SMART VILLAGES
New thinking for off-grid communities worldwide

# Smart Villages in East Africa: Arusha Workshop Report

## Workshop Report 2

ARUSHA, TANZANIA

June 2014

Key words:
Energy Access, Rural Energy, East Africa

## Smart Villages

We aim to provide policymakers, donors, and development agencies concerned with rural energy access with new insights on the real barriers to energy access in villages in developing countries—technological, financial and political—and how they can be overcome. We have chosen to focus on remote off-grid villages, where local solutions (home- or institution-based systems and mini-grids) are both more realistic and cheaper than national grid extension. Our concern is to ensure that energy access results in development and the creation of 'smart villages' in which many of the benefits of life in modern societies are available to rural communities.

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MALAYSIAN COMMONWEALTH STUDIES CENTRE

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## Foreword

With the news full of stories of major energy supply shortages, juxtaposed with the discovery of new fossil fuel reserves, it is easy to forget that over 1.3 billion people globally are without access to electricity and 2.6 billion people cook on open, smoky fires. More than 95% of these people are either in sub-Saharan African or developing Asia, and 84% are in rural areas.

Fortunately, there are several major projects to extend grid coverage in impoverished areas funded by a combination of international donors and governments. However, these efforts are beset by two fundamental problems. Firstly, they tend to take a top down approach extending outwards from existing urban or industrial hubs. But many rural communities are far from such hubs, so connection will not be feasible in the foreseeable future. Secondly, efforts are insufficiently ambitious, generally aiming to provide minimal levels of energy access rather than the full range of energy services needed to support development goals.

The determination of the Smart Villages initiative (E4SV.org), to take an in-depth and independent look at off-grid village level energy provision, builds upon and complements work by others, including the United Nation's Sustainable Energy for All (SE4ALL) initiative, which seeks to provide universal energy access by 2030. As you will see from this first regional workshop report, Smart Villages has already yielded a rich picture of the challenges and opportunities.

The ingenuity of the Maasai in Terrat in northern Tanzania is just one example. Taking their local Jatropha crop, they have developed a renewable power supply with far-reaching implications for not only the local community, but also the Maasai people as a whole.

A key and distinctive aim of the Smart Villages initiative is to give us a clear picture of villagers' own levels of ambition. Rather than second guessing or imposing our own concepts, it will be a case of seeking to match energy provision targets with desired standards of living. The challenge then of course is how to achieve this in a sustainable way.

We are at a moment of transition where technological advances in renewable energy, such as affordable solar panels, begin to open up a new vista. From improved healthcare and basic utility provision through more accessible education to increased business and entrepreneurship, so-called technology leapfrogging and integrating energy access with other development activities should lead to the creation of the Smart Villages envisioned by the initiative. Perhaps even sooner than anticipated.

**Professor Sir Brian Heap**
Senior Scientific Advisor
Smart Villages initiative

July 2014

## Summary

The workshop held in Arusha, Tanzania from 2 to 5 June, 2014, was the first in the series of six major international workshops planned to be held in Africa, Asia and Latin America over the period 2014 to 2017 as a core component of the Smart Villages Initiative (www.e4sv.org). The organising partners for the Arusha workshop were the Cambridge Malaysian Education and Development Trust (CMEDT), the European Academies Science Advisory Council, the International Science Programme (ISP) at the University of Uppsala, the Swedish Secretariat for Environmental Earth Systems Sciences (SSEESS) at the Royal Swedish Academy of Sciences, the Tanzanian Academy of Arts and Sciences, and the Kenyan National Academy of Sciences. The workshop was funded by CMEDT, ISP and SSEESS.

The concept behind the 'smart village' is that modern energy access acts as a catalyst for development – in education, health, food security, productive enterprise, environment and participatory democracy – that in turn supports further improvements in energy access. The Smart Villages Initiative aims to develop and communicate to policy makers, donors and other stakeholders insightful, bottom-up views of the challenges of providing energy to off-grid villages to enable their development, and how those challenges can be overcome.

The workshop brought together some 60 people concerned with off-grid village energy for development in East Africa: a diverse and unique cross-section of scientists, social scientists and local stakeholders with practical experience in developing energy services for off-grid villages (entrepreneurs, villagers, NGOs, financiers, business leaders, regulators, policy makers, etc.). Its aim was to collate and distil the views of these 'frontline' practitioners on the challenges of village energy provision, and how they can be overcome through harnessing entrepreneurial capacities. The workshop was therefore designed to provide plenty of opportunities for plenary and breakout discussions.

HE Lennarth Hjelmåker, Swedish Ambassador to Tanzania

Prior to the opening of the workshop itself on 3 June, delegates had the opportunity to visit two villages – Terrat and Ngarenairobi – that exemplify many of the features of smart villages. These visits proved to be highly instructive in bringing to life the practical challenges and opportunities of off-grid village energy and the development benefits that have flowed from energy access.

On the first day of the workshop, opening and scene-setting presentations were followed by a series of short, sharp inputs ('elevator pitches'), bringing into focus the experiences of key players, particularly local entrepreneurs, involved in village energy provision. A panel session followed on breakthrough approaches to energy access in off-grid villages. The first day ended with breakout groups considering the R&D and capacity development challenges.

Day 2 began with presentations from the perspective of key services enabled by energy access. Further perspectives from funders and government, considering societal engagement and fostering entrepreneurship, followed. Breakout sessions addressed issues of integration and poverty alleviation, and the distinctive challenges of delivering energy to support community services and productive enterprises. The workshop dinner that evening was hosted by the Swedish ambassador to Tanzania, HE Lennarth Hjelmåker.

Plenary inputs on day 3 addressed innovation systems in Tanzania and the African Enterprise Challenge Fund. Breakout groups then discussed key issues that had been identified by workshop participants: anticipated winners and losers in energy technologies, partnership models and finance, research gaps and technology transfer, and outcome metrics. An important final session identified and debated the main messages that should be taken back to key audiences including policy makers, funders and the corporate sector.

## Key points arising from the workshop were as follows:

1. Substantial reductions in the costs of solar photovoltaic (PV) panels and light-emitting diode (LED) lighting, together with innovative financing models tied to mobile telephones, have meant that solar lights, and increasingly solar home systems, have reached a tipping point in which sales are rapidly increasing on a fully commercial basis. Key constraints on further increases in the rate of growth lie in distribution systems for remote villages and access to working capital for the small and medium enterprises (SMEs) involved in this field. An 'energy escalator' approach to upgrading solar home systems promises to bring additional applications such as TVs, refrigerators and sewing machines into the reach of householders.

2. Mini-grids are needed to power many productive uses of electricity (for example milling, welding, machining, water pumping, etc.) but at present generally require some form of government or donor support to achieve returns that are acceptable to businesses. There is much current interest in mini-grids and the search is on for scalable business models that will enable fully commercial operation in due course. Hybrid systems involving renewable energy sources along with a diesel engine for backup are emerging as a promising approach.

3. An interesting dynamic is developing between home-based and mini-grid approaches that may result in mini-grids being favoured for larger villages, where productive uses of energy may then concentrate, and solar home-based approaches serving surrounding, more dispersed communities (a 'hub-and-spoke' model).

4 Financing costs for mini-grids can be punitive as lenders often perceive risks to be high. Support from funding bodies and governments may appropriately seek to reduce the risk of investment sufficiently to bring interest rates down. Socially oriented 'impact investors' who are able to offer lower than commercial rates may also play an important role. Such impact investors may appropriately build a relationship with entrepreneurs similar to venture capital funders in which they continue to support the entrepreneur as his or her business progresses through various stages of growth.

5 A supportive policy and regulatory framework is needed, and entrepreneurs made a plea for less red tape and more breathing space in relation to taxation regimes to get their businesses off the ground. Government and donor funding may usefully support the creation of datasets, for example national/ regional maps of wind or hydropower potential, which are useful to entrepreneurs but which they could not fund themselves.

6 Certification schemes for solar lights and home systems can help to overcome the problem of poor quality products undermining consumer confidence and the creation of commercial markets.

7 Better arrangements need to be put in place for sharing of experiences across East Africa. Case studies of smart villages will help to promote the concept and inspire communities to pursue this route.

8 More work is needed to develop approaches to evaluate the outcomes of energy schemes in respect of development benefits. The absence of evaluation systems is acting as a barrier to financiers supporting schemes.

9 Public–private partnerships should be extended to public–private–community partnerships as community ownership and involvement is necessary for the success of mini-grid initiatives. Large corporations have an important role to play given their scale of operation, their distribution networks and their business know-how.

10 With regard to technologies, all renewable energy sources are anticipated to play a useful role. It is expected that costs will continue to come down, and new technologies such as printable organic solar cells may come on the market in 5 to 10 years, potentially offering substantial further cost reductions and the possibility of local manufacturing. Improved control systems, more easily used 'plug-and-play' technologies and upfront consideration of recycling of energy system components are needed. Closer links should be developed between university researchers and the SMEs implementing energy access on the ground: the Smart Villages Initiative is well placed to promote such links.

11 There is a confusing array of funding schemes, and funders often seem to compete rather than to cooperate. There is an urgent need for better cooperation between funders.

12 National champions of smart villages are needed in governments to stimulate appropriate initiatives and ensure integration across governmental departments and agencies.

## 1. Introduction

The workshop held in Arusha, Tanzania from 2 to 5 June, 2014, was the first in the series of six major international workshops to be held in Africa, Asia and Latin America over the period 2014 to 2017 as a core component of the Smart Villages Initiative (www.e4sv.org). This report provides a record of the knowledge shared and the findings and recommendations arising from the workshop.

The Smart Villages Initiative is identifying how barriers to sustainable energy access in off-grid rural communities in developing countries can be overcome, and will make recommendations to policy makers, donors and stakeholders more generally regarding actions that need to be taken to address those barriers. The concept behind the 'smart village' is that modern energy access acts as a catalyst for development – in education, health, food security, productive enterprise, environment and participatory democracy – that in turn supports further improvements in energy access.

