Key elements for the analysis of electricity access in Sub Saharan Africa, review of rate of adoption at planning stages and relation to MDG fulfillment in two reference countries:
Ghana and Mozambique

ENERGY FOR ALL 2030

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01. INTRODUCCION: SUB-SAHARAN AFRICA HAS THE WORLD'S LOWEST ENERGY ACCESS RATIOS

The situation in sub-saharan africa is poignant: on average, 2 out of 3 families, mainly in rural areas, live without electricity or access to modern energy services

Access to a sustainable energy services is vital for the achievement of all eight Millennium Development Goals (MDG) [1]. The United Nations Development Programme and the International Energy Agency estimate that one fifth of the world's population currently lacks access to such services, with 1.4 billion people having no access to electricity while 3 billion people continue to rely on solid fuels (traditional biomass and coal) for cooking and heating, mainly living in rural areas in Sub-Saharan Africa and south Asia [2] [3].

In the current context of reviewing the MDG fulfilment status [4], the situation in Sub-Saharan Africa is poignant: on average, 2 out of 3 families, mainly in rural areas, live without electricity or access to modern energy services, in what experts have come to address as the "Hidden Energy Crisis" [5].

TABLE I. ELECTRICITY ACCESS IN THE WORLD — REGIONAL AGGREGATES [2]

	PEOPLE WITHOUT ELECTRICITY MILLIONS	ELECTRIFICATION RATES		
		Global %	Urban %	Rural %
Africa North Sub-Saharan	**587** 2 585	**41.9** 99.0 30.5	**68.9** 99.6 59.9	**25.0** 98.4 14.3
Developing Asia China & East Asia South Asia	**799** 186 612	**78.1** 90.8 62.2	**93.9** 96.4 89.1	**68.8** 86.5 51.2
Developing countries	1,438	73.0	90.7	60.2
World	**1,441**	**78.9**	**93.6**	**65.1**

It is clear that many of the world's poorest will never be reached, in their life time, through centralized national electricity infrastructures alone if the 'business as usual' approach to energy planning continues. At the same time, decentralised renewable energy based solutions have proofed to be the only viable option for users with low or very low energy demands, who live in remote or isolated areas [6].

02. INDICATORS FOR ELECTRICITY ACCESS TO MDG FULFILLMENT AND POST-2015 VIEWS

A definition of energy poverty is lack of access to at least 120kWh electricity per capita per year (for lighting, access to most basic services plus some added value to local production)

The MDGs and the time reference of 2015 have driven formal international and national efforts to reduce poverty in the developing world. There is no specific MDG for energy access, even though the role of energy access is important for all MDGs, as widely discussed in related literature [7] [8] [9]. UNDP-WHO (2009) [8] includes in its Annex 4 an exhaustive list of global and regional MDG-related energy targets, suggested in the last decade by up to 10 different institutions (UN Millennium Project, IEA, GTZ, McKinsey and Company, Stockholm Environment Institute, FEMA, ECOWAS, EAC, SADC and CEMAC) regarding the Sub Saharan African context. In terms of access to electricity, suggested targets range from "Ensure reliable access to all in urban and peri-urban areas" or "Provide electricity for all schools, clinics, hospitals and community centres", to"66% of the population [in the ECOWAS] will have access to individual electricity supply (...)" or "70% or rural communities [in the SADC] have access to electricity (by 2018)".

Despite these efforts at macro-policy level, Sub-Saharan Africa is the world's region most off-track in progressing towards the MDG related electrification targets, as shown in Table I, especially in rural areas. Apart from the lack of effective funding, an additional reason from the planning point of view would be that the mentioned targets have a main qualitative nature. Without a quantification of how much electricity (demand) would be needed, it is difficult to assess the ultimate quality of a certain electrification intervention, and therefore the above targets may not have been effectively useful in electricity planning practice.

In this sense, some authors and planners have put efforts in characterizing and quantifying electricity access. Sánchez (2010) [5] includes lack of access to at least 120kWh electricity per capita per year (for lighting, access to most basic services plus some added value to local production) in a definition of energy poverty. With lighting being the most basic electricity use, a minimum consumption reference of 100 kWh per person and year is suggested to have continued access to basic services (health, communication, drinking water), while 1000 kWh per year and person would be needed for a widespread access to Education and concern for Environmental degradation [10]. Other studies in the Latin American context [11] have shown that the

02. INDICATORS FOR ELECTRICITY ACCESS TO MDG FULFILLMENT AND POST-2015 VIEWS

majority of households (up to 70% of a community) would have a domestic electricity demand in the range of 8 to 20kWh per month, even with access to a 24h service scheme.

