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ENHANCING ACCESS TO ELECTRICITY FOR CLEAN AND EFFICIENT ENERGY SERVICES IN AFRICA

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ABBREVIATIONS

ADB	Asian Development Bank
AFD	L'Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
AGECC	Advisory Group on Energy and Climate Change
CLUB-ER	Club of National Agencies and Structures in Charge of Rural Electrification
EIB	European Investment Bank
ESMAP	Energy Sector Management Assistance Program
EVN	Vietnam Electricity
FBE	Free Basic Electricity
FDA	French Development Agency
GEDAP	Ghana Energy Development and Access Project
GEF	Global Environment Facility
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographical Information System
GNESD	Global Network on Energy for Development
GoG	Government of Ghana
ICT	Information and Communications Technology
IEA	International Energy Agency
IDB	Islamic Development Bank
INEP	Integrated National Electrification Programme
IPCC	Intergovernmental Panel on Climate Change
JBIC	Japan Bank of International Cooperation
LPG	Liquefied Petroleum Gas
LV	Low Voltage
MDG	Millennium Development Goals
MoE	Ministry of Energy
MoEP	Ministry of Energy and Petroleum
MSE	Micro and Small-scale Enterprises
MV	Medium Voltage
MW	Megawatt
MW_p	Megawatt Peak
NEF	National Electrification Fund
NEL	National Electrification Levy
NELF	National Electrification Forum
NEMP	National Electrification Master Plan
NEP	National Electrification Programme
NEPS	National Electrification Planning Study
NER	National Electricity Regulator
NES	National Electrification Scheme
NGO	Non-Governmental Organisation
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
ONE	Office National de l'Electricité
PC	Power Corporations
PERG	Programme d'Electrification Rurale Globale
PURC	Public Utility Regulatory Commission of Ghana
PPA	Power Purchase Agreement
PPER	Programme de Pré-Electrification Rurale
PPP	Public Private Partnership
PURC	Public Utility Regulatory Commission of Ghana
PV	Photovoltaics
PVER	Programme de Valorisation de l'Electrification Rurale
RDP	National Reconstruction and Development Programme
RE	Renewable Energy
REA	Rural Electrification Agency
REF	Rural Electrification Fund
RESPRO	Renewable Energy Service Project
SHEP	Self-Help Electrification Programme
SHS	Solar Home System
SME	Small and Medium-sized Enterprises
SSA	Sub-Saharan Africa
SWER	Single Wire Earth Return
UNDP	United Nations Development Programme
VAT	Value Added Tax
WB	World Bank
WEO	World Energy Outlook

PREFACE

The first draft of this report was prepared under a contract with the Danish Ministry of Foreign Affairs as input to a meeting held in New York on 20 April 2012, hosted by the UN Permanent Missions of Ethiopia, Kenya, Denmark and Norway, in partnership with UNDP and the UNEP DTU Partnership.

A subsequent meeting “Sustainable Energy for All: Powering Africa” hosted by Danida was held in Copenhagen in September 2012, where the results and recommendations of this report were presented and discussed with a large group of regional experts. The original draft was revised in late 2014 and has been updated using the latest literature available in the field.

The New York meeting took place during the development stages of the Sustainable Energy for All (SE4All) initiative. The initiative has since, evolved significantly with establishment of regional and thematic hubs and national level activities focussing on the three targets for 2030: i) Ensure universal access to modern energy services, ii) Double the global rate of improvement in energy efficiency, iii) Double the share of renewable energy in the global energy mix.

Significant progress has been made, including concrete plans for increased investment in cleaner energy across the developing world. However, access to clean energy and particularly electricity, in many African countries still remains a serious challenge. This is not least because of the scale of the challenge, the complexities and the sheer amount of investment required to provide reliable and affordable clean energy supplies to a significantly larger share of the population in Africa.

This report examines key issues related to electricity access in Africa, through the lens of selected case studies of countries that have successfully managed to increase access significantly in a short period of time, backed up with more general regional analysis. On the basis of this overview and analysis, the report makes a number of recommendations on priorities and necessary actions by countries and the donor community as to how the electricity access challenges may be addressed.

EXECUTIVE SUMMARY

In most African countries the greater part of the population has no access to electricity, and many have only limited or no access to cleaner and more modern fuels such as kerosene, liquefied petroleum gas (LPG) or natural gas.

600 million Africans have no access to electricity. Unless dedicated national efforts are implemented with major international support the situation will only get worse, and by 2030 two thirds of the people in the world without access to electricity will be on the African continent.

For access programmes to be sustainable, it is important that they make provisions for energy for both basic services and productive uses in order to improve livelihoods and also to help drive local economic development on a sustainable basis. Electrification programmes should therefore be combined with a strong development focus and should target productive sectors as well as households and social services. National programmes should have a strong focus on the demand side rather than the supply side, and devote attention to the energy services to be delivered rather than the megawatts to be built.

Several renewable energy technologies can contribute to the central grid, local mini-grid and off-grid provision of electricity, and a number of technologies can provide energy for specific services directly. Most renewable technologies have the potential to engage local communities and businesses in both the production and maintenance of equipment and installations.

Some African countries have been very successful in moving away from a low and stagnant level of electrification and in moving up to a significantly higher level within a relatively short period of time. These cases have been analysed to produce findings that form the basis for the recommendations in this report.

Recommendations and key issues at the national level include:

- **Strong and sustained government support** is the single most important pre-condition for a successful access programme
- **A strong central institution should be placed in charge** of the overall electrification programme, whether a government agency, utility or a dedicated independent institution
- **A nationally integrated electrification and development plan** covering a span of several decades needs to be developed as basis for the prioritization of actions
- **Grid extension and off-grid solutions** need to be considered in an integrated manner and may very well be implemented in different parts of the country in parallel with one another
- **A gradual build up and structured transitions** should be adopted as the foundation for access expansion in a manner that accommodates the ability of different target groups to adopt electricity
- **Strong engagement by local communities** is crucial for the successful implementation and longer term management of local electricity supply
- **Financing for access programmes** will need to be scaled up significantly, both nationally and internationally, and business models need to be developed to utilize public–private partnerships in ways adapted to the local context
- **Subsidies and social tariffs are necessary** in order to implement access programmes. Tariffs need to be designed to make it possible for targeted customers to connect and use the resource provided. At the same time, tariffs and subsidies in combination need to ensure full cost recovery for the service as delivered in order to make provision viable in the longer term.
- **The strong potential for renewable energy** technologies to contribute significantly to electrification both via grid extension and through mini-grid and off-grid systems should be exploited.
- **A focus on productive uses and employment generation** is crucial for access programmes to have a chance of achieving the targeted economic development benefits
- **The international community can play an important role**, especially in creating political awareness

around the development benefits of enhanced access

- Donor support will be crucial in
  - **Strengthening the institutional structure for planning and implementation** on both the national and local scales, including specific support for increasing the renewable energy uptake in programmes
  - **Contributing to the sustained financing** of the subsidies required for access programme expansion and tariff structures that will actually allow the targeted poorer part of the population to benefit fully
- **Donor coordination and coherence, both internal and external,** will be essential to ensure consistent and sustained support for nationally led access programmes.

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Photo: Jbdodane2

1 BACKGROUND AND CONTEXT

In the developed world energy is almost universally available and accessible: light at the flick of a switch, heat for cooking or comfort at the turn of a knob. In many parts of the developing world the picture is very different. In most African countries the greater part of the population has no access to electricity, and many have only limited or no access to cleaner and more modern fuels such as kerosene, liquefied petroleum gas (LPG) or natural gas. The situation is not unique to Africa, as will be discussed in more detail in Section 1.1, but the unique challenge for the region is the large number of countries with limited access combined with extremely low electrification levels. This report focuses on electrification in Africa in order to address the specific challenges that face many of the countries in the region.

The concentration on electricity is not meant to imply that other options for clean energy, like efficient stoves, LPG or mechanical Renewable Energy (RE)[1] technologies, are not equally relevant for many needed services. But as for most countries the "ultimate objective" is to provide electricity to the whole population, which makes electrification especially relevant. In addition, the issue of energy access in general is immensely complex and beyond the scope of a short study like the present one. Nevertheless, in spite of this focus on electricity and Africa, many of the issues discussed and recommendations made in this report are equally relevant for non-electricity options, as well as for countries in other regions that are aiming to increase access.

Although Africa is the region with the lowest level of access to modern energy services, especially electricity, the situation varies greatly between countries, as shown by a number of case studies commissioned for the present report. The report focuses on providing a better understanding of the key driving factors in those countries where rapid progress on electricity access has taken place in the last couple of decades. The case studies summarized in Chapter 3 offer a number of valuable insights into national programmes and approaches, which, combined with the generally available literature, provide a solid foundation for presenting a number of recommendations for national governments and the international community on how to move rapidly forward with large-scale energy-access programmes.

1.1 OVERVIEW OF THE ACCESS SITUATION

With the energy access issue gaining increased political prominence globally in recent years, global figures have been regularly quoted in policy discussions, as well as in the interested media. A number of institutions have undertaken dedicated efforts to improve the understanding of the current situation concerning access to electricity, as well as modern cooking fuels. In this report the figures provided by the International Energy Agency (IEA) are quoted for several reasons. The IEA has made a remarkable effort in recent years to improve its data for non-OECD member states, including a significant effort to improve understanding of the energy access situation and the challenges it faces. Another more pragmatic reason for using only IEA figures is that there is a large element of internal consistency about data which are highly uncertain by nature.

It is important, however, to emphasize that the IEA's figures are not treated here as more or less precise than any other global figures regarding energy access. The actual situation on the ground may differ significantly for a number of reasons, of which only a few are listed here as examples:

- Very few of the countries with low levels of access collect energy data as part of any national statistical census activities, so most of the figures have been scaled up from limited case samples.
- Utility data in many countries are not detailed enough to provide information about consumer categories or their consumption levels.

[1] The abbreviation RE is used exclusively in this report for "renewable energy". As RE is often also used for "rural electrification", the latter will always be spelled out in full in this document to avoid misunderstanding.

- Large population groups live in informal settlements, often with no legal status, and typically with significant mobility.
- Definitions of access vary between data sources, and even if figures on electricity connections were correct, they do not indicate anything about supply availability or affordability.

Thus, global and often even national numbers need to be used with a large degree of caution for practical planning purposes. One of the first efforts of any access programme is to obtain a clear and precise idea about the actual situation on the ground.

The inclusion of well-known global data obviously does not provide us with any new revelations, but such data have been cited to draw attention to the magnitude of the global problem and to provide a clear rationale for this report's focus on the African region.

Table 1.1 shows the IEA's figures for 2011 with projections up to 2030 according to the new policies scenario (with planned policies but no dedicated additional access efforts). According to this scenario, the number of people with no access to electricity is expected to fall in all other regions than Africa. The African region will increase its share quite dramatically, especially in countries in Sub-Saharan Africa (SSA).

While the figures are challenging, they do conceal the fact that populations grow and therefore that many people will actually gain better access in the coming years. For example, in the 1990s more than 250 million people gained access to electricity, mainly in China. So even though the percentage of people in SSA with access will increase over the next decades, even more people than today in absolute terms will remain without access to electricity in 2030. This calls for dedicated policy efforts and international support if any significant dent is to be made in the number of people with no access to electricity in the future.

When examining the number of people who still rely on traditional biomass for cooking purposes (Table 1.1), it is apparent that electricity access in no way indicates that households are able to use electricity for all their energy service requirements. The reasons are many, but they typically relate to affordability, the lack of stable supply or an inability to purchase equipment like cookers, etc.

The fact that the number of biomass users in Africa does not differ very much from the number without electricity when compared to the situation in Asia is most likely attributed to the very low electrification levels in rural areas in the African region rather than any structural differences in approaches to electrification between regions.

Table 1.1. Projections of people (in millions) without access to electricity by region

	Without access to electricity		Without access to clean cooking facilities	
	2011	2030	2011	2030
Developing countries	1,257	969	2,642	2,524
Africa	**600**	**645**	**696**	**881**
Sub-Saharan Africa	599	645	695	879
Developing Asia	**615**	**324**	**1,869**	**1,582**
China	3	0	446	241
India	306	147	818	730
Latin America	**24**	**0**	**68**	**53**
Middle East	**19**	**0**	**9**	**8**
World	**1,258**	**969**	**2,642**	**2,524**

Source: (IEA 2013b)

The uncertainty relating to biomass users is probably even higher than for electricity. A study by the Global Network on Energy for Sustainable Development (GNESD 2008) show that many households, especially in poor urban areas, rely on a number of different cooking options, including woodfuel, kerosene and, in some countries, also LPG. Actual use depends on income variations, supply availability, etc. The study showed that if a household experiences a period with a steady income, it tends to shift to higher quality fuels. However, it often shifts back again if the LPG or kerosene supply becomes unstable or if its income goes down due to seasonal variations or changes in employment.

The dimension of gender is also important, and the link between gender and energy access continues to receive important attention, for example, through the Energia Network.[2] It has been well known for many years that many of the negative effects of low-quality

[2] ENERGIA is the international network on gender and sustainable energy, founded in 1996. In Africa and Asia it works through and with regional and national gender and energy networks. See http://www.energia.org

Table 1.2. The role of energy and scope of policy interventions for achieving and sustaining the MDGs

MDG	Indicator	The role of energy	Energy needs and policy interventions for meeting and sustaining the MDGs
1. Eradicate extreme poverty and hunger	• Proportion of population <$1/ day • Poverty gap ratio • Share of poorest 20% of society quintile in national consumption. • Prevalence of under-weight children < 5 • Share of population below minimum dietary consumption. • Share of population suffering from water-borne diseases	• Access to energy services facilitates economic development – development of micro enterprises, livelihood activities, locally owned businesses that create employment, and so on – and assists in reducing extreme poverty • To reduce hunger and improve access to safe drinking water, energy services can provide pumped water and fuel for cooking 95% of the staple food.	• Post-harvest processing for home consumption and for generating a surplus • Support improved nutrition • Improve supporting infrastructure and services to utilize surplus properly • Enhance income-generating activities
2. Achieve universal primary education	• Net enrolment in primary education • Share of pupils finishing primary school • Literacy rate among 15-24 year-olds	• Energy services reduce time spent by school-going children (especially girls) on basic survival activities (gathering firewood, fetching water, cooking, and so on) • Lighting permits home study, increases security, and enables use of educational media and communication in schools	• Electricity for teaching aids • Improved energy efficiency in school buildings • Free children from the drudgery of fuel collection
3. Promote gender equality and empower women	• Girl/boy ratio in school and tertiary education • Literate women/men ratio for 15-24 year-olds • Proportion of women in wage employment • Proportion of women in parliament	• The use of improved devices reduces the household burdens of girls, allowing them to stay in school longer; they also have the time to do school work at home	• Provision of better cooking fuels to reduce indoor air pollution • Access to mechanical energy for women

Source: (GNESD 2007)

Table 1.3. Common Energy 'Myths' and Clarifications

Myth	Reality
The poor do not consider access to energy to be a priority.	The poor may not use the term "energy", but they often spend far more time and effort obtaining energy services compared to the richer section of the population. They often spend a substantial proportion of their household income on energy for basic needs like lighting, cooking, keeping warm, etc.
Poor people cannot pay for their energy services.	Many poor people pay more per unit of energy than the better off, partly due to small and costly fuel purchases, inefficient conversion equipment and pricing policies.
Access to electricity, grid or decentralized, will by itself address all the energy needs of the poor.	People need to access a range of energy services to satisfy their energy needs, including lighting, cooking, heating, transport and communications. Electricity can make an important contribution, but it is not the only solution.
Access to modern energy services will by itself stimulate economic development.	Improved energy access can be an important enabler for local economic development, but it is only a necessary, not a sufficient component for local development and needs to be combined with dedicated cross-sectoral development efforts.
Only rural areas suffer from a lack of access to energy.	Poor people in urban and peri-urban areas also suffer from a lack of access to modern energy services, and with rapid urbanisation rates expected in the coming decades urban access should be high on the political agenda as well. It is expected that 50% of the population of Africa will be living in urban and peri-urban areas by 2030.
Commercial energy required to satisfy the needs of the poor is significant with respect to total global energy consumption.	According to the IEA, reaching the poor with basic modern energy services over the next two decades would, depending on the approach used, only increase commercial energy consumption by around 1%. The same applies to global GHG emissions.

Source: (GNESD 2007)

fuel use (woodfuels, crop residues, animal waste, etc.) in developing countries impact on women and on the young children in their care (WHO 2006). In addition, the burden of gathering biomass fuel and of fetching water often falls on women and girls. As described in the next section, clean and affordable energy access, whether for thermal purposes like cooking or as motive power for water pumping, milling, etc., can alleviate these burdens and have an important impact on achieving the MDGs. The gender dimension in energy access is not, however, limited to alleviating the burdens on women, but can also be an important driver of income generation and development through productive uses. This is discussed in Chapter 2.

1.2 IMPORTANCE OF ACCESS FOR ACHIEVING THE MDGS AND SOCIAL AND ECONOMIC DEVELOPMENT

The understanding of the crucial role of energy for poverty eradication and in achieving the Millennium Development Goals (MDGs) has been researched extensively over the last decade. Using another example from GNESD (GNESD 2007), Table 1.2 shows a number of specific areas where energy services are critical for addressing the MDGs.

The examples in the table are in no way exhaustive but simply illustrate some of the typical areas where improved access to modern energy services can contribute to addressing the underlying problems related to achieving the MDGs. Many other examples and research findings could be quoted, but instead the issue is nicely captured by the report from the MDG review summit in 2010 (UN, 2010: 9) where it is stated:

"We emphasize 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."

In the same study, GNESD also addressed some of the broader "myths and realities" linked to the political and public understanding of energy access. The listing has been adapted and expanded here as an entry point to the discussion of the need for a more differentiated understanding of the access issue.

While Table 1.3 provides a somewhat simplistic and popular way of addressing some serious issues, the aim is to move quickly beyond the often quite generic understanding of energy access that is reflected in many recent policy statements.