The organising partners for the Arusha workshop were the Cambridge Malaysian Education and Development Trust (CMEDT), the European Academies Science Advisory Council, the International Science Programme (ISP) at the University of Uppsala, the Swedish Secretariat for Environmental Earth Systems Sciences (SSEESS) at the Royal Swedish Academy of Sciences, the Tanzanian Academy of Arts and Sciences and the Kenyan National Academy of Sciences. The workshop was funded by CMEDT, ISP and SSEESS.

The workshop brought together some 60 people concerned with off-grid village energy for development in East Africa (see attendance list at Annex 2): a diverse and unique cross-section of scientists and local stakeholders with practical experience in developing energy services for off-grid villages (entrepreneurs, villagers, NGOs, financiers, business leaders, regulators, policy makers, etc.). Its aim was to develop insightful, bottom-up views of the challenges of village energy provision, and how they can be overcome.

The programme for the workshop is presented at Annex 1: it comprised a series of presentations, panel and plenary discussions, and breakout groups. Summaries of the presentations and discussions follow. Copies of the presentations can be found on the Smart Villages website: www.e4sv.org.

Prior to the opening of the workshop itself on 3 June, delegates had the opportunity to visit two villages – Terrat and Ngarenairobi – that exemplified many of the features of smart villages. These visits proved to be highly instructive in bringing to life the practical challenges and opportunities of off-grid village energy and the development benefits that have flowed from energy access.

## 2. Workshop Proceedings

### Day 1: Morning session

#### Welcome

**Professor Esther Mwaikambo, President of the Tanzanian Academy of Arts and Sciences; Professor Sir Brian Heap, Senior Advisor to the Smart Villages Initiative; and Ms Maria Berlekom, Head of Development Cooperation, Embassy of Sweden in Tanzania.**

Esther Mwaikambo provided some background information on the Tanzania Academy of Arts and Sciences, and Brian Heap summarised the aims of the Smart Villages Initiative. Maria Berlekom spoke of the need for a collaborative effort in addressing development issues and of the value of bringing together researchers, the private sector and policy makers, as in this workshop. Barriers to village energy provision identified in a joint Sweden–UK study included poor availability of long-term loans and risk guarantees, lack of clear incentives for the private sector, absence of clear national strategies for energy implementation, and political risks such as changes in policy when governments change.

#### Opening speech

**Dr Lutengano Mwakahesya, REA**

Lutengano Mwakahesya described Tanzania's vision to be an industrialised country by 2025 and an associated aim to increase electricity access from 36% to 65% of the population. As a large proportion of Tanzanians live in dispersed communities, off-grid approaches will need to be used alongside grid extension in order to make these additional connections. Dr Mwakahesya considered cooperation between the private sector, NGOs and the government to be essential, and he pointed to the importance of this workshop in bringing those various players together.

Energy is in short supply and climate change poses a substantial threat, so the Tanzanian government is pushing hard for energy efficiency and conservation. The Rural Energy Agency was created to support the provision of affordable energy to rural communities and it aims to create the conditions necessary for the private sector to be involved, including establishing appropriate feed-in tariffs. The Rural Energy Agency provides matching funds and over 30 projects have been supported to date. However, it is proving hard to overcome the barriers identified by Maria Berlekom.

#### The Smart Villages concept

**Dr John Holmes, Smart Villages Initiative**

John Holmes summarised the activities of the Smart Villages Initiative over its two-year preparatory phase, and explained its focus on off-grid villages, where energy access can act as a catalyst for development. The Arusha workshop marks the start of a series of six workshops in Africa, Asia and Latin America held over three years: each of the workshops will be followed by a nine-month programme of engagement activities. The initiative aims to provide policy makers, funders and stakeholders an insightful 'view from the frontline' of the challenges of village energy provision for development, and how they can be overcome.

Smart villages are considered to be a necessary analogue for the much-touted 'smart cities', as 47% of the world's population and 70% of the world's poor live in rural villages. Smart villages will provide good education and health services, enable enhanced participation in governance processes, foster entrepreneurship and build more resilient communities. Energy access is a necessary enabler of all of these outcomes. Technological advances and game-changing technologies, if combined with an integrated

approach to development, can shift the balance of opportunities between cities and villages.

In the ensuing discussion of the smart villages concept it was pointed out that where villages have been electrified there has been a movement of people back to villages from urban areas and from villages without electricity. It was considered appropriate to base electricity projects initially on shopping centres in villages, enabling them to grow into business centres. Agriculture is the main source of employment in most rural communities but productivity has not increased; a key consideration must therefore be how energy access can increase agricultural productivity. It was suggested that surveys could usefully be undertaken in villages to get views on what smart villages should look like. (Such surveys are already planned in India as a component of the Smart Villages Initiative.)

## Keynote speech on the village-level energy situation in East Africa

**Dr Ewan Bloomfield, Practical Action Rwanda**

Ewan Bloomfield summarised the energy supply, energy use and energy policy frameworks in four East African countries: Kenya, Tanzania, Rwanda and Uganda. He concluded that electrification rates in East Africa are still very low in rural areas and there is a high rate of biomass dependency: more effort is needed regarding efficient and sustainable biomass technologies. Solar PV technologies have great potential and need further support, including for the development of larger systems and application to productive uses such as agricultural irrigation. Mini-grids have been piloted successfully but models need to be developed to take them to scale. Mechanical power and productive use of energy are still underserved and need greater focus and investment.

He recommended that East African energy policies increase focus on rural energy supply, setting targets for a range of energy markets (solar PV, improved cookstoves, mini-grids and mechanical power services) and establishing capacity-building programmes. Lessons should be learned and shared within the region on a range of technologies and approaches:

- Solar PV lantern and solar home systems programmes (in particular, the experience of Kenya).
- Improved cookstove technologies and sustainable biomass supply (Uganda and Rwanda).
- Mini-grids (Tanzania).
- Innovative distribution, marketing and finance models.

In the following discussion the drive for industrialisation in East Africa was judged to tend to drive energy investments towards big projects serving industrial and urban loads. The pressure must therefore be kept up for complementary investments in energy for smart villages. The wide-scale problem of illegal charcoal production was mentioned and discussion centred on whether it should be legalised and consequently regulated to ensure sustainable production, though concerns were expressed that it is difficult to define what constitutes 'sustainable charcoal production'.

## Case study 'elevator pitches'

Eleven presentations were made, each of five minutes duration, summarising experiences implementing village-level energy services, and highlighting technologies used, delivery/implementation methods, acceptance rates and outcomes.

Malgorzata Wojewodka described the work of **SolarAid** and **SunnyMoney** to bring solar lighting to East Africa with the goal of eradicating the use of the kerosene lamp by 2020. Ms Wojewodka summarised the problems associated with using kerosene lamps and pointed to the health, education and environmental

benefits, and the savings that result from switching to solar lights: around GBP£74 per year for a family in Kenya. This money can be used for food, education or investing in farming and small businesses.

SolarAid sells its lights (1 million so far) through its social enterprise—SunnyMoney—as a more sustainable approach than giving lights away. Head teachers play a key role in the business model, acting as the interface with the community and promoting uptake of the solar lights.

Dan Klinck's presentation on **DC Hydro** focused on the experience of the Musarara 438 kW mini-hydropower project in Rwanda, originally conceived as an off-grid project, but which was on completion connected to the national grid through a

6 km transmission line (which substantially enhanced the profitability of the project). During construction the project employed up to 1,300 local workers, which led to a high social impact. Mr Klinck's conclusions were that private plants perform better than public ones, grid-connected plants are more easily made viable than isolated ones and conducive regulatory frameworks lead to greater private sector contributions. Key success factors for a private sector-led hydropower project are a financially viable business plan, a robust technical plan, a coherent and favourable regulatory environment, strong plant ownership arrangements, good expertise (both technical and management) and strong leadership. It is important to do your homework, stay on schedule, source locally and build local capacity.

Joshua Kabugo explained **Embark Energy's** approach to achieving its mission to empower thousands of clean energy entrepreneurs to sell and service clean energy products around the world. Embark has a three-pronged business model: providing education and training to entrepreneurs, facilitating access to finance and providing access to vetted products and technologies. Training utilises Embark Energy's renewable energy e-learning platform and customised one-to-one coaching, typically over a period of 18 months or more. Financing support seeks to identify bottlenecks as SMEs move through launch, initial operations and growth, identifying potential sources of seed, working and growth capital.

Steven Martin Saning'o, journalist from Terrat

Jodie Wu described the approach of **Global Cycle Solutions** (GCS) to selling quality solar lights to rural communities in Tanzania. GCS recruits, trains and supports local micro-entrepreneurs ('rafiki') who are trusted people in their communities, and who provide villagers information on, and access to, quality solar lights and after-sales service, and who provide GCS feedback on customer demand and satisfaction. Key challenges are geographic isolation and poor infrastructure, illiteracy and risk aversion, maintenance of products and identification of what customers want.

Rafiki attend training courses twice a year where they are taught the fundamentals of operating a business, the importance of customer-centricity, and product and service knowledge, and where a sense of community with their colleagues is reinforced.

Arthur Karomba explained how **Wind Power Serengeti** trains rural communities to build and operate small wind turbines that provide power to a village through a mini-grid. Most components of the wind turbines are locally made (including blades from wood), and the villagers are supported in establishing a renewable energy cooperative society to own and operate the system. Gender equality is considered important and women have to be involved from the beginning of the process. Support for this initiative has been provided by a French donor.

Emmanuel Michael described **UNIDO's** activities to promote renewable energy technologies in Tanzania as part of its overall vision to reduce poverty through sustainable industrial growth. UNIDO aims to create business development opportunities through increasing access to energy through mini-grids, to mainstream the use of renewable energy in industry (particularly SMEs) and to support innovative business models to promote renewable energy in the business sector. UNIDO has sponsored a number of off-grid pilot projects in Tanzania that make use of biogas, solar PV and micro-hydropower technologies. A particular focus is on market-based approaches to micro-hydropower mini-grids: a mini-hydropower technical centre has been established and more than 30 people have been trained, including through a partnership with Indonesia.

