

Proceedings and abstracts of the International Research Conference

# Strategies for Sustainable Energy Transitions in Urban Sub-Saharan Africa – SETUSA 19 – 20 June, 2017

And REPORT on the EDUSA CPD Training Course (21-24 June 2017)

Hosted At ISSER, University of Ghana

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**1.0**

**SETUSA**  
**19-20 JUNE 2017**

The International Research Conference on the theme “Strategies for Sustainable Energy Transitions in urban Sub-Saharan Africa (SETUSA)” was hosted by ISSER, University of Ghana and University College London (UCL) - Energy Institute, United Kingdom. Planning of the main event involved contributions from SAMSET partners especially, ISSER, UCL-Energy Institute and SEA. A Local Organizing Committee (LOC) was set up to oversee the planning and actual organization of the event<sup>1</sup>. The planners of the event also set up a Scientific Committee to review submitted abstracts, comprised of experts in the fields of energy sustainability, planning, urban development and local governance<sup>2</sup>.

The calls for abstracts for the conference were issued through the website designed specifically for the conference, and hosted by the ISSER internet domain. The Scientific Committee received well over 70 abstracts from authors across the world. These abstracts were reviewed by the Committee leading to the acceptance of 39 abstracts, of which 10 came from SAMSET project partners. SETUSA 2017 was structured under nine (9) thematic areas:

- Energy access and informal settlements;
- Urban energy governance and inclusiveness;
- Energy access between centralized and distributed generation;
- Modelling and energy system;
- Energy efficiency and buildings;
- Energy efficiency and suppressed demand;
- Biogas, biomass and waste management;
- Cookstoves and energy access; and
- Planning and transport.

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<sup>1</sup> The committee comprised of SAMSET – ISSER researchers (Simon Bawakyillenuo and Innocent Agbelie), Arhizah Blay-Abiti (ISSER Administrator) and Ebenezer Ato Acquah (ISSER ICT).

<sup>2</sup> Simon Bawakyillenuo (ISSER, University of Ghana), Xavier Lemaire (UCL), Vanesa Castan-Broto (UCL), Paul W. K. Yankson (Geography Department, University of Ghana), Mark Borchers (SEA) and Ed Brown (Loughborough University, UK).

## DAY ONE OF CONFERENCE (19<sup>TH</sup> JUNE 2017)

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The first half of this day was allotted to opening events of the conference. An overview of the SAMSET project was given by Mr. Mark Borchers (SEA) following the general Welcome Remarks by Prof Felix Ankomah Asante (Director, ISSER), who also doubled as the chairperson. The final half of the opening programme was graced by a keynote speech delivered by Prof Daniel Kebera Irurah (University of Witwatersrand). His philosophical digestion on the human capacity to have the competence to inhabit in two worlds at the same time --the ability to be in this *status quo* but at the same time anticipating a better world-- set the tone for a great conference. The keynote address was followed by a message delivered by Dr Xavier Lemaire (UCL-Energy Institute) who emphasized the necessity of building cities as an open forum for citizens with democratic institutions and not just a conglomerate of economic actors.

Two parallel sessions ran from the late morning of Day One with papers on “*energy access and informal settlements*” thematic area in Session One, while papers on “*urban energy governance and inclusiveness*” theme were discussed in Session Two. The parallel sessions continued in the afternoon with papers on the “*energy access between centralized and distributed generation*” theme in Session Three, and papers on “*modelling and energy systems*” and “*energy efficiency & buildings*” themes were discussed in Session Four through to the end of the day.

## DAY TWO (20<sup>TH</sup> JUNE 2017)

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Day Two began with a plenary session moderated by Innocent Agbelie (ISSER) where Dr Ed Brown (Loughborough University) and Ms. Juliet Mekone Sale (Regional Director, UCLGA) gave presentations on “*Overview of the low Carbon Energy for Development Network – UK LCEDN*” and “*Background to the Covenant of Mayors for Sub-Saharan Africa – COM SSA*” respectively. Discussions on the two presentations continued until mid-morning. From late morning until early hours of the afternoon, the conference activities took place in two parallel sessions with papers under “*energy efficiency and suppressed demand*” theme being presented in Session One while papers under “*biogas, biomass and waste management*” theme were presented in parallel Session Two. The afternoon parallel sessions, which discussed papers under “*cookstoves and energy access*” theme in Session Three and “*planning and transport*” theme in Session Four, ran until end of the day.

## CLOSING SESSION: SYNTHETIC REMARKS

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During the concluding session of the conference in the afternoon of Day Two, all the Sessions' Chairs for the nine (9) panels gave remarks on how things unfolded.

Simon Batchelor, who chaired the session themed “**Energy access and informal settlements**” recalled a session in which the issues of growth in electricity use in informal settlements, bridging the gap between South Africa and Ghana in terms of embedded inquiry research were discussed. Accordingly, little has been given back to informal settlements or participants in general after so long a period of extracting data or acquiring information about them in Ghana. There were emphases on community inclusiveness and improvement in access to renewable energy in informal settlements.

Mark Borchers chaired the parallel session themed “**Modelling and energy system**”. He highlighted the discussion point in their session, which was to do with urban energy data situation for energy modelling and future energy scenarios in SSA. Accordingly, the urban energy data in SSA is very sparse and that the level of understanding of urban energy in SSA is inadequate and improperly managed. At the same time, it presents opportunities for people and organizations to engage in action research to fill these gaps, critically involving municipal and other players so that the research meets all the developmental needs of SSA urban areas.

Sarah Ward gave an account of what transpired in the session themed “**Urban energy governance and inclusiveness**”. Accordingly, developing institutional relations and building capacity inside cities are key to sustainable development agenda for SSA cities including gathering quality data to enable better management of urban system. She opined that South Africa had no energy data before, but with the commitment of resources, cities in South Africa now have rich data that they can use for planning purposes. She concluded that, change does not just appear out of the blue, it takes time and commitment coupled with making the best out of the opportunities presented by new and efficient technologies.

Daniel Irurah who chaired the session themed “**Planning and transport**” also flagged up key issues discussed in that session. The discussions focused on how transportation issues, urban forms and other kinds of responsive strategies should be managed so that in the long term cities are better integrated and better surfaced to improve quality of life of the inhabitants. The question of competing technologies need to be rooted in the transport sector especially the public transport sub-sector, such as investing smart transport systems such as the BRT systems and the Loop-ways Cable Car systems.



Xavier Lemaire gave some insights on what transpired in the session themed “**Energy access between centralized and distributed generation**”. After discussing the availability of different renewable energy resources in SSA, it appears that some like solar are more readily available in most countries than others like mini-hydro. The increase of the share of RET in the energy mix is greatly accelerating, notably due to the fact that solar technologies are becoming cost-competitive and already widely disseminated in many countries. The discussion then focused on the articulation between decentralized and centralized generation. It was made clear in the presentations that solar can now be a major electricity generation source for small loads, but could also be a complementary power source for bigger loads especially for firms or whole cities. The right balance between the large-scale dissemination of small systems and the implementation of utility-scale solar farms for instance remains linked to the specific political, geographical and demographic conditions of each country.

Megan Euston-Brown also shared some insights on the presentations in the session themed “**Energy efficiency and buildings**”. The presentations focused on architects working and engaging with municipalities and how to make buildings more efficient and relevant to the people. According to her, the highlight of all issues discussed in that session point to the fact that, the energy efficiency and sustainability approaches not only more follow, but also create much more liveable human spaces.

Alex Ndibwami chaired the session themed “**Energy efficiency and suppressed demand**”. The session focused on households and the kinds of appliances they choose, how efficient those appliances are and how households effectively use these appliances in times of crises. Another issue that came up was the low uptake of new efficient technologies and how researchers can come together to understand how people take up different technologies. He highlighted one particular presentation that gave insight of how they practically demonstrated the functionality of different technologies to people and how they tried to convince people to take an efficient technology over the other relatively inefficient one. The key message from the discussion was that, it is useful for all players to begin looking at how far they will like to impact beyond who they are and their respective views of knowledge or operations and, begin to research and understand that for these initiatives to take shape, you need to go beyond your department, go out and talk to people at the grassroots, stakeholders at the ground. It must be bottom-up approach rather than the reverse and accompanied by innovation as a custom of development.

Adrian Conrad Stone highlighted issues raised in the session themed “**Cookstoves and energy access**”. Accordingly, the discussion started off with households or consumers in general having to deal with not only fuel, but also appliance stacking at the household level. Issues of fuel choices are highlighted and evidently shown to depend on variety of factors. He noted that one presenter mentioned traditional practices have a big influence in energy choices in Benue State, Nigeria. Another presenter also discussed price parity of fuels in comparative countries; Uganda and Ghana.



He noted that Uganda pays 3 times the price for LPG and 2 times the price of electricity than Ghana. There was also a discussion on informal settlements and energy access in Ghana. He highlighted that with reference to the presentation on Abuja, an informal settlement in Ghana, the debate focused on the networks that exist in informal settlements in order to get access to utilities such as electricity, yet these settlements are largely ignored in planning by local authorities.

Finally, Simon Bawakyillenuo gave account of what transpired in the session themed “**Biogas, biomass and waste management**”. He pointed out that the first presentation demonstrated practically how biogas technology is working in some settings but not in others due to different climatic conditions. Accordingly, the discussions concluded that, while biogas is a desirable solution and can function everywhere, policy drivers need to think of a mixed solution rather than an absolute concentration on one technology. There was also a presentation on the resource potentials for waste to energy in Nigeria. While highlighting the opportunities, the presenter also touched on the challenges that are faced and what stakeholders can do to move away from overdependence on fossil fuel to really using opportunities that are embedded within waste-to-energy technologies in the sub-region. There was also a discussion on how the biofuel issue is being contested, especially within the urban peripheries.

# SESSION 1

## ENERGY ACCESS AND INFORMAL SETTLEMENTS

## Sixty Years of Energy Transition in Urban South Africa: the Changing 'Energy Underclass'

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This paper examines the development of South Africa's versions of the modern infrastructural ideal and energy transition for electricity provision over the last sixty years. Using Cock's (2004) conceptual framework of environmental justice, the relative importance of the 'red', 'brown' and 'green' agendas in the apartheid, post-apartheid and low-carbon phases of the energy transition are analysed in relation to the changing extent and nature of the 'energy underclass'. The paper argues that recognition of the potential uneven and differentiated urban spatial effects of a sustainable energy transition will continue to be integral to the planning and management of such transformations.

