including irrigation/pumping, agro-processing, manufacturing and resource extraction.

A set of 12 minimum standards for access to six key energy services (shown across the top of Table 1) is proposed in the Poor People's Energy Outlook (Practical Action, 2010). In terms of energy carriers, estimates for access to basic energy needs range between 20 kWh and 120 kWh per person per year of electricity and 35 kg and 100 kg of modern fuels (depending on the efficiency of the stove used) for cooking and heating (AGECC, 2010). However, when it comes to productive use of energy services, such metrics are less relevant in that any growth in energy use will be linked to the demand for the product or service derived from that energy use. Minimum standards for services in these cases relate more to the fact that unavailable, unreliable or over-expensive energy access should not constrain creation or expansion of an enterprise or income-generating activity.

Each energy service can be produced in an appliance by one of a series of energy carriers that are often converted between forms, often complicating analysis. Take the production of electricity in a diesel generator, for example: Chemical energy in a fuel is converted into heat and pressure in an engine and then to mechanical power in a shaft. Next, it produces electricity in a generator to transfer the energy to a user, at which point it may be converted back (for example) into heat in a toaster or into mechanical power in a mill. This report focuses on three primary energy carriers as an input to the appliances that produce the energy services:

- Fuels: in solid, liquid or gaseous states that are combusted in appliances in order to deliver the energy service.
- Electricity: alternating or direct current, provided by a grid, stand-alone generation or battery supply.
- Mechanical power: generally on a shaft that inputs to the desired appliance.

There is often debate over whether to apply the prefix 'modern' to energy services and/or carriers – and particularly to fuels (on the basis that electricity would be considered 'modern' anyway) – in order to differentiate between 'traditional' biomass and 'modern' gas and liquid fuels. However, as set out in the introduction, this report focuses on the adequacy, cleanliness, convenience and reliability (and cost) of energy services and supplies. This means that, for example, the efficient combustion of biomass waste residues in drying tea leaves from the tea industry (a process that would reduce carbon emissions and operational costs) would not be considered any less 'modern' than the use of furnace oil.

Each of these energy carriers maps onto the energy services people and enterprises need via a range of appliances, with some carriers being more applicable to some energy services than others. This connection is illustrated in Table 2.

Table 2: Energy services and energy carriers

	Energy Services	Fuels	Efficiency	Mechanical Power
Energy Services	Lighting	XX	XXX	
	Cooking/water heating	XXX	XX	
	Space heating	XXX	XX	
	Cooling	X	XXX	
	ICTs		XXX	
	Irrigation	XXX	XX	XXX
	Agro-processing	XXX	XX	XXX
	Manufacturing	XX	XX	XXX
	Lifting–crossing		XX	XXX

Key: X – Possible but not usually preferable, XX – Applicable but limited, XXX – Suitable.
Source: Adapted from UNDP/Practical Action Consulting, 2008.

These energy carriers are derived from a range of energy resources that can be categorized as:

- Fossil: finite energy resources produced naturally underground over millennia including crude oil, natural gas and coal, as well as derived fuels such as diesel, kerosene, petrol, etc.

- Renewable: energy resources that cannot be depleted, including wind, hydro, solar, tidal, wave and sources considered to be in practically infinite supply, such as geothermal (from the earth's core), although it can eventually be exhausted in some local areas.
- Regenerable: Bioenergy resources can be classed as regenerable. If used within regrowth rates or replanted, they can be renewable, but, if over-extracted and unmanaged, they can be finite.

In general, for the purposes of increasing energy access, particularly for poor people around the world, energy resources cannot be considered the key constraint. The overall conclusion of the Survey of World Energy Resources states (WEC, 2010), "There is no shortage of energy resources in the world either today or for decades to come. It is the way we are using these resources that has to change to ensure sustainable energy future." Their analysis paints a picture of large reserves of fossil energy relative to consumption as well as widespread renewable resources. Many renewable resources remain almost completely untapped in developing countries and the WEC, for example, drawing on International Hydropower Association data, estimates that only around one third of the technically and economically feasible global potential of hydropower has been exploited.

2.1.2. Energy poverty in sub-Saharan Africa

About 1.3 billion people worldwide still lack access to electricity, while around 2.7 billion people rely on traditional biomass for cooking (IEA, 2011). Many of these 'energy poor' live in sub-Saharan Africa. Of a total population of 850 million in 2009, about 586 million did not have access to electricity, while 653 million did not have access to clean cooking facilities (IEA, 2011).

This reflects the gross inequality in energy consumption globally. Per capita electricity consumption in sub-Saharan Africa is around 52 kWh per capita, while it is 2050 kWh per capita in the state of New York in the United States of America, for example. This means that the 19.5 million inhabitants of New York state consume the same amount of electricity in a year (40 TWh) as the 791 million people in sub-Saharan Africa (IEA, 2010). In fact, the disparity in energy access is actually worse than this figures suggests. In Organization for Economic Co-operation and Development (OECD) countries, people use energy with higher efficiency. For example, people using LPG stoves are cooking with about 60 percent energy efficiency, while many families in sub-Saharan Africa cook using biomass on traditional stoves with low energy conversion efficiency of 10 percent to 15 percent – and severe health implications for the women and children most exposed to the smoke.

There are large variations in electrification rates across and within regions, as shown in Figure 2. Transition economies and countries belonging to the OECD have virtually universal access. Northern Africa has almost universal access (roughly 99 percent), Latin America 93 percent, eastern Asia and the Pacific 90 percent, and the Middle East 89 percent. By contrast, southern Asia has an electrification rate of 60 percent, whereas sub-Saharan Africa has a rate only of around 29 percent. Together, the southern Asian and sub-Saharan African populations without electricity account for 83 percent of the total world population without electricity. Sub-Saharan Africa has by far the lowest urban and rural access rates, at 58 percent and 12 percent, respectively (UNDP/WHO, 2009).

However, even these stark figures tend to hide the full extent of the inequality that exists between regions, rural and urban areas and between different population strata. In capital cities and main urban areas, per capita energy (and electricity) consumption is several times higher than in small towns or villages, even if these have energy access. In most sub-Saharan African rural communities, households largely depend on wood-fuel, agricultural residues, dung and other locally derived biomass fuels to meet energy needs – with corresponding impacts on health and time spent in drudgery. Apart from these locally available fuels, kerosene remains the most widely used 'modern' source of lighting, even though it is smoky and widely linked with accidental burn injuries (UNESCO, 2003; Practical Action, 2010) .

This energy inequality, both in urban and rural areas, also applies to productive uses of energy where many rural industries (agro-based and non-agro-based) and enterprises of all sizes are unreliably or unserved by grid or conventional power infrastructure. Such enterprises have to create their own energy access (primary or backup) to fuels, electricity and mechanical power if they are to survive, let alone grow. Ubiquitous diesel engines and generators can fill the gap for electricity and mechanical power, but only at increasingly high cost and low reliability, while biomass in basic boilers is used, often inefficiently, for process heat. However, there are also emerging examples of enterprises creating new energy access patterns with the decentralized technology options that are becoming more available, effective, efficient and affordable, including technologies based on renewable energies such as solar, wind, hydro and bioenergy.

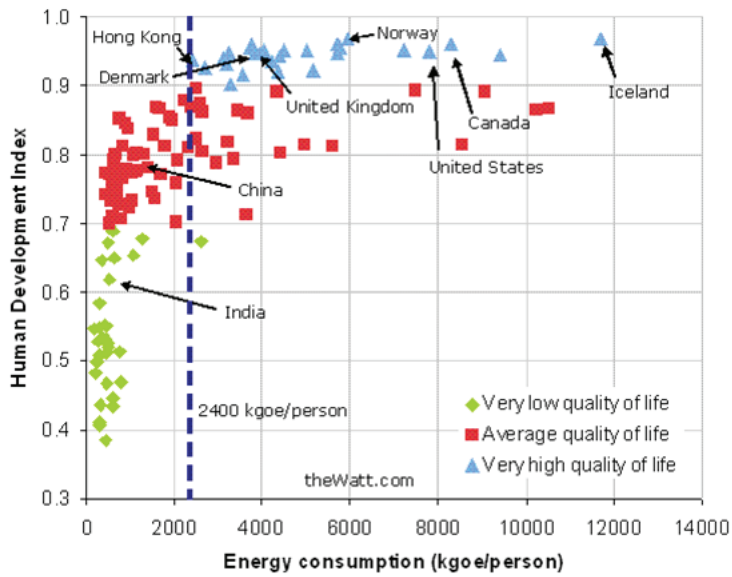
All supply options will have to be combined in order to overcome the current state of widespread energy poverty throughout rural sub-Saharan Africa and particularly the debilitating lack of access to energy services to support the productive end-use activities that are needed to support income generation and employment growth.

2.1.3. Connecting energy and development

As discussed in the introduction, energy is widely recognized as an underpinning factor for achievement of poverty reduction and the MDGs (AGECC, 2010). At a macro level, it is clear that energy consumption is strongly correlated with human development, as illustrated in Figure 4.

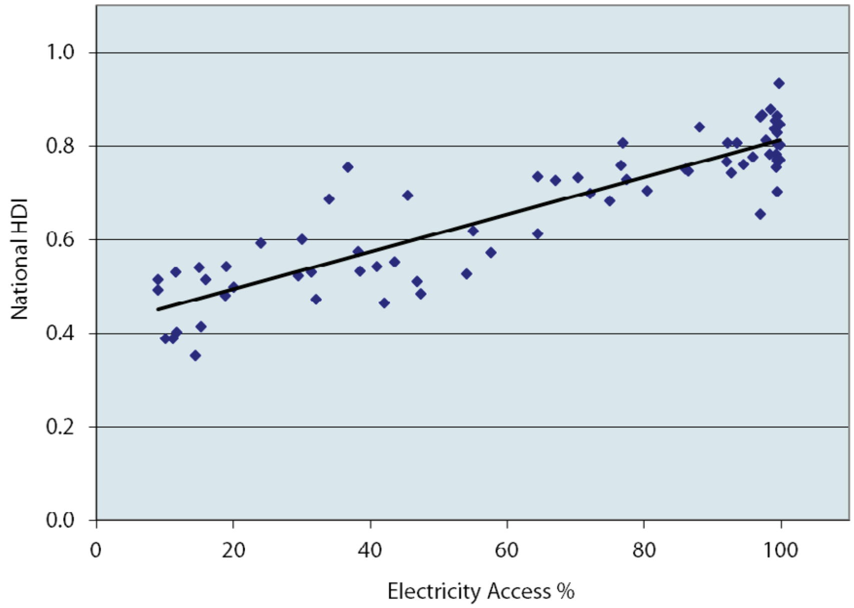
Although the correlation between energy consumption and HDI is strong at the transition between low to median values of HDI, that correlation weakens at low and high levels of HDI. This indicates that advances can be made in HDI with very limited energy consumption, but that medium to high levels of HDI cannot be achieved without energy. It also indicates that additional energy consumption after a certain level (approximated by the dashed line shown) does not correlate strongly with further increases in HDI. Excess energy inefficiently used, for example, does not contribute to HDI improvements.

Figure 4: Human Development Index (HDI) against gross energy consumption per person



Note: Hong Kong is referencing Hong Kong SAR.
Source: www.thewatt.com/node/170.

Figure 5: Electricity Access vs. Human Development Index



In terms of policy and implementation, this poses an important challenge, since development outcomes depend strongly on who uses the energy and for what purpose. While gross consumption of energy supplies is a useful macro indicator, it is too aggregated in general to pick up these issues that are better understood by considering the extent of energy access, as defined in the previous sections. Using access to electricity as a percentage of the population, rather than energy consumption, apparently provides a much better predictor for HDI, as shown in Figure 5.

Energy access percentage is a better (more linear) predictor of HDI probably because energy access figures generally connect more closely than overall consumption figures to development outcomes. This is partly because increased energy access contributes (in the form of basic energy services) directly to development outcomes for more people. Another reason is that access percentage figures are less distorted by large individual or institutional users, such as industries, which may boost total national energy consumption substantially (which affects a per capita consumption figure significantly) while not contributing a great deal to HDI of the overall population.

It is also possible that an increasing percentage of electricity access mirrors greater levels of equity within countries and general quality of governance, which could be expected to have knock-on impacts on other public service provision, thereby raising HDI; however, such linkages are likely to be context-specific. The potential contribution of decentralized energy options, though, does support this hypothesis, since lack of grid extension and of 'energy equity' often correlates with weak governance and institutional scenarios. Decentralized energy options tend to use a greater variety of delivery mechanisms, fewer of which are state-dominated, as explored through the case studies in Chapter 3.

An important linkage between energy and development, though, is their contribution to employment. The subsequent sections of this chapter put forward a framework for this contribution.

2.2. Employment and development

2.2.1. Defining employment

The International Labour Organization (ILO) definition states that "persons in employment comprise all persons above a specified age who during a specified brief period, either one week or one day, were in the following categories: paid employment or self-employment."[7]

However, the significance of employment goes far beyond this definition. For human beings, employment is not only crucial in enabling people to financially support themselves and their families, but can also play a critical role in developing transferable skills, social networks and even a sense of self-worth. Employment creation also takes a central role in public policy worldwide. Poverty Reduction Strategy Papers (PRSPs) produced in Africa highlight employment creation as a key goal in poverty alleviation with at least 17 of 21 in 2005 including specific targets on youth employment in particular. Example quotes from PRSPs include the statement that "poverty reduction requires a rapid increase of employment opportunities" (Burkina Faso). In Zambia it is stated that development of an export-led manufacturing industry "will lead to an increase in job opportunities, sustainable export earnings and the growth of manufacturing, GDP and employment". Employment is such a key component of PRSPs that it often almost goes undefined and unanalysed, as it is considered such a self-evident good, often alongside economic growth.

The ILO offers a more detailed breakdown of employment as follows:

1. Wage and salary workers
2. Family workers
3. Self-employed (including subsistence agriculture)

Moving from 1 to 3, it is recognized that less formal work arrangements are likely to occur, although 'self-employed' clearly can also include business owners who may be in a stronger employment position in some cases than wage and salary workers.

Another important concept relating to employment is that of 'decent work'. This is defined by the ILO as "work that gives people the opportunity to earn enough for themselves and their families to escape poverty, not just temporarily but permanently". More broadly, decent work is considered to "reflect the aspiration of men and women [everywhere] to obtain decent and productive work in conditions of freedom, equity, security and human dignity".[8] The category of 'working poor'—people working but earning less than USD 1 per day—describes those who are technically employed but unable to access decent work (ILO, 2007).

Building on these definitions and issues, this study will define improvement in employment as being contingent on one or more of the following three conditions:[9]

7 *stats.oecd.org/glossary/detail.asp?ID=778* (accessed 7th December 2011)

8 'Working out of Poverty', Report of the Director-General Juan Somavia to the 91st International Labour Conference (Geneva, 2003). Available at *www.ilo.org/public/english/standards/relm/ilc/ilc91/pdf/rep-i-a.pdf*

9 See also, Practical Action, 2010.

- **New jobs:** the quantity of employment

  'New jobs created' (or its inverse, job losses) is often the only measure of employment used. While it is a useful gross indicator, it can also be manipulated by sub definition of full- versus part-time or seasonality of labour, for example, and can mask issues such as with the 'working poor' earning under the income poverty line. The definition of 'new' employment used in this report reflects the increase in the person-hours of work undertaken for pay or in self-employment, which better illustrates the extent to which people are working more and accounts for the issue of the 'underemployed'.

- **Improvement in jobs:** the quality of employment

  In order to address the more qualitative aspects of employment (in both new and existing jobs), this study will also assess the extent to which jobs are improved in several key dimensions toward a standard of 'decent work'. Aspects include income earned per hour of employment, level of job security, level of efficiency versus drudgery in workplaces, level of benefits over and above pay, and reduced use of unwaged family labour.

- **Reduced opportunity costs:** the chance to earn

  The final dimension of employment that this report will evaluate is time newly available for gainful employment that was previously spent to ensure mere survival. This is an important dimension, particularly for women who, without access to energy services, can be trapped in a situation where they are spending large portions of their day in basic processing tasks such as preparing food crops, carrying water or collecting firewood. These activities are often not valued or recognized, but they have an important opportunity cost with respect to removing the possibility of income-generating activities in that time. Challenges in analysing this exist in that time saved is not always converted into income via other avenues; however, failure to recognize this benefit would ignore the potential contribution of women to household earnings and the importance of women's inputs in bringing a family out of poverty.

2.2.2. Connecting employment and development

As described in the introduction, MDG Target 1.B, which was added in 2005, aimed at "achieving full and productive employment and decent work for all, including women and young people". This indicates the constituent role that employment has in addressing MDG 1 on ending poverty and hunger. Khan (2007) states, "The link between employment growth and poverty reduction is predominantly a one-way link in which growth in productive and remunerative employment brings about rapid poverty reduction." Creation of new jobs representing 'decent work' is seen as essential to enabling the jobless to work their way out of poverty, while improved returns on existing employment activities are needed for people to escape the status of working poor. Meanwhile, reducing household drudgery is required if women are to be free to participate in either new jobs or improvements in existing employment.

However, employment also has wider implications for development and meeting the full set of MDGs. A summary of these, drawing on extensive work in this area to date, follows (Osmani, 2005b; Khan, 2007):

- Lack of decent work on the part of parents can make it necessary for children to work to help support the family rather than learn in school – a key challenge to meeting MDG 2 on universal education.

Higher family income, based on employment, can also pay for private education if necessary, while improved education improves long-term opportunities for employment, creating a potentially virtuous circle.

- Family incomes are an important predictor of child and maternal health, via increased expenditures on health care and nutrition, relevant to MDGs 4 and 5.

MDGs 2, 4 and 5 can therefore be considered to be strongly linked with increasing and improving employment, although they are also linked to wider structural and societal issues such as the quality of public services (number of schools, health clinics, etc.). In this respect, they depend on a combination of private and public provision of these services, with private access more directly enhanced by higher incomes. However, where good governance is in place, higher tax revenues from employment could also expectedly translate into improved public services (and into more jobs in providing those services).

Similarly, MDGs 3, 6 and 7 have strong 'public good' elements, so progress depends on coupling expanding employment with other factors, namely:

- Access to employment opportunities by women and the resultant balancing of gendered income and power disparities are important components in the achievement of MDG 3 (gender equality). Public policy is a major driver of this. Yet where employment is high for any reason (e.g., during the Second World War in Western nations), gender equity can be promoted.
- Income poverty and joblessness in sub-Saharan Africa can play a role in forcing women into sex work, thereby increasing their vulnerability to HIV/AIDS. Low incomes can make access to anti-retroviral drugs unaffordable (where public or aid agencies are not providing these).
- Where decent work is not available, poor people are often pushed back onto the natural resources of the land, including illegal firewood extraction, environmentally harmful agricultural practices and killing of wild animals, all of which obstructs progress toward MDG 7 (environmental sustainability).

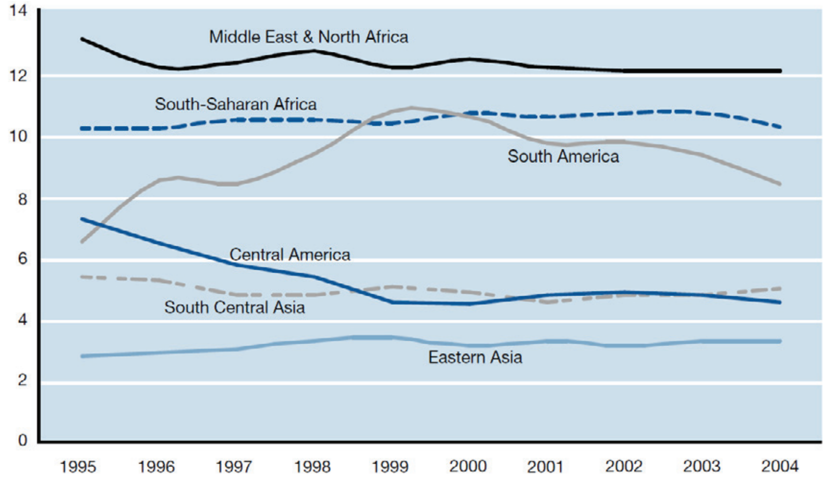
MDG 8 on global partnerships is less directly coupled to increasing employment, although meeting specific targets on MDG 8 (e.g., larger aid inflow, a non-discriminatory trading and financial system, comprehensively dealing with developing countries' debt, and developing and implementing strategies for youth employment) would positively affect employment. An additional linkage, however, consists in the current regional discrepancies of employment opportunities, a key driver of the economic migration that can put pressure on international relations.

2.2.3. Employment in sub-Saharan Africa

The level of unemployment in sub-Saharan Africa has for several decades been estimated to be among the highest in the world, as shown in Figure 6 , which illustrates unemployment percentages by region.

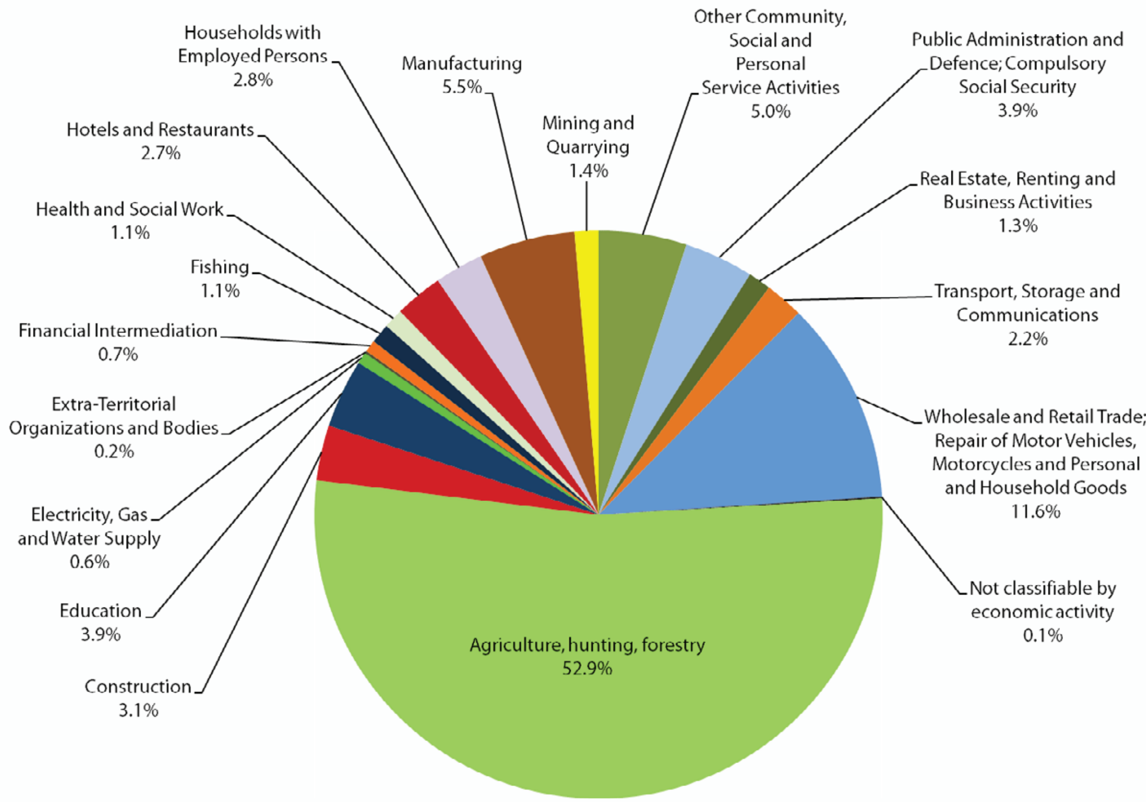
However, a lack of accurate, complete and comparable data frustrates such analysis of employment status and trends in the region. For the last 10 years, the ILO has data on only 11 sub-Saharan African countries; for seven of these countries, only one year of data is available. Using the most recent year of available data for those countries that provide it, Figure 7 shows the current pattern of official employment by sector in sub-Saharan Africa, with averages for employment percentages across countries.

Figure 6: Unemployment percentage by region



Note: South-Saharan Africa is referencing sub-Saharan Africa.
Source: UN ECA, 2005.

Figure 7: Average employment percentage in 11 sub-Saharan African countries



Source: Based on data from the ILO LABORSTA online database.

Even allowing for inaccuracies in the figures, the dominance of the agriculture, hunting and forestry sector is clear and this remains a crucial employer and source of livelihoods in the region. If the total number of people employed, rather than an average of percentages, is taken, then the picture is stacked even more heavily toward agriculture, hunting and forestry, which accounts for more than 64 percent of the total number of people officially employed in the reporting countries.

Clearly second in terms of employment importance, although with less than a quarter of the share of agriculture, is wholesale and retail trade, which includes motor vehicles as well as personal and household goods. This sector is more than twice as important as the next most significant employers – manufacturing, and community, social and personal services – and is closely connected with energy access in that growth in use of vehicles and appliances is based on energy use. In terms of energy supply sectors, electricity and gas are bundled together with water supply and represent just 1 percent of employment.

While such information is useful and, if more attention and support were available for improved data collection in more countries, could be more useful, the picture presented cannot be a basis for current decision-making. Such official statistics are likely to substantially underestimate unemployment in sub-Saharan Africa in all three dimensions of employment: new employment, improvement in jobs, and reduced opportunity costs.

Other available data, although still patchy, points to critical issues in the quality of employment in terms of 'decent jobs'. Table 3 illustrates the challenging proportions of working poor and emphasizes that sub-Saharan Africa has the highest and most persistent level of working poor globally.

According to Table 3, an estimated 53.5 percent of the total number of people employed in sub-Saharan Africa in 2006 were 'working poor'. This figure may even be an understatement, since the working poor work mostly in the informal sector and in agriculture, where underemployment is the norm. Workers in the informal economy tend to earn less than their counterparts in the formal sector. Informal workers also tend to have little or no access to formal risk-coping mechanisms, such as insurance and pensions, or to services for production. They also lack the resources to pay for housing, health care, education and training (ILO, 2002b).

The role of the informal sector in employment is probably the most important aspect not covered in official statistics. This is estimated to account for up to 72 percent of non-agriculture-related employment in sub-Saharan Africa, and 78 percent if South Africa is excluded (ILO, 2002a). The same studies imply that the informal sector actually grew rather than diminished as a share of employment in the region through the 1990s. Informal employment is generally

Table 3: Proportions of working poor internationally

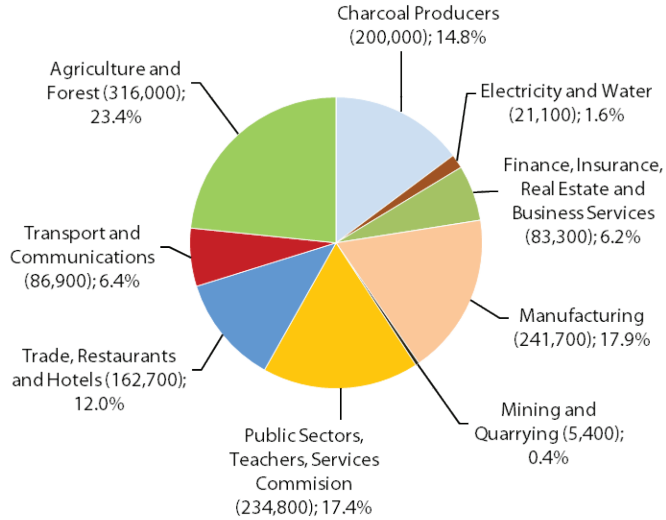
	Working Poor Shares (USD 1/day)	
Region	**1996**	**2006**
WORLD	25.0	16.7
Developed Economies & European Union	0.1	0.0
Central & South-Eastern Europe (non-EU) & CIS	7.5	1.9
East Asia	19.5	9.5
South-East Asia & the Pacific	22.1	13.6
South Asia	56.6	33.5
Latin America & the Caribbean	12.1	8.0
North Africa	2.8	1.6
Sub-Saharan Africa	**58.5**	**53.5**
Middle East	2.3	4.9

Source: ILO, 2007.

a larger source of employment for women and, 84 percent of female non-agricultural workers in sub-Saharan Africa are informally employed. A later study even put this last number at 92 percent, while agreeing closely with the previous numbers on overall proportions (Becker, 2004).

This is obviously important when considering employment growth and patterns, but especially so when the informal energy sector is considered, as shown in Figure 8 for Kenya. The data show quite a different profile of employment than the official figures indicate and are more diversified. In this case, the role of charcoal production as a direct employer of 200,000 people stands out with respect to energy. An estimated 500,000 people are involved in the trade (transporters, vendors, etc.) and the industry supports approximately 2.5 million additional dependents. As the second biggest employer in rural areas after agriculture, this is a very important sector for rural employment. Given the prevalence of fuel-wood and charcoal use, this pattern can be expected to recur in other countries in the region, especially in those with important forest resources.

Figure 8: Employment in Kenya by sector



Source: ESDA, 2005.

The final important factor for interpreting official statistics is the role of seasonality in employment, particularly given the importance of agriculture as an employer. Agricultural employment levels, and workers' incomes, rise and fall over the year with the seasons and this is a key source of vulnerability for those living in income poverty. If the statistics were gathered in the harvest season, for example, then employment levels would be significantly greater than the average level for the year; however, if 'full-time permanent' employment is the standard, then many more people would appear unemployed than in fact are able to earn an income.

An increasing proportion of energy access and usage in employment sectors may be expected to soften the effect of seasonality of income as improved irrigation, processing and storage of agricultural products should reduce feast and famine, while non-agricultural energy-based sectors are generally much less seasonal.[10]

The underlying trend in these statistics, however, which was picked up in the Africa Commission 2009 report, is the unemployment among youth in sub-Saharan Africa, which is twice that of the overall labour force (UNECA, 2005; ILO, 2004). In realizing the potential of Africa's youth, the current employment structure of African economies cannot necessarily be used as a guide to a future economy with greater levels of employment and diversity of economic activity. Economic growth and greater energy access must be part of that future. The following sections explore how each contributes to boosting employment.

10 However, research showed that tailoring and carpentry in North India had much stronger peak seasons if they had machines and light (Kooijman, 2008).

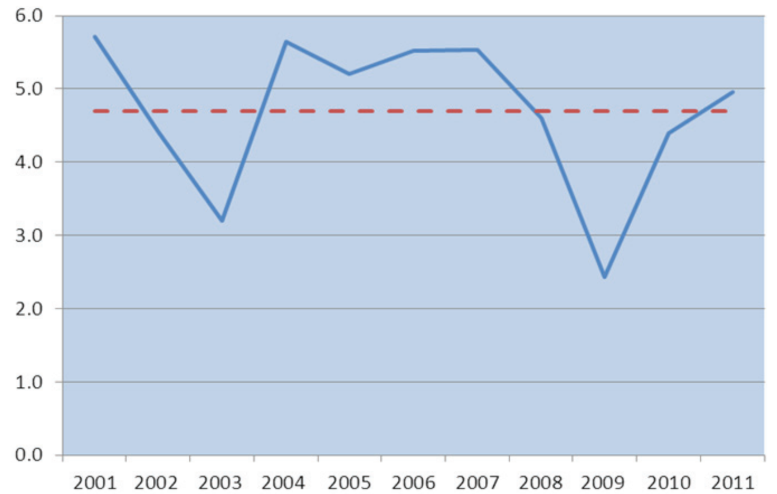
2.3. Growth as a driver of employment

While employment is a key objective for all governments, whether in rich or poor countries, it is not generally within the power of public policy to directly mandate an increase in employment. Governments do directly employ a proportion of the workforce, but this is generally fairly low. In the 11 sub-Saharan African countries for which ILO data is available, less than 9 percent of employment is in state employment sectors. While public procurement also plays an important role via large public works and investment projects, the extent to which the state can directly create employment is limited. The Africa Commission Report (2009) estimates that nine of 10 jobs in the developing world are in the private sector and private companies are the main long-term source of jobs and incomes.

Since gross domestic product (GDP) is the main measure of economic activity, it is generally assumed that increased growth leads to greater employment and less poverty. For example, the World Bank states that "policymakers who seek to reduce poverty should implement policies that enable their countries to achieve a higher rate of growth" (World Bank, 2005). As noted in defining employment, employment in this type of equation is considered to be a self-evident good as well as the mechanism through which the benefits of national economic growth 'trickle down' to the population. There is indeed a connection between growth and employment, but not a direct one.

Figure 9 shows the average economic growth in sub-Saharan Africa over the past 10 years. A comparison of Figure 9 with Figure 6 (presenting unemployment percentages) reveals an interesting phenomenon: while macroeconomic performance has markedly improved in Africa since the mid-1990s, this seems to have had little impact on unemployment. Average annual GDP rose from less than 3 percent in 1998 to an average of between 4 percent and 5 percent in the last decade. Yet unemployment appears (based on official employment figures) to have remained largely unchanged since 1995, implying that the formal sector has not been able to absorb the unemployed.[11] It should be remembered that the official figure almost certainly underestimates the true level of unemployment, while many more are also underemployed in the informal sector, as illustrated in Table 3.

Figure 9: Economic growth percentage in sub-Saharan Africa, 2001 to predicted 2011



Source: ADB/OECD, 2010.

11 For example, the latest IMF economic forecast for Namibia, released in October 2010, predicts strong economic growth of 4.8 percent for 2011. However, Namibia's official unemployment currently remains at around 50 percent (Duddy, 2011).

2.3.1. Jobless growth

The United Nations Economic Commission for Africa (UN ECA) has made an analysis of the disconnect among growth, employment and poverty in Africa, highlighting how "the share of the total population living below the USD 1 a day threshold of 46% is higher today than in the 1980s and 1990s; this despite significant improvements in the growth of African GDP in recent years. The implication: poverty has been unresponsive to economic growth." Connecting more specifically with employment, they go further, stating that "underlying this trend is the fact that the majority of people have no jobs or secure sources of income." The authors ascribe the lack of impact of growth on employment in Africa to three issues (UN ECA, 2005):

- Inadequate growth compared with scale of economic challenge
- Low labour absorption in growth sectors, especially the capital-intensive extractive sector rather than high-employing sectors such as agriculture
- The inequality of employment opportunities created

The first of these reiterates the assumption that increasing growth boosts employment, but that there was not enough growth in the 10- to 15-year period in question. However, as the following section explores, the other two present potentially important disconnects, which have implications for the connection between economic growth and employment.

2.3.2. Elasticity and integrability of growth

The World Bank 2005 report, which asserted the primacy of growth for eliminating poverty, goes on to say that "growth is more effective in reducing poverty in some countries than in others, depending on the capacity of poor people to participate in and benefit from growth". The poor can participate in and benefit from growth predominantly through employment, although this is again not made explicit. An ILO-UNDP report (Osmani, 2003) identifies more explicitly the two main factors accounting for the disconnect between growth and poverty alleviation, via employment, as follows:

- **The elasticity factor:** The extent to which economic growth is connected to an increase in the employment potential. Key variables in this regard include the sectoral composition of output ("Is growth occurring in labour-intensive sectors?"), the choice of technique ("Are more labour-intensive processes being used?") and the terms of trade ("Are internal and external prices improving the returns on labour?").
- **The integrability factor:** The extent to which employment growth potential is in sectors and job types that poor people are able to access and participate in with skill sets that they already have or could relatively quickly gain. The poor face many barriers to becoming integrated with expanding employment, such as market failures (insufficient financing for poor people to invest in an opportunity), poor infrastructure (which inhibits rural people's access to job markets), lack of information (which prohibits understanding of emerging opportunities), mismatch of skills (inability to be able to do the new jobs created), institutional barriers (existing labour institutions may exclude poor people) and gender barriers (certain types of employment may be 'gendered').

It appears clear from this analysis that, if growth is to contribute to employment (and ultimately poverty reduction), then the nature of that growth must be taken into account more clearly in order to understand growth benefit distribution. For example, a growth sector may yield substantial GDP benefits via exports (e.g., a large aluminium smelter), but may not necessarily generate much employment. That GDP increase could translate via taxes into increased public spending on services or infrastructure, creating wider development benefits, although this will not necessarily actually be the case. A currently widely accepted model of 'inclusive growth' proposes a growth-led strategy coupled with wider distribution of benefits via progressive tax and social security policy, as well as improved opportunity for poor people to participate in growth sectors more directly via employment.