Robert Zeidler presented on **Mobisol**, a company in Tanzania with 40 staff and 400 agents selling 'plug-and-play' solar home systems. A key component of the technology is the solar controller, which not only charges the system but also communicates data on generation, usage and payment back to Mobisol. Micro finance is made available to customers who have a choice of repayment plans, up to a maximum of three years (the duration of the initial product warranty, which is then renewable for a further three years).

Samwel Kessy summarised the experience of **TANESCO** (the state-owned Tanzania Electric Supply Company) with a project to establish a wind-solar hybrid system for sustainable health services. The project aims to power six rural health centres and has successfully installed systems combining 1 kW of wind and 1 kW of solar PV power. Mr Kessy reviewed the project's background and funding, sustainability issues, barriers and opportunities encountered, local acceptance and outcomes.

Steven Martin Saning'o gave a short description of the experience of the **Institute for Okonerei Pastoralists Advancement** (IOPA) in implementing off-grid electricity projects in the Maasai village of Terrat.

The village has built a 300 kW diesel-generating plant, fuelled by biofuel from jatropha and proton, and supporting a mini-grid supplying over 100 households, a radio station, a dairy, a village training and social centre, and several small shops and workshops. Social impacts have included improved health and new opportunities

for income generation, giving villagers reasons to continue to reside in the village.

Jim Elsworth described the work of **TAREA**, the Tanzania Renewable Energy Association. A membership organisation of renewable energy entrepreneurs in Tanzania, its objectives are to advance knowledge and skills, create networks between members and other key actors, support an enabling environment, encourage best practice, promote local manufacture and facilitate market development. It has branches in the Lake and Northern Zones. He also briefly discussed **Kakute Ltd**, a company which disseminates technology and provides training, and his own consultancy Twende that develops and disseminates appropriate energy technologies with an increasing focus on harnessing animal power.

**Azuri Technologies** sells pay-as-you-go solar home systems in Africa, supplying a market estimated to be worth 30 billion US$/year. Edward Ntumwa explained the Azuri approach in which customers can start with a simple 2.5 W system that powers two LED lights and a mobile phone charger (saving 50% on current spending on kerosene for lighting and third-party mobile charging), and then progress up the 'energy escalator' as they pay off their system costs and add more power and the ability to support more energy-using appliances. Solar home systems up to 80 W can support fridges, sewing machines, TV, Internet access, etc. Azuri has a vision of the 'un-grid' in which solar home systems run a new generation of low-power, low-DC voltage appliances.

A problem for mini-grids identified in the discussion that followed these 'elevator pitches' is that the cost of capital is high – interest rates are typically 18–25% – and though it may be possible to refinance at better rates when a track record has been established, this may be too high an initial hurdle for many projects. Dan Klinck suggested that mini-grids are best developed and operated in private hands though with community members encouraged to be investors in the scheme. Without grid connection a challenge for micro-hydropower projects can be to secure enough customer connections. A careful choice of location is an essential factor for micro-hydropower projects.

Certification of solar products can play a useful role in building customer confidence and weeding out poor quality products. Warranties and efficient product exchange are also important, but participants identified building customer trust as the key to success. Teachers in particular have played an important role in promoting solar lighting in their villages.

Terrat residents in woodworking shop

## Day 1: Afternoon session

In this session five presentations were made on the production and use of off-grid electricity, including novel technologies that may potentially enable breakthroughs in solar technologies, consideration of environmental impacts and issues of sustainable implementation.

### Off-grid renewable energy systems

Ir Ahmad Zaidee Laidin, Akademi Sains Malaysia

Ahmad Zaidee's presentation focused on experiences of off-grid renewable energy systems in Malaysia. Starting with an overview of renewable energy technologies, Ir Zaidee emphasised the need for a long-term, pragmatic and clear policy environment. He stressed the need for:

- rigorous cost-benefit analysis that will allow countries to select technologies appropriate to their geographical characteristics and existing energy systems;
- a clear roadmap based on realistic goals that is sufficiently flexible to account for technological developments and unforeseen events;
- reducing administrative barriers and improving capacity;
- fostering awareness of renewable energy technologies to facilitate social awareness;
- reducing investment risk for private sector investments; and
- a transitional incentive scheme designed to foster technological innovation.

Malaysia's rural energy experiences point to the need for a national champion to drive renewable energy development. In Malaysia this is the newly established Sustainable Energy Development Authority (SEDA): a statutory body that works closely with key stakeholders to drive the adoption of renewable energy. Ir Zaidee discussed Malaysia's earlier micro-hydropower failures (and more recent successes) that show the need for a rigorous cost-benefit analysis to be undertaken. He also offered another cautionary tale about a biodiesel project in which biomass that was assumed to be 'free issue' to the project acquired a market price, undermining the financial viability of biodiesel production.

Finally, Ir Zaidee profiled the Rimbunan Kaseh smart village to show how rural poverty can be addressed by promoting sustainability through technology. Rimbunan Kaseh is a model rural community consisting of approximately 100 affordable homes, state-of-the-art educational, training and recreational facilities, and an integrated, sustainable farm (which also uses aquaponics) designed to both provide subsistence foodstuff and supplementary income for villagers. It was noted that the community is served by the electric grid but that one of the stated goals of the project is to increase the use of renewable energy generated in the community. Rimbunan Kaseh is a collaborative initiative between the Malaysian government, the private sector and the New York Academy of Sciences.

### Organic photovoltaic modules and biopolymer super-capacitors for Supply of renewable electricity

**Professor Olle Inganäs, Royal Swedish Academy of Sciences**

Olle Inganäs shared recent breakthroughs in organic photovoltaic modules and biopolymer super-capacitors that have the potential to be part of the solution to providing affordable electricity after sundown in off-grid communities. Substantial R&D efforts have been

Ir Ahmad Zaidee Laidin, Akademi Sains Malaysia

dedicated to developing flexible polymer photovoltaic modules that can be produced using low-cost printing techniques. A power conversion efficiency of 12% has been achieved in laboratory conditions (but only 6% in modules produced), and the projected stability when encapsulated is 30 years (5 years in modules produced). Organic solar cells are lightweight (150 kg materials/km2) and flexible, and are anticipated to be printable at the rate of 1 km2 per 24 hours. They offer the prospect of a price breakthrough compared to silicon cells.

Professor Inganäs also provided a brief overview of the potential for storing electrical energy in technologies based on renewable resources rather than lead acid batteries, which have a 6–10 year lifespan. Storage technologies based on lignin from (sub-)tropical plants in biopolymer electrodes were identified as demonstrating improved storage capacity, and as having the potential to match some of the electricity storage needs of off-grid communities.

Professor Inganäs concluded by providing an overview of his positive and fruitful collaboration with the University of Addis Ababa. His vision is for Africa to be self-reliant in the use of such processes and in the printing of organic solar cells.

In response to questions, Professor Inganäs indicated that the required printing technologies should present a much lower technical barrier for indigenous production in African countries than silicon-based PVs. A major component of cost is the substrate: if organic solar cells can be made like food packaging then the technology will be very cheap.

## Sustainable implementation

### Dr Heather Cruickshank, University Of Cambridge

Heather Cruickshank's presentation began by setting out three considerations necessary to achieve sustainable development: longer geographical and temporal scales, complex systems and wider impacts, and context-specific challenges and aims. Development involves dealing with people, values, power and politics at a micro-level, and sometimes has unintended consequences. Dr Cruickshank argued that community self-reliance is a naïve concept and that actors should work together to achieve sustainability.

Appropriate energy technology depends on the following factors and their interaction: single-purpose vs. multi-purpose technology, systems independence, image of modernity, individual technology vs. collective technology, evolutionary capacity of technology, risk factors and cost of technology. Dr Cruickshank made the point that the maintenance of a selected energy technology requires the private sector, the public sector and sufficient funds.

It may be anticipated that any project will be a long and uneven process, requiring flexibility to respond to changing circumstances. Evaluation should focus on outcomes rather than outputs. Commitment from the local community to participate is essential; factors that may limit participation include power, knowledge, time, money and culture. Before project implementation begins consideration must be given to final ownership, management of day-to-day operations, method of payment for repairs and maintenance, and the possibility of future extensions to neighbouring communities. A spiral of unsustainable dependence should be avoided.

Lastly, Dr Cruickshank introduced guiding principles that are key for sustainable implementation: identifying functional requirements, encouraging participatory development, valuing indigenous knowledge, promoting local innovation and striving for sustainability.

## On the impacts from renewable energy systems

### Professor Sverker Molander, Chalmers University

Sverker Molander introduced his presentation by framing renewable energy in the context of sustainable development: it has social, economic, cultural, technical, institutional and environmental impacts, some of which may be negative. 'Problem-shifting' needs to be addressed: renewable energy may simply shift the problem from being, for example, an economic or technical problem to an environmental problem. To avoid this, Professor Molander emphasised the importance of assessments (e.g., environmental impact assessments).

He noted that although almost all countries have legislation mandating environmental impact assessments, they do not tend to impact the implementation of projects.

Environmental impacts are caused by the combination of the technology used, local conditions and scale. Professor Molander also emphasised the need for systems thinking, such as environmental impact cause-effect chains. Additionally, he argued that although production, installation, operation and maintenance are covered in current environmental impact thinking, it is important to incorporate plans for the decommissioning of renewable energy technology and waste handling before it becomes a serious problem. His presentation finished on an optimistic note suggesting that if insights from sustainability and environmental assessments are combined it is possible to achieve a win-win solution and avoid problem-shifting.

In response to a question, Professor Molander indicated that prospective environmental assessments of new technologies should be undertaken before actors are 'locked in'.

## African network for solar energy

### Professor Teketel Yohannes, University Of Addis Ababa

Teketel Yohannes presented on the African Network for Solar Energy (ANSOLE: www.ansole.org). Created in 2010, ANSOLE is a platform of exchange with three main goals: fostering training and education in solar energy at various skill levels, facilitating

Professor Teketel Yohannes, University Of Addis Ababa

research activities in the field of solar energy among African and non-African scientists and promoting and encouraging the use of solar energy in Africa. Its objectives are: training and education programmes, student exchange and laboratory visits by member scientists, joint research proposals and publications, organising meetings in Africa, designing and hosting graduate programmes on renewable energy, creating a database of scientific and economic operators of solar energy in Africa, creating regional research centres in different parts of Africa, promoting the use of solar energy in Africa and making solar energy accessible to everyone in Africa.