Electrification of formal settlements has made great strides in the post-Apartheid era and a range of pro-poor subsidies have been introduced (such as free basic electricity and inclining tariff structures) to address, at least partially, the extent of the energy underclass. However, in-migration from rural areas continues to fuel the growth of informal settlements, which cannot be connected to the grid, and modern energy use by the poor is constrained by their ability to pay. While small-scale embedded renewable energy generation offers a form of decentralised generation which matches the informal nature of this form of urbanisation, there are considerable practical limitations to this prospect: namely, the availability of space and the ability of households to pay for installation and maintenance of the technology.

The introduction of small-scale embedded renewable generation also presents some challenges to the governance of municipalities in South Africa. In the post-Apartheid constitution of 1996, municipalities were granted a role in the distribution of electricity to reflect their social inclusion and development function. Municipalities purchase their electricity from Eskom, but reap significant profits from on-selling, which then cross-subsidises the pro-poor policies. If more high-consumption consumers buy into embedded generation, the ability of municipalities to cross-subsidise the tariffs of the existing poor consumers as well as fund capital expenditure to extend the grid will be reduced. The perpetuation of a so-called 'energy underclass' appears to be a real likelihood from the sustainable energy transition (Bickerstaff, *et al.*, 2013, p.5).

The main argument of the paper is that strategies for energy transitions must be more cognisant of local conditions and circumstances. The challenge of achieving an effective energy transition involves not just the introduction of appropriate technology and infrastructure, but incorporates political, urban planning, and governance issues. The current trajectory of the energy transition in South Africa potentially presents a risk of continuing uneven and differentiated urban spatial effects within society. These considerations must be integral to the planning and management of such transformations.

**Keywords:** Energy Transition, Municipalities, Apartheid, Post-Apartheid, Renewable Energy

## Networking the African city – The Challenges of Electrifying Urban Informal Settlements in Cape Town

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The historical development of large, networked grid electricity infrastructure is associated with a more formalised urban planning context. This networked system is spatially fixed, highly capital intensive and has long life times that shape the economic geography of a place (Prud'homme, 2005). It typically suits big once-off implementation rollouts and requires a high degree of regulation and control to provide a safe and reliable service. By contrast, low-income informal settlements have widely differing degrees of permanence and fluidity, experience on-going in-fill densification, a lack of legal tenure, and lower ability of formal institutions to regulate practises. All of these are challenging to the logics of grid infrastructure.

Investments in electricity infrastructure are influenced by the degree of permanence of a household in a physical space, its legality, geophysical and site characteristics, as well as the political and social dynamics of settlements. All of these vary across different spaces and, furthermore, combine to produce unique and emergent characterisations of the 'informal' (Misra, 2014; Huchzermeyer, 2006). This paper explored the challenges of electrifying informal settlements, using Cape Town as a case study. It discusses how the adherence to networks as the sole supply solution are fragmenting urban landscapes and compromising energy security for informal households.

**Keywords:** Informal Settlements, Electrification, South Africa, Networks, Energy Security

## Transition Management in Energy Transition among Informal Settlements in Ghana and South Africa

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The paper explores Transition Management (TM) in energy transition in informal settlement in Ghana and South Africa, adopting a Transdisciplinary (TD) research approach as sustainable research process and a response to TM criticism. This is also complemented with the case studies of energy transition in two contextually distinct and mutually re-enforcing cases of techno-centric innovation on one hand to social innovation and learning on the other, departing from the longstanding techno-centric lead innovation paradigm, which is the prevailing and predominant norm to social co-design, learning and innovation as emerging norm.

This shift however, require a re-thinking of how social system are envisaged or perceived, since established research modelled on singular, multi or inter disciplines have not been able to address the persistent challenging plaguing our modern societies today. This paper offers a practical solution on how TM complemented with transdisciplinary (TD) should be envisioned made relevant especially within developing countries context. The paper proposes a radical shift from the highly patronized, paternalist, elitist outlook on how research is done in the global south, to a more intentionally embedded process of inquiry, one that places social actors at the center, diffuses power dynamics and engenders social empowerment as it hallmark.

**Keywords:** Transition Management, Energy Transition, Informal Settlement, Social Innovation

## Community Development in Ashaiman Slums: Challenges Encountered and Mechanisms to Address Them

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Community development as a process through which members of a community collectively define their needs and work towards meeting such needs has been very useful in the Ghanaian development agenda. As a process which exploited the rural values of mutual aid, reciprocity and self-help, community development has thrived well in solving the problems of rural Ghanaian communities. This success has motivated successive governments and civil societies in Ghana to replicate community development efforts in urban communities such as Accra and Kumasi. Within these urban communities, new informal settlements referred to as slums have emerged. These slums are faced with many problems such as poor housing, overcrowding, poor sanitation and lack of portable drinking water. In order to deal with their developmental challenges, community development efforts such as housing and sanitation projects have been undertaken in such slum communities. Although some community development efforts have been undertaken in the urban slums to solve the developmental problems in those communities, the problems are still existent. Additionally, there is not much is known about how projects have fared. This is as result of the fact very little studies on community development has not focused on slum communities. This study was then conducted with a qualitative design to understand the challenges that have been faced in community development in urban slums and mechanisms that can be adopted to overcome those challenges.

This study was conducted in Ashaiman, a municipality in the Greater Accra region, because there are many slums coupled with high ethnic diversity in this municipality. Within the Ashaiman municipality, three slums namely, Tulaku, Taboo line and Valco flat were selected for this study. Data was collected from a sample size of 17 participants consisting of two officials of the Department of Community Development, nine workers of community development agencies, chiefs and assemblymen. Data was collected through interviews with participants. The main challenges encountered in community development efforts in Ashaiman slums include negative attitude of slum dwellers towards development efforts, lack of funds and other resources, ethnic and tribal differences, poor monitoring and supervision of projects. Some mechanisms have been adopted by the stakeholders of community development to resolve the challenges encountered whereas others have been suggested by participants as having the potency to resolve the challenges. These mechanisms include capacity building, ensuring constant dialogue on community development agenda, ensuring that community development efforts are regularly assessed, formulation of by-laws, soliciting for funds and involving community leaders in community development processes. The adoption of these and other mechanisms would help overcome the impediments that are encountered in community development in Ashaiman slums and in essence lead to the betterment of the lives of the urban slum dwellers. This study therefore recommends that stakeholders in community development in urban slums put measures in place to ensure that community development efforts undertaken achieve the targets set for such projects.

**Keywords:** Community Development, Ashaiman, Ghana, Stakeholders, Informal settlements

## The Use of Solar Electricity in Informal Settlements

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A decade ago solar electricity was still considered as an expensive source of electricity appropriate only for generation in remote areas which could not be reached by the grid. The decrease of the cost of solar panels of more than 90% last 10 years has completely changed the landscape of electricity generation. Solar electricity is today a cheap source of electricity generation which can now compete with electricity generated with conventional fossils fuels even in urban areas.

This paper examines the particular case of informal settlements and the rationale for using solar as an electricity source for the poorest in an urban setting. Electrification with solar photovoltaic can be done via mini-grid or individual solar home systems. Individual systems can be acquired by individuals via Pay as You Go Payment without any long waiting list or any administrative authorization for a connection; monthly fees can be lower than with conventional electricity with the grid. Not only solar tend to be cost-competitive but it can offer a more reliable service than - in some African countries – where grid electricity can actually be very intermittent due to the poor state of the grid and lack of generation capacity.

The paper takes then the point of view of utilities; it could make sense for utilities to provide communities living in informal settlements with solar as a cost-effective solution easier to implement than the extension of the grid. Furthermore, solar systems tend to be more and more conceived as modular installations which can be adjusted to the evolution of the needs of local communities as part of a pre-electrification or permanent electrification program. But the management of these small systems may be better left to local cooperatives or local enterprises. The issue of long-term maintenance and the one of battery recycling imply the existence of a local robust network of technicians and retailers.

**Keywords:** Solar Electricity, Informal Settlements, Grid Connection

## The Contours of Electricity Access: Are Informal Governance Practices Left Out of the SDGs?

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This paper interrogates the notions of informality and how it features in the context of the sustainable development goals (SDGs) launched by the UN in 2016. Through an analysis of electricity access in Abuja, an informal settlement in Ghana, the paper argues that several informal practices lead to the provision of basic urban services, which in turn, influence the functioning of formal governance processes. The study highlights how marginalised residents navigate the electricity topographies in Accra and reveals a more nuanced politics and dialectics of everyday access that reflect complex realities of the shifting spheres of governance.

The paper illustrates that if the urban SDG is to become a functional policy tool for achieving and monitoring sustainable urban development, we must consciously engage with informality in a complementary rather than in a binary fashion. It concludes that for all cities in Ghana, and by implication worldwide, to be able to report on this urban Goal 11 and at comparable scales, distinctions about formality and informality of urban service delivery need to be addressed to allow for local contextualization and greater policy relevance.

**Keywords:** Urban Sustainable Development Goal, Informality, Electricity, Poverty, Governance, Ghana

# SESSION 2

## URBAN ENERGY GOVERNANCE AND INCLUSIVENESS

## Sustainable Energy Transitions in Urban Sub-Saharan Africa: Lessons from Research in Six Municipalities

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As part of a programme to promote sustainable energy transitions in urban Sub-Saharan Africa (SAMSET – Supporting Sub-Saharan African Municipalities with Sustainable Energy Transitions), urban energy research has been undertaken in six municipalities in three sub-Saharan African countries – Ghana, Uganda and South Africa. This work provides useful insights into the dynamics of urban energy on the sub-continent, and this paper presents issues and opportunities emerging. The overall motivation behind this focus on urban energy transitions is the fact that the future of energy on the sub-continent will increasingly revolve around urban energy use due to expected urbanization rates. This provides a counterpoint to the common historic focus on rural energy in Africa, particularly around the question of access to modern energy.

The municipalities in question vary in size, from 100 000 to 4 million people. Some are closely linked to nearby large cities, some are in predominantly rural areas, some are more industrial, others predominantly residential. All are growing fast. Together they provide a rare level of detail and spectrum of characteristics from which some sustainable energy transition lessons can be drawn to guide the energy trajectory of fast-urbanising Sub-Saharan Africa.

The purpose of this paper is to explore the emerging trends, problems and opportunities from the research undertaken on the six municipalities. The paper is framed by the Sustainable Development Goal 7 and Sustainable Energy for All focus areas of access to modern energy, energy efficiency, and renewable energy. The paper outlines and compares the different energy use characteristics in residential, commercial, industrial and transport sectors in each urban area, and synthesises the energy futures modelling undertaken to highlight both future problems that the analysis points to, such as woodland depletion, unhealthy energy use persistence, rising prices, inefficient use of energy and transport congestion, as well as opportunities to move to a more sustainable urban energy future. These include more efficient buildings, improved urban planning, and alternative energy options for low-income households. Of particular concern is the unaffordability of modern energy for poor households, for which there is no solution in sight. It concludes with reflections on the role of local government in sustainable energy transitions in urban sub-Saharan Africa.

