Dissemination of Solar Energy Technologies in Kenya for Rural Electrification: Challenges & Opportunities

Report on the Solar Energy Stakeholders' Workshop on 11th June 2014 at Desmond Tutu Conference Centre, Nairobi, Kenya

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Table of Contents

List of Figures

List of Boxes

1. List of Abbreviations

AC	Alternating Current
ACTS	African Centre for Technology Studies
AFD	Agence Française de Développement (France)
BIPV	Building-integrated photovoltaics
CCK	Communications Commission of Kenya
CCT	Controlled Cooking Test
CFL	Compact Fluorescent Lights
CIC	Climate Innovation Centre
DC	Direct Current
EEA	Eastern Africa Association
ERC	Energy Regulation Committee
DFID	Department for International Development (UK)
ERC	Energy Regulatory Commission
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
KEBS	Kenya Bureau of Standards
KEREA	Kenya Renewable Energy Association
KfW-GIZ	Kreditanstalt für Wiederaufbau Gessellschaft für Internationale - Zusammenarbeit (Reconstruction Credit Institute - German Society for International Cooperation)
KIRDI	Kenya Industrial Research & Development Institute
KPT	Kitchen Performance Test
LED	Light Emitting Diode Lights
MDG	Millennium Development Goal
MFI	Micro-finance Institute
MTOE	Million Tonnes of Oil Equivalent
NAREWAMA	Natural Resource and Waste Management Alliance
NEMA	National Environment Management Authority
OTEC	Ocean Thermal Energy Conversion Technology
PV	Photovoltaic
REA	Rural Electrification Authority
REP	Rural Electrification Programme
SME	Small and Medium Enterprises
SREP	Scaling-up Renewable Energy Program in Low-Income Countries
TERI	The Energy and Resource Institute (India)
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
WB	World Bank
WBT	Water Boiling Test
WHO	World Health Organization

2. Introduction

Understanding the challenges and opportunities in the solar energy technology value chain is essential for key actors in order to disseminate these technologies for rural electrification in Kenya. Once the challenges and opportunities have been identified, it is essential to understand how these challenges can be overcome. This was one of the key messages emerging from the solar energy stakeholders' workshop at the Desmond Tutu Conference Centre in Nairobi on 11th June 2014. The workshop was organized by the African Centre for Technology Studies (ACTS) as part of The Energy & Resource Institute (TERI) project. The workshop brought together experts from the practical and academic sides of this topic, to explore the current issues, identify barriers, and possible solutions regarding large scale dissemination of solar energy systems. A summary of the challenges and opportunities identified and key recommendations made during the seminar are detailed at the end of this report.

3. Workshop Background

Small-scale renewable energy solutions continue to play critical role in enhancing accessibility to clean energy. As economies grapple with high fossil fuel prices, many countries are now adopting renewable energy technologies as an alternative to the heightening cost of oil and dwindling supply base. Approximately 80% of Kenya's industrial sector is powered by fossil fuels, which make up 28.57% of national energy consumption, an aspect that threatens stability of its economy in the near future (KIPPRA 2010). Petroleum fuel accounts for about 28.57% of the total final energy consumption while electricity and combustible renewable accounts for about 3.11% and 67.65% of the total final energy consumption (KIPPRA 2010). According to International Energy Agency, Kenya's electrification rate stands at 19% with about 34 million people lacking access (WEO 2013).

According to the United Nations Economic Commission for Africa (UNECA 2013), around 33 million people (83% of population) lack access to modern energy. Considering household lighting, majority of families use kerosene and candles. This has considerable impact on the health of over 90% of rural population compounded with inefficient biomass combusting cook stoves. The Government of Kenya committed itself to enhancing rural electrification so as to increase the number of households using clean energy mainly for lighting. This has not been adopted by majority of rural households due to perceived high upfront costs. Other renewable energy technologies such as wind and Ocean Thermal Energy Conversion Technology (OTEC) are under exploitation and capacity is expected to increase though emphasis by the government has been on geothermal power sector. Solar energy is rapidly picking up in comparison to other renewables. Solar technologies were boosted by the previous administration when economic incentives were put in place to lower end user price for solar devices. This saw a marked increase in the number of people purchasing and installing solar appliances both at household and institutional levels.

3.1 Solar energy base in Kenya

Kenya receives 4 – 6 kWh per square meter of insolation per day. This is equivalent to 250 Million Tonnes of Oil Equivalent (MTOE) per day. Despite this potential, only a small portion is harnessed and converted into utilizable forms. Solar energy technologies prove to be the most

convenient low carbon technologies. Communities could strive to adopt these low carbon technologies for meeting their cooking and lighting requirements, alongside a myriad of energy demands at farm and industrial levels. By 2009, it is estimated that 220,000 solar PV units were already in use in Kenya (Byakola et al, 2009).

Notwithstanding the potential, there are a number of challenges – institutional, policy and regulatory, financial and technical. These challenges need to be addressed in order to ensure the sustainable, large-scale implementation of the decentralised solar energy devices in Kenya, especially for rural electrification. This workshop brought together experts from the practical and academic sides of this topic, to explore the current issues, identify barriers, and possible solutions regarding large scale dissemination of solar energy systems.