Based on the above references and our own field experience, we suggest the following categorisation approach to demand levels in off-grid rural areas:

TABLE II. SUGGESTED ELECTRICITY DEMAND LEVELS REFERENCE IN RURAL COMMUNITIES.

CATEGORY		DEMAND LEVEL – REFERENCE
1	Basic Domestic (lighting, communication)	up to 20 kWh/month - 500W (DC or AC) per household
2	Medium Domestic (1+ small low consumption frid-ge)	up to 50 kWh/month - 1000W (AC) per household
3	Community (2+ community premises)	Medium domestic + school, health centre (50 kWh/month - 1000W) + public lighting (20kWh/month - 80W for each 200m2)
4	3 + small productive uses	Above the previous values

The target of universal access to basic energy services by 2030 recommended to the UN system by the Secretary General's Advisory Group on Energy and Climate Change (AGECC) provides an opportunity to galvanise support from national governments and international organisations for action to improve access. Adoption of such a target would demonstrate their commitment to the eradication of poverty, recognizing the critical role of access to basic energy services.

03. STRATEGIC PLANNING PRINCIPLES IN THE PROVISION OF ELECTRICITY SERVICES

There are no fundamental technical barriers, but mainly lack of long term policy planning and inter-institutional coordination. UNDP stresses three key areas in which capacity building is needed in order to meet the energy access challenges for the poor:
- strengthening national policy and institutional frameworks,
- mobilizing and expanding financing options, and
- developing effective approaches to scale up energy service delivery at the local level.

Many factors condition the success or failure of a given action aimed at increasing access to sustainable energy. The starting point of the proposed guidelines are lessons learnt from experiences in the last decades. Some authors stress the lack of integrated approaches in energy planning as a fundamental drawback for a larger success of cleaner and more sustainable energy solutions, based on renewable energy technologies [13].

Practitioners in the field consider that there are no fundamental technical barriers, but mainly lack of long term policy planning and inter-institutional coordination. [14]. UNDP (2010) [3] stresses three key areas in which capacity building is needed in order to meet the energy access challenges for the poor:
- strengthening national policy and institutional frameworks,
- mobilizing and expanding financing options, and
- developing effective approaches to scale up energy service delivery at the local level.

Other projects (EC Coopener programme) pointed out several needs:
i. Define and optimise roles and responsibilities in the public sector
ii. Improve intra- and inter-institutional communication
iii. Enable bottom-up diffusion, promote local participation and private involvement via PPP
iv. New approach, considering decentralised schemes , with enhanced quality (standardisation of technological solutions vs flexibility to adapt to demand profiles)

African experts also state the importance of considering energy as a service and not only an installation, to cover fundamental, basic AND productive needs [15].

The logical articulation of any energy access intervention (both using centralized or decentralized schemes) is based in the three basic units:
1. Communities: Target population or users of a planned electricity service. Their socio-economical benefit must be the final goal of the action.
2. Programme (or Plan): Integral action framework encompassing design, implementation, monitoring and evaluation in the mid and longer term. Sets the regulatory, institutional, social development and financial components of the planned action. The duration of a programme is variable (depending on the desired impact), typically ranging from 3 to 15 years.