2.3.3. Productivity

A final key factor connecting growth and employment is productivity. Productivity is a generally positive characteristic of any production system, associated with increased throughput, greater efficiency and reduced costs to end-consumers. The application of new methods and technologies (including new energy services) to production systems is often linked with increased productivity. Productivity can be measured in terms of units of output compared with any unit of input and, at national levels, would be expected to translate into improved living standards based on better use of resources. Improving productivity at the level of the firm can be expected to improve competitiveness, which creates a potential for enterprise growth and thus for increased levels of new and improved employment.

Although there are many measures of productivity, a key factor with respect to employment is labour productivity. Efforts to increase labour productivity may expectedly have more complex effects on employment. For example, reducing the workforce in a firm or economic sector while maintaing the same level of output would require an increase in labour productivity, but would result in fewer jobs. However, increasing overall productivity (which includes labour productivity) should, as discussed above, increase competitiveness, which may in some circumstances protect or create jobs in the longer run. Such analysis can only really be conducted on a case-by-case basis for firms, sectors and economies in question, although this is often a contested issue.

The dominant current employer in Africa, the agricultural sector, is also the one most noted for low levels of labour productivity (UN ECA, 2009). According to the Food and Agriculture Organization (FAO), the agricultural labour productivity in sub-Saharan Africa has been declining annually (FAO 2005). Labour productivity improvements in agriculture (for example, via use of tractors or pumped irrigation) would be associated with reductions in drudgery (hand-hoeing, water carrying, etc.) as well as improved returns on employment (better returns for each hour worked for farmers). However, if overall productivity improves in the agricultural sector, it is possible that fewer people will be engaged in this activity as a proportion of the population. On the other hand, an increase in productivity could also result in increased output, addressing increasing food requirements and export markets, but without increasing labour rates. At the same time, an overall increase in employment is possible if new related enterprises (such as agro-processing co-operatives) emerge. Such apparent paradoxes and wider implications must also be taken into consideration when assessing the contribution of growth to employment.

2.3.4. Connecting growth and employment

Drawing from the above analysis, the following factors will be used in this study to assess the extent to which economic growth contributes to employment creation in the dimensions described in its definition:

- **Employment intensity of growth sectors:** The extent to which new employment opportunities are created by growth in a sector and as a whole. This factor will be strongly mediated by productivity, with varying short- and longer-term impacts on employment.
- **Accessibility of opportunities created:** The extent to which new opportunities are accessible to the general workforce and to poor participants in particular (this assumes that improvements in existing employment are by their nature accessible to those in that employment).
- **Wage Equality:** The equitability of returns from growth in a sector and as a whole, or the extent to which benefits of growth are shared among employees in wages, as an indicator of the extent of employment improvement.

The last factor can be considered important in ensuring that employment opportunities are converted into 'decent jobs' at wage levels that enable employees to sustain their families. Tools such as minimum wage levels are often used in this regard, although they are less effective in primarily informal economies.

A final element of the growth-employment nexus to consider is the connection between growth and reduced opportunity costs. Although this connection is not direct, growth that translates into new and improved employment 1) raises the level of household income available to purchase household labour-saving devices/services (often energy-based services) and 2) raises the value of the opportunity cost (the wages that could otherwise be earned when conducting a time-consuming, non-productive chore). This combination would expectedly promote a shift away from drudgery, reinforcing benefits to employment and development.

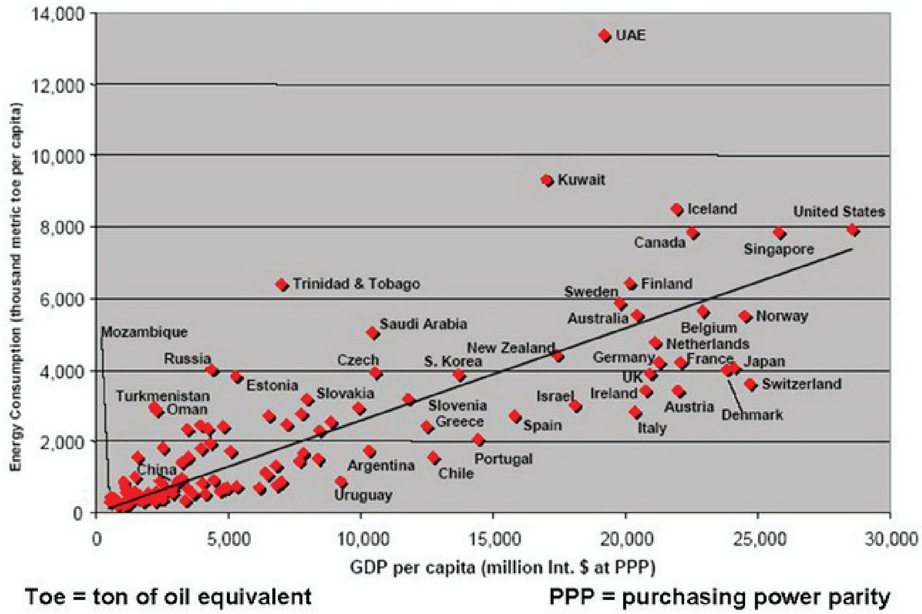
2.4. Energy as a driver of growth

Of course, very many studies over many years have discussed how to generate sustained growth in economies. This study, though, specifically addresses the question of how energy access might support or increase the kind of growth that would increase employment, particularly for the poor, and so reduce poverty. Energy consumption per capita and GDP have been demonstrably correlated, as illustrated in Figure 10.

However, although a general correlation can be seen, as with the graph of energy consumption against HDI (Figure 4), there is significant scatter, indicating that the energy intensity of GDP (a key measure of energy productivity) can vary widely between countries. Again, the issue of who does what with the energy is a key factor in the connection between energy consumption and GDP. If we plot electricity access percentage, as opposed to energy consumption, against GDP per capita (eliminating rich countries and oil states), we get some interesting results that are presented in Figure 11.

First, the relationship between electricity access and GDP remains, but is less linear. The reason for this may be that large individual electricity consumers (and GDP producers) like mines and mineral processors are now excluded. There are also some very significant outliers, including Botswana and Gabon, which have high

Figure 10: GDP vs. energy consumption

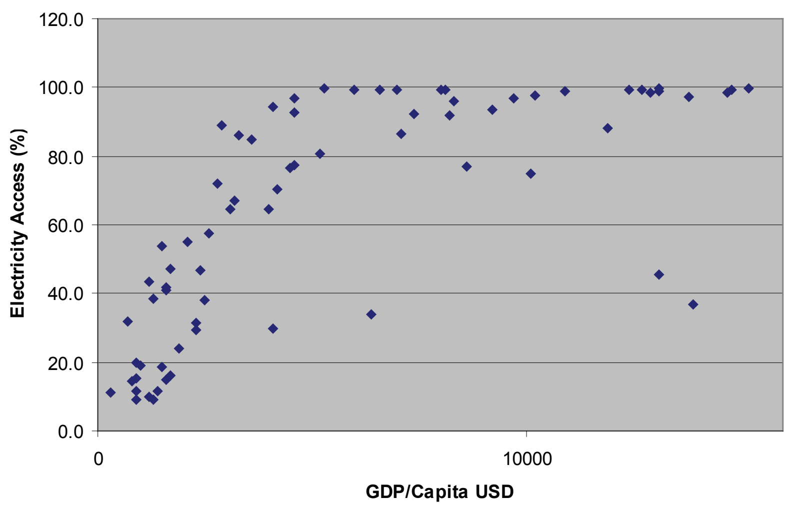


Source: www.greenparty.ca/sites/greenparty.ca/files/Energy_Consumption_vs_GDP_655.jpg

GDP per capita, but relatively low rates of electricity access; this may highlight issues relating to distribution of wealth and/or challenges in developing electricity infrastructure. It should be remembered that electricity access percentage, rather than energy consumption per capita, is a better predictor of HDI.

Energy is connected with growth and the underlying distribution patterns can be unpicked in more detail using tools like the Energy Gini (see Box 1). However, a direct causal relationship cannot currently be shown and available studies on the issue conflict (Ozturk, 2010). Causality can be in both directions, i.e., growth can lead to increases in energy consumption and energy consumption can lead to growth. This implies some kind of non-linear feedback relationship between these factors that will also contain other variables, including employment.

Figure 11: GDP per capita vs. electricity access



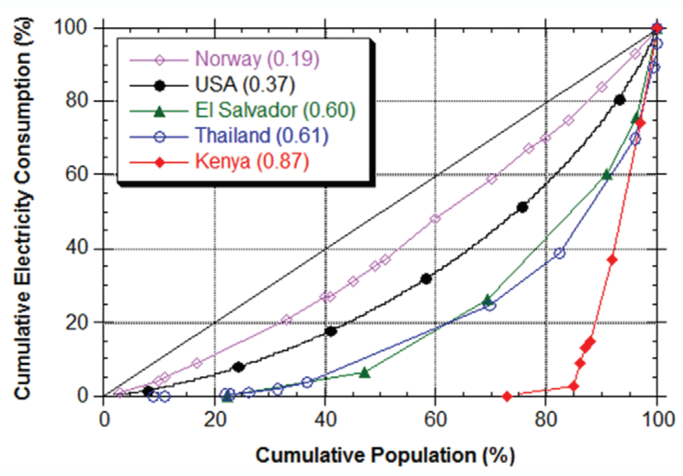
Source: GDP per capita is from World Bank and Electricity Access from IEA, accessed in 2011

Box 1: Measuring energy equality

Energy consumption has long been seen as a critical indicator of socio-economic opportunity, national economic activity and growth, and as a key factor in the human impact on the environment. Some measures of energy usage, most of which rank energy consumption on a per capita or per productivity basis (e.g., kWh/capita, kWh/GDP), are widely used for tracking national economic performance as well for measuring development. Beyond these crude measures, however, few analytic tools exist to examine the interactions between economic activity and energy services, to examine, on a macro level, the temporal evolution of energy infrastructure, and to examine the economic and social returns on energy investments. The use of disaggregated consumption data to analyse distributions of energy consumption is extremely rare. However, the significance of energy distribution trends — including equity-related trends — cannot be determined without consideration of disaggregated data.

Lorenz curves, which are commonly used by economists to estimate income inequality, are largely unused in energy analysis. Lorenz curves can play a valuable role in the energy field as a new analytical tool that combines energy access and consumption into a single metric. This metric allows for inter-country comparisons while simultaneously providing information about intra-country distributions of energy consumption. Lorenz curves can be used in longitudinal studies to identify distributional trends in a country or region. Longitudinal analyses are a particularly important tool for understanding changes in energy equity due to policy shifts, for exploring the often complex relationships between patterns of energy consumption and economic trends, and for examining the potential returns on investment in national or regional energy infrastructure programmes.

The **Gini coefficient** is a numeric measure of inequality that reveals the difference between a uniform distribution and the actual distribution of a resource. It is calculated from the Lorenz curve by taking the ratio between (1) the portion of the area enclosed by the diagonal line and the Lorenz curve and (2) the total area under the diagonal line of uniform distribution. The Gini coefficient ranges from perfect equity among all members of the population (G_e=0) to complete inequity (G_e =1). Because more than one Lorenz distribution of a resource can lead to the same Gini value, it is often advisable to view both metrics simultaneously.



To illustrate the application of the Lorenz and Gini metrics, the figure above presented Lorenz curves for Norway, the United States of America, El Salvador, Thailand and Kenya. The Lorenz curves reveal dramatic differences in the intra-country distribution of residential power consumption among the nations.

Norway, where half of residential electricity is used by the top 38 percent of the household customers, has the most evenly distributed electricity consumption pattern. It is followed by the United States of America, where half of the electricity is consumed by about 25 percent of the households, and then by El Salvador (≈15 percent), Thailand (≈13 percent) and Kenya (≈6 percent). The analysis shows that the distributional characteristics of household electricity consumption depend heavily on a combination of the countries' wealth, income distribution and historical government infrastructure-building policies. For example, a strong relationship is observed between increasing household income and higher electricity consumption levels for the United States of America. A range of additional factors shape the Lorenz curve, such as conditions, energy efficiency measures and the size and geographic distribution of a country's rural population.

Source: Kammen & Kirubi, 2008.

Before attempting to develop this in more detail via case study analysis in Chapter 3, a framework for the contribution of energy to economic growth is required for analysis of existing cases as well as potential and existing policy and practice interventions. In this study, we consider that energy can contribute to growth of economic sectors in two ways.

- **Demand pull:** Growth sectors pulling energy access

  Any economic sector requires reliable, adequate and cost-effective energy services at various points in the value chain. Growth of such a sector is dependent on energy, but is actually driven by other wider factors, including competitiveness, policy, institutions, financing, leadership, natural resources and technologies. Unreliable, inadequate or expensive energy services hamper the emergence and growth of such a sector, but if the wider viability is sufficient, it will pull energy services to it, even at elevated prices. Examples of this scenario that are analysed in detail in Chapter 3 include the tea sector in eastern Africa and the mobile phone sector in southern Africa.

- **Supply push:** Energy interventions pushing economic growth

  Creation of energy access can stimulate economic activity across the board by introducing new energy services to a range of economic activities in a particular geographical area. Such interventions are not targeted at a particular subsector, but are an available amenity for a range of economic sectors and subsectors that can use the services to improve productivity and quality, reduce costs and increase profitability. Examples analysed in Chapter 3 include the rural electrification of a market town in South Sudan and the introduction of Multi-functional Platforms (MFPs) in Mali.

Table 4: Potential linkages of energy and employment

Energy service	New income and employment opportunities	Improvement of existing employment	Opportunity cost saving
Lighting	Street lighting enables night-time stalls and entertainment	Later opening of restaurants, cafes and shops, also production	Creating opportunity for night-time activities in increased safety
Cooking	Sale and distribution of commercial modern fuels and stoves	Cleaner and more cost-effective cooking	Time saved in wood collection and pot cleaning
Refrigeration	Selling ice, ice-cream, new markets for refrigerated products, e.g., milk, meat and fish products or vegetables	Less waste of agricultural and fishery products, creating more income	Reduced time spent keeping goods fresh or selling intensively in a short period
Heating	Process heat for new industrial processes	Improved comfort in hotels and cafés	Time saved in collecting wood for heating
Communications	Internet cafés, mobile phone charging, radio stations	Finding best prices at various markets	Reduced travel time associated with communication

Source: Practical Action, 2010.

Table 4: Potential linkages of energy and employment (contd.)

Energy service	New income and employment opportunities	Improvement of existing employment	Opportunity cost saving
Irrigation	Growing cash crops, in addition to staple crops	Better yields on existing land compared with rain-fed agriculture	Less time spent manually watering crops
Agro-processing	Adding value by refining agricultural products	Increasing throughput and lowering costs	Less time spent manually grinding/pounding, etc.
Manufacturing	Welding and metalwork enabled	Improved quality and speed of carpentry	Time saved by mechanization of repetitive designs
Lifting–crossing	Crossing services can be charged for	Reduced transport costs	Reduced time lost travelling to crossing points

Source: Practical Action, 2010.

2.5. Energy and employment

2.5.1. Micro-level linkages

At the micro level of the household, community or enterprise, it is possible to recognize a series of direct linkages between energy service access and employment. Examples of these are given in Table 4 for each of the key energy services identified and for the three types of employment impact developed in Section 2.2.

Such examples illustrate the wide variety of potential connections between individual enterprises and employment opportunities with energy services. Indeed, there are too many connections to map in a single table, given the extent to which energy is intertwined with modern lives and modes of production. This information is useful at an enterprise or programme level in order to ensure that all possible connections are made between an energy service enabled and employment opportunities that may be derived. However, to understand the wider employment implications, it is also necessary to look at the way in which the energy service is provided.

Table 5 provides an overview from the supply perspective of the linkages between access to the three primary types of energy supply and the employment linkages in the delivery and use of these. Again, the extent of the connections between energy and employment are as clear as they are multifaceted. However, what is not clear from Table 5 is the causality or process of evolution between the factors, which is essential in order to start to develop policies to create and accelerate such connections.

Figure 12 indicates a model of causality between energy supply infrastructure being put in place and potential changes in poverty status. The diagram illustrates the disconnect between the two and the necessary steps that individuals and enterprises have to take in order for the benefits of energy access to be realized, particularly, the focus of this study is the way in which the enterprise is changed by energy access in its success and growth and how that converts into employment outcomes. The way in which decentralized energy systems can act as a driver for this process is the input factor that will be explored in the most detail.

Table 5: Linkages between energy demand and supply options

	Employment linkages	Equity and Employment linkages	Specific contributions of energy carriers		
			Electricity	Mechanical power	Modern fuels
SUPPLY of the Energy Services	**The Fuel** - Production - Processing - Retail	Traditional woodfuel collection a huge issue for women (and children). Not a 'job', but work and opportunity cost	Option for power generation with biofuel, biogas, and fossil fuels (diesel, gasoline)	Mechanical power (MP) input to fuel production, esp. processing (e.g., oil expelling)	All modern fuels have fuel production steps: charcoal, biodiesel, bioethanol, briquettes
	The Appliance - Product Production - Sale/Marketing - Maintenance	Often forgotten in electricity projects as 'other side of meter'. This delivers the service, though	Electrical appliances: phones, TVs, radios, hairdryers, lights	Pumps, lathes, drills, circular saws etc.	Production and sales of improved stoves, gas lights,
	The Conversion Equipment - Production - Installation - Maintenance	Technology transfers of equipment must incorporate capacity building. Ownership issues with household systems	Hydro turbines, solar panels, diesel generators, wind turbines, transformers	Watermills, windmills, MFPs	MFPs are a crossover with fuels/electricity/ MP. Biogas digesters, flare gas capture and bottling
	Other linked Delivery services - By-products - Supporting services (e.g., marketing, transport, standards, testing)	By-products can offer additional employment to others outside the main chain. Women's societies as marketing groups and in micro-finance have had success	Electrical safety equipment, surge arresters, circuit breakers, spares	Grease and oil inputs, belts, blades, gear replacements	Glycerine and soap from biodiesel production, charcoal dust briquettes from waste
USE of the energy services	**Households** - SMEs and self-employment - Time saving, regained opportunity cost	Household-based employment may be only option for some women to earn cash they can control	Lighting in households for night study to boost income potential	Weaving, milling and grinding of staple foods	Cooking and production of food to sell
	Enterprises - Shops/retail - Workshops - Agro-processing - Restaurants	Entrepreneurial capabilities and opportunities required to develop businesses. Can energy supply stimulate alone or is additional Business Development Services support required?	Night-time retailing becomes possible, entertainment, internet opportunities, welding	Especially carpentry, machining; Local processing of agricultural and forestry products	Fuels for cooking to restaurants/ hotels; Fuels for heating in agro-processing
	Agriculture and Forestry - Farming - Forest products - Forest management	Largest rural enterprises in most developing countries. Trade-offs with food production and biofuels, forest and wood/charcoal	Electricity enables diversification away from total reliance on biomass fuels	Agro-processing, planting, sowing etc., with mechanical aid. Wood processing, irrigation	Better modern fuels reduce impact on forest of woodfuel use via efficiency gains in conversion and alternative fuels
	Transportation - Public transport - Goods transport - Private vehicles	Connecting goods produced in rural areas with urban markets	Limited, except in electric vehicles	Engine power can be applied in land preparation (tractors), lifting/ crossing (towing) and harvesting	Strong connection via fossil fuels, LPG, biodiesel/ethanol
	Public Services - Schools - Hospitals/Clinics	Modern energy crucial to attract and retain health and education professionals in rural areas	Refrigeration of vaccines, lighting (schools, clinics, community centres) clean water supply	Lifting/crossing services across rivers/ravines; Hand water pumps	Institutional cooking, water pumping

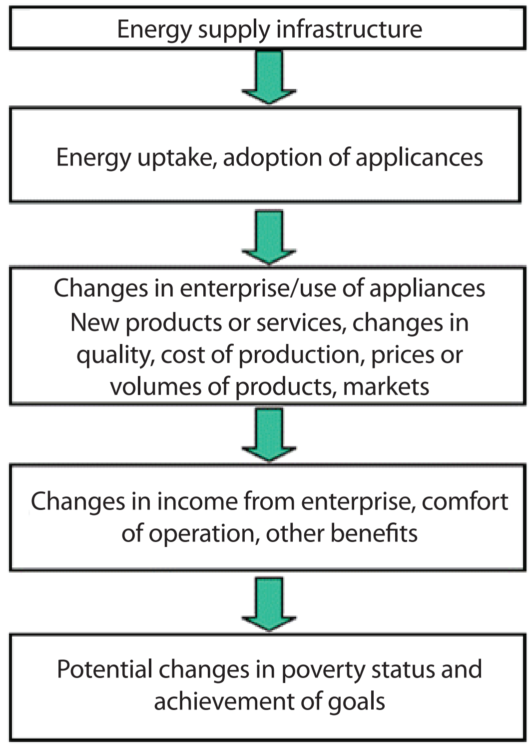
The dynamics and policy entry points to generate the virtuous circles of energy use and employment generation at the micro level are analysed in the next chapter in a series of sub-Saharan African case studies showing how decentralized energy systems have directly stimulated these processes.

2.5.2. Macro-level linkages

Conceptual analysis in Section 2.4 proposes that energy access can contribute to growth via inputs to demand pull sectors as well as to broad-based growth via supply push in an area in which energy access is created. Analysis in Section 2.3 of growth indicates that it can in turn contribute to increased employment, although subject to conditions of employment intensity in the growth sectors, integrability of employment opportunities and wage equality. An increase in employment, however, would also be expected to stimulate the economy and energy access via increased purchasing power and demand from those employed.

The only direct relationship between energy and employment at the macro level appears to be within the energy sector itself; production and distribution of energy imply that a certain amount of employment is needed. However, investments in energy projects can enable economic growth, while any growth requires more energy (unless efficiency in energy use increases).

Figure 12: Steps in achieving income growth and other benefits after introducing energy access



Source: Kooijman van Dijk, 2008.

Combined, these analyses indicate that, while energy, growth and employment are correlated, relative causalities go both ways among the three. This implies the existence of a dynamic feedback relationship among these three factors, with multiple additional factors mediating the likely employment and development outcomes. Through analysis of empirical evidence from case studies in sub-Saharan Africa, Chapter 3 will try to shed further light on these relationships such that a usable framework can be developed to inform policy recommendations on harnessing the drivers and overcoming the barriers to increasing modern energy access and employment.

3. Empirical Analysis of the Impact of Energy Services on Employment

A core component of the study was a series of case studies, conducted in sub-Saharan Africa by regional specialists, that inform the conceptual framework and provide the empirical basis for analysis of drivers of and barriers to scale up. The cases were selected to illustrate a range of geographical contexts in sub-Saharan Africa as well as a range of decentralized energy supplies, services and related technologies. With respect to the conceptual framework, they fall into three categories:

- **Demand pull:** in which a successful employment-intensive sector has emerged, enabled by its ability to pull in different forms of modern energy access at a series of stages in the value chain.
- **Supply push:** in which a specific kind of modern energy access has been introduced in a particular geographical area, making a contribution to a series of different employment-creating value chains.
- **Supply-side cases:** in which the modern energy supply sector itself can be seen to be a significant employer.

After summarizing the contextual background, each case employs a market-mapping approach to identify the full extent of the relevant market system and thus the extent of the contribution of energy access and impacts on employment in the dimensions defined in Chapter 2. Drivers and barriers are also assessed in each case; these are provided in full in the annexes, as are recommendations that are analysed in the concluding chapter of this report.

3.1. Growth sectors 'pulling' energy

3.1.1. Case selection and approach

A hypothesis arising from the literature review and preliminary conceptual framework is that employment sectors in sub-Saharan Africa are dependent for their growth and success on access to energy. In particular, it was proposed that new energy approaches could support such sectors at some levels, assisting in overcoming constraints relating to grid and infrastructure access, particularly in rural areas. In order to analyse this hypothesis, a series of cases were selected that are at the forefront of growth and employment creation in the region and that have benefited in their expansion from decentralized or renewable energy inputs. The cases selected were:

The tea sector in eastern Africa — Tea accounts for 20 percent of the export earnings of Kenya and the country is the third largest producer of tea in world. The tea sector contributes substantially to employment generation in eastern Africa. In Kenya, the sector is thought to employ 800,000 people, with some 3 million — 10 percent of the country's population — being dependent for their livelihood on the sector. The sector is dependent on various energy services at different points in the value chain and various decentralized energy options have underpinned the success of the sector. The sector also features a hybrid ownership and employment structure, incorporating


Photo: Graeme Watson

Photo: Tinashe Nhete, Practical Action

large private plantations as well as a national co-operative structure (the Kenya Tea Development Association), which influences the key mediating factors of accessibility, employment intensity and wage equality.

The mobile phone sector in southern Africa—In 1999, only 10 percent of the African population had mobile phone coverage, primarily in northern and southern Africa. In 2009, 60 percent of the population in sub-Saharan Africa had mobile phone coverage, while only around a quarter had 'electricity access'. The subscriber base in Zimbabwe alone grew more than 300 percent, from just under two million in January 2009 to over six million in 2010 as business conditions improved. The mobile phone sector has been strongly linked with economic growth and accessible job creation. With grid power unavailable in so many rural areas, decentralized energy options, including renewable ones, have played a role at various levels of the value chain in underpinning the success of the sector in scaling up in sub-Saharan Africa.

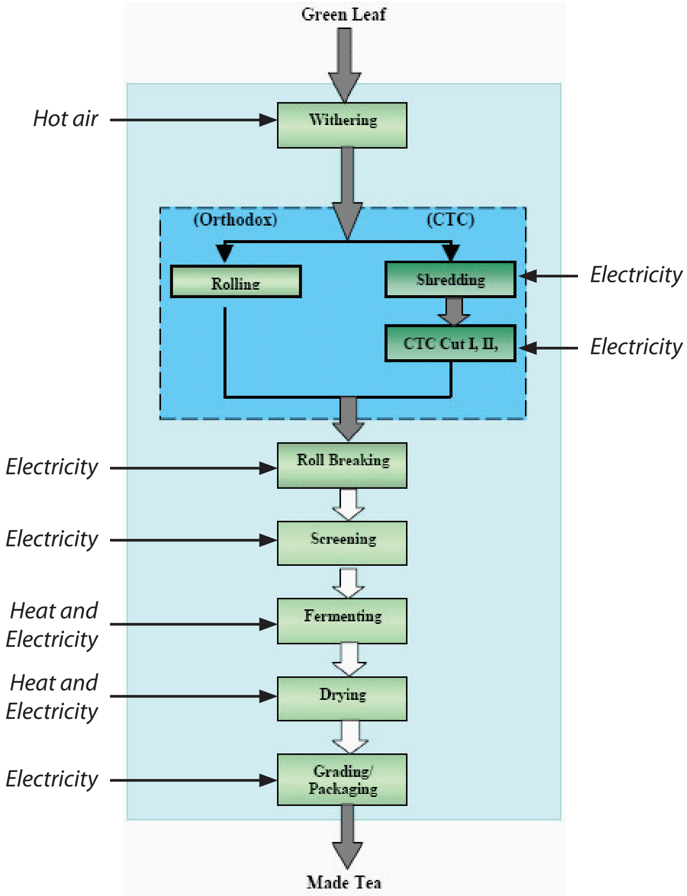
3.1.2. The role of energy services

In both 'demand pull' cases analysed, the role of a variety of energy services and carriers can clearly be seen at various stages of the respective value chains.

The tea sector requires thermal and electrical energy. Thermal energy (from fuels) is required for the withering and drying process; meanwhile, electricity is primarily used as an input to produce mechanical power for operating fans for withering and drying, to power motors for the cutting, tearing and curling (CTC) process and for vibrating sieves to sort and grade tea. The full extent of these connections is illustrated in Figure 13.

Tea processing is energy-intensive, requiring 4.5 kWh/kg to 12 kWh/kg of made tea, compared to 6.3kWh/kg for steel processing (UNEP, 2007). The proportions of electricity and fuels required and their volumes per unit of made tea are shown in Table 6.

Figure 13: Black tea production processes for Orthodox and CTC Tea



Source: AIT, 2002.

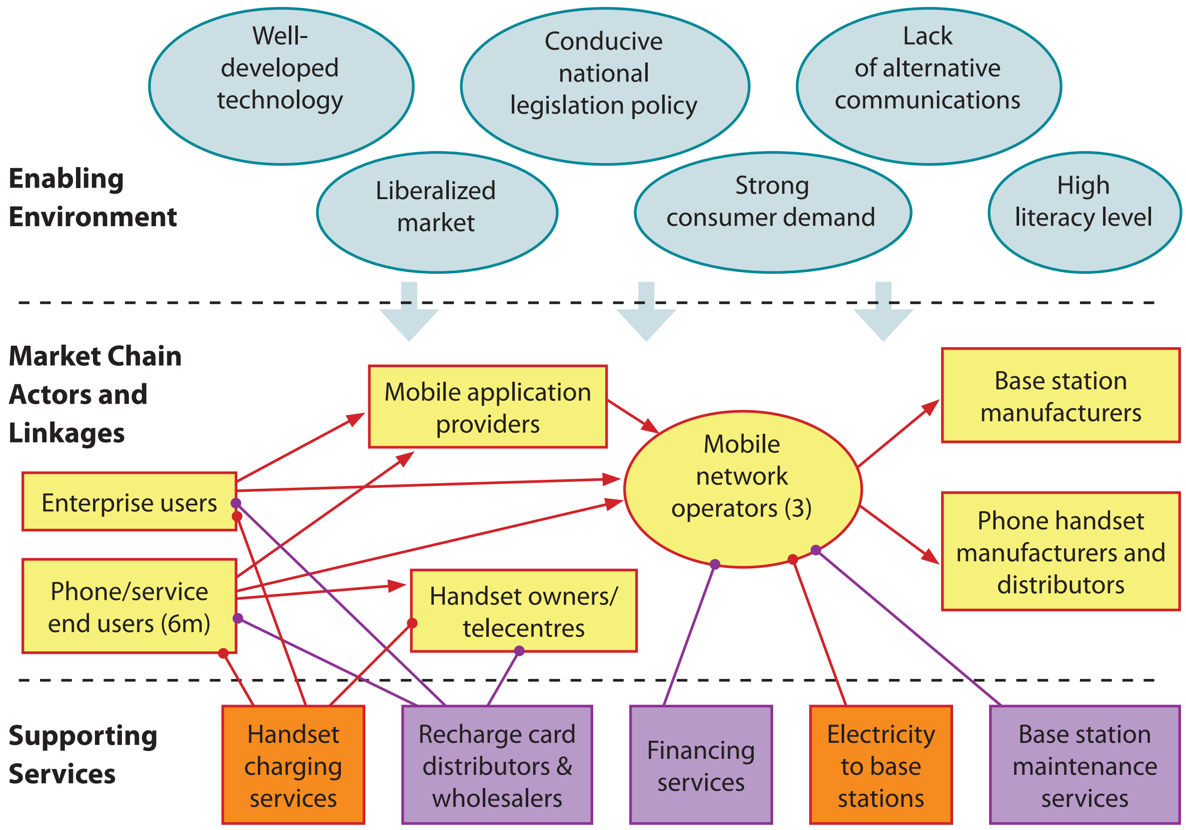
Table 6: Energy requirements in the processing of tea

Process	Electrical Energy %	Electrical Energy kWh/kg made tea	Thermal Energy %	Thermal Energy kWh/kg made tea
Withering	15	0.10	13	0.59
CTC	45	0.29	0	0.00
Drying	15	0.10	87	3.86
Grading	25	0.16	0	0.00
Total	**100**	**0.65**	**100**	**4.45**

Source: UNEP, 2007.

The tea sector can therefore be seen to be strongly dependent on energy access for its basic operation. The same is true of the mobile telecommunications sector. The market map for the sector in Zimbabwe in Figure 14 illustrates (in orange dotted lines) the role of electricity at two crucial points in the value chain: the powering of mobile base stations creating the network coverage on which the technology depends and the charging of handsets at the point of use.

Figure 14: Mobile telecommunications sector market map



The multiple roles of the energy services and carriers listed in Chapter 2 is summarized in Table 7 for each of these two sectors.

Table 7: The roles of energy services in the two 'demand pull' case studies

		Tea sector	Mobile phone sector
Energy Services	Lighting	In factories	At card sale points
	Cooking/water heating	—	—
	Space heating	For drying leaves	—
	Cooling	—	—
	ICTs	For process management	ICT is the core service
	Irrigation	For tea plantation	—
	Agro-processing	Agro-processing is the core service	—
	Manufacturing	—	—
	Lifting–crossing	—	—
Energy Carriers	Fuels	For withering, fermenting and drying	—
	Electricity	At all stages, converted to mechanical power	For base station power and handset charging
	Mechanical Power	Fans, CTC, sorting & sieves	—

3.1.3. The role of decentralized energy approaches

In addition to being significant employers and generators of growth, the decentralized and renewable energy approaches used to meet energy needs and overcome barriers to growth, particularly in rural areas, makes these two cases interesting for this study.

Electricity, which makes up about 15 percent of the energy needs of the tea sector, is supplied to 90 percent of tea estates by the national grid, but producers have persistently faced problems with grid supply reliability and the rising cost of electric power as well as the fluctuating cost of diesel, needed for back-up generator sets. Since tea processing, once started, cannot be interrupted, as any interruption will damage the quality of made tea, every tea factory has a provision for back-up electricity supply from a diesel generator. Energy can make up as much as 6 percent to 25 percent of the total cost of tea production, depending on process and equipment efficiencies and types and cost of fuels used. Tea companies that have their own small hydropower (mostly from the colonial period) have a competitive advantage over those relying on the grid and diesel back-up in that they have a clean and reliable source of electricity supply that also reduces operating costs. In 2008, four small hydropower plants (total installed capacity of 2 MW) in Kericho made six Unilever Tea Kenya factories 70 percent self-sufficient in meeting their electricity needs and saved the company USD 1 million in energy bills (Ogada, 2009).

The thermal energy, needed in tea industries to wither, ferment, and dry tea leaves, is generally produced through wood-fired furnaces. Fuel-wood is grown and harvested in plantations to ensure supply and minimize cost at the majority of private tea plantations while commercial fuel-wood suppliers provide wood to others. Four hectares of tea plants require an estimated one hectare of land to produce the wood used for tea processing. This means that tea factories are meeting their thermal energy needs (seven times as great in energy terms as their electricity needs) with a decentralized and renewable (if managed) energy source, one that, as will be discussed in the next section, also has significant rural employment implications on the supply side.

In the mobile telecommunications sector, phone charging is a key energy input to end-users, as described above. Those in towns who are lucky enough to have the grid use that directly, while poorer and more remote consumers must generally walk or take a bus into towns to use mobile charging facilities in shops. Where grid access is sparse, this charging service is often provided via solar photovoltaic (PV) systems. The recent introduction of solar-powered mobiles in Zimbabwe also gives end-users off the grid the opportunity to charge their own mobile devices without going into town to find a charger. One operator in Zimbabwe has been selling around 1,100 solar-charged handset units per day, with a total of over 80,000 units sold to date (2010). Decentralized energy therefore enables more people to charge handsets and to access mobile phone services, which, in turn, builds the viability of the rural market for operators.

The other key electrical input is power to base stations, a service required by the network operators. One of the main considerations in base station site acquisition is the availability of reliable power, since this is a major factor in network performance. Where the grid is available, its unreliability necessitates redundancy or back-up to the grid power supply. Options being used in southern Africa include inverter and battery back-up, diesel generators, wind turbines and solar power systems. Decentralized systems are standardly used in expanding coverage to rural areas far from the grid. The inherently decentralized nature of mobile telephony, matched with decentralized energy options, has enabled this expansion.

3.1.4. The employment impacts

The challenge in assessing the contribution of energy services to employment in demand pull sectors is that it is extremely difficult to separate the contribution of energy services from the overall success and competitiveness of the sector itself. For example, the tea sector in Kenya is strongly driven by climatic suitability and a history of tea production with the skills and market connections that this brings. The market demand for mobile phones, and for the services they provide, is strong in southern Africa. The demand-side employment impact in these sectors is therefore large and dependent on access to energy, but not driven by it.