4. ACTS - TERI Energy Program

ACTS is collaborating with TERI to jointly implement a Clean Energy Access Program in Kenya with funding support from the UK Department for International Development (DFID). This project is aimed at creating a sustainable market-based clean energy project to provide rural households with affordable clean solar power for lighting and cooking. As part of the overall DFID-TERI–ACTS Partnership on achieving the Millennium Development Goals (MDG's), this project aims at piloting scalable models for provision of clean lighting solutions for poor households in Africa especially Kenya and Ethiopia. This is achieved through:

a) Review of existing technological solutions and business/delivery models and identification of barriers to promotion of clean energy (lighting) options in Sub Saharan Africa;
b) Share lessons and best practices from the Indian context in the area of policy, regulation, financing, technology and delivery models; and
c) Demonstration of the techno-social viability of the decentralised solar energy applications through innovative business models and financing options to bring improved quality of life to the rural households in the region.

Through the program, DFID India is supporting research and piloting of innovative or improved technologies and private sector-led business models which will increase community awareness and demand, enable provision of appropriate products and services, and thereby promote use of solar lighting solutions on a much larger scale.

5. Main Objective

This workshop sought to establish opportunities and challenges affecting diffusion and uptake of solar energy technologies for decentralized application and rural electrification in Kenya and explore potential measures for stabilizing the sector.

5.1 Specific Objectives

5.1.1 To identify existing gaps in the solar energy arena for rural electrification
5.1.2 To deliberate on the potential of solar energy to address energy poverty in Kenya
5.1.3 To analyze and evaluate the Government's plan on solar power and strive towards adoption of solar energy technologies.

6. Introductory Remarks

The workshop began with words of prayer from Mr Wycliffe Amakombe (ACTS), followed by a welcome and introduction to the workshop by Dr. Ben Mouk (ACTS). After introductions, Dr Cosmas Ochieng (Executive Director of ACTS) welcomed everyone to the workshop and thanked all the stakeholders, with special mention to UK DfID who fund the TERI project. Dr. Ochieng set out that the fundamental development challenge of sub-Saharan Africa this century is in sustainable energy. He pointed out that although Africa is making good progress in food security, water access and poverty reduction, one area where numbers continue to rise is in people who lack access to energy. He noted that the workshop set out to discuss the challenges and opportunities in the solar energy sector and to find a way to look forward and generate sustainable energy technologies that are affordable and acceptable.

7. Government strategy towards solar energy harnessing and adoption in Kenya

Eng. Sam Kasanga from the Ministry of Energy and Petroleum gave a brief overview of renewable energy and gave an overview of Government projects in renewable energy and the associated policy, legal and regulatory frameworks. Solar PV (Photovoltaic) technologies are used widely in the country in off-grid electrification (lighting, powering electronic equipment, telecommunications, water pumping, refrigeration and electric fencing). The only existing grid-integrated solar PV systems are two pilots (SoS Children's village at the Coast and the UNEP headquarters in Nairobi). Annual market for solar photovoltaic (PV) panels estimated at 500 kW and projected to grow at 15%. One company (UBBINK in joint venture with Chloride Solar) has set up assembly plant for solar panels in Naivasha, Nakuru County with estimated production of 100 kW peak annually. The Solar PV System installation has resulted in the installation of off-grid solar PV systems in about 1,000 institutions across the country at a total of KShs.2 billion. The total output of installed solar PV systems is 2 $MW_{p.}$ Currently the government has projected to install electricity and solar PV (in areas far from the grid) in all primary schools to provide power for the Laptop Programme.

Mandatory Solar PV Regulations have been gazetted and will soon become enforceable. In the meantime licensing of solar PV technicians, contractors solar PV practitioners continues as per regulations to build capacity.

The Government of Kenya has commenced installing solar/wind hybrid systems at off-grid power stations. This aims to reduce fuel costs. Eng. Kasanga noted that more will be done in this area, with funds from the Government of Kenya, Agence Française de Développement (AFD), World Bank and the Nordic Development Fund.

Renewable energy policy framework is comprehensively provided for in the Energy Policy “Sessional Paper No. 4 of 2004 on Energy”. The “Energy Act No. 12 of 2006” was operationalized from July in 2007 and provides the legal and regulatory framework for the energy sector. The energy sector framework has been undergoing review mainly to align it to provisions and aspirations of a new constitution (promulgated in August 2010) and Vision 2030. The Constitution of Kenya 2010 substantially changed the governance structure of the country by introducing two levels of governance: National and County. Vision 2030 is the country’s economic blueprint comprising three pillars: economic, social and political and aims at transforming Kenya into an industrializing economy status by the year 2030. Energy in general

and renewable energy in particular are expected to play a key role as enablers in achieving the goals of vision 2030.

Both existing energy framework and the reviewed draft recognize the high solar energy resource potential of the country and recommend an accelerated and focused approach for its exploitation. Sessional Paper No.4 of 2006 highlights in:

- 6.4.1 (iii) promote the development of local capacity for manufacture, installation, maintenance and operation of solar energy technologies;
- 6.6.3.2 (ii) continue current fiscal policy of allowing procurement of plant, equipment and related accessories and major spare parts for power generation free of duty and taxes during project implementation.