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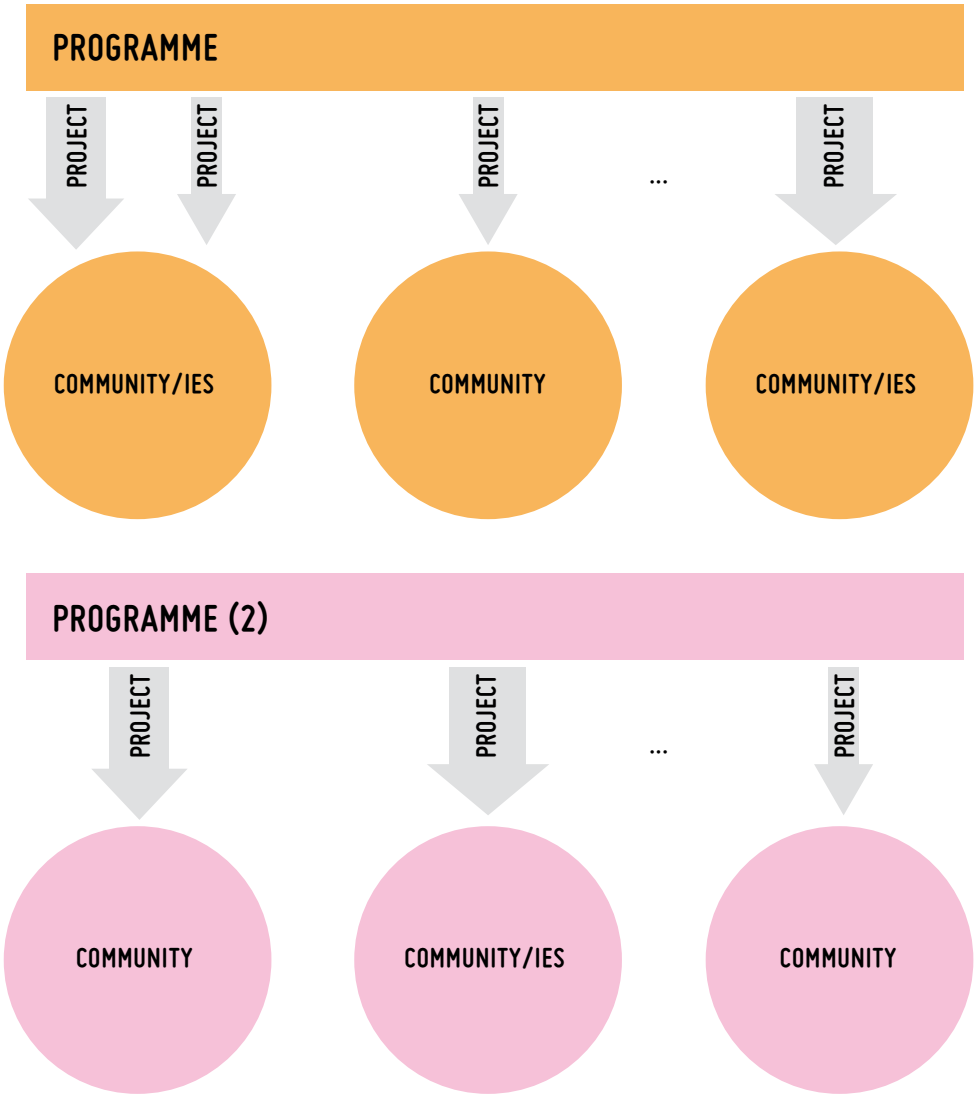
03. STRATEGIC PLANNING PRINCIPLES IN THE PROVISION OF ELECTRICITY SERVICES

3. Project: Sequence of specific actions for the materialisation of the directives set in a programme in the short term. Based on the selected communities, sets the technological, economic and organizational component of the planned action. The duration of a project is variable (depending on the available resources), typically ranging from 1to 4 years. One same project can be aimed at more than one community, and one same community can be addressed by more than one project. The range of 8 to 20kWh per month, even with access to a 24h service scheme.

FIGURE 1: SCHEMATICS OF ENERGY ACCESS INTERVENTION BY MEANS OF PROGRAMMES AND PROJECTS



03. STRATEGIC PLANNING PRINCIPLES IN THE PROVISION OF ELECTRICITY SERVICES

An electrification project must allow the start up of an energy service and lay the grounds for its sustainability. The following key components can be considered within programmes and projects in an integral approach to energy services

Most importantly: an electrification project must allow the start up of an energy service and lay the grounds for its sustainability. The following key components can be considered within programmes and projects in an integral approach to energy services:

TABLE III. KEY COMPONENTS UNDERLYING ANY RURAL ELECTRIFICATION (RE) PROJECT OR PROGRAMME

RE PROGRAMME	RE PROJECT	GOAL (AS AN ENERGY SERVICE)
Social Development	Social Integration	Equity
Institutional	Organisational	Empowerment
Technical	Technological	Reliability
Economic	Financial	Viability

04. SPECIFIC NEEDS TO IDENTIFY IN ELECTRICITY ACCESS PROGRAMME PLANNING

The BEST (Biomass Energy Strategy) initiative by the EU Energy Initiative - Partnership Dialogue Facility (EUEI PDF) and the German Cooperation (GIZ) has worked on a guideline to support the development of African strategies to optimise the use of thermal applications of biomass (traditional biomass sector), which promotes a participatory approach led by national governments [16].