As of May 2014, ANSOLE consisted of more than 640 members based in 37 African countries and 19 non-African countries. It operates two student exchange programmes—the Intra-Africa Exchange and the Africa-North Exchange—and has held a number of successful workshops, symposia and conferences.

## Breakout groups on technology and capacity development

Two breakout groups considered issues of technology development (questions A and B below), and two considered issues of capacity and skills development (questions C and D below). Key points made by the breakout groups may be summarised as follows:

### A: What new technologies and improvements are most needed to enhance prospects for off-grid village energy provision and use?

There are a range of technologies available but more integrated and hybrid systems may be anticipated after an evidence-based assessment of the suitability of sources.

- Power plant and mini-grid control systems need to be simplified to facilitate this. Electricity generation and use technologies need to be developed to be 'plug-and-play' wherever possible.

- Thermal or mechanical energy should be used directly where appropriate – not everything needs electricity.
- Better batteries are needed, suited to the needs of electricity storage in a village setting.
- Technologies are needed that process bioenergy more efficiently and that reduce emissions from biomass cookers.

## B: what research, development and demonstration activities are needed to deliver these?

- Research institutions should work more closely with the private sector and social enterprises in order to influence development of the technology to suit local demands.
- Develop intelligent systems that monitor use, output, payments, etc. (along the lines of the Mobisol systems).
- Address recycling issues in the development of technologies, including the use of materials that do not produce toxic waste.
- Making use of feedback from stakeholders, develop a publicly available database of the suitability of technologies in respect of particular applications and of good/bad practices.
- Develop and make publicly available better information on energy markets in rural communities.
- Develop and promulgate approaches to life cycle assessment of technology options.
- Develop cheap/short-life technologies that permit entry to the technology ladder and enable capital to be raised for subsequent, more advanced approaches.
- Establish demonstration projects in trading hubs, providing energy for productive uses, with monitoring schemes to evaluate impacts and outcomes.

## C: where are the main shortfalls in skills and capacity?

- A wide range of skills – business and technical – is needed among the actors involved in designing, building, financing and operating energy supply systems, and in making effective use of the energy. A shortfall of skills at any point can have a detrimental impact on project outcomes, and projects should include a comprehensive analysis of skills/capacity needs.
- Aspects such as gender, trust, access to good machinery and infrastructure bottlenecks all impact the ability to build capacity.
- On the operations and maintenance side, villagers or local technicians need to have the skills to operate and maintain systems. There is a lot of investment in new projects, but without local technical skills, those projects often fail and the investment is wasted.
- In the private, NGO and academic sectors, there is a lack of outcomes measurement and metrics to support projects. Without these projects are starting to lose funding entirely. For all actors, it is important to promote capacity and skills building realistically,

Steven Martin Saning'o shows award-winning maasai cheese room in Terrat, powered from the village bio-diesel mini-grid

and to make sure that people understand their limits with regard to self-reliance and are able to contact actors for necessary assistance (e.g., end users repairing an off-grid energy unit without appropriate tools or skills).

## D: where should training initiatives be targeted to maximise impact?

- For end users, training courses should enable them to understand and be aware of energy technologies and their productive uses.
- A vocational training focus is needed for agents to operate and maintain off-grid technologies.
- For entrepreneurs, it was deemed important that they first understand the position of the entrepreneur in the value chain and that they be provided training in areas such as bookkeeping, the basics of finance and how to access loans/equity, managing the value chain and networking.
- Training is needed to improve the understanding and capacity of financiers, including issues such as the seasonal nature of the rural economy and the consequent need for tailored and more flexible loans.
- Universities can play a useful role in training – not so much at the degree level but by focusing on the practical skills needed by people involved at the various stages of village energy projects.
- The approach taken in Rwanda may be relevant elsewhere: a school dedicated to training for renewable energy technologies has been established.

## Day 2: Morning session

Four presentations were made in this session on key energy uses highlighting key services and productive enterprises enabled by energy access.

### Ekocenter as a catalyst for sustainable community growth

**Simon Bartlett, Coca-Cola**

Simon Bartlett's presentation on Coca-Cola's EKOCENTER provided a private-sector viewpoint on how energy can catalyse sustainable development at the village level. He stressed the global reach of companies like Coca-Cola and the scale of private sector financial resources: consequently there is a need to engage the private sector in development (as part of the golden triangle of government, business and civil society). A key premise for Coca-Cola is that a business can do good by doing good business.

The remainder of his presentation focused on Coca-Cola's EKOCENTER, a 'community centre in a box'. The EKOCENTER is a modular solar-powered kiosk that can be delivered as a 'flat-pack' and is readily assembled. It provides clean drinking water, allows people to connect to the Internet and provides a suite of products and services that are determined by each community. There are 25 to 30 EKOCENTERS planned to be in operation in five different countries in Africa by the end of 2014, and it is intended that scale up beyond that will happen quickly in order to have a transformational impact.

Provisionally, the business model is that the EKOCENTER will be franchised to a female entrepreneur from the local community. She will be trained by Coca-Cola and partners, and will need to generate an operating profit, reinvest and grow. Mr Bartlett stressed that the revenue streams will primarily flow to the kiosk operator and her staff. When addressing Coca-Cola's reasons for developing and deploying the EKOCENTER, Mr Bartlett stated that a business can only be as healthy as the community it is in, and that the sustainability of business is linked to the sustainability of the communities in which it operates. Furthermore, the EKOCENTER is a social business with the chance to build trust between the local community and Coca-Cola, and an opportunity to open up new routes to market through partnerships. It is intended as a catalyst for sustainable community growth.

Responding to questions, Mr Bartlett indicated that Coca-Cola's key criteria in choosing partners to take forward the EKOCENTER model are a shared sense of purpose and a longer-term perspective on market development. Candidate communities to host EKOCENTERS will be carefully evaluated and the female entrepreneur chosen to run each EKOCENTER will be identified by the respective communities. The intent is for the entrepreneur to run a sustainable 'for-profit' enterprise. The cost of providing clean water will be borne by the charitable arm of the EKOCENTER initiative.

### Rural healthcare innovations (video presentation)

**Dr Kanav Kahol, Public Health Foundation of India**

Kanav Kahol's video presentation introduced the public health situation in India, where, like much of the developing world, there are diverse health issues and insufficient frontline health workers. As a result, Dr Kahol saw the potential for a technological interface to improve the capabilities of frontline health workers. This was visualised as a diagnostic unit that within a single tablet computer can have multiple diagnostic tools, and has come to realisation as the Swasthya Slate. The Swasthya Slate interfaces with Android tablets and mobile phones to conduct up to 33 diagnostic tests, as well as a water quality test. It is designed on a

'plug-and-play' basis and requires relatively little training of healthcare workers to be able to use it effectively.

The Swasthya Slate has the potential to make a major impact on rural communities with poor healthcare access. It is approximately 1/100th the cost of its component diagnostic tools and is expected to further decrease in cost after mass production. The Swasthya Slate stores information in the cloud with each user being given a registration number, making it easy for clinics and hospitals to access patient data. It will be distributed through nurses in India, and its use of standard protocols should make it easy for them to use.

It can be taken into a remote village where everyone can be tested and the results transmitted to a doctor who can decide who needs treatment. An issue is to have enough resources in the data-receiving hospitals. A question was raised about the maintenance of the Slate and the maintenance of its correct calibration in operation. The sensor components that send data to the Slate digital platform are standard 'off the shelf', requiring low levels of maintenance and are easily replaced. Their operation can be remotely monitored. Calibration and maintenance issues have been addressed in the current roll out to tens of thousands of villages in India.

## Poor people's energy outlook (PPEO) and energy market system framework

**Dr Ewan Bloomfield, Practical Action Rwanda**

Ewan Bloomfield gave an overview of Practical Action's Poor People's Energy Outlook and Energy Market System Framework – both designed to tackle energy injustice. The Poor People's Energy Outlook (PPEO) report series began in 2010 and set out to redefine what energy means by prioritising energy needs from the point of view of the poor. In particular, the PPEO emphasised heating and mechanical power alongside electricity, and the importance of community services and earning a living. It also established minimum standards for energy services that people use (e.g., lighting, space heating and cooling, cooking).

The PPEO has defined total energy access as an objective, which is met when there is access to all energy supplies and services required to support human, social and economic

Simon Bartlett, Coca-Cola

development at the household, enterprise and community service levels. Building on the framework developed for PPEO, Practical Action has developed with others the Global Tracking Framework for the Sustainable Energy for All (SE4All) initiative: it measures progress towards universal access to energy through a system of tiers for households, enterprises and livelihoods, and community services. Dr Bloomfield mentioned that there is a significant shortfall in funding to meet the commitments of the SE4All initiative.

Practical Action has also developed the Energy Market System Framework, which is a practical and replicable tool that, through participatory methods (e.g., mapping workshops), identifies market barriers for a given energy technology. In turn, this allows for recommendations to be derived from all stakeholders for interventions to address market barriers.

In response to a question about the tiers of energy access, Dr Bloomfield indicated that the tiers increase awareness and capacity to produce technologies that meet standards. They allow technologies to be categorised within tiers, and performance claims to be tested against the tier criteria (including end-user acceptance). The challenge now is to make people aware of the tiers.

## Energy for agricultural innovation

**Dr Claudia Canales-Holzeis, B4FA**

Claudia Canales Holzeis introduced the Biosciences for Farming in Africa (B4FA) project and, in particular, its pilot project on how to strengthen agricultural extension services for smallholder farmers in sub-Saharan Africa using a digital learning platform on mobile devices. Increasing agricultural productivity is essential for rural poverty reduction and increased food security, and agricultural value chains are becoming more knowledge and energy dependent.