The tax, fiscal and other incentives enumerated in Sessional Paper No. 4 are amplified in the draft energy framework. In recognition of the renewable energy resource endowment in the country, the draft energy bill recommends the establishment of a Renewable Energy Resource Advisory Committee.

The Feed-in-Tariff (FiT) in Kenya is applicable to wind power, biomass, small hydro, solar, biogas and small geothermal. To attract private sector capital in solar energy resource electricity generation, the Ministry of Energy issued the Feed-in-Tariff for Solar Energy Resource generated electricity. For the purpose of this tariff, solar refers to photovoltaic (PV) or thermal energy resource obtained from the sun. The thermal solar energy encompasses concentrated solar energy. Besides feeding into the national grid, solar technology is intended to be used to supply the off-grid (mini-grids) systems, to partly displace the fossil oil based thermal generation.

8. Solar-Diesel hybrid mini-grids in Kenya – A case study by Kenya Power

Eng. Henry Gichungi gave a presentation on a case study by Kenya Power on the use of solar-diesel hybrid mini-grids. Currently there are 15 operational mini grids operated by Kenya Power with a total installed capacity of 15MW. These are owned by Rural Electrification Authority (REA) & the Ministry for Energy and Petroleum which is 100% owned by the Government of Kenya. 14 more are currently being developed by REA. All these are diesel based. Four solar plants are tied to national grid (SOS-60kW, UNEP-515kW, Timau-70kW and Changoi-1MW). There is a lot of interest in generation for own use.

Operational expenditure for mini-grids are funded through cross-subsidy i.e. uniform tariff policy & fuel adjustment cost. Generation costs account to approximately 90% of total operation cost of mini grids. Fuel costs account for approximately 80% of the generation costs thus the need for hybridization.

The Government of Kenya decided to introduce renewable energy in mini-grids to reduce operational costs and so far, 7 have been made hybrid. Two plants have wind generation with installed capacity of 50kW and 500kW. Six plants have solar generation with installed capacities of 10, 30, 50, 60, 60 and 330kW$_{p.}$ Retro-fitting and construction of new hybrids at Rhamu, Takaba and Laisamis is in progress. The capital cost is met by the government through a tendering process. The grid-tie without batteries design is currently in use due to limitation of resources. Future solar hybrids will have batteries and solar controller so as to increase renewable energy penetration e.g. Laisamis, Mfangano.

The Government of Kenya has prepared an investment plan for renewable energy. Retrofitting of existing and currently under construction diesel mini grids with a total of 3.7 MW is planned (sizes of 100kW to 800kW each). These figures will be adjusted as advised by consultants following feasibility studies on each site.

Total estimated capital expenditure:

- Retrofitting existing and stations under construction - USD 43 million
- Green-fields (44 stations) - USD 173.8 million

This will be financed through Government budgetary support, grant or concessional financing from development partners-commitments and pledges from the WB, AFD, Scaling-up Renewable Energy Program in Low-Income Countries (SREP), Kreditanstalt für Wiederaufbau Gessellschaft für Internationale - Zusammenarbeit (KfW-GIZ), DFID and Japan International Cooperation Agency (JICA). AFD committed 30 million euros to fund retrofitting of existing mini grids including expansion of existing hybrids. Capacity of renewable energy is still under discussion so as to maximize renewable energy penetration. NDF, AFD and KfW-GIZ have all engaged consultants to do feasibility studies and designs.

Eng. Gichungi summarised by outlining the opportunities in solar energy. There is plenty of sunshine all year and plenty of space for installation of solar panels. Solar generation plants displaces expensive diesel and the Government of Kenya is committed to increasing RE in rural areas and increasing access to modern energy. However, the capacity of solar plant is limited by the power demand. Stabilization by means of batteries or solar controller is required so as to increase renewable energy penetration.

9. Marketing perspective for solar home systems (SHS) in Kenya

Dr. Nicholas Ozor from the African Technology Policy Studies Network (ATPS) began by outlining the market trend for solar PV in Kenya (Figure 1).

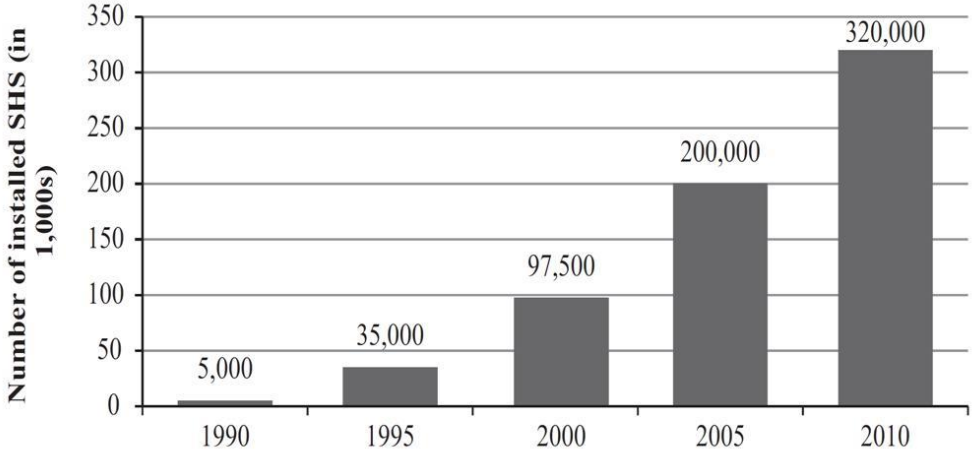

Figure 1: Trend for Solar PV in Kenya. Source: Ondraczek, J. (2013).