Building on the BEST principles, and addressing the case of strategic planning of electricity access, this section describes a set of specific aspects that should be assessed in the planning process of an electrification programme.

4A) SOCIAL DEVELOPMENT COMPONENT

- Location and preliminary demand assessment of the targeted communities
- Prioritisation of services to cover: Survival (food, water, shelter), Basic (health, education, communication), Commercial & Productive
- Income generating activities (existing and potential) and study of the formal and informal biomass energy markets.
- Social and cultural structures of the communities – organization, literacy levels, socio-cultural values, energy role within local culture
- Local capacities, political and administrative leadership intra and inter communities
- Definition of programme duration and milestones
- Selection of indicators for monitoring and evaluation, setting up of a weighted qualitative indicators matrix for project scoring and qualification.

4B) INSTITUTIONAL COMPONENT

-Energy access policy and administrative powers at the national, regional and local levels

-Definition of electricity service operator models (vendor, concession, fee-for-service, community, mixed) according to current regulations

-Definition of the key roles that should take part in the programme (see next

04. SPECIFIC NEEDS TO IDENTIFY IN ELECTRICITY ACCESS PROGRAMME PLANNING

section), and appointment of the ones without whom the programme should not progress (by legal enforcement, direct appointment of tender processes):

1. Coordinator
2. Institutional Developer
3. Regulator
4. Standardizing agent
5. Funder(s)
6. Users (or Communities)
7. Social Developers
8. Technical Director or Implementer
16. Evaluator / Inspector
17. Dissemination Director

- Definition of administrative criteria for electrification Project qualification within the Programme, as well as related evaluation processes.

4C) TECHNICAL COMPONENT

- Definition of electricity service quality performance criteria – typically, grid-quality standards also applicable for decentralized generation.
- Technical conditions for concession regimes (typically, minimum power generation capacity level above which it is compulsory to apply for a concession).
- Pre-selection of technological solutions that will qualify within the programme. Use of renewable energy based systems can be a ranking criterion, as well as fossil fuel genset substitution.
- Development of certification and standards for renewable energy systems and biomass supply chains.
- Development of standards for electricity generation from renewable energy sources, with categorisation by power capacity levels
- Definition of technical criteria for electrification Project qualification within the Programme, as well as related evaluation processes.

04. SPECIFIC NEEDS TO IDENTIFY IN ELECTRICITY ACCESS PROGRAMME PLANNING

4D) FINANCIAL COMPONENT

- Definition of minimum levels of sustainability (private IRR, social IRR)
- Quantification of social benefits of the electricity service, social NPV
- Users willingness to pay (WTP) levels and capacity to pay (CTP) levels (assessment of the current expenditure that could be replaced by the electricity service)
- Definition of sources for:
    1. Appraisal and Design Costs (of the social, technological and economic aspects)
    2. Capital (Infrastructure) costs:
        i. Initial investment
        ii. Equipment replacement
    3. Running costs: Management, Operation and Maintenance of the energy sourcing and the electricity service
    4. Social support costs: Training, Dissemination, Monitoring.
    5. Evaluation and Inspection costs
- Availability of subsidy schemes (donations, cross-subsidies, taxes) and/or micro credits schemes, and type of costs that these schemes can be applied to.
- Tariff schemes applicable
- Availability of private investment (national or international) or multilateral financing – with what counterparts?

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05. INSTITUTIONAL COMPONENT: ROLES AND RESPONSIBILITIES

Key roles for an efficient inter-institutional framework, based on the differentiation of responsibilities that can be applied to any electricity sector or socio-political context.

The exhaustive identification of the agents that participate in a certain energy provision action tends to be a difficult exercise, given the variety of actors involved and legal or administrative requirements existing in every country, region ore even municipality.

Building on the analysis of several experiences and international standards on small decentralized energy infrastructure (1), in the following table we can offer an identification of key roles for an efficient inter-institutional framework, based on the differentiation of responsibilities that can be applied to any electricity sector or socio-political context.