**Keywords:** Sustainable Energy, Transitions, Municipalities, Sub-Saharan Africa, Urbanisation

## The Governance of Energy Transitions in Cities: A Non-Institutionalist Perspective from Kampala City in Uganda

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Cities across Africa are undergoing an energy transition in a bid to address the environmental and economic challenges associated with fast-paced urbanization and climatic risks. Pressure is continuously mounting on national and local governments that seek to build institutional capacities for a sustainable energy transition. This is partly why research that links transition theory to urban governance studies in the context of energy systems has gained prominence over the continent. But much of the available knowledge is based on institutionalist approaches to governing energy transitions, with greater focus on the mechanisms and processes through which state and non-state organisations (majorly private sector and civil society) can collaborate to effectively implement policy reforms and exercise administrative authority.

Little research has so far been devoted to non-institutionalist dimensions of governing energy transitions, where authority is derived from building networks of un-regulated practices across city scales to diffuse alternative energy solutions that stem from local innovations. This paper presents a non-institutionalist account of governing energy transitions in African cities, using case studies of non-formalized waste vendors and green charcoal producers in Kampala city, whose actions have incrementally resulted into the up-take of alternative energy solutions in their neighbourhoods through networks that are formed using relational dynamics that contrast with those found in hierarchical organisations. Waste vendors and green charcoal producers have shaped energy futures at neighbourhood level by maximizing the value of discarded materials and woodlots to generate and distribute energy for cooking, heating and selling. The uneven diffusion of their knowledge and practices reveals that multilevel interactions and interdependencies beyond the purview of the state can create laboratories of innovative practices for sustainable energy transitions.

**Keywords:** Governance, Energy Transitions, Cities, Institutional, Non-Institutionalist, Local Innovations

## Strategies for Sustainable Energy Transitions in Urban Sub-Saharan Africa: Microfinance and Decentralised Polycentric Governance Approaches for Addressing Africa's Twin Development Challenges of Reducing Climate Change Vulnerability and Improving Renewable Energy Deployment

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The Sustainable Development Goals (SDGs) are calling for state and non-state actors to reduce the vulnerability of communities to climate related extreme events, and other economic, social and environmental shocks and disasters; and for universal access to modern energy preferably through the use of Renewable Energy Technologies (RETs). There is a great threat that increases in energy access and demand in Sub-Saharan Africa can potentially lead to rises in anthropogenic emissions of greenhouse gases which result in climate change. Additionally, climate change can be anticipated to increase as Intended Nationally Determined Contributions (INDCs) containing global ambitions to mitigate and adapt to climate change are falling short of the goal to limit temperature increase to 2°C.

Using data from various research articles, case studies, policy briefs, and expert interviews, this paper partly expounded upon the work of Elinor Ostrom on polycentric governance systems by presenting a polycentric Microfinance Beneficiary Led Development Framework (M-BLDF) that can provide a mechanism to simultaneously enhance the capacities of the informal sector for RET deployment and improve climate risk management in Africa. Additionally, the paper analysed how Waste-To-Energy projects can be promoted in African urban centres and the roles to which Africa's informal sector has in waste management and renewable energy deployment. The paper shows that increasing financial inclusion, and formulating comprehensive strategies to tap into the INDCs framework and Forum on China-Africa Cooperation (FOCAC) framework can enhance RET deployment in Africa by unravelling numerous sources of technical and financial support to assist African countries with their climate change and renewable energy challenges.

**Keywords:** Forum on China-Africa Cooperation (FOCAC), Informality, Intended Nationally Determined Contributions (INDCs), Joint Crediting Mechanism (JCM), Waste-To-Energy Technologies, Waste Management

## The Role of Gender in Urban Energy Transitions

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SDG7 calls for “affordable, reliable, sustainable and modern energy for all”. It is important to ensure – in line with SDG5 on gender equality - that efforts to provide access to modern energy also reduce energy gender divides rather than reinforcing them. Much of the literature focuses on women as consumers of energy, considering their energy needs, and deficits in how these needs are met.

The paper considers innovative demand for energy by women in urban settings, such as productive use of electricity in the household. It also considers consumer behaviour such as attitudes towards energy efficient appliances, and gendered purchasing decision making within the household. It describes the absence of women in businesses and policy making, and the consequent barriers.

Given the context of an urban location and the sustainable energy agenda to change not only what energy decisions are made, but who makes them, the paper considers the importance of bringing women into energy decision making. It notes that males tend to be most common in decision making and discusses what might be done to adjust this balance into the future. Finally, the paper also presents some more positive examples of how women are involved in energy service provision.

**Keywords:** Energy, Household, Gender, Women

## Sustainable Energy Transitions in South African cities: Reflections on Enablers of Change over the Past Two Decades

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South African cities have been grappling with the shift to sustainable energy for the past two decades. Some have been proactive in this regard, leading national government on the sustainable energy agenda and taking their place amongst the pioneering sustainable energy cities of the world, while others have shifted little. Sustainable Energy Africa, a not-for-profit organisation specialising in supporting urban energy transitions, has partnered with many cities in this process, and has tracked urban energy changes both qualitatively and quantitatively.

The paper documents the changes observed over the past two decades, and outlines approaches that have been found effective in facilitating such a transition. The paper focuses on the renewable energy options that fall within the ambit of South African local government, but also covers other sustainable energy areas such as energy efficiency, sustainable transport and energy poverty.

**Keywords:** Sustainable Energy Transition, Local Government, Municipalities, Renewable Energy, Decentralized Generation

# SESSION 3

## ENERGY ACCESS BETWEEN CENTRALISED AND DISTRIBUTED GENERATION

## The Installation of Solar Photovoltaic Street Lamps: A Sustainable Energy Transition Strategy for the Cities of Sub-Saharan Africa?

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According to the United Nations Population Fund, more than half of the world's inhabitants now live in cities. This dynamic of concentration of populations in urban centers is highly visible on the African continent, known for its strong population growth, with a population that could double in 2050 and would accommodate three out of five of its citizens in the cities. This situation, which is accompanied by a drastic increase in energy demand, is a real challenge for Africa and particularly for its sub-Saharan region. With an increasing urbanization rate of 4 % per year, economic growth rising by 5.3 % per year and a low rate of access to electricity by 30 % in 2016, the leaders of the countries of Africa in the south of the Sahara would benefit from having a prospective vision of this sector by developing efficient strategies to best manage the future energy needs of their community. On the one hand, it is a question of continuing to reflect on credible alternatives to the current difficulties of supply of electricity within this set and on the other hand to study and propose the best models of sustainable energy transition based on the exploitation of renewable energy sources.

In this article, we focus on the solar potential of the African and the use of solar photovoltaics for electricity generation, in this case as a source of energy for solar street lamps public lighting in sub-Saharan African municipalities. We start with a practical case in Benin which, like 8 countries of the West African Economic and Monetary Union, benefited from a regional project for the development of renewable energies and energy efficiency. This study analyzes, using a SWOT model, the strengths and weaknesses of the installation of photovoltaic solar street lamps in relation to the basic principles of sustainable development. To achieve this, a documentary research based on a rich bibliography, combined with field surveys, including direct observation and semi-direct interviews. The fundamental aspects of the social, economic and environmental sustainability cycle were compared with the advantages and constraints of the use of solar photovoltaic lamps in cities. Thus, we have noted that the latter illuminate the isolated areas autonomously without depending on the conventional network and promotes the development of evening activities generating income; are economic for the state in long term, in that their adoption cancels the energy bill for public lighting in the city and makes it possible to invest in other social projects, do not generate any pollution of the environment and are fully recyclable. At the end of our research, we concluded that there is a strong correlation between the installation of solar street lamps and the sustainable energy transition, it being understood that the solar photovoltaic lamps are totally compatible with the requirements of sustainable development as defined in the Millennium Development Goals. Their adoption is undoubtedly an efficient strategy for sustainable energy transition in sub-Saharan cities.

**Keywords:** Sustainable Energy Transition, Renewable Energies, Electricity, Solar Photovoltaic Lamps Solar Energy, Urban, Sustainable Development.

## Increasing Energy Access: The Solar Kiosks Model

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With Uganda's electricity access rate being 14.8% with only 6.9% in rural areas (SEforALL Action Agenda, 2015), the solar kiosk project is a small-scale project managed by The Centre for Research in Energy and Energy Conservation, Makerere. The aim of the kiosk is to increase energy access to people living in off-grid areas. The different product and services that the solar kiosk provides include renting out solar lamps, secretarial services, mobile charging and mobile internet services. The kiosk also works as a field laboratory to assess the performance and user perception of pico-PV products. This paper presents results on the impacts, challenges and success factors of the kiosks. The research showed that the actions that need to be taken to follow the mission include creating community demand for solar energy, offering basic services through solar energy and giving individuals the right to global services such as the internet. The fulfilment of the needs of action will lead to impacts on the community such as increased literacy levels due to longer reading hours, awareness on clean energy products, tackling climate change and most importantly clean and safe lighting for homes.

The main need of these areas is the need for clean, efficient and safe lighting. This can be increased through door to door advertising, workshop day, print and social media advertising. Sales of distribution currently is only through the shop front but potential distribution channels includes having various entrepreneurs recruited in different areas of the community to further reach more potential users, and a mobile charging station.

**Keywords:** Energy Access, Solar Kiosks

## Energy Access Strategies in Urban Sub-Saharan Africa: The Role of Centralised Solar PV in Urban Electricity Supply

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Sub-Saharan Africa currently has the highest urban growth rate in the world. As population increases and rural-to-urban migration continues, reliable energy sources will be essential to ensure that demand for services, jobs and improved quality of life can be met. This paper focuses on the role of centralised photovoltaic power systems in providing the burgeoning urban populations of Sub-Saharan Africa with the energy they need. Economic growth in Africa is currently at a level of approximately 5.5% per annum, but unreliable access to electricity will continue to be one of the biggest barriers to development. In a continent where peak energy demand is still often met by the use of privately-owned diesel generators, an expensive and polluting source of energy, a sustainable, large-scale solution must be found. Africa, home to 7 out of the 10 sunniest countries in the world, has a total solar power-generating capacity projected to reach 3,380MW by 2017 (Ola, D, 2016). Until recently, solar PVs have principally been adopted as a method of decentralized electricity supply in rural Africa.