The pilot project was carried out with Farm Africa and focused on sesame production and marketing, with the aim of obtaining proof of principle of the suitability of the digital learning platform to deliver agricultural extension services to rural communities.

Philipo, a Terrat resident, with the village's biodiesel generator

Four off-grid villages in Babati District, Tanzania, were selected and farmers in two villages were trained on tablets using the digital learning platform. Farmers in a control group of two villages were trained using traditional methods. This involved the development of a modular course on sesame production and marketing (in English and Swahili and developed locally with the involvement of the farming community); the development of the back-end application to increase off-line functionality and cope with intermittent Internet connections during updating; and data on the baseline level of knowledge, demography and socioeconomic conditions.

Project evaluation is currently underway. In order to scale-up the project a power source (currently a 6 km walk to access electricity), connectivity (mobile Internet) and a sustainable business model are required. An innovative and effective knowledge-sharing model was also presented where information is shared through forms of entertainment, such as a song competition. A key point was made in concluding: access to knowledge is only one part of the puzzle and other enabling policies are required in the areas of, for example, finance, energy, infrastructure and access to markets.

In the ensuing discussion it was recognised that an important issue is the price that farmers are willing to pay for agricultural extension systems compared to what they cost. Smart phones are expected to be used increasingly by villagers and may prove to be the preferred vehicle in future for the digital learning platform. Agricultural extension services are weak in many countries and are dominated by men, whereas women do much of the agricultural work. The tablets are a good way for women to get information and to be more empowered.

## Appropriate technologies and delivery models to upscale the use of clean lighting and cooking for the household sector in Africa

**Dr Janakaraj Murali, The Energy Research Institute, India**

Janakaraj Murali introduced The Energy Research Institute (TERI), a not-for-profit Indian R&D and policy think tank employing 1,000 professionals with strong programmes on energy access. A key global initiative is 'Lighting a Billion Lives', which is facilitating the setting up of energy enterprises offering clean lighting solutions to villages in Africa and Asia.

A joint project with the UK government's Department for International Development (DfID) is piloting scalable, private sector-led business models for the provision of clean lighting solutions and cooking devices, and aims to reach 20,000 households in East Africa over the period 2011 to 2015. National focal points have been established in Kenya and Ethiopia, coordinating activities on R&D (universities

in Nairobi and Addis Ababa are collaborating with TERI's Solar Lighting Laboratory), lamp assembly and cookstove fabrication by local enterprises, marketing and dissemination using existing and new business models, and establishing energy shops and micro-franchises that provide responsive repair services and sales. A range of lights and cookstoves has been developed, catering for different segments of the market. So far, 3,500 homes have been reached with cookstoves, and 2,800 with solar lights. Monitoring and performance verification of lights and stoves have been established in Kenya and Ethiopia.

Challenges in establishing local fabrication have included: non-availability or irregular supply of raw materials that are expensive;

Off-grid barber shop in Ngarenairobi, Tanzania

lack of skilled personnel; high cost of battery, electrical and electronic components; lack of testing centres; very few dealers in the market (and who prefer imported products over local fabrication); current focus on institutional and commercial sectors rather than domestic; and imports driven by customs duty waivers. Key ongoing issues include problems for customers arising from different programmes promoting different lighting products and the need for performance benchmarks.

## Breakout Groups to Consider the Energy Needs and Possibilities in Rural Communities

Four breakout groups each considered different questions as recorded below.

1 How can we achieve an effective integration between initiatives for energy access and other strands of development? How can the rate of progression through higher levels of energy access be increased, and 'lock-in' at lower levels be avoided?

- The issues should be addressed from the service demand perspective. There is not a single solution, and appropriate approaches will be determined by a range of factors, including the levels of centralisation and/or dispersion of communities. There may be advantages, particularly for electricity provision for productive uses, to start with more centralised communities.
- Anchoring loads (such as mobile phone towers or grain mills) around which other businesses may congregate, may provide an appropriate basis from which to develop mini-grids, provided that they are designed so that the scheme can grow and so that household needs are also met (if not, lock-in may occur).
- There can be a tension between the need to take a long-term view and the short-term need for returns to service loans, etc. Investment from within the community should be encouraged.
- Selling products and services and generating a surplus are key to progression to higher levels of energy access and development. Energy supply to, and

stimulation of, productive enterprises, and creation of effective markets, should therefore be priorities.

- Governments should take an active role in advertising and promoting success stories. Also, they should advise local entrepreneurs on opportunities for services/products that customers elsewhere have shown that they want, and on good practices in meeting those needs while minimising risks.

- The analogy with the rapid take-off of mobile phones cannot be taken too far: mobile phones have always been a commercial product, with a cost-benefit ratio that has proved attractive to customers, whereas electricity provision through mini-grids generally still requires some level of public support. Also, people would never expect to get a mobile telephone free of charge, but in some areas they do expect free solar lights because of previous government distribution programmes.

2 How should energy access initiatives be constituted so as to enable the poorest families to escape the poverty trap? How can a focus on energy provision and use at a community level result in greater overall value than a focus on individual access?

- There is a need to involve the poor and to have an integrated and concerted effort to provide energy access in rural areas. This should include government- and/or donor-led activities to raise awareness of energy access initiatives among the poor, as well as the benefits of modern energy sources compared to traditional sources and the productive uses of modern energy sources.

- Existing village-level support institutions may be harnessed appropriately along with innovative financing mechanisms to enable poor households to get onto the first rung of the energy access ladder.

- Different business models may be needed to provide energy to community services (schools, hospitals, etc.) than those used for household energy access.

- Mini-grids can have more impact than solar home systems but the settlement patterns of remote rural villages means that there may be areas where it is feasible to have a mini-grid and areas where it is preferable to have solar home systems (a hub-and-spoke approach).

3 What are the distinctive energy needs of village-level education, health care, clean water and sanitation? What are the key challenges and opportunities for meeting those needs?

- There is a major problem with fake products of poor quality that undermine customer confidence: better quality control and product standards are needed to protect customer interests. A better understanding of the links between affordability, availability and quality is needed.

- There is a need for a consumer right to reply, particularly to comment on customer service and quality control.

- At the household level, electricity for appliances such as sewing machines, food mixers and bread makers can help women to make products to sell for income. More should be done to raise awareness of the benefits of electricity access, including such home-based income-generating opportunities.

4 What are the distinctive energy needs to support productive enterprises and income generation? How can we establish a 'positive spiral' where energy access generates income that can be used to progress up the energy/development ladder?

- The needs and opportunities are always dependent on the particular resources and existing economic activities that a village has. It may not always be possible to anticipate the new opportunities arising from energy access. Certain needs such as refrigeration require reliable 24/7 energy supplies.

- It may be appropriate to start with existing productive enterprises and demonstrate how energy access can improve yields and productivity. A common need of villages is the milling of crops: access to power can substantially improve productivity and reduce the cost of food.

- Establishing a positive and robust spiral requires diversification of the village economy, not relying on a single product. Investments are needed in the equipment required for productive uses of energy, not just in energy supply: initiatives are consequently needed to enable entrepreneurs to access financing for such equipment. Alongside this, training should be provided to enable people to develop the skills necessary to run successful businesses.

- Modular energy supply systems that can grow with the load are needed. Micro-hydropower schemes can be problematic in this regard.

- Understanding the social context for energy schemes is essential: for example, an earlier improved cookstove project in Tanzania failed because villagers enjoyed the opportunity for social interaction around an open fire that was no longer possible with the new technology.

- Systems should be put in place to enable the sharing of lessons from previous projects, both successes and failures.

## Day 2: Afternoon session

The six presentations in this session gave additional perspectives on the issues arising from the provision of energy to off-grid villages in East Africa.

### Village-level energy, REA's experience

**Eng Advera Mwijage, REA**

Advera Mwijage explained that the Tanzania Rural Energy Agency (REA) was set up in 2005 to support improved energy access to rural communities in Tanzania. It undertakes experience sharing and networking initiatives, and provides financing for technical assistance for pre-investment activities, training and capacity building, market development for renewable energy technologies and implementation of projects. Funding for REA comes from the Tanzania Rural Energy Fund, the World Bank and special purpose funds such as the ACP-EU Energy Facility for renewable energy planning.

The REA provides several lines of funding for rural energy projects:

- Matching grants support pre-investment activities such as feasibility studies, socioeconomic studies and market analysis; environmental and social impact assessments; preparation of bankable business plans; financial intermediation and closures; training and capacity building; and market development.
- Performance grants support the buy-down of project capital costs to lower the unit cost of energy service provided. For example, 500 US$ is provided per grid extension connection and 5 US$ per watt-peak solar PV installed.
- Long-term financing provides a credit line to shortlisted banks for loans up to 15 years with a grace period of 5 years (3 projects have been supported).
- Access to carbon finance, in which the REA acts as the coordinating and management entity in partnership with the World Bank.

To date, 171 projects have been supported, of which 96 have been completed; 117 have been for grid extension. Electricity connections have included public services, households and irrigation systems. REA also runs a 'Lighting Rural Tanzania' competition that awarded 100,000 US$ to each of 10 projects in 2010 and to each of 15 projects in 2012. Three million US$ will be awarded in the 2014 round.

Ongoing challenges include: securing enough funds to match grant requests, compensating properties affected by rural electrification projects, attracting private sector investments for the provision of modern energy services in rural areas, and long transmission distances and irregular population densities in rural areas. Important elements of REA's forward programme include promoting and facilitating more innovation in rural electrification projects, creating an enabling environment to attract private sector participation in rural energy projects and continuing initiatives to connect all social facilities in rural areas by either grid electricity or stand-alone systems.

### Fostering entrepreneurship—Impact investing

**Emma Caddy, ERM Foundation**

Emma Caddy explained how impact investments aim to solve social or environmental challenges by investing on sub-commercial terms while generating sufficient financial returns. Impact investments support private businesses that provide goods or services offering healthy

and affordable options for overlooked, lower income customers. Such businesses are often innovative and too high risk for commercial capital: they suffer from first-mover disadvantages and need subsidised capital, typically 50,000 to 1,000,000 US$, to scale up.