From practical experience over a couple of decades, the available literature and the underlying case studies, it is clear that there are no simple or generally valid approaches to the issue of providing access to clean and efficient energy services: efforts need to be tailored to specific national and local circumstances. However, in order to be successful, it is important at the same time to utilize the opportunities of a global scaling up of access efforts to drive down the costs of a number key technologies and services whenever possible. This is especially important where elements of standardization and larger-scale equipment production can be applied successfully.

It should also be emphasised that, while improved access is mainly a rural issue, it is also relevant for urban settlements and peri-urban slums around the larger cities. Table 1.1 shows that in Africa currently over 120 million urban residents lack access, and with rapid urbanization over the next two decades, this points to a need for dedicated political action as well. The case studies show that implementation of successful access programmes needs not only to differentiate between national settings, but also to develop tailored approaches to address the differences between access issues and options in settings that vary from remote small rural settlements to townships, small cities and large peri-urban slums. To do this successfully will require both improved understanding of the current energy service and fuel use situation, and the development of more integrated approaches, possibly including the elements of a planned transition to electrification: for example, from initially providing better access to individual services like lighting based on PV home systems to building local mini-grids, and potentially in the longer term linking these to a national grid.

In addition to the physical and technological aspects, a better understanding of income differentials in the relevant population groups will also be required in order to target financing and tariff solutions: for example, using market-based approaches in situations where the current energy supply is largely monetized. This may be combined with carefully targeted subsidies where required in order to make access affordable for very low income groups.

The need for such differentiated and transitional approaches will be further discussed in Chapter 2 along with a more principle introduction to different definitions of access and how they relate to the social and productive aspects of development.

2 UNDERSTANDING ACCESS AND ENERGY SERVICES

2.1 ESTABLISHING A COMMON UNDERSTANDING OF ACCESS

The first basic issue that needs to be addressed when discussing enhanced energy access is to have some form of common understanding of what is meant by having access, and implicitly "access to what?"

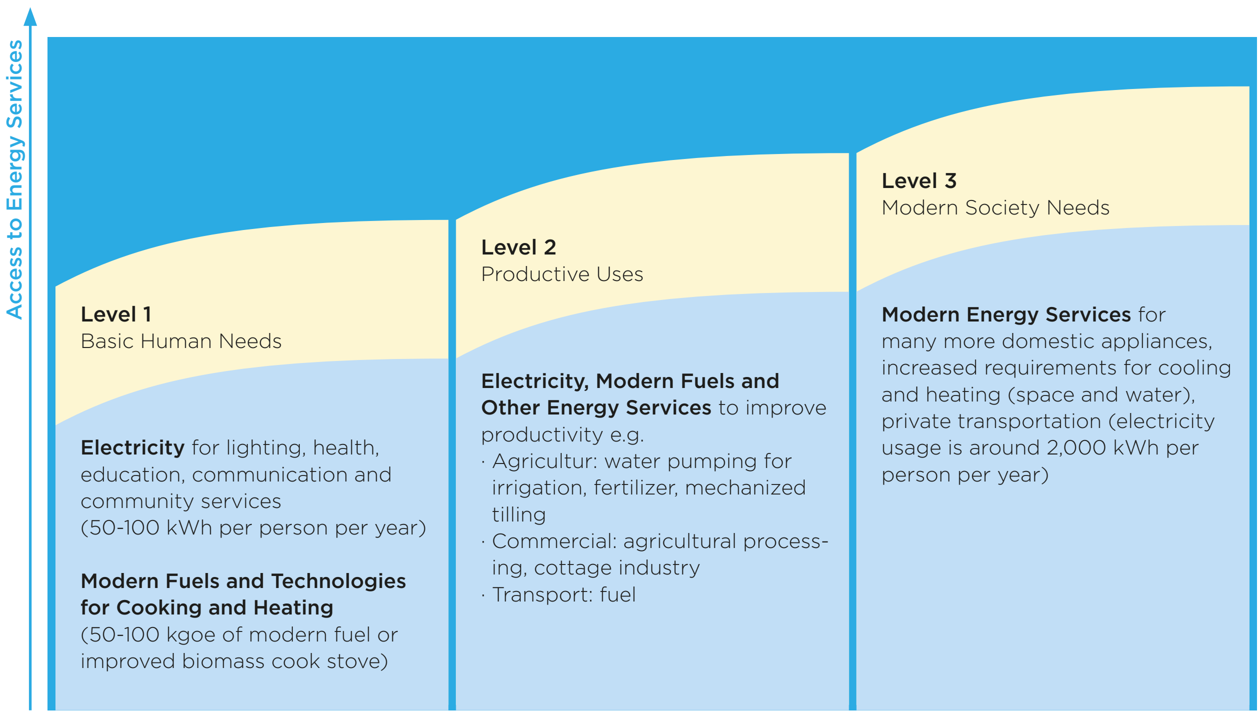
A number of definitions of access exist, ranging from numerical minimum requirements to social and economic criteria (Modi et al. 2005). For the purposes of this study, the definition put forward by the UN Secretary General's Advisory Group on Energy and Climate Change (AGECC) in their 2010 report has been adopted (AGECC 2010).

The AGECC definition is as follows: "access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses", illustrated as Level 2 in Figure 2.1. The AGECC approach shows that access is often an incremental process starting with focus on servicing basic human needs, but also that it needs to move further to create a self-sustaining process based on local economic development.

Even the basic Level 1 energy access, which includes lighting and provides for communication, health care and education, can provide substantial benefits to a community or household, and with the right pricing structures it can even include cost savings. The important point made in the AGECC report, however, is that, if energy services are to improve livelihoods as well as help drive local economic development on a sustained basis, then the appropriate level at which to define access is the provision of energy for basic services and productive uses.

In order to design effective access programmes, it is important to have a clear understanding of the types of energy services that the targeted communities demand. Reflecting the access structure presented

Figure 2.1. Access levels and underlying services



Source: (IPCC 2012)

above, demand can be usefully grouped into three categories:

- Household energy services, such as lighting, cooking, water heating, space heating or cooling, communications, etc.
- Productive or enterprise energy needs, including processing crops, pumping water, industrial machinery, other motive power uses, etc.
- Energy for social or community purposes, including schools, hospitals, water supply, communication systems, etc.

Transport is often not considered when analysing energy access, but the availability of transport services is clearly an important parameter in integrated rural and urban development, and the AGECC does in fact include transport fuel as part of its definition of access.

With the basic definition of access and understanding of service needs in place, the next step is to move from having access to ensuring that the targeted beneficiaries actually can and do use the opportunities provided, so that the desired impacts on livelihoods and economic development do occur in practice.

The three key terms most commonly used are accessibility, affordability and availability. Linking the terms to electricity provision, the first aspect is to provide physical access to power in some form. The second is to ensure that the user can afford not only the power provided, but also the necessary connection costs and appliances required to make efficient use of the electricity. Finally the supply needs to be available and reliable so that consumers can depend on it for the services required.

Accessibility and affordability are discussed in greater detail in the following sections. Availability and reliability issues are not addressed directly but are covered in the general discussion about supply options. As an illustration of the importance of these issues, Table 2.1 sets out the consequences associated with unreliable supply.

The economic consequences for domestic consumers and private companies are not monetized, but the figures in Table 2.1 clearly illustrate the problems directly related to outages and the reaction by many customers to purchase their own generators, which is not only an additional investment but often provides much more costly supply.

2.2 TOWARDS AN "ENERGY PLUS" APPROACH

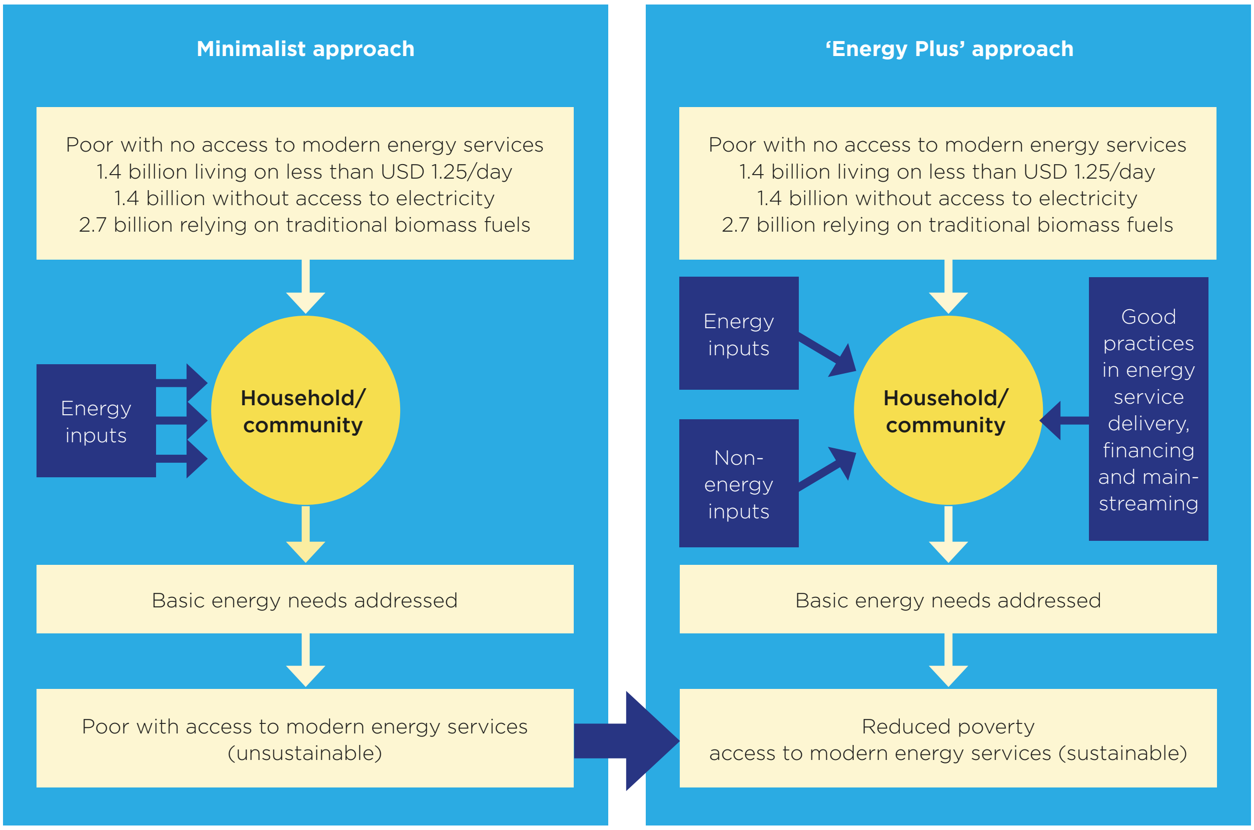
Building on the AGECC definition of access and its focus on the inclusion of productive uses, it is important to acknowledge that most experience shows, as documented by a number of studies (summarized by Bernard (2010)), that providing electricity or other modern energy services does not on its own lead to economic development. Electricity is often seen as a necessary condition for stimulating economic activities, but it is not a sufficient condition. Provision of electricity access needs to be combined with other types of action in an integrated development plan for the targeted area to realize the potential benefits associated with improved access in the current political rhetoric.

Table 2.1. Indicators of the reliability of infrastructure services

	Sub-Saharan Africa	Developing Countries
Delay in obtaining electricity connection (days)	79.9	27.5
Electrical outages (days per year)	90.9	28.7
Value of lost output due to electrical outages (percent of turnover)	6.1	4.4
Firms maintaining own generating equipment (percentage of total)	47.5	31.8

Source: (IEA 2010)

Figure 2.2. The 'Energy Plus' Approach



Source: (UNDP 2011)

In a report from 2011, UNDP introduces the concept of an "energy plus" approach (UNDP 2011) in which the provision of energy access is combined with other enabling inputs like:

- Infrastructure (e.g. roads and communications)
- Access to markets
- Access to capital
- Availability of information and skills training
- Social services such as medical facilities and schools

Figure 2.2 illustrates the "energy plus" approach compared with what in the UNDP report is called the minimalist approach, which is actually more a business-as-usual approach with infrastructural expansion being seen as the key to development.

The importance of these enabling inputs will vary between rural and urban access programmes. The UNDP study has examined seventeen energy access programmes in the Asian region and largely reaches the same conclusions as Bernard (2010) regarding the impacts of electrification projects in Sub-Saharan Africa. In this region electrification programmes have mainly brought social benefits in the form of better lighting, communication and information, as well as improvements in education and health where power has improved schools and hospitals. However, the studies generally show that improvements in incomes and livelihoods are less clear. A few programmes have taken a more integrated approach, and here UNDP clearly finds that it is possible to document the positive impacts on poverty reduction, economic and human development and that programmes have become self-sustaining.

The studies consistently highlight the strong involvement of local communities in the planning and implementation of access programmes as one way of strengthening the development aspects.

2.3 LINKING SUPPLY OPTIONS AND SERVICE NEEDS

The energy services required for household, productive and social uses can be supplied in different ways (e.g. electricity, fossil fuels such as kerosene, diesel or gas, or biofuels such as fuelwood or charcoal). However, electricity has a number of attractions, as it is the most flexible energy carrier and can be utilized for virtually all required services. In addition, it can be produced on the basis of a large number of different energy sources and readily transmitted over long distances.

When discussing how to address the energy access challenge, it is essential to focus on realistic and pragmatic approaches. These approaches must embody optimal combinations of the three ways of providing access to electricity, reflecting the specific country and local conditions:

- Extension of the central grid
- Establishment of local mini-grids
- Off-grid options

One of the key premises of this report is that the access challenges can best be addressed in an incremental way, making optimal use of gradual transitions, both from one level of access to the next and from individual supply options to integrated systems. How best to do this depends strongly on the local settings and evidently differs tremendously between remote rural areas and peri-urban settlements. Common to all contexts, however, is the need to start from a strong focus on the demand side rather than the supply side. Increased capacity on the supply side does not in itself lead to increased access, and the important starting point is therefore local demand and a focus on the energy services to be delivered. How to build supply infrastructure and find the optimal combination of sources will have to be carefully considered too. In reality many national planning processes have to address both bottom-up energy service needs and the top-down expansion of supply options pragmatically based on the existing infrastructure.

In order to provide a shared understanding of the focus on services and the need for a transitional process, the following section briefly discusses the main household services (cooking, lighting, communications and services for productive uses such as pumping, milling or sewing), how they are currently served, the options for change in the direction of cleaner and more efficient service provision, and the role of electricity and other modern options interacting to facilitate a gradual move away from the traditional supply options, with the ultimate but often distant aim of the full electrification of all services.

Cooking, which is by far the most important household energy service, is traditionally done using woodfuels, the distribution between fuelwood and charcoal depending on the specific local circumstances. Peri-urban areas and townships with limited access to forests generally rely heavily on charcoal markets, while fuelwood plays a larger role in rural areas depending on local availability. Relatively few areas in the region have a situation in which collected wood is readily available, so some elements of fuelwood markets exist in most countries. Households, institutions and small businesses collect or buy depending on the time requirements related to collection, the availability of income etc. Cooking with woodfuel presents a health risk primarily to women and children due to their frequent exposure to smoke and pollutants caused by poor combustion in traditional stoves.

Lighting, which is another basic energy service, is traditionally provided by the cooking fire, candles or kerosene lamps in low-income areas. In rural areas power for communication services such as radio and mobile phones is typically provided by batteries and battery charging stations. Mobile phones have spread rapidly in the last decade, even in households without access to electricity. Evidence from Kenya indicates that rural cell phone use plays an important role in facilitating both rural-urban connectivity and business activity among certain segments of the rural economy (Jacobson 2007). In rural areas services for productive use are often linked to agricultural activities such as pumping, milling or irrigation. Mechanical power for these activities is primarily provided by animal or human power or by diesel gensets.

Since most low-income customers can only purchase small quantities of fuel, the price per unit is usually very high. Combined with the low efficiency of cook stoves, traditional cooking arrangements, lamps or diesel genset, this means that the effective energy cost for the poorest part of the population is the highest of all. Poor households tend to spend a larger percentage of their income on energy than well-off households.

Although energy expenditure in low-income households varies greatly across regions, studies suggest that the poorest parts of populations across Africa use between 10% and 40% of their income on energy (GEA 2012; IEA 2002).

Cooking with electricity would obviously be significantly cleaner and more efficient, but as the data in Section 1.1 show, the issue of electricity for cooking purposes poses some specific challenges compared to lighting and communications. The main challenge is that, while lighting only requires power capacity from tens to a few hundred watts, it is necessary to have around ten times more for cooking purposes. This has implications both for household connection costs, wiring and ultimately the scale of the power source. In addition, the cost of even simple cooking equipment and new pots is much higher than simply light fixtures and bulbs. Combined with often poorly designed tariff structures for small-scale consumers, these constraints are the major reasons globally for over one billion people who do have an electricity connection still relying on solid fuels for cooking purposes.

Significant efforts in recent decades have been devoted to the development and distribution of more efficient stoves, but with more than two and a half billion people globally still cooking with solid fuels the urgency of global action is pressing. The Global Alliance for Clean Cookstoves was launched in 2011 by the UN Foundation in collaboration with a large number of partners with the goal of fostering the adoption of clean cookstoves and fuels in 100 million households by 2020. This is a highly commendable effort, which if successfully implemented will make a significant contribution to improving the livelihoods and health of many people, as well as reducing the pressure on woodfuels.

This situation presents an opportunity to introduce electricity in a gradual fashion, if this is desirable, starting with a limited supply for lighting and communication, and gradually expanding to eventually providing all the desired services. This has been experienced in many countries where small household systems or limited capacity grid connections have provided this first step.

These aspects will be discussed in more detail in Chapter 4 with reference to ways of establishing transitional electrification schemes and showing what this requires with regard to more integrated planning compared to the current situation in many countries, where planning and implementation are often quite fragmented.