While the provision of off-grid solar energy will vastly improve quality of life in rural areas, off-grid solar cannot meet the energy demands of cities, and so a centralized solution is required. Solar PV farms can provide a renewable, feasible solution to the predicted increase in energy demand from urban Africa. Steps have already been taking towards the development of solar PV farms in Africa. In Rwanda a, 8.5MW was opened in 2015 and Morocco has recently opened the first phase of a plant predicted to create a staggering 580MW of energy when completed in 2018. This paper explores the economic, technical and geographical feasibility of supplying sub-Saharan Africa with electricity from centralized solar plants. On the scale required, decentralized power options are expensive and do not provide the resilience of centralized power networks. Solar plants can be built within 6 to 12 months, so offer a reasonable solution to rapidly increasing energy 2 demands.

The report considers the role of China, having invested \$15 billion into Africa in 2011 alone, in catalysing this key infrastructural development. The paper concludes that while centralized solar PV solutions cannot deliver the entirety of energy needed by the sub-Saharan urban population, they can play a key role in sustainably meeting the energy needs required to ensure continued economic growth and prosperity in the world's fastest growing region.

**Keywords:** Solar PV, Centralisation, Sub-Saharan Africa, Urban, Electricity

## Renewable Energy in Overcoming the Dilemma of Darkness in Nigerian Urban Centres.

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It will be very difficult to ignore the fact that electricity situation in Nigerian urban centres is at crisis point. Increasing urban population is also not helpful to the poor electricity situation in the country. In this situation, both households, the community and enterprises within the urban centres suffer. Inadequate supply of electricity means low energy services and an adaptation system that attracts high emission of greenhouse gases and engender other environmental problems. Attempts at higher energy supply by the Federal Government have not seen visible success. While initial efforts at electricity supply focused on hydropower, later efforts shifted to fossil-based sources for electricity generation.

Recent crisis in the Niger Delta, the threat of GHG emissions and climate change and the clear picture of resource exhaustion all mean that the current supply system is not secured. In addition, secured system based on the deployment of renewable energy is limited. It is easy to see frustrations in electricity supply and use among the urban residents in Nigeria. This study intends to explore the dimensions of electricity problem in Nigerian urban centres, assess adaptation by different segments of the urban sector to inadequate supply, examine the current level of deployment of renewable energy and propose specific strategies to deploy renewable energy for sustainable electricity supply in the urban centres.

**Keywords:** Nigeria, Renewable Energy, Electricity Supply

## Decentralization: The Key for Mass Access to Modern Energy Services?

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The surge of interest over the last ten years in dispersed and decentralized rural electrifications has been driven primarily by the spatial, geographical and logistical challenges of imposing an occidocentric, centralized grid model on countries that anyway lack the infrastructure and resources to make the model functional. Basing such decentralized systems on renewable energies, furthermore, has added to the pragmatic technical view of localized systems, recognizing as it does that many countries in the Global South lack access to the fuel supplies required to maintain inefficient centralized energy production and distribution systems. While urban centres seem committed to centralised grid provision, in practice businesses and the elite use diesel and petrol generators to cover load shedding and households supplement the weakness of modern energy provision with other forms of energy such as solar and kerosene lights, and biomass for cooking. These are effectively forms of decentralised energy and need to be framed as such.

What has so far been lacking in these evolving technical, logistical and economic understandings has been a socio-cultural understanding that decentralization by itself brings many advantages, in imbuing modern energy supply with the potential to positively enhance a range of social 'goods' such as empowerment, capacity-building and poverty alleviation. This paper draws on a range of recent and ongoing projects in which the authors have been involved to provide empirical examples of why this might be so, adding to a body of literature that suggests, as Ikejemba et al (2016) do, that lack of understanding of the benefits of energy decentralization as an end in itself may be one reason why so many renewable energy projects in sub-saharan Africa are unsuccessful and that " the energy problems experienced in Sub-Saharan Africa today can only be solved by the decentralization of energy generation to the smallest subset possible (Ikejemba et al, 2016: 239).

**Keywords:** Decentralization, Energy Access, Energy Services, Sub-Saharan Africa

# SESSION 4

## ENERGY MODELLING AND ENERGY SYSTEM

## Modelling the Urban Energy Future of Sub-Saharan Africa – Exploring Strategies for Sustainability

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This paper explores the results of a modelling exercise undertaken to assess the future urban energy demand of Sub-Saharan Africa as a whole covering all 49 states aggregated into 5 regions. The work was a component of the Supporting African Municipalities in Sustainable Energy Transitions (SAMSET) project a multi-partner collaboration between African and UK research organisations which supported 6 city municipalities in South Africa, Uganda and Ghana with the development of cross sector energy use surveys, data analysis, modelling and the development of sustainability plans. An energy systems model was developed drawing on the SAMSET city data as well as the recently improving data picture for Sub-Saharan Africa on electricity use and access, rates of urbanisation, vehicles parc size, biomass use and influence on carbon flux and typical urban energy profiles. Initial results indicate that the demand for energy could double by 2025 and grow fourfold by 2040, with CO<sub>2</sub> emissions rising 280% by 2040, shifting the region's share of global emissions from 1% to 4%. Strategies for improving urban sustainability are assessed quantitatively and critically compared; access to modern energy could for instance reduce CO<sub>2</sub> emissions by around 17%. Survey work shows suppressed demand to be high and so energy efficiency measures may however be offset by the demand that access to modern energy unlocks.

The results suggest that urban areas have a key role to play in the energy future of sub-Saharan Africa, and may be an increasingly important global energy player. Sub-Saharan African cities, due to low electricity access rates, high costs and poor quality of supply still account for a substantial and growing demand for biomass with demand for fuelwood having grown in the region by 3.8% year on year and charcoal by 1.7% year on year between 2004 and 2014. Continued compound growth in the energy system as it is now, could see fuelwood become a serious source of GHG emissions and a more damaging component of deforestation adding to the already severe pressures brought to bear by agricultural practice. Understanding the state of energy in cities – where energy is being used, how this is likely to change over time, and locally appropriate sustainability measures – are likely to be an important part in shaping a prosperous future for sub-Saharan Africa and implementing global intentions around the SE4All and energy-related Sustainable Development Goals.

**Keywords:** City, Energy, CO<sub>2</sub> Emissions, Strategies, Modelling, Sustainable Development, Sub-Saharan Africa

## Spatial Pattern of Household Energy Use in Kano Metropolis, Nigeria

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Kano metropolis has been identified to be socially and spatially heterogeneous, and this might result to both spatial and social inequality in the pattern of household energy consumption. This discrepancy could also result to several environmental and health concerns, as some parts of the metropolis are believed to be using unclean sources of energy compared to others. Therefore, this study examines how the pattern of household energy consumption in the metropolis varies both spatially and among the different socio-economic groups.

A clustered sampling technique was adopted to categorize the study area into different residential zones on the basis socio-economic status. Thereafter, a systematic sampling technique was used to select households at specific intervals, resulting to 528 sampled households. Using Questionnaire, the results reveal that LPG is more associated with areas of high income, senior staff quarters of tertiary institutions, which are areas of low residential density, while woodfuel is associated with areas of lower income and lower levels of formal education.

The study concludes that a wide disparity exists in the choice of household energy, spatially and among the different social groups. This calls for government and stakeholder intervention, through provision of LPG at a subsidized rate, provision of modern cooking stoves especially to areas identified with low-income earners and public enlightenment on the negative impacts of using unclean sources of energy.

**Keywords:** Household, Energy, Income, Education, Metropolis

## Sustainable Energy Use in Kano Metropolis, Nigeria

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In recent years there has been a lot of support for renewable energy systems, owing to their having more environmentally-friendly qualities. Energy use pattern in the Nigerian economy is in the industrial, transport, commercial, agriculture and household sectors, with household carrying the larger share in use, signifying Nigeria's low level of economic development. In Nigeria, electricity supply has been very limited and erratic, with only about 50% of the population having access to its supply. Urban areas are the hub of development for any nation, as most of the industries tend to be situated in cities or areas closely around the cities, with this comes high demand for energy use.

Kano in Nigeria is located in the sunbelt region and is one of the country's largest cities, with a population of over 9,383,682, a commercial hub and had functioning industries in the past. But with poor energy supply, most of the industries have closed down. This paper looked at available sustainable energy sources for use in Kano Metropolis, and it was found that the metropolitan solid waste energy content of four major dumpsites could be used to generate a total of 805,579.68 kWh/day of electricity which could be used to power households while solar energy could also be harnessed to supply households, institutions and small scale production companies and enterprises because the city receives at least 8 hours of sunlight energy daily. This would go a long way in solving problems of urban poverty, provide jobs and grow the economy of Kano. And the same time help sustain a cleaner environment as the stress on use of Fuelwood will reduce and also issue of solid waste management enhanced.

**Keywords:** Sustainable, Energy, Solar Energy, Solid Waste, Environment

## Future Energy Scenarios for African Cities: Unlocking Opportunities for Climate Responsive Development

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The future development of African cities entails a high level of complexity and uncertainty, particularly in relation to the issues of energy and climate change. A scenario-based strategic foresight methodology has been used in order to provide a basis for long-term strategic visioning and planning. This study applies this methodology to support decision makers, by identifying risks and opportunities in present and future trends, which can assist in the planning, implementation and evaluation of projects, as well as informing the policy debate.

Concretely, this study:

- breaks down the complexity of urban planning (including inter-sectoral inputs of energy, transport, climate change etc.) by presenting four scenarios and strategic policy choices which are integrated across sectors;
- identifies the main drivers for change that will shape the future of Africa cities;
- classifies uncertain drivers for change and wildcards in order to improve risk management in strategic policy-making; and
- identifies opportunities and challenges of urbanisation to avoid lock in to unsustainable patterns of growth.

With an inter-disciplinary approach, and based on previous literature and consultations and validations from experts in various and cross cutting fields via interviews, workshops and peer reviews, this study provides:

- an analysis of the main megatrends that will shape the future of African cities;
- four alternative scenarios for African cities until 2050 with a focus on the implications for energy; and
- recommended areas for action for decision makers including policy makers, the private sector, civil society and the donor community.

Urban population growth, economic growth, increasing energy demand, climate risks and health and education provision are found to be megatrends that will shape the development of African cities in the next decades. Additionally sources of uncertainty are identified: infrastructure and governance, economy and society, urban structure and environment and natural resources. The analysis revealed that the following scenarios ought to be considered:

- Reliance on a centralised energy model
- Strong climate commitment & weak policy enforcement
- Green and Enabled City Expansion
- Technologically enabled growth

Finally, policy options and action frameworks for unlocking opportunities for climate responsive development in cities are derived. Specific sectoral implications are inferred and key areas for action are provided to different stakeholders:

- National governments
- Municipal governments
- The private sector
- Civil society
- The international donor community

The study entails a number of limitations. The analysis is focused on macro urbanisation patterns and therefore city specific scenario building is required to identify context specific actions and policies. Furthermore, it has been proved that secondary and smaller cities face significant resource constraints and therefore, capacity development and further support for these cities may be required before actions recommended here can be implemented. Finally, EUEI PDF acknowledges that implementing the study outcomes requires substantial stakeholder participation as well as cross-sectoral cooperation.