In terms of new jobs, it is not possible, for example, to disaggregate the number of jobs that are created by small-hydro as a back-up or primary option compared to grid power in the tea sector since, although cost savings can be calculated (see previous section) and an increase in individual enterprise and sector competitiveness implied, the translation of this into new jobs depends on a wide range of factors. It is clear that the tea sector, employing 800,000 people in rural areas of Kenya, is labour-intensive one that demonstrates a high degree of accessibility to poor people. Part of the reason for this is that there are large private plantation companies offering paid employment opportunities, as well as a co-operative system in which people can participate as grower-owners. The Kenyan Tea Development Agency (KTDA) is owned by 54 tea companies that are, in turn, owned by 500,000 tea growers (small-scale farmers), producing 60 percent of the tea. The income for these tea growers, however, is only affected by energy access in so far as the end factories are competitive and efficient. Since the majority of employment consists in picking, which cannot be mechanized, the employment intensity of the sector is relatively stable.

The mobile phone sector presents similar difficulties in disaggregating the effect of decentralized energy options. Unlike the tea sector, the mobile phone market employs relatively few people directly, with the operators employing only around 1,400 people in the country. However, this masks a huge number of people and micro-enterprises that can participate in the sector by selling recharge cards. It is estimated that at least 15,000 people nationwide in Zimbabwe alone are reselling recharge cards, which acts as an important and accessible improvement to the viability of shops and stalls and creates an opportunity for street vendors to improve existing employment.

In the tea case, there is no evidence of reduced opportunity costs, in that the energy services are used within the sector itself. However, in the case of mobile phones, there is certainly a savings in opportunity cost from charging phones with solar PV and other decentralized chargers, a practice that saves time otherwise spent by rural people walking to charging stations. The use of the phones themselves also improves business efficiency by enabling people to find out prices remotely, etc.

Both cases also demonstrate employment impacts linked directly to energy on the supply side. The tea sector uses an estimated 1.3 million tonnes of fuel-wood each year, which supports around 5,400 jobs, on the basis of 1,000 person years of employment generated per TWh of wood energy (AFREPREN, 2009). Additionally, the design, construction and operation of hydro schemes have created an estimated total of around 5,000 person months of jobs created/MW (or around 416 person years/MW) over the lifetime of the scheme. The construction of energy infrastructure for powering remote base stations also has an effect. Econet, the largest operator in Zimbabwe, is currently putting up one base station every day and each site employs at least 300 person-days of local unskilled labour, paying an average of USD 10 per person day. The other two operators combined are also expanding their coverage at the same rate, resulting in an annual employment of 108,000 person-days and USD 1,080,000 in rural wages in the country.

3.1.5. Key lessons arising

Some specific lessons that may be taken forward from analysis of the 'demand pull' cases are:

- **Employment growth sectors depend on energy access:** The Kenya tea industry and the mobile phone sector in southern Africa are successful and growing sectors that depend on energy all along the value chain and provide employment on the supply and demand sides. Lowering energy costs and increasing availability increases sector viability and can also reduce barriers to entry for new domestic entrants, thereby 'thickening' the market. This is underlined by the surveys of African business leaders who cite availability, reliability and affordability of energy among the most important constraints on expansion of enterprise activities (CGDEV, 2009).
- **Strong sectors can 'pull' energy services:** Market demand propels the mobile phone case, while the Kenyan tea sector builds on international demand and sector-specific domestic resources. In this context, both cases exhibit the financial and political power to 'pull' energy services in whatever available form from the grid to diesel generators and to solar PV if necessary, since income from the sector is sufficient to do so. They can even pull energy supply from outside the specific energy services required for the sector, e.g., if companies supply electricity for workers or nearby for communities.

- **There is a role for decentralized and renewable options, particularly in rural areas:** Both cases illustrate the complementary contribution of decentralized and renewable energy options in creating energy access for enterprises in rural areas. With grid infrastructure often insufficient, unreliable and unaffordable, decentralized renewable sources are shown to help meet energy needs and improve viability for rural industries, including in agriculture-based sectors. Decentralized and renewable options should, however, not be seen as an 'either-or' proposition with respect to centralized options, as both may contribute to enterprise energy mixes responding to the available resource, finance and need contexts. The tea case, which involves the use of grid and non-grid electricity as well as of biomass fuels for heating, illustrates this.
- **Lead sectors can break down barriers:** For other market sectors that do not currently enjoy such strong demand, the use of new forms of energy service in rural areas offers potential new opportunities. Piggy-backing on energy access created by 'lead firms' is possible in enterprise and even domestic situations. Technologies being trialled by lead sectors will improve and drop in price through volume and experience. Barriers such as affordable financing for such schemes and lender experience issues may be overcome by well-capitalized lead developers, paving the way for others in the future.
- **Energy access/employment payback:** High accessibility and employment intensity are features of both cases in terms of the employment impact for poor and rural people. Wage disparity is a more complex issue, but structures such as the mixed private/co-operative model within the Kenyan tea industry can be seen to offer benefits in mixing paid employment with the opportunity for rural people to take a direct stake in the sector as owner-growers. The recharge card employment opportunity similarly provides an accessible type of participation, while accelerating market reach for the mobile phone companies. Energy access support targeted at such sectors can therefore be seen to have a particularly positive payback in terms of multiplier benefits in employment outcomes.
- **Whole value chain analysis can reveal new energy opportunities:** The approach taken to mapping the sector market system can assist in identifying 1) the full extent of the actual and potential contributions of energy to a whole value chain as well as 2) multiplier benefits for viability and employment impacts. This could be applied to other chains such as the fruit and vegetable sector where, in Nigeria, for example, 60 percent to 70 percent of fruits and vegetables rot before being consumed. Local processing and storage could reduce the amount of agricultural wastage, improving the market for small-holder farmers, reduce food imports and increase domestic food supply, thereby reducing hunger. Without affordable, dependable power along the chain that is dispersed in rural areas, though, this is not a possibility.

3.2. Energy supply 'pushing' growth and employment

3.2.1. Case selection and approach

The second hypothesis from the conceptual framework was that, if some form of energy access is created in a specific geographical area, then a range of employment-creating enterprises would be able to improve in terms of service delivery, viability and productivity, with corresponding impacts on employment. In this way, an increase in energy access at a micro (and, by implication, also at the macro-national) scale would stimulate (or 'push') economic activity and thus employment in the area served. The cases selected in order to analyse these linkages are leading examples of decentralized rural electrification and the introduction of mechanical power into communities in sub-Saharan Africa. The specific cases are:

Rural Electrification of Yei, South Sudan — Yei is a medium-sized South Sudanese market town near the borders of Uganda and the Democratic Republic of Congo. It was electrified with USAID funding in 2005, shortly after the end of the civil war, with 1.2 MW of diesel-based generation providing service to residential and 717 registered commercial customers. A randomized survey of 150 commercial clients of the Yei Electric Cooperative (YECO), which now operates the electric system, was conducted in order to evaluate businesses' creation and employment trends resulting from electrification. Each business was asked questions about the nature of its businesses, start date, employees and employment trends (family members versus non-family members, formal versus casual labour, etc.) and business volume.

Multi-functional Platforms (MFPs) in Western Africa — The MFP typically has a 6 kW to 9 kW diesel engine, mounted on a chassis, to which can be added as many as 12 modular components in an integrated system that can supply a variety of services. These include mechanical power for time-and labour-intensive work such as agricultural processing and carpentry, as well as electricity for battery charging, lighting (approximately 200–250 small bulbs), welding and other applications. There are estimated to be well over 500 MFPs in Mali since first introduction in the 1990s and around 300 in Burkina Faso, with hundreds more installed and in progress in Senegal, Ghana and the United Republic of Tanzania. An estimated 10,000 women use the MFPs currently installed in Mali every day on a fee-for-service basis, while management and maintenance of the platforms there employ over 6,000. With recent financial support from the Gates Foundation, there were plans to install 1,300 platforms before the end of 2011 in Mali. Latest update, in April, 2010, marks the installation of Mali's 1,000th engine unit in the village of Mounzoun (*www.tinyurl.com/mali-mfp*).

3.2.2. Enterprise applications of energy access

The introduction of a new energy carrier such as electricity or mechanical power creates the possibility of conversion into a wide range of energy services within productive and enterprise settings. The process through which an energy carrier is converted into an energy service within a household or enterprise and then in turn into increased income and employment is not automatic, though. The case studies illustrate some interesting insights into this.

In the case of the electrification of Yei, 717 of all 970 customers of YECO are registered as 'commercial customers', which implies that enterprises strongly value (and are able to pay for) the service in the town, although other factors limiting accessibility by households, such as affordability and location, may also be important. In the case study, the sectoral composition of commercial electricity users was assessed, separating those enterprises that started before 2007, when electrification was fully introduced, and those that have started since electrification. The change in profile is as illustrated in Table 8.

Table 8: Sectoral composition of electricity users in Yei, South Sudan

Type of Business	Established after 2007		Established before 2007	
	Number	%	Number	%
Trader/Retailer	30	32%	9	45%
Wholesaler	6	6%	3	15%
Manufacturer	2	2%	1	5%
Service Provision	55	59%	7	35%

In terms of application of the electricity, it is clear that electricity is being used predominantly in trader/retailer and service provision environments. There is a marked lack of manufacturing activity using electricity in Yei, although it is possible that manufacturers are also using separate mechanical power sources, such as diesel engines, if cheaper than electricity, while process heat applications would similarly be likely to use non-electricity inputs. In general, Table 8 illustrates a shift toward service provision from a traditionally trading base in Yei since the introduction of electrification. This is analysed further in looking at the employment impacts of the case, although it may highlight a new potential created in the service sector, particularly for new electricity-derived services in a town surrounded by villages without this amenity. The applications found in Yei are consistent with Table 2, illustrating the flexibility of electricity in providing a range of energy services, and Table 5, which highlights the whole chain connections between supply and use of electricity and employment.

The **Multi-Funtional Platform (MFP)** provides mechanical power as well as some limited electricity. Table 9 shows the productive uses and end-users that are reported for each energy carrier.

Table 9: Applications of Multi-Functional Platforms

Energy Carrier	Energy Services	Main End-users
Mechanical power	Grinding cereals	Women in charge of securing household goods or small agro-processing enterprises
	Crushing shea nuts (for butter)	
	De-husking	
	Water pumping	
	Pressing oil from seeds	
Electricity	Lighting	Shops and restaurants
	Welding/repair	Mainly men operating small service enterprises
	Battery charging	
	Refrigeration	Shops and restaurants, pharmacies

This analysis interestingly reveals that mechanical power is actually used in providing processing services directly to women, assisting them with household chores, particularly improving the productivity of food processing at the micro/

Figure 15: Power for charging mobile phones (left) and running a small roadside restaurant

household level. In a thicker market, with more active players, such services would presumably be conducted within enterprises, with the finished products being sold to the women in shops. However, for women in rural Mali, such tasks are often done by hand and the MFP thus offers women a valued service. Productive uses of electricity are more oriented to cash-income generation directly with use in shops, restaurants and workshops, again with an emphasis on service provision and trade. Some manufacture of chairs, doors and windows is reported, but repair services, including welding, appear to be more significant.

3.2.3. The role of decentralized energy systems

The Yei and the MFP cases are decentralized in that energy is generated and used separately from grid or centralized infrastructure. The Yei case relies entirely on diesel as an energy source and distributes energy locally through a mini-grid operated by a co-operative, YECO. The MFPs can also support a small mini-grid, but mechanical power services are provided at the site of the platforms. MFPs have also been used with Jatropha vegetable oil as a fuel, although, to date, only relatively few platforms have run on this fuel. Both cases, though, retain strong parallels with off-grid energy service provision via other kinds of decentralized and renewable energy technologies, including small hydropower, community biogas, watermills, bioenergy-fired heat and power installations, etc.

The role of decentralized options in creating energy access in both cases is a combination of the following factors:

- **Overcoming lack of grid access in the foreseeable future:** The rural electrification of Yei and the MFPs spread around western Africa are in towns and villages without grid connection now or in the foreseeable future. In the case of Yei, the mini-grid provides an equivalent service to grid power to those who purchase connections, while villages with MFPs have mechanical power and a relatively small amount of electricity. Decentralized options in these cases were seen to provide the only option for creation of energy access in those locations, due to cost and/or institutional capacity.

- **Relative cost-efficiency in case contexts:** The rural and dispersed location of the towns serviced in each case creates a relatively high cost to provide energy services per household compared with denser populations in cities. However, in both cases, it has been more cost-effective to bring energy services to the town by using decentralized means rather than by extending the grid over many kilometres. In the long run, if the grid came to either town, the decentralized electricity generation would probably not continue due to operating costs (diesel), although it is likely that the mechanical power element of the MFPs would remain viable. However, the decentralized options used, based on diesel generators or renewable energy, are currently 'least cost' supply options for respective services for the towns and villages in question.
- **Enabling local service delivery:** A key issue in extending centralized infrastructure is governance and institutional challenges: grid-based infrastructure requires a large-scale utility or corporate structure that is either centralized or has complex interrelationships among capable operators at the supply, generation, distribution and transmission levels. In both cases, such structures are not currently available and, in this context, the decentralized models of energy service delivery used were possible since they did not require the same centralized institutional positioning and are amenable to local management and control in the localities in which they are used. With properly designed local institutions and capacity, local organizations such as the YECO co-operative in Yei and the management groups for MFPs are able to take control of and deliver decentralized energy systems.
- **Donor support overcoming lack of energy 'pull':** Another key reason for the lack of centralized energy services to rural towns and villages is that, as markets, they are weak in generating effective demand in 'pulling' energy services (see previous section). In the Yei and MFPs cases, donor support has been instrumental in financing the creation of energy access, overcoming capital cost barriers and supporting capacity and institutional development processes. Such interventions have been based on the contention that, without external support, domestic finance, governance and markets will not be able to create the energy access that, in turn, could have a catalytic effect on promoting development and employment. This support could have been applied to centralized infrastructure, but decentralized systems presented a wider range of opportunities for different actors to play a variety of roles in meeting the full range of energy needs, particularly where poverty is most acute, as in rural areas. In this way, decentralized energy options in rural areas are amenable to targeted donor support, co-ordinated with government but not necessarily dependant on it, and rooted in local institutions with a vested interest in success.

Decentralized options do not come out in these cases, or in this study, as a panacea. However, in both cases analysed, decentralized options have overcome barriers to creating a level of energy access in each town. The next section assesses the effect of this access on employment.

3.2.4. The employment impacts

In terms of creating new jobs, the cases present a complex picture that does not fit neatly into a conventional impact framework. The headline figures for new jobs in the 150 enterprises surveyed in the Yei electrification case are shown in Table 10.

Bearing in mind that existing businesses are the entire sample, it can be seen that the average number of employees per surveyed business has not changed in businesses established before and after electrification (in 2007)—equalling 3.7 employees per business. The total number of employees has increased between the pre- and post-2007 businesses, but this is mainly because significantly more YECO-serviced businesses started after 2007 than have survived from before that year. This could have been stimulated by electrification, but could also have been connected with the increase in population seen in the town and its function as a local business hub in the same period.

Table 10: Employees in the YECO customers surveyed in Yei

	Established after electrification	Established before electrification
Number of employees total	348	71
Average number of employees per business	3.70	3.74
Standard deviation	4.67	4.25
Minimum number of employees	1	0
Maximum number of employees	26	17

Note: employees, defined as not including the owner

The maximum number of employees in one business also increased (26 employees at The New Tokyo Hotel). However, the standard deviation for before-and-after cases was relatively similar and, if the relatively few outlier businesses that employ a large number of employees are removed, the average number of employees per business has actually decreased, from 3 to 2.5, between the pre-2007 and post-2007 businesses, respectively. This small difference may not be statistically significant, but could be connected to an increase in productivity as a result of electricity access being available or due to an increase in competition due to the larger number of businesses in the post-2007 group.

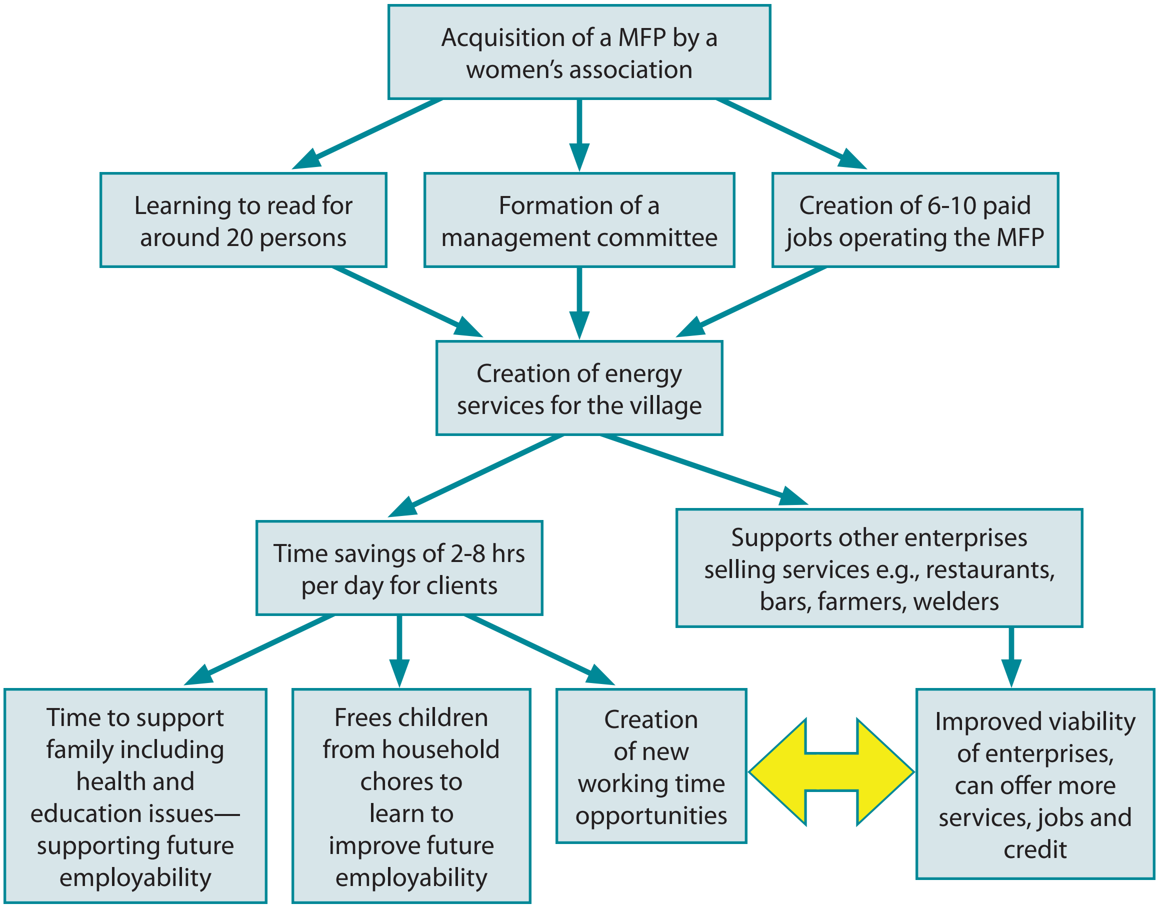
Issues with the Yei survey include the lack of a pre-electrification baseline that may disguise changes in the pre-2007 businesses themselves since the introduction of electrification. Although the Yei study is of a fixed number of businesses, the larger number of post-2007 enterprises can be taken as a proxy for an increase in growth in the post-electrification period. However, the figures from Yei do not show a strong increase in new employment on the demand side in the time period of the study. On the supply side, around 20 jobs were created in the YECO co-operative, which is a non-negligible contribution to local employment, especially given that these are in technical/professional roles that are not common in the town.

The conclusions from Yei on new jobs are also roughly mirrored by the MFPs case. The primary applications noted for the MFPs are not 'new' jobs in the short term, but rather improvements to existing jobs. The installation of welding sets on the platforms improves the work of existing craftsmen by enabling new techniques that improve productivity and quality and diversify product offering. Similarly, lighting on streets and in bars and restaurants has made villagers feel more secure from accidents and robbery, extending the operation time of commercial activities such as food selling and bars.

New employment impacts on the supply side include six to ten full-time or part-time female jobs created per village for the management and operation of the MFP (women management committees comprising treasurers, cashiers, supervisors, millers) and for the maintenance and repair of the platform for local artisans. This supply-side employment generates a relatively important wage bill at the village level; if this number of jobs per platform were extrapolated to the total number of MFPs installed in Burkina Faso and Mali, then an average of at least 6,600 new full-time jobs would be created. Using Jatropha feedstock as a fuel for MFPs opens up additional supply-side opportunities for farmers, as discussed in more detail in Section 3.3 on energy production cases.

This conclusion about higher employment is also supported by the Yei electrification case, which showed that the average number of immediate family members per average total employees per business declined from 39 percent for those businesses started earlier than 2007 to 26 percent for those original owner businesses started after 2007. This reduction in working in family businesses – particularly among wives and children – represents a shift in commercial electrified enterprises in Yei becoming less dominated by immediate family-provided employees. This implies that business growth supported by modern energy services is making paid employment more available as the local economy develops. An increase in the average number of permanent employees per business was also noted among the post-2007 businesses: 89 percent of permanent employees compared to 76 percent of pre-2007 businesses. Such a change is linked to increased viability and incomes in existing enterprises and an overall maturation of the Yei economy.

Figure 16: Causal chain for MFP impacts



Source: adapted from A. Crole-Rees et al. 2006.

Figure 16 attempts to capture the full flow of benefits to employment from the MFP programme, highlighting the improvement to existing employment noted above and the role of opportunity cost saving.

A key driver for development benefits from MFPs is the two to eight hours that women save daily through increased productivity of household chores. The MFP programme in Mali saves an estimated average of 2.5 hours per day for 10,000 women, or around 12 person years of effort every day. This directly affects women's lives and well-being. It also allows them to spend time on other, more productive activities, including additional income-generation activities where possible. Whether that is possible, however, is connected to the availability of jobs in the area, as indicated in the block arrow in Figure 16.

3.2.5. Key lessons

Although the case studies conducted under this study cannot be considered comprehensive of all types of energy supply intervention and additional longer timeframe studies would strengthen the robustness of conclusions, several consistent lessons are discernable from the case studies and other relevant studies cited.

- **Introduction of energy services contributes more immediately to improving existing employment:** The cases show that enterprise activity and growth may increase in a newly served area, although the total number of new jobs resulting from the introduction of energy services may be relatively modest, and mainly on the supply side, in the short run. This is due to a combination of potential delays or disconnects in job creation and improvements in existing jobs (as described in Figure 12) as well as productivity increases.
- **More new jobs are created in the medium term:** By expanding or offering additional services, existing businesses are best placed to take up new energy services made available. This improves income, working conditions, enterprise viability and job security. Because many SMEs are owner-operator establishments, such benefits are visible in incomes and viability in the short run, but may create new employment as they expand over time or as new business start up as prosperity increases.
- **Reducing opportunity cost is a major benefit of introducing mechanical power in poor communities:** The demand-side impact of the introduction of this service is primarily on basic household or processing activities. Although this offers a large opportunity cost saving to women in particular, the question of whether the time freed up can actually be applied to an income-generating opportunity depends on other factors.
- **Additional multiplier effects can boost the employment impacts of energy 'push' interventions:** In the medium to longer term, additional benefits of energy access are expected to become more visible in areas where the service is available. This can include increases in the local market size, as seen in Yei, due to in-migration at least partly linked to the energy access available, although the town's location as a trading hub has also helped. This has boosted overall economic activity and the total number of jobs. Additionally, energy services also available to public services and households can also be expected to improve education and health, boosting longer-term growth, while retention of professionals is known to be better in towns served with electricity.

One of the common threads emerging from the analysis of the 'demand pull' cases and referenced studies (e.g., Kooijman-van-Dijk, 2008) is that the conversion of newly created energy access into employment benefits is not automatic in every case and is rather linked with other contributory factors. These must also be considered when designing policies and programmes to promote energy access and employment.

3.2.6. Converting energy access into employment

In summary, the key disconnects between energy access and the creation of new jobs and improvement of existing ones are:

- **Lack of change in the market demand situation:** There are no more customers or market access even though something new could be offered or produced.
- **Lack of capital to invest in new appliances:** Sometimes, energy access is limited to the presence of light bulbs in households if people do not have the capital to afford other appliances linked with productive use.
- **Lack of knowledge/skills relevant to new business opportunities created:** Lacking knowledge or capacity, people may be unable to recognize or practice a new energy-based income-generating activity.
- **Wider business environment barriers to enterprise development:** These may be linked to policies, entrepreneurialism, corruption, lack of resources, etc.

A conclusion arising from this analysis is that, if additional policy and practice support is provided, it may be possible to increase the impact of an energy access 'push' intervention by addressing one or more of the barriers cited. It was felt that an additional case study of what could be done to maximize the conversion of energy access into employment was warranted; the result was the following case:

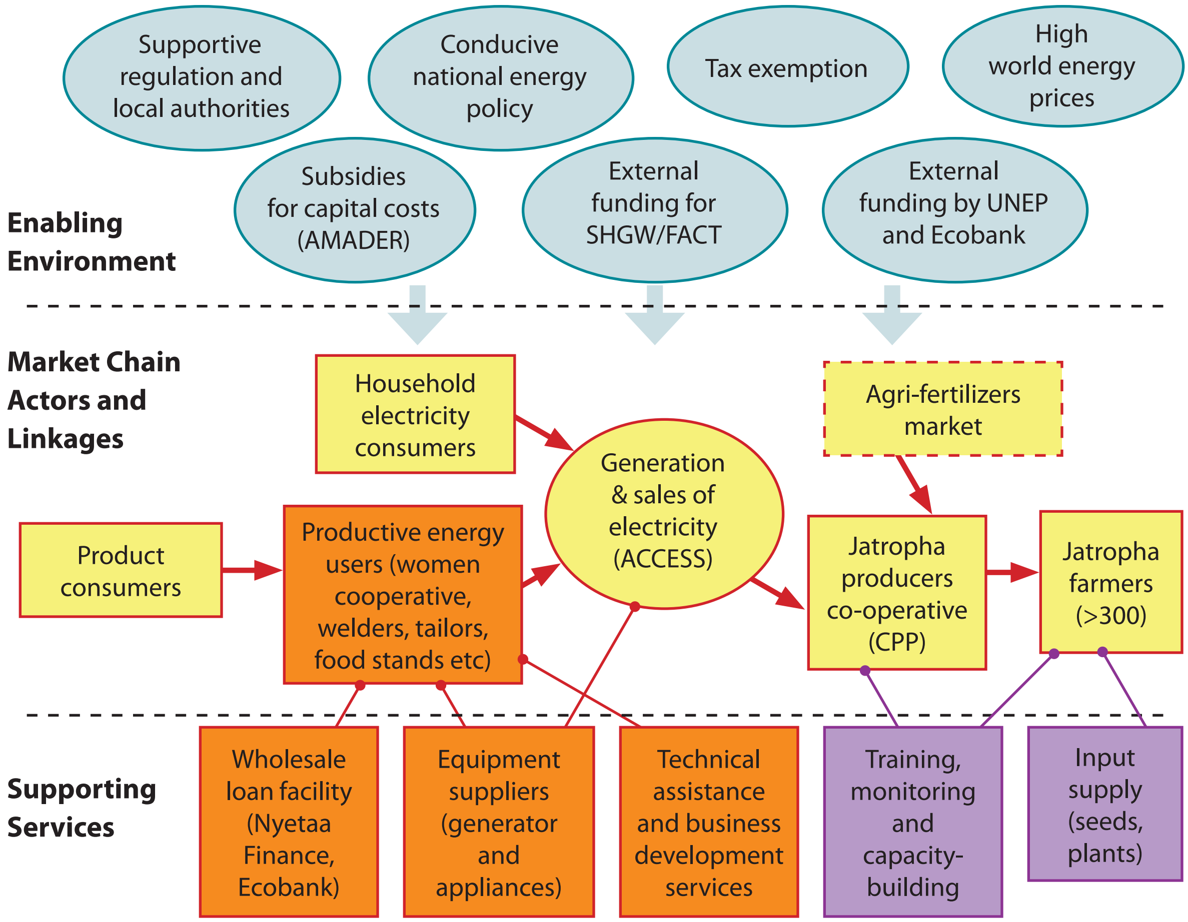
Connecting electrification with productive uses in Mali — As a demand-side extension to UNEP's African Rural Energy Enterprise Development (AREED) programme in Mali, which from 2001 had mainly been supporting energy supply enterprises, a wholesale loan facility was secured from Ecobank-Mali to provide credit to end-users in newly electrified rural areas to purchase electric equipment (appliances) for productive uses. By the end of 2009, Nyetaa Finance had invested about EUR152,675 for energy end-use equipment for 1,774 clients, including 850 women in 15 villages. The case study focuses in particular on how this programme has been implemented in the town of Garalo in Mali, which has been electrified via a hybrid diesel-Jatropha generator system.

Figure 17 illustrates the AREED programme's approach to overcoming the cited disconnects in Mali and how they connect to the electrification scheme in Garalo.

The approach creates additional supporting services for the wider market in addition to the support provided in establishing the energy access in the first place.

Nyetaa Finance uses the loan facility to provide credit to enterprise end-users in newly electrified rural areas to purchase electric appliances and has included electric tools for carpentry, electric sewing machines, welding equipment, battery charging equipment, refrigeration, seed oil presses, grain grinders, crop drying equipment and other equipment for the processing of local agricultural crops (honey, mango, cashew, etc.). In Garalo, the types of equipment supported by the energy end-use loan facility included freezers for ice making, sewing

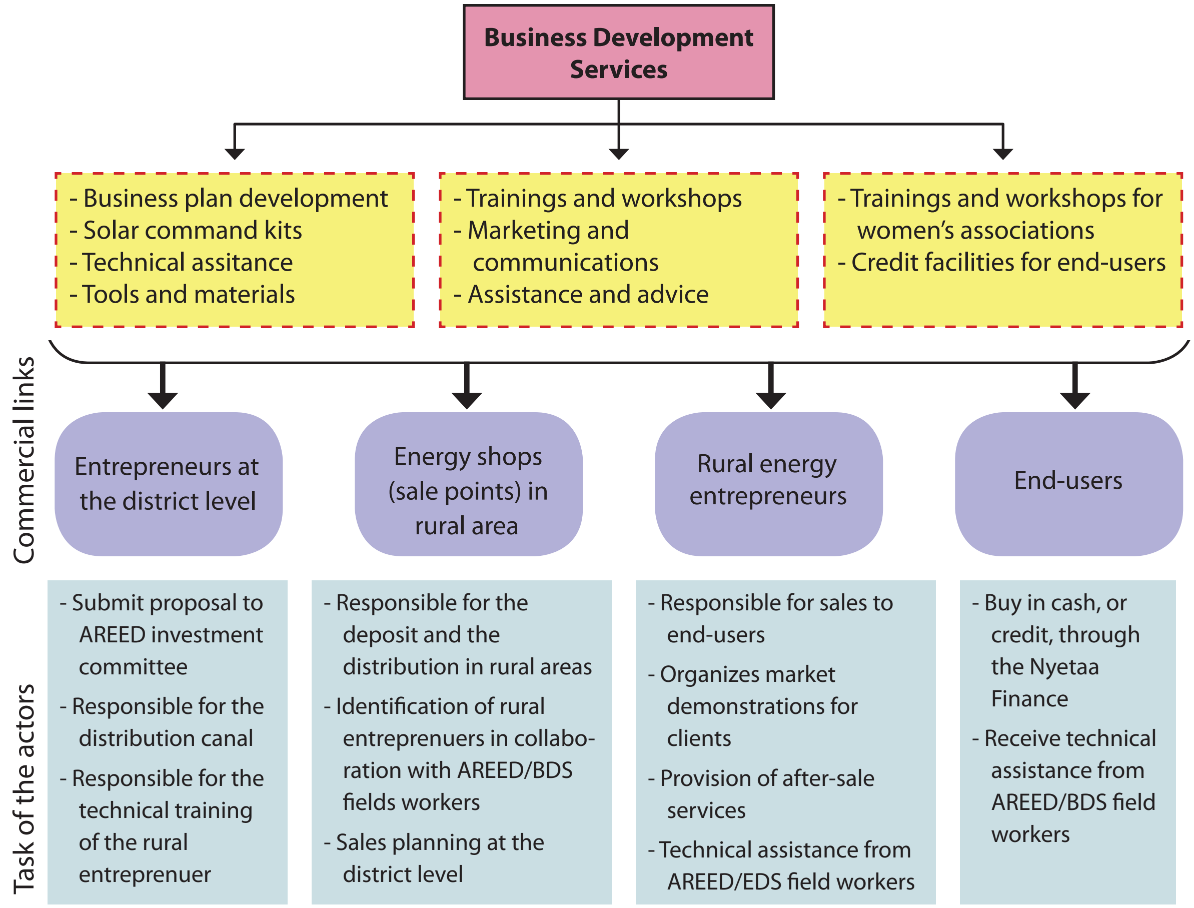
Figure 17: Market map of electrification scheme



machines, carpenter's electric equipment, de-huskers and cereals mills. Nyetaa Finance works in collaboration with Mali Folkecenter (MFC) to identify, analyse and select demand from the energy end-users. After this assessment, loans in the range of USD 300 to USD 5,000 are provided to the borrower according to his or her ability to pay at an interest rate between 18 percent and 20 percent. Some loans can be high as USD 20,000. Before the loan is disbursed, a down payment in the range of 20 percent is required from the borrowers. Regular monthly payments of the principal and interest are paid over the 12- to 24-month term of the loans. In total, the energy end-users' portfolio of Nyetaa Finance includes more than 227 loan demands totalling around USD 592,000. The initiative is relatively young and the longevity and success of these enterprises remains to be evaluated, but the case's explicit approach to maximizing the potential of employment resulting from creation of energy access is promising.

In addition to the loan facility, MFC Nyetaa provides technical and business development assistance to the borrowers to support identification of and access to market opportunities and to connect users with providers of necessary appliances. Figure 18 illustrates the overall system and the roles of the various actors in supporting expansion of energy end-users.

Figure 18: Structure of AREED end-user support and finance system in Mali



3.3. Energy sector employment cases

All cases presented so far have shown employment impacts. In the 'energy demand pull' cases, the employment impact of introducing energy access was relatively minor compared with the employment provided by the economic demand-side chains they enabled. In the 'energy supply push' cases, introducing energy access was a relatively important creator of new jobs in the longer run, with more impacts on existing employment and opportunity cost in the short term. An analysis of the impact of energy on employment would not be complete, though, without consideration of the energy sector itself as an employer.

In developed countries, with their saturated energy markets, employment is dropping in the energy sector as a whole (except in the newer and expanding renewable energy subsector). However, with the very low levels of energy access in sub-Saharan Africa, there is a huge potential for job growth over the coming decades in expanding energy supply, including via decentralized and renewable technologies.

3.3.1. Case selection and approach

Centralized and conventional sectors such as grid electrification, fossil fuels and large hydro are well covered by existing IEA and other analyses. In this study, the employment impact of emerging energy subsectors linked to decentralized and renewable energy supplies is the focus. Supply-side impacts associated with a range of decentralized electrification and mechanical power approaches, including small-hydropower, have been included in the previously analysed cases and illustrate employment linkages in these sectors. While the current proliferation of lighting products such as lanterns and solar home systems (SHSs) has employment impacts on the distribution side, manufacture is currently dominated by China.

Sugarcane bioethanol production in Malawi — There has been a global trend in recent years toward greater biofuel use as petroleum products have become more expensive and concerns about climate change have led to the search for low-carbon transport fuels. In sub-Saharan Africa, biofuels have gained increasing attention because of their potential as a new market for agricultural economies in equatorial regions with strong year-round plant growth rates and large uncultivated land areas. The potential for this expansion to be connected with land-grabbing, food price increases and labour exploitation has, however, also been a source of fierce debate. Malawi is a leading producer of bioethanol from sugarcane molasses and offers some insights into the real impact of biofuels as an agricultural employer.