Per capita, solar PV in Kenya is the most successful global market for off-grid PV and accounts for about 10% of the global market and second to China. The success of the market for SHSs and other off-grid solar electrical services in Kenya was due to a range of capability and innovation system building activities undertaken by key actors over time. Findings show that solar PV was first used in Kenya in the late 1970s and early 1980s – USAID, World Health Organisation (WHO), Telecom Agencies to provide electricity access for telecom plants and vaccines.

Other Innovation system builders for solar home system (SHS) market include Mark Hankins, Harold Buris, Eastern Africa Association (EAA), Kenya Renewable Energy Association (KEREA), International Finance Corporation (IFC), United Nations Development Programme (UNDP), Ministry of Energy, World Bank, Chloride Exide, Solar World East African Limited, Kenital Solar Limited and the Ubbink East Africa Limited. The total penetration of the PV market in Africa is about 1-1.5% as of mid-2011 and 3-4% for a leading PV market like Kenya.

The Dutch-Kenyan joint venture solar module assembly plant in Naivasha is suggestive that the Kenyan PV niche is opening a trajectory of development that could lead to much more complex capabilities, innovations, and technology development in the country. The Kenyan Climate Innovation Centre (CIC) is another platform that will promote climate-compatible development in Kenya. It supports over 70 sustainable climate technology ventures and will create about 4600 direct and 24,000 indirect jobs within 10 years.

Enablers of the SHS market in Kenya include:

- The need for electricity in rural households to provide lighting and power television sets, radios, recharge mobile phones;
- Government and Donor interests in SHSs e.g. Zero tariffs and Grants respectively;
- Endogenous capacity building opportunities for stakeholders especially technicians and manufacturers
- Existing policies that favour SHS market in Kenya (Box 1)

BOX 1 - Existing policies that favor SHS market

- Sessional Paper No. 4 on Energy of Kenya
- Energy Act 2006
- Kenya rural electrification master plan
- Feed-in-Tariff (FIT) policy
- Kenya Vision 2030
- The Kenya National Climate Change Response Strategy
- The Final Draft National Energy Policy of 2013

These policies and frameworks provided some enablement for the skills development around the SHS technology as well as its uptake and diffusion in the country.

Inhibitors of the SHS market in Kenya include:

- Policy level barriers: e.g. re-introduction of 16% VAT on Solar products in October 2013
- Sector level barriers: e.g. lack of adequate knowledge/information for investors
- Project level barriers: e.g. lack of technical capacity and business models

- Technology level barriers: e.g. high cost of technologies and accessories. A solar panel of 120Watts costs between 30,000 and 80,000 KSH.

Dr. Ozor concluded by saying that market forces will not deliver on their own, and that policy must foster capabilities by:

- Building networks that link diverse stakeholders;
- Conducting market & technological research & monitoring, making results publicly available;
- Raising awareness among consumers & investors to reduce perceived risks & build shared visions;
- Fund experimental initiatives (e.g. new stakeholder configurations to test new technologies and approaches)

He said that national institutions like CICs could achieve this, but must be designed to do so and that they should link across countries to learn lessons and share best practice.

10. Developing innovations towards region specific technologies for solar lighting and cooking in Kenya

Willis Makokha (KIRDI) gave a presentation on the untapped innovations in solar energy. He began by introducing the role of KIRDI and the research themes in the energy division (which amongst others include solar energy, renewable energy, solid biomass and clean cook stoves). He spoke of the different types of solar cells available, that are made up of different materials and have different efficiencies. The PV surface area depends on the type of cell used. The cost of solar PV modules stayed flat at around 2.9 – 3.4 euros/Wp between 2004 and 2009. However, since then, module price has fallen to as low as 0.7 – 0.85 euros/Wp by April 2012.

There are four types of PV systems. These are:

- Off-grid non-domestic
- Off-grid domestic (stand alone)
- Grid-connected distributed
- Grid-connected centralised

Grid-connected Building Integrated Photovoltaic (BIPV) offers some key advantages as it is the only renewable energy technology suitable for the urban environment. It is distributed, modular and generation at point of use. Mr Makokha noted that the Government must show an interest in this type of system.

There is a lack of access to affordable energy systems and 'energy poverty' disproportionately affects women and girls due to their traditional family roles. In collaboration with development partners, NGO's and the private sector, the Government is promoting growth of wood fuel as well as sustainable use of biomass resources. The Government has also formulated a strategy (SREP) to make the country kerosene-free by substituting renewable energy for kerosene in lighting applications.