2.4 PRODUCTIVE ENERGY USE, POVERTY ALLEVIATION AND GENDER ISSUES

In one form or another, energy is an essential input for most micro and small-scale enterprises (MSEs)[3] that constitute a major potential for income generation and the economic development of the poor in Sub-Saharan Africa. The importance of the energy dimension in the economic uplift of the poor, especially the rural poor, has been discussed recently by, for example, Practical Action (2012). In many of these MSEs, moreover, women play active and leading roles. The energy service needs of MSEs differ according to the particular activity, scale of operation and tradition. In general, energy service requirements for MSEs may include:

- Process heating and cooking
- Mechanical processing
- Cooling
- Manufacture and repair
- Powering information and communications technologies (ICTs)

The extent to which males, females or both are involved and affected often varies with the type of energy service involved. Thus women are often disproportionately represented in enterprises that are related to cooking, hairdressing, washing clothes and tailoring. The availability of clean cooking fuels can therefore have a big effect on women, while the availability of electricity for cooling and small machines like sewing machines can provide important inputs for income generation. Heavy machinery, machine tools for carpentry and repair equipment like electrical welding sets are usually the domain of men, so the provision of electricity for such uses would favour enterprises that involve men.

As always the situation is a complex one, and the provision of energy is an essential but not sufficient

[3] There is no universally agreed definition of small industries according to size. The recent report by Practical Action (2012) uses the term MSE (micro and small-scale enterprises).

Table 2.2. Transitions to renewable energy in rural (off-grid) areas

Rural Energy Service	Existing Off-Grid Rural Energy Sources	Examples of New and Renewable Energy Sources
Lighting and other small electric needs (homes, schools, street lighting, telecom, hand tools, vaccine storage)	Candles, kerosene, batteries, central battery recharging by carting batteries to grid	• Hydropower (pico-scale, micro-scale, small-scale) • Biogas from household-scale digester • Small-scale biomass gasifier with gas engine • Village-scale mini-grids and solar/wind hybrid systems • Solar home systems
Communications (televisions, radios, cell phones)	Dry cell batteries, central battery recharging by carting batteries to grid	• Hydropower (pico-scale, micro-scale, small-scale) • Biogas from household-scale digester • Small-scale biomass gasifier with gas engine • Village-scale mini-grids and solar/wind hybrid systems • Solar home systems
Cooking (homes, commercial stoves and ovens)	Burning wood, dung, or straw in open fire at about 15 percent efficiency	• Improved cooking stoves (fuelwood, crop wastes) with efficiencies above 25 percent • Biogas from household-scale digester • Solar cookers
Heating and cooling (crop drying and other agricultural processing, hot water)	Mostly open fire from wood, dung, and straw	• Improved heating stoves • Biogas from small- and medium-scale digesters • Solar crop dryers • Solar water heaters • Ice making for food preservation • Fans from small grid renewable system
Process motive power (small industry)	Diesel engines and generators	• Small electricity grid systems from microhydro, gasifiers, direct combustion, and large biodigesters
Water pumping (agriculture and drinking water)	Diesel pumps and generators	• Mechanical wind pumps • Solar PV pumps • Small electricity grid systems from microhydro, gasifiers, direct combustion, and large biodigesters

Source: (REN21 2010)

input for enterprise development. What is important is to be aware of the central role of energy provision in the development and support of small enterprises, especially the different roles of men and women with regard to use of the different forms of energy and services, as well as the decision-making processes involved.

2.5 SPECIFIC WAYS RENEWABLE ENERGY CAN CONTRIBUTE

Few national electrification programmes in Africa have focused on renewable energy, apart from those countries where large hydropower plants provide the major share of their central grid supply. One exception is South Africa, where, through three recent bidding rounds (2010-2013) for RE projects to supply power to the national grid, the government has awarded a total of 64 RE projects with a total capacity of 3,916 MW_p (Rycroft 2013).

This situation of a general lack of RE focus is changing in many countries due to a number of factors, especially the high cost of fossil fuels. The improved competitiveness of many renewable energy technologies also plays a strong role in attracting new political attention, along with efforts to develop better data on the availability and reliability of renewable energy resources like wind, solar and geothermal. Solar PV, for example, has experienced significant price reductions in the past few years. Between 2008 and 2013 the market saw a decrease of 60% in residential system prices in the most competitive markets and a decrease in module prices of 80% (Jäger-waldau 2013). In South Africa, for example, the average power purchase agreement price for PV tenders was gradually reduced from 22.44 EUR cent/kWh in December 2011 to 13.39 EUR cent/kWh in March 2012 and finally to 7.17 EUR cent/kWh in October 2012 (PVInsider 2014).

A number of African countries now have some form of renewable energy target for either energy supply generally, electricity or biofuels. However, many of these targets have not been backed by policy implementations and hence remain political ambitions.

Several renewable energy technologies have the potential to contribute to the central grid, local mini-grid and off-grid provision of electricity, and in addition a number of technologies can provide energy for specific services directly. The case studies presented in the next chapter show how renewable energy can play an important role in electricity access solutions, while Table 2.2 from REN21 (2010) shows how individual energy services can be provided by a range of different renewable energy sources.

Many of the examples shown are proven technological options like solar crop dryers and water heaters, household and community biogas systems, mechanical pumps etc. Small-scale mini-grids based on renewable energy systems are in comparison a new and emerging area (Tenenbaum et al. 2014). There is relatively limited experience on the African continent with such systems, whereas in Asia, in particular in India, a number of programmes are being implemented (see e.g. Schnitzer et al. 2014). Diesel mini-grids are in comparison quite well established in West African countries especially, and they can evidently provide important learning in terms of experience with local grids. Similarly solar home systems have been implemented for a couple of decades in the region, with Kenya being the lead market (Hansen et al. 2015).

3 REGIONAL EXPERIENCE AND LESSONS FROM THREE COUNTRY CASES

Moving from conceptual issues, this chapter will focus on the core theme of electrification in Africa. It will start with an analysis of trends in electricity access rates observed in countries within the region in the last two decades, and continue by providing an overview of the electrification models used on the continent. Against this background, three case studies of electrification in South Africa, Morocco and Ghana will be presented. This will provide a background to the analysis in Chapter 4, which identifies the key issues that countries must address, provided there is the political will to expand electricity access significantly over the coming decades.

3.1 AFRICAN ELECTRIFICATION IN RECENT DECADES

The 54 African countries exhibit a wide range of levels of electrification, from about 5% in some countries at the beginning of the last decade to essentially full access. Every country context is unique, and there is a plethora of reasons for the large differences in the level of electrification and the lack of action or rapid progress. Nevertheless, the attempt being made here is to identify and clarify some general patterns and tendencies which can help us in specifying the necessary political, economic and institutional conditions and actions that are common for countries that have provided or are planning to increase access to electricity.

Figure 3.1 shows how the level of electrification in thirty African countries has developed since 2000, using available data from IEA. All six data points in the graphs have been obtained from the same source, thus ensuring some level of consistency in the dataset. That said, data of this kind have to be used and interpreted with caution. A sudden increase or decrease in access levels can in some cases be merely the result of different definitions of electricity access between data points. For example, just such a suspect anomaly can be detected in the case of Namibia, where access levels increased from 35% in 2009 to 60% in 2011. The reasons for these anomalies would have to be investigated on a country by country level in order to explain them, but this will not be done here. In the following we will identify some interesting overall patterns that can be detected from the data.

The graphics illustrate that countries can be grouped into four quite distinct groups: three groups with somewhat stable levels of access over the time period, and one group of countries that have made distinct progress in the last decade and thus stand out from the other countries.[4] The first group consists of five countries with almost full access (mainly North African countries), the second group consists of four countries with medium-level access (20%-60%) and the third group consists of five countries with very low levels of access (20% and below). The fourth group consists of sixteen countries with access levels that have increased more than ten percentage points over the time period. Examples from this group include Senegal, where access levels increased from 30% in 2000 to 57% in 2011 (27 percentage point increase), and Zambia, where access levels increased from 12% in 2000 to 22% in 2011 (10 percentage point increase).

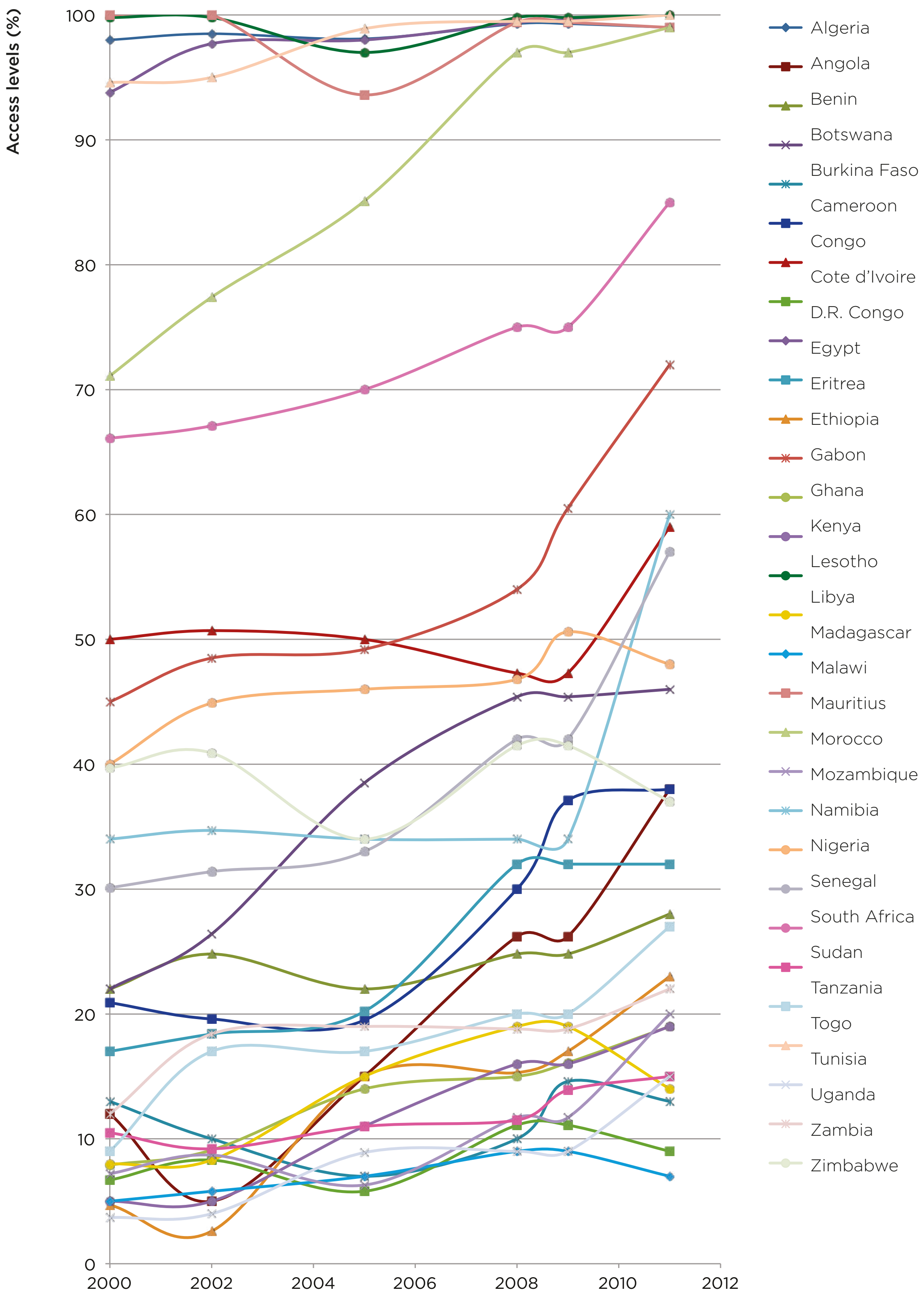
Thus the initial analysis reveals the following four distinct categories:

1. a high (90%-100%) electrification group
2. a medium (30%-60%) electrification group
3. a low (30% and below) electrification group
4. countries which have changed level significantly

The first three groups become more distinct with closer inspection in Figure 3.2, from which the fourth group of countries with significant increases in electrification have been left out.

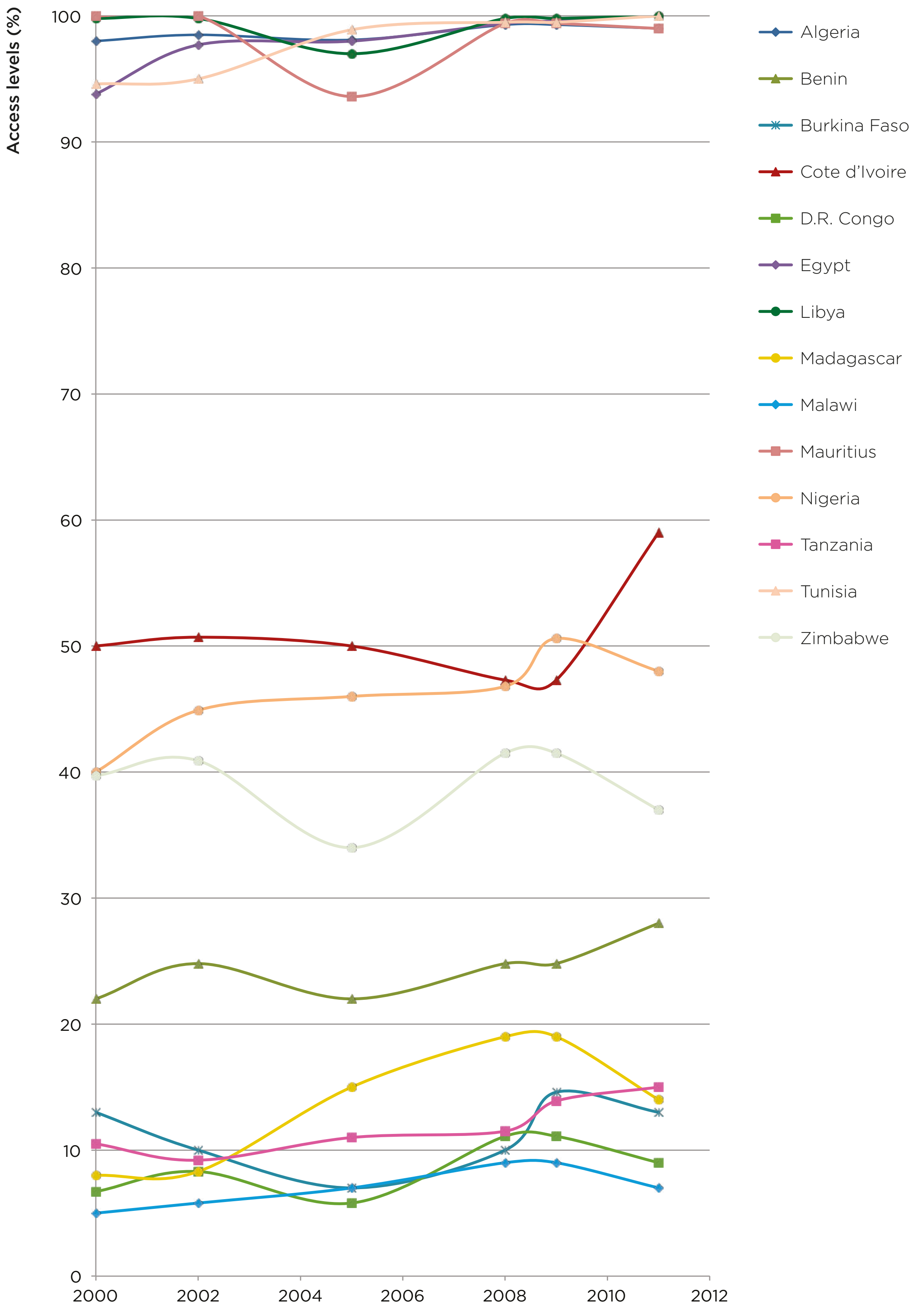
[4] Data from two countries (Cameroon and Gabon), where data was otherwise available, have been excluded from the figure due to suspected anomalies in the data, which are probably due to different definitions of electricity access between data points.

Figure 3.1. Electrification levels of thirty African countries 2000-2011



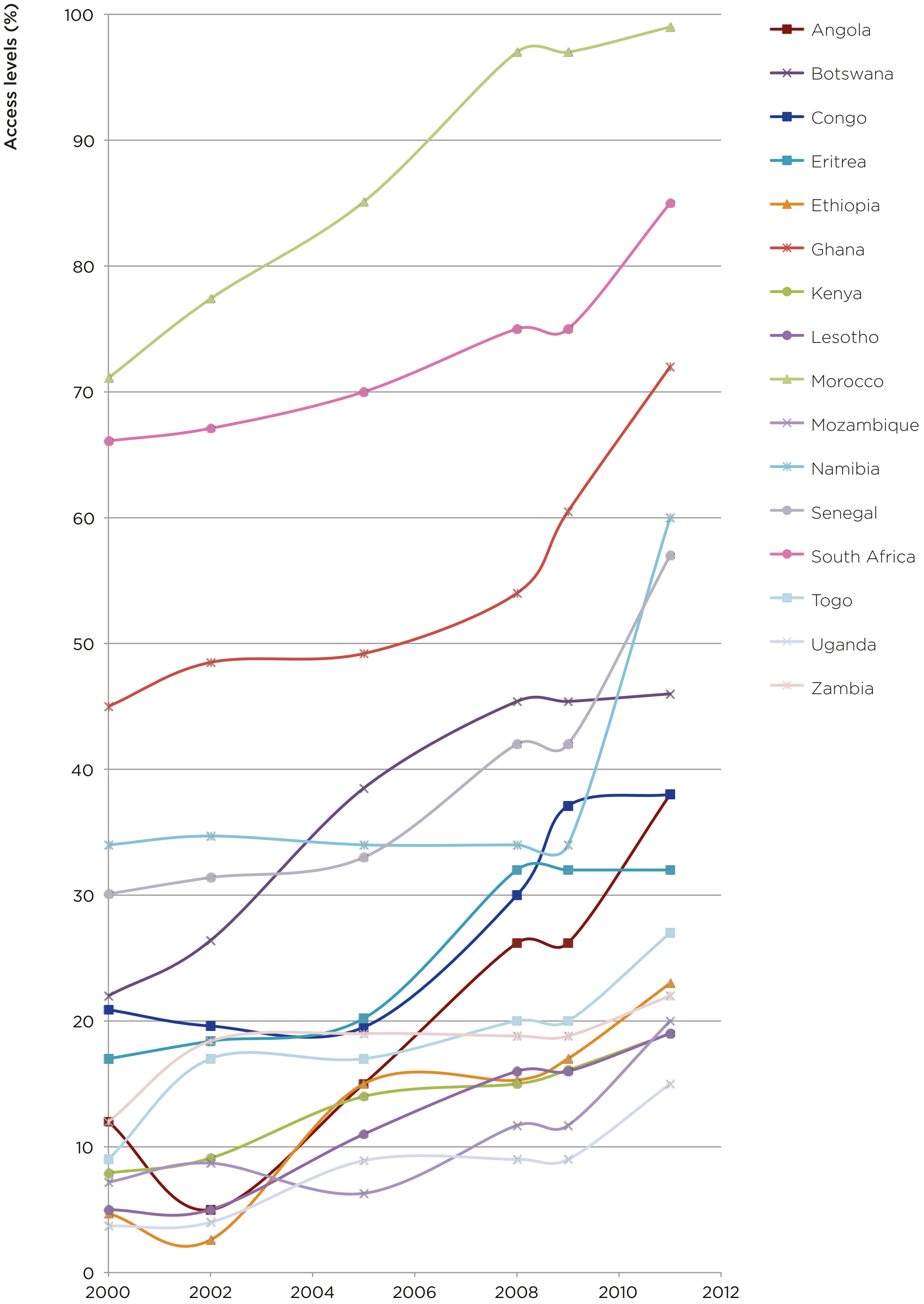
Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a)

Figure 3.2. Electrification levels of fourteen African countries with stable levels of electrification



Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a)

Figure 3.3. Electrification levels in sixteen countries with significantly increased levels of electrification



Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a)

Figure 3.3 highlights electrification rates in sixteen countries where there has been significant change. It is worth noticing how this increase in electrification levels has picked up speed in the past few years in many countries. Furthermore, of the fourteen countries which had the lowest electrification levels in 2000, nine have managed to increase access levels by ten percentage points or more over the ten-year period. The reasons for these rapid changes in electrification levels need to be found at the national level, and in the next sections the experience of some of these countries is presented in more detail.