The charcoal sector in Kenya — The charcoal sector is currently Kenya's second largest rural employer after agriculture (see Figure 8). About 200,000 producers operate in the country, with around half a million people (producers, transporters and vendors) involved directly in the charcoal trade (around half of these on a full time-basis), supporting around 2.5 million dependents. However, Kenya's dwindling forest resources are estimated to be decreasing by 2 percent annually and the sector has been criminalized over many years by government regulation, which was ineffective to halt the trade in the absence of energy alternatives for householders. More recently, however, with concern about climate change and energy security, wood is being increasingly looked at again as a fuel for cooking and heating in modern appliances. In Kenya, there are examples of modern and efficient charcoal conversion systems and stoves, with feedstock coming from sustainable fuel-wood plantations. This presents a new, and by its nature decentralized, opportunity to provide employment in an important economic activity in rural areas of Africa; this is not always noted as such due to the sector's informality.

Employment impacts are visible all along the energy value chain: from the production of the resource or fuel, through conversion equipment, processing and transportation, to the provision of appliances for end-use in domestic or enterprise settings. Case studies have again used a market mapping approach to capture the full extent of linked employment opportunities.

3.3.2. The employment impact of biofuels

The ProAlcool programme in Brazil is the largest biofuel programme in the world. In 2005, it produced some 16,500 million litres of ethanol from sugarcane, replacing some 250,000 barrels of oil a day, mainly in transport fuel applications domestically and internationally. Today, Brazil operates almost 50 percent of vehicles on pure ethanol, with the rest running on blends. A 10 percent blend requires no engine modifications at all (*www.inforse.org/europe/dieret/altfuels/ethanol.htm*).

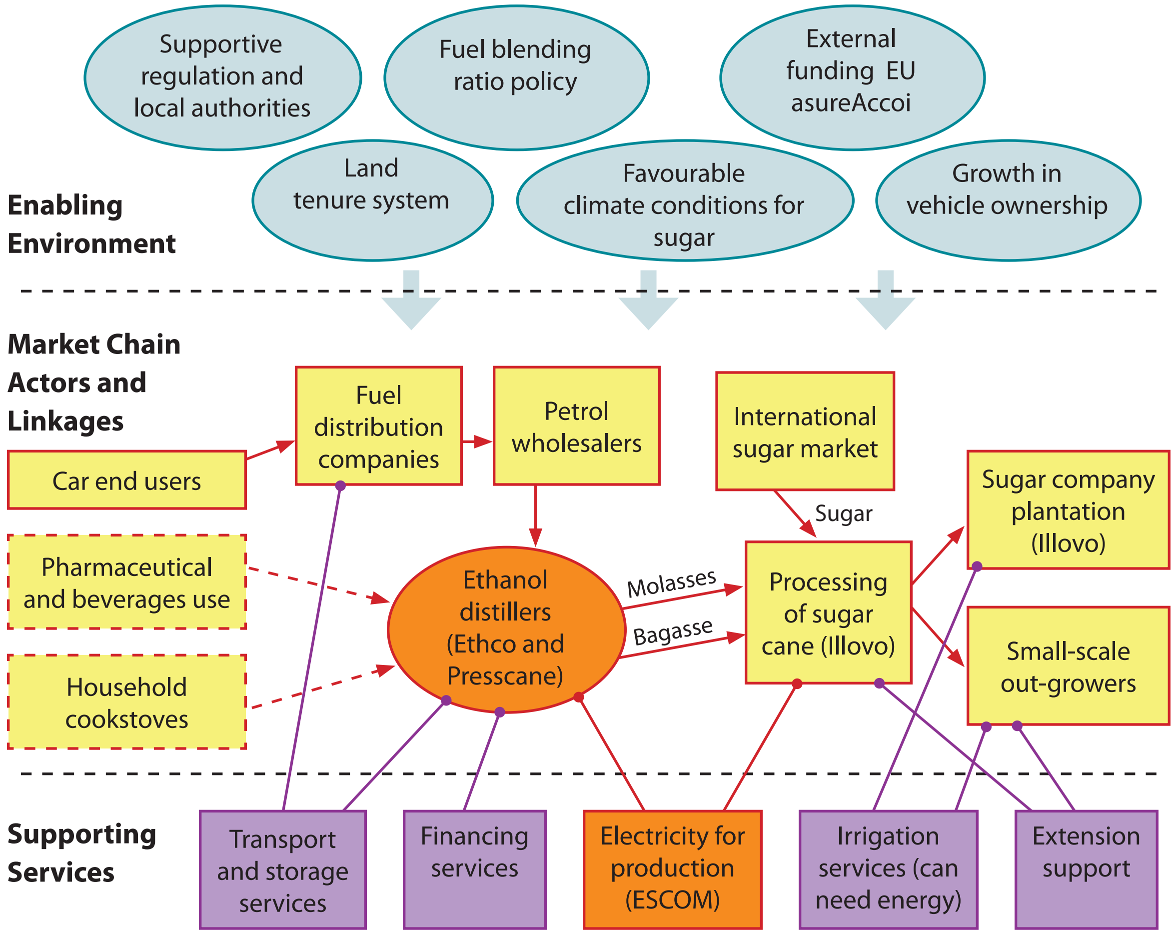
Rural job creation has been cited as a major benefit of ProAlcool because alcohol production in Brazil is highly labour-intensive. Some 700,000 direct jobs with perhaps three to four times this number of indirect jobs have been created. The investment to generate one job in the ethanol industry varies between USD 12,000 and USD 22,000, about 1/20th of that in the chemical industry for example. Of the 700,000 total jobs, about 300,000 are cane cutters who earn about USD 300 to USD 400 per month, depending on the amount they can cut. Earnings are USD 1.35 per hour each day for six days a week during the growing season of six to seven months (APEC, 2010).

In sub-Saharan Africa, alcohol fuels have also been strongly pursued in a number countries currently producing sugar, notably Kenya, Malawi, South Africa and Zimbabwe – often with support from Brazil as a leading international proponent of the fuel. The Malawi case study conducted for this assessment provides a deeper insight into the value chain and potential employment and income generation impacts of the sugarcane to ethanol initiative. Although biodiesel production from oil plants such as Jatropha has some different dynamics (e.g., Jatropha is not a by-product, but an energy crop in itself), some of the lessons from this case can be applied to biofuels production more widely in the region.

The market for ethanol in Malawi, as in Brazil, has been created by government policy. In the Malawi case, a mandate requires that automotive fuels be blended with a 20 percent composition of ethanol, although the requirement has recently dropped to 11 percent. The basis for this policy is stated as creating employment opportunities for Malawian farmers while reducing importation and dependency on fossil fuels. The market map for the sector in Malawi is in Figure 19, with orange dotted lines indicating where the sector is itself a consumer of energy.

In terms of new jobs, ethanol processing is currently large-scale and mechanical, employing relatively few labourers for the significant value that is being processed. In terms of the ethanol component of the value chain alone, the two ethanol companies employ 220 people. Indirect employment (upstream and downstream) is 280 people, with limited downstream impact, since ethanol is used only in transport fuel blending and thus goes into existing (fossil) transport fuel distribution systems. If pricing were such that household cooking stoves were an additional demand sector for ethanol (and supply sector to households in its own right), then an additional channel for employment and improved household energy access could be created. This has not yet emerged successfully, though.

Figure 19: Ethanol in Malawi — Market map



The main employment impact relating to the ethanol chain currently is in the main feedstock supply chain, i.e., sugarcane production. In contrast to ethanol distillation, farm production of sugarcane is labour-intensive, providing employment opportunities for farmers and farm hands. In the sugarcane sector, about 10,700 people are directly employed and 13,350 people are employed indirectly in supporting industries and distribution. Upstream services are financing, transport and storage, extension support, equipment hire and technical support services and irrigation services. Taking into account the national average of seven dependants per employee, the industry directly supports more than 154,350 people and supports many thousands more whose livelihood depends on the sugar industry. In this respect, the ethanol subsector, which is based on the molasses residue of the sugar sector, supports the viability of the sugar sector by improving revenues, essentially extracting more value from the original sugarcane product by producing a fuel from the bio-residue.

Being a rural agricultural value chain, the sugar and ethanol sectors would presumably be widely accessible to rural people. With respect to large plantations, jobs are available at the dominant sugar company, Illovo. However, unlike in the tea sector in Kenya, there is only a limited opportunity for grower-owner participation in the sector and smallholder cane growers account for approximately 9 percent of sugarcane agriculture and only 5 percent of the overall sugar industry, including milling. This is the opposite ratio to the agricultural sector as a whole in the country, where the smallholder subsector contributes more than 70 percent of agricultural GDP and the estate subsector contributes less than 30 percent.

Initiatives to encourage biofuel production require sensitive analysis and balance. Ethanol production will generate a significant new employment impact only if demand for ethanol encourages farmers to produce more sugarcane to supply the ethanol processors or a more extensive ethanol distribution system, such as in household cooking, is created domestically. This would require an increase in either domestic or international demand or in both. However, with many countries considered to be food-insecure, using land for biofuel production is a politically sensitive issue on the domestic and international stages alike. Government policy must be consistently supportive in order to encourage investment in ethanol production if it is to achieve the employment impacts that Brazil has enjoyed. However, in order to ensure wide support and sustainability, such policy must also promote modes of production that maximize distribution of benefits to rural populations, including via energy access as well as accessible and equitably waged employment, and manage environmental and natural resource impacts.

3.3.3. Employment in transforming traditional biomass

Fuel-wood and charcoal markets are extremely well established throughout sub-Saharan Africa, mostly in the informal sector. In spite of its grey market status, the Kenyan charcoal industry produces 1.6 million tonnes of charcoal per year, equivalent (by weight) to one third of Kenya's sugarcane production. The annual income from charcoal is around USD 400 million, almost equivalent to the income generated from Kenya's tea industry. Average incomes generated from charcoal are about USD 60 per month for producers, USD 142 for transporters and USD 95 for vendors (ESDA, 2005). As the second biggest employer in rural areas after agriculture, this is a very important sector to rural employment, although, due to the sector's informality, it is not visible in official statistics. Given the prevalence of fuel-wood and charcoal use in sub-Saharan Africa, a similar pattern can be expected to recur in other countries in the region, especially in those with important forest resource and relatively high levels of urbanization.

In 2002, the Youth to Youth Action Group, with financial support from Thuiya Enterprises Ltd., initiated community-driven commercial afforestation in order to enhance the livelihood of local communities using two types of Acacia tree to make charcoal. The initiative included plantation and management of woodlots on farmers' own lands, improved efficiency charcoal kilns and distribution of improved stoves. The initiative sought to create employment opportunities for rural farmers, processors, transporters and distributors by ensuring a sustainable supply of raw material for the urban charcoal market (Practical Action Consulting, 2009).

Plantation farming was mainly a way to improve existing employment for rural farmers who were growing trees as an energy crop in addition to their other cash crops. Although this has already increased tree cover substantially in the area, barriers remain. For example, there is not yet an enabling business environment for strong business contracts between the actors to ensure that processors, on the one hand, have a steady supply and that suppliers, on the other hand, have a level of profitability that allows them to re-invest to continue production and to expand. Also, corruption in providing licenses for charcoal remains an issue.

Improving the energy conversion efficiency from fuel-wood into charcoal would increase sustainability by reducing the impact that the requirements for wood feedstock have on the environment. Roughly half as many trees are needed for the same amount of charcoal if an improved half-orange or other kiln, rather than a traditional earth kiln, is used. However, while this increase in productivity would improve returns for producers, it would likely diminish the total number of processors required to meet demand (and thus have a negative immediate impact on employment).

However, a sustainability-oriented approach to charcoal production would help in the creation of new jobs on the appliance side (i.e., production of charcoal stoves). In fact, Kenya is a leading country in terms of energy-efficient charcoal stoves.

Figure 20: A range of Kenyan stoves

Source: www.solutions-site.org/kids/stories/KScat2_sol60.htm

The Kenya Ceramic Jiko (KCJ) is a portable charcoal stove now used in over 50 percent of all urban homes and 16 percent of rural homes in Kenya and its use is spreading to neighbouring African countries. With proper use and maintenance, the KCJ can reduce fuel consumption by 30 percent to 50 percent, saving the consumer money, reducing toxic gas and particulate matter and resulting in better overall heath for the user. Less charcoal use also means that less wood is burned to make charcoal and thus that fewer trees have to be cut down. The cost ranges between USD 2 and USD 10. With around three million KCJs in use in Kenya, KCJ production contributes significantly to employment in Kenya´s informal economy, which provides close to three quarters of all employment and creates about 90 percent of all new jobs (Daniels, 2010). Expansion of improved stove access in other countries could multiply the impacts of improved cook stove production on new jobs in the manufacturing sector.

Policies in Kenya have now legalized charcoal. The challenge of achieving market sustainability now consists in implementing the new policies and making them known. Financing linked with global environmental funding for protecting the forest and reducing greenhouse gas emissions could help to accelerate progress.

3.3.4. Key lessons

Key lessons regarding the impacts of decentralized and renewable energy applications on energy sector employment are taken from the earlier examples of energy service delivery in vertical and horizontal chains as well as in the bioenergy supply cases covered in this section. They are:

- **The massive gap in energy access creates opportunity for decentralized supply employment growth in sub-Saharan Africa:** With rural electrification at just over one quarter and access to improved fuels and mechanical power even lower, a massive unserved market exists at the 'base of the pyramid'. A wide range of energy services and carriers will be required and a range of public, private and civil society actors will have to meet those needs. Decentralized and renewable options, alongside grid and conventional options, have a strong role to play, and their distributed nature lends them well to creating employment in rural areas all along the supply value chain. The range of technologies and renewable resources involved offers a range of opportunities in fuel production and processing, the manufacture of conversion equipment and appliances, the construction and operation of installations and a host of supporting services.

- **Bioenergy is already a huge rural employer and could provide further jobs:** As a major rural employer in many sub-Saharan African countries, existing biomass market systems are currently important and are a potential leverage sector for change. Improvements in the sustainability and formality of the sector could leverage employment impacts through improved production, conversion and appliance practices. As international attention regarding climate change focuses on "reducing emissions from deforestation and degradation" (REDD) and black carbon, climate finance may also stimulate an acceleration in change in this sector. Policies in countries like Kenya have already moved in this direction.
- **Biofuels can contribute new jobs, but must be managed carefully if they are to do so:** There is no question that the creation of new demand for a product produced in rural areas, i.e., biofuels, could open a new market opportunity to support the viability of agricultural economies. This could also reduce oil import dependency, limit exposure to oil price fluctuation, reduce foreign exchange drain and boost domestic energy resources and access. However, it is clear from the Malawi case that, if institutional structures are not in place to enable widespread participation, employment benefits claimed for the sector will remain out of reach. There could be environmental damage and worse exploitation of labour in estates if there is no appropriate regulatory system.

4. CONCLUSIONS AND RECOMMENDATIONS

The findings of the case studies described in the previous chapter have underlined the role of energy access as a necessary precondition for growth and employment. The correlation among these three factors has been shown via a number of analyses presented at the macro and micro levels that draw on available literature and the case studies conducted for this study. The growth of expanding employment sectors, which would otherwise create new jobs, is inhibited by expensive, unreliable or insufficient energy access. Meanwhile, without energy access, existing employment and livelihood activities remain inefficient, provide low returns and absorb crucial time in drudgery, which has a real opportunity cost in terms of output foregone. Additionally, the employment potential of the energy sector itself will not be realized while levels of energy access remain as low as they are currently in sub-Saharan Africa. Decentralized energy options are shown to have a complementary role in creating wider and more cost-effective energy access in certain cases, thereby accelerating processes leading to increasing growth and employment on the demand and supply sides.

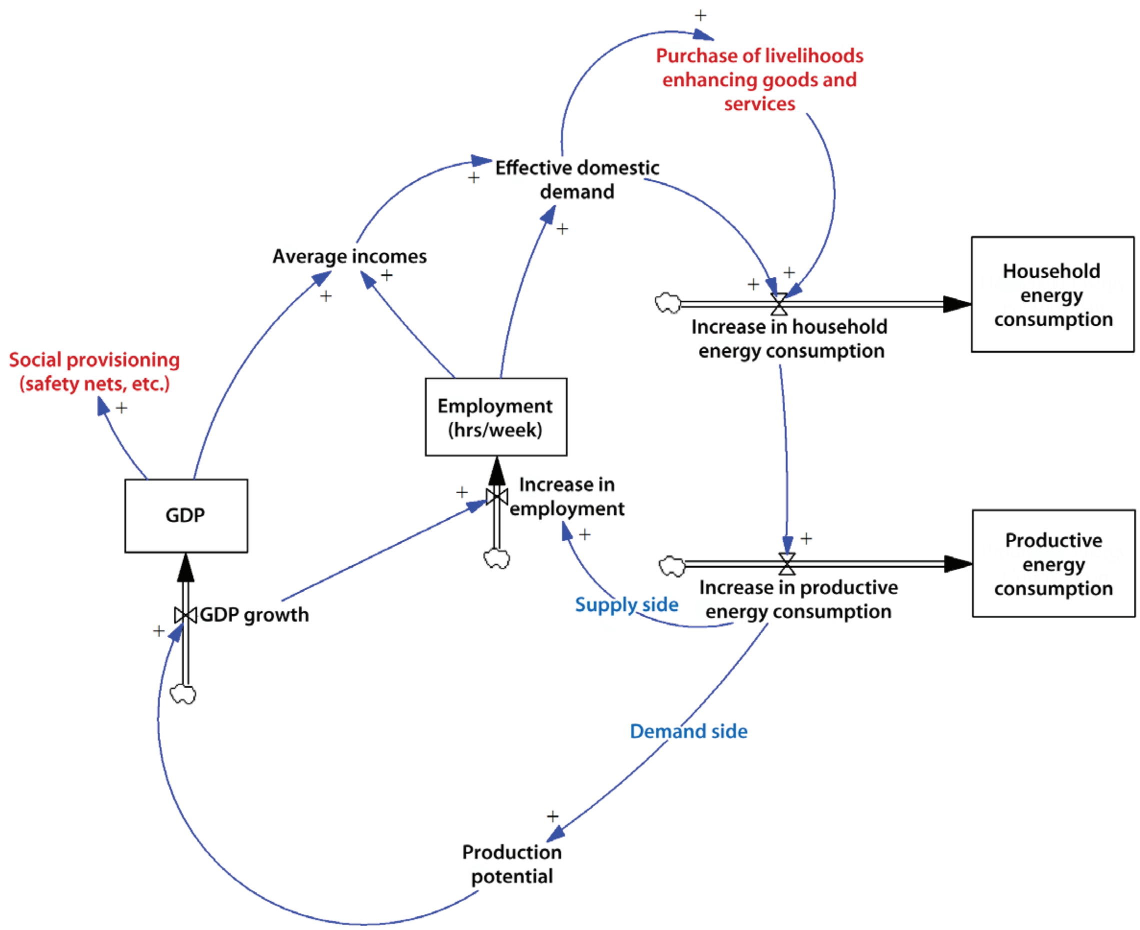
However, crucially, the study has also found that expanding energy access alone is an insufficient condition for achievement of growth, employment and the MDGs. Several steps connect energy access to employment, including the taking up of (sometimes expensive) appliances and equipment, improvements in enterprises and increased income generation, which only then eventually lead to expansion and the hiring of new employees. In some cases, growth can be jobless. In all cases, variability in the employment intensity of growth sectors and the accessibility of new employment opportunities to poor people govern the employment impact of any growth created or supported by energy access. Without wage equality, energy access or growth do not guarantee an increase in the availability of opportunities for decent work. Furthermore, energy access is not in the short run converted into new jobs, particularly in the absence of other factors, including market access, technology/skills access, access to finance and economic/social stability. Additional processes linked to stimulating and supporting enterprise development have demonstrable potential to accelerate this process, including several linked specifically to the use of decentralized and renewable energy technologies.

4.1. The dynamic feedback relationship among energy, growth and employment

This compelling evidence confirms that there is a connection among energy, growth and employment. However, the cases have also illustrated the lack of clear and linear causalities among the three factors. Instead, each factor has the ability to boost or undermine the other and the effect of each factor on each other is mediated by a series of other factors. As proposed in the preliminary conceptual framework in Chapter 2, this implies that, rather than constituting a single linked framework, these three factors are in fact connected in a non-linear feedback relationship in which each is dependent on the other in a mutually reinforcing (or undermining) system. Such a relationship is commonly known as a 'virtuous circle' or, in the negative version, 'a vicious circle'.

Systems such as these can be modelled using systems dynamics tools that are particularly suited to illustrating virtuous circle relationships as well as technology uptake dynamics and complex feedback system phenomena such as 'tipping points'. The causal loop diagram presented in Figure 21 is an initial attempt to summarize the

Figure 21: Causal loop diagram linking energy, growth and employment

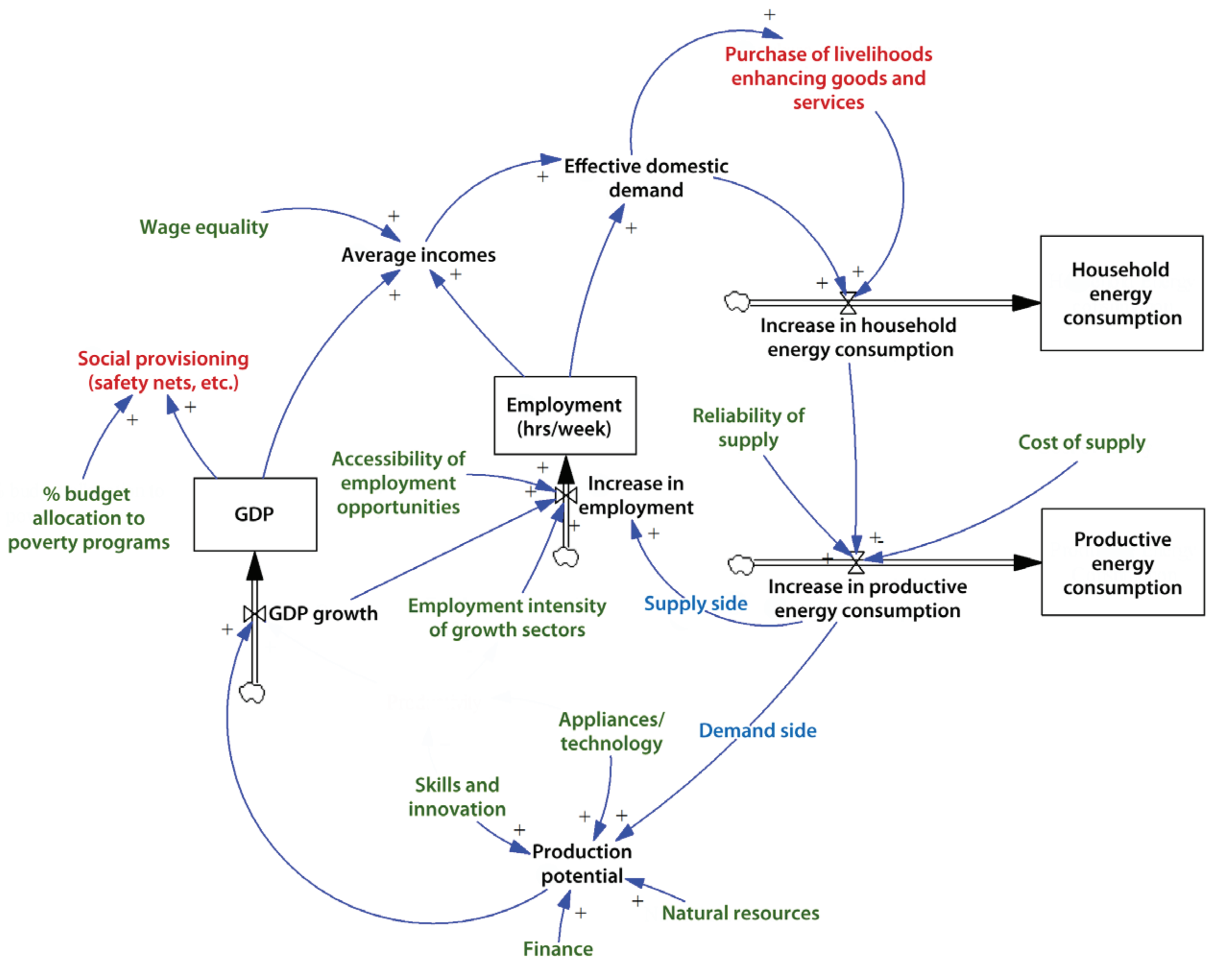


series of primary feedback relationships and mediating factors derived from the conceptual overview and case studies.[12]

This diagram illustrates that increases in (consumptive and productive) energy consumption, GDP and employment are mutually reinforcing within positive feedback loops. As each increases, generally so do the others – although proportions and pathways are influenced by mediating factors that will be described next. The circular links back to energy access via the improvements in incomes and in demand that result from growth and employment, are important for completing the loop. An increase in domestic consumption of goods and services also feeds back into an increase in energy consumption (to produce and use the products) and so back into GDP and employment (making and selling the products). In this respect, energy access is not only a driver of the growth-employment system, but is also driven by it – a relationship that matches with empirical evidence of the potential of energy access to bring about growth and the potential of growth to

12 The boxes represent stocks or levels; the valves going into the boxes represent the rate of increase of the levels, while the factors not in boxes or at the valves represent dynamic variables. The blue arrows linking them represent causal linkages, positive or negative, depending on the sign. A positive arrow should be 'read' as 'if X increases, then so does Y', with X at the base of the arrow and Y at the head.

Figure 22: Causal loop diagram linking energy, growth and employment, with mediating/influencing factors



bring about energy access. These two mechanisms at the macro level mirror, at the micro level, the 'demand pull' cases, where growth in a sector 'pulls' energy access, as well as the 'supply push' cases, where introduction of energy 'pushes' economic activity.

To the core diagram in Figure 21 are added in red the two primary impacts that this cycle has on development benefits. This is due to the purchase of livelihood-enhancing goods and services by employees who enjoy more purchasing power because they are employed as well as via 'social provisioning' in public services enabled by larger GDP and tax revenues available to government. This corresponds with the mechanisms identified in Chapter 2 linking growth and employment with development.

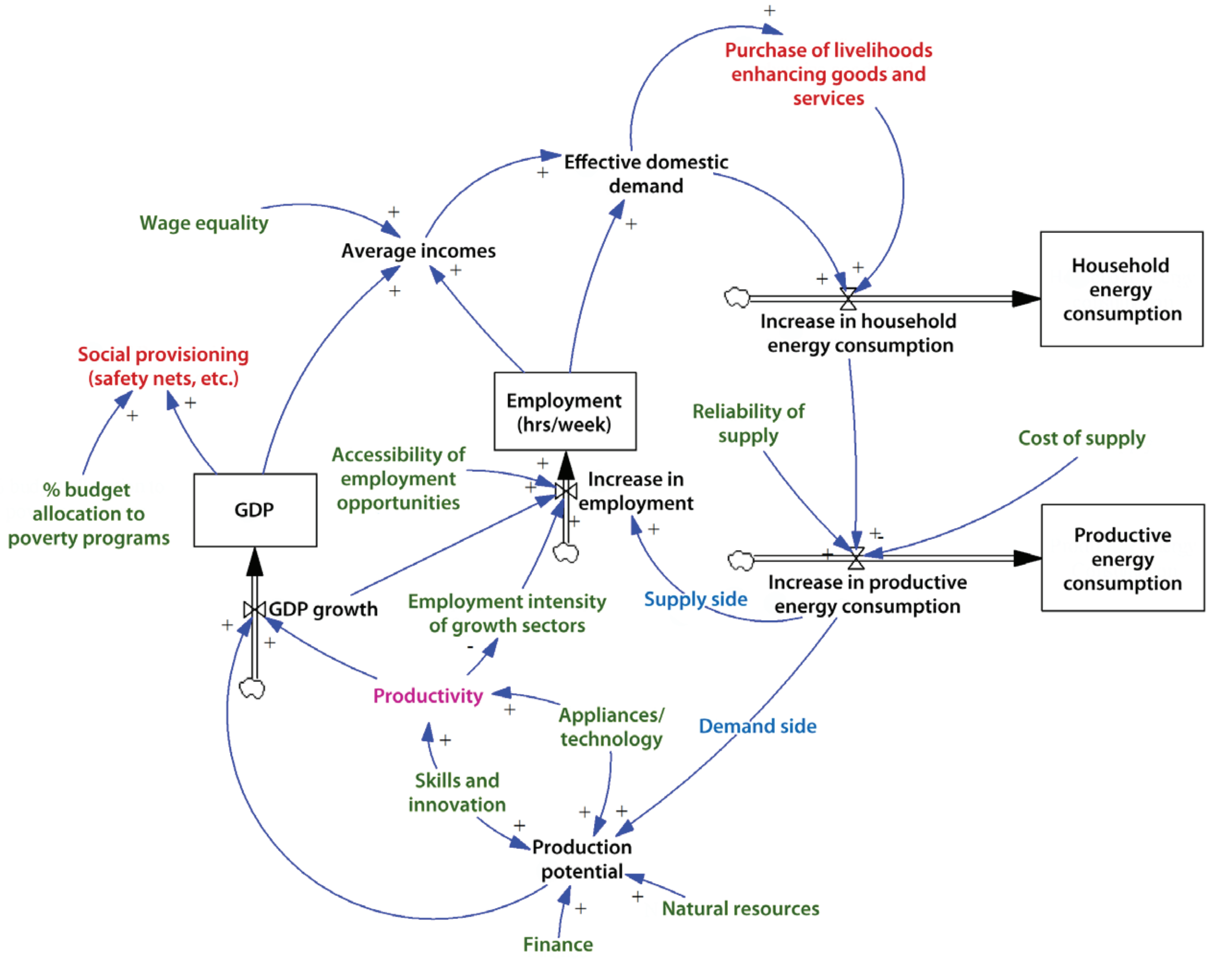
The factors that are considered to mediate or influence the extent of these relationships are illustrated in Figure 22, with these factors added in green.

The rate of increase of productive use of energy is dependent on the reliability and cost of supply, as highlighted by African business leaders (CGDEV, 2009). The extent to which production potential in the country grows is dependent not only on the supply of energy, but also on the availability of natural resources, finance, appliances/technology and skills and innovation. The extent to which economic growth is converted into an increase in new jobs is dependent on the accessibility of employment opportunities and the employment intensity of growth sectors. The extent to which new jobs and GDP produce greater incomes is also connected with wage equality. Finally, the conversion of increases in GDP into improvements in public services will also be connected to the issue of whether and how budgets are allocated to poverty programmes.

The final aspect to be added to this diagram based on the analysis to date is the element of productivity (see Figure 23).

As discussed in Section 3.3, productivity (including labour, resources and financial and energy productivity) is an important factor in a growing economy, but can act on growth and employment in different ways over different periods. The diagram illustrates how productivity (in purple) is derived from the skills and innovation and appliances/technology needed to create production potential. It also indicates that productivity can boost

Figure 23: Causal loop diagram linking energy, growth and employment including productivity



growth — which, in turn, boosts jobs — and reduce employment intensity, which can eliminate some jobs in the short run.

Although this diagram is preliminary, it offers as comprehensive a visualization of the connection among energy, growth and employment as we are aware of. A systems diagram illustrates the bi-directional causality found in previous studies. Further, the factors that mediate outcomes and also imply policy entry points can be shown explicitly.

4.2. Barriers to scaling up

Lessons have been derived from the analysis of each case study, including barriers faced and drivers encountered in increasing energy access and employment, particularly via decentralized and renewable energy approaches. In this section, case experience relevant particularly to policy is presented with respect to barriers and drivers to scale up. In summary, the key barriers noted in the cases are:

- **High up-front investment cost of renewable energy technologies combined with limited affordable financing available to project developers**

  Because the locations of the selected cases are rural, any energy supply source will be more expensive than it would be in urban locations, where dense populations reduce connection and distribution costs. However, the up-front costs of decentralized and renewable energy technologies remain a barrier to uptake, as witnessed in the Kenya tea example, even where cost savings are apparent and payback periods relatively short. This issue is compounded by the availability of affordable financing for project developers and businesses working in weak rural market areas. Lack of capital can also retard uptake of the appliances needed to convert energy access into productive use and employment at the level of the individual energy user.

- **Limitations on technical and management capacity in place within local/national public and private institutions to operate, manage and maintain energy systems**

  The challenges that apply to the slow spread of grid power and centralized infrastructure also apply to establishing decentralized energy systems and, in some cases, are more acute in that institutional capacity in rural areas is often less than in urban centres. This applies in governance and private spheres and can affect the cost and practicality of installing systems (a costly reliance on outside capacity) as well as the reliability of systems in operation (local maintenance and parts supply chains are essential), due to the lack of a reliable technology support system (consisting of technology and service providers).

- **Lack of market maturity and purchasing power at the consumer level, particularly in dispersed rural communities**

  While markets remain 'thin', i.e., have a relatively small number of weak players providing services, the potential for a market to pull energy services is limited, as is the potential of that market to convert energy services into productive uses that sustain businesses and jobs. Such communities are locked in a cycle of poverty and cannot be expected to act as a demand centre within a market system in a conventional sense. In such cases, an external input to one of the key elements – energy access, growth or employment – may be required to enable change. Even if energy access is created, additional barriers linked to lack of market access (e.g., infrastructure and natural resources) may also have to be addressed.

- **Lack of energy policies, regulations and institutional structures integrating decentralized renewables within overall energy planning and linking energy planning with other sectors**

  Many decentralized and renewable sectors within sub-Saharan Africa are operating in a relative policy vacuum, with limited institutional and regulatory context to enable players to invest and plan within a clear framework. Uncertainty about future grid extension plans, for example, undermines decentralized planning. At the same time, strategic direction in developing a sustainable and equitable energy access and employment situation can be lacking or variable, as in the Malawi ethanol case. The interrelationship between energy access and demand-side sectors like agriculture are extremely important, but respective policies are often delinked and fail to reinforce one another, thereby limiting the returns on energy access investments and the productivity and growth of those demand-side sectors.

- **Energy access has not yet been a major priority of the donor community, e.g., the limited integration of energy into the MDGs remains a barrier**

  The need for external support in assisting rural economies to kick-start virtuous circles of energy access, growth and employment remains. However, the general national and international failure to fully appreciate the great importance of energy access for growth and employment has undermined progress. Nevertheless, this situation may be changing, as evinced by the United Nations Advisory Group on Energy and Climate Change (AGECC) report and the UN 'International Year of Sustainable Energy for All' in 2012.

4.3. Drivers of scale up

Some of the above barriers are specific to decentralized energy approaches, while others are more general sector-relevant challenges facing communities and countries. At the same time, however, a series of drivers is countering these barriers, accelerating progress on energy access and employment growth via these same technologies. These are:

- **Low reliability, high cost and low coverage of grid power systems drives decentralized renewable options**

  Although the poor performance of grid operators and systems harms the overall economy, it creates a strong driver for alternative options, which may have other multiplier benefits for governance, the environment and long-term sustainability. In particular, with the longer-term goal of a low-carbon future increasingly in focus via climate change negotiations, an opportunity exists for African countries to develop an energy access pathway making use of technologies that were not available when grid systems in industrialized countries were put in place.

- **Availability of key resources, including renewable energy resources, land availability and year-round growing conditions, offers a comparative advantage**

  The renewable energy potential of Africa remains massive. For example, only around 30 percent of its hydropower potential is exploited. This presents an opportunity for grid systems and decentralized energy systems alike. The potential of solar power in niche markets, such as in the telecom case, for rural services (clinics, schools, etc.) is well-documented. The bioenergy potential of the land area and growing conditions present another potential driver of scale for growth and employment creation in rural areas.

- **Strong unmet demand for energy services coupled with improving decentralized technologies**

  There is extremely strong demand for energy and energy-related services. This is visible most notably in the case of electrification and mobile phones, but also in the case of efficient stoves and mechanical services, irrigation, etc. Given the low penetration of the power grid in this context, the development of increasingly effective decentralized products is likely to meet with an increasingly appreciative market that can drive growth. The spread of solar products such as chargers in the mobile phone market and solar lanterns in sub-Saharan Africa, linked with technology improvements and cost reductions, is evidence of this.

- **Growing recognition of the need to reduce fossil fuel dependency and foreign exchange drain and of the importance to expand energy access to development**

  Although dominant discourses remain focused on grid electricity and fossil fuels, high oil prices and concerns over climate change have combined to elevate low-carbon approaches in national and international policy agendas. The increasing international recognition of the importance of energy access to development (e.g., AGECC, 2010; IEA, 2011) also expands the space for all options meeting the range of energy services that people need, including decentralized options. In addition to government and civil society, or perhaps in response to it, the private sector is also mobilizing in some energy subsectors around more sustainable energy technologies and business models.