TABLE IV – KEY ROLES AND RESPONSIBILITIES IN A ELECTRIFICATION OR ELECTRICITY ACCESS PROGRAMME. KEY ROLES ARE MARKED ACCORDING TO THEIR GRADE (INDISPENSABLE, RECOMMENDED). A SINGLE ORGANIZATION CAN PLAY SEVERAL KEY ROLES, AND ONE SPECIFIC KEY ROLE CAN BE CONDUCTED BY MORE THAN ONE ORGANIZATION.

(next page >)

KEY ROLES		GRADE	MAIN RESPONSABILITIES
1	Programme coordinator	I	Planning, control and management of the programme over its whole life.
2	Institutional developer	I	Ensure communication with and between the key roles
3	Regulator	I	Defines objectives, strategies and mechanisms for the project execution, according to the conditions set by the regulator.
4	Standardizing agent	R	Establishes the conditions for the energy sourcing, infrastructure implementation and management of the service (licensing, permitting, tariffs, quality criteria, subsidies...).
5	Funder(s)	I	Establishes the technical conditions for the infrastructure implementation and management of the electricity service (equipment certification and guarantee, quality criteria, safety)
6	Users	I	Provides economic resources (possibly financial options as well)
7	Social developer	I	Beneficiaries from the service; must commit to the system conservation, and to the payment of a tariff for the service.
8	Technical director or Implementer	I	Represent and assist the users' rights, mediate and communicate with other key roles..
9	Generators	I	Controls the adequate execution of the infrastructure execution and the service start-up. Can provide further assistance to the service operator or the users, if required.
10	Electricity service operator	I	Own the generation systems and produce electricity under the quality conditions set by the Regulator and Standardizing agent.
11	Installer	I	Controls the sustained and correct operation of the system, the service financing and users payments.
12	Maintenance provider	I	Adequate installation, start-up and commissioning of the system equipment.
13	Biomass supplier(s)	I	Technical specialist, conducts maintenance of the system infrastructure (spare parts, collection of used parts, etc.)
14	Infrastructure provider(s)	I	Production and supply of the biomass resource, under the conditions and quality criteria set by the Regulator and Standardizing agent.
15	Trainer - communicator	I	Supply materials and equipment (and corresponding guarantees)
16	Evaluator or Inspector	R	Conducts specific training and capacity building activities for local technicians, users, and other local entities involved in the management of the system.
17	Dissemination director	R	Periodical supervision of the infrastructure execution and service provision according to the conditions set by the regulator.

06. RESPONSIBILITIES: WHO SHOULD DIAGNOSE THE NEEDS? WHO SHOULD RECEIVE THIS DIAGNOSIS?

The ultimate responsible for the diagnosis of the Programme needs will depend on the promotion mechanism followed; in a bottom-up promotion, it will be up to the Social Developer, while in a top-down promotion it will be up to the Institutional Developer.

In both cases, the responsible of the needs diagnosis will have to receive the support of:

- Programme Coordinator
- Social / Institutional Developer
- Technical director

The recipients of the Programme needs diagnosis are:

- Funders
- Electricity service operators
- Dissemination Director

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07. REFERENCE LIST OF DELIVERABLES FOR AN ENERGY ACCESS PROGRAMME

List of Deliverables:

- **Socio economic characterisation (Maps, population census, reference on CTP and WTP)**
- **Appointment of roles and responsibilities at programme level**
- **Initial planning (with quantified milestones, budget and time plan)**
- **Definition of financial and qualification requirements for projects**
- **Final planning (after project design)**
- **Periodic (progress) evaluation reports**
- **Final revaluation report**

Legal and administrative regulations define the minimum documentation required, especially in Top-down promotion schemes).

In the absence of regulations or directives (typically the case when Bottom-up promotion schemes are followed), success or failure depends greatly on individual actions and attitudes, that could lead to either very satisfactory results or premature budget cuts or even closure. In such absence of directives, international standards or references can be followed (part of the responsibilities of the Technical Director). In any case, we can think of a reference (minimum) list of Deliverables:

- Socio economic characterisation (Maps, population census, reference on CTP and WTP)
- Appointment of roles and responsibilities at programme level
- Initial planning (with quantified milestones, budget and time plan)
- Definition of financial and qualification requirements for projects
- Final planning (after project design)
- Periodic (progress) evaluation reports
- Final revaluation report

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CASE STUDIES IN SUB SAHARAN AFRICA

A first approach to the application of the methodology described in the previous sections is being considered within the EuropeAid project “Energy for All 2030” for the specific case of two reference countries in Sub Saharan Africa, Ghana and Mozambique.