There is a notable problem with counterfeit goods that make their way on to the off-grid renewable energy services market. Counterfeit products are short-lived and do not come cheaply. They can also emit hazardous rays to our eyes and as such, can pose a public health

risk. Therefore, Kenya Industrial Research & Development Institute (KIRDI), Kenya Bureau of Standards (KEBS) and other stakeholders have drafted Off-Grid Solar PV Lighting Kits Requirements for small systems below 16W referencing from IEC/TS 62257-9-5.

The Government has a role to play in terms of policies e.g. innovative use of both "carrots and sticks" to drive the solar energy market. Ample provisions for solar energy have been made in the draft National Energy Policy, but harmonization of implementing agencies is still lacking and/or out of synchrony. The private sector does have potential, with enabling environment, to drive the solar energy market. Mr Makokha concluded by saying that most PV businesses have relied mainly on innovating advertising to capture the market, but noted that they can do more.

11. Progress on development / implementation of cooking and lighting regulations and standards in Kenya.

Eng. Zacharia Lukorito began by giving an overview of the work of KEBS. See box 2 for further information on standards.

BOX 2 – Standardization – The Role of KEBS

What is a standard? Who enforces standards?

- A Standard is a precise and authoritative statement of the criteria necessary to ensure that a material, product, or procedure is fit for the purpose for which it is intended.
- Development/harmonization of Standards (Normative)
- Maintenance of Measurement Standards (Metrology)
- Kenya Standards can be grouped into 5 categories: Product specifications, Codes of Practice, Glossary of Terms, Test Methods & Metrology (measurement) standards
- Standards are enforced by Gazetted KEBS Inspectors & Regulatory agencies such as Government of Kenya & County Ministries (Health, Agriculture, Local Authorities), Energy Regulatory Commission (ERC), Communications Commission of Kenya (CCK) and the National Environment Management Authority (NEMA).

Why standardize?

- The process of formulating, issuing and implementing standards is called standardization.
- Standards give requirements, rules and guidelines for a process, product or service.
- Standards are the result of a consensus and are approved by a recognized body (KEBS in Kenya).
- Standards aim at achieving the optimum degree of order in a given context – e.g. Standards for Maize, milk, maize flour, sugar, bread, rice etc.

Principles of standardization

- Openness: The procedure of the preparation of standards must be open to the public from its very beginning and at all its stages. The public must be appropriately informed about the development of the standard.
- Transparency: The principal documents associated with the work programme of the committee are available on request. The identities of the organizations represented on a committee are in the public domain.
- Consensus: This entails trying to ensure that the interests of all those likely to be affected by the standard are taken into account, and that individual concerns are carefully and fairly balanced against the wider public interest.
- Coherence: A standards collection must be coherent, i.e. must not contain conflicting standards (by the adoption of a new standard on a subject the old standard is withdrawn).

11.1 Solar lighting standardization – Standard KS 2542

Standard KS 2542 is titled "Off-Grid Solar Photovoltaic Lighting Kits —Requirements" and is currently at Public Review Stage, which ends on 16th July 2014.

The draft standard applies to off-grid lighting appliances or kits that can be installed by a typical user without employing a technician. The kits are generally comprised of an energy-efficient light source such as Light Emitting Diode (LED) or Compact Fluorescent Lights (CFL), a rechargeable energy storage device (usually a battery), an energy generation device or source (PV module, dynamo, alternating current (AC) grid, unregulated direct current (DC) input, or other), and internal electronics. Lighting appliances or kits with PV modules larger than 15 W (peak power under standard test conditions) are excluded from the scope of this standard. The test methods are designed for pico systems with small PV modules and batteries. For the test methods not to be too costly, the methods exclude some procedures associated with module and battery evaluation which would be appropriate to include in larger systems. The test methods are not therefore recommended for use with solar modules with peak output larger than 15 W (peak). The process for developing test methods for use with larger systems (up to 100 peak Watts) is on-going at international level.

Standard KS 2542 aims to address the following issues:

- Fuel based lighting technology is expensive, unhealthy and inefficient;
- Low rates of electricity access in rural and peri-urban areas of the country has led to increased uptake of pico power systems, including off-grid LED lights, as cost effective substitute for kerosene lighting;
- There has been an increase in off grid lighting kits in the Kenyan market with some of the models being of low quality;
  Proliferation of poor quality product has resulted in erosion of consumer confidence in the off-grid lighting solutions currently available in the market.

This standard seeks to curb the proliferation of poor quality off-grid products by setting the requirements. This will ultimately ensure that the lighting kits available in the market are quality assured. The Kenyan market for solar off-grid lighting systems has grown rapidly, with more than a million quality assured systems sold in the past three years and continued focus on quality assurance is needed to ensure additional growth.

11.2 Solar cookers standardization progress

In rural areas, people mainly rely on biomass, such as fuelwood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. These resources account for over 90% of household energy consumption. Solar cooking offers an effective method of utilizing solar energy for cooking energy and hence protecting the environment. There are various types and design of solar cookers which pose a great challenge when it comes to standardization. The best approach is to start with the test methods and have standardized procedures for evaluating the solar cookers e.g. thermal performance, safety and durability. These are the same metrics used to evaluate biomass improved cook stoves.

Test methods include the water boiling test (WBT), controlled cooking test (CCT) and kitchen performance test (KPT).