- **Recent increase in availability of climate-related and donor finance for low-carbon and climate-resilient development**

  Sub-Saharan Africa has not yet benefited strongly from carbon finance, lagging well behind other regions, most notably Asia. However, some installations have received carbon finance and, with more and more funds integrating development targets, including energy access with low-carbon objectives, decentralized renewable energy options are likely to benefit from increased support. Examples of such funds include the Clean Energy Investment Framework of the World Bank and the EU Energy Facility.

4.4. Policy recommendations

The Secretary-General has called for universal access to modern energy (i.e., electricity and clean cooking facilities) by 2030. A recent estimate by the IEA (2011) estimates that the cost of this would be USD 48 billion annually, or about USD 1,000 billion, over the period 2011–2030. The level of actual investments in 2009, on the other hand, amounted to about USD 9 billion. Although this sounds like a staggering amount of money, the annual USD 48 billion for global investment in energy access by 2030 would be equal to 3 percent of global investment in energy infrastructure over the period to 2030 (IEA, 2011). In other words, the problem of ensuring universal energy access is surmountable.

Based on the findings in this report, the following policy actions are recommended to achieve the goal of increased energy access while maximizing the linked and reinforcing objective of expanding employment. These are presented under three headings, with an emphasis on the role of decentralized (and renewable) energies:

Improved regulation and planning

- **Governments need to prioritize energy access as part of national development priorities, set national targets for universal energy access and put in place plans, institutions and an enabling environment to deliver them.**

  Clear energy and employment-oriented policy direction, governance capacity and regulatory systems are needed, as are incentives to engage participation from the private sector. Energy access targets should address the full range of energy needs of households, social institutions and productive activities as well as the various types of energy, including electricity, fuels and mechanical power.

- **Governments should integrate decentralized renewable energy into their energy policy and planning alongside conventional grid extension – with clear interim goals for progress that are monitored.**

  This will require the adoption of appropriate legal and regulatory frameworks enabling participation by a wider range of actors. Successful rural electrification programmes have demonstrated that setting up a dedicated electrification agency is a fundamental requirement. Setting up dedicated rural electrification funds, in which government, private sector, donor and banks can join in funding and lending schemes for energy solutions, have also been useful. Grid extension and off-grid alternatives should complement rather than compete with each other. Rural electrification planning frameworks should clearly define grid extension plans and off-grid areas and explicitly encourage off-grid renewable energy in lieu of grid extension in areas where they are the most economically viable option.

- **There is a need to integrate energy planning with planning in other sectors and to target energy access support to all geographical areas with economic and/or employment potential that can enable multiplier benefits.**

  This includes agriculture, roads, telecommunications, water, health services, schools and local enterprise development. Through this approach, synergies can be found between sectors for maximizing the impacts of energy access on income generation and employment. This requires more authority and funding for local planning bodies. This may also involve targeting rural development hubs, such as towns with strong market connections, in order to release their existing potential to create employment and provide energy-derived services to populations within their catchment area.

- **Policy guidelines are required for the sustainable development of the biofuels industry because of its broad linkages and impacts on environmental, economic and social pillars of development.**

  This is required before realization of its employment potential as well as its potential to meet domestic energy service needs, import substitution and export markets. This requires review of legal frameworks across energy, land, agriculture and trade sectors as well as the promotion of collaboration among government, the formal sector and the informal economy. In order to increase the accessibility of the biofuels sector and benefit-sharing, the promotion of structures that encourage smallholder participation and outgrower models, etc. should be considered, as should be mandates on proportions of products available for local energy access. Governance structures are also required to ensure that trade-offs among land issues, water supply, food production and fuel are monitored and managed.

- **Targeted direct support, including subsidies and incentives, can be warranted in developing energy delivery subsectors such as decentralized renewables or an employment growth sector that is pulling energy.**

  Worldwide, all rural electrification programmes have involved some form of subsidy. In principle, subsidies should be easy to administer (i.e., be efficient), have an impact on the desired population (i.e., be effective) and reach the poorest of society (i.e., be equitable). Subsidies are best used only where necessary and have a phase-out schedule built in and should preferably target investment in infrastructure (e.g., extension of transmission lines or generating equipment) rather than consumption (e.g., fuel usage or operation and maintenance of systems). Mandating biofuel blending as in Malawi, for example, can also be a way to create markets, while pricing in local employment and national economy multiplier benefits.

Enabling private sector and community action

- **Conditionally target energy access support to private subsectors with employment growth potential.**

  Public policy support to growth subsectors should be provided, but linked to a market structure that gives local people access to employment opportunities. This may involve breaking monopolies or supporting the establishment of co-operative or community models alongside private enterprises, as in the Kenya tea case. Where possible or feasible, incentives could be provided for public-private partnerships to invest in the creation of energy access. Public finance alone cannot meet the financing gap for energy access, but public policy and financing leadership can draw on increased private sector investments; base-of-the-pyramid approaches to decentralized renewable technologies exemplify this potential.

- **Build capacity in decentralized and renewable energy supply chains that provide technology and after-sales services, recognizing also the role of industry associations and academic and vocational training institutions.**

  This includes the capacity to plan, design, deliver, install, service and repair renewable energy systems. This may be via government procurement and private training as well as international co-operation; however, such capacity should be consolidated within industry associations and academic institutions within the sub-Saharan Africa region. Consistent support to the development of capacity and experience in a given sector is crucial to that sector's evolution and establishment, as illustrated by the Brazil ethanol example.

- **Promote community marketing, awareness creation and capacity- and confidence-building with regard to decentralized energy options.**

  Regardless of whether the community has formal ownership or whether the management model is co-operative or via an enterprise, the local population needs to be engaged in the energy development process – as stakeholders, consumers, productive users and, potentially, participants in supply. With proper awareness creation, confidence-building and capacity-strengthening, a community-based organization can successfully organize, manage and maintain a local mini-grid infrastructure, as is shown in the Yei electrification case study in South Sudan.

- **Energy initiatives should incorporate end-use support (in terms of capacity and market linkages as well as finance) to households and businesses to ensure that employment connections are made.**

  This includes end-use finance and business development support. Micro-loans for appliances and business mentoring, for example, can connect energy access and productive uses in employment-creating enterprises. Without it, electricity access, for example, may be used only for lights and a TV or radio, missing the multiplier opportunities of employment creation.

Co-ordinated action at the international level

- **There is a need for more explicit recognition of the importance of energy access for growth and development, coupled with a process translating this into expanded and improved programming.**

  This programming should balance on-, mini- and off-grid approaches as well as cleaner cooking and mechanical power and maximize employment impacts. The launch of the UN Secretary-General's 'Energy for All' initiative at Rio+20 offers a promising opportunity for this.

- **Increased concessional support from the international community to developing countries in sub-Saharan Africa for creating energy access.**

  Such support remains essential, especially in the difficult areas that do not initially offer an adequate commercial return. These financing requirements can be partially met by ODA as well as climate-related (carbon) finance, although the use of such funding to stimulate additional private sector investment in expanding access (e.g., through results-based financing or loan guarantees) will also be essential in closing the funding gap.

- **The international community should enhance collaborative mechanisms for research and development as well as knowledge exchange and transfer regarding decentralized energy technologies.**

  In order to expand applicability and drive down costs, innovation systems need to be accelerated within and between countries. Such mechanisms must develop a pragmatic approach to intellectual property that enables retention of value created while accelerating the affordable spread and uptake of beneficial technologies.

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ANNEX: INTRODUCTION TO CASE STUDIES

The case studies in this document were produced by regional experts based on literature review, interviews, analysis and experience. All case studies were produced according to an agreed and common template derived from the theoretical framework developed in Chapter 2 of the main report.

The structure of the case studies is as follows:

- **Background and context:** Introduction to the country and region context, especially energy and employment aspects. Introduction to the sector being analysed and the energy services required.
- **Market Map of the Value Chain:** Describing the main elements of the chain, enabling environment and supporting services according to the template provided by Practical Action, noting also entry points and features in the business environment as well as the specific energy services involved.
- **Evaluation of the employment impact of the initiative:** Providing (where possible) a numerical analysis of the income generation and employment creation aspects of the sector and/or energy service provision. Describing any multiplier effects of the intervention on employment (e.g., additional jobs created indirectly to the energy intervention, but that are stimulated by it nonetheless).
- **Key drivers and barriers to scale up:** Describing the factors within the design of any initiative and within the enabling policy and business environment that can obstruct or enable the energy service provision (and demand sector) to be viable.
- **Policy recommendations:** Recommending what policy interventions at the local, national or international levels may boost the spread and impact of this kind of initiative – based on this country and sector-specific experience.

The cases were selected to cover a range of contexts in western, eastern and southern Africa; a spread of energy access services and technologies (with a focus on decentralized renewables); and a spread of examples across the categories of demand pull, supply push, and energy sector (supply-side) employment – as defined in the Conceptual Framework in Chapter 2.

Case studies can be used as stand-alone examples of experiences regarding specific subsectors and the applications of decentralized renewable energy supplies and services. They can also be seen as representative of the contexts experienced in the respective countries and regions regarding energy provision and enterprise activity more widely. The main report attempts to look across the whole set of cases and draw conclusions and policy recommendations based on the commonalities and repeating themes visible in the case studies.

1. THE TEA SECTOR IN KENYA, EASTERN AFRICA

Energy service(s)	Tea Production – Withering, cutting, curling, tearing, screening, grading, packaging, drying, heating
Energy vector(s)	Electricity, mechanical power, heating fuel
Energy Resource(s)	Hydropower, geothermal, fossil fuel, biomass
Location	Kenya
Linked projects	Greening the Tea Industry in East Africa Project (GTIEA) About a dozen small hydropower plants with a total of 5.42 MW serving tea factories in Kenya: James Finlay (a number of plants totalling 2.4 MW), Unilever (4 plants totalling 2 MW), EPK Ltd. (120 kW) and KTDA Ltd. (900 kW)
Key actors[1]	GTIEA: Project with Executing Agency: East African Tea Trade Association (EATTA), Donor Global Environmental Facility, Co-implementing partners: UNEP and AfDB, and participating tea companies, Kenya Tea Development Agency Ltd. (KTDA), Unilever Tea Kenya Ltd. (UTKL), and Eastern Produce Kenya Ltd. (EPKL), in Kenya
Energy access beneficiaries	Tea Factories
Employment beneficiaries	Demand-side employment: 200,000 people are directly employed in the tea industry while some 3 million, 8 percent of the Kenyan population, are dependent for their livelihood on the tea sector. The smallholder tea sector, which accounts for about 60 percent of made tea produced in Kenya, has more than 500,000 growers supplying tea leaves to 63 tea factories, of which the farmers are shareholders. Supply-side employment: 5,400 in fuelwood supply and 2,250 person years of employment in installing and operating the hydro-schemes.

Background and Context

Kenya has a population of 38.8 million (2008) and is a low-income country, with an HDI ranking of 147[2] and a per capita income of USD 730.[3] In Kenya, the agricultural sector accounts for 24 percent of GDP, two thirds of the employment and 70 percent of export earnings. Kenya has achieved sustained economic growth during the last few years as GDP grew from 0.6 percent in 2002 to 7 percent in 2007 and the poverty level decreased from 56 percent in 2002 to 46 percent in 2006. This growth is considered to have benefited development indicators and the Kenya Vision 2030, launched in October 2007, aims to transform Kenya into "a newly industrializing, middle income country" and a "globally competitive and prosperous country with a high quality of life by 2030". The document recognizes energy access as one of the foundations of achievement of the vision and has set a target to increase access to electricity in rural areas from 4 percent in 2007 to 12 percent by 2012 (Kenya Vision 2030, 2007).

1 While GTIEA pilot project spans Kenya, Uganda and the United Republic of Tanzania, this case study will focus particularly on the tea industry in Kenya because of its global scale of operation.

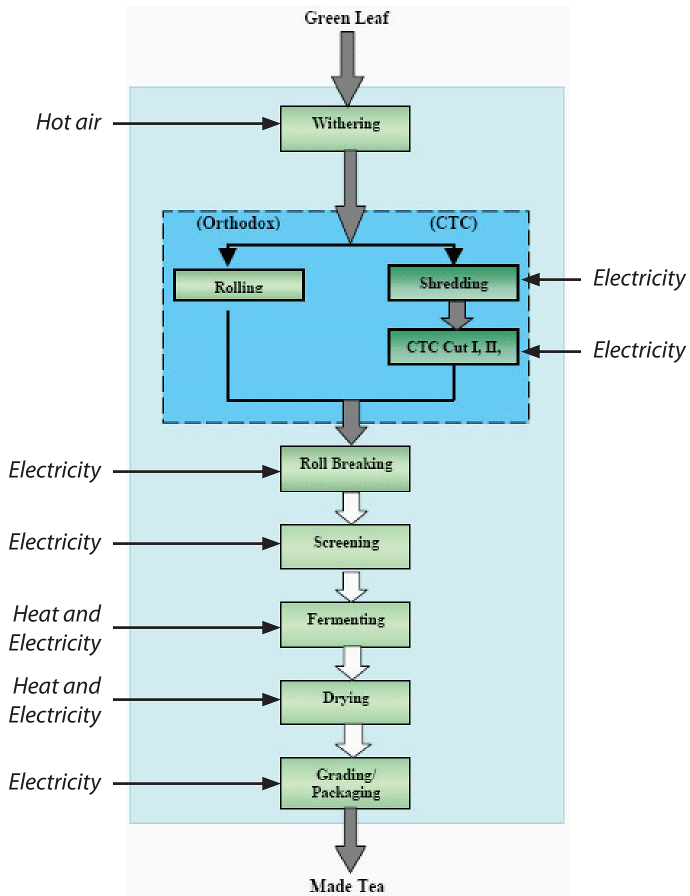
2 Source: *hdr.undp.org/en/reports/global/hdr2009/* cited on 7 September 2010.

3 Source: *data.worldbank.org/country/kenya* cited on 7 September 2010.

After the introduction of the first tea seedlings in Kenya from India by a colonial settler G.W. Caine in 1903, the commercial cultivation of tea began in Kenya in 1924 (Tea Board of Kenya brochure, undated). While, the large commercial plantations owned by multinationals (mainly Unilever Tea Kenya Ltd. (UTKL), James Finlay and Eastern Produce Kenya Ltd. (EPKL)) became well-established thereafter, the development of the smallholder tea sector began after the establishment of Kenya Tea Development Authority (KTDA) in 1964 by an act of Parliament, a year after Kenya became independent in 1963.

The aim of KTDA was to develop the small tea growers sector. From one factory serving 19,000 growers and 4,700 hectares of tea (Gesimba et al., 2005), KTDA today manages 63 tea factories spread across 12 zones, with over 500,000 growers who cultivate tea on 107,115 hectares. The growth of the smallholder tea sector through KTDA is a major success story. KTDA, a state corporation, was privatized in 2000 and transformed into what is today known as the Kenya Tea Development Agency Ltd. KTDA Ltd. is owned by 54 tea factory companies[4] that are its corporate shareholders. The tea factories are owned by the more than 500,000 growers who supply green tea leaf to the factories. KTDA Ltd. has a management agreement with tea factory companies to provide management services that include tea extension, sales and marketing, financial services, engineering and other management services. The growers currently receive between 60 percent to 70 percent of the final auction price of tea while the remaining 30 percent to 40 percent goes to processing and operation costs (UNEP, 2007). The market share of production of made tea in Kenya is 60 percent for smallholder tea sector and 40 percent for large-scale commercial plantations owned by multinationals.

Figure A1.1: Black tea production processes for Orthodox and CTC Tea



Source: AIT, 2002.

Tea is one of the key drivers of the Kenyan economy, accounting for 20 percent of national export earnings. About 70 percent of tea produced in Africa is from Kenya and the country is the third largest producer and the leading exporter of tea in the world (UNEP, 2007). In 2008, Kenya produced 345,817 metric tonnes of made

4 Some of the tea factory companies have more than one tea factory; this makes a total of 63 tea factories.

tea from 157,720 hectares of planted area and exported over 325,533 metric tons of made tea (Tea Board of Kenya brochure, undated) worth about USD 0.9 billion. The East African Tea Trade Association (EATTA) is a central organization in the export of tea from Africa and with its members include tea producers, buyers (exporters), brokers, packers and warehouses. EATTA member countries account for some 28 percent of the total tea exported in the world, most of it through the Mombasa Auction (UNEP, 2007).

Tea processing is not possible without thermal and electrical energy. Thermal energy is required for the withering and drying process. Electrical energy is primarily used to operate fans for withering and drying and to power motors for the cutting, tearing and curling (CTC) process and to vibrate sieves for sorting and grading tea (see Figure A1.1). Table A1.1 below shows the energy required for each of the processes of made tea.

Table A1.1: Energy requirements in the processing of tea

Process	Electrical Energy %	Electrical Energy kWh/kg made tea	Thermal Energy %	Thermal Energy kWh/kg made tea
Withering	15	0.10	13	0.59
CTC	45	0.29	0	0.00
Drying	15	0.10	87	3.86
Grading	25	0.16	0	0.00
Total	**100**	**0.65**	**100**	**4.45**

Source: UNEP, 2007.

Tea processing is energy intensive, requiring 4.5-12 kWh/kg of made tea compared to 6.3kWh/kg for steel processing (UNEP, 2007). Energy makes up 6-25 percent of the total cost of tea production in EATTA countries, depending on process and equipment efficiencies and types and cost of fuels used (UNEP, 2007).

The tea industry consumes over 225 GWh,[5] or 4 percent, of the electricity on the national grid and over 1.3 million tonnes,[6] or 4 percent, of fuelwood consumed in Kenya.[7] The share of primary national energy consumption in Kenya consists of biomass (68 percent), petroleum (22 percent), electricity (9 percent) and others including coal (1 percent) (Kenya Vision 2030, 2007). Thirty-one percent of electricity generation in Kenya comes from imported fossil fuels. The import of fossil fuels is the major source of foreign exchange drain from Kenya. This also makes electricity prices in Kenya vulnerable to changes in the international price of oil. Generation of electricity from renewable sources such as small hydropower reduces this dependence, the cost of electricity and carbon emissions.

Tea-growing areas are situated at an altitude of 1,500 metres to 2,700 metres above sea level in hilly areas with high mean annual rainfall from 1,500 millimetres to 3,000 millimetres (IED, 2006). The Small Hydropower

5 Author's estimate based on 0.65 kWh of electricity consumed per kilogram of made tea, with annual production of 345,817 tones of made tea.

6 Roughly 4 kilogram of fuelwood is consumed per kilogram of made tea. For example, during 2009-2010, 836,453 tonnes of fuelwood (apart from the use of 8.65 million litres of furnace oil) were consumed to produce 220,000 tons of made tea in 63 KTDA managed factories. (Source: Personal communication with Lucas Maina, KTDA on 26 August 2010).

7 31 million tonnes of fuelwood is consumed per annum in Kenya. (Source: Study on Kenya's Energy Demand, Supply and Policy Strategy for Households, Small Scale Industries and Service Establishments 2001).

Scoping Study carried out in 2006 for UNEP/EATTA by IED, a French consulting firm, showed abundant potential for small hydropower in the tea-growing areas. However, of about 100 tea factories in Kenya,[8] only about a dozen (most owned by large commercial plantations) have electricity supplied from their own small hydropower plants, mostly established during 1928-1940 (IED, 2006) and still in good working order. In spite of the high potential for small hydropower development in the tea growing areas, the tea companies have invested little in small hydropower projects during the last 20 years.

The main source of supply of electricity to 90 percent of tea factories in Kenya is the national grid.[9] Since tea processing, once started, cannot be interrupted, as interruption damages the quality of made tea; every tea factory thus has provision for a back-up electricity supply from a diesel generator. Given the low reliability of the Kenyan grid, a study by IED in 2006 showed that, on average, tea factories use diesel generators as back-up supply when the grid supply fails – which is around 7 percent of the time. Since 31 percent of electricity generated in Kenya is from imported fossil fuels, the electricity tariff in Kenya is one of the highest in the region. Because Kenya has no fossil fuel reserves, the electricity tariff in Kenya is vulnerable to international oil price fluctuations. The sharp increase in electricity tariff in July 2008 and ongoing adjustment in electricity tariff based on the international oil price has significantly increased electricity cost in tea production. This combination has prompted tea companies to look for cheaper and more reliable sources of electricity. Tea companies therefore have taken increasing interest in generating their own electricity from small hydropower plants.

Tea companies with their own small hydropower report benefits deriving from a clean and reliable source of electricity supply, which also reduces operating costs. Using four small hydropower plants in Kericho that had a total installed capacity of 2 MW, Unilever Tea Kenya Ltd. saved USD 1 million in energy costs in 2008 by being 70 percent self-sufficient in the electricity needs of six of its tea factories[10] (Ogada, 2009). As the cost of electricity is the major energy cost component in processing of tea, tea companies such as Unilever Tea Kenya Ltd. and James Finlay, with their own small hydropower supplying electricity to their tea factories, have a cost and competitive advantage over other tea companies that rely on expensive grid electricity.

The objective of the Greening the Tea Industry in East Africa Project (GTIEA) is to increase investment in small hydropower in order to reduce energy costs to the tea industry, improve reliability of power supply, increase power supply for rural electrification and reduce greenhouse gas emissions through removal of barriers. The project aims to establish six small hydro demonstration projects in four tea-producing countries in the region: Kenya, Rwanda, the United Republic of Tanzania and Uganda. The generated power will primarily meet the needs of the tea factories and additional power will be used to electrify adjoining communities to the tea factory/estate or feed into the national grid. The four-year project is in its fourth year of implementation. Three projects are in the implementation phase, one of which has begun construction. Preparations for implementation of other three more projects are underway. The GTIEA project has supported participating tea companies in preparation of bankable feasibility studies and providing advisory support in the implementation

8 From 91 in 2007, the number of tea factories has increased to 100 in 2010, the nine new factories being added in the smallholder sector managed by KTDA. (Source: Personal communication with Lucas Maina, Project Manager, KTDA on 26 August 2010).

9 The 5,907 GWh annual supply mix for Kenya consists of hydro (51 percent), fuel oil (31 percent), geothermal (17 percent) and a tiny fraction of cogeneration, wind and imports (Kenya Vision 2030, 2007).

10 Based on 70 million Ksh saved, at an exchange rate of 70 Ksh to USD 1.

process. However, the entire investment in the small hydropower projects is made by tea factories through equity and loan from financial institutions.

Fuelwood is the main source of thermal energy for tea production. While most large commercial farms cultivate wood lots for supply of fuelwood to the tea factories, the KTDA-managed smallholder tea factories purchase their supplies from commercial suppliers. Some of the smallholder-owned tea factories are in short supply of fuelwood and also use furnace oil to meet their thermal energy needs. In recent years, KTDA has launched an initiative for factories to plant their own trees to meet part of their fuelwood needs in the long term. Conversion to efficient boilers and efficient-energy use are other measures being taken to reduce thermal energy needs.

Market Map of the Kenyan Tea Sector

The main chain market actors are over 500,000 farmers who sell tea leaf,[11] producers who produce tea, tea brokers, buyers (exporters in Kenya or local wholesale purchasers) and the importers in the destination market. The supporting service providers are the electric utility (supplying more than 80 percent of electricity needs), commercial fuelwood suppliers, fossil-fuel[12] suppliers, (tea factory-owned) small hydropower plants, warehousing, courier and road transport companies, shipping companies, ports authority and financial institutions.

The enabling environment consists of the Ministry of Energy and Energy Regulatory Commission for energy policy and regulatory framework, Kenya Power and Lighting Company for buying and selling of electricity and electricity-generating companies (KenGen and Independent Power Producers). With respect to the tea industry specifically, the Tea Board of Kenya provides regulation, the Kenya Revenue Authority administers taxation, the Kenya Bureau of Standards sets industry standards and Kenya Plant Health Inspectorate Services (KEPHIS) conducts monitoring and quarantine. A recent addition to the enabling environment is the announcement by the Kenyan Ministry of Energy of a feed-in tariff for renewable energy, which includes small hydropower, in March 2008.

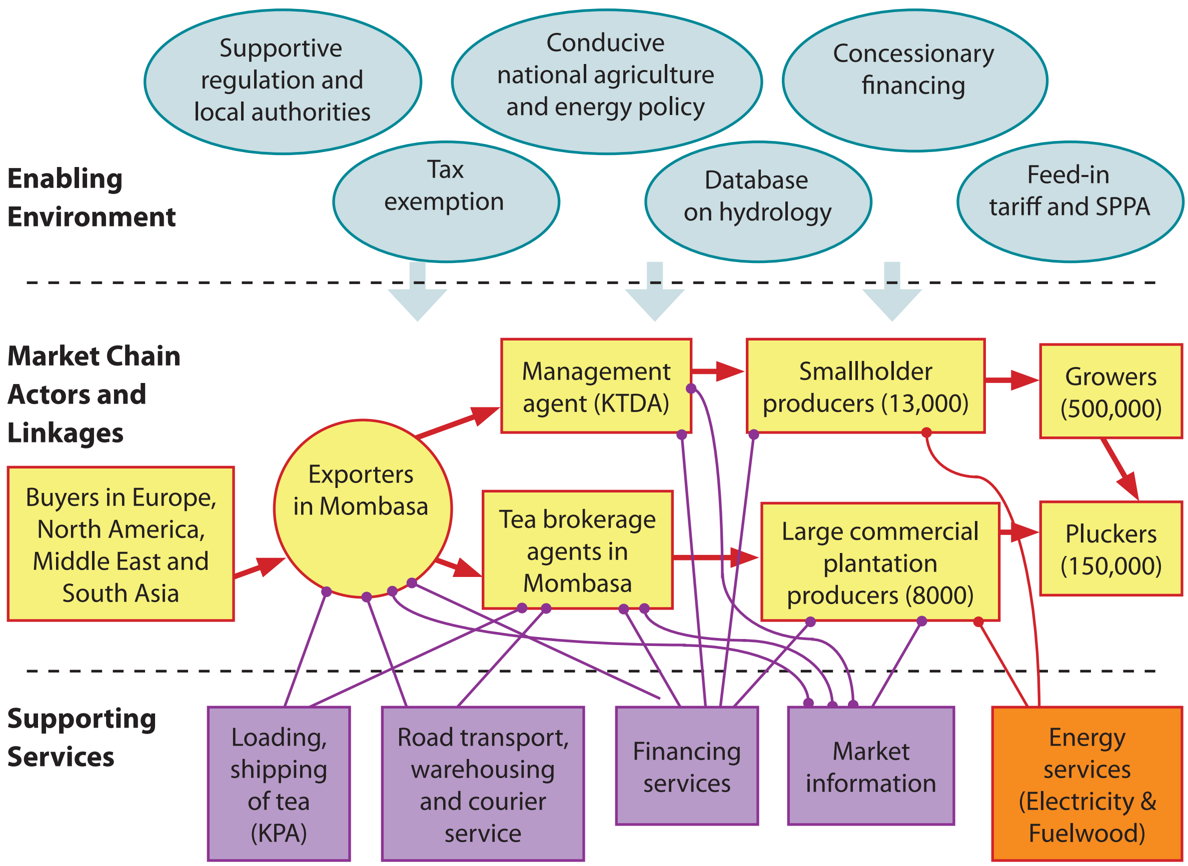
As illustrated above, electricity is a crucial supporting service to the tea sector. Large tea estates such as those owned by UTKL, James Finlay and EPKL have had one or more of their own mini-hydropower plants operating since the 1930s, partially meeting the electricity demand of the tea factories. The deficit is met from grid supply and diesel generators for back-up electricity supply. Currently, the total installed capacity of tea factory-owned small hydropower is 5.42 MW, which supplies electricity to over a dozen tea factories and provides about 10 percent of the total electricity consumed in tea factories in Kenya. Of the KTDA managed factories, only the Imenti Tea Factory has so far generated its own electricity from a 900 kW small hydro plant supplying power to production, with surplus sold to Kenya Power and Lighting (KPLC). However, further small hydropower power plants have applied for a power purchase agreement and the government also has given concessions on import duties on equipment for renewable energy.

The large commercial tea plantations have also maintained their own wood lots and are self-sufficient for their fuelwood needs. Roughly 1 hectare of wood lot is required for every 4 hectares of tea plantations (UNEP, 2007).

11 The number of farmers selling tea leaves will be higher than 500,000, as some of the tea factories owned by multinationals also buy green leaf from smallholder farmers.

12 Diesel for back-up generator, furnace oil for thermal energy and diesel, petrol for road and shipping transportation.

Figure A1.2: Kenyan tea sector market map



In the case of KTDA, they depend on commercial suppliers for their fuelwood needs. However, in the recent years, they have encouraged tea factories to plant their own trees. Some of the KTDA-managed tea factories that have short supply of fuelwood rely on furnace oil[13] to meet their thermal energy needs.

The non-energy supporting services to the main chain that are important to the continued viability of the tea industry are financial services for credit and payment transfer, courier, warehousing and transport services for sending tea samples, storage and road transportation and shipping overseas.

Evaluation of the Employment Impact of the Initiative

In terms of energy demand-side employment impacts, tea production is highly labour-intensive, with labour accounting for around two thirds of the production costs ex-factory (UNEP, 2007). Plucking is done by hand and accounts for 75 percent of labour cost. In Kenya, the employment generated from tea production is estimated to be 80,000 in the large commercial plantations (Gesimba et al., 2005), which produce 40 percent of made tea

13 A total of 8,646,355 litres of furnace oil was consumed in these factories in 2009/10. (Source: Personal communication with Lucas Maina, KTDA on 26 August 2010)

in Kenya. Based on this, it is estimated that the smallholder tea sector that produces 60 percent of made tea[14] in Kenya provides direct employment to around 120,000 people. Although most of this employment is in manual labour, this labour would not be required or possible without the energy services necessary to process the tea after growing and picking. This makes the combined employment creation (new employment compared to a scenario without the tea sector) in the sector 200,000. In total, three million people, 8 percent of the population (in 2008) of Kenya, are dependent for their livelihoods on the tea sector (Gesimba et al., 2005).

An estimate shows the annual average tea-related income of a grower to be about USD 625[15] and that of a plucker in large commercial plantations to be USD 1,262.[16] Further published documents on the employment impacts of the tea sector were not available. This employment opportunity would not have been created without access to energy services, which the tea factories are dependent on for processing tea. There is only six hours of lead time from the plucking of a tea leaf to the start of tea processing in order to maintain the quality of made tea. This requires locating tea factories close to the tea plantations so that fresh tea leaf can be delivered on time. As a result, tea factories are located in rural areas that gradually grow to be town centres.

In addition to being an employment intensive sector, the tea sector as currently structured in Kenya enables the involvement of a wide variety of rural people in direct employment (as pickers, etc.) as well as service provision (transport, etc.) and via purchase of tea produced by smallholder farmers. The share in the ownership of the 60 tea factories held by the smallholder farmers takes this general accessibility a stage further and also stabilizes issues such as wage disparity in the sector while maintaining shared focus on overall sector competitiveness.

On the energy supply side, employment impacts as a result of supply of fossil fuel and electrical energy specific to the tea industry is not significant compared to the employment created by the main actors in the value chain in the tea sector. The most significant employment impact linked to energy supply to the tea sector is through the estimated 1.3 million tonnes of fuelwood consumed annually by the 100 tea factories. As is clear from Table A1.2, the generation of 5.4 TWh of primary energy from 1.3 million tonnes of fuelwood (at 15 GJ/tonne) creates around 5,400 new jobs, assuming 1,000 person years of employment generated per TWh of wood energy (AFREPREN, 2009).

The employment created in hydropower is less significant, but non-negligible. The installation of a

Table A1.2: Comparison of job creation — biomass and conventional energy forms

Sector	Jobs (person years per TWh)
Petroleum	260
Off-shore oil	265
Natural gas	250
Coal	370
Nuclear	75
Wood energy	1000
Sugarcane cogeneration	4000

Source: Goldemberg, 2003. Extract from AFREPREN/FWD (2009)

14 Processed tea is known as 'made tea', which, as a finished product, is packed and sold.

15 In 2008/09, KTDA paid a total of USD 0.312 billion to about 500,000 growers who supplied tea leaves to 63 tea factories managed by KTDA. This translates to an average annual income of USD 625 per grower. (Source: Personal communication with Lucas Maina, KTDA on 26 August 2010)

16 Based on plucking rate (in 2010) of Ksh 8.36 per kilogram of green leaf and average 40 kilogram of green leaf plucked per day per person and 302 working days per annum. Exchange rate: 80 Ksh = USD 1. (Source: Personal communication with Chris Ballard, Director of Engineering, Eastern Produce Kenya Ltd. on 13 September 2010).

small hydropower plant involves tens of people in a variety of roles from engineers to labourers. The 5.4MW currently in use is estimated to have generated over 2,000 person years of employment. If plants were installed in a significant proportion of the 88 or so tea factories currently without small hydro, then this would have a more significant, although time-limited, employment benefit to the engineering and construction sectors. The numbers of employees engaged in the operation and maintenance of each hydropower plant are relatively small, but could total several hundred, should many more tea factories take up small hydro. Such a drop in reliance on the grid would not significantly affect employment in the utility, but would free up generation capacity to widen access in the country.

As the tea growing and manufacturing is carried out in rural areas, the tea industry has potential to contribute to the development of rural infrastructure and socio-economic well-being of the rural communities (Tea Board of Kenya, undated). The vicinity of tea factories often has medical facilities, schools, housing, drinking water supply and electricity for the workers (UNEP, 2007), although this co-benefit could be further expanded.

Key Drivers to Scale up of the Use of Small Hydropower Plants in the Tea Industry

The main overall driver of the growth of the tea sector and its consumption of energy is the history of tea production in the region along with the corresponding skills, market connections and natural resources. In terms of driving employment impacts, the labour intensity of the tea production sector has been the key in reaching the very high levels of employment. However, the accessible post-independence structure of the industry, incorporating both private and cooperative models, has enabled a variety of types of employment engagement with the sector and has driven wider benefit distribution. Energy access, however, underpins these drivers, in that the industry could not exist without it.

The extension of grid electricity to tea-growing areas has been instrumental alongside other infrastructure, such as access roads, in the growth of tea factories. However, the high electricity tariffs and unreliable grid supply in Kenya have driven interest among tea companies in small hydropower, which can generate electricity at less than half the price of the utility tariff, as illustrated in Table A1.3.

Table A1.3: Electricity price in Kenya in USc/KWh from different sources

Grid supply	Tea company-owned back-up diesel generator	Small hydropower plant[17]
16	30	3.64 – 7

As the cost of electricity is the major energy cost in tea production, reductions in electricity cost from small hydropower will enhance Kenya's competitiveness in tea in the world market. With the announcement of the feed-in tariff, tea companies can also size their power plant at optimum for the site conditions and sell excess to the grid for additional revenue power (after meeting the needs of tea factories). This combination of process reliability, operating cost reduction and additional revenue opportunity is driving the resurgence in interest in using small hydro in the tea sector.

17 Plants running since the colonial days are still well maintained and have a very low generating cost (3.64 USc/kWh for, say, Unilever plants), as they have paid their investments long ago. The generation cost for plant that will be built are expected to be 5 to 7 USc/kWh.

Analysis of market players (such as Unilever, which has installed hydro) indicates that those tea factories with small hydro are in a stronger competitive position than those without, in terms of reducing operating costs and additional revenue – essentially increasing overall productivity via improved energy access. Currently, however, the large private tea estates have the small hydro plants and so improved profitability is likely to revert to the company owners and shareholders rather than automatically be translated directly into more income for more employees. Nevertheless, the profitability of these firms can also be expected to translate into enterprise growth (until a market or physical limit is reached) and more secure employment for local people within the firm. Should hydro schemes also be picked up in the KTDA factories, then a wider and more direct spread of benefits to smallholder grower shareholders is a possible outcome. Most immediately, if the 30 percent to 40 percent of the sale price of tea current taken for processing could be reduced, the share that the growers take (currently 60 percent to 70 percent) could be increased. The mixed private/cooperative nature of the Kenyan tea sector can be considered a source of strength in terms of blending elements of entrepreneurial leadership and benefit distribution, as demonstrated in its employment-intensive growth to date.