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CASE STUDIES IN
SUB SAHARAN AFRICA

GHANA

The Government of Ghana (GoG) intends achieving universal access to electricity by 2020. Most of those without access are in areas where extending the national grid is difficult and costly. Targets for this area are to increase the share of renewables in the energy mix to 10% by 2020 (excluding large hydro) and to increase to 30% the use of decentralised renewable energy systems for electricity use in rural areas.

The Government of Ghana (GoG) intends achieving universal access to electricity by 2020 [17]. With barely ten years to go, about 40% of the Ghanaian populace are still without access to electricity. While the electrification rate reaches 85% in urban areas, in rural areas is about 23% [8]. The majority of those without access are located in remote areas and island communities where extending the national grid is difficult and costly. The two strategic targets for this area are to increase the share of renewables in the energy mix to 10% by 2020 (excluding large hydro) and to increase to 30% the use of decentralised renewable energy systems for electricity use in rural areas.

The following chart contains an identification of institutions and key agents that could take part in a pilot decentralised electrification programme, given their specific powers and expertise in each respective key roles. This first approach follows a top-down diffusion model.

KEY ROLES		GHANA
1	Programme coordinator	Ministry of Energy
2	Institutional developer	Ministry of Energy
3	Regulator	Energy Commission, Forestry Commission, PURC
4	Standardizing agent	Energy Commission Ghana Standards Board
5	Funder(s)	Ministry of Energy, Energy Commission, Multilateral agencies (GEDAP, UNDP) Bilateral cooperation Tariffs
6	Users	Rural communities without access to grid
7	Social developer	District Assemblies, Traditional authorities, CBOs - NGOs
8	Technical director or Implementer	Ministry of Energy The Energy Centre (KNUST) Specialist NGOs (KITE, CEESD)
9	Generators	Utilities (VRA-NED, ECG) Independent producers (<500kW) with specific permit
10	Electricity service operator	Utilities (ad hoc unit for generators <500kW) District Assemblies or local cooperatives
11	Installer	Private contractors
12	Maintenance provider	Private contractors or local trained staff
13	Biomass supplier(s)	Agro forestry waste (est. 2Mton/year) Dedicated woodlots (wood chips)
14	Infrastructure provider(s)	Private contractors
15	Trainer - communicator	KNUST, Council for Scientific and Industrial Research (CSIR)
16	Evaluator or Inspector	Energy Commission Forestry Commission
17	Dissemination director	Ministry of Energy TEC-KNUST Specialist NGOs (KITE, CEESD)

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CASE STUDIES IN
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MOZAMBIQUE

Although Mozambique is a large hydro electricity producer, its electricity sector is export oriented, and its national population electrification rate, about 12%, is amongst the lowest in the continent. The objective of the Government is to reach an electrification rate of 15% by 2019 (and 20% by 2020

Although Mozambique is a large hydro electricity producer, its electricity sector is export oriented, and its national population electrification rate, about 12%, is amongst the lowest in the continent [8]. While the electrification rate reaches 21% in urban areas, in rural areas is about 6.3% mainly served by diesel generators in isolated systems [19].

According to the Ministry of Energy's Management Strategy for the Energy Sector (2008-2012), the objective of the Government is to reach an electrification rate of 15% by 2019 (and 20% by 2020). [20].

The following chart contains an identification of institutions and key agents that could take part in a pilot decentralised electrification programme aimed at promoting renewable energy systems. This first approach follows a top-down diffusion model.

KEY ROLES		MOZAMBIQUE
1	Programme coordinator	Fundo de Energia (FUNAE)
2	Institutional developer	Ministries of Energy, Agriculture, Science and Technology
3	Regulator	CNELEC, National directorate of Land and Forest
4	Standardizing agent	National Institute for Normalisation and Quality
5	Funder(s)	Ministries of Finance, Planning Development, Multilateral agencies (EDAP, UNDP) Bilateral cooperation, Tariffs
6	Users	Communities with diesel gensets, population not served
7	Social developer	Administrative councils, Traditional authorities, CBOs - NGOs
8	Technical director or Implementer	FUNAE Electricidade de Moçambique EDM ad hoc unit for generators <500kW)
9	Generators	EDM Independent producers (<500kW) with specific permit (CNELEC)
10	Electricity service operator	FUNAE, EDM (ad hoc unit for generators <500kW) Administrative councils or local cooperatives
11	Installer	Private contractors
12	Maintenance provider	Private contractors or local trained staff
13	Biomass supplier(s)	Agroforestry waste (est. ca. 7EJ/year) [21]
14	Infrastructure provider(s)	Private contractors
15	Trainer - communicator	Universidade Eduardo Mondlane (UEM), Institute for Agro Research (IIAM)
16	Evaluator or Inspector	Ministries of Energy, Agriculture, Science and Technology, CNELEC UEM
17	Dissemination director	FUNAE, Ministry of Energy