WBT is a laboratory test that evaluates stove performance while completing a standard task (boiling and simmering water) in a controlled environment to investigate the heat transfer and combustion efficiency of the stove/cooker. They are the easiest, quickest, and cheapest to conduct, but reveal the technical performance of a stove, not necessarily what it can achieve in real households.

CCT is a field test that measures stove performance in comparison to traditional cooking methods when a cook prepares a local meal. The CCT is designed to assess stove performance in a controlled setting using local fuels, pots, and practice. It reveals what is possible in households under ideal conditions but not necessarily what is actually achieved by households during daily use.

KPT is a field test used to evaluate stove performance in real-world settings. It is designed to assess actual impacts on household fuel consumption. KPTs are typically conducted in the course of an actual dissemination effort with real populations cooking normally, and give the best indication of real world changes. KPT is benchmark testing that solar cookers will also need to be evaluated with. It will help in finding the appropriate solar cooking technology to partner with other clean-fuel cooking options. The primary goal is to find integrated cooking solutions to stem the environmental damage currently being caused by deforestation, and eliminating respiratory disease from cooking with smokey, inefficient fuels over open fires.

Eng. Lukorito concluded by outlining the challenges that lie in the standardization process. These include how to integrate different test methods? How to increase stakeholder participation in developing national standards? How to improve reference materials and combat wide variations in designs and performance?

12. Appropriate policy environment for clean energy access

Mr Michael Ojudi (KIPPRA) began by discussing biomass, which is still widely used despite widespread disadvantages. He stated that there is inadequate incentives which hinder achieving 100% electricity access by 2020. There are numerous challenges in connecting to electricity and as such, there is a need for a shift in provision of electricity. Mr Ojudi presented the policy, legal and regulatory framework for clean energy access (Figure 2).

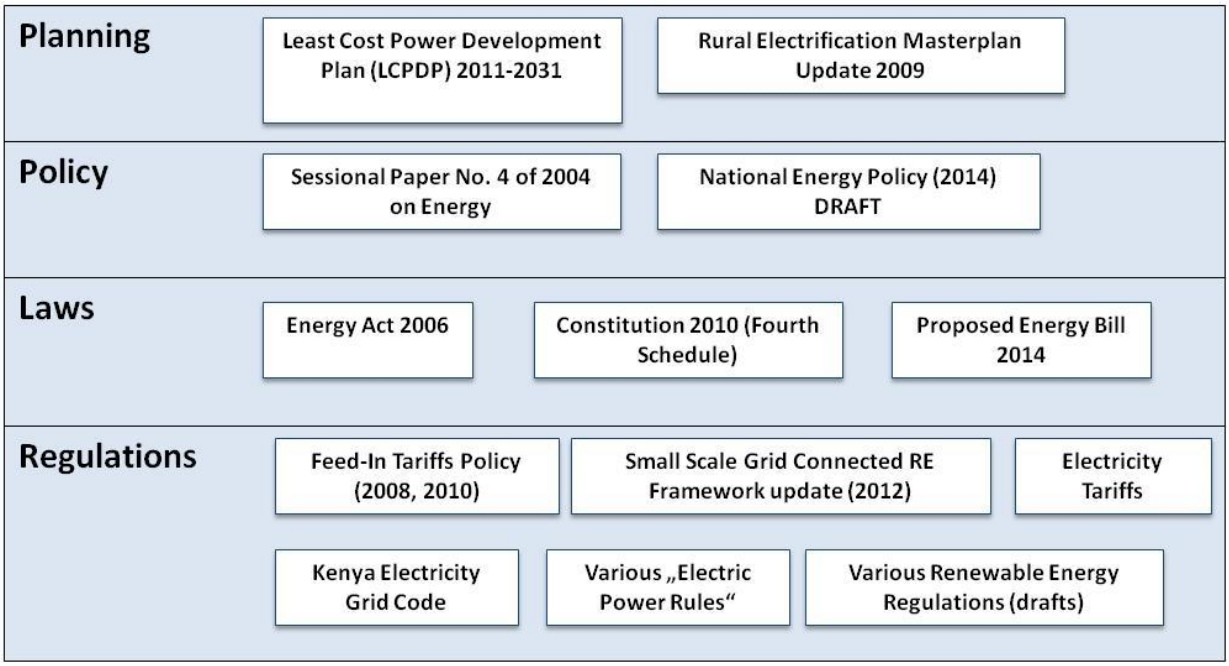

Figure 2: Policy, Legal and Regulatory Framework for Clean Energy Access in Kenya

Currently, the Government of Kenya objective to increase electricity access to 100% by 2020 has developed growing attention on renewable energy through policy support. There is an evolving need for Public Private Partnerships and global initiatives such as Power Africa Initiative led by the USA to help achieve this objective.

Challenges in access to clean energy use include inadequate incentives to enable the poor access clean energy at affordable rates. There is also informal participation by private sector players. The high costs of installing clean energy system also pose a challenge. In addition, focus on grid connection leads to low public awareness of alternative technologies and finally, involvement of county governments not well defined.