The essential observation at this point is that some countries have managed to move away from a stagnant level of electrification and to move up to a higher level within a relatively short period of time. To illustrate the complex dynamics behind this rapid increase, we have selected three of these countries – Morocco, South Africa and Ghana – for detailed case studies in Section 3.4. Both the start and end points of their electrification rates differ significantly, and the same applies to some of the factors that have driven these processes, but as discussed later there are some strong common features which can provide guidance for other countries wanting to embark on similar processes.

The factors that maintain the majority of Sub-Saharan African countries at medium to low levels of electrification are also country-specific, but one common feature is that virtually all have extremely low levels of electrification in rural areas. A World Bank study from 2011 (Eberhard et al. 2011) found evidence of a correlation between general urbanization patterns and levels of rural electrification, attributing this to the fact that many rural electrification programmes have used urban customers to provide some of the cross-subsidies for rural customers. This still requires more analysis, as other aspects like general economic development are surely important factors too.

From Figure 3.4 it is evident that, without exception, urban electrification far exceeds the rural level in all countries, and in some case like Eritrea, Ethiopia, Tanzania and Uganda, the difference in percentage terms is an order of magnitude. Since these are all countries with relative low levels of urbanization and low GDP per capita (between USD 351-530 per capita), the data support the hypothesis of the importance of general economic development and the opportunity for cross subsidization from urban consumers.

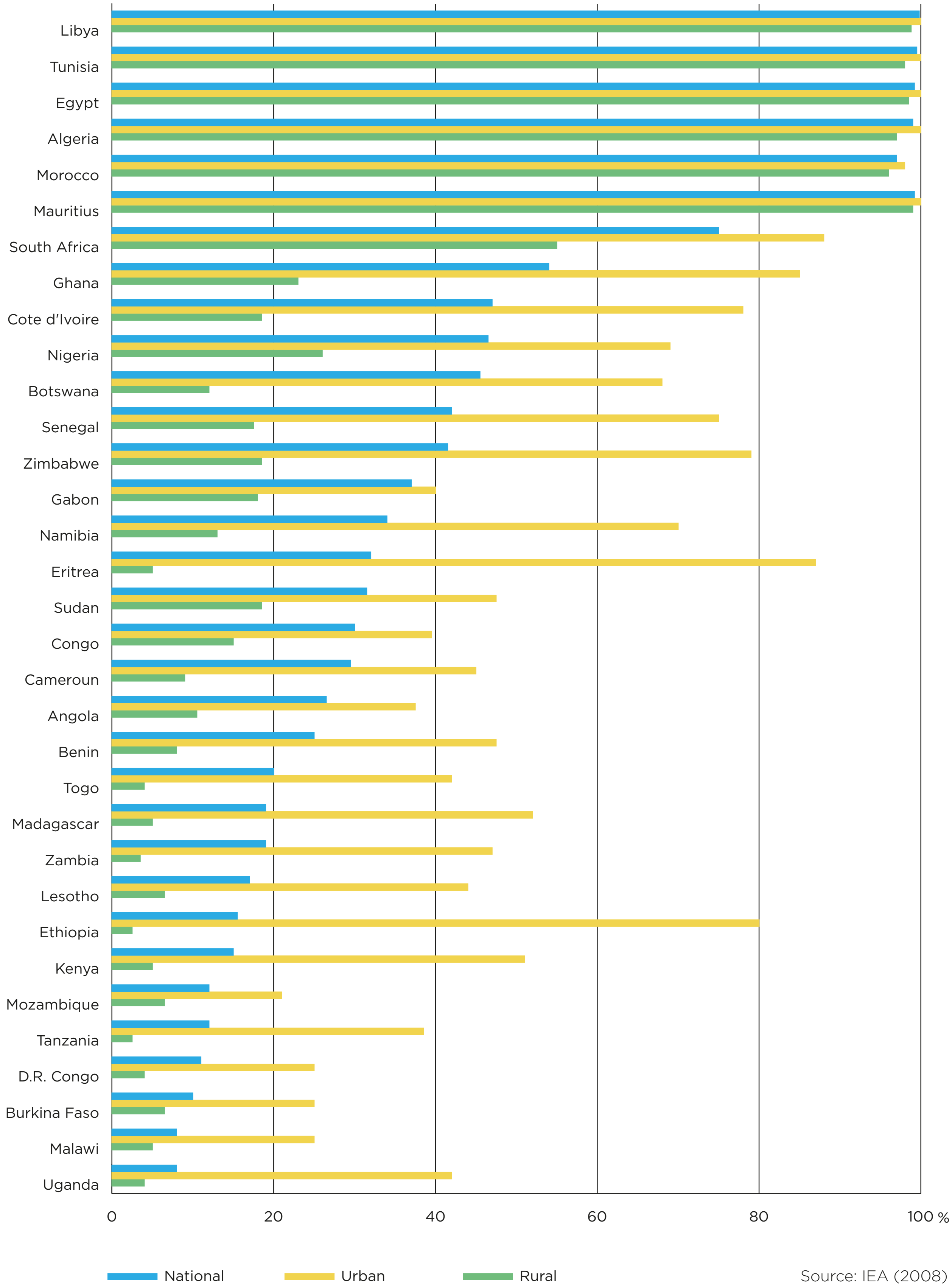
3.2 ELECTRIFICATION MODELS IN AFRICA

Rural electrification in Africa has often been described as being organized according to two different models: the utility model (the centralized model), and the rural electrification agency (REA) model (the decentralized model) (Massé 2010; Mostert 2008; Tenenbaum et al. 2014). The utility model has historically been the dominant one, but it is now the minority model in African countries. In this model the national electricity company has maintained its role as the central entity for rural electrification.

The Rural Electrification Agency (REA) model, on the other hand, reflects the situation in countries where major reforms of the electricity sector have taken place and utilities are only responsible for a small part of the financial burden of rural electrification programmes. These reforms were implemented as a response to the strong pressure from the WB in the late 1990s for national utilities to be unbundled and privatized (Wamukonya 2003). Consequently, the REA model, in which rural electrification agencies are responsible for rural electrification, became dominant in most SSA countries (e.g. Burkina Faso, Mali, Kenya, Madagascar, Mauritania, Senegal, Tanzania and Uganda). In these countries, REAs are responsible for implementing rural electrification plans, either through support to private enterprises or local cooperatives in providing electricity to rural dwellers, or through a bidding process in which local or international enterprises bid for contracts to provide electricity to larger concession areas, which could be of the size of administrative regions.

A closer analysis, however, discloses that, rather than being two distinct models, the utility model and the REA model should be seen as constituting to poles of a continuum, with a variety of organizational set-ups in between. A utility-led model, where the utility is fully responsible for rural electrification, constitutes one pole of a continuum, while the rural electrification model, with rural communities being responsible for their own electricity supply, may be seen as the other pole. This is illustrated in Figure 3.5.

Figure 3.4. Electrification levels for rural and urban population (2008)



Source: IEA (2008)

Along the whole continuum, the utility is responsible for rural electrification based on extension of the existing grid to villages located close to the grid. The major differences appear when it comes to dispersed settlements and the electrification of villages located so far from the grid that individual solutions or mini-grids are the least-cost options.

As illustrated in Figure 3.5, approaches implemented in Burkina Faso represent one pole of the continuum, being an extreme case of the REA model. Here villages far from the grid are supported by REA to form cooperative to own and operate small local electricity companies. The cooperatives are highly subsidized by the rural electricity fund, which is replenished by donors and a levy on grid-based electricity. In most cases, cooperatives contract private companies to build and operate the local grids for a period of time. Grids can be isolated mini-grids or mini-grids connected to the coherent grid through the Single Wire Earth Return (SWER) technology. Until 2009 the REA in Burkina Faso had no specific programme for dispersed villages, which are left to donor project finance (Somé 2009). Mali has implemented a similar model, where cooperatives or private entrepreneurs can establish new local electricity companies, with substantial support from the rural electrification agency (Diallo 2010). In parallel to this approach, Mali also established a concession model under which large private companies could bid for a concession, including both mini-grids and solar home systems. The concession model, however, was abandoned in 2011 due to a lack of bidders being able to finance implementation of their concessions (AMADER 2011).[5] As in Burkina Faso, the REA has no specific programmes for dispersed villages, which are therefore left dependent on donor project finance. Senegal has also established a rural electri-

[5] Verified by personal communication with Alhousseini Maiga, CNESOL-ER, Mali, February 2012.

Figure 3.5. The continuum of rural electrification models in Africa illustrated by selected countries

Segment	Organization/finance	Burkina Faso	Mali	Senegal	Ghana	South Africa	Morocco
Rural electrification agency		Yes	Yes	Yes	No	No	No
Grid connection	Organizational model	Utility ownership			Utility ownership		
	Finance	Utility, concessional loans			Utility, concessional loans		
Villages far from grid (minigrids)	Organizational model	Cooperative ownership	Private operators	Concessions	Demonstration sites planned 2015	Demonstration only	Utility-managed fee for service concessions
	Finance	REF, donor grants, concessional loans, levy on electricity	REF, donor grants, concessional loans, levy on electricity	REF, donor grants, concessional loans, levy on electricity	Demonstration sites planned 2015	Demonstration sites only	Utility-managed cross subsidies, taxes, concessional loans, grants
Villages far from grid and dispersed settlements (PV for institutions and SHS)	Organizational model	Various, not programmed	Various, not programmed	Various, not programmed	Fee for service Private	Fee for service concession	Utility-led fee for service concessions
	Finance	Project-based, mainly donors grants	Project-based, mainly donor grants	Project-based, mainly donor grants	Project-based, mainly donor grants	Government, donor grants and concessional loans	Utility-managed cross subsidies, taxes, concessional loans, grants

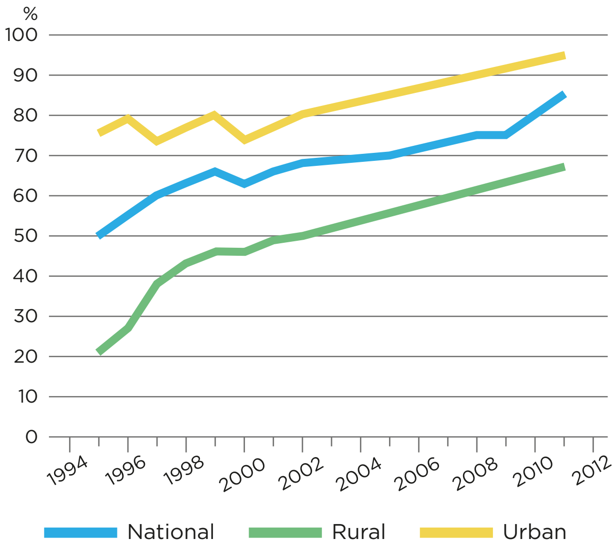
Source: Compiled based on background reports, authors' fieldwork and consultancy in Burkina Faso, Mali and Senegal and information from (Somé 2009; Diallo 2010; AMADER 2011; Sarr 2012; Abavana 2012; Ahiataku-Togobo 2014; Bekker et al. 2008; Lemaire 2011; ONE 2007; TEMASOL 2012).

fication agency, but has opted for a full concession model. The concession model has been operationalised by dividing the country into ten concession areas, with the concessionaire being responsible for providing electricity through mini-grids and to some extent also through SHS for dispersed settlements. In 2012 this model was almost fully operational, but it has proved difficult to implement due to the complexity involved in setting up tenders and reaching the terms of the concession agreement (Sarr 2012).

Moving to the utility side of the continuum, Ghana has maintained a utility-led model, where the utility is the operator of all grid-connected electricity provision. For the electrification scheme, utilities carry out network design and prepare the bill of quantities, while construction mainly is done by private contractors engaged by the Ministry of Energy (MoE), which is also responsible for financing along with international donors. PV electricity for institutions and SHS in dispersed villages have to a limited extent been supported by donor-financed projects outside the domain of the utility (Abavana 2012; Ahiataku-Togobo 2014). In the utility model in South Africa, it was planned to provide 300,000 consumers in villages far from the grid with solar home systems via six concessions, partly financed by the utility, partly by the government. The concessions were managed by the utility, but eventually only about 30,000 SHS were actually implemented (Bekker et al. 2008; Lemaire 2011). Morocco constitutes the other pole of the continuum, as the utility in Morocco has been responsible for the entire rural electrification program, including dispersed settlements. The utility has extended the grid to reach more than 95% of the rural population, and, uniquely in an African context, it has also provided electricity to isolated villages comprising about 2.5% of the rural population, and about 10% of the villages (ONE 2012). These dispersed settlements have been supplied by SHS through a fee-for-service model, which is overseen by the utility, but operated and managed by private service companies on ten-year concession contracts (ONE 2007; TEMASOL 2012; Nygaard & Dafrallah 2015).

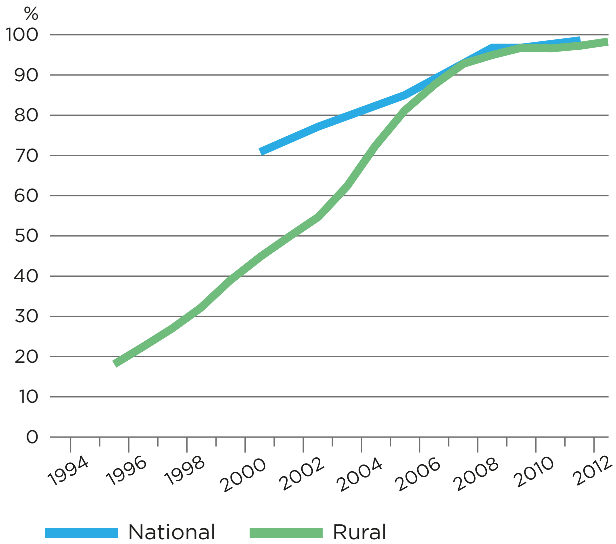
There is limited research-based knowledge on the advantages and disadvantages of the different models, but according to the background paper to this report and the report elaborated by the CLUB ER secretariat (Massé 2010), the REA model countries face a number of general challenges, which have been summarized as follows:

Figure 3.6. Development of electrification in South Africa from 1995 to 2011



Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a) and (Davidson & Mwakasonda 2004)

Figure 3.7. Development of electrification in Morocco from 1995 to 2012



Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a) and ONE (2012)

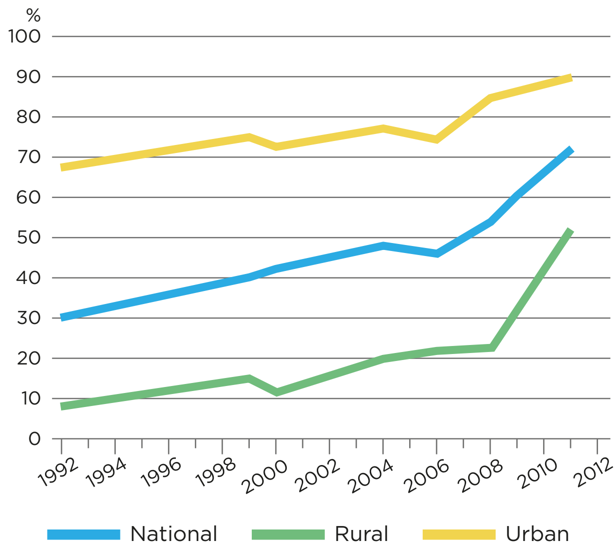
- Weak legal and institutional frameworks, with difficulties in attracting private operators, in particular international ones.
- Weak domestic financial institutions; high up-front costs of renewable energy technology; inadequate financial incentives to attract the private sector; weak channelling of finance from international sources in the rural electrification context characterized by the unprofitability of the investments (low demand, low income)
- Poor functioning institutional structures (REA, Rural Electricity Funds (REF) etc.)
- Insufficient political will to set out clear plans and strategies in coordination with other key sectors.

More details on the challenges and the experience of the REA countries are incorporated into the analyses in Chapter 4 and 5.

3.3 OVERVIEW OF CASE STUDIES ON ELECTRIFICATION

The three countries chosen for case studies represent three different but illustrative examples of how combinations of policies, funding and specific national circumstances have succeeded in increasing electricity access significantly, especially in providing services to the rural populations. First the general features of how the electrification levels have developed over the past two decades are described, followed by a discussion of the specific factors that led to the observed development in each case.