Impact investing occupies a gap between bank financing, savings and credit cooperative organisations, multilateral banks and development finance institutions, NGOs, and traditional private equity. It can help entrepreneurs through flexible and patient funding, diversified investment structures, sub-commercial financing terms, assuming higher risks, bringing in financing partners, and increasing the investee's marketability and brand. However, it has limitations, for example in seeking to take a market approach where a market does not exist, in managing tensions between wanting a return but also impact, and in investing in small businesses but seeking scale. Challenges to investment partnerships include the ability of entrepreneurs to keep up with evolving markets and products; the provision of support to ensure entrepreneur preparedness; misaligned expectations between funds, boards and fund investors; and unsupportive regulatory environments.

The ERM Foundation runs the Low Carbon Enterprise Fund (LCEF), which provides early-stage financing (50,000 to 250,000 US$) and pro bono support from ERM consultants to SMEs whose products or services offer reduced carbon emissions.

## Swedish development cooperation

### Samer al Fayadh, Embassy of Sweden

Samer al Fayadh summarised the objectives of the Swedish energy policy platform as increasing energy efficiency, the share of renewable energy, and access to modern energy services and decreasing subsidies to fossil fuels and carbon dioxide emissions. Specific objectives in Tanzania are to support energy access to an additional 300,000 people, increase the participation of the private sector, support institutional development, increase the share of renewable energy in Tanzania's energy supply, and increase transparency and financial sustainability. Associated activities are supported by an extensive programme of dialogue with stakeholders. Mr Fayadh indicated that the coordination of donor support needs to be improved.

## Changing rural economies in Tanzania following small-scale electrification

### Dr Helene Ahlborg, Chalmers University of Technology

Helene Ahlborg's presentation focused on the experience of the Mawengi micro-hydropower scheme in the southern highlands of Tanzania. Initially, 260 users (including 30 commercial and 6 productive enterprises) were connected to this scheme, which was funded by donors but owned by a local NGO, LUMAMA. In this first phase there was low consumption for productive use (less than 30%); revenues were insufficient to cover operation, maintenance and depreciation costs; and LUMAMA did not have the capacity to manage the service efficiently.

An additional problem for the project was caused by farming practices upstream of the hydropower plant that led to a build-up of silt that compromised the plant performance. Appealing to the upstream villagers was difficult as they were not connected to the energy output of the hydropower scheme. By 2014 connections had risen to 1,200, and maximum output was 260 kW. Concerted effort has been put into capacity building of LUMAMA, and the electricity scheme has been integrated with other development initiatives related to agriculture, business, education, land-use planning and water conservation. Upstream farmers were being persuaded to move away from the riverbank to reduce siltation. A shift has

Dr Helene Ahlborg, Chalmers University of Technology

been made to a pre-pay tariff structure and a balanced budget was achieved thanks to an increase in productive uses, in particular milling machines. Local participation has been valuable in protecting infrastructure, enabling collaboration around the common resources, capacity building, building trust between the community and LUMAMA, and preventing capture by an elite.

Take-home messages are that renewable energy projects normally ignore what happens after electricity is produced, but we need to understand how available services translate into sustained impact. Achieving impact requires the identification of productive uses, needs and market potentials and a consequent suitable energy source; getting to know the rural entrepreneur in his/her context and value chain; establishing business models that cater for seasonality; and investing in people's abilities to use electricity productively.

## Market-based solutions for scaling access to energy in Tanzania

**Martijn Veen, SNV**

Martijn Veen described the work of SNV, a Dutch non-profit, international development organisation, to provide renewable energy services. He identified key success factors as inclusive development, systemic change, local ownership and contextualised solutions. Projects in Tanzania have involved biogas, improved cooking solutions and pico-PV solar. A current four-year, results-based financing project aims to establish a temporary financial product within mainstream banking for pico-solar import-suppliers actively engaged in distribution chain development.

An increasing number of reliable solar suppliers are entering the market in Tanzania but further expansion of the industry is dependent on the ability to consistently place large import orders. There is a lack of reliable retail chains tapping the deeper portions of the rural off-grid consumer market, and economies of scale cannot be achieved without incurring high costs and/or monopoly of the supply chain.

With regard to retailers, sources of quality solar technology options capable of meeting diverse consumer energy needs and incomes are unreliable, and low levels of working capital paired with poor pricing practices embed a high margin/low turnover culture. This has led to uniform, expensive and low-quality solar products becoming the market norm. There has been limited entry of new players

in agribusiness with linkages to deeper rural markets. In rural communities up to 60% of consumers indicate that they prefer solar-based energy technologies. Their average monthly energy expenses are 40,000 TZS (40 US$), of which 45% could readily be satisfied with pico-solar, but only 3.5% of consumers currently own solar products.

The rural market is very large: consumers want solar products and can afford them. The key challenge is distribution, and in particular connecting suppliers and retailers.

## Technical capacity building in solar PV installation and maintenance

**Dr Justus Simiyu, University of Nairobi**

Justus Simiyu explained that electricity demand is growing rapidly in Kenya, and there is a high potential for solar PV. Most installations to date are off-grid solar home systems and there are 800–1000 solar PV technicians supporting installation and maintenance, and sometimes acting as sales agents. The Kenyan government has put in place regulations to guarantee the quality of solar home systems and their components, and has established a system of licensing for technicians working in this sector.

The University of Nairobi has established residential training modules to meet these licensing requirements and has trained 150 technicians over two years from Kenya, Uganda and South Sudan. This initiative has been supported by the International Science Program. World Vision has been involved. The impact of the initiative has been restricted by a lack of outreach, as might be accomplished, for example, through a mobile training facility, and a lack of capacity to train at the top 'T3' level.

## Q&A

In the question-and-answer session that followed the presentations by panel members, Martijn Veen indicated that results-based financing can be used if the market is sufficiently mature, i.e., there is a demand from customers and sufficient suppliers for there to be a competitive situation. Emma Caddy observed that impact investors are increasingly operating in more of a venture capital mode in which they stay with an entrepreneur as his/her business develops, putting in incremental funding. Unfortunately, the sector is becoming very risk averse: funders should be prepared to lose money but also to get out quickly.

Helene Ahlborg pointed to the important role played by the church in the Mawengi micro-hydropower scheme, enabling connections to local lenders and mobilising people to help. However, when the pastor moved on the church became more passive. Community involvement and ownership have been essential. What are needed are public–private–community (PPC) partnerships.

## Global village energy partnership

**Lindsay Van Landeghem, GVEP International**

Lindsay van Landeghem introduced the work of GVEP International, whose mission is to work with local businesses on the ground in developing countries to accelerate access to modern energy. Activities include providing support to micro-enterprises and advice to SMEs, conducting market research and facilitating access to capital.

Ms Landeghem outlined the challenges facing SMEs in the field in respect of seed capital for start-ups, working capital for existing SMEs, end-user financing so that products are affordable, distribution, after-sales service, and access to market data. For each, she reviewed the

current situation and challenges, and how they may be resolved.

Market trends include:

- Novel end-user financing mechanisms are enabling base-of-the-pyramid access whereas several years ago upfront costs were prohibitive.
- There is increasing interest in local manufacturing, particularly for cookstoves, but limited technical capacity, quality control and lower costs in Asia are barriers.
- Local debt financing is highly inaccessible given risk perceptions/interest rates, collateral requirements, and lack of capacity, but some donors are trying to overcome this barrier.
- Large amounts of capital raised by established players show that all types of capital are available, though an early-stage gap still exists.
- There is increasing interest in mini-grids as a means to deliver scalable access amongst donors, investors and SMEs.

Regulatory frameworks are underdeveloped for mini-grids, scalable business models are still being developed and, as yet, there is relatively little private sector involvement. While mini-grids may offer similar returns to grid-connected generation, risks are perceived to be higher and hence it is more difficult to access funding.

Ms Landeghem concluded by identifying steps that need to be taken to move forward:

- SMEs need to continue to innovate to address some of the challenges inhibiting scale-up.
- Donors must engage with SMEs and fill gaps where private sector financiers will not participate.
- Regulators should improve policy, legal and regulatory frameworks to enhance businesses' ability to operate effectively in the market and to unlock sources of commercial credit.

Lindsay Van Landeghem, GVEP International

Ir Andrew Mnzava of the Tanzania Commission for Science and Technology (COSTECH) demonstrates sample of thin-film organic solar cell technology.

- Various parties should continue to facilitate access to private capital by mitigating risks, such as credit and currency risk.
- Data should continue to be created and aggregated in order to promote best practices and to enhance companies' ability to model and forecast with more precision.
- Investment should continue in incubation, business development and advisory support in order to promote the growth of businesses and to facilitate the flow of capital.

In response to a question about the use of carbon credits, Ms Landeghem indicated that companies sometimes include carbon credits in their business case. But the carbon market is very volatile, and hence such inclusion undermines the viability of the business case: it is generally better to work without it. Carbon credits are not contributing at the village energy level: it costs 10,000 US$ just to be accredited, which most companies cannot afford. Ms Landeghem indicated that in Kenyan culture trust is built, and defaults are dealt with, at a village level.

## Day 3: Morning session

### Africa Village-level energy innovation systems

**Ir Andrew Mnzava, Tanzania Commission for Science and Technology (COSTECH)**

Tanzania is currently reviewing its energy policy established in 2003; Andrew Mnzava indicated that a key concern is to enable a transition to clean energy access in villages. When surveyed, villagers have expressed a preference for improved woodstoves over charcoal-burning stoves as wood can be collected for free. Barriers to using alternative sources of energy were identified as cost, lack of knowledge and lack of available equipment. There is a wealth of village-level innovations that can play an important role, for example embedding clear plastic bottles filled with water and bleach into a roof to bring sunlight into a room. Sometimes high-tech components can be brought together with local innovations, for example in the use of LED lights to improve fishing catches.

Another innovation is 'Village Industrial Power' which uses biomass from crop waste to produce thermal energy, mechanical power

and electricity. A challenge is that production of palm oil, the source of waste biomass originally envisaged, has decreased, so alternative sources have had to be sought. 75 solar-powered water pumps and distribution systems have been installed that use innovative software to monitor performance, ensuring better maintenance and fewer breakdowns.

The role of COSTECH is to coordinate and facilitate research and technology transfer, support innovators, provide support with regard to patents and IP issues, and give awards for innovation, environment, science, etc. COSTECH is also concerned to build the capacity of villages. Its role cuts across the interests of other ministries, which can be both a strength and a challenge.

## Africa enterprise challenge fund

### Eliguard Dawson, AECF REACT

Eliguard Dawson explained that the AECF is a fund of donor money available to the private sector on a competitive basis. Its goal is to accelerate pro-poor growth in Africa, and it looks to fund projects that are commercially motivated and innovative to realise systemic impact. The AECF REACT window aims to catalyse private sector investment and innovation in low-cost, clean energy and climate change technologies. Two rounds of funding have already been completed and a third round, with funds of 20 million US$ from DFID and SIDA, will be initiated in June.

Previous rounds of funding have supported novel systems for the production and distribution of biogas, power generation from sisal waste, gasification of rice husks to generate power, production of briquettes from rose wastes, and new mobile payment distribution technologies.

Funding applications can be submitted for between 250,000 to 1,500,000 US$ and must be match-funded in cash and kind. First-round selection criteria are: capacity of the company (20%), strength of the business case (20%), development impact (35%), innovation (10%) and environmental sustainability (15%).

In response to a question about failure rates, Mr Dawson indicated that out of a portfolio of 12 projects, one has failed (due to inadequate technical capability to execute the project) and another has requested a change in its business model. The matching fund requirement can tend to favour larger foreign companies over smaller indigenous SMEs; looking to the future, funds may be earmarked for indigenous companies that will be given technical assistance to develop quality proposals.

## Strategic breakout groups

Four breakout groups were established to address key strategic questions identified by workshop participants on day 2. The questions and the results of the breakout groups' deliberations are summarised below.

### Group discussion

1 Which will be the winning and losing technologies over the next 10 years in africa? Which ones could have a significant local manufacturing component?

- The market will decide – though markets will be influenced by subsidies. A good outcome would be that there are no clear winners, rather that there should be a good mix of technologies. We may expect that in the mix there will be: a big role for solar; more emphasis on wind; more biogas for cooking, but with potential conflicts with recycling nutrients to the ground and using wastes for animal feed; and more hybrids, for example combining solar and wind technologies that are complementary.

- Factors that will influence which technologies prove to be winners, beyond price, include: environmental impact, for example technologies that are closed cycles producing no waste products; easy adaptability and manufacturing (particularly with potential for local manufacture); and not contributing to climate change.

- There is a need for more data, backed by strong research, for example: a wind map of Tanzania; mapping the availability of water from micro-hydropower, taking account of the potential impacts of climate change; and good environmental assessments.

- Women are currently the losers: there is not enough focus on providing energy to the rural poor and this has a critical impact on women in particular. In smart villages women can become winners in that energy provision enables them to avoid drudgery (for example fetching water and collecting firewood), gives them pride as the 'owner of the house' and leads to knock-on benefits to children. There are cultural barriers, although less so for the younger generation.

- Both wind and micro-hydropower can include a large component of local manufacturing (the latter relating mainly to civil works). Assembly also counts, for example for solar panels.

- Over the next 10 years there will be substantially more opportunities for local manufacture: for example, printed organic solar cells. More generally, Africa has substantial raw materials and cheap labour, and wages are rising in China.

2 What are the most appropriate partnership/implementation models for different situations: public, private, community, gender, environmental? How do we join up the various finance models to form a coherent whole for businesses and consumers, and to 'liberate' finance from all sources: public, private, commercial?

- Different partnership models are required for different situations, but partnerships are often hindered by asymmetric information, principal-agent problems and issues of trust.

- For interventions at the village level, partnerships with local or regional governments are often more effective than with the central government. Rural energy agencies can play an important mediating role facilitating communication and information sharing between actors.

- The focus on women entrepreneurs has highlighted how the pool of entrepreneurial talent is small and how it is often very difficult to access women because of gender-relation barriers, especially in more remote areas. Men need to be included in partnership models as a way to facilitate change in gender relations.

- Disposal of end-of-life energy technologies is increasingly a problem. Legislation needs to be effectively enforced and incentives constructed to attract private-sector recycling firms.

- In recent years financing has been hindered by a poor macroeconomic environment.

- A lack of cooperation and partnership among financial actors is a barrier. Some institutions are blighted by poor management.

- The impact of microfinance is questionable with examples of good and poor performance.

- Village-level financial institutions (e.g., village committee banks) may be usefully harnessed although there are some concerns regarding scale.

### 3 Where are the gaps in research? How do we best harness and foster local ability and capacity? How do we promote technology transfer?

- There is a big gap in applied research, especially regarding how innovations affect people in the field, and a need to develop new tools to evaluate the appropriateness of local projects. There are too many failed projects and wasted resources. A manual is needed that focuses on the process of how to design projects to suit local circumstances rather than the specific elements – how to do instead of what to do.

- There are significant gaps in measuring practical outcomes, especially for corporate and impact investors and donor-financed projects. Financers are starting to halt financing or not grant it in the first place if outcome measures are not provided. Several entrepreneurs present at the conference noted they were not able to apply for significant pots of funding because they were not able to implement systems to measure the outcomes of their projects.

- The University of Addis Ababa has set research priorities that are aligned with the goals and transformation plans of Ethiopia. To avoid poorly designed, wasteful research, projects must meet core criteria: for example, there must be a PhD or Master's student in the project, there should be benefit for the community and research should be thematic across departments.

- To better support local students and stakeholders to have an impact, there needs to be greater emphasis on, and more funding to support, fieldwork and applied research. Currently, the focus rests too much on theory and models. Researchers should be sent out into rural areas, and more efforts should be made to connect entrepreneurs to professors conducting research relevant to their businesses. (COSTECH does this to some extent in Tanzania.)

- More students should be trained to become researchers; currently it is easier to get funding for equipment than for students. PhD programmes in Tanzania need to be reformed: students have insufficient control over their research and it can take up to 10 years to complete a PhD.

- There is a lack of ICT to access resources for PhDs. It can be very difficult to get existing relevant literature in Tanzania. It was noted, though, that many publishers give free access to their publications to researchers in disadvantaged countries; librarians need to be aware of what is available and to be in good communication with researchers. A journal dedicated to village energy for development is needed.

- Technician training programmes should spread throughout the country, not just stay on university campuses.

- Within academia, there is a need for more interdisciplinary collaboration, especially between disciplines with different views of the problems (engineers, economists, natural and social scientists) so as to address broader, more socially relevant questions. There are significant barriers around import duties and customs that delay shipments of research and technology equipment, sometimes indefinitely.

- Within government, there is a need for more autonomy and better access to funding streams for organisations promoting technology transfer, such as COSTECH.

- Within communities, there is a need for greater knowledge of how to operate and maintain technologies once they are installed. Involvement of local technicians during installation is a key element that should be included in project tender processes. Training should be provided by the supplier to avoid a situation of obsolescence due to lack of knowledge about how to maintain systems.

- One way to guard against 'brain drain' is to train people with ties to the community, for example women and people with families. Barefoot Power has taken this approach and it has been a success in India. A secondary effect of this is that it can change gender perceptions about what women can do.

- Progress has been made where there are specific people in charge of forming and advancing connections. This is the way forward. If it is everyone's responsibility, it is no one's responsibility.

## 4 How do we design a 'model' smart village? What are appropriate outcome metrics?

- For the purposes of the Smart Villages Initiative, a village has the following characteristics: it has a leader and sometimes a council; it can have a population between 50 and 6,000; it has one or more amenities such as a market place, shops, religious centre, school and medical centre; and it can be dispersed over a large area.

- A smart village should be designed using an existing village and models will vary according to geography. It should be developed to meet three areas of aspiration: physical, economic and cultural/social.

- Metrics for projects that provide energy to villages should include levels of energy access achieved by households; the number of men, women and children with access to lighting, power, heating, water and sanitation; education access (traditional as well as vocational); and access to finance, healthcare and government services.

- Metrics for consequent outcomes should include levels attained in education, health, economic activity (commercial, industrial and agricultural), entrepreneurship and income.

## 3. Final panel and plenary discussion

In the final session of the workshop a panel and then a plenary discussion considered what messages should be given to key audiences. The following main messages were identified:

1 A supportive policy and regulatory framework is needed that sets clear targets, establishes systems to measure progress and supports the creation of indigenous businesses. Entrepreneurs made a plea for less red tape and more breathing space in relation to taxation regimes to get their businesses off the ground

2 Government and donor funding should focus on capacity building and enabling local people to 'do it for themselves' rather than being continuing recipients of aid. It may usefully include support for the creation of datasets, for example maps of wind or hydropower potential, which are tremendously useful to entrepreneurs but which they could not fund themselves.

3 We need better coordination among funders: at present, each has its own objectives and initiatives. This leads to duplication and confusion, and creates difficulties for public and private players seeking to advance village energy provision in developing countries.

4 A national champion for smart villages is needed in government.

5 More work should be undertaken to develop and apply approaches to evaluate the outcomes of energy schemes in respect of development benefits, and to identify what works and why. The absence of evaluation systems is acting as a barrier to financiers' willingness to support schemes.

6 Better arrangements need to be put in place for the sharing of experiences across East Africa. Case studies of smart villages will help to promote the concept and inspire communities to pursue this route.

7 Clear messages that are well targeted at key policy makers and decision takers are needed. However, sometimes it is not clear who in government (national and local) should be targeted: governments should make it clearer who are the key contact people.

Welder in Terrat village, Tanzania

# Annex 1: Workshop Programme

## Day 1: Tuesday 3, June

0900 **Welcome speech**

*Prof Esther Mwaikambo, President, Tanzanian Academy of Arts and Sciences*
*Prof Sir Brian Heap, Leader, Smart Villages Initiative*
*Ms Maria Berlekom, Head of Development, Embassy of Sweden, Tanzania*

0915 **Opening speech**

*Dr Lutengano Mwakahesya, Director General, Tanzanian Rural Energy Agency*

0945 **Presentation: Smart Village concept**

*Dr. John Holmes, European Academies Science Advisory Council*

Plenary discussion to refine/adapt/augment to circumstances in East Africa

1030 **Break**

1100 **Keynote speech on village-level energy situation in East Africa**

*Dr Ewan Bloomfield, Practical Action Rwanda*

(Q&A Chair: Prof Ernst van Groningen, International Science Programme, Uppsala University)

1130 **Case study 'elevator pitches'**

*Chair: Prof Olle Inganäs, Royal Swedish Academy of Sciences*

Five-minute lightning presentations of projects implemented in East Africa – synopses of technologies used, delivery/implementation method, acceptance and outcomes; accompanied by posters & demonstrations outside meeting room

1. SolarAid/SunnyMoney – Malgorzata Wojewodka (Tanzania)
2. DC Hydro – Dan Klinck (Rwanda)
3. Embark Energy – Joshua Kabugo (Tanzania)
4. Global Cycle Solutions – Jodie Wu (Tanzania)
5. Windpower Serengeti – Arthur Karomba (Tanzania)
6. UNIDO mini-hydro mini-grid projects – Emmanuel Michael (Tanzania)
7. Mobisol household PV systems – Robert Zeidler (Tanzania)
8. TANESCO hybrid solar wind systems – Samwel Kessy (Tanzania)
9. Tanzania Renewable Energy Association – Jim Elsworth (Tanzania)
10. IOPA Terrat smart village – Martin Kariongi (Tanzania)
11. Azuri Technologies – Edward Ntumwa (Uganda)

1300 **Lunch**

1400 **Panel session 1 – Breakthrough approaches**

*Chair: Dr Kenneth Kaduki, Kenyan National Academy of Sciences*

Presentations of new approaches for production and use of off-grid energy; what would revolutionise the field and the options?

Technology overview – Ir Ahmad Zaidee Laidin, Akademi Sains Malaysia

Organic photovoltaics – Prof Olle Inganäs, RSAS

Sustainable implementation – Dr Heather Cruickshank, Cambridge University

Environmental impact – Prof Sverker Molander, Chalmers University

African Network for Solar Energy – Prof Teketel Yohannes, University of Addis

1600 **Break**

1620 **Breakout groups**

Technology developments x2 (Prof Mghendi Mwamburi & Dr Gratian Bamwenda)

Capacity & skills x2 (Dr Michael Gatari & Dr Carla Puglia)

1700 **Report back to plenary**

## Day 2: Wednesday 4, June

0900 **Summary of day 1**

*Dr. John Holmes, European Academies Science Advisory Council*

0915 **Panel session 2 – Key energy uses**

*Chair: Prof Esther Mwaikambo, TAAS*

Key services for which energy provision is an enabling technology

Coca Cola EKOCENTER – Simon Bartlett, Coca Cola

Rural healthcare innovations – Dr Kanav Kahol (video presentation)

Poor people's energy outlook – Dr Ewan Bloomfield, Practical Action

Agricultural innovation – Dr Claudia Canales Holzeis, B4FA

1030 **Break**

1100 **Mini keynote: TERI India Africa programme**

*Dr Janakaraj Murali*

1100 **Breakout groups to consider energy needs and possibilities in rural communities**

Development integration & progression (Prof Sebastian Waita)

Community vs individual access (Dr Asifa Nanyaro)

Distinctive village needs – individuals (Samer al Fayadh)

Distinctive village needs – entrepreneurs (Ir Andrew Mnzava)

1230 **Report back to plenary**

1300 **Lunch**

1145 **Panel session 3 – Other perspectives on village-level energy**

*Chair: Dr Kenneth Kaduki, KNAS*

Other aspects of village-level energy, e.g., funding, government, regulation, entrepreneurship

Tanzania Rural Energy Agency – Eng Advera Mwijage

Fostering entrepreneurship – Emma Caddy, ERM Foundation

International development – Samer al Fayadh, Swedish Embassy TZ

Results-based financing – Martijn Veen, SNV Tanzania

Societal opportunities and challenges – Dr Helene Ahlborg, CTH

Technical training – Prof Justus Simiyu, University of Nairobi

1300 **Break**

1400 **Keynote address 2: Global Village Energy Partnership**

*Lindsay van Landeghem*

Q&A Chair: Prof Ernst van Groningen, ISP, Uppsala University

1700 **Plenary discussion on overall perspective and choose final breakout topics for tomorrow**

*Chair: Prof Olle Inganäs, KVA, & Dr John Holmes, EASAC*

Evening **Workshop reception & dinner**

*Hosted by HE Lennarth Hjelmåker, Ambassador of Sweden*

## Day 3: Thursday 5, June

0900 **Summary of day 2**

*Dr. John Holmes, European Academies Science Advisory Council*

0915 **Keynote address 3**

*African innovation systems, Dr Andrew Mnzava, COSTECH*

**Keynote address 4**

*Africa Enterprise Challenge Fund – Eliguard Dawson*

**Q&A Chair: Prof Ernst van Groningen, ISP, Uppsala University**

1015 **Break**

1100 **Strategic breakout groups**

Winners & losers in energy technologies over next 10 years (Prof Mghendi Mwanburi)

Models for joined-up finance and partnership (Prof Michael Gatari)

Research gaps, harnessing local ability and tech transfer (Dr Kenneth Kaduki)

Designing a Smart Village prototype, and outcome metrics (Dr Asifa Nanyaro)

1145 **Report back from breakout groups**

1200 **Lunch**

1400 **Panel & plenary discussion**

*Chair: Dr Gratian Bamwenda, Tanzania Academy of Sciences*

What messages should we be giving to key audiences – funders, EU, AU, corporate sector, regulators, etc.?

Tanzania Renewable Energy Association – Eng Jim Elsworth

Kenyan Ministry of Energy – Eng Samson Kasanga

Rwanda Energy Private Developers Association – Dan Klinck

GIZ – Sven Ernedal

ANSOLE – Prof Teketel Yohannes

UNIDO – Emmanuel Michael

1515 **Summary & farewell**

Dr John Holmes, EASAC
*Dr Gratian Bamwenda, Dr Kenneth Kaduki – East African Science Academie*

1600 **Close**

## Annex 2: Workshop Participants

| Name | Organisation |
|---|---|
| HE Lennarth Hjelmåker | Ambassador of Sweden |
| Prof Esther Mwaikambo | President, Tanzanian Academy of Arts and Sciences |
| Prof Sir Brian Heap | Chief Scientific Advisor, CMEDT |
| Prof Ernst van Groningen | ISP, Uppsala University |
| Dr Kenneth Kaduki | Kenyan National Science Academy |
| Prof Olle Inganäs | Royal Swedish Academy |
| Dr Lutengano Mwakahesya | Director General, Tanzania Rural Energy Agency (TAREA) |
| Dr Helene Ahlborg | Chalmers University, Sweden |
| Samer al Fayadh | Swedish Embassy, Tanzania |
| Dr Gratian Bamwenda | Tanzanian Academy of Arts and Sciences |
| Simon Bartlett | Coca-Cola, EKOCENTER |
| Maria Berlekom | Swedish Embassy, Tanzania |
| Dr Ewan Bloomfield | Practical Action Rwanda |
| Emma Caddy | ERM Foundation |
| Dr Claudia Canales Holzeis | Biosciences for Farming in Africa |
| Dr Heather Cruckshank | Cambridge University, UK |
| Eliguard Dawson | Africa Enterprise Challenge Fund |
| Jim Elsworth | Tanzania Renewable Energy Association (TAREA) |
| Sven Ernedal | Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) |
| Claudia Fichtner | E4SV |
| Prof Michael | Gatari University of Nairobi |
| Richard Hayhurst | E4SV |
| Dr John Holmes | European Academies Science Advisory Council |
| Molly Hurley-Depret | E4SV |
| Dr Bernie Jones | E4SV |
| Clive Jones | Power Providers |
| Joshua Kabugo | Embark Energy |
| Martin Kariongi | IOPA Terrat |
| Eng Arthur Karomba | Serengeti Windpower |
| Eng Samson Kasanga | Ministry of Energy, Republic of Kenya |
| Eng Samwel Kessy | TANESCO |

| | |
|---|---|
| Dan Klinck | DC Hydropower (Rwanda) |
| Eng Emmanuel Michael | UNIDO Tanzania |
| Lilian Mkony | Epitome Excellence Ltd |
| Ir Andrew Mnzava | COSTECH |
| Prof Sverker Molander | Chalmers University, Sweden |
| Dr Janakaraj Murali | The Energy and Resources Institute, India |
| Janet Mwania | University of Nairobi |
| Prof Mghendi Mwamburi | University of Eldoret |
| Eng Advera Mwijage | Tanzania Rural Energy Agency (TAREA) |
| Dr Asifa Nanyaro | Tanzanian Academy of Arts and Sciences |
| Edward Ntumwa Azuri | Technologies, Uganda |
| Prof Carla Puglia | ISP, Uppsala University |
| Seetha Ramasamy | Akademi Sains Malaysia |
| Thomas Richard | Power Providers |
| Dr Kristin Shine | E4SV |
| Prof Justus Simiyu | University of Nairobi |
| Steven Martin Saning'o | IOPA Terrat stevesaningo@gmail.com |
| Dr Terry van Gevelt | E4SV |
| Lindsay van Landeghem | Global Village Energy Programme |
| Martijn Veen SNV | Netherlands Development Organisation |
| Prof Sebastian Waita | University of Nairobi |
| Malgorzata Wojewodka | SolarAid |
| Jodie Wu | Global Cycle Solutions |
| Prof Teketel Yohannes | University of Addis Ababa |
| Ir Ahmad Zaidee Laidin | Akademi Sains Malaysia |
| Robert Zeidler | Mobisol |

# SMART VILLAGES

New thinking for off-grid communities worldwide

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