08. NOTES

(1) Technical Standard IEC 62257-6 "Recommendations for small renewable energy and hybrid systems for rural electrification – Part 3: Project development and management – Part 6: Acceptance, operation, maintenance and replacement". November 2005.

09. REFERENCES

[1] World Future Council (2010) "Report of the World Future Council Workshop on Renewable Energy Policies for Sustainable African Development", Addis-Ababa.

[2] International energy Agency (IEA), 2009, World Energy Outlook 2009, Paris.

[3] UNDP (2010) Brochure on UNDP and Energy Access for the Poor – Energizing the MDGs http://content.undp.org/go/cms-service/download/publication/?version=live&id=2850412 (consulted 2 March 2011)

[4] Sundaram, J. K. (2010) Keeping the Promise. World Economic and Social Survey 2010. MDG Gap Task Force Report 2010. UN-DESA, New York.

[5] Sánchez, T. (2010) The Hidden Energy Crisis: How Policies are Failing the World's Poor. Practical Action (UK).

[6] Brew-Hammond et al. (2008), "Guidebook on Modern Bioenergy Conversion Technologies in Africa", UNIDO, Vienna.

[7] Modi, V., S. McDade, D. Lallement, and J. Saghir. (2006). Energy and the Millennium Development Goals. New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank.

[8] UNDP and WHO (2009) "The Energy Access Situation in Developing Countries – A review focusing on Least Developed countries and Sub Saharan Africa". UNDP, New York.

[9] Practical Action (2010) Poor People's Energy Outlook 2010. Rugby, UK.

[10] Pereira, M.G. Vasconcelos Freitas M.A., da Silva N.F., Rural electrification and energy poverty: Empirical evidences from Brazil, Renewable and Sustainable Energy Reviews, Volume 14, Issue 4, May 2010, Pages 1229-1240.

[11] Vallvé X., González S., Arranz-Piera. P., (2007) Solar-diesel Hybrid Options for the Peruvian Amazon - Lessons Learned from Padre Cocha - ESMAP Technical Paper 111/07 – The World Bank.

[12] Paris-Nairobi Climate Initiative (2011) Access to clean energy for all in Africa and countries vulnerable to climate change (www.developpement-durable.gouv.fr/La-conference-Paris-Nairobi-21) .

[13] Silva, D; Nakata, T (2009) Multi-objective assessment of rural electrification in remote areas with poverty considerations. Energy Policy 37 (2009), pp 3096–3108.

09. REFERENCES

[14] Practical Action Consulting (2009). "Small-Scale Bioenergy Initiatives: Brief description and preliminary lessons on livelihood impacts from case studies in Asia, Latin America and Africa". Prepared for PISCES and FAO by Practical Action Consulting, January 2009, p.41.

[15] Brew-Hammond, A (2010) Energy access in Africa: Challenges ahead. Energy Policy 39 (2010), pp 2291-2301.

[16] Biomass Energy Strategy (BEST) Guide, EUEI Partnership Dialogue Facility and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), March 2011.

[17] Strategic National Energy Plan (2006-2020). Volume II Electricity. Energy Commission, Government of Ghana. 2006.

[18] Energy Commission (2010) Draft Bioenergy Policy for Ghana. Government of Ghana.

[19] Mulder, P. (2007). Energy Outlook for Mozambique (DNEAP Discussion Paper No.53E, p-7). Maputo: Ministry of Planning and Development.

[20] Energy Development and Access project, Ministério da Energia, Government of Mozambique. Maputo, October 2009.

[21] C.A. Cuvilas, R. Jirjis, C. Lucas, Energy situation in Mozambique: A review, Renewable and Sustainable Energy Reviews, Volume 14, Issue 7, September 2010, Pages 2139-2146.

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