Figure 3.8. Development of electrification in Ghana from 1992 to 2011



Source: (IEA 2002; IEA 2004; IEA 2006; IEA 2008; IEA 2011b; IEA 2013a)

South Africa is a special case of electrification where an aggressive programme following the transition to democracy in 1994 led to a rapid increase in the level of rural electricity access over just a few years (see Figure 3.6). The electrification of rural areas has since flattened out to below 70%, reflecting the fact that the remaining 30% of rural households are difficult to electrify due to a combination of difficult terrain, remoteness and poverty.

In Morocco, whose access development is shown in Figure 3.7, a steady increase in the level of rural electrification occurred, from below 20% in 1995 to close to 99% by 2012. The level of urban electrification (not shown in Figure 3.7) was close to 100% throughout the period, and the approach to virtual saturation was therefore achieved almost entirely by electrifying rural areas.

The situation in the third case-study country, Ghana (Figure 3.8), shows a situation more typical of Sub-Saharan Africa, that is, rural electrification was initially at a very low level (below 10% in 1992), and the urban level were relatively high (68% in 1992). However, significant progress has been achieved since then. With a national electrification level of 72% in 2011, Ghana is the country in SSA with the third highest electrification level after Mauritius and South Africa (IEA data).[6] There is still a gap between urban and rural areas (90% and 52% electrification respectively in 2011 (IEA data)) so there is a challenge for the government to continue the expansion of its electrification programme into the more difficult and more sparsely populated rural areas. Nevertheless, compared to typical electrification rates of 25% and less in the region at large, Ghana provides an important example for other countries and regions.

[6] Other references (e.g. Eberhard et al. (2011) Fig 5.2) report similar national electrification levels in Côte d'Ivoire, Senegal, Nigeria and Cameroon, but the latest data available do seem to indicate that Ghana is in the "first place" for the time being. The Ghana case study (Abavana 2012) conducted in conjunction with the present work states that the 2010 national level was 72% in 2010.

Common to the countries with the highest increases in electrification levels in Africa is that they have all followed some form of the utility model to rural electrification. Due to their relatively high GNP, they have been able to allocate funds through government budgets to electrification, while lower levels of dependence on foreign aid has made them able to resist external pressures for the deregulation and wholesale privatization of the energy sector. Morocco and South Africa have experienced a significant backlog compared to other countries in similar economic situations, which has made it somewhat easier for them to catch up to levels equal to the countries they otherwise compare themselves to. In addition, they have all been able to extend grids to a large part of the rural population because the production costs of electricity were relatively cheap, as it was produced from large-scale hydropower (Ghana) and coal and hydropower (South Africa and Morocco). Finally, high electrification rates in urban centres have in all three countries created a basis for the cross-subsidisation of rural electrification programmes. This mobilisation of cross-subsidies to support rural electrification is driven by the state-owned utility in each case, a type of funding that is considerably more difficult to mobilise in privatised and deregulated energy sectors.

Following this general introduction of the case countries, the next section will provide a detailed analysis of each of them.

3.4 FACTORS SUPPORTING ENHANCED ACCESS

The case studies carried out for South Africa, Morocco and Ghana combined with a survey of recent literature, point to a number of factors that contribute, or indeed may be essential, to a transition from low and medium levels of electrification to higher levels.

National experience and studies in the literature show that expanding urban electrification generally comes first, as can be expected. Providing electricity to high-density areas and predominantly high-income sections of the population is basically the logical approach from a business perspective, so it is predominantly rural populations and poorer peri-urban areas that invariably lag behind (Singh et al. 2014). Consequently, the main challenge for countries even at medium levels of electrification is to bring power to dispersed and mainly poor communities in rural areas. These challenges have been met, or are being met in some African countries, including the three case-study countries, to varying degrees. The factors that have been identified as supporting enhanced access are:

- Sustained government commitment
- Effective policies and institutions
- Sustainable financing
- Tariffs and subsidies
- Effective prioritization and planning, and reliable data
- Reducing construction and maintenance costs
- Combination of grid and off-grid options.
- Focus on demand, and linking electricity to local development
- Skills and capacity

The following sections bring together the experience of each of the three countries structured according to the categories outlined above.

3.4.1 SOUTH AFRICA

Sustained government commitment

Since the end of the apartheid era in 1994, when the African National Congress came into government, the goal of providing power to poor black communities has been a main priority. The rapid increase in rural electrification was achieved through a combination of reasons, but the main driver was the political will of the new government and a concerted effort coordinated through the state-owned utility Eskom, mainly with public funds. Political commitment and financial support have been dedicated at all levels, and while the approach to implementation has changed a number of times, the political ambition has remained the same.

This long-term commitment has, according to Bekker et al. (2008), been sustained by three groups of actors that have played an essential role in supporting the electrification programme. Eskom was able to mobilise unique resources (managerial–technical skills, financial, economies of scale) early in the process, and it acted as a significant resource for central government in facilitating the development of organisational capacity within government itself. Despite being a fragmented group faced with many challenges, the municipalities made a significant contribution to the overall electrification effort. The third group were a smaller number of electricity researchers at the universities who were the architects of the accelerated rural electrification programme and who facilitated its essential political legitimacy (ibid.).

The result of the political priority given to electrification was a number of very ambitious but not entirely realistic targets. In the National Electrification Programme (NEP) the first target was set for electrification of 2.5 million households by the year 2000, and 80% of households were to be electrified by 2012 (Bekker et al. 2008). In 2004 this target was changed to universal access to electricity by 2012, but already in 2008 Bekker et al. (2008) claimed that this target would be practically impossible due to capacity and financial constraints, and that a more realistic and achievable set of planning targets needed to be developed.

Effective policies and institutions

In 1994, Parliament approved the National Electrification Programme (NEP) as part of a National Reconstruction and Development Programme (RDP) to ensure equal access to basic services for all South Africans. Later it was renamed the Integrated National Electrification Programme (INEP), having been established in the Department of Minerals and Energy on a permanent basis.

The National Electrification Forum (NELF) was set up as a broad-based stakeholder body with participants from the government, Eskom, the municipalities, unions and others with the objective of shaping the electrification programme by combining technical and financial capabilities with political legitimacy and support. According to Bekker et al. (2008; 3118) the NELF "formed an arena where stakeholders could negotiate the shape of the programme in a way that would be both politically acceptable and practically implementable". One outcome of the NELF was the establishment of a National Electricity Regulator (NER), who was given the task of developing and overseeing implementation of the INEP until 2002 (ibid.).

Eskom was restructured early in the process so that it could function on more market-based terms. The earlier prohibition on making a profit or loss was lifted, which allowed the company to take into consideration the viability of the proposed electrification projects. In 2001 Eskom adopted the same institutional structure as a private company, with a board of directors (replacing the stakeholder-based electricity council) and a sole shareholder (the state in the form of the Department of Public Enterprises), and it would henceforth pay tax (Bekker et al. 2008).

In the late 1990s, electrification priorities shifted from being primarily on urban areas to becoming mainly a rural programme, and in 1999, in addition to the grid extension programs, a fee-for-service concession-based off-grid PV solar programme for remote rural areas was introduced to increase the speed of rural electrification. Six private consortia were engaged through an open bidding process to provide SHS, but no fixed business model was required, leading to differences in approaches and results (Lemaire 2011).

Sustainable financing

Eskom had been operating the national electrification programme prior to 1994 primarily as a self-funding programme. This formed the basis for the initial activities, but the realization that electrification of the poorer parts of the population could not be self-funded led to a second phase of programme financing, from 1995 to around 2000. During this period Eskom played the lead role in financing the programme, with capital from grants, loans and bonds or so-called Electrification Participatory Notes, which were raised from private capital markets on which returns were linked to growth in consumption. Most funding, however, was in the form of a cross-subsidy from industrial users and bulk sales to municipalities, as well as many (relatively small) hidden cross-subsidies (Bekker et al. 2008).

The corporatization of Eskom in 2001, combined with the shift in emphasis of the electrification programme from urban to rural areas, thus introducing higher average costs for connections, meant that Eskom was not willing to continue funding the programme. This led in 2001 to the state funding electrification directly from the national budget (ibid.).

Subsidies and affordable tariffs

Electricity tariffs in SA have been low compared to other African countries due to the large share of coal-produced electricity. ESCOM's average selling price for electricity was ZAR 0.17 (USD 0.022) in 2005, and although this price was expected to double within a few years, the price remains low compared to other SSA countries (Niez 2010). Part of the low price is due to a policy of Free Basic Electricity (FBE) which was introduced in 2004. This policy stipulates that the poor connected to the grid receive 50 kWh free of charge every month, which is sufficient for lighting, communications and very occasional basic cooking. Effective payment recovery was achieved through, for example, pre-paid cards, which have been successfully used as an alternative form of metering and payment (Bekker et al. 2008).

The solar concession programme was also heavily subsidized. The recipients of solar home systems (SHS) paid an installation fee of about ZAR 100 in 1999 (USD 16 in 1999), increasing to ZAR 500 in 2006 (USD 68), which was only a fraction of the actual cost, which was approximately ZAR 4,000 (USD 550) for the system in 2006. The service provider subsequently owned the SHS and charged a fee of ZAR 61 (USD 8) per month for service and maintenance (Lemaire 2011). The FBE reform introduced in 2004 also included the service fee for SHSs. This fee should be paid by the municipalities, which in many cases they were not willing to do, and consequently the subsidy created a lot of uncertainty for both consumers and concessionaires and contributed to SHS's bad reputation for being an expensive and second-best solution provided only for the poorest (Lemaire 2011; Prasad 2007).

Effective prioritization and planning and reliable data

New and improved implementation processes played a crucial role, including greater use of decision-aiding techniques and tools, the adoption of new financial evaluation methods (e.g. the modified Internal Rate of Return method used by Eskom), computer-based asset management, and software for feeder design. Eskom's decision to use a blanket electrification approach after 1995 (i.e. provide supply to all potential customers in an area, also known as area coverage) instead of selective electrification (i.e. connect only the customers who are applying and paying for connections) allowed for long-term rather than ad hoc planning, and removed cumbersome quoting and payment procedures. In addition, blanket electrification reduced perceptions of unfairness, as everyone in the area received access to electricity (Bekker et al. 2008).

Reducing construction and maintenance costs

As Bekker et al. (2008) describe, a number of measures to reduce costs were introduced during the life of the program. The first hurdle was to change the conservative design specifications to accommodate the requirement for typical new consumers. This included moving away from the standard three-phase supply (four lines) to single-phase supply (two lines) and even to the Single Wire Earth Return (SWER) technology (one line) to rural consumers with low demand and long connection lines. This shift in technology reduced the cost of grid connection considerably in rural areas, and it was only possible due to important research activity and knowledge sharing among South African and foreign actors. Innovative solutions such as prepayment meters were also implemented in South Africa at a very early stage in order to increase connection rates and ensure the recovery of costs in remote areas.

Combination of grid and off-grid options

With a goal to install 300,000 SHS in the period from 1999 to 2006, the concessions scheme for solar home systems in South Africa represents the most ambitious project of off-grid rural electrification using solar energy in Africa. Its achievements, however, did not match expectations, as only 20-30,000 SHS were actually installed by 2004 (Prasad 2007). Out of six concessions (each of 50,000 SHS) only five had reached the implementation stage, and by 2011 only three concessions remained operational. This outcome seems to be due to a combination of changing policies, inconsistent planning, a lack of commitment by government, low profitability for concessionaires and low take-up by consumers (Lemaire 2011; Prasad 2007).

Nonetheless the limited success of the SHS concession program should be seen in relation to its achievements in terms of grid connection. The SHS program was from the outset mainly seen as a solution in a transitional period until grid connection could be rolled out, and some of the concession areas have in the meantime been connected to the grid. By 2008, a total of 6.9 million households were still not connected to the grid, so even full implementation of the SHS program would only have reduced the number of unserved households by 4% (Bekker et al. 2008).

Photo: UNAMID

Customer focus, and linking electricity to local development

Under the RDP program, electrification projects were implemented without integration into other local development initiatives. This changed under the INEP framework, in which all implementers, including Eskom, were required to situate electrification projects within the applicable Integrated Development Plan, developed by local government (Bekker et al. 2008). According to Bekker et al. (2008) this process resulted in slower and less efficient implementation, but it laid the foundations for the long-term sustainability of the electrification programme as it shifted from a narrow focus on connection targets to a broader set of development criteria.

Skills and Capacity

NEP was based on research activities by a wide range of specialists, which was crucial to the success of the electrification program, as was the ongoing development of skilled staff to implement the programme. Multi-stakeholder knowledge-sharing and transfer also occurred related to electrification, encouraged by a number of workshops and conferences (Bekker et al. 2008).

3.4.2 MOROCCO

Sustained government commitment

The Programme for Global Rural Electrification (PERG) was launched by the Moroccan government in 1996 as an ambitious national programme in which rural electrification was considered a key sector along with other important development areas such as rural road networks and rural water supply. PERG moved rural electrification in Morocco away from fragmented donor-driven initiatives towards a sequential programme approach characterized by long-term planning and financial commitment (Jamrani 1997).

PERG embodied clear and time-bound targets: 80% rural electrification by 2010, with a total investment of Dh 15 billion (US$ 1.8 billion) and an annual average of 1,000 villages (100,000 households) electrified (Jamrani 1997). This objective was changed midway to a more ambitious target of 98% rural electrification by 2007, reflecting more rapid process than anticipated (ONE 2005).

Effective policies and institutions

The main outcome of the power sector reforms in Morocco was the privatization of national power production and power distribution in the major cities. The Office National de l'Electricité (ONE) is an integrated power company, a national transmission and system operator, a distribution company (especially in rural areas) and a 'single buyer' of electricity. It has a 51% market share in final power supply, while municipal and private distribution companies supply the rest. ONE maintained the full responsibility for implementing the PERG (covering both grid and off-grid rural electrification).

To coordinate PERG, ONE set up a new, dedicated rural electrification department or 'directorate' that over time consisted of around hundred staff with experience of the power sector. The directorate was responsible for overall electricity planning, identifying villages, mobilizing villagers, supervision, quality control, Geographic Information Systems (GIS), etc. (Jamrani 1997).

The PERG approach is based on participatory principles involving the utility as project owner and project manager, local municipalities as partners and co-funders, and the beneficiaries as co-funders and electricity users. Consultation committees were set up to discuss and validate the RE actions and to follow up on implementation at the local, regional and national levels (Jamrani 1997).

Decentralized electrification: PPP with a fee-for-service model

Off-grid electrification is an alternative option included in the PERG, being targeted at remote villages and dispersed settlements with expensive grid connections. SHS were the main option considered for PERG on grounds of technical and economic feasibility, convenience in use and the high levels of solar radiation throughout the county.

In 1996, when PERG was launched, 150,000 households were identified as having high costs for on-grid electrification. This represented around 10% of households in rural areas and led to Morocco becoming one of the world's most important solar-based electrification schemes at the time (ONE 2007).

This was a huge challenge for ONE and, based on experience from a pilot project for off-grid electrification, PPER,[7] a main concern was the long-term maintenance of the systems. In order to speed up the process, to ensure a sustainable electricity service and to integrate existing technical and organizational knowledge, ONE decided to outsource the off-grid component to private-sector actors (ONE 2007). An international bidding process was established to select enterprises for ten-year concessions, and a first contract to supply 16,000 households with electricity was signed between Temasol[8] and ONE in 2002 (FGEF 2005). Four other concessionaires were included in successive bidding rounds, including bids for a total of 105,000 SHS (Bakri 2005).

The concession contracts set up the conditions for a fee-for-service model, according to which the concessionaires were to install and maintain the installations for a period of ten years. The consumers pay a connection fee, as well as a monthly fee that depends on the size and year of installation.

Sustainable financing

The general financial model for rural electrification in Morocco is based on the sharing of responsibilities between the consumers, the municipalities and the utility (Saddouq 2009; Jamrani 1997).

For grid electrification

Consumers paid either a fixed rate of Dh 2,500 (USD 290) per household upon connection, or Dh 40 (USD 4.7) per month over seven years. Local municipalities paid either Dh 2,085 pre-connection (USD 250) at the start-up of electricity supply, or Dh 500 (USD 59) per year for each connection over five years. The utility paid the remainder in all cases, and as the costs increased by including more distant villages, ONE's share increased from 21% (PERG1) to 65% (PERG 2-4). By 2009, ONE had on average paid 55%, while consumers and municipalities had provided about 25% and 20% of the total investment respectively. The financial resources of the municipalities came from their Value Added Tax (VAT) allocation, as well as support from the ministry budget and the Municipal Development Fund.

7 Programme de Pré-Électrification Rurale (PPER), which was implemented in 1990-2000 in parallel with PNER II (Jamrani 1997).

8 Temasol was a subsidiary of EDF, TOTAL and TENESOL, the latter itself a subsidiary of EDF and TOTAL. By July 2008, Temasol became fully owned by TENESOL, apparently now fully owned by TOTAL (Allali 2011; TEMASOL 2012).

The resources of the utility came from a solidarity tax, comprising 2.25% of on-grid sales, from concessionary loans from development banks (53%) and from equity. The main development banks were the European Investment Bank (EIB), the French Development Agency (AFD), the Islamic Development Bank (IDB) and the Japan Bank of International Cooperation (JBIC) (Saddouq 2009).

For solar electrification
In the fee-for-service model, consumers pay a connection fee and a monthly fee to the concessionaire. The monthly fee is designed to cover all the costs of service and maintenance, including renewal of batteries. The connection fee, equal to 10% of the investment, is paid by the consumer to the concessionaire, while the last 90% is paid by ONE, which remains the owner of the installation. This means that the concessionaire has full cost recovery in the investment phase (Allali 2011). The first phase of the concession programme has benefited from a USD 6.5 million grant from KfW and a USD 1.5 million grant from the French GEF (FGEF) (FGEF 2009; FGEF 2005; WBCSD 2005).

Subsidies and affordable tariffs

Rural solar customers were highly subsidized, as they pay only 10% of the investment costs. On the other hand they pay the full maintenance costs, namely a monthly fee of 65 Dh (USD 7.6) for a 50 Wp installation in PERG1 and the same for a 75 W_p in PERG2. This price is close to what city-dwellers pay for the electricity they receive from the grid and is affordable for a rural household that normally spends fifteen to twenty percent of its income on energy (TEMASOL 2012).