Key Barriers to Scale up of the Use of Small Hydropower Plants in the Tea Industry

Some of the barriers to uptake of small hydropower by private developers, including tea companies, are related to investor confidence, financing and local technical capability. Policy and regulatory and measures being undertaken to address these are described here.

- **Policy and regulatory uncertainty:** If clear rules exist for the sale of excess power to the utility or other entity (say, distribution company for rural electrification), this will allow for a hydropower project to be developed at its optimum size rather than to meet the needs of tea factory only. Although the Government of Kenya has announced a feed-in tariff for renewable energy, including small hydropower, there is still uncertainty about the price being offered, as the feed-in tariff announced is not a guaranteed tariff, but a maximum tariff that can be given on case-by-case basis. The investor is therefore not sure of a guaranteed tariff in advance and this creates uncertainty, even at the pre-investment stage, about carrying out a feasibility study. The need for negotiation of tariffs on a project-by-project basis increases project transaction cost and risk. Examples of countries that have had increased private-sector investment in small hydropower show that the reason for success was the guaranteed feed-in tariff and standard power purchase agreement that removed market uncertainty.
- **Investor confidence:** The small hydropower sector is new to the tea industry and many factories are not aware of the potential for small hydropower development in their areas. Being new to the sector, tea companies are not ready to take early 'pre-investment' expenses to carry out a detailed feasibility study when there is no guarantee that such an investment will bear fruit. Such risks are reduced by supporting tea companies in carrying out high-quality detailed feasibility studies and providing technical backstopping for project implementation, as GTIEA has done.
- **Lack of financing experience:** The small hydropower sector is new to financing institutions in Kenya. They have no experience in financing of small hydropower projects on commercials terms. The banks also have no due diligence capacity to review loan applications for hydropower project. The GTIEA

project has attempted to produce high-quality feasibility study reports in order to provide confidence to the financing institutions to provide loans to developers. At the same time, financing institutions have been exposed to the small hydropower sector through study tours to small hydropower plants and attendance at small hydropower financing workshops.

- **Limited national technical capacity:** Few investments have been made in hydropower projects in Kenya during the last 20 years. As a result, the engineering and construction firms in Kenya had little opportunity to be involved in carrying out feasibility studies, design and construction of hydropower projects and therefore have limited experience. Building the technical capability in the small hydropower sector will take many years. This can only happen with the engagement of local firms in the training and actual work of carrying out the studies and construction of the schemes. The GTIEA project addresses these barriers through organizing study tours and training workshops, engaging local firms in feasibility studies and design, and working in partnership with external experienced firms during the implementation phase.

Policy Recommendations

The following are the policy recommendations arising from the analysis of the Kenyan tea industry and, in particular, the role of small hydropower within it.

- **Support lead players to overcome initial barriers:** The small hydropower sector is new to many tea companies, increasing perceived risk as the cost involved in developing projects is relatively high and the availability of local expertise limited. External intervention is therefore required to provide tea companies with advisory support and financial assistance on a cost-sharing basis for carrying out feasibility studies and thus minimizing pre-investment risk, while sector experience is built up.
- **Ensure critical renewable energy sector data is available:** As in many sub-Saharan African countries, measurement and collection of hydrological data is not functioning widely. This is the type of information on which investments in a renewable energy sector are based, but that cannot generally be produced by individual private participants, especially in early phases of market development.
- **Promote national capacity-building and institutions:** In order to develop local capacity in design, construction, operation and maintenance of hydro schemes, local firms can be engaged through training and involvement in studies and construction, initially in partnership with experienced external firms if required. Additionally, the creation or reinforcement of institutions for capacity retention and creation, such as industry associations and university departments, should be encouraged
- **Promote energy supply diversity, including both centralized and decentralized technologies:** Electricity supply diversity, blending grid, hydropower and diesel back-up, is the most pragmatic and effective solution for tea factories in remote areas. This enables them to have the supply reliability they need, along with the lowest cost supply options. A local and sustainable supply of fuelwood, coupled with the potential to access wood via commercial providers, is another example of supply diversity in the face of changing resource availability and prices and also linking to creation of employment on the supply side.
- **Support energy investment linked to employment-intensive sectors:** Small hydropower projects are capital intensive and require high up-front investment. In most cases, the size of investment is

more than the cost of a tea factory at USD 2.5 million to USD 3 million per MW. Small hydropower projects therefore have a payback period of 7 to 12 years. As many commercial banks in sub-Saharan Africa are not used to providing financing for more than five years and their rates are high, special financing windows need to be created that require donor assistance or assistance from development banks. The employment intensity of the tea sector, compared with less employment intensive sectors, would support such targeted assistance.

- **Encourage the creation of accessibly structured energy-linked sectors:** An additional important element of the Kenyan Tea case is the diversity of its ownership, including large private institutions and cooperatives made up of many smallholder farmers. This blended structure seems to contribute to sector productivity and competitiveness, magnifying employment growth impacts, enabling local ownership, and distributing benefits via a range of employment opportunities accessible to rural people.

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2. MULTIFUNCTIONAL PLATFORMS (MFPs) FOR LOCAL AGRO-PROCESSING IN BURKINA FASO AND MALI

Energy service(s)	Grinding, dehusking, battery charging, water pumping, oil pressing, welding machines, carpentry tools, and lighting through mini-grids
Energy vector(s)	Mechanical power, electricity
Energy Resource(s)	Petroleum diesel, straight vegetable oil or biodiesel
Location	Burkina Faso and Mali in western Africa
Linked projects	Multifunctional Platforms for the fight against poverty, 1999-present
Key actors	Women's groups, artisans, households, UNIDO, FAO, UNDP, Gates Foundation, Norwegian Agency for Development Cooperation (NORAD), Swiss cooperation, Governments of Burkina Faso and Mali
Energy access beneficiaries	Mostly women, but also households, private operators and SMEs, local level institutions, metal artisans
Employment beneficiaries	New supply-side jobs: Around 6,600 to date in 545 MFPs in Mali and 285 in Burkina Faso. Additionally, one artisan is trained to maintain and repair an average of 17 MFPs. Opportunity cost savings: In Mali alone, 2.5 hours per day are saved for 10,000 women by the MFPs currently installed. That equates to around 4,300 person/years of employment potential freed up. New demand-side jobs: Include creation of 26 micro enterprises for welding by rural artisans in Mali.

Background and Context

The Multifunctional Platform (MFP) consists of a source of mechanical and electrical energy, typically provided by a diesel engine of 8 to 12 horsepower (hp), equivalent to 6 to 9 kW mounted on a chassis. A variety of end-use equipment can be added. The configuration of equipment – such as grinding mills, battery chargers, electric water pumps, vegetable or oil nut oil presses, welding machines, carpentry tools, and mini electricity grids for lighting – is flexible and can be adapted to the specific needs of each application. The 'basic module', without water or lighting distribution network, including the engine, mill, dehusker, battery charger, cooling system, shelter and installation, costs about USD 4,300, of which 50 percent to 60 percent is directly financed by the beneficiaries, the remaining 40 percent to 50 percent being financed by the project via a subsidy.

The widest and longest-term experience with MFPs has been in western Africa. The concept of the MFP for rural energy access was first introduced in western Africa by UNIDO/FIDA from 1993 to 1995 and UNDP from 1996 to 1998. Burkina Faso and Mali were the first countries with pilot projects. Today, there are on-going full-scale and pilot programmes in Burkina Faso, Mali, Senegal, Ghana and Guinea in western Africa. There are also attempts to apply the MFP concept in other regions. In the United Republic of Tanzania, a local non-governmental organization recently received funding from the EU Energy Facility to establish more than 150 MFPs by 2013. In the Philippines, a pilot is ongoing on a Biomass Productive Use Platform (Nygaard 2009).

Annex 2: Multifunctional Platforms (MFPs) for Local Agro-processing in Burkina Faso and Mali

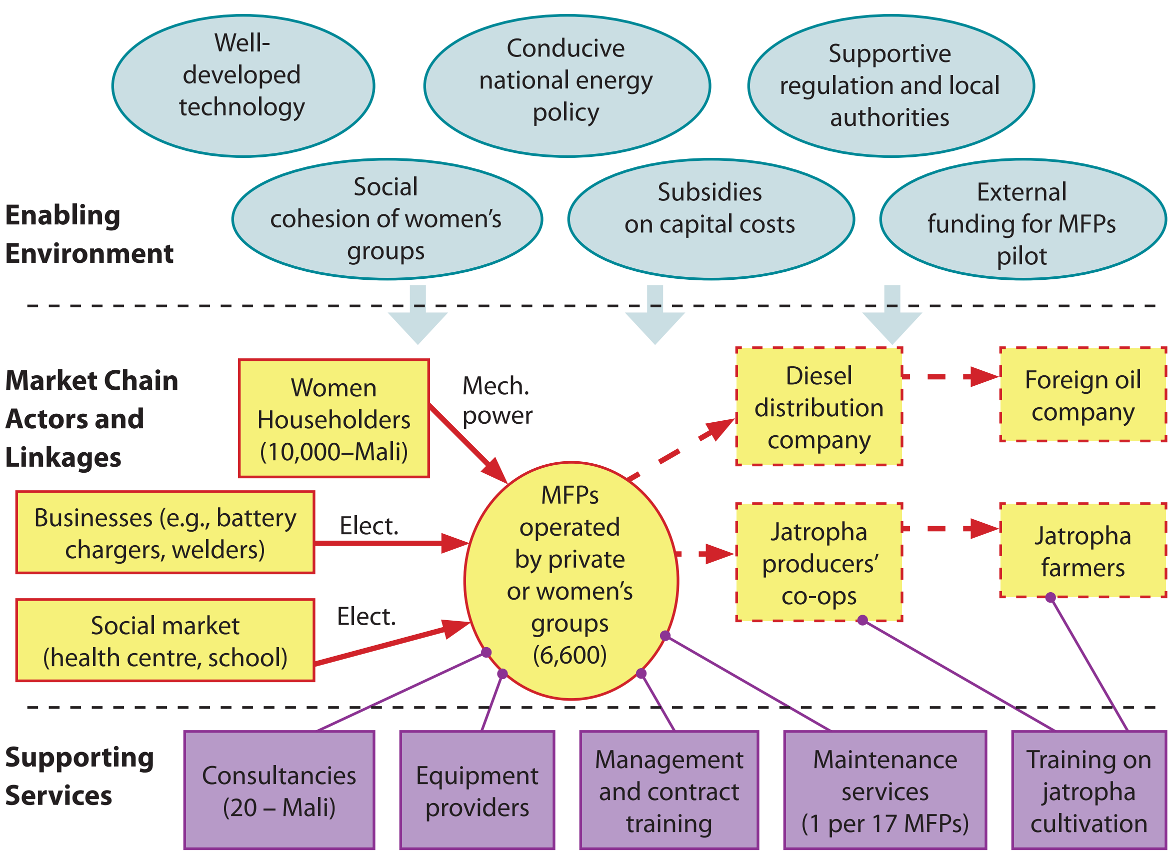
The MFPs programme started in 1996 in Mali and went through a number of phases before an additional injection of funding was provided partly by the Ministry of Promotion of Employment and Professional Training and partly by the Bill and Melinda Gates Foundation. Consequently, the Mali programme restructured its operations in 2008 and is now aiming to have 1,300 platforms installed before the end of 2011 (Nygaard, 2009), which will create an estimated of 10,400 jobs, given that one MFP creates 6 to 10 permanent jobs (A. Crole-Rees, 2006).

In 2009, it was reported that the programme in Burkina Faso had installed 235 MFPs benefiting more than 800,000 people (J. S. Leverton, 2009). Following the positive impacts of the MFP programme on the ground, the Government of Burkina Faso decided to install 3,031 MFPs by 2015, of which 2,031 will be equipped with water and electricity networks (J. S. Leverton, 2009). Senegal, Ghana and Guinea also have smaller, but growing, programmes.

Market Map of the Value Chain

The diagram below illustrates the market system for MFPs in Burkina Faso and Mali, with the numbers in brackets indicating numbers of employees at each stage. The two dashed chains for diesel and Jatropha indicate the fuel chain options for the MFPs (in the instances where Jatropha oil is available). A generally

Figure A2.1: Market map of MFPs in Burkina Faso and Mali



supportive business environment in Mali for MFPs has been a key factor, with subsidies and external funding available, as well as local and national government support and existing women's groups to build management models with. Supporting services include those directly contributing to the installation of the MFPs as well as training in the supply chain and consultancy support to project designs. The mixture of mechanical services and electricity produced by the MFP serves different customer groups within the community.

The MFP was initially targeted with women's groups as the main recipients of the technology via ownership and management of the daily operations of the installations. The project trains the women's groups to establish a management committee. The installation of a platform is demand-driven. When the project receives a request from a village, a participatory feasibility study is conducted to assess the socio-economical and technical feasibility. The services of consulting firms are sometimes requested to carry out this study.

When the decision is made to install a platform in a village, literacy training is provided to the women's group, which then elects a management committee. The members of this management committee are trained in managerial and entrepreneurial skills to promote the technical and economic viability of the platform. Local artisans in rural areas are trained in mechanical and electrical installation, maintenance and welding.

The women's groups run the MFP, but, in some cases, the women's association signs contracts with the local technicians trained by the project to operate the MFP. The MFP provides two classes of energy services: a) mechanical power for grinding cereals and shea butter and b) electricity for lighting, welding, battery charging, refrigeration, etc. The main customers for the mechanical power provided by the MFP are mainly women, because this service is related to household tasks such as grinding cereals, processing of shea or pressing oil from seeds collected by women. The electric power is used mostly by men for battery charging and welding, but it also benefits women by providing light in homes and, in some cases, pumped drinking water, which otherwise is usually fetched by women.

Table A2.1 summarizes the main actors involved, the role of each actor, the supporting services that they need and the number of jobs created.

Table A2.1: Main actor roles and supporting services provided

Actors	Role in the market	Support services needed
UNDP, Government of Mali	Mobilization of funding from donors for the programme, setting policy environment	—
Project coordination team	Planning and coordination of the MFP programme Transfer of technologies; linking the women groups to technology providers; facilitating technology procurement	—
Women's group	They own, manage and operate the MFP to provide energy services (mechanical power and electricity to the customers)	Support in the establishment of MFP management Training in basic accounting (bookkeeping)

Table A2.1: Main actor roles and supporting services provided (contd.)

Actors	Role in the market	Support services needed
Customers groups: • battery chargers • food stands & restaurant • welders • tailors and dress makers • health centre, school • local authorities • households	They use the energy services provided by the MFP and pay for the use of the services, which, in turn, creates the revenue to sustain the operation of the MFP	Training in business management
Local technicians	Install, maintain and repair the MFP	Training in the installation maintenance of the equipment
Consultancy firms	Provide support for feasibility studies	—
The village community	Provide demand for the MFP's services	Participatory approach to explain the benefits of the MFP to the population

In most cases, diesel is the fuel used in MFPs, however, in some cases, locally produced Jatropha oil has been used as an alternative. Jatropha seeds are pressed using the MFP, then the filtered oil can be used in the same MFP engines to run the system. In such cases, an additional set of agricultural employment opportunities is created and the value flowing out of the community (and the country) in fossil fuel expenditure is reduced. However, the price per litre of diesel is not always cheaper than an equivalent litre of Jatropha oil (depending on oil price, Jatropha production efficiency, etc.) and, as such, an integrated or community-level approach is required if this wider benefit-sharing is to be realized, even if the short-run cost to the MFP operator may be more.

Evaluation of the Employment Impact of the Initiative

The impacts of the MFP programme are widely dispersed around the rural areas of western Africa and the specific impacts in each village depend on a range of contributing factors, including access to markets, financing availability, local natural resources, etc. However, a number of studies have provided information on some of the impacts of employment that can be expected when the mechanical and electrical energy services of an MFP are introduced at the village level.

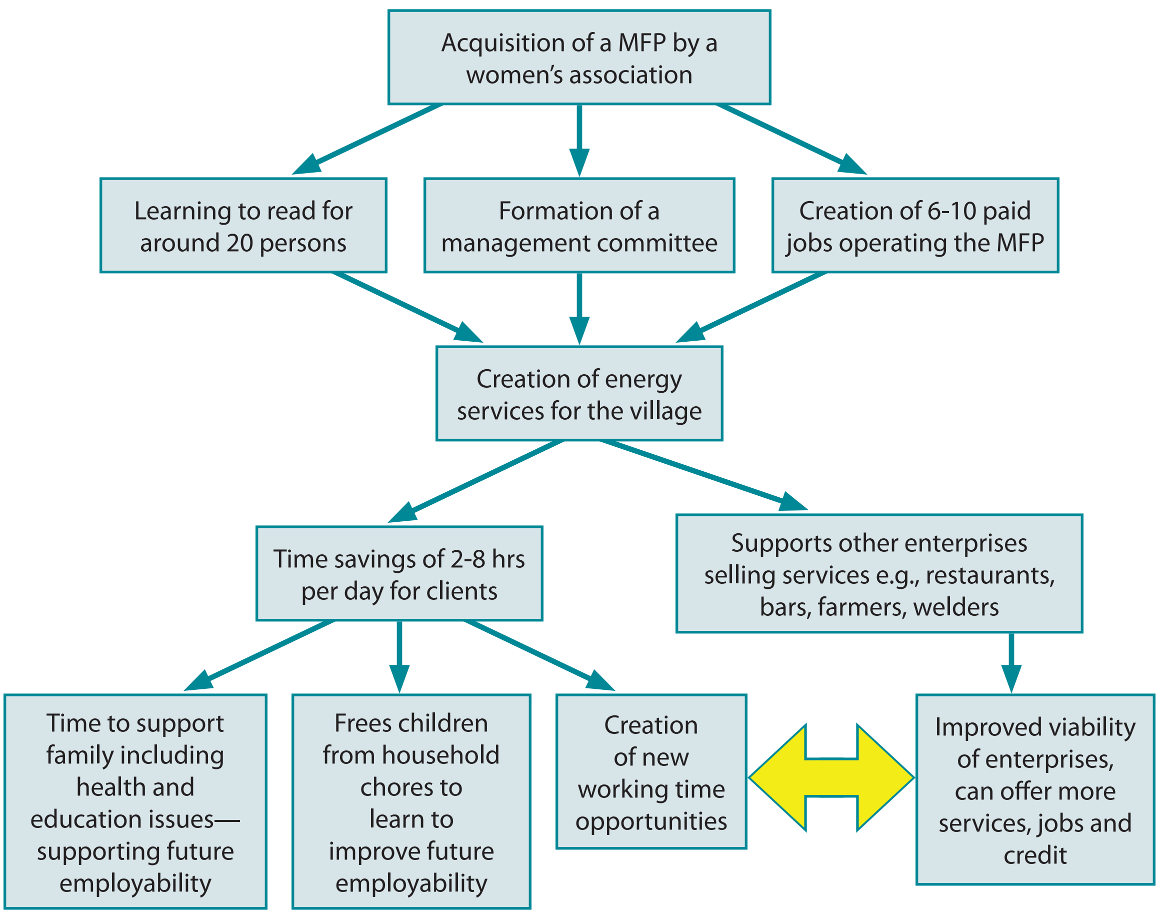
In terms of new job creation, the main immediate employment impact is on the supply side. It is reported that 6 to 10 full-time or part-time female jobs are created per village for the management and operation of the platform (women management committees comprising treasurers, cashiers, supervisors, millers) and for the maintenance and repair of the platform for local artisans. This supply-side employment generates a relatively important wage bill at the village level. If one extrapolates this number of jobs to the total number of MFPs installed in Burkina Faso and Mali, this implies an average of 6,600 new full-time jobs created. In Mali, about 1,000 women have been trained in running the mill and 64 artisan repairers have also been trained. According to Crole-Rees et al. (2006), one artisan, on average, takes care of the maintenance and repair of 17 MFPs.

Support services also create employment and the MFP programme in Mali has involved 20 consulting firms for the prefeasibility and feasibility studies. This has not only supported employment, but also contributed to building and sustaining professional capacity in the energy and development sectors.

Some new enterprises do also seem to have emerged on the demand side from the availability of energy services, including creation of new 26 micro-enterprises for welding by rural artisans in Mali. Generally, however, on the demand side, it is existing craftsmen who have seen improvement of existing jobs rather than creation of new ones. The installation of welding sets on the platforms improves the work of existing craftsmen via enabling new techniques improving productivity and quality as well as extending the fields of expertise and service offering. Indeed, services offered by craftsmen have been reported as diversifying to include repairs and/or manufacturing of chairs, repair of carts, manufacturing of doors and windows, etc.

The lighting provided on the streets has also made villagers feel more secure from accidents and robbery. This has extended the operation time of commercial activities such as food selling and bars. Although new jobs in these existing enterprises are not reported, and many are run by owner-operators, the lengthening of hours and increase in revenue secure these jobs.

Figure A2.2: Causal chain for MFP impacts



Source: Adapted from Crole-Rees et al., 2006.

Where Jatropha seeds are used as a feedstock for the MFP, then additional income opportunities are opened up to local farmers who can plant Jatropha or sell seeds from the existing Jatropha plants often used as fencing. This is generally a supplementary income for farmers, rather than a sole income source or encouraging new people into farming. Additional picking and collection opportunities are also linked to this fuel supply chain.

The primary contribution of the MFPs on the demand side, however, is the reduction in the opportunity cost of household drudgery for women. The mechanical power provided by the MFP for milling and husking, crushing of shea nuts, etc. benefits mostly women responsible for household chores and helps reduce the time spent by women on these activities. It is estimated that the MFP programme of Mali saves, on average, 2.5 hours per day for 10,000 women for manual cereal grinding and water pumping, which can be spent on other income-generating livelihoods, leisure or family activities. Whether such savings are reallocated to employment depends on a range of factors. However, the evaluation report of the MFP programme in Mali conducted in 2006 by Crole Rees et al. states, "[T]he MFP promotes income generating activities and self-employment for the poor through the time and energy saved allowing for the reallocation of these gains towards income generating activities, and self-employment and increased productivity."

The causal chain in Figure A2.2 summarizes the flow of employment-related benefits deriving from the installation of an MFP, including the employment aspects.

The connection highlighted in yellow is a key interaction between the existing viability of enterprises in the village supported by MFPs and the newly created potential to work on the part of people, especially women who have more time for employment opportunities.

Box 1: Stories of the population of Soualigou in Burkina Faso where an MFP has been installed

Yarga Timbendi is an entrepreneur in Burkina who quickly recognised the benefits of connecting to the MFP. Before implementation of the platform, he used to run a grain warehouse, but he could not develop his business because there was no electricity in the community. Human power was the only energy he could use. This seriously limited the possibilities to manage a modern business. Also before the installation of the MFP, people used to travel 150 kilometres to town to recharge a battery or for welding. Now with the installation of a MFP in Souliagou, Yarga has a repair shop where he recharges car batteries for which he charges 500 FCFA (USD 1.10) per battery and 500-700 FCFA for small welding. With his earning, Yarga is making a much improved living, was able to employ an assistant and can afford to send his 8-year-old son to school.

Increasingly, Yarga is adding cell phones battery charging to his activities. Yarga said, "We are in a dynamic place, located at a busy intersection and always full of people — Fbut without electricity, we would have struggled to develop. We could have waited 20 years for the national electricity grid to reach our village."

In the same article, Lamoussa the president of the MFP management committee said, "[W]hen the sun set we used to go to bed. Today the electricity provided by the MFP provides light for the village at night. The village has a video room where the young people come to watch video and TV programmes. This brings the community to modernity." Adama Rouamba, a citizen of the village of Soualigou says, "Before the installation of the platform, women spent more than three hours and a half for grinding millet, now half an hour is sufficient."

The following case study of the population of Soualigou in Burkina Faso, located 350 kilometres from Ouagadougou, reported in an article by (J. S. Leverton, 2009), illustrates in a specific instance how the MFP can extend employment opportunities, expand income-generating activities and improve the status of women.

Key Drivers

From the above analysis, the following main factors can be identified as having driven the success of the MFP concept in western Africa. These include:

- The latent demand for the variety of energy services added by the MFP to the traditional grinding mill that was already used in many villages of Mali and western Africa. The technical output of this platform was enhanced with additional appliances including dehuskers, oil presses and electric generators for battery charging or for lighting, pumping water or electrical equipment such as welders, drills and saws appropriate for the local need. This ability to respond to multiple energy service needs with mechanical and electrical energy has driven the widespread adoption of the MFP.
- The inclusion of poverty alleviation, gender equity, environment, decentralization and local democracy in the presentation of the MFP concept contributed greatly to attracting donor support and funding outside the traditional energy sector. This assisted in overcoming capital barriers and expanding the accessibility of the platforms into poor communities not well served by conventional markets and public service systems. Even though only relatively few platforms to date have used Jatropha oil, the inclusion of this feature was important in attracting donor support, since this also supported low-carbon objectives. If this fuel source could be developed further and made viable, it would also support increased employment in the Jatropha supply chain.

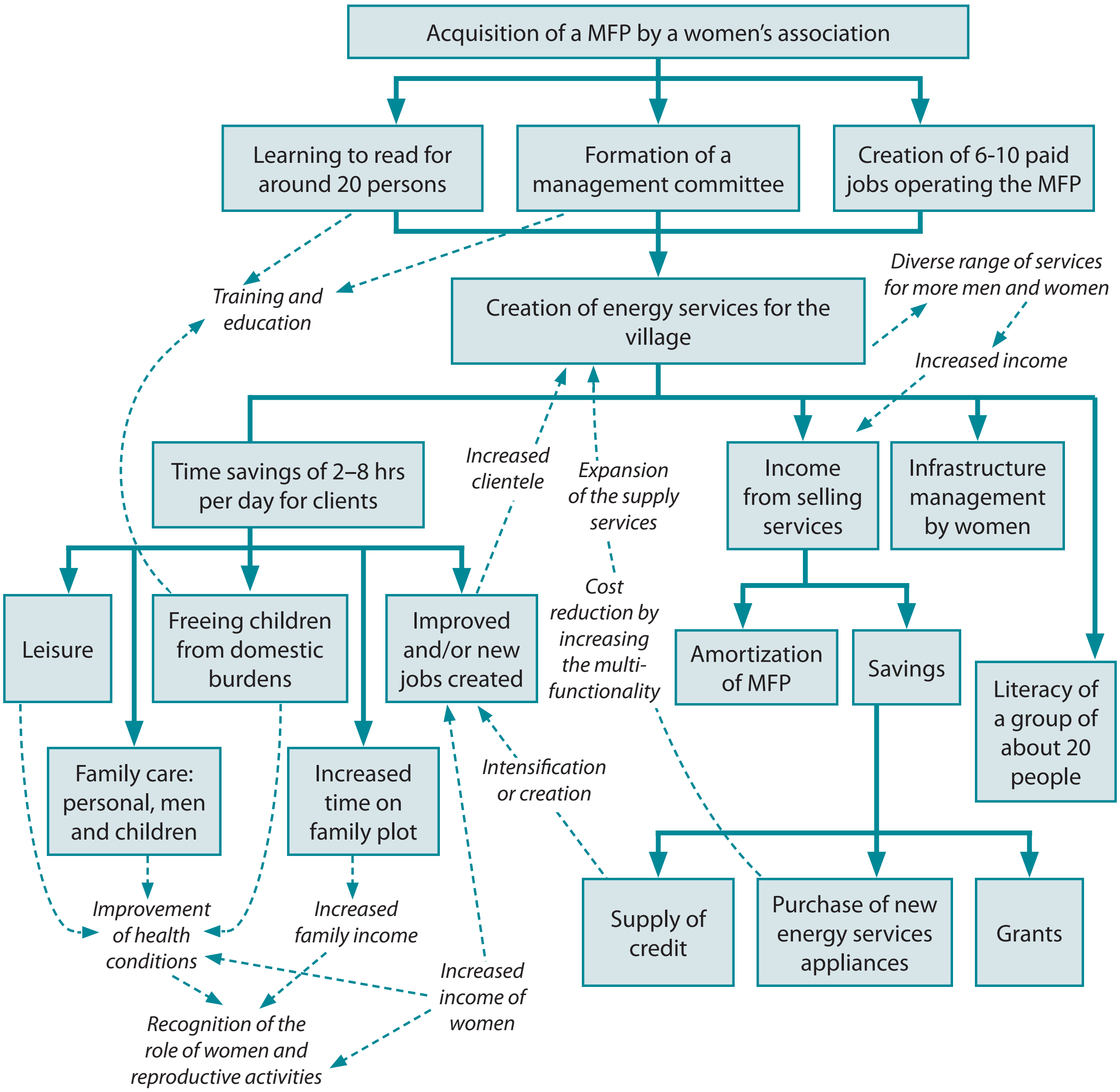
Barriers to Scale Up

There are several factors that constrain the scaling up of the MFP concept including:

- **Socio-organizational problems in operation and maintenance:** The review of the MFP programme in Mali indicated barriers linked to the organizational modality of intervention. According to the Malian MFP programme review, 60 percent of non-functioning MFPs were the result of socio-organizational problems, which were caused by conflicts at different levels. This included internal conflict on the management committee and rivalry between women's groups and other village structures, such as the traditional authorities, politicians, etc. (Crole-Rees et al., 2006). In order to address these barriers, changes were introduced in the organizational set-up during the programme to allow the women's groups to hand over the platform to a concessionaire. Private millers were employed in these cases to manage the platform, paid according to the revenue of the platform or at a fixed monthly rate. In these cases, the village women's group maintained its role as owner and manager. In these cases, which show promise of increased sustainability, the MFP is operated on a commercial basis and the customers pay for the services rendered, which facilitates the mobilization of resources for the maintenance and replacement of worn out parts, contributing to the sustainability of the MFP.

- **Capital intensity of the installations:** The capital cost of around USD 4,300 for installation of an MFP remains a significant barrier to scale up, requiring ongoing support from donor or government funds. While capital support such as that from the Gates Foundation is available, this can be overcome. Yet, purely private replication of the concept does not appear likely. Nevertheless, given the paucity of other energy options available and the clear opportunity cost saving for rural women, which is not a demand segment often targeted privately, such initial capital support can be justified on employment and development grounds.

Figure A2.3: Full Causal chain for MFP benefits



Source: Crole-Rees et al., 2006.

- **Lack of support to full use of multi-functionality:** Although the MFPs are capable of producing a range of energy services, in practice, many services are often not used. This can be due to lack of financial support for the additional appliances required to produce these services where basic single-function MFPs are installed.

Policy Recommendations

The concept of the MFP has achieved great attention at the national policy level. In 2001, the Malian president declared that, ideally, all villages in Mali should have MFPs. Although energy generally has a low priority in the Poverty Reduction Strategy Papers (PRSPs) used as political foundation for much donor support, the MFP concept is explicitly mentioned in the PRSP for Burkina Faso and Mali (Nygaard 2009). In the light of the above drivers and barriers analysis, the following policy recommendations can be made.

- Government support should focus on developing technical and organizational capacity and supporting affordable financing schemes accessible by the customers of MFPs to initiate new productive uses of the energy. Additionally, existing local entrepreneurs running milling businesses should have access to credit and business support to expand their businesses with, for example, a dehusker, welding facility or simplified grid for providing electricity.
- Future MFP programmes should investigate options for blending women's group and private ownership of MFPs based on co-operation with a micro-financing institution. This mixture of local community ownership with private operation offers potential to promote efficient operation, clear allocation of responsibilities, good local service governance and benefit-sharing.
- There should be additional targeted support for the development of local fuel production systems as key elements in the design of future MFP programmes. Such an approach could benefit from carbon finance and, if viable, would create additional employment opportunities and reduce value loss from the community by extending the local element of the production chain.

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3. RURAL ELECTRIFICATION, THE MISSING CONNECTION WITH PRODUCTIVE USES IN MALI, WESTERN AFRICA

Energy service(s)	Productive uses of electricity: Lighting, refrigeration, welding, battery charging, carpentry, refrigeration for ice and cold water
Energy vector(s)	Electricity
Energy Resource(s)	Straight vegetable oil (Jatropha oil), petroleum diesel
Location	Mali, with a specific example from the village of Garalo, southern Mali, western Africa
Linked projects	Garalo Bagani Yelen – A New Paradigm of Energy for Sustainable Development. The power plant was commissioned in 2006. The African Rural Energy Enterprise Development Project (AREED) energy end-use financing, started in 2009
Key actors	Energy end-users, Jatropha growers, local authorities, ACCESS SARL, Nyetaa Finance, Mali-Folkecenter (MFC), Nyetaa, UNEP, Ecobank-Mali, Government of Mali through AMADER
Energy access beneficiaries	Electricity is provided to 250 customers benefiting 2,500 people directly. Eventually 10,000 inhabitants of the village of Garalo will benefit from the electricity. More than 20,000 people in the whole commune of Garalo will benefit directly or indirectly from the electricity
Employment beneficiaries	50 supply-side jobs have been created in Garalo with many more improved on the demand side. Under AREED, Nyetaa Finance has given micro-loans for end-use appliances for enterprise use to 1,774 clients, including 850 women in 15 villages.

Background and Context

The rural electrification rate in western Africa is below 17 percent, although there are wide variations between and within countries. Four of the community's 15 countries have an overall electricity access rate ranging from 20 percent to 40 percent: Benin, Senegal, Ghana and Cote d'Ivoire. There are also considerable service access gaps between urban zones (average 40 percent) and rural areas (average 6 percent to 8 percent), as illustrated by the following two specific cases in the Economic Community of West African States (ECOWAS): in Niger, only 2 percent of rural households are connected, compared with 17 percent of urban households, while the rate in Senegal ranges from 12 percent for rural areas to 67 percent in cities. The rural electrification rate in Mali was estimated at 12 percent in 2009. The low rate of access to electricity is also reflected in the average levels of electricity consumption, which is estimated at 88 kWh per capita per annum in the ECOWAS countries, as compared to 350 kWh in eastern Asia.

This limited access rate and low consumption level indicates the degree of energy poverty, which is hindering efforts by governments and regional and international development organizations from making serious progress to reduce poverty and from attaining the MDGs.

Many countries in western Africa are running dedicated national electrification programmes, with various degree of success.

- In Ghana, the Self-Help Electrification Programme (SHEP) has been operative since 1990. The objective of this programme is to extend the national electric grid to electrify rural communities situated within 20 kilometres of the existing 33kV or 11kV network. This programme has contributed to increasing access to electricity from about 10 percent in 1989 to around 60 percent in 2008 in rural areas and is being seen as a success story for rural electrification in western Africa.
- In Mali, the Household Energy and Universal Rural Access (HEURA) project has been in implementation since 2003, supporting the government's efforts to increase the access of rural populations to electricity. Through the HEURA project, the Malian Agency for the Development of Household Energy and Rural Electrification (AMADER) is providing subsidies to the private sector for the implementation of rural electrification projects. This project has contributed to increasing access to electricity from less than 1 percent in 2003 to around 12 percent in 2009.

These national initiatives to bring electricity to rural areas are heavily focused on geographic coverage. The bulk of electricity in rural areas is being used for household needs like lighting and watching TV. While this presents a service improvement for households, there is a clear gap in using electricity to create wealth and improving lives and livelihoods more widely. Such productive use of electricity is important for increasing the quality and quantity of employment, but also for ensuring that consumers of electricity have the incomes needed to pay for the electricity supplied, enabling an economically viable supply.