Mr Ojudi made some key policy recommendations for energy access:

- Provision of basic alternative energy - Using county governments to provide clean energy system to identified poor households (e.g. solar & ethanol);
- Basic electricity programme - Advance the full amount of grid connection and recover cost from monthly deductions and advance full amount for solar technologies and recover through a credit system;
- Solar subsidies and tax waivers - Proportion of the Rural Electrification Program (REP) Levy of 5% on electricity sales be used for solar energy which is widely available;
- Focus on off-grid power solutions especially by County Governments.

13. Barriers and Opportunities for the financial & investment sector in solar energy

Ms. Dora Waruiru (K-REP) spoke of the barriers and opportunities to investment in the sector in order to address the financial gap. Barriers to investment in the solar energy for rural electrification sector include:

- Financial institutions have little knowledge about the sector. Many investors and financial institutions (domestic and international) have little or no knowledge about the sector.
- There is a lack of investment-ready business entities in the country. Most solar enterprises are at an early stage of development and require patient capital as well as business development assistance.
- Clear standards for assessing and benchmarking product performance are needed as it is critical that financers know the quality of the solar technology they are financing.
- High operating cost / transaction costs also pose a barrier to investment. Cost structures are higher in low-income rural markets, with populations in rural areas being low and scattered.
- An enabling policy environment is essential. For example, current high tariffs such as VAT are a barrier to investment. As such, many microfinance institutions still offer high cost credit facilities as the loan can be as low as 3000 KES.
- Consumers are risk-averse and have irregular and limited incomes and therefore want trusted low-risk products at an affordable price. Currently, demand for solar technologies is low and this is partly due to low consumer awareness and low perceived value of the benefits of the technologies. There is little evidence on the impacts of the interventions.
- There is a lack of data and market information. Acquiring market data on rural low-income consumers interests, preferences, spending habits and purchasing power is costly and difficult to obtain.
- Vandalism of solar systems is also a concern
- Land tenure problems and high costs of reticulation are also challenges that need to be addressed.

Opportunities for investment in the solar energy for rural electrification sector:

- Opportunities for improved market research. Companies can leverage new mobile data-gathering tools in order to gain greater insights into low-income consumers interests, preferences and spending habits.
- Innovative pricing and payment design. Companies can facilitate small, frequent payments, rather than demanding high up-front fees, in order to adapt pricing options to low-income consumers. In addition, companies can utilize mobile money, thereby making it easier and faster to collect, distribute and handle payments of products and services.
- Financial Institutions can leverage ICT to achieve greater scalability in their operations, lower their expenditure and create better tailored products for low-income users. Thus, they can achieve increased revenues, reduced costs, improved business functions, and more inclusive product and service innovations.
- Expand marketing and deepen consumer relations. Companies can leverage mobile communication tools in order to improve marketing and deepen their consumer relationships. This enables companies to improve consumer acquisition in low-income markets where users tend to be risk-averse and have little knowledge of alternative products and services.
- Transform sales and delivery channels. Companies can incorporate ICT in order to improve their sales efforts, deliver products and services via new electronic channels and enhance their after-sales and customer-care services.
- Develop and finance SMEs in the supply chain sector in set up of distribution channels.
- Patterns of growth are reflecting sharp growth in home systems and lanterns (community off-grid systems require licensing, thereby increasing the financing costs)

- Aggressive promotion of non-paraffin use by intensive consumer awareness campaigns of the health benefits and savings benefits
- Opportunities exist in developing M-commerce billing and payments system and the installation, service provision & maintenance of mini-grid / power stations.
- For microfinance institutes (MFIs), the option of bundling can facilitate the offer of affordable loans by MFIs. Loan repayments can be from mobilized savings at either group or individual level. These savings can be from savings that would otherwise have been used for purchase of Paraffin.

14. Solar Cooking: Barriers and Opportunities

Ms Faustine Odaba (NAREWAMA; Natural Resources and Waste Management Alliance) briefly discussed the social, health and environmental problems associated with traditional cooking methods. She then presented her work on solar cooking as a sustainable alternative to the abundant overuse of wood for fuel.

Parabolic solar dishes concentrate sunlight on a small point under the pot and instantly create temperatures in the 450-500°F range. Although most traditional African foods do not require such high temperatures, it is suitable for boiling and frying foods, and boils water very quickly. Box cookers can be built to cook a number of pots and/or large amounts of food. The CooKit has been intentionally left un-patented by NAREWAMA so that anyone in the world can replicate and use it.

The CooKit is practical and efficient for village use. Cooking time is about twice that of cooking over fire, but the food does not need to be watched or stirred and never burns. This can provide the cook (women) with more time to spend on other activities.

Although the opportunities are vast, there are some challenges for CooKit. The technology cannot match the microwave oven and society is geared to faster cooking. Climate change is also an issue as areas that were formerly dryer and sunnier are getting wetter and cloudier; there is a dependence of solar cookers on sunshine. Additional challenges include the cost of buying the technology and the need to have an affordable durable solar cooker which could still be portable. Technology design is an issue as the solar cooker can only cook one pot at a time.