The three-way split in the financing mentioned above, including cross-subsidies provided by grid-connected consumers paying a 2.25% levy on their monthly bill for rural electrification, has helped provide financial sustainability to the programme, financial robustness for ONE and a tariff system which is the same for rural as for urban dwellers.

Effective prioritization and planning, and reliable data

A needs assessment was initiated at the start of the PERG throughout the country using a survey campaign that aimed at covering 40,000 villages. The utility technicians visited the villages to investigate their geographical locations and boundaries, populations, number of households and businesses, their electricity needs, existing and required infrastructure, existing social amenities, etc. A database of the power distribution networks was also developed.

In order to manage the large amount of information collected on rural households and villages and on economic, social and electricity infrastructures, the utility used a Geographical Information System (GIS). The GIS has been utilized for the RE planning and costing, the spatial positioning of the villages throughout the country and evaluation of the PERG progress. During the conception of the programme the priority was given to villages whose households presented low electrification costs (less than the limit fixed by the utility). The planning decisions have thus been based on the spatial optimization of the grid extension, that is, the maximum village connections for the lowest cost.

The main criterion in choosing the technical option based on the lowest cost of electrification was later complemented by a criterion of regionally balanced coverage to ensure that all regions benefit equally from the PERG. It was decided to build medium voltage infrastructure networks, called ‘medium voltage backbones’, in insufficiently electrified provinces and areas to open up areas where the electricity network is underdeveloped and, by doing so, reaching a better territorial distribution of electrification throughout the country. The financing of these backbones was fully covered by ONE.

The various studies and pilot programmes operated by ONE prior to the large-scale implementation of the solar programme was used to provide technical, social and economic data validation on concerns such as climatic conditions, the needs of the rural population, purchasing power and geographical distribution. This information assisted the Moroccan government in opting for the fee-for-service model, instead of the sale of equipment model that has been adopted in many other countries implementing rural solar electrification projects.

Reducing construction and maintenance costs

Cost-efficiency principles were put in place under the PERG, including efficient design and construction for the grid extension (Jamrani 1997). Special cost-reduction actions included lowering the height of the Low Voltage (LV) poles from 10.5 to 9m, then to 8m, which led to a reduction of 20% in the cost of the poles, and placing the transformers at the top of poles, which permitted a more than 35% cost reduction for transformer installation.

Combination of grid and off-grid options

Besides the high electrification rate, the combination of grid and off-grid electrification is the most remarkable in the Moroccan case, and, in contrast to South Africa, the achievements have almost universally been pronounced a success (Allali 2011; TEMASOL 2012; ONE 2009). However, a scrutiny of the literature, mainly that available from the main stakeholders such as ONE and Temasol, shows that the Moroccan concession scheme also had difficulties from the outset in reaching the set targets , and hence the intended effect of the combination of grid and off-grid options.

The goal set for the off-grid option by the launch of PERG as late as 2002 was 150,000 PV systems (ONE 2002), but only 51,559 systems were actually installed. This is about one third of the original goal, and while it covers about 10% of villages, it only constitutes about 2.5% of total connections achieved within the period of PERG. The literature does not provide much explanation as to why only 105,000 of the estimated 150,000 SHS were actually tendered, and more interestingly there are few signs of why only 51,559 of the tendered 105,000 were actually implemented (Bakri 2005).[9]

The most obvious reason is that, as in South Africa, consumers saw SHS as a second-best option, since it was more expensive and did not provide the same services as grid-connection (indicated in ONE (2006); and Allali (2011)); also, not all households in rural areas were actually able to or willing to pay the connection fee and the monthly fee for electricity. This explanation is supported by the fact that, already in 2010, ONE started a grid-extension programme, the aim of which was to 'respond to the needs of the population, which wants a grid connection instead of SHS, and therefore again to electrify villages which were not in the program due to their remoteness and the consequently high cost of grid connection at the time' (ONE 2010), p. 17).

Therefore, while the achievements of the SHS program in Morocco were remarkable at the time, it only contributed 2.5% of the new connections under the rural electrification program. Moreover, as ONE started a programme to provide grid-connected electricity to villages with SHS, off-grid connection has apparently changed status from being a final solution to being a solution filling the gap in the transition to grid-connected electricity.

Customer focus, and linking electricity to local development

Even though the ultimate objective of the PERG was the promotion and facilitation of social and economic development as well as rural empowerment, there was initially limited consideration of the development dimension at the village/community level. It seems that, when PERG was launched, there was no clear vision of how to undertake integrated local development. It was only after the completion of a comprehensive impact assessment in 2006 that, by launching the Programme de Valorisation de l'Electrification Rurale (PVER), ONE significantly increased its emphasis on the development dimension of rural electrification (ONE 2006a).

Institutional arrangements have been set up to implement the PVER, with a dedicated office to elaborate and manage the programme. The regional/decentralized offices of the utility manage the programme at local level in collaboration with regional partners. Their main focus is to increase the number of clients with productive uses. The utility partners for the PVER include NGOs involved in rural development, micro-finance institutions, universities, financial institutions, local municipalities, international organizations, national and regional development agencies and the ministries in charge of agriculture, tourism, handicrafts, etc. (ONE 2006b).

Skills and Capacity

The necessary human capacity has been built at the utility company though the creation of dedicated office structures to implement and supervise the rural electrification programme. The regional offices of the utility have been mobilized to supervise implementation of the programme at the local level.

[9] It is worth mentioning that there is considerable variation in the figures presented in various documents. This seems to be due mainly to confusion between the number of people and the number of households with access to SHS electricity. For example, Allali (2011) mentions that 106,200 customers were connected by Temasol, apparently being 'people in connected' households rather than SHS installations.

Photo: Mike Freedman

The installation and maintenance of the solar equipment could have been a costly venture for the private partner when compared with the experience of other programmes. But strong public support and the decision to train and hire local technicians helped the company to provide prompt and reliable services to its customers at affordable rates, thereby creating a viable business (Allali 2011).

3.4.3 GHANA

Sustained government commitment

Successive governments have given a high priority to improving access to energy services, with a strong emphasis on electricity and grid extension. In 1989 the National Electrification Scheme was introduced as the principal instrument with which to extend the grid to all parts of the country, setting the goal to reach all district capitals, and all towns and villages with more than 500 people by 2020 (ESMAP 2005).

Strong and consistent commitment from the Government of Ghana (GoG) is seen as a decisive factor in the rapid expansion of especially grid-connected access. Access to power has become a major selling point for local politicians, and the issues remains high on both the national and local political agendas.

Effective policies and institutions

The National Electrification Scheme (NES) has been implemented by two main programmes, the National Electrification Programme (NEP) and the Self Help Electrification Programme (SHEP). The first phase of NEP implemented between 1991 and 1998 included electrification of all district capitals and towns, plus villages en route to district capitals. The subsequent phases targeted communities in order of economic viability, based on a number of standardized criteria (Abavana 2012). This strategy was adopted to ensure that the political administrative centres, which in most cases are also the commercial hubs of the districts, were covered first, thus enhancing economic activity and the overall development of the districts. This had general acceptance politically, made economic sense and received general social acceptance.

The SHEP is a complementary activity to achieve the targets outlined in the master plan. Under the SHEP, communities within twenty kilometres of a distribution network which have also initiated their township electrification projects receive government support for completion of their projects earlier than the scheduled date of connection under the NEMP. In this way the programme provides an incentive for local engagement in order to accelerate the pace of electrification.

The SHEP has been quite effective in connecting smaller communities and was so popular that it had to be divided into several phases in order for the government to meet the demand. From 1990 to 2009, 2,837 towns were connected through the SHEP. The programme has been effective in connecting many households, but it has given little attention to smaller communities below the SHEP threshold criteria, resulting in smaller communities feeling left behind, with no clear plans for connections in their case (Abavana 2012)

The first tangible results of the power-sector reform process that started in Ghana in 1994 was establishment of the Energy Commission (EC) and the Public Utility Regulatory Commission of Ghana (PURC) in 1997. The Energy Commission is responsible for developing rules for the technical and environmental operation of the utilities, while the PURC is a "regulatory body with powers to set tariffs, ensure compliance of the obligations by concessionaires, and arbitration of disputes between power utilities or between power utilities and customers" (Edjekumhene et al. 2001). The first important result of these new institutions was the restructuring of electricity tariffs in 1998, including the already instituted lifeline tariff.

Compared to many other African countries, the power-sector reforms have been moving slowly in Ghana, and the electricity companies have continued to be government-owned. The indications are that government is not convinced that structural reform and privatization are the best paths to performance improvements (Prasad 2008). In 2008, plans for the establishment of a rural electrification agency were elaborated along similar lines to those seen in other West African countries (Kemausuor et al. 2011). However, the plans were not adopted because the new government in place after the 2008 elections felt that the REA was going to create another level of bureaucracy, which was unnecessary considering what had been achieved with the existing system (Abavana 2012).

The electrification model used in Ghana is unique in the sense that it comprises close collaboration between three parties, the Government (Ministry of Energy and Petroleum), the government-owned utility and the private sector. Utilities carry out network design and prepare the bill of quantities, while construction is mainly done by private contractors engaged by the Ministry of Energy and Petroleum (MoEP) with supervision by private consultants engaged by MoEP. Commissioning is done with the utilities before they take over the network. In turnkey projects the utilities will have to approve the network design. The grid extensions to consumers that are not part of the NEP or the SHEP are wholly done by the utilities (Abavana 2012).

The model appears complicated because the MoEP is responsible for financing, planning and the contracting of entrepreneurs and procurement of material, while the government-owned utility is responsible for the technical design and subsequently for the operation and maintenance. It does, however, provide strong central control combined with the engagement of the private sector where it makes good sense.

Sustainable financing

The funding for the NEP came from a combination of domestic funds and international donors, mainly in the form of grants and soft or concessionary loans. For SHEP the GoG has relied on grants and "tied" concessional mixed-credit facilities to finance materials and equipment for the projects. The loans are contracted by the GoG and are not passed on to the distribution utilities because the SHEP is considered a "government-sponsored" programme. In addition to donor aid and direct government assistance, the National Electrification Fund (NEF) established in 1989 has played a key role in supporting the NEP, the SHEP and other programs. The NEF is managed directly by the MoEP and collects a one percent levy on electricity tariffs, charged on electricity consumption by all classes of consumers. Contributions from the local communities involved have also played a facilitative role (ESMAP 2005; Abavana 2012).

Subsidies and affordable tariffs

Tariffs in Ghana have historically been low compared to neighbouring countries due to the low cost of electricity from the Akosombo dam. To readjust to the increased costs of thermal power plants, a tariff reform in 1998 increased tariffs by up to 300% and reduced the favourable lifeline tariff of 100 kWh/ month for all consumers to 50 kWh/month limited to households consuming less than 50 kWh per month. High inflation has been a challenge in Ghana, and even with recurrent tariff changes, distribution companies claim that they have no incentives to connect consumers, as they are selling electricity below the average price. The lifeline tariff in 2005 was about USD 2 per month or equivalent to USD 0.04 per kWh, while the average consumer tariff was about USD 0.08 per kWh (ESMAP 2005). These tariffs may seem high to Ghanaian consumers, and many poorer households have found it difficult to afford to continue being connected to the grid (ESMAP 2005). However, the average Ghanaian consumer only pays 30 to 50% compared to neighbouring countries such as Mali and Burkina Faso, which are dependent on electricity produced from diesel.

As well noted by ESMAP (2005), a main challenge in rural electrification is to provide incentives to electrify while at the same time keeping tariffs affordable for consumers.

Effective prioritization and planning, and reliable data

The original National Electrification Planning Study (NEPS), which was carried out by Acres International of Canada, established the foundation for the National Electrification Master Plan. The latter outlined an implementation plan made up of six five-year phases spanning the thirty-year period from 1990 to 2020. While the electrification sites under the NEP had been pre-determined under the NEPS, selection of sites under the SHEP involves a more dynamic planning process undertaken by the District Assemblies contingent on requests from the communities in question. The District Assemblies communicate their decision to the MoE, which will include the communities in the plans according to the availability of funding.

Various sources claim that the strong government control of rural electrification exercised through the MoE has allowed political influence over which towns and communities should be prioritized for electrification. This was more predominant before the electricity sector reform started (ESMAP 2005), but apparently it continues to be an issue after the reform process, as in the case of the solar project, described in more detail below, where local politicians influenced the grid to be extended to the area already electrified by solar PV (Ahiataku-Togobo n.d.; Bawakyillenuo 2009). Plans have therefore not always been followed to the letter, and the eternal struggle for external funding has often delayed the process. So, in spite of the observed progress in electrification in Ghana, a recent review of trends and plans in the energy sector in Ghana warns that the 2020 goal will not be fulfilled at the rate observed in 2010 (Kemausuor et al. 2011).

Reducing construction and maintenance costs

Cost reductions through the structured rollout of both the NEP and the SHEP have been a consistent focus of the programmes, but it is hard to quantify. One specific example is a technology where the shield wires of the high-voltage transmission lines are used as conductors for 20 or 30 kV transmission, making access cheaper for communities along the transmission lines. This approach, which has been deployed to serve fourteen communities in the Brong Ahafo and Northern regions, has the potential to reduce the line costs for supplies to communities near the main line to about 10% of conventional costs (Abavana 2012).

Combination of grid and off-grid options

Until recently, and in contrast to the situation in SA and Morocco, off-grid solutions were not considered suitable in the official planning of rural electrification, and due to the utilities' progress in providing low-cost grid electricity to rural dwellers, the market for private procurement of SHS that has been seen in, for example, Kenya has never materialised (Bawakyillenuo 2012).

A few attempts to prove support to PV/SHS utilization was premised on the fact that it proved virtually impossible to electrify certain islands on the Volta Lake and other remote areas by extending the national grid. The two major PV /SHS projects implemented in Ghana have been a Spanish-funded off-grid solar PV rural electrification project in Wechiau in Wa West District initiated in 1998 and a GEF-funded programme on a Renewable Energy Service Project (RESPRO) in Bunkpurugu/Yunyoo District in 1999-2004 (Bawakyillenuo 2009). The USD 3 million RESPRO project had the potential to become a provider of electricity on a fee-for-service basis as seen in Morocco. The project was heavily subsidized, and consumers had a choice of 50 or 100 kW_p systems, for which they paid an installation fee of USD 25.6 and 51.2 respectively and a monthly fee of USD 1.5 and 2.6 (Bawakyillenuo 2009). This was close to or a bit higher than the 50 kWh lifeline tariff of USD 2 per month, but it was substantially lower than the monthly fee for 50 W_p systems of 65 Dh (USD 7.6) in Morocco and ZAR 61 (USD 8) in South Africa. The low fee made it difficult to make even the operation and management economically sustainable. Again, according to (Bawakyillenuo 2009), other aspects were also different from the Moroccan case:

- The project was limited in scope and scale, as it supplied the only two districts which were not grid-connected in 1998. Consequently, the consumers saw the project as providing them with the second-best solution at a higher cost and were therefore reluctant to be connected or to pay their monthly fees.
- The project was run by a public entity, a subsidiary unit of the MoEP in Accra, which was formed through the secondment of some of its personnel.
- A large proportion of the PV systems were found to malfunction, apparently due to the lack of service after the initial part of the project.

According to the official evaluation of the project, 1,800 PV systems had been installed by 2002 (Amous et al. 2002), but in 2005 the project was abandoned as the monthly fees could not recover the maintenance costs, and the villages were provided with grid-connected electricity instead (Bawakyillenuo 2009). Based on this experience, the next logical intervention was support for a more commercial 'dealer' model led by the WB. Since 2008, in cooperation with local banks, the Ghana Energy Development and Access Project (GEDAP) project has supported a subsidy and financing scheme for SHSs in some island communities and in selected districts with low access rates (WB 2008). By end of 2012 the financing scheme had supported 9,000 households with either solar PV or solar lanterns (WB 2012). Statistical information on the number of installations nationally is sparse, but according to the MoEP, 4,500 SHS were installed in 2003 (Ahiataku-Togobo n.d.), while more than 41,000 individual systems were installed in 2014, including SHSs, solar lanterns, street lighting systems and institutional systems (Ahiataku-Togobo 2014).

Mini-grids have not been on the agenda until recently, with the GEDAP project mentioned above supporting socio-economic surveys and demonstration plants for island communities with a view to implementation in 2015 (GIZ 2013). In 2014, the MoEP predicted that only about twenty to fifty mini-grids will be established in isolated communities before 2020, especially in and around Lake Volta, while up to 50,000 SHS are expected to be installed in the same period (Ahiataku-Togobo 2014). A recent study, on the other hand, indicates that in, for example, the Northern region, SHS and mini-grids would be the least-cost option for providing electricity in up to 20% and 15% of the communities respectively (Kemausuor et al. 2014).

Consumer focus, and linking electricity to local development

Customer focus and linking electricity to local development have been among the objectives of SHEP. In addition, strong involvement by local communities was seen as reducing the overall costs for the government. Once the community contributes to the building of its local electricity network, it is also expected to engage more in protection and guarding it against illegal use.

In the NEP, educational and health institutions have been among the first to be connected, and some communities have ridden on the back of these facilities to obtain access for the whole village (Bawakyillenuo 2009).

Skills and Capacity

The NEP promoted substantial institutional development and capacity building in the utilities engineering function through transfers of knowledge and expertise. Contracts under the NEP were implemented using local contractors in all regions, thus promoting the development of local capacity in distribution network construction (WB 2001). The donors that have provided finance to the restructuring of the electricity sector and to the Ghanaian rural electrification program have over time provided a substantial amount of capacity-building to the MoEP, the utilities and the regulating authority (see e.g. (ESMAP 2005; WB 2012).

4 KEY ISSUES FOR NATIONAL ELECTRIFICATION PROGRAMMES EMERGING FROM EXPERIENCE

The presentation and discussion of key issues in this chapter focuses on the national perspective. The aim is to contribute to a better understanding of both the basic conditions for successful electrification programmes and the approaches that have proved effective in countries that have succeeded in rapid expansion of access. It has been emphasized throughout the report that all programmes need to be country-specific and adapted to the local conditions in every sense of the word, but the case studies presented above provide significant evidence that national programme design can benefit from being built on.

The case studies do not cover all aspects. For example, central power capacity and grid structures have not been addressed in detail. Nevertheless the South African case shows strongly the importance of significant initial power capacity and central grid structures in the choice of expansion model to be adopted. Similarly, financing is not addressed in detail in all cases.