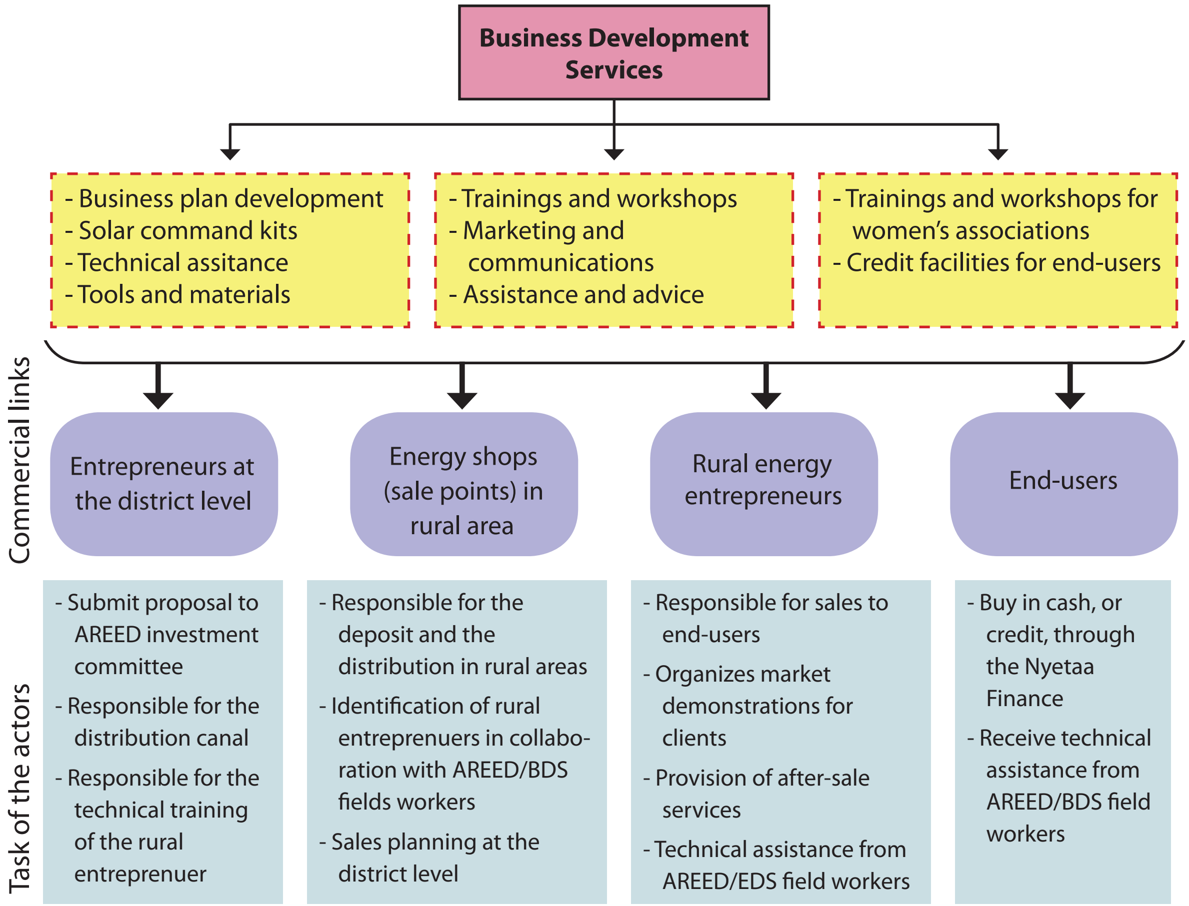
This case study discusses how energy end-use financing has been used to stimulate electricity consumption for productive activities, focusing on the case of Garalo in Mali.

Within the framework of the Government's rural electrification programme managed by AMADER, Mali Folkecenter (MFC) Nyetaa in collaboration with ACCESS SARL (an innovative energy service company) worked together with the population of Garalo in the district of Bougouni southern Mali to implement a rural electrification project powered by Jatropha oil. The project comprises the cultivation of 1,000 hectares of Jatropha by small-scale Jatropha producers that are organized in a cooperative called "cooperative pourghère". The project constructed a Jatropha seed-processing unit for the Jatropha producers who supply ACCESS SARL with oil to run the power station commissioned in October 2006. A diesel power plant comprising 3 gensets of 100 KW each has been installed for electricity production, which is distributed to the population of Garalo through 13 kilometres of electric grid.

With the arrival of electricity in Garalo, the population had many opportunities to generate income and employment via productive use of the newly available energy. However, there was no financing mechanism to enable the electricity customers to purchase the electricity use equipment (appliances) that can stimulate electricity consumption and enable new value chains to transform and add value to local products.

In this context, MFC Nyetaa established Nyetaa Finance, a microfinance institution, in 2008 to provide energy financing services in the districts of Bougouni and Yanfolila (South Mali). In the frame of the AREED project, UNEP provided end-user finance to MFC Nyetaa in 2009. This funding, together with co-funding from MFC Nyetaa, was used to leverage a wholesale loan facility from Ecobank-Mali, a commercial bank based in Bamako. This loan facility is used by Nyetaa Finance to provide credit to end-users in newly electrified rural areas to

Figure A3.1: Structure of AREED end-user support and finance system in Mali



purchase electric appliances such as electric tools for carpentry, electric sewing machines, welding equipment, battery-charging equipment, refrigeration and ice making equipment, seed oil presses, grain grinders, crop drying and other equipment for the processing of local agricultural crops (honey, mango, cashew, etc.).

Nyetaa Finance work in collaboration with MFC to identify, analyse and select demand from the energy end-users. After this assessment, loans in the range of USD 300 to USD 5,000 are provided to the borrower according to his or her ability to pay at an interest rate between 18 percent and 20 percent. Some loans can be high as USD 20,000. Before the loan is disbursed, a down payment in the range of 20 percent is required from the borrowers. Regular monthly payments of the principal and interest are paid over the 12- to 24-month term of the loans. In addition to the loan facility, MFC Nyetaa provides technical assistance to the borrowers to support business development.

The end-user financing delivery model is described in the schematic representation in Figure A3.1.

Market Map of the Value Chain

The main actors in the end-user finance initiative and its application in the Garalo case in particular include:

- UNEP: providing funding for the establishment of the end-user fund
- MFC: a Malian NGO providing facilitation and advice to the population on technical issues for small and micro-businesses, households and farmers to use electrical appliances for profitable enterprise and how to manage their business
- Nyetaa Finance: providing micro-loans for the acquisition of electrical equipment for productive activities
- Ecobank: providing a wholesale loan facility for the productive use of electricity
- Jatropha cooperative group: made up of Jatropha growers spread around 29 villages in the Garalo commune
- ACCESS SARL: the private company running the power plant and selling electricity to end-users
- AMADER, SHGW Foundation from the Netherlands and Christian Aid from the United Kingdom provided funding for the project.

Figure A3.2: Market map of electrification scheme

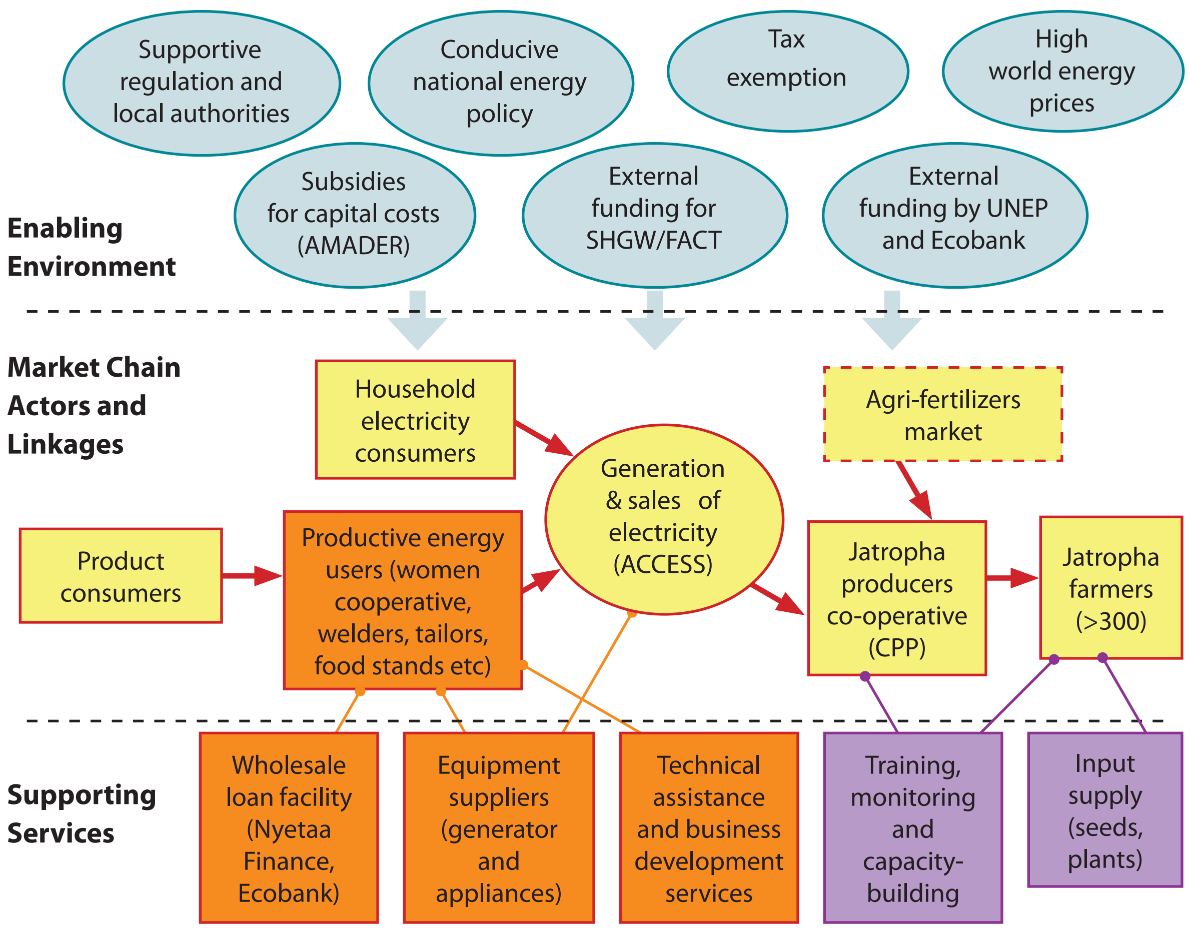


Figure A3.2 shows the different actors, their roles within the main chain, the enabling environment and supporting services.

The areas highlighted in orange are specific to the additional supporting services that were applied in order to assist in converting electricity access into employment and income generation. These focus on creating access to business ideas and management skills, to appliance technologies and to financing to acquire the equipment. The target of these measures is to increase the accessibility of enterprise and employment opportunities that people may not be aware of, not have the skills for or not have the capital to start up.

In Garalo, the types of equipment supported by the energy end use loan facility included: freezers for ice-making, sewing machines, carpenter's electrical equipment, dehuskers and cereals mills. In the district of Yanfolila, a loan was requested for equipment, including a multifunctional platform to provide mechanical power for agro processing, commercialization of solar products, vegetable drying using LPG, etc.

The potential of a parallel market in fertilizer produced from the Jatropha seed cake is also a relevant co-benefit of this market chain, although some of the seed cake may also go back to the Jatropha farmers.

Evaluation of the Employment Impact of the Initiative

The electrification of Garalo brought about 50 direct new jobs on the supply side in running the power plant, the oil-pressing equipment and the maintenance of the equipment (ILO, 2010). This includes six permanent jobs for the management of the power plants and three jobs created for the management of the end-user fund.

Several new employment activities on the demand side were created, including in welding, refrigeration and ice making. Battery charging is also an important new business as people from surrounding villages bring their batteries for charging in the newly electrified village. When the welding company acquires electric tools and machinery for expanding their business, they also hire unpaid apprentices who receive on-the-job training, which can be regarded as positive contribution to job creation, providing the skills that enable further business creation.

The electrification of Garalo also brought a range of opportunities for improving existing employment. For example, there are carpentry businesses that were able to expand their business thanks to the use of electric tools, while the availability of electricity has enabled tailors to continue working after dark. Processing of local agricultural crops (honey, mango, cashew, etc.) has also improved in productivity for sale and reducing opportunity costs for the women who previously processed them by hand.

The following example also illustrates how the productive use of electricity is contributing to improving existing jobs. Masara Kané (on the right of this picture) runs a restaurant on the main road through Garalo. With the arrival of electricity, she says that she can stay open longer and has increased her revenues. She uses electricity for lighting and for charging mobile phones. She is now thinking about investing in a refrigerator, which would allow her to sell cold water and soft drinks.


Photo: MFC Nyetaa

The Jatropha plantation component of the project for the production of pure Jatropha oil for local use constitutes a new source of income for the local population and is creating employment in the whole chain from the plantation up to the collection of seeds and their pressing to get the oils. The potential benefits of running on locally produced, ecologically sound fuel are significant. The growing process as practiced is close to carbon-neutral. The money paid for the fuel by ACCESS-SARL goes straight to the growers and collectors, rather than leaving the village, and then to the country to pay for fossil fuel imports.

The wider financing of electricity end-uses under the AREED programme had, by the end of 2009, invested about EUR 152,675 for energy end-use equipment for 1,774 clients, including 850 women in 15 villages. The total energy end-users portfolio of Nyetaa Finance includes more than 227 loan demands totalling around EUR 400,000. Each client has had access created to a new or improved employment opportunity via the scheme, in addition to the electrical connection that they had previously gained, but not fully used.

Key Drivers to Scale up

The main drivers that have enabled the link between access to electricity and productive uses to be made are as follows:

- **The leveraging of a mixture of financing sources:** Energy technologies and appliances require a high up-front investment, which often cannot be met by the rural population, given the level of poverty. Microfinance institutions intervening in rural areas generally offer only short-term loans (maximum six months); these loans, though, are not suitable for energy technologies and appliances, which require longer-term financing. It was possible to address this gap by blending donor finance from UNEP with private finance from a Malian Bank. Purely private financing of the initiative was not possible due to the poor, rural and dispersed nature of the market, while donor financing alone would have been insufficient and limited in duration. As the loans are repaid through the value created in the enterprises supported, it is hoped that further private finance will come in to extend the loan window. Indeed, two additional banks have initiated talks about financing energy end-use entrepreneurs in Mali, namely BMS (the Malian Bank of Solidarity) and BNDA (the National Bank for the Development of Agriculture).
- **Build-up of technical capacity among financial institutions:** The rural energy sector is new to finance institutions, which typically have limited experience and awareness of the potential market and opportunities. They also often have limited technical capacity to appraise loan applications for energy technologies. The close collaboration between MFC Nyetaa and Nyetaa Finance in the initiative has facilitated the appraisal of applications by lenders and provided the technical and advisory assistance needed by the borrowers to develop and manage bankable projects. This was key in generating deal flow and entrepreneurial activity that could then avail itself of financing.
- **Support to rural market creation:** Even if the rural population can afford to pay for energy end-use equipment, equipment dealers are often based in urban areas. The initiative also attempted to bridge this gap between equipment suppliers and customers by facilitating the establishment of energy appliances selling points/shops in rural areas. Working with women's credit groups has also facilitated the growth of the demand side for productive use energy appliances. These credits groups also constitute networks that facilitate the collection of credit for loans by Nyetaa Finance.

Barriers to Scale up

There are many barriers to the scaling up of access to modern energy services in sub-Saharan Africa as well as to converting this access into productive, income-generating activities and employment creation. Among these barriers are:

- **Limited understanding and financing of energy access by donors:** There remain relatively few donors that intervene in the energy sector. Where donors do intervene, this can often be focused on large electricity infrastructure projects or interconnectors, which may have limited linkages to energy access issues for the wider population. While support to energy connection for large enterprises is often prioritized, wider direct access by the population and small to medium enterprises is not.
- **Limited understanding of the need to go beyond 'connections':** Even where people get electricity access, then they may not have access to the means to use it productively. With the AREED programme remaining an exception rather than the rule, it remains difficult to scale up the investment of private institutions in financing accessible by the rural poor to enable access to energy production and end use appliances
- **Poor reliability and intermittency of grid electricity supply:** In many grid-connected rural electrification projects in sub-Saharan Africa, electricity supply is unreliable and intermittent. In some cases, electricity only comes on in the evening, which does not favour those productive activities that are carried out during daytime. In addition to financial challenges for utilities investing in generation capacity and maintenance systems, the technical and organizational capacity to maintain electrical systems in rural areas remains a critical barrier. However, the unreliability of the grid conversely also presents an opportunity for decentralized systems, including those for improved cooking and mechanical power.

Policy Recommendations

A number of policy lessons can be drawn relating to the promotion of productive uses of electricity within rural electrification projects:

- Access to electricity infrastructure does not, in itself, guarantee that poor people will have sustainable access to electricity, since monthly recurrent charges at cost-reflective rates can still be unaffordable to the poor. In this regard, lifeline tariffs can be used in the short run, but, more widely, rural electrification should be coupled with measures to promote the productive use of electricity to generate income. This, in turn, can enable poor consumers to pay for the electricity supplied, in turn supporting an economically viable supply.
- Where people are not able to afford the up-front cost of the electrical appliances that can save time, create value or enable start-up or improvement of enterprises, there is a need to put in place institutions and mechanisms to provide end-user finance for micro-investments in the appliances people need for productive uses of electricity. These schemes can take the form of equipment loans or a revolving or guarantee fund. The capacity of local financial institutions and micro-credit agencies needs to be increased with relation to the opportunities and assessment of the risks in the energy sector.

- Inclusive biofuels policies are needed which adequately protect land ownership for local populations, as well as ensure the benefits of energy services afforded by biofuels development are not all exported. While export markets and foreign investment are important potential revenue sources, if local energy needs are not met, the potential multiplier benefits of associated incomes and job opportunities for local households, businesses, and communities cannot be realized.

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4. THE BIOETHANOL INDUSTRY IN MALAWI

Energy service(s)	Transportation, lighting, cooking, heating
Energy vector(s)	Ethanol blend, ethanol gel
Energy Resource(s)	Sugarcane molasses (bioresidue)
Location	Malawi, Southern Africa
Linked projects	Mainly private investment EU – Sugar Accompanying Measures Fund
Key actors	Private sector: Ethanol Company of Malawi (Pvt) Ltd and Presscane (Pvt) Ltd. Fuel distributors and small-scale growers
Energy access beneficiaries	Motorists in Malawi, although ethanol for cookstoves is also a possible application.
Employment beneficiaries	Sugar Sector: 10,700 directly, 7,500 indirectly in supporting industries and 3,850 in distribution. Ethanol only: direct employment to 220 people and indirectly 250 upstream and 30 downstream.

Background and Context

Agriculture is the most important sector of the Malawian economy, employing about 80 percent of the workforce, contributing over 80 percent of foreign exchange earnings, accounting for 39 percent of GDP and contributing significantly to national and household food security. The agricultural sector has two main sub-sectors: the smallholder sub-sector that contributes more than 70 percent of agricultural GDP and the estate sub-sector that contributes less than 30 percent (GoM, 2009).

The Malawi Growth and Development Strategy (MGDS) of November 2005 (linked to Vision 2020, the Malawi Millennium Development Goals, the Poverty Reduction Strategy and the Malawi Economic Growth Strategy) aims at reducing the poverty level of the rural population in the country and creating more employment opportunities in the agricultural sector.

Sugarcane is the second most important agricultural crop in terms of foreign exchange generation for the country after tobacco. It accounts for about 20 percent of total national exports to the European Union and 9 percent (USD 50 million) of total export earnings. It contributed 8 percent to GDP in 2009 (GoM, 2010). Ethanol production is strongly linked to the sugar production industry in Malawi due to its total dependency for feedstock on the molasses from the sugar refining process. The ethanol chain serves to improve the viability of the sugarcane sector by creating value from an otherwise little-used by-product, which is often otherwise dumped into rivers, creating pollution. The contribution is incremental throughout the vertical chain of sugar cane production, processing and the use of its final by products for the production of ethanol. The ethanol also contributes to national energy supply, as it is currently sold directly to oil companies for blending with petrol within the country at a maximum 20:80 ratio of ethanol to petrol.

Malawi produces ethanol from sugarcane molasses at Dwangwa, in the central region lakeshore district of Nkhota-kota and Nchalo in southern district of Chikwawa. Malawi has only two ethanol producing companies, Ethanol Company of Malawi (ETHCO) and Presscane Limited, both run by a private local conglomerate, Press Corporation. Each of the factories has capacity to produce 16 million litres of ethanol a year. ETHCO produces seven million litres of ethanol a year at its plant in Nkhota-kota, a town in central Malawi, while Presscane delivers 10.8 million litres from its plant in Chikwawa in southern Malawi.

Due to the lack of a developed infrastructure and its landlocked status, Malawi suffers from high transportation costs. Malawi imports 97 percent of its transport fuel requirement, with the balance contributed by locally produced ethanol. The country's fuel-blending programme has been running since 1982 and government policy has until recently been to blend ethanol with petrol at a 2:8 ratio. However, this ratio was not generally being met (it is usually around 12:88), because molasses availability limits ethanol production and because of a lack of legislation to make the blend mandatory. If ethanol production ran at current factory capacity, it could produce 32 million litres annually, nearly 7 percent of the total liquid fuels market (GoM, 2004).

The pricing policy for ethanol has been on the basis of the avoided cost of petrol and was premised on supporting import substitution rather than influencing the final price for petrol. In this regard, therefore, the ethanol-producing companies enjoyed exceptional profits at the peak of global fuel prices. Production volumes were consequently not paramount to company viability. However, the pricing policy for ethanol has recently been changed to reflect production cost. At the same time, government revised the blending ratio down to 10:90 when they switched to unleaded petrol. These changes eroded the margins for ethanol production for blending leading to the ethanol companies starting production of ethanol for pharmaceutical purposes, which is slightly cheaper to produce. Secondly for viability, the companies now have to produce larger volumes to maintain profitability. A recent Malawi Energy Regulatory Study has recommended that the blending ratio revert back to 20:80, which would roughly double demand and production would have to scale up to match.[18]

The current distillation capacity is only 50 percent used, owing to the lack of molasses feedstock. The projected increase in demand above would attract more farmers to join the Cane Growers Associations both at Dwangwa and Kasinthula and an anticipated growth in land under sugar cane in the country. Expanded sugarcane fields offer employment opportunities to local Malawians in the villages working for plantations and also potentially as out-growers. Malawians can also access additional employment opportunities in sugar as well as in ethanol production and marketing as ethanol is moved from the factory to vehicles through pumping stations.

In general, with output going to transport fuels at current blending ratios, ethanol production does not directly improve energy access to an increased number of people. On the demand side, the price of a litre of ethanol-blended fuel has, until recently, remained the same as a litre of fossil petrol. With the introduction of production cost reflective tariffs (assuming that the price of oil is high), it is possible that the overall price of petrol may drop slightly (depending on taxation policy), but this is unlikely to substantially affect accessibility at the local level. However, the benefits to the country overall in terms of avoided foreign exchange drain, increased security of fuel supply and creation of employment multiplier benefits are important policy drivers. Additionally, the Government of Malawi has a much broader vision for ethanol as a transport fuel in the country and, through the Ministry of Technology, has put in place a policy and committed resources to testing and roll-

18 Interview with Director of Malawi Regulatory Authority, Blantyre Malawi, August 2004.

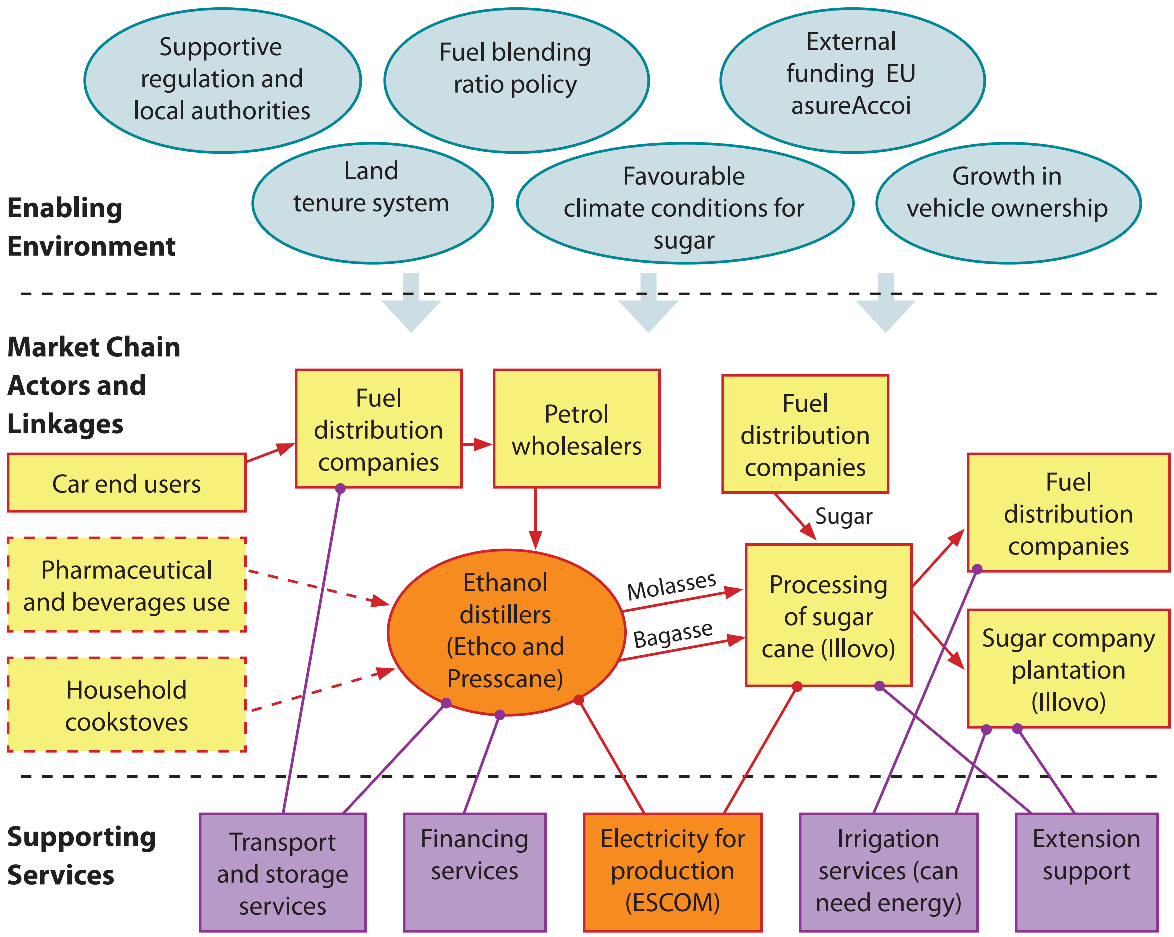
out of fully ethanol-powered cars. Such a move, following the Brazilian model, could cut fossil fuel imports and boost rural employment, although resource and land-use trade-offs would have to be managed.

Ethanol cookstoves using a gel version of the ethanol fuel have also previously been piloted in Malawi. However, the viability of this sector was undermined by the fuel blending policy and limited molasses supply, which created a higher value for a litre of ethanol in the transport sector. The household cooking sector is an additional market for ethanol that could be grown in the future, with its additional potential multiplier benefits to a healthier population, particularly women and children.

Market Map of the Sugarcane/Ethanol Value Chain

The central actors in the main chain are the Illovo sugar company (which also runs the plantations and buys raw product from small-scale out-growers) and the two ethanol distillers that sell to the ethanol markets. The fuel-blending ratio underpins the enabling environment for the ethanol component of the chain, while land tenure and regulation strongly influence the equity of benefit distribution. The fuel-blending ratio and pricing policy will largely determine the volume of ethanol produced and consequently the number of jobs

Figure A4.1: Ethanol in Malawi — market map



produced. The new pricing policy of cost-based regulation of the ethanol should see the price of blended petrol going lower than unleaded petrol, thereby encouraging adoption by users of compatible vehicles. Supporting services to the chain are fairly typical of agricultural production systems, but with a particularly important energy service requirement. The highlighted yellow and orange linkages indicate energy inputs into the sugarcane and ethanol production processes.

The sugar and ethanol industry is a major electricity consumer for irrigation and processing. Nchalo Estate is the single largest individual consumer of power in the country, with peak requirement of 17.5MW, equivalent to 6 percent of national grid capacity. The company has negotiated discounted tariffs with the utility Electricity Supply Commission of Malawi (ESCOM), due to their peak demand being in summer, while the overall national peak demand occurs in the winter months. In the year 2000, ESCOM's total installed capacity was estimated at 304 MW. Of this, approximately 285MW (94 percent) is generated by hydropower and the remaining 19MW (6 percent) is thermal. Except for a miniature hydro plant at Wovwe (4.5MW) in Karonga, all of ESCOM's generation capacity is located along the Shire River, the main natural outlet for Lake Malawi (GoM, 2004).

The sugarcane/ethanol industry is sensitive to electricity tariffs and power supply outages. The Nchalo estate currently estimates that it is losing up to 10 percent in yield through power interruptions. This has ripple effect on the cost of production and the investment returns for the company. Nchalo Estate is the supplier of molasses to Presscane Pvt Ltd. A switch to gravity-fed irrigation at Nchalo would free up at least 15MW of electricity for other uses in industry and avert load shedding. Electricity for water pumping currently constitutes 35 percent of the production costs for the Nchalo Estate as well as the Kasinthula Out-growers. The switch to gravity would turn the lower Shire Valley into a sugar cane zone. An additional 25,000 hectares can be irrigated beyond the current area under sugar cane. With at least one job created for every hectare of sugar cane under irrigation, at least 25,000 additional jobs would be created.

If power supplies are insufficient to meet current demands, planned smallholder expansions to put new areas under cane will certainly be compromised. Unreliable power supply could deter new investment in any segment of the private sector, and at the very least add cost and loss of competitiveness. At the same time, increasing production of ethanol as a fuel can support other sectors of the economy and expanding energy access, such as in transport on and off the farm.

Bagasse, which is another by-product of the sugar production process, is also used as a source of process heat in the distilleries. This reduces the requirement for additional sources of heating fuel such as fuelwood or furnace oil. This, in turn, helps to reduce production costs as well as environmental footprint through reduced waste and use of energy resources from within the sugarcane production process itself.

Evaluation of the Employment Impacts

The sugar sector is the second largest employer in Malawi after the government. Currently, the sector directly employs 10,700 people and a further 7,500 are employed indirectly in supporting industries such as independent cane cutters, haulers and service providers. In addition, the distribution of sugar and its by-products within Malawi and for export adds a further 3,850 direct jobs. Taking into account the average of seven dependants per employee, the industry supports more than 154,350 people directly and supports many thousands more whose livelihoods depend on the multifunctional role of sugar industry. This makes the sugar sector one of the key sources of employment in rural areas, providing a brake to rural-urban migration in the country. Smallholder cane growers account for approximately 9 percent of sugarcane agriculture and nearly 5 percent of the overall sugar industry, including milling (GoM, 2009).

As discussed above, the production of ethanol is currently inextricably linked to the upstream sugar production as a by-product of the sugar industry. The employment impact of ethanol production in upstream cane production and support services is difficult to estimate; however, for the purpose of this study, it is estimated at 2 percent (214 people) of the sector, based on the ratio of the annual revenues for 2008/09. The main premise for the estimate is that the use of molasses as a feedstock for ethanol production helps to increase income streams and security for Illovo, the main sugar producer, and therefore translates into better job security for employees and out-grower suppliers to the firm, thereby improving existing jobs. Whether this added viability is translated into improved incomes for workers or cane suppliers, however, is not clear-cut.

Direct new employment in the production and distribution of ethanol is small compared to the upstream activities, with 220 people currently employed by the two ethanol companies. The two companies are currently working at 50 percent of production capacity due to a shortage of molasses. There are plans to explore backward integration and there are dedicated estates to produce cane juice for ethanol production. The target is estimated at 2,500 hectares with a supporting 10 percent (250 hectares) under out-growers. This would create at least 2,500 jobs.

Ethanol is currently delivered directly to wholesale storage facilities, where it is immediately blended with petrol. The process is very simple, given the nearly equal density of ethanol and petrol. The transport and storage services are estimated to employ at least 20 people directly to deliver the fuel to storage and distribution points. Beyond this point, ethanol becomes part of the petroleum companies' distribution system and there are no direct further downstream employment impacts discernable. If ethanol cars became available, it is likely that the same distribution systems as for petrol would be used. However, if production costs for ethanol were lowered such that the fuel were more widely affordable, then the energy access end-use impacts would be greater. In this case, the use of ethanol in rural engines and ethanol cookstoves could be more widely taken up, creating additional distribution and appliance chains, as well as enterprises delivering services involving additional new job creation.

If the policy conditions, particularly the blending ratio and/or mandate of a cooking fuel market, are right, then the ethanol sector could move from being a positive, but relatively minor, co-benefit of the sugarcane sector to being a major co-driver of that sector. For example, in the case where the proposed 20:80 blending ratio is implemented, this would increase demand for molasses by at least 100 percent, from 100,000 tonnes to 200,000 tonnes per year. If the current production model were maintained, this would require an increase in the sugarcane processed in the country. This would impact marginally on the number of people directly employed by the distillers, but imply a tremendous impact upstream in the labour-intensive cane-growing feedstock side. The estimated number of additional jobs is an extra 15 percent, while 30 more people would be employed directly at the distillers.[19] Alternatively, the production model could be changed to accept cane juice directly rather than molasses. Using this model, less land will be required, as the alcohol yield is much higher from cane juice than it is from molasses. Additional investment in cane-crushing facilities would be required

19 Interview with General Managers of Ethco (Pvt) Ltd and Presscane (Pvt) Ltd Mr Chipukunya and Mr Evans Kacelenga, respectively, Blantyre August 2010.

for the established plantations, as the current ones produce only for Illovo. Through the second alternative, an estimated 2750 hectares would need to be put under plantation to produce adequate juice for the two plants. This would involve a total of 2,750 new jobs based on the industry average for employees per hectare. This includes jobs in growing, distribution and support services.

Drivers of Scale up

The following are considered the main drivers for expansion of the ethanol sector in Malawi:

- **Policy consistency on the blending ratio:** The growth in the use of ethanol as a fuel or fuel additive is to a large extent dependent on the government policy and regulations on the blending of petrol in the country. Government regulation determines the blending ratio of ethanol and so the expansion or contraction of production and linked employment outcomes. The revision of the blending ratio to 20:80 would double the required ethanol for the country.
- **Pricing with respect to petrol:** Where oil prices were high, ethanol producers enjoyed windfall profits under the avoided cost calculation of pricing, driven by an import substitution policy priority. In this respect, world oil prices remain a key driver for biofuels production and viability.
- **Potential environmental credits:** There has been a surge in local and foreign investor interest in the biofuels sector in Malawi, targeting ethanol production. This is largely driven by the anticipated growth in carbon credits in an increasingly environmentally conscious global community.
- **Globally competitive sugar production:** Malawi is the third least expensive producer of sugar after Brazil and Zimbabwe. This is mainly due to favourable climate and labour costs. Costs could be further reduced by improving the energy efficiency of production, including in irrigation systems, etc. This may, in turn, reduce pressure on wages to some extent, if the regulatory system and industry structure enabled such a degree of benefit distribution.
- **International investment support:** The removal of global sugar subsidies forced the EU to provide funds to cushion African, Caribbean and Pacific Group States (ACP) countries that had hitherto enjoyed a fixed quota of sugar export to the EU market. Malawi is one such country and the EU is currently working with the sugar sector to promote additional income streams and improve viability of the sector in the face of global competition. The EU Accompanying Measures Fund is funding the expansion of Kasinthula Out-growers Scheme.
- **Growth in vehicle ownership:** The number of cars in Malawi has been increasing over the years. Increase in vehicle ownership has been driven by the import of cheap used cars from Asia, mainly from Japan and Singapore. The increase in vehicle numbers has been pushing national petrol consumption up and, with it, a corresponding demand for ethanol for blending.

Barriers to Scale up

The following are the major barriers to scale up of ethanol sector employment in Malawi:

- **Feedstock supply:** Ethanol production in Malawi uses molasses as feedstock to the distillation process. There is a currently a shortage of adequate feedstock to use available plant capacity. The current supply from Illovo factories that feed the two distilleries is adequate only for six months of the year. As the technology for sugar processing improves, the sugar content in molasses has been reducing and hence the quality of the molasses as a feedstock has suffered. The supply of feedstock will be a key driver in enhancing the employment impact of ethanol production. If sugarcane production is to be increased, then an increase in land under sugarcane will be required as will an increase in the electricity available for irrigation and processing. This would have to be managed within the environmental and social limits of the Malawian agricultural economy, but, properly managed, could represent a significant rural employment potential.