15. Question & Answer Session

The meeting ended with lively discussion about the points raised during the presentations. It was the consensus that lots of important points had been raised and that all stakeholders had a responsibility in helping to address the points, particularly in identifying ways to address any gaps in policy and in making clear and coherent policy recommendations. A summary of the challenges and opportunities in the dissemination of solar energy technologies in Kenya for rural electrification are described below. Finally, some key recommendations were made during the discussion and throughout the workshop, and these are detailed at the end of this document.

16. Summary of Challenges & Opportunities

16.1 Opportunities

- Participants noted that there are many opportunities for the dissemination of solar energy technologies for rural electrification in Kenya
- Health, environment and social benefits are to be gained from uptake of solar and renewable energy technologies
- The Government of Kenya has committed to increase electricity access to 100% by 2020. Global initiatives such as Power Africa will help achieve this objective
- Standardization of solar energy technologies will ensure trust and quality within the solar energy market
- There is a huge scope for entrepreneurship at all stages of the solar energy value chain

16.2 Challenges

- The capacity of solar energy technologies is limited by the power demand. Stabilization by means of batteries or solar controller is required to increase renewable energy penetration.
- Policies such as the reintroduction of VAT on solar energy technologies are an inhibitor of the solar energy market
- Lack of adequate knowledge and information available for private investors and the Kenyan general public
- Lack of technical capacity and business models
- The high cost of technologies, accessories and installation are unaffordable for many people living in rural Kenya
- Counterfeit goods harm the reputation of the solar energy market

17. Key Recommendations

- **The Government of Kenya** has a very important role to play in terms of policies in order to help drive the solar energy market. It was noted during the workshop that the Government must show more of an interest in all renewable energy technologies

- **County Governments** should focus on off-grid power solutions in order to provide basic energy systems to poor households and to raise awareness of renewable energy technologies

- **Solar energy policy** must foster capabilities by building networks that link diverse stakeholders

- **Harmonization of implementing agencies** for the National Energy Policy must take place and these organizations must work together to ensure the provisions for solar energy in the national energy policy can be met

- **National institutions** should link across countries to learn lessons and share best practice

- **Market & technological research and monitoring data** is needed to foster policy capabilities

- **The private sector** must work in partnership with the public sector to capture the market. Policy should ensure that the private sector has an enabling environment

- **The standardization process** must increase stakeholder participation in the development of national standards for solar and renewable energy technologies.

- **Standards** must be rigorously enforced to ensure quality products and promote consumer trust of the solar energy market. Standardization will also promote investment from financers

- **Counterfeit products** must not be able to gain access to the solar energy market. Removal of counterfeit products from the market will also help promote consumer trust in the market

- **Awareness** needs to be generated amongst consumers and investors to reduce the perceived risks and to build shared visions

- **Funding** is required for experimental initiatives e.g. new stakeholder configurations to test new technologies and approaches

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Annex 1: List of Participants

A. List of Speakers

1.	Dora Waruiru	K-REP
2.	Henry Gichungi	Kenya Power
3.	Nicholas Ozor	African Technology Policy Studies Network
4.	Michael Ojudi	Kenya Institute of Public Policy Research & Analysis
5.	Willis Makokha	Kenya Institute of Research & Development
6.	Faustine Odaba	Natural Resources, Environment & Waste Management
7.	Sam Kasanga	Ministry of Energy & Petroleum
8.	Zachary Lukorito	Kenya Bureau of Standards

B. Secretariat

9.	Wycliffe Amakobe	African Centre for Technology Studies (Chair, Session 2)
10.	Mourine Cheruiyot	African Centre for Technology Studies
11.	Gary Kerr	University of Edinburgh / ACTS
12.	Bernard Mouk	African Centre for Technology Studies (Chair, Session 1)
13.	Cosmas Ochieng	African Centre for Technology Studies
14.	Mary Muthoni	African Centre for Technology Studies
15.	Jane Wanjeri	African Centre for Technology Studies
16.	Ann Kingiri	African Centre for Technology Studies
17.	Debajit Palit	The Energy & Resource Institute (Chair, Session 3)
18.	Himanshu Verma	The Energy & Resource Institute

C. Other Delegates

19.	Jimmy Njai	Generic Energy Ltd.
20.	John Kimani Kirari	UN-HABITAT
21.	Tameezan Wa Gathui	Renewable Energy Practitioner
22.	Macben Makemzi	GIZ
23.	Saleem Ahmed	Biotech (K) Ltd.
24.	Caroline Odera	Ecofinder Kenya
25.	Jairus Omwenga	Burn Manufacturing
26.	Benson Kimathi	Suntransfer Kenya
27.	Dennis Maiyo	Lemorio Energy Ventures
28.	Kevin Wombugu	Ecozoom
29.	Paul Ndungu	Kenya National Cleaner Production
30.	Jechoniah Kitaca	SNV Kenya
31.	Walter Tinega	KDA
32.	Mercy Wambui Kamau	SCODE
33.	Nkatha Michira	IFC
34.	Samuel Kising	SCODE
35.	Andrew Lomosi	Chevron
36.	James Chege	Visionary Empowerment Program
37.	Benard Karago	Visionary Empowerment Program
38.	Albert Wong	One Degree Solar
39.	Andrew Lomosi	Energy Consultant
40.	Samuel Kisengi	Sustainable Community Development

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