In addition to the information from the case studies, the following sections therefore draw upon research papers and recent studies of electrification programmes in Africa and other regions commissioned by ESMAP (Barnes 2007), the World Bank (WB 2010; Eberhard et al. 2011) and the International Energy Agency (Niez 2010).

4.1 POLITICAL COMMITMENT

One of the clearest conclusions of all the case studies and the literature studies is that *strong and sustained government support* is the single most important precondition for a successful access programme. In most cases this means long-term commitments by both central and local governments over a fifteen- to twenty-year timescale as the framework for the more detailed institutional, technical and financial aspects.

Political commitment has to be combined with effective policies and institutional approaches for programmes to become successful. Political will is therefore an absolutely necessary precondition for success, but not a sufficient one. It must be accompanied by well-designed policies and implementation approaches. This includes transparent regulatory and fiscal frameworks and incentives for the private sector, particularly regulation mechanisms adapted to rural electrification specificities. Special attention should be given to the creation of a regulatory framework capable of boosting the use of renewable energy sources and technologies, for example, feed-in tariffs to sell electricity to the grid, or power purchase agreements (PPAs) adapted to renewable energy, thus promoting this type of investments. Government commitment to enhanced energy access will require the incorporation of these priorities into national development and poverty-reduction strategies, plus, as discussed further in Section 5.3, elaboration into detailed policies and plans.

How government support emerges or can best be established may merit a study in its own right, but the best driver would be strong local interest reflected in local election agendas. Strong engagement of local communities is in any case an important factor for successful programmes. International agreements and target-setting, as discussed in connection with the Rio+20 Summit, is a completely different way of generating more top-down political commitment. However, as noted earlier in connection with the current national renewable energy targets in the African region, such internationally established goals often remain political aspirations, unless it is documented that they clearly support and can be integrated into local development. The emphasis introduced in Chapter 2 on combining electricity access programmes with a strong focus on productive uses and employment generation to stimulate local economic development is therefore likely to provide stronger political motivating factors than a globally agreed target on its own.

4.2 INSTITUTIONAL ISSUES: THE ROLE OF NATIONAL OR LOCAL INSTITUTIONS IN ELECTRIFICATION

The case studies all point to the importance of having a strong central institution in charge of the overall electrification programme, either in the form of a government agency, a utility or a dedicated independent institution. The World Bank studies that have taken a broader look at other countries in the region note that there is no evidence of any one clearly superior organizational model, but in almost all cases a clear institutional framework is a prerequisite for success.

With power reforms in many African countries over the last two decades, most of the earlier state-owned utilities have been privatized and independent regulatory bodies established to oversee the power market. The results of the reform programmes still need to be fully evaluated with regard to how well they have delivered on the key drivers for reforms, often the inefficiency of the former utilities in terms of cost-effective delivery, maintenance, attraction of foreign capital for expansion, etc. However, it is worth noting that the countries which have adopted the dominant rural electrification agency model as a consequence of energy-sector reforms are those that are registering the worst performances in terms of electrification.

The study by Eberhard et al. (2011) records very mixed results with reforms in the region, noting that, after a first round of the private management of utilities, many countries have reverted to some form of state-led operation, maybe in a hybrid fashion, with a degree of private engagement. The report also notes that power markets in many African countries may basically be too small to provide a sustained basis for a number of power generators, thus questioning one of the underlying premises for reform. However, a country like Kenya has experienced some success in introducing both part-private ownership of the national utility and recently allowing private power producers to sell to the grid.

When examining what reforms have done to expand access for the urban and rural poor, the answer is more clearly negative (GNESD 2008). Access expansion has often been a secondary objective of reform efforts and has therefore been left for later action, after the central structures have been established. Many countries have then subsequently established what in Chapter 3 was identified as the "REA model", where responsibility for electrification expansion was left with relatively weak Rural Electrification Agencies, often combined with a dedicated Rural Electrification Fund. The study by Mostert (2008) has specifically examined the experience with REAs and REFs in the African region, and the conclusion is quite clear: "ring-fenced" funds for electrification programmes are necessary to achieve consistent, long-term improvements in access rates, and the earlier quoted GNESD study also confirms this finding. The studies are less conclusive on the need for a dedicated REF and on whether the "ring-fencing" can be achieved by other institutional means.

Regarding analysis of the REA experience, the conclusion by Mostert (2008) is very clear and supports the findings of the case studies that a central institution or utility is likely to be more effective as the responsible agency for a national electrification programme, while institutions like REAs may be better suited for management and for the implementation of the mini-grid and off-grid parts of an integrated electrification plan. This is supported by the fact that mini-grids have not been seriously considered in South Africa and Ghana, and that only few have been implemented in Morocco, while they play an important role in REA countries like Burkina Faso and Mali. There may be examples where this broad-based conclusion is not fully applicable, as it is impossible to isolate institutional issues from other factors like political commitment and domestic finance availability (Barnes 2007). These factors may have been strong contributors to the lack of success for REAs in some of the countries analysed, but as general guidance for new national programmes the conclusions seem quite robust.

How the responsibilities of the central entity are designed and delineated will depend on the existing national institutional conditions and the tasks to be performed. This will be further discussed in relation to policy, strategy and implementation in the next section.

4.3 POLICY AND STRATEGY DEVELOPMENT AND IMPLEMENTATION

On the policy and strategy development aspects, the case study conclusions are again quite uniform. The supporting studies by the WB (WB 2010; Eberhard et al. 2011) and IEA (Niez 2010) generally confirm this and are summarized below.

A nationally integrated electrification and development plan covering a period of several decades needs to be developed as a basis for prioritizing actions. It should examine both central grid expansion, the establishment of local mini-grids and off-grid solutions based on careful studies of the existing distribution of population, current energy and electricity consumption, and projections over the relevant planning period.

The responsibility for development of the plan should lie directly with the government or with the type of centrally responsible institution described above. Reflecting the discussions of the need for an "energy plus" and service-oriented approach in Chapter 2, it is emphasized that the plan should not only address electrification, but also local development plans. This means that close collaboration with relevant ministries and local authorities will be required to facilitate the desired economic development benefits of electrification.

Very few countries in the region would today be able to replicate the Moroccan experience, which was based largely on cross-subsidies and public finance, with a strong utility responsible for the initial programme implementation. National action must therefore be prioritized as part of the plan, and to ensure public acceptance the criteria for this prioritization need to be clear and transparent, and made public. Prioritization may, as in the Ghanaian example, involve incentives for local communities to engage actively in planning and financing where participation and co-finance can help accelerate programmes for the local community. This evidently needs to be balanced, so that it does not leave the poorest of the poor at the end of the line, with no option to move up.

Traditional power-sector planning, including electrification programmes, has focused on least-cost approaches, but it is often interpreted in a very narrow sense and with little consideration of development effects, employment aspects or even capacity requirements for the grid system. Eberhard et al. 2011a) note that power supply, especially in Sub-Saharan Africa, is notoriously unreliable and that capacity expansion has been lagging behind demand, leading to extensive power outages in large parts of the grid-connected system in many countries. So even if access programmes do not require large-scale capacity, they may both risk straining already under-capacitated central systems, leading to a situation in which physical access to the grid cannot deliver the expected services. This situation was described in Section 2.1, where the IEA analysis showed that this leads to productive losses and parallel independent generation and reduces the incentive for poorer households to pay for connection and equipment.

New mini-grids and stand-alone systems are obviously not affected by deficiencies in the central system, but there are some important differences in what kind of services the different options provide. Stand-alone systems like PV solar can deliver an important basic supply of electricity to remote communities and households, but it is not economically feasible at present to use this technology to provide services beyond lighting, ICTs and low-power equipment like sewing machines and small refrigerators. As described in Section 2.1, the social benefits of lighting and communication are still very valuable, but they do not form the foundation for self-sustained economic development. Local mini-grids are well established in many countries, mainly powered by diesel generators, and they are generally accepted by the communities served. An important feature of mini-grids is that they can generally provide a full range of electricity services and three-phase electricity, which is powerful enough for productive and community needs, such as water pumping, machinery, grinding, welding or street lighting. Another benefit seen from the integrated national programme point of view is that mini-grids can operate with the same voltage and frequency as the bigger national grid, meaning that the same appliances and wiring can be used if or when the community is connected to the national grid. Local mini-grids are increasingly being powered by a range of local renewable energy resources (solar, wind, biomass, hydro etc.), reflecting both the rapid increase in diesel prices and the increased competitiveness and reliability of many renewable energy technologies.

The national electrification plan will need to take these aspects into account and develop technological solutions for the different parts of the country, from peri-urban settlements to townships and all the way to the more remote rural villages. The main point to emerge from the discussion above and from the national case studies is that grid extension and off-grid solutions need to be considered in an integrated manner and may very well be implemented in different parts of the country in parallel.

As already discussed, it will be important for the success of the programme to involve local communities in the decisions on how best to provide electricity in the short and long terms. The criteria for making choices also need to be clear and well communicated. The ultimate goal for most countries is assumed to be an integrated national grid system, and other (decentralised) solutions for some communities may be regarded as second best. However, if the choice is between local solutions now, with a clear plan for a gradual transition towards later grid connection, and a long wait for any form of electricity supply, most communities would opt for the gradual build up, especially if this can be combined with strong local involvement in planning and implementation.

Over recent decades, most countries in the region have been engaged with external donors in a series of pilot programmes to bring stand-alone systems or local grid systems to rural communities. Many of these programmes have resulted in significant benefits, but the lack of an integrated national planning framework has often left communities with limited capacity and no clear plan for how to expand or even sustain supply. This broad statement evidently does not do justice to the many well-designed and well-functioning programmes that have also been implemented, but the point is that, assuming a political ambition to make major improvements in electricity access in Sub-Saharan Africa, there is a need to move from fragmented programmes and pilot projects towards integrated action nationally.

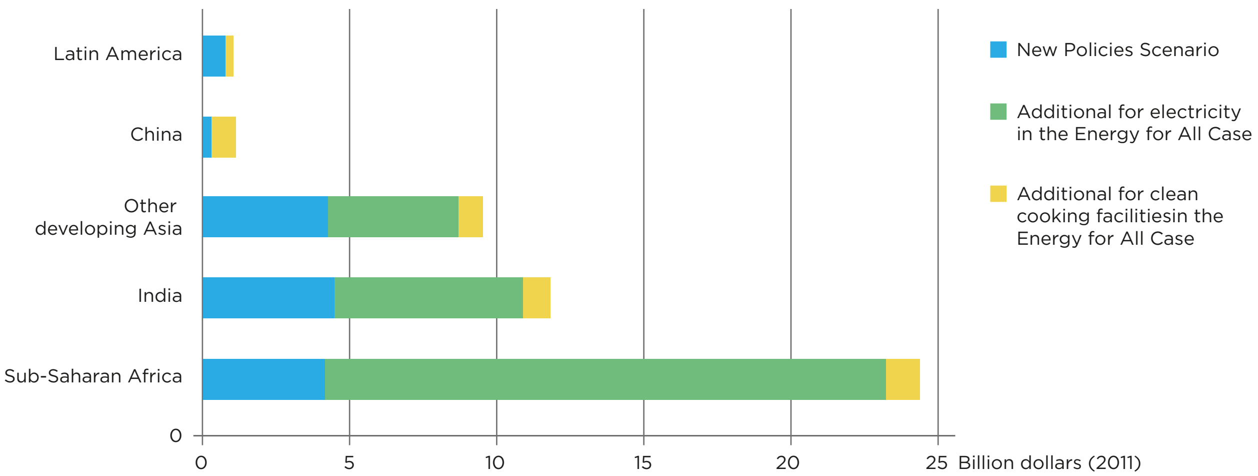
At the same time, it will be conducive for success if the often fragmented debate between groups of "believers" in respectively centralised or decentralised solutions realises that action needs to include all options in an integrated manner and that the appropriate solutions really depend entirely on local circumstances.

4.4 FINANCING ACCESS: THE POSSIBLE ROLES OF PUBLIC AND PRIVATE ACTORS

The finance necessary to implement universal access programmes across the African region will be significant both in total amounts and in comparison to the national economies of many countries. The IEA has estimated the finance needed to develop universal access to reliable electricity supply service, the results being presented in Figure 4.1.

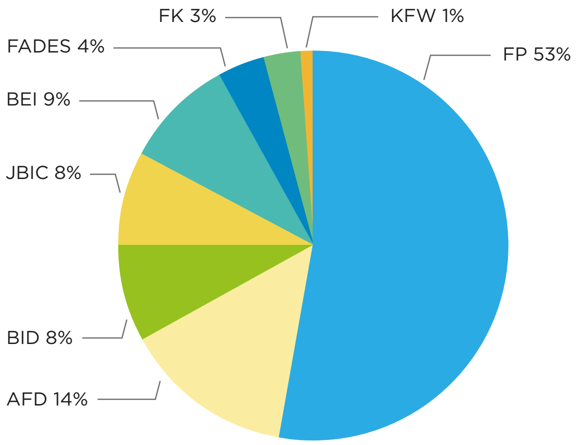
Reflecting current electrification levels, the greatest need for financing activities is in Sub-Saharan Africa excluding South Africa. Most of these countries do not have the necessary national funds to undertake major programmes on their own, and donor resources will not be sufficient to cover the gap. There is a strong need to bring in private-sector funding in ways

Figure 4.1. Average annual investment in modern energy access in selected regions (2011-2013)



Source: (IEA 2012)

Figure 4.2. PERG Programme pre-financing



PERG programme pre-financing

AFD	Agence Française de Développement (French Development Agency)
EIB	European Investment Bank
IDB	Islamic Development Bank
AFESD	Arab Fund for Economic & Social Development
FP	ONE own funds
JBIC	Japan Bank for International Cooperation
KfW	German Development Bank
KF	Kuwait Fund

Source: (Massé 2010)

that are compatible with coordinated nationally led action, requiring the private sector only to engage in viable business opportunities.

National funding, complemented in many cases by significant shares of international grants, will be required to ensure institutional strengthening and the planning and prioritization processes, while actual implementation in many countries will need to focus on some form of public-private partnership arrangement.

As described in the Morocco and Ghana examples, the strong policy and institutional frameworks enabled a financing structure which involved central government or utilities, local government and beneficiaries in a flexible financing model that encouraged the participation of a number of bilateral and multilateral institutions in the overall financing package through grants or soft loans.

Figure 4.2. illustrates the combination of domestic, bilateral and international sources that provided the core financing for the Moroccan PERG programme (Massé 2010). The South African case relied to a greater extent on domestic public and utility funding, but it has also involved the private sector in PPP arrangements, especially for off-grid programmes.

Details of power-sector investments are not widely available, and the case studies presented in this report have not focused particularly on the financial aspects. Nevertheless, (Eberhard et al. 2011) have carried out a series of studies and estimates that reveal a very mixed picture across countries, depending on income levels, resource endowments etc. Their macro-picture indicates that governments spend around US$ 5 billion annually on power-sector investments. Official development assistance (ODA) from OECD countries for the energy sector in Africa has been expanding in the last decade to around US$ 1 to 3 billion per year, mainly in the form of concessional loans and a smaller amount of grant finance. Non-OECD countries like China, India and the Arab region collectively also invest in the order of US$ 1 billion per year in the power sector more broadly and generally target large-scale supply in resource-rich countries. Foreign Direct Investment by private companies is roughly of the same order of magnitude, but has been quite volatile and dependent on large-scale investments coming through. Thus, looking at the AfDB figures, there is clearly a large gap between current action and the needs related to achieving full and sustained access. Eberhard et al. (2011) present a lengthy analysis of possible options for filling this gap, which go beyond the scope of this report, as it relates predominantly to financing the central supply structure, rather than enhancing access.

Rural industries may in many cases have a promising potential to supply electricity to local mini-grids by expanding their own supply to cover nearby communities. Many rural and biomass-producing industries are surrounded by clusters of households due to the presence of workers in the industry and the secondary economy that emerges as a result of this settlement. The efforts and investments of expanding power production are often marginal compared to the social and economic benefits for the community. In addition, subject to having a PPA with the electricity distribution utility, any excess electricity could be sold for distribution to the utility's electricity customers if location permits.

The ability to attract private partners and capital to access programmes depends very much on the viability of the operational phase, that is, whether it is possible to implement subsidy and tariff structures that, in combination with government investments or guarantees, can make electrification sustainable in the longer term.

The next section will therefore address the issues of subsidies and tariffs and the experience gained from the case studies where the main message on this topic clearly was that it is not possible to implement access programmes without some form of government subsidy and/or cross-subsidy. Tariffs need to be designed to make it possible for the target customers to connect and use the resource provided. At the same time, tariffs and subsidies in combination need to ensure full cost recovery for the delivered service to make the provision viable in the longer term.

4.5 DESIGNING TARIFFS AND SUBSIDIES TO CREATE SUSTAINED BENEFITS FOR THE POOR

Morocco, Ghana and South Africa have all implemented some form of subsidy scheme for investments in delivery systems, especially for off-grid customers, and tariffs are generally socially adjusted to make them more affordable to the poor. Cross subsidies by higher-income customers, typically in urban areas, are common along with government-based financing. When combining the case-study experience with the World Bank results, it is not possible to point to any one dominant approach, but it is uniformly reported that an investment subsidy is necessary in all cases, and tariffs need to be designed to fit the specific target groups and their ability to pay. The studies also point to the fact that subsidies should not only focus on the supply system – for example, the local mini-grid – but also address the connection costs of the consumers and maybe even develop a system for how to finance appliances. Financing structures like those used successfully in Morocco with a small upfront fee and a multi-year amortization period may provide examples of nationally appropriate approaches.

Most countries in Africa operate with some form of block tariff structure, where the first block, typically up to 50 kWh per month, is heavily subsidized, after which prices go up either gradually or directly to reach cost price. As already mentioned, South Africa has for some years operated with a tariff where the first 50 kWh are free of charge. One challenge with tariff design is to ensure that the subsidies actually reach the target group and do not end up reducing electricity bills for the middle- and high-income groups, as it was the case in Ghana until the 1998reform. This may in practice be very difficult to avoid, but a number of more technical solutions have been successfully implemented. Pre-paid meters, for example, with a smart card arrangement are being implemented in South Africa, where only low-income consumers can purchase subsidized cards.