- **Limited accessibility in the sector:** The ethanol industry in Malawi is dominated by two large companies operating the factories that receive the majority of their feedstock from the large private sugar producer Illovo. In this respect, the accessibility of the ethanol market limited mainly to working for these dominant firms and this can constrain poor people's ability to benefit from sector growth. However, feedstock remains a key constraint and the opportunity remains for the existing small-scale out-growers sector (representing 7 percent of current production) to expand production and supply to the distillers to take up unused processing capacity.
- **Natural resource and land limitations:** Improved data, management and governance systems are required if an expansion to the area under sugarcane is to take place. This would have implications on land use, water use and power consumption. The current private sector monopoly of the ethanol sector implies a requirement for regulation of the sector and/or encouragement of entry into the market by additional local players.
- **Delays in the move to ethanol and flex-fuel cars:** There has been a long and protracted process to approve the use of ethanol after two years of successful testing. If a higher blending ratio or ethanol powered cars are introduced, then the market for ethanol would expand.

Policy Recommendations

The following recommendations relate to the successful development of an employment-intensive ethanol subsector, based on a sustainable sugar sector. The various interlinkages of ethanol production with rural employment point to a series of multiplier benefits for a country that can support growth in agricultural production – and thereby create employment – while meeting domestic transportation (and potentially cooking) energy demand and simultaneously offsetting fossil fuel imports. Brazil makes a strong case for such a model and is currently a leading advocate for this in Africa. Malawi is an important sugar and ethanol producer in Africa today and, as such, offers important insights into the potential and way forward for this sector on the continent.

Recommendations on policy for wider consideration include:

- **Establish a blending ratio policy:** The blending ratio level and enforcement set the market for ethanol and, as such, this should be set in such a way as to stimulate increased production. Setting such a ratio in policy is the only way to ensure that energy security, foreign exchange and employment gains to the country are realized, where an otherwise unregulated energy market will not incorporate these broader interests.

- **Build employment benefits into blending pricing policy:** The wider benefits to society of using a domestically produced agricultural product rather than an imported fossil fuel imply that the principle of avoided cost should be considered in pricing policy at least initially, since the main policy objectives remain import substitution and employment creation. If cost of production is lower than fossil fuel prices in the long term, then some correction may be justified on the basis of increasing energy access. If cost of production is higher than petrol prices in the long term, then support to the sector on cost reduction may be required.
- **Support process cost reduction:** In general, cost reduction in the ethanol sector via process efficiency should be a priority and government support to R&D as well as related infrastructure investments can support this. This may include, for example, support to gravity irrigation systems and capital support to more efficient processing facilities. A situation where cost reduction is not focused primarily on pushing down wages for labourers will improve wage equality and so improve existing employment.
- **Review taxation to enable multiplier benefits:** Ethanol producers are currently lobbying for the removal of 17.5 percent value-added tax on ethanol in reaction to the zero rating of petrol. Review of taxation on fossil fuels versus biofuels based on their respective employment and foreign exchange implications may be considered to assist in levelling the playing field and maximizing benefits.
- **Regulate to enable an accessible industry structure:** Although private sector leadership in the sector has been, and will remain, important, the monopolistic nature of the current market can be expected to limit competition, innovation and benefit-sharing compared with a more diverse market. In particular, governments should seek to encourage expansion and organization of the smallholder sugarcane producer sector in order to improve accessibility of the sector.
- **Improve sector management:** Expansion of the sector could also be connected with negative impacts on land and water rights if not properly regulated. Government should act to ensure fair wages and conditions in the plantation sector via labour laws. Adequate governance of water use and land rights would also ensure that benefits are shared and that environmental and social impacts are minimized.
- **Promote additional energy access end-use markets:** An ethanol cooking fuel market would have strong pro-poor benefits by reducing household dependence on firewood for the 98 percent of people who currently rely on biomass for cooking. This would have multiplier benefits to public health (via reduced indoor air pollution), reducing deforestation and reducing opportunity cost losses to rural women who otherwise collect firewood. Policy support to this sector and rural static engines for mechanical services, for example, would boost the ethanol market and distribute the benefits of ethanol to energy access more widely than only to those with cars.

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5. MOBILE PHONES IN SOUTHERN AFRICA

Energy service(s)	Communication, including for trade and commerce
Energy vector(s)	Electricity (for mobile charging and base stations)
Energy Resource(s)	Solar, wind and diesel (alone or in hybrid configuration)
Location	Zimbabwe
Linked projects	—
Key actors	Private sector: Econet Wireless and Net One Small-scale enterprises, individuals
Energy access beneficiaries	6 million people using phones including access of electronic information for trade and commerce
Employment beneficiaries	At least 2,000 directly employed in the mobile phone sector in Zimbabwe alone. A much larger number have benefited from the economic growth linked to expansion of mobile phone coverage, enabled by energy access.

Background and Context

Sub-Saharan Africa has some of the lowest levels of infrastructure investment in the world. Only 29 percent of roads are paved, barely a quarter of the population has access to electricity, and there are fewer than three landlines available per 100 people (ITU, 2009). Yet access to and use of mobile telephony in sub-Saharan Africa has increased dramatically over the past decade. There are ten times as many mobile phones as landlines in sub-Saharan Africa (ITU, 2009) and 60 percent of the population has mobile phone coverage. Mobile phone subscriptions increased by 49 percent annually between 2002 and 2007, as compared with 17 percent per year in Europe (ITU, 2008). In 1999, only 10 percent of the African population had mobile phone coverage, primarily in North Africa and Southern Africa (GSMA, 2009). By 2008, 60 percent of the population (477 million people) had mobile phone coverage and an area of 11.2 million square kilometres had mobile phone service — equivalent to the United States of America and Argentina combined. By the end of 2012, most villages in Africa will have coverage, with only a handful of countries – Guinea Bissau, Ethiopia, Mali and Somalia — relatively unconnected (GSMA, 2008).

Mobile telephony has brought new possibilities to the continent. Across urban-rural and rich-poor divides, mobile phones connect individuals to individuals, information, markets and services. These effects can be particularly dramatic in rural Africa, where, in many places, mobile phones have represented the first telecommunications infrastructure of any kind. Mobile phones have greatly reduced communication costs, thereby allowing individuals and firms to send and to obtain information quickly and cheaply on a variety of economic, social and political topics. For firms, this improves productivity by allowing them to better manage supply and distribution chains spread throughout rural areas. As telecommunication markets mature, mobile phones in Africa are also evolving from simple communication tools into service delivery platforms. New innovative applications and services can create value and improve enterprise efficiency for users, as well as create new jobs in producing the mobile-based services. Mobile phone-based development projects – sometimes known as "m-development" – can also facilitate the delivery of financial, agricultural, health and educational services for livelihoods and development.

Reliable and cost-effective energy supply is critical to the expansion of mobile telecommunications access and usage. Charging of handsets is a requirement for every mobile user and a source of electricity within an acceptable distance and price must be available for growth in users, a big challenge in rural areas where grid power is extremely sparse. Mobile phone signal coverage is provided via a network of specialized base stations, which can provide service in a 5- to 10-kilometre radius. However, due to the unreliability of electricity supply where it is available, and unavailability everywhere else, all major mobile network operators have powered their base stations using decentralized systems, mainly diesel generators, in order to accelerate expansion. However, reliance on diesel has added to the cost of operation and has reduced the speed at which network expansion can occur into rural areas. In Zimbabwe, the two leading mobile network operators have embarked on two distinct approaches to the problem.

Net One, the state-owned operator, has installed seven solar-powered base stations around the country to cover areas out of reach of the central grid. The move has been widely advertised as innovative and responsive to local development needs. The network has also introduced a low-cost calling plan for communities served from the same base station. Currently in those areas, there have emerged micro-enterprises offering those without handsets the opportunity to make and receive calls for a fee. Teachers at schools are the main service providers as a way to augment their salaries in a salary-controlled environment, where a teacher earns USD 200 per month.

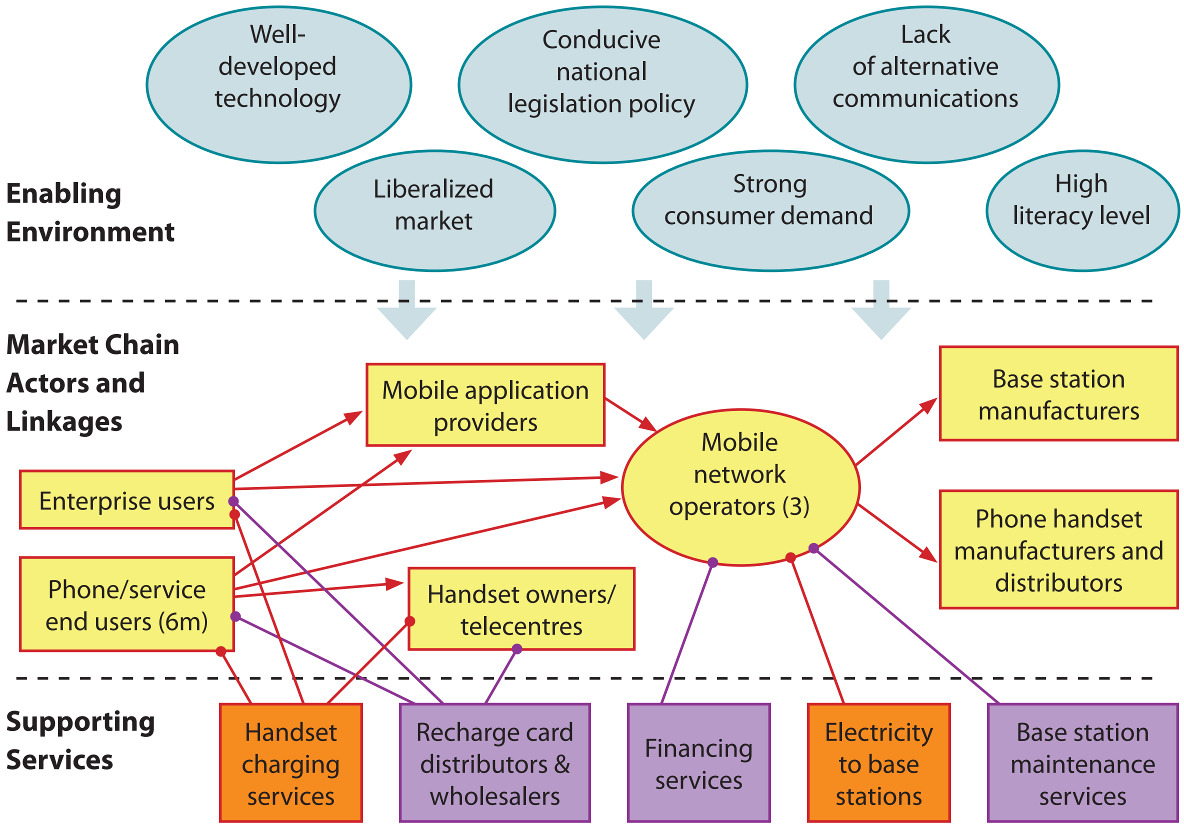
Econet, the leading private operator with a market share of over 60 percent and over 4 million subscribers, has opted to extend the grid to power its rural base stations. However, to enable end-users to use their services, they are also offering low-cost solar power handsets. To date, the operator has been selling around 1,100 units per day. A total of over 80,000 units have been sold so far. The same operator has established rural telephone centres to enable people to make and receive phone calls without owning a mobile phone. The rural telecentres include phone and internet facilities and a limited range of copying, faxing and printing services. The facilities, in urban and rural areas, have included mobile telecenters in retrofitted buses. The services are run under a franchise and employ at least three people per bus.

Market Map of the Mobile Telecommunications Value Chain map

In the main market chain, the three main operators are: Econet Wireless, which is a publicly listed company; the state-owned NetOne; and Telecel, which is majority-owned by an Egyptian company. The sector had stagnated over a decade of very little investment, owing to a declining political and economic climate. Over the 18 months since conditions improved, however, the sector experienced exponential growth to satisfy latent demand. The subscriber base grew more than 300 percent, from just under two million in January 2009 to over six million mobile phone end-users in 2010. Most of the subscribers are prepaid customers and the operators distribute recharge cards through a retail network that includes all major retail chains and fuel stations around the country. The bulk of the recharge cards, however, are sold through a wide network of street vendors, who buy from established wholesalers, with margins and income enabled at each stage.

This rate of growth is a strong indication of the value attached by people to mobile phone services as well as the rapid scaling potential of this inherently decentralized technology, where the enabling environment permits. Key factors in addition to the policy and general economic situation relate to the known technology and business delivery models proven in other countries as well as the strong demand.

Figure A5.1: Mobile telecommunications sector market map



Energy is a key supporting service to operators and end-users, as highlighted in yellow. Those end-users in towns who are lucky enough to have the grid use this directly, while poorer and more remote consumers must generally walk or take a bus into towns to use mobile charging facilities in shops. The introduction of solar-powered mobiles also gives end-users off the grid the opportunity to charge their own mobiles without going into town to find a charger.

The other key energy service to operators is power to base stations. One of the main considerations in base station site acquisition is the availability of reliable power, since this is a major factor in network performance. Where the grid is available, provision for redundancy or back-up to grid power supply is still a requirement, given its unreliability. Options include inverter and battery back-up, wind turbines and solar power systems. Decentralized systems are used as standard in expanding coverage in rural areas far from the grid. The inherently decentralized nature of mobile telephony, matched with decentralized energy options, has enabled this expansion.

Mobile applications providers also form an important part of the value chain for mobile phones. For example, since 2005, mobile financial applications (known as "m-money" or "m-banking") have emerged in developing countries. Most m-money systems allow the user to store value in an account accessible by the handset, convert cash in and out of the stored value account and transfer value between users by using a set of text messages, menu commands and personal identification numbers (PINs). There are also currently a few m-money systems in developing countries that allow international money transfers. Different institutional and business models provide these services; some are offered entirely by banks and others entirely by telecommunications providers while still others involve a partnership between a bank and a mobile phone service provider (Porteous, 2006).

Evaluation of the Employment Impacts

In terms of energy access, the entire mobile phone sector can be considered as demand side, since the sector is entirely dependent on energy for its operation. Some jobs are, however, also created in the energy supply side relating to the solar panels, small wind turbines and diesel to the decentralized and backed-up grid-connected base stations and charging stations on which the sector relies. This can be quite substantial and, for example, temporary employment has been created in local communities by contractors who put up energy infrastructure for powering remote base stations, finding it cheaper to employ local people to avoid transport and accommodation costs. Although the beneficiaries change constantly, the number of such opportunities is actually growing. Econet, the largest operator, had a programme in 2011 of putting up a base station each day for 180 days, with each site employing at least 300 person days of local unskilled labour and paying an average of USD 10 per person day. The other two operators combined are also expanding their coverage at the same rate, resulting in an annual employment of 108,000 person days of employment and USD 1,080,000 in rural wages.

However, the vast majority of employment opportunities are created within the mobile phone sector itself, enabled by this energy access.

The mobile communications industry is one of the highest performers on the Zimbabwe Stock Exchange. The operators have been realizing high returns, with average annual revenue per user of USD 12. The operators employ a combined total of 1,400 people in Zimbabwe and employees are among the top 10 percent of income earners in their respective categories. The sector has thus played an important role in creating new jobs at good levels of remuneration.

Retailing of recharge cards, along with improving revenues for existing small shops and larger retailers, is a major income earner for a very large number of new street resellers. No official figures are available, but it is estimated that at least 15,000 people nationwide are reselling recharge cards. The majority of these resellers (more than 80 percent) are in urban areas. This component of the mobile telecommunications sector demonstrates high levels of accessibility, enabling wide participation by relatively unskilled persons.

Rural and urban mobile telecentres are a source of employment enabled entirely by decentralized energy services. A mobile bus telecentre employs at least three people. Currently, 50 mobile telecentres employ 150 people in new jobs created by the sector.

There are also 26 street phone dealers for Econet wireless. Each dealer has at least 20 street phone vendors offering phone call services to a catchment of local clients without handsets. The street phones are battery powered and through this facility a further 500 people have been employed.

In terms of applications being provided through mobiles, a wide variety is coming onto the Zimbabwean market, linked to the rapid growth of the sector. Employment impact to date is not known, but the experience in Kenya with M-Pesa may act as a guide to the potential employment impact of m-money, for example.

Introduced in 2007, M-Pesa ('M' for 'mobile' and 'Pesa' for 'money' in Swahili) is a mobile phone application that facilitates a variety of financial transactions for its users, such as purchasing airtime, transferring money and paying bills. As of September 2009, M-Pesa had eight million subscribers and a network of 13,000 agents, with almost 40 percent of Kenyans having used the service to send and receive money. This is in spite of the fact that only 15 percent of the population has electricity access (Legros et al., 2009). As mobile phone coverage continues to expand in Zimbabwe, employment impacts such as these on the applications side can be realized in addition to the direct mobile phone demand and energy supply-side impacts discussed above.

Employment impacts among mobile phone users themselves are much more difficult to estimate, as they are extremely dispersed and vary between someone using a phone purely for personal communications to someone running their business around the use of the phone. However, at the macro level, the estimated contribution of mobile phones to growth is well-recognized. A 10 percent increase in the number of telephone subscribers in a country is estimated to contribute 0.6 percent to GDP growth, mainly through the productivity improvements in small and medium-sized businesses (IDA, 2009). The accessibility of this energy-dependent growth in the mobile phone sector as well as in use of phones would imply that such growth would have a strong linkage to employment and development benefits.

Drivers to Scale up

The crucial driver for increasing energy access to the mobile telecommunications sector is the extremely strong demand for the services provided by mobiles. The desire for up-to-date information for social and business decisions as well as to communicate between dispersed families is a strong market driver. Due to decentralized energy services, it has been possible to serve this market in spite of grid power access limitations. The revenue generated by the mobile phone users has created a financial flow that has justified private investment in creating the base-station infrastructure and has pulled energy access into rural areas.

However, expansion in rural access to mobile communication services has also been accelerated due to regulatory requirements for universal coverage, which are part of the licence conditions and to which all operators contribute 2.5 percent of annual sales. Without such requirements placed on operators, some may prefer to focus on built-up urban areas or rural towns, rather than reaching more sparsely populated areas.

However, there has been a win-win in this respect, as strong competition in a liberalized market has seen operators looking beyond urban areas for future growth. This has entailed tapping the rural market, which had long remained unserved. This has itself been made feasible by the continued drop in prices of handsets and the service itself. At the launch of mobile communications in Zimbabwe, an entry-level cell phone cost USD 100. Now an entry-level phone with several times more functionality costs USD 10, making it affordable for many rural poor. The introduction and subsequent proliferation of 'pay-as-you-go' schemes has ensured that many people can access the services and match their usage to their means and lifestyle.

In addressing rural markets, alternative energy has become viable in many instances, since the most favourable position for locating base stations is the highest point (unsheltered and windswept, ideal for solar and wind technologies) and, in many cases, the optimum position for coverage is several kilometres away from the grid. This driver has coincided with a previous barrier in the erratic grid power supply available due to a prolonged and persistent national generation deficit. This means that outages of more than 48 hours in a week are normally expected. This combination has meant that operators have considered alternative and decentralized energy in all situations.

The advanced state of development of mobile phone technology has aided scale up, but innovation continues in the design of both network equipment and end-user handsets. This continues to drive costs and energy consumption down, allowing for renewable energy technologies such as solar or hand chargers to offer an improved and affordable service compared with walking or travelling a distance to a charging station. The solar powered mobile phone is well on its way to achieving national scale in Zimbabwe, with its benefits to phone producers and resellers. This innovation has high potential for scale up and replication in sub-Saharan Africa and this is already starting.

With mobile phone coverage in rural areas, employment creation has been mainly through informal jobs in reselling recharge vouchers. The main driver of this mode of retailing of recharge vouchers has been the deliberate strategy of all operators to maintain a lean structure and distribute through agents and informal traders. The poor state of road infrastructure also deters large operators from establishing national distribution chains, thereby leaving room for the small informal reseller.

The high literacy rate in Zimbabwe has played a big part in uptake of mobiles and related services as well as employment in rural telecentres, as there is demand for the communication services.

Barriers to Scale up

As can be seen by the rapid scale up of the mobile phones market in southern Africa, any existing barriers are being overcome by a combination of the strong demand and decentralized energy technologies that enable expansion of coverage and handset use.

However, some subsectors do have growth limitations. For example, rural telecentres and street phone services are considered to have peaked in Zimbabwe and may not reach further scale. The reason for this is that more and more individuals are expected to be able to afford their own handsets and connection as the cost of both continues to come down. Such a shift should not necessarily be considered negative from a macro perspective, as it is connected to a general expansion in handset distribution, subscriber numbers and access to mobile services.

Policy Recommendations

The following are the policy recommendations deriving from the analysis of the contribution of decentralized energy to the mobile phone sector in Zimbabwe:

- **Decentralised energy options should be considered in energy planning:** An ideal scenario is one in which the expansion of a grid with increasingly low carbon intensity goes hand-in-hand with creation of access via decentralized renewable means for those further from the grid and with renewable resources on hand. However, decentralized technologies can be an engine for expansion of energy access in their own right. Where substantial financial, institutional or technical challenges face the expansion of grid access, decentralized options provide an alternative, as demonstrated for the mobile phone sector.

- In Zimbabwe, the growth of alternative energy in the mobile phone sector has not primarily been driven by policy, but rather by a reaction by sector players to grid unreliability and the need to create energy access in rural areas. It is clear, however, that the improvement in the enabling environment from early 2009, particularly stabilization of the currency, was crucial to enabling sector growth. In this respect, the role of good governance remains a crucial factor, even in market-based approaches such as that taken in the mobile phone sector.

Additionally, although urban competition may have moved operators to rural areas in the longer run, it appears clear that the license requirement on operators to expand rural access, including the levy on operators to create a Universal Access Fund, has promoted expansion of services into poorer communities. A regulatory policy such as a license requirement can improve the employment and benefit accessibility of a sector and expand benefit-sharing into rural areas. A major effect of the license and levy policy has been to accelerate investment in the decentralized energy infrastructure, which is the foundation for expansion of mobile phone services.

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6. ELECTRIFICATION AND NEW BUSINESS CREATION IN YEI, SOUTH SUDAN

Energy use(s)	Small to medium-sized industries and businesses
Energy vectors	Electricity
Energy resources	Diesel
Location	Yei, South Sudan
Linked projects	Sudan Infrastructure Services Project – SISP (USAID/Sudan)
Key actors	USAID, Government of South Sudan, Louis Berger Group, NRECA, Yei County Commission
Energy access beneficiaries	Market town population of Yei, South Sudan, including 253 connected households
Employment beneficiaries	Small and medium businesses of Yei, South Sudan – roughly 717 registered commercial businesses receive electricity

Background and Context

After a 30-year civil war, the Republic of South Sudan (now a sovereign state) not only suffered untold human tragedy, but was also left with no functioning public service infrastructure. There is no power generation-transmission grid in South Sudan and communities have power only if diesel generation plants have been installed. For those communities that have not yet benefited from public investment in electric power infrastructure, commercial and small industrial activity relies on individual generators.

Within these 'off-grid' areas, service for small, islanded diesel mini-grids is typically limited to 18 or fewer hours per day and characterized by high generation cost. This often translates into higher cost, and less reliable, electric service (as compared to utility power stations) for residential and commercial clients.

As South Sudan emerged from civil war in 2005, one of the first infrastructure development efforts initiated after peace was the Yei rural electrification project, financed by the US Agency for International Development (USAID). The generation/distribution system in Yei, a medium-sized South Sudanese market town near the borders with Uganda and the Democratic Republic of Congo, is comprised of 1.2 MW of diesel-based generation, extending service to residential, commercial and small industrial consumers. The project was designed by USAID in collaboration with the Government of South Sudan prior to that country's independence. It was originally implemented to illustrate how small, isolated systems – if properly designed and managed by a well-trained management team – could effectively provide electric service even under very challenging commercial and logistical conditions.

Yei is a medium-sized market town within the South Sudan context. Its population in 2005 was estimated to be around 70,000 to 80,000, but has grown to an estimated urban population of approximately 289,000 today. It is located roughly 100 kilometres south of the capital Juba and is approximately 50 kilometres north of the Ugandan border and 75 kilometres northeast of the Democratic Republic of Congo. Due to its proximity to these borders, Yei serves as a relatively major commercial centre for goods entering and exiting western South Sudan.

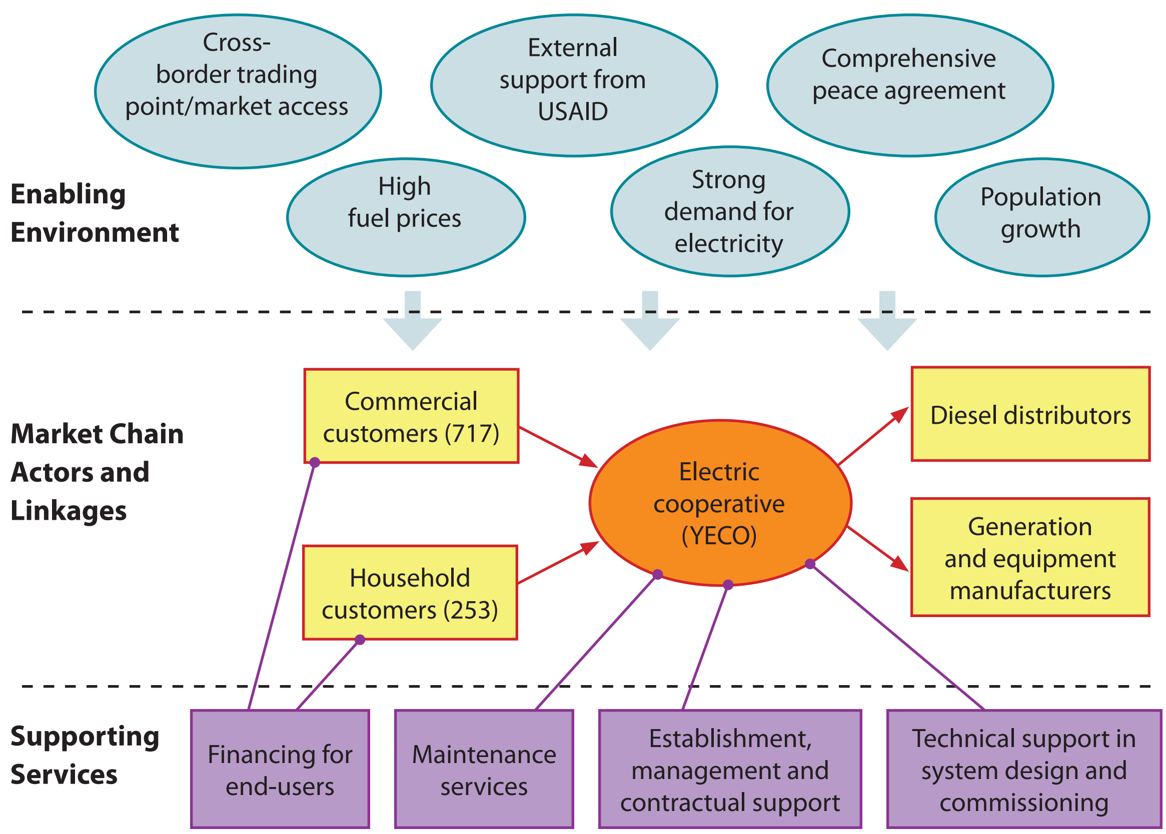
The Yei electrification project installed an electric power system comprised of a diesel power station with an installed capacity of 1200 kW that supplies power to the community via a medium voltage (11 kV) distribution grid. The system provides power for a public street lighting system and small industrial, commercial and residential consumers. Formal commercial operations began in March 2007, as the project activities were transformed into a rural electric utility. The utility was officially registered to provide commercial electric service as an electric cooperative under the name Yei Electric Cooperative (YECO).

When YECO was officially inaugurated in May 2008, it served approximately 400 customers, 80 percent of whom were commercial consumers. Today, YECO serves over 970 electric customers, of whom 717 are classified as commercial customers, and directly and indirectly benefits more than 17,000 local inhabitants.

Market Map of the Yei Electrification Scheme

As part of post-project monitoring and evaluation procedures, NRECA (prime contractors of the Yei electrification project) designed a survey of commercial clients with the intention of evaluating business creation and employment trends that resulted from electrification in the town. A team of enumerators surveyed a randomized selection of 150 YECO commercial customers. Each business was asked various questions related

Figure A6.1: Yei electrification market map



to the nature of its business, its businesses start date, employees and employment trends (family members versus non-family members, formal versus causal labour) and its business volume.

While a baseline survey was performed prior to project implementation, the survey was aimed at collecting more basic demographic information. Therefore, baseline data on the effect of high-cost energy provided by small diesel generators and other individual sources is not available to provide a clear before-and-after picture of the effect on Yei businesses. However, comparisons are possible between businesses with original owners started after YECO formal commercial operations began (2007) with those businesses started earlier than 2007. In addition, as will be described later in this case study, energy is seldom the only factor affecting business start-ups or whether it hires employees (Meadows et al., 2003). Moreover, causation between access to energy supply and broader economic growth is not straightforward and the outcomes of various studies have provided conflicting causational results (Ozturk, 2009).

While a more extensive survey would be necessary to statistically correlate business creation and employment trends within Yei's commercial sector, this case study does present indicative results of the relationship between energy access and business development and employment trends. Of particular note are the increases in relative percentages of 'service provider' YECO consumers as well as greater percentages of businesses providing permanent positions to non-family members. Additional complementary, and perhaps mutually reinforcing, factors in creating these outcomes have been identified, including Yei's recent population growth and location as a commercial hub.

Evaluation of Employment Impacts

By looking at a cross-section of businesses that are connected to the Yei mini-grid, the study is best positioned to analyse change in businesses due to electrification rather than overall expansion in business activity. Within this limitation, however, the study can identify with some precision trends within business activity in the town in the wake of electrification.

Of the 150 commercial customers surveyed, 113 (75 percent) were established during 2007 or later, after the introduction of electricity. Of these 113 new business start-ups, 94 (63 percent) stated that they were the original owners of the businesses. Although drawing a direct correlation between availability of reliable commercial energy service and businesses start-up is not possible, this figure indicates that provision of commercial energy tends to facilitate new business starts. Just 19 (13 percent) of those surveyed reported that they were in business prior to the 2007 electrification date and 15 (10 percent) reported that the business that originally requested service had been closed.

Of the commercial businesses using electricity, 91 percent of those surveyed were male-owned. Ninety-five percent of the businesses established after 2007 with original owners (herein referred to as 'post-2007 businesses') were male, while those started before 2007 (herein referred to as 'pre-2007 businesses') reported being 88 percent male-owned. This is not a statistically significant change, but highlights the male dominance of business in Yei.

A comparison of businesses started before 2007 with those with original owners started after 2007 reveals not only that the absolute number of each type of business has increased, but also that there has been a significant shift in the nature of business activities in Yei from trading to a service orientation. This points to the maturation of the economy in Yei, a process that is supported by the provision of reliable commercial electricity.

The average number of employees per surveyed businesses did not change before and after electrification: 3.7 employees per business. However, the total number of employees increased between the two cases, as there are significantly more YECO serviced businesses started after 2007. The maximum number of employees in one business also increased (26 employees at The New Tokyo Hotel). However the standard deviation for before-and-after cases was relatively similar. Moreover, the fact that the average values of the observations were approximately equal to the standard deviation tells us that the average is significantly skewed by a relatively small number of businesses in the sample. Where the employee data has been adjusted to remove outlier businesses that employ a relatively large number of employees, the average number of employees per businesses has actually decreased from 3 to 2.5 between the pre-2007 and post-2007 businesses, respectively. This could indicate that, as there have been more businesses (and thus more competition) in Yei after 2007, businesses have had to become more efficient and thus streamline their operations, as perhaps manifested by the lower average number of employees per business.

With regards to immediate family members employed in each business, the data show that that the average number of immediate family members per average total employees per business declined from 39 percent for those businesses started earlier than 2007 to 26 percent for those original owner businesses started after 2007. While the percentage of businesses that only employ family members decreased moderately from 42 percent to 31 percent, the percentage of businesses that do not employ any family members increased rather notably from 32 percent to 51 percent – when comparing pre-2007 to post-2007 original owner businesses. This reduction, particularly in wives and children working in family businesses, represents a shift in commercial electrified enterprises in Yei becoming less dominated by immediate family-provided employees. This would imply that business growth supported by modern energy services is resulting in increased availability of paid employment and thus cash circulation in the Yei economy.

When examining the trends regarding permanent employment versus day labour, we note that the average number of permanent employees per business has increased within the post-2007 businesses case: 89 percent of employees are permanent in post-2007 businesses compared with 76 percent of pre-2007 businesses. Within this same figure, one can also note that the percentage of businesses with 100 percent permanent employees has also increased.

Finally, the average number of clients served per week has not changed between the two cases: 146 for post-2007, and 147 pre-2007. In addition, when outlier businesses that serve more than 400 clients per week are removed from both cases, the average number of clients is maintained across both cases, post-2007 and pre-2007 while the average number of clients decreases in both cases to 121 per week. This indicates that, while more businesses have emerged in the wake of electrification, particularly for service provision, the average number of clients that they have served has not significantly changed. This could point to the effect of Yei's rapid population growth on the demand for services, particularly energy-derived services, within the community.

Drivers to Scale up

It is important to note several contributing factors that add context to the results discussed above.

- Yei is very favourably located for business ventures as the first commercial centre connecting South Sudan to northwestern Uganda and northeastern Democratic Republic of Congo. Both a local latent demand and market access accelerated uptake and viability of productive uses of electricity.
- The population has dramatically increased very quickly from roughly 80,000 to around 289,000 (urban Yei only). This has occurred largely due to the signing of the Comprehensive Peace Agreement, during the implementation of the project. This factor alone would have led to an increase in businesses and employment. It is likely that the electrification of the town and the improved amenities and services that it made available has also accelerated immigration and visitation to the town. Although evidence is not available from this case specifically, other factors point to improved retention of professional classes in electrified communities, for example (IEG, 2008).
- Yei was formally nicknamed "little London" and became the headquarters for the Sudan People's Liberation Army (SPLA) during the war. Therefore, it has always been a community of traders, government officials, etc. An element of entrepreneurship and economic dynamism was already present before the introduction of electricity, which again meant that electricity was quickly converted into economic activity.

Disaggregating the effects of electrification on employment in this context is therefore extremely difficult. Indeed, it is also likely that some of the above will have had a mutually reinforcing relationship. The availability of electricity in the town may well have accelerated population increase, along with the peace deal, all of which would have been expected to boost growth. While it is clear that electricity has not been the only factor in the expansion of employment in Yei, it has also clearly been a desirable factor for those businesses that have been created, given the increasing number of businesses in the town that have taken connections.

Barriers to Scale up

The main barrier to scale up of the electrification of Yei is the fact that the electrification was based on donor funding and, as such, there is a limit to the extent of the natural replication of the model. However, with the vast majority of rural electrification worldwide having taken place with public sector support, this is not necessarily surprising or a deterrent to the use of the model. For example, the model is now self-sustaining from local revenues and managed by a locally based cooperative structure. In this case, it can be seen as a viable example of donor funds creating a service that, in turn, leverages future development and does not imply an on-going commitment.

The use of diesel to power the generator was considered to be the least costly option at the time of installation. In addition, for a mini-grid of this size and in the absence of other alternative energy sources (particularly small hydro), diesel-based generation may still be the least expensive option for electric supply to this number of consumers. However, with diesel prices high and the cost of renewable options falling, particularly solar PV, and the energy efficiency of appliances improving, the equation may be changing. For example, in service industries mainly using light and ICTs, a stand-alone rather than mini-grid option may be competitive. If carbon finance were applied, this would change the balance of costs and revenues in the future and a biofuelled scenario such as that proposed for the MFPs in Mali may also approach future viability.

Policy Recommendations

In conclusion, while a more extensive survey would be necessary to statistically correlate business creation and employment trends with electrification within Yei's commercial sector, this study does present anecdotal results of the relationship among energy access, enterprise development and employment trends. The following recommendations can be derived:

- Introduction of electrification will tend to support new business start-up and create more non-family paid employment positions within served communities. However, the extent and profile of these changes will depend on a variety of factors, including the conduciveness of the business environment and environmental factors such as market access. In this context, electrification policy will achieve greater impact against investment if electrification for 'rural commercial hubs' is prioritized. Such rural commercial centres can serve as energy-related service centres for rural areas providing energy-derived services and employment opportunities for the rural catchment surrounding them.
- The survey illustrates the current limitations associated with properly defining and accounting for the effects of energy access on income generation and employment creation. In future access to energy projects, developing a well thought-through approach for evaluating this linkage should be made a priority well before project implementation.

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