**Keywords:** Climate Change, Development, Climate Responsive Development, Urbanisation, Africa

# SESSION 5

## ENERGY EFFICIENCY AND BUILDINGS

## Integration and Implementation of High-Density Plant Modules in Office Buildings for Reduction of Building Energy Use

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Energy use in the built environment is expected to increase as a result of the additional 3.5 billion people to be living in urban areas by 2050. A large part of this energy increase will come from demand for cooling in fast growing cities in Sub-Saharan Africa. This study considers the application of hydroponic plant modules as a way to reduce energy demand for heating, ventilation, and air-conditioning (HVAC) in an open-plan office in Cambridge, UK.

The initial modelling indicates that this approach could reduce ventilation requirements in office buildings by as much as 55%. The use of hydroponic plant modules to reduce ventilation energy demand in sub-Saharan Africa could provide a low-cost alternative with wider socio-economic co-benefits than traditional energy reduction measures. However, implementation of this strategy to cities in the region would present both technical and policy related challenges that would need to be addressed.

**Keywords:** Energy Efficiency, Urban Farming, Hydroponics, Heating, Cooling & Ventilation, Air Quality

## Zero Degrees of Separation: Changing the Direction of Architecture One Building at a Time

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It is widely acknowledged that buildings contribute a considerable proportion of global GHG emissions in their construction and use, making them a key contributor to global climate change. It is however the case that only limited attention to this reality is seen in architectural design, more so in sub-Saharan Africa, where a business-as-usual approach still predominates. This is ironic given the effects of climate change are already evident in the region; seen in changed weather patterns, with longer, hotter and drier seasons, and less predictable rains. The consequential increase in demand for climate modification equipment places additional demands on already stretched resources. While much of electrical energy produced across much of sub-Saharan Africa is from renewable sources, the penetration of this energy is still extremely low, with many towns still lacking formal electrical connections. Thus the business as usual approach may have consequences to the future growth patterns across the region.

Contemplating the responsibility of architects, landscape architects, urban designers and urban planners have in curbing GHG emissions, this paper reflects on how these professionals could respond to the challenges posed. As transformational professions, these professionals can and should be front-and-centre in this challenge through their actions and outputs, rather than a hindrance to change through the business as usual approach. Using examples from East Africa, this paper presents the on-going dialogue surrounding the need to address climate change as an integral part of architectural discourse, not only in academia, but significantly in practice, looking at the attendant opportunities and challenges that arise from this process, and what we can learn from the ensuing discourse

**Keywords:** ESD, Future Proofing, Construction Approach, Architectural Education, Transformational Education

## Public Buildings as Beacons of Energy Efficiency: A Key Strategy for Local Governments to Champion Energy Efficiency

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Following efforts thus far by the UN-Habitat on the programme promoting *Energy Efficiency in Buildings in East Africa* (EEBEA) to improve energy efficiency, energy saving and conservation measures in buildings in the member countries of the East African Community, this paper is interrogating two public buildings in two pilot municipalities in Uganda in as far as they respond to those three tenets. The buildings are both administrative headquarters in the municipalities of Jinja to the East and Kasese to the West. The choice of these municipalities is tied to an ongoing project *Supporting Sub Saharan African Municipalities in Sustainable Energy Transitions* (SAMSET) whose aim is to “design, test and evaluate a knowledge exchange framework to more efficiently and effectively support sustainable energy transition in Africa’s Sub-Saharan urban areas. The Green Paper on Energy Efficiency (2005) offers a practical precedent based in tried and tested evaluations of on-going practice.

The trilogy of EEBEA, SAMSET and the Green Paper on Energy Efficiency is based in what Dubois and Gadde (2002) front as *systematic combining* – that is grounded in an adductive logic. This enables a process where a theoretical framework, empirical fieldwork, and case analysis evolve simultaneously, and it is particularly useful for development of new theories. The study is based around technical and institutional provisions. The technical provisions follow the guidelines for green building design of the UN-Habitat EEBEA programme while the institutional provisions follow the SAMSET findings thus far with regard to local government mandates in the area of energy efficiency. The Green Paper on Energy Efficiency (2005) addresses the competing and non-linear nature of a set of criteria that include: energy consumption, environmental performance, investment cost, operational cost, indoor environment quality, security and social factors, all of which complement EEBEA and SAMSET.

A key observation from this study is the disjoint between existing/unseen potential, priorities and aspirations in local government. Energy Efficiency is not necessarily an in-house priority perhaps because it is not understood. While it is evident that capacity to enforce it is inadequate, it is interesting to note that resource mobilisation and allocation is potentially flexible if a case is built. An intended outcome is to promote a renewed attitude through an enabling environment that is responsive to existing guidelines, is conducive for monitoring and evaluation and inviting to investment in design, construction, refurbishment and retrofit of buildings that will act as beacons of energy efficiency. Thus far, both buildings are undergoing a process to achieve this, while key players at the municipality have undergone capacity development to equip them with skills, knowledge and an attitude to deliver energy efficient buildings.

**Keywords:** Energy Efficiency, Municipality, Local Government Mandates

# SESSION 6

## ENERGY EFFICIENCY AND SUPPRESSED DEMAND

## Viability of Energy Efficient Appliances in Bauchi, Nigeria for Sustainable Energy Transition

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Energy is being converted into various useful forms daily as most human activities is linked directly or indirectly to energy resources extraction, making energy an essential input to all aspect of modern life. The cost of energy has become a constraint in the daily ramifications of most Nigerians. In improving energy efficiency particularly electricity, more people are supplied with same electricity as well as slow down the electricity demand growth and reduce investment needed by expansion. In order to ameliorate this challenge, this study understood the existence of factors such as building, systems (services) and occupants but investigated energy services in buildings in Bauchi, Nigeria through an inferential descriptive survey by conducting energy audit for a baseline data. It analysed the energy service phenomena in homes of the study area to determine equipment and building efficient element utilization.

In all the 379 homes investigated, the descriptive analysis of the results obtained showed that there is high literacy level, with over 64% unaware or have poor conception of energy efficient appliances knowledge or what it stood for. It also recognizes a variegated range of appliance for home use at 67.68% with homes having One, Two or More refrigerators at 50%, 18.97% and a preference level of Electric Kettle use at 30.91%. The study further established that a poor and inefficient appliance adopted for use in most homes were immersion heater at 12.73% while the use of Electric cooker, Electric Water Heater, and Electric Stove at 6.36%, 2.73%, and 4.55% respectively. Equally, it was observed that majority of households in the region of the study had generator set as means of electricity energy support in the event of power outage giving credence to a poor energy supply across the Nation.

The study posit that even though service appliances are available, the lack of desired efficient service has further constrained this poorly available electric energy and recommends the adoption of efficient energy service economy, the use of modern architectural ideals through solar architecture involving Building Integrated Photovoltaic (BIPV's) that is solar refrigerators, solar water heating and energy efficient materials as measures to enable quality energy service economy and end user comfort/satisfaction in the Tropical region of Nigeria.

**Keywords:** Nigeria, Energy Efficiency, Appliances, Sustainable Energy

## Living with Energy Crisis: Survey of Households' Coping Strategies in Katsina Urban Area, Northern Nigeria

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Across much of Sub Saharan Africa, the energy sector has been facing a lot of crises that have deprived a substantial part of the population from having access to energy. The nature and effects of such crisis has been well documented but little research information exists on how people (especially urban dwellers) across much of SSA have been coping with it. Using qualitative interview data from local households in Katsina urban area of northern Nigeria, this study sets out to assess how urban dwellers cope with energy crisis. The results obtained revealed that about 90% of the households are connected to grid-based electrification but over majority (about 87%) rely on wood-based (charcoal, firewood) sources, with about 47% relying on fossil-based (kerosene, natural gas, gasoline and diesel) and less than 5% relying on renewable (wind, solar and biofuel) sources. The main challenges faced in meeting energy demands include scarcity and high costs of fossil-based fuel sources, and wood and charcoal; erratic supply of grid-based electricity and disappearance of tree species from which to derive firewood and charcoal. The major coping strategies employed by the households include reduction in non-energy spending to free resources for meeting energy demands, reduced frequency of cooking, uses of candles, solar-powered lightning devices and solid wastes in domestic combustions; reduced frequency of ironing of clothes; increased efficiency in energy usage and reduced use of high energy consuming devices.

Where electricity is available, it is used for lighting by most (>95%), but only few (<30%) use it for cooking and cooling. However, over 75% use candles (for lightning) and firewood (for cooking). Only 23% use liquefied gas (for cooking) while about 72% use gasoline and diesel to power generators and generate private/off-grid electricity. Only 2% use dry cell and car batteries, and solar, wind and biofuel systems. The major determinants of use of coping strategies are households' low resource base, social-cultural considerations, technical complexity of the many hi-tech energy solutions and lack of incentives for the people to use energy conserving devices. Some suggestions have been made on how to enhance the coping capabilities of the households and ensure greater access to energy in the area.

**Keywords:** Sustainability, Energy, Crisis, Coping, Katsina, Nigeria

## Examining the Knowledge Base of Households on Energy Efficiency Programmes in Ghana and the Level of Participation: The Case of Energy Efficient Refrigerator Adoption in Ga East and Awutu Senya East Municipalities in Ghana

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Global new investment in renewable power and fuels by the end of 2014 amounted to USD 12.6 billion in Africa and Middle East compared to USD 57.5 billion in Europe, USD 60.7 billion in Americas and USD 140.4 billion in Asia and Oceania. The slow process of transitioning to efficient renewable energy technologies in Africa compared to other parts of the world calls for consideration to efficient energy demand management to enhance GHG emission reductions in the region. Using energy survey data from two municipalities in Ghana (Ga East and Awutu Senya East Municipalities) and drawing on the theory of Diffusion of Innovations, this paper investigates households' knowledge base vis-à-vis the extent of patronage of the ongoing national energy efficiency programmes that are part of SEA4ALL initiatives.

The analysis reveals high awareness level, recognition and acceptance of the compact fluorescent lamps (CFLs) distribution programme by households in the two municipalities. The awareness level of the fridge replacement and efficient cookstove programmes is likewise very high in the two municipalities (above 60%). In contrast, the number of beneficiaries of these programmes is low in the two municipalities. Stemming out of the analysis is that, the high level of knowledge base is limited to the mere existence of the programmes, since most households have little or no ideas regarding the details of how to benefit from them. It is therefore evident that beyond the high level of awareness, other equally important measures are needed to underpin the high adoption of these EE innovative programmes.

**Keywords:** Renewable Energy, Energy Efficiency, Knowledge, Awareness

## Demand Side Contextual Drivers of Inclusive Innovation: The Case of Kenya's Energy Efficient Appliances Sector

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Inclusive innovation has been gaining momentum as a concept since the mid-2000s. It refers to the idea that products, services or organisational arrangements can be introduced into new contexts in ways that reduce poverty through one or more of the following: (i) meeting the needs of the poorest in society; (ii) engaging the poor in business or (iii) actively reducing societal problems e.g. climate change. As such it is increasingly seen as a means of increasing access to energy through creating access to low carbon energy technologies which sometimes includes the development of viable business opportunities for the marginalised in society. Three types of inclusive innovation have been predominately discussed in the literature: (i) grassroots innovation; (ii) base of the pyramid innovation and; (iii) below the radar innovation. These types of inclusive innovation are deemed to create benefits for individuals, communities and/ or countries in terms of money, time and opportunities.

There is however, recognition that innovative activity is hampered in its level of inclusivity by a range of technological and social factors. These have traditionally been examined from the supply side. However, recent work in the renewables field, and by the authors in Kenya to encourage development of low cost energy efficient domestic appliances, highlight that a series of complex supply side contextual factors cannot be ignored. Specifically, it highlights the importance to end users of a technology's usability, its ability to fit with various environmental factors and prevailing habits in a household or community. This paper – very much a work in progress – highlights the deficiencies of currently dominant inclusive innovation narratives that implicitly try to address contextual supply side factors. It uses the case of Kenyan cookstove debates as an illustrative example while outlining an inclusive innovation typology to assist those working in this field.

**Keywords:** Renewable Energy, Inclusive Innovation, Kenya, Discrete Choice Modelling, Base Of The Pyramid

# SESSION 7

## BIOGAS, BIOMASS AND WASTE MANAGEMENT

## Investigations into the Role of Small-Scale Biogas in Sustainable Urban Development in Africa

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Continuing urbanisation in Sub-Saharan Africa provides many development challenges including; energy provision, waste management and sanitation. On-site biogas has the potential to provide renewable energy to meet primary energy needs, whilst also addressing waste management and possibly sanitation. In urban settings, organic waste typically comprises more than 50% of the municipal waste which remains an untapped energy source, while the total waste volume continually increases with population growth. Whilst some countries (including Ethiopia and Uganda) have support via national government and/or foreign investment for biogas deployment, their focus is on rural biogas for agricultural waste, not urban biogas for municipal waste.

We investigate the case for small-scale biogas as a technology to assist sustainable urban development in three distinct parts. The first part compares biogas and other technologies for the same purpose of meeting primary energy needs i.e. solar cookers and efficient wood-stoves, the latter for which there are notably clean development mechanism projects underway in Uganda and Kenya. The matrix used was built for urban energisation, and it was found that there are important considerations to be taken by energy planners when considering biogas were health, safety, cleanliness, cost and market compliance. Efficient wood-stoves also face a possible issue with health, safety and cleanliness, while solar cookers have an important climate and location consideration. Biogas has advantages of being able to address waste management and sanitation needs, and the additional output of digestate, which is beneficially utilised as a compost additive. However, it must be noted that the digestate, if not planned for can be a troublesome off-take stream.

The second part analyses the factors which affect the productivity and stability of small scale biogas units by analysing data sent in from ten small scale biogas units across South Africa and Swaziland via mobile phone application. Biogas operators were given a mobile phone with the application pre-loaded, as well as pH test strips. Readings of pH, burn time, pressure and mass and type of feed were captured and analysed. Data was collected over 18 months, and analysis showed: clear seasonal fluctuations in productivity; stability wavering with heterogeneous feed-stocks; and an efficiency analysis indicating that many units are under-utilised.

For the third and final study, two test units were used to verify the analyses in the previous study, and determine the value of the digestate as a compost additive. It was demonstrated that organic waste can be the sole feed-stock for biogas units with appropriate knowledge support. It was also shown that the use of digestate in a composting operation significantly increased the economic attractiveness of small-scale biogas. In conclusion, it was found that given the right climate and a champion with governmental and knowledge support, small-scale biogas should be considered as an important technology for urban development.

Whilst waste-based biogas would meet only a small portion of the total energy requirement in any particular urban area (up to 5%), typically for household or small-business cooking, it offers significant development contributions through improved waste management and plant nutrient recovery

**Keywords:** Small-Scale, Biogas, Sustainable Urban Development

## Contested Issues of Biomass Production in Peripheral of Urban Areas of Ghana: Implications for Long-Term Urban and Energy Sustainability

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Recent interest in foreign direct investments (FDIs) in commercial agricultural projects, particularly in bioenergy, has gained momentum in Sub-Saharan Africa. National and local support for large-scale biofuel expansion reflected, and at the same time reinforced, three types of expectations: energy security, climate mitigation, and rural development. Many of these projects are located in peri-urban areas of small cities with many challenges and opportunities for promoting sustainable urban energy. What seems salient are that, generally, the debates on biofuel or bioenergy and the new urban agenda are taking place separately. Few studies have shared perspectives on the synergies of bioenergy production in an urban context and the trade-offs in promoting bioenergy within his context.

Understanding the challenges and opportunities for urban areas can have ramifications on policy choices in transitioning to a greener urban energy in Africa, at the same time achieving the goal of 'inclusive' cities (SDG 11). By selecting two cases in Brong-Ahafo Region in Ghana, this study highlights the barriers and enablers for bioenergy development in and around urban areas. It was found that the widespread negative impacts in terms of land rights, compensation for land, water access and ecological restoration are key drivers of those bioenergy projects but also highly contested issues, which in turn led to their failure. However, there is still willingness on the part of urban dwellers to promote biofuels, given the prospects for employment and better income. These findings reflect governance and sustainability challenges, while at the same time indicate opportunities for a transition to a greener economy. The findings suggest the strengthening of the urban-regional governance and integration of bioenergy planning into mainstream proactive urban planning practices are imperatives if urban areas are to harness the opportunities offered by the bioenergy sector.

The paper finally engages the debates on the new urban agenda by indicating that a new conceptualization of the bioenergy rural-urban interface is needed in order not to distort the rural-urban divide. Achieving 'inclusive' cities (SDG 11) will remain counterintuitive if rural-urban dichotomy is not addressed in the new urban agenda. The extreme focus on 'cities' and the neglect of peri-urban areas in the new urban agenda serve as an inevitable challenge in meeting the SDG on "inclusive cities".

**Keywords:** Biomass, Biofuels, Energy, Governance, Peri-Urban, Sustainability, Urban, Africa

## Role of Non-Governmental Organizations on Waste Management and the Potential Energy Generated From Waste in Kano, West Africa

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Affordability and accessibility to energy services is a major challenge facing the African nations since energy is fundamental for socioeconomic development and poverty eradication. There is no doubt that the current energy shortage afflicting Kano city will be at increased rate unless the state government and other energy stake holders diversifies the energy sources in domestic, commercial, and industrial sectors and adopts new available technologies to reduce energy wastages and to save cost. The city of Sub-Saharan Africa like Kano which is the second largest city in Nigeria, have experiences environmental related problems associated with uncontrolled waste generation and poor disposal. The contribution of non-governmental organizations (NGOs) in waste management in Kano city is not well documented. The information generated could be documented and use for decision making for policy formulation for sustainable and effective waste management in the city and explore the form and amount of energy to be generated from combustible MSW for household and industrial consumption. The roles of NGOs were examined using questionnaire and potential energy generated from MSW was evaluated from the previous studies.

The findings show that waste disposal (37%) is the major environmental problem with erosion (3.7%) in the area, however five major roles of NGOs were identified among the selected NGOs in the city. It was discovered that the MSW is dominated by food/organic waste (58%) while polyethene have the highest energy content of 46.5 MJ/Kg and lower in textile waste (9.27MJ/Kg). The MSW generated in Kano city is approximately 3050 metric tons per day and 1, 0805,000 tons per year with potential of electricity generation of about 33,565.8229 kWh/day and 403,653.3kWh/year respectively. Waste to energy technology reduced he volume of MSW and high potentiality of generating electricity. It was concluded that WTE technology reduced MSW volume and the MSW of Kano city have high proportion of combustible matter that contain substantial amount of energy which can generate huge and efficient heat with high potential of electricity supply can generated huge amount of energy. Government invest in small WTE project at low cost that can be sustainable and also more investors should be invited to invest in WTE project and the energy should be sold to government and use for street light and other facilities such as water treatment plant, and other private companies, and individual to reduce relying on fuel.

**Keywords:** Waste Management, NGOs, Waste to Energy, Disposal and Environment, Energy

## Strategies for Energy Production from Combined Coal-Solid Waste Mixture for Sustainable Urban Areas with Special Focus to Bauchi Metropolis, North-Eastern Nigeria

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Solid waste management has become a global problem especially in developing cities of the world. However, Municipal Solid Waste (MSW) is a promising resource for electricity production especially when combined with a higher calorific value fossil fuel such as coal. Electricity is a necessity for development but its supply is highly inadequate in most metropolitan settlements in Nigeria. The combination of fossil fuel with MSW for electricity generation is justified due to the acute inadequacy of electricity in Nigeria coupled with the abundance of fossil fuel. Therefore, this research investigates the electricity generation potential of coal-MSW mix for Bauchi metropolis. Population and MSW generation for the study area were determined from the year 2010 to 2070. In 2020, the population of the metropolis will be over 668,000 people generating more than 195,000 tonnes of MSW. The characterization studies showed high proportion of plastics and other combustibles which makes the MSW a good stock for combustion in turbine. The calorific values were determined for various coal-MSW mix and the results range from 8,762 kJ/kg (0% coal and 100% MSW) to 11,044.65 kJ/kg (100% coal with 0% waste).

The energy production for the metropolis was based on five scenarios depending on coal-MSW mixture and time frame: Scenario A (100% coal:0% MSW) for years 2020 – 2029, Scenario B (75% coal:25% MSW) for years 2030 – 2039, Scenario C (50% coal:50% MSW) for 2040 – 2049, Scenario D (25% coal:75% MSW) for 2050 – 2059 and Scenario E (0% coal:100% MSW) for 2060 – 2069. Results show that Scenario A can produce 16.7 MW (146,719 MWh) of electricity in the year 2020 for the metropolis and will gradually increase to 32 MW in first year of Scenario E. Although, more electricity can be produced from coal alone but the prevailing environmental laws on global CO<sub>2</sub> emissions like the Kyoto Protocol have constrained its use. In terms of emission from coal utilisation or reduction (by supplementing with MSW), Scenario A has the most energy output potential but generates the highest amount of CO<sub>2</sub> emission (zero CO<sub>2</sub> reduction) while Scenario E (e.g. in 2060) produced the least electricity per kilogram of fuel combusted thereby saving 91,295 tonnes of CO<sub>2</sub>. In Scenario C, a carbon-neutral power production process was achieved as the amount of CO<sub>2</sub> reduced cancels out the amount emitted. In addition, the economic and environmental impact study of the scenarios revealed that Scenario A is the most attractive in terms of revenue from electricity but least in revenue from carbon credit. Although, Scenario E generates the least per capita revenue, it was found to be the best considering environmental safety concerns. If penalty were to be imposed on coal due to CO<sub>2</sub> emission, the seemingly economic attractiveness of coal in Scenario A would diminish because it is either abandoned or huge costs incurred in flue gas cleaning. This research therefore provides flexible mechanisms for the production of energy in urban areas to contain MSW problems and reduce CO<sub>2</sub> emission from the use of whole coal.

**Keywords:** Municipal Solid Waste, Electricity, Coal, Emission, Bauchi, Nigeria

## The Utilization and Underutilization of Waste as a Resource: A Bottom-up Approach to Waste Management and its Energy Implications in Lagos, Nigeria

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Municipal solid waste (MSW) has significant levels of negative externalities in Lagos state, especially on the environment and with regards health. Burning, uncollected and improper disposal of waste has been established to be a norm in Africa. Recommendations and strategies have been offered to manage waste more effectively. This study utilises a bottom to top approach in identifying the issues that are still inherent in waste management

This study employs a survey approach in establishing meaningful data. It involved the development and administration of a survey questionnaire with over 200 respondents, carefully structured to answer WM questions governed by the four pillars of sustainability (Environment, social, economic and institutional). In addition, interviews were also conducted to obtain additional information and for case study purposes. The analysis method involved the utilization of Statistical package for social science (SPSS) to establish correlations and trends within the data set.

While this study provides insightful results from the bottom-up approach, the novelty lies within the process of discovery including 1) utilizations of the citizen-led approach (contextual approach), 2) utilization of the pillars of sustainability in the development of the survey questions (sustainability approach), 3) categorizations and mapping of results (Structural Approach), and 4) The SWOT analysis of the current status and recommendation for improvement in Lagos state WM sector (Framework Approach).

The associated results were categorized into Perceptions of the current status waste management and the energy implications of such perceptions and experiences. In the results, issues such as lack of infrastructure, wide spread burning and burying of waste, lack of awareness, inefficient disposal techniques etc. were raised. However, the respondents also proffered implementable solutions such as improving coverage and frequency of collection, introduction and optimization of legislation to support waste management plans, increase awareness of children to waste utilisation etc. This was reviewed through SWOT analysis to draw up an energy mapping strategy to not only reuse waste but to do so with “energy” as the by-product.

**Keywords:** Waste Management, Energy Implications, Lagos, Municipal Solid Waste

# SESSION 8

## COOKSTOVES AND ENERGY ACCESS

## Ecook – the Near Future Landscape of Cooking in Urban Areas in Africa

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Many households in urban areas across Africa have access to electricity, through both formal and illegal connections to the grid. Electricity is used for lighting and entertainment, but there is very limited use of electricity for cooking. Biomass continues to be the dominant choice of cooking fuel, primarily in the form of charcoal in urban areas. The burning of biomass brings with it associated health problems, deforestation, and makes a contribution to global climate change. Sustainable Development Goal 7 calls for affordable reliable access to modern energy. And yet much of the discussion of SDG7 avoids the challenge of cooking. In some cases, for example Ghana, LPG value chains have been established and LPG has been promoted as the 'modern energy' alternative to biomass – however, LPG is a fossil fuel and while it does reduce the harmful emissions within the household, it nevertheless still contributes to climate change and costs will increase as reserves dwindle. This paper seeks to determine why urban households do not use electricity and whether action can be taken to overcome these barriers?

The reluctance to use electricity for cooking, even in urban in Africa, does not seem to be based on household economics, but rather has been reported as a consequence of load shedding (cooks cannot be sure it will be available when required), a perception that it is expensive (even if it is not) and weak local infrastructure (brown outs and black outs if cooking stoves draw too much energy). Because many grids are already operating at their limits during peak demand (both generating and local distribution capacity), utilities do not encourage cooking, which would lead to further problems with managing supplies. The paper acknowledges that South Africa is an exception to this generalization and gives reasons why this is the case.

Batchelor (2013) proposed that falling component prices would mean that by 2020, solar electric cooking systems (eCook) would be cost effective in many markets currently dominated by charcoal. Leach and Oduro (2015) confirmed that eCook could compete as a discounted monthly cost with biomass in many markets in Africa by 2020. This paper presents the results of a choice modelling survey in Kenya, which confirms that urban households would like to adopt modern energy for cooking. The preferences of the respondents were used to inform the design specification of two prototype solar home systems built in the UK and Bangladesh, which incorporate cooking. This paper describes the two design approaches – the first focused on battery energy storage alone, and a second low power version focused on insulation. The paper ends with a call to reframe the problem of cooking – seeing it not as a problem of biomass but as an opportunity for stimulating a greater uptake of modern energy.

**Keywords:** Improved Cookstoves, Solar PV, Kenya, Biomass, Cooking, Urban, Energy

## Household Perceptions of the Value of Improved Cookstove (ICS) in Benue State, North Central Nigeria

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It is estimated that 80 percent of households in Sub-Saharan Africa rely on solid biomass such as wood and charcoal as fuel for cooking and heating needs. According to the latest DHS survey, about 69 percent of Nigerians use wood, charcoal or other solid biomass to meet their household needs. A 2015 World Health Organisation (WHO) report estimated that the use of biomass fuels on inefficient stoves was responsible for household air pollution that caused 4.3 million premature deaths globally (70, 000 in Nigeria). Despite the potential of Improved Cookstoves (ICS) in reducing household air pollution, household perception of the value of ICS ownership often doesn't align with the benefits promoted by manufacturers and other external agencies.

Despite their promotion, many households continue to use solid biomass fuels and see them as a cost-effective solution given other household financial priorities. In line with this, the Sustainable Energy for All Initiative (SE4ALL) recognises that to increase adoption rate of renewable energy technologies will “require a radical rethink of the way we produce, distribute and consume energy” especially at household level.

Our study discusses results from ongoing qualitative research investigating enablers for the uptake of ICS in Benue State, North Central Nigeria, particularly in the urban community of Gaadi. The research used interviews and household questionnaires to gain an understanding of household perceptions of ICS and the value attached to cooking technologies. The study highlights household priorities and choice as it affects the use of ICS. It further discusses household aspirations and priorities in the study area drawing attention to low levels of awareness of the health benefits of ICS adoption, preferences for using a range of cooking technologies for different cooking task (stove stacking) and the lack of sustained ICS use for financial and cultural reasons. The results suggest that the use of solid biomass is informed by user perceptions and priorities, socio-cultural practices and the availability of wood at no financial cost, even in some urban areas.

We conclude that, ICS uptake is likely to be higher if manufacturers and promoters design and promote a more diverse mix of traditional and new renewable energy cooking technologies (RETs) that reflect user priorities and aspirations.

**Keywords:** Households, ICS, Cookstoves, Perceptions, Nigeria

## Transitioning to Modern Energy for Cooking

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The hazards associated with biomass combustion in the household for cooking are well documented. Much effort has concentrated on reducing biomass energy use through the promotion of improved stoves, and by displacing with alternative, modern fuels. Adoption of improved cooking practices has not been as rapid as might be hoped for, and a number of hypotheses for this are reviewed. The SAMSET project takes a comprehensive look at ways in which municipal authorities in sub-Saharan Africa can play an active role in transitioning to more sustainable use of energy. Under the project, independent household surveys were conducted in urban areas of Ghana and Uganda. Both surveys gathered data on a range of aspects of domestic energy use, including cooking, and these data sets have been analysed to provide insights into cooking behaviour.

The paper presents data on patterns of consumption of various cooking fuels, along with data on expenditure on each fuel. Both surveys gathered some data on preferences for different fuels for cooking, as well as the reasons lying behind these preferences. The paper then goes on to explore some of these issues in more detail, focusing, for example, on relative costs, showing the cost differentials between biomass and modern fuels, given the prevailing costs in both countries. It explores specific cooking energy consumptions for different fuels, which highlight characteristics of different fuels and appliances.

The paper discusses the influence each may have on cooking behaviour and looks for trends evident among different consumer segments found within the urban environment. Finally, the paper discusses those issues that appear to be acting as barriers to the adoption of modern energy and improved cooking practices.

**Keywords:** Cooking Fuel, Fuel Prices, Modern Energy, Urban, Ghana, Uganda

# SESSION 9

## PLANNING AND TRANSPORT

## Urban Ropeways: An Innovative and Sustainable Alternative for Public Transport in Sub-Saharan Africa

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Especially in developing countries, unsustainable mobility and urban planning increasingly becomes a limiting factor for socio-economic development. The growth of motorized traffic has reached levels which start to hinder the function of the cities' transport systems. There are multiple risks related to the current mobility paradigm which has developed during the 1960ies and 70ies in the industrialized countries of Europe and the U.S., but is now being exported to the whole world.

Africa's cities should not lose time importing obsolete strategies from Europe and the U.S. but use worldwide knowledge and experiences to achieve:

- multi-centric urban growth, based on proximity, density and short distances, in order to avoid trips
- mobility-systems shifting from individual motorized transport towards an efficient mix of economical mass transit and high capacity feeder systems including non-motorized modes
- technical improvement of the transport systems by decreasing the dependence on fossil fuels and using alternative sources of energy.

The use of areal ropeways as an urban mode of transportation is rapidly gaining ground in developing regions like Latin America or Africa. They present a perfect way to start using a highly effective mode of public transport, which is cheaper, faster and easier to implement, to integrate and to operate than other transit modes, such as Bus Rapid Transit (BRT) or Light Rail Transit (LRT). Apart from this Ropeways present a very interesting tool to influence urban development in a larger scale. Many African cities have serious transport problems, residing in the the lack of efficient public transport and an uncontrolled extensive urban growth. The almost total dependence on ground based transport modes operating in mixed traffic causes an increasing level of congestion, which generates accidents, deteriorates the air-quality and limits the accessibility within the city and from other parts of the country. This situation is not only socially and ecologically unsustainable, it will eventually limit the economic potential of the African Metropolises, which are the base for Africa's economic growth. A modernization of the transport systems is overdue.

Since 2013 EURIST has been working on the transfer of knowledge about the potential of urban ropeways and on their implementation in Africa. We have accompanied the formation of task forces in numerous African cities working towards the implementation of ropeway pilot systems. We have produced a study on the success factors for these systems in Africa and another one on their potential as a tool for urban development in Europe, and we have produced a technical and economical case Study in order to showcase the enormous potential of a ropeway pilot in Accra.

In a presentation at the "International Research Conference on Strategies for Sustainable Energy Transitions in Urban Sub-Saharan Africa" we would summarize the results of our work and especially elaborate on the potential of ropeways as a sustainable urban transport mode and development tool - using the example of Accra. We would further elaborate on the possibilities to use alternative sources of energy in order to run them.

**Keywords:** Urban Transport, Sustainable Transport, Ropeways, Sub-Saharan Africa

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## Application of New Urbanism Principles in Transitioning African Cities. A Case Study of Harare

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Harare as any other cities in transition in Africa is experiencing significant urban population growth from both natural population increase and from in-migration. The urbanisation has led to challenges of increasing urban sprawl, and unsustainable urban mobility. In efforts to address the challenges of urban sprawl and automobile dependency, Harare has been implementing the principles of New Urbanism. New urbanism is an urban planning movement, which seeks to create sustainable urban communities. It is based on traditional neighbourhood design of creating walkable compact communities with mix of land uses for environmental and social diversity.

This paper explores the nature and scope of City of Harare to achieve sustainable land use planning and urban transport through adoption of New Urbanism principles. It analyses three principles of New Urbanism's ten principles and how they are applied. The application of principles of smart transportation, mixed-use development, and densification were evaluated. Questions on this study proliferate to how are selected New Urbanism principles applied in Harare? What are the challenges associated with implementing New Urbanism principles in Harare? What are the prospects towards successful implementation of new urbanism principles? To examine these questions critically, primary data was collected through semi-structured interviews from key informants and documentary analysis on urban policies and planning instruments was conducted.

The paper identifies challenges of theory-implementation gap, poor conceptualisation and contextualisation of the principles, fragmented implementation approaches, weak regulatory frameworks and external economic challenges.

**Keywords:** New Urbanism, Smart Transportation, Urban Mobility, Land use Planning.

## A Spatial Planning Approach to Assessing Energy Resource Flows in African Cities: A Comparative Study of Dar es Salaam and Lusaka

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Achieving a sustainable energy transition in Sub-Saharan Africa will depend on the density and spatial structure (or form) of cities. Yet – for many cities – spatial planning instruments are rarely integrated with energy sector activities, mainly because of insufficient collaboration between policy-makers, local planning authorities and infrastructure agencies. In response, we investigate the following research questions: What is the role of spatial planning in realizing more energy-efficient urban environments? How does uncontrolled and sprawling growth influence energy resource flows in cities? What are the different energy futures that cities will experience under continued urbanization?

We develop scenarios that are consistent with the Shared Socioeconomic Pathways (SSPs) using the Long-range Energy Alternatives Planning (LEAP) software and data from the World Bank's Climate Action for Urban Sustainability (CURB) database. Specifically, we detail narratives (SSP 1 to 5) and outcomes for energy use and urban spatial structure. For each scenario, we calculate future energy demand in residential and passenger transport sectors to 2100. Findings show that total energy demand is highest under SSP 2, 3 and 4 scenarios, and lowest under SSP 1. In achieving sustainability (SSP1), we highlight the role of spatial planning in securing low-carbon (and resilient) urban development pathways in Africa.

**Keywords:** Spatial Planning, Urbanization Pathways, Energy Demand, African Cities

## The Nexus between Urbanization and Energy: Contextualizing the Electricity Demand and Consumption in Accra Metro, Ga South, Ga East, Awutu Senya East and Gomoa East Municipalities in Ghana

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The 2010 Population and Housing Census of Ghana showed the level of urbanisation increasing from 43.8 percent in 2000 to 50.9 percent in 2010. The increase in population has resulted in an unprecedented increase in demand for the limited housing units within the urban areas. Consequentially, many people have migrated to the peri-urban enclaves, creating an urban sprawl and the associated energy demand. In addition, with Ghana's attainment of a lower middle income status in 2010, its economic space has since expanded, triggering a surge in energy demand.

The question therefore is "to what extent is electricity supply infrastructure in the country adequately matching electricity demand of modern housing infrastructure development?" With recourse to Accra Metropolitan Assembly (AMA), Ga South, Ga East, Awutu Senya East and Gomoa East municipalities, this paper discusses the interlinkages between electricity demand and rapid urbanization in Ghana from 2000 to 2015. Using quantitative and qualitative data, complemented by Geographic Information System, the empirical analyses reveal an expansive sprawling westward of AMA since the year 2000. The built-up areas of AMA increased from 55% of the total land area in 2000 to about 82% in 2015, with limited space for horizontal expansion. These sprawling trends, have in turn resulted in corresponding increases in electricity demand and consumption over the years while electricity supply lags behind.

With Ghana's envisioned goal of becoming a higher middle income economy by 2020, inevitably, many more of such built infrastructural development will take place and pragmatic sustainable energy strategies will be needed to close the electricity demand shortfall that will ensue.

**Keywords:** Urbanisation, Urban Sprawl, Energy Demand, Infrastructure, Electricity Supply

## 2.0 ESUDA 2017

The Continuing Professional Development (CPD) course dubbed “Energy and Sustainable Urban Development in Africa” (ESUDA) followed swiftly from 21<sup>st</sup> June, 2017 after the SETUSA 2017 Conference ended on 20<sup>th</sup> June, 2017. The four-day course which ended on 24<sup>th</sup> June, 2017 was jointly organized by ISSER-University of Ghana, SAMSET Project and the Covenant of Mayors in Sub-Saharan Africa (COM-SSA). The course was coordinated by Dr Simon Bawakyillenuo (ISSER) and Innocent S.K. Agbelie (ISSER). ESUDA 2017 was the third in the series of SAMSET CPD courses, having successfully organized the maiden and the second courses in Cape Town, South Africa and Kampala, Uganda in 2014 and 2016 respectively.

Unlike the previous two CPD editions, the ESUDA 2017 was multi-national and bilingual in terms of participants’ composition. The participants and resource personnel came from ten (10) different countries including, UK, France, Belgium, Ghana, Benin, Uganda, South Africa, Ethiopia, Togo and Senegal. English and French were used as the means of communication and delivery because participants were from both Anglophone and Francophone countries. A brief summary of the Four-Day CPD activities are provided below.

### DAY ONE: INTRODUCTION AND CONTEXT

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The course content of ESUDA on the first day was geared towards building the situational context of energy and sustainable urban development in SSA. After welcome addresses given by Simon Bawakyillenuo (ISSER) and Juliet Mekone (Regional Director, UCLGA), the first session dealt with the global to local energy and climate change pictures. Mark Borchers (SEA) unpacked the global to local energy picture, followed by Simon Bawakyillenuo (ISSER) who unpacked the global to local climate change picture. Daniel Irurah (Witswatersrand University, South Africa) discussed the interface between the energy and climate change pictures, highlighting the challenges that cities in SSA face.

The presentations drew salient questions from the participants including the following: 1. *Should SSA countries be concerned about the possible effects of climate change on water resources and how could flood waters be turned into productive uses?* 2. *Is it that energy is not being used productively?* 3. *Do climate change initiatives have a future after the White House stands on climate change?”* Daniel Irurah explained that productive uses of energy are not in doubt, but it is important to ensure efficient use of energy and not follow the business as usual pathway. He noted that as a sub-region, SSA doesn’t have the sufficient mechanisms to slow down floods, partly because of the nature of the infrastructure.

He quipped that it is necessary for “*our engineers to re-engineer as they haven’t done before*”. Juliet Mekone added that local governments need to think like some individual states in the USA who said they will continue with climate change agenda, despite the U.S. Government’s stand, because they are different level of government and not an inferior level of government.

The next session discussed the state of SSA cities, starting with an overview presentation by Adrian Stone (SEA). These were followed by presentations on the State of South African Cities by Hlengiwe Radebe (SEA), State of Ugandan Cities presented by Alex Ndibwami (Uganda Martyrs University), State of Ghanaian Cities presented by Innocent Agbelie (ISSER) and State of Senegalese Cities presented by Rokhaya Sarr (City of Dakar). Issues of renewable energy adoption and desirable architectural building designs were discussed.

The last session for Day One covered issues of Energy Governance; local government mandates across SSA. Preceded by an overview presentation by Megan Euston-Brown (SEA), a panel of local government practitioners, representing cities from Ghana, Uganda, South Africa and Senegal responded to questions such as “*Do local governments have sufficient mandates for sustainable energy planning? If yes, what are they doing in the area of sustainable energy planning in their cities?*” While the panellists, especially those from Ghana, Uganda and Senegal acknowledged that South African Cities wield much more power in terms of energy governance mandates relatively, they did, however, indicate that municipalities in these other countries have some mandates to tackle energy issues, at least those best described as low-hanging issues that require easy solutions.

Energy policies remain centrally driven by the national government in these countries (except in South Africa) and the energy mandates required for sustainable energy transition at the local level are insufficient at the local government level.

## DAY TWO: ENERGY PLANNING – FROM METHODS TO DATA AND STRATEGY

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The day’s activities began with an overview of data profiling exercises, tools to support data, modelling tools and strategy approaches moderated by Mark Borchers. The activities ran in two parallel sessions: parallel session one covered issues on mitigation and energy access planning while parallel session two covered adaptation to climate change.

In parallel session one, ISSER, represented by Innocent Agbelie shared Ghana’s energy survey experience with the participants in which the methods employed and the tools used were discussed. He emphasized on collaboration and the involvement of the local government practitioners as key components of the data building process.

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The participants acknowledged the amount of detailed procedures and scientific methods involved in the data gathering process and urged the municipalities not to allow the findings from the survey to gather dust on the shelves. Following Innocent's presentation, Mark Borchers led the discussion on understanding the useful outputs for decision makers and other stakeholders and how data gathered from surveys should be packaged in an easily-understandable format. He remarked that surveys provide data that is very relevant for projecting the future. Participants were divided into groups to discuss some outputs presented in charts on selected cities and report back their observations, including their understandings of the charts and possible sustainable policy interventions.

A key issue that came up during the feedback was related to the fact that researchers should think about the audience in presenting outputs of analysed data, because communication of the technical information to the policy maker in the language and formats he/she can understand best is key to convincing the policy maker to act proactively.

The late morning session was facilitated by Muriel Desgeorges (Agence de l'Environnement et de la Maîtrise de l'Énergie- ADEME) who discussed the tools to help with energy and emissions baseline development. The presenters acknowledged that spill-over effects of emissions from industries on