With major national access programmes, the total cost of subsidies will need to be considered in terms of implications for state budgets, especially in countries where cross subsidies by better off customers will be limited. If the programmes lead to the desired economic development, the net result will hopefully be very positive in the longer term. In the initial stages, however, funding for subsidies and tariffs needs to be ensured and sustained.

The World Bank studies underline the benefits of an early focus on peri-urban electrification as a way of building up the customer base, which can later facilitate elements of cross subsidization for the extension of electricity to remote rural areas, based on the general experience of "take-off" levels of electrification. The situation in peri-urban areas differs between cities and countries, but in most cases energy services are based on some form of marketed energy source, be it charcoal, kerosene or LPG. This means that introducing electricity is often easier than in the rural setting, where part of the supply is non-market based. An analysis by GNESD (2008) has shown that, apart from the affordability of electricity connection and tariff structures, one of the critical issues for peri-urban electrification is legal tenure in the settlements. As

Photo: Lollie Pop

many city councils do not want to recognize informal housing arrangements, households or businesses with no legal tenure cannot be connected to the grid, which often leads to innovative "neighbouring" arrangements or outright illegal connections. Solutions therefore need to include not only electrification and development aspects, but also elements of urban planning.

4.6 ROLE OF RENEWABLE ENERGY TECHNOLOGIES IN CENTRALIZED AND DECENTRALIZED SYSTEMS

The discussion has so far focused on electrification and access expansion and less on how this can be done as cleanly and efficiently as possible. The two sets of issues are clearly interlinked as already described in Section 2.5 focusing on renewable energy technologies. Given the current performance records for most power systems in the region, it is clear that there has to be a focus on efficiency all the way from production to end-use, there being many cost-effective approaches that are available. The issues are very diverse, however, and they have not been analysed in any detail in the case studies. The role of renewable technologies on the supply side is better understood, and some key issues can be extracted.

For off-grid stand-alone provision, PV solar systems have evolved into a reliable option that is increasingly being implemented in many developing countries. The pros and cons are well known. Reliability is generally good and maintenance needs are limited except for the cost of batteries. In spite of recent rapid decreases in module prices, systems are still relatively costly and therefore limited to small amounts of power mainly for lighting and communications (including TV, radio and mobile phone charging). Fluctuations in supply from variations in solar radiation are usually addressed by the storage systems.

As mentioned already, mini-grids can help to improve the reliability of supply compared to stand-alone single-source systems. At the same time they have the ability to provide more energy and three-phase electricity, thus making it possible to meet additional loads. Compared to PV home systems covering basic needs for lighting etc., mini-grids can provide electricity for community requirements such as drinking water supply, street lighting, vaccine refrigeration, schools, and productive and commercial activities in shops and small businesses, including grinders and various machine tools and equipment. Technically different renewable energy technologies can be connected to one mini-grid, but while this may result in a more robust system with respect to resources, such a configuration is costly, as well as being complex and vulnerable to technical problems.

Mini-grids should be designed from the outset as a first step in a longer term, integrated access programme where connection to a central grid is expected later in the process: that is, they need to be "grid-ready". This issue, for example, has been addressed in recent Indian mini-grid programmes, where the provision of grid-compatible power-conditioning units have been made mandatory in project design and where smart grid technologies have been developed, so that if or when the central grid reaches the site, the mini-grids can be directly connected and can in fact provide valuable additional capacity (Palit & Sarangi 2014).

Existing diesel-powered local grids in many African countries may offer an additional opportunity to increase the use of renewable energy in rural areas. The Government of Kenya, for example, has initiated a project to install solar PV and wind systems in existing larger off-grid systems using diesel power plants to replace a proportion of the fossil fuels. This approach will result in an increased proportion of renewable energy going into the local grid system, as well as increased availability of electricity (Gichungi 2013).

The introduction into the central grid system of renewable energy as a power source is also a major option and has become increasingly attractive for countries as a way of reducing the pressure on the national power supply from high oil prices, or in some cases reduced production at large hydropower plants, due to drought. Many countries in the region do have a fairly high share of production from large hydro systems, so this specific renewable source is already very important. With significant hydro resources still unexploited, it is expected that the share of hydro in the regional supply will continue to go up.

Other renewable technologies are, however, starting to make a real impact. For example, the use of geothermal sources is expanding significantly in Kenya and is being explored in other countries along the Rift Valley (REN21 2013). Solar has for many decades mainly been used in stand-alone systems, but within the last few years the introduction of large-scale grid-connected solar plants has started to take off, with South Africa taking the lead, 1,400 MW_p having been installed by 2014 (PVInsider 2014). Both Kenya and Rwanda are in the construction phase of solar plants of 50 MW and 8.5 MW respectively (Woods 2013; Clover 2014). Morocco currently has a 470 MW CSP plant in operation and is planning another 160 MW plant, expected to be in operation in 2015 (Konate & Arfaoui 2012). Furthermore, in Ghana and Burkina Faso a number of initiatives are being developed for different stages in the project cycle, from studies to financial closure (Hansen et al. 2014). Since the 1980s, a series of large-scale grid-connected wind-energy projects have been installed in Egypt, 120 MW being added in 2010, taking total installed wind capacity to 550 MW. South Africa and Kenya have wind-power systems, and in 2014 financial closure was reached for a 300 MW wind farm near Lake Turkana in Kenya (Tarnoy 2014). Similar developments are under way in a number of North African countries.

Experience from other regions shows that it is important to introduce and implement appropriate quality standards of equipment and services when introducing new renewable technologies. Quality specifications for off-grid equipment may be mandatory in order to secure access to financing, and for successful programmes it is important to reduce the use of poor quality systems.

Thus, conclusions from the case studies and examples from other regions indicate that there is a significant potential for renewable energy technologies to contribute to electrification both via grid extension and through mini-grid and off-grid systems.

Further expansions of renewable energy electrification will, however, require strong political commitment along with dedicated policies and regulation. Many of the issues raised in relation to long-term planning for access programmes are very similar for renewables, and integrating the two sets of issues will be the most effective way of ensuring success. This also implies the need for a better understanding of specific policy tools for grid integration like feed-in tariffs and opening of the grid to private power producers. Both have been successfully introduced, for example, in South Africa and Kenya, and experience could form a basis for similar approaches in other countries (Hansen et al. 2014).

4.7 STIMULATING PRODUCTIVE USES

A final issue for national access programmes to be raised here is the need for development integration. It has been emphasized throughout the report that the inclusion of productive uses in the access definition is crucial in order for access programmes to have a chance of achieving the targeted benefits for economic development. Experience from Morocco points directly to the need for dedicated efforts to link access with a focus on productive uses and other development efforts. The PVER programme in Morocco was established explicitly to address the lack of results from the earlier narrow focus on electricity. In each district the programme has engaged a broad range of stakeholders active in local development activities, as well as ministries in charge of agriculture, tourism, business development, etc., thus combining a focus on introducing electricity for existing business use, as well as structuring programmes so that relevant components can be produced, installed or maintained locally. The Moroccan case also showed that it is necessary to include an assessment of financing needs and opportunities in order to obtain finance for businesses that would like to switch to electricity. The costs of connection and new machinery may be prohibitive unless some appropriate financing scheme can be introduced. Direct subsidies may not be required in most cases, but enabling access to credit may be in order to achieve the desired results (ONE 2006a).

At the national level it has already been underlined that the process of developing a national access programme should include all relevant actors and focus not only on the electricity side but really on access as an enabler of local development. This entails both strong links to national and local development planning and a multi-sectoral approach including the establishment of national multi-sectoral groups and a strengthening of their political and institutional grounding nationally. Also, multi-sectoral strategies, plans and programmes should be consistent with the strategies, plans and programmes that are aimed at universal access to energy services for a given area or timescale. Lastly, future operational funding for multi-sectoral coordination should be ensured by incorporating it into the governmental budget.

This focus is further emphasized in the next chapter, in which the areas for international cooperation and support are highlighted in direct response to the key issues for electricity access programmes at the national level, discussed in this chapter.

Photo: Ken Doerr

5 HOW CAN THE INTERNATIONAL COMMUNITY BEST SUPPORT NATIONAL PROCESSES?

Most recipient and donor countries, along with all major international organizations, adhere to the Paris Declaration and Accra Agenda for Action.[10] This means that development collaboration should be founded on five core principles:

- National ownership
- Donor alignment with national priorities
- Donors seeking to harmonize in-country support
- Focus on clear goals and results
- Donors and recipient countries are mutually accountable for achieving these goals

Based on the discussion of priorities for national action in Chapter 4 and the identification of some key conditions for the successful expansion of access to electricity, this final chapter will suggest ways in which the international community more broadly, and donors and finance institutions both collectively and individually, can support enhanced national action to provide large-scale electricity access in line with the principles listed above.

5.1 CREATING THE POLITICAL MOMENTUM

Political commitment was identified as the single most important precondition for the successful expansion of access at the national level. The same argument would apply broadly to the international donor community. Unless the importance of enhanced energy access for economic development is fully recognized by the international community, it will not be possible to generate the financial and technical resources required to support the many poor and institutionally weak countries, especially in Sub-Saharan Africa, in establishing and implementing integrated electricity access programmes.

As mentioned in Section 5.1, national political commitments can be established or enhanced in different ways. The demand for cleaner and more efficient energy services from local communities may in some countries be strong enough to create the necessary momentum on its own: a political champion who takes on access expansion as a personal cause has been seen to make a difference in several countries. The international community at large and major development partners can play an important role from the outside to create political awareness around the development benefits of enhanced access.

The current strong international focus on "Sustainable Energy for All" led by the UN Secretary General and the World Bank President, with its goal of achieving universal access for all by 2030, has raised the issue of energy access in many political forums around the world. There has not been a similar international political push in several decades. This one builds on an already emerging enhanced dialogue between countries and development partners on the broad importance of the energy sector, reflected, for example, in the increased focus in recent years on energy issues in many national poverty-reduction strategies.

5.2 STRENGTHENING INSTITUTIONS AND POLICY DEVELOPMENT

Our findings support the need for a strong national institution responsible for planning, prioritization and managing implementation of any major national access effort, and hence a key priority for donors should be to support the strengthening of relevant capacities in the relevant institutions. This will include areas such as policy analysis, forecasting and modelling, technical expertise, especially related to renewable options, legal and financial capability, and links to relevant development expertise and ways to create multi-stakeholder engagement.

[10] Paris Declaration and Accra Agenda for Action: see http://www.oecd.org/dac/effectiveness/parisdeclarationandaccraagendaforaction.htm (accessed 18 August 2015)

Needs differ between countries. Countries like South Africa and many North African countries have reached high electrification levels where there may be a small but difficult remaining challenge, but where the existing structures can, broadly speaking, manage the process, and the need for outside support is minimal.

As middle-range countries like Ghana are likely to have relatively well-established policies, plans and institutional frameworks, the need for international support may be targeted more towards the financing of expansion plans and technical innovations using mini-grid and off-grid solutions. This may particularly be the case for national public institutions, while there may be a strong need to build technical and financial understanding and expertise in the private sector to increase its involvement in and ability to benefit from the electrification programme, especially where the aim is to increase the renewable energy share of power production. Finance institutions are traditionally risk-averse and need to understand the business case for renewable energy, which often differs at least structurally from traditional power financing. Similarly there may be a need to stimulate stronger engagement at the regional and community levels where outside assistance could be important, especially if this involves expertise from the same levels in other countries and NGOs that are already active in local community development issues.

Finally, the many countries where current access levels are around 10 to 20% are those where significant scaling up will require substantial international support for most parts of a national programme, but initially mainly technical assistance to establish the policy and institutional framework that will lead the process. As mentioned earlier, many of these countries have relatively poorly performing electricity sectors in general, and it may be necessary to take much broader and more extensive action than just providing support for a national access programme. While this problem is of fundamental importance, it goes beyond the scope of this report. It is clear, however, that it will be very difficult to build a sustained access programme without simultaneously addressing the wider sectoral problems. It is nevertheless possible to move in parallel, especially because a large part of the initial action on access is likely to be focused on decentralized options through solutions like mini-grid systems.

Support for private-sector, local government and community engagement would be needed in similar ways as described for the middle group of countries.

5.3 STIMULATING REGIONAL COOPERATION

Countries at low electrification levels are likely to be able to benefit from countries that have made strong progress, so inter-regional exchange and technical assistance programmes should be among the actions stimulated by international support. Thus, what is increasingly referred to as peer-to-peer learning and South-South collaboration would constitute important components of institutional support.

Sub-regional collaboration is already emerging around the so-called power pools. The best established is the Southern African Power Pool, which has been in existence formally since 1995 and over time has developed both long and short markets enabling daily internet-based trading. The other three regional pools for West, East and Central African countries are less mature, and the traded amounts of electricity are still limited. Expanding regional power systems faces a number of technical, financial and political barriers related to the need for costly enhanced transmission systems, the development of real markets and market-based pricing while allowing for the necessary large-scale investments in power supply. Finally, the political stability of many countries is still fragile, meaning that it is risky to rely on imports, and governments may want to have control over supply. Nevertheless, the potential benefits are significant in terms of the potential to utilize the large untapped hydropower resources available within the region and simply of the scale of the systems to provide more reliable supply to existing and new customers.

The power pools are mainly relevant in relation to creating a better functioning electricity sector in general, which, as discussed in the previous section, is necessary for national access programmes to become successful. Collaboration at the sub-regional level may, however, also be very relevant for aspects related to access programmes. The most direct example is bilateral collaboration across borders, where a settlement in one country may be located closer to electricity systems in the neighbouring country, and where cross-border connection can provide easier access than a national option.

Other types of sub-regional collaboration that may not involve power pool arrangements directly could be joint development of equipment for mini-grid and off-grid systems, where the standardization of components and local involvement in production would bring clear cost reductions and enhance local economic benefits. Some experience exists in the areas of energy efficiency equipment and joint standard setting in southern Africa. Even where implementation is a challenge, this would represent a very promising area for regional collaboration, and support from outside donors, along with technical cooperation with relevant Northern institutions, could provide a boost to mini-grid expansion as part of the overall national programmes.

Coordinated action at the sub-regional level in general may also be able to create sufficient market potential to attract or develop new businesses. A prime example is the area of renewable energy technology, where national markets in smaller countries may be insufficient to sustain viable businesses. Detailed analysis of regional trade barriers and import rules would be required before any action was decided, but in favourable cases there are likely to be good opportunities for boosting employment generation in connection with the national access programmes.

5.4 PROVIDING TARGETED FINANCING

The importance of donor financing for African power-sector development was illustrated in Section 4.4. Provided there is international willingness to support a major scaling up of energy access, either in the SE4ALL context or just as a development cooperation priority, there will be a strong need for increased funding from bilateral and multilateral donors, and from finance institutions, for dedicated access programmes.

Reflecting priority actions at the national levels discussed in Chapter 4, it is necessary for increased and sustained international grant financing to be made available for: i) strengthening the institutional structure for planning and implementation both nationally and locally, including specific support for increasing the renewable energy uptake in programmes; and ii) contributing to the sustained financing of the subsidies required for access programme expansion and tariff structures that will actually allow the targeted poorer part of the population to benefit fully.

In addition, the existing concessional funding opportunities for the electricity sector need to be increased and preferably targeted more towards access programmes. Mini-grid expansion in particular may need a specific financial window to allow for a significant scaling up. Financing needs for mini-grids alone in order to meet the Energy for All goal are, according to IEA (2011b), in the magnitude of USD 12 billion per year until 2030.

At a time when official ODA is actually declining this will be a real challenge, as it will require difficult prioritization exercises. Involving the rapidly growing private foundation funds in access support may be one way in which the international community could tap significant new resources. But it should be stressed that access should not be about new technology showcases with “ribbon-cutting opportunities”, but is really about addressing basic development issues, as well as the fundamental needs of some of the poorest people on earth.

5.5 DONOR COORDINATION AT THE NATIONAL AND INTERNATIONAL LEVELS

It may be trivial to discuss donor coordination when it is already listed as one of the basic principles that most donors and countries adhere to. But if the aim is to provide a massive scaling up of electricity access in a large number of African countries, the challenge can only be overcome if all actors work closely together.

This will imply collaboration internationally to ensure the prioritization of energy access in all the major development organizations and multilateral finance institutions, with some significant central funds set aside to assist on a long-term basis if relevant. It would be immensely important if the major donors could align themselves around a set of principles for energy access support, so recipient countries would not receive confusing signals and have to adhere to many different approaches. On the other hand, it is clear from the analysis that this should not become a “one size fits all” approach, as was the case with many of the energy-sector reform efforts, resulting in very mixed results.

Coordination of country priorities would also be highly desirable so that donors do not end up focusing on the "usual" ten to twenty countries, but really become involved more widely regionally, if relevant using sub-regional collaboration as a lever with countries that are not able to move forward on their own. SE4ALL has the potential to play a focal role in such a coordination effort.

Finally, in-country coordination of effort remains crucial, but here both the international organizations and the bilateral donors are already quite advanced in ensuring internal coherence. A more cross-sector approach may, however, need to be introduced to ensure a focus is maintained especially on productive uses and economic development. If access programmes are to deliver the desired benefits in terms of both social and economic development, it is not enough to consider it an energy sector issue. It is necessary to think energy access into industrial, agricultural and other sectoral and rural development activities.

5.6 INTERNAL DONOR COHERENCE

A number of the issues mentioned in relation to donor coordination are also relevant for the internal activity organization of many donors. For instance, in order to be successful, donor support to energy access needs to reflect the national priority action areas, as outlined in Chapter 4. However, it is also necessary for many donors and international organizations to take a hard look at the internal organization of their support to access. For example, the balance between different instruments like technical assistance, grants and loans and the integration of energy issues into other sector programmes has to be considered carefully. Additional funding for access programmes will be required, but a lot of synergies can be gained by focusing on integrated action where energy is seen as part of most development efforts and as an important enabling factor in employment generation.

The issue of long-term commitment is also important at the individual donor level, but international organizations and funding arrangements may provide a buffer against shorter term political changes in the same way that strong institutions in recipient countries may carry programmes forward, even if political commitment is weakened in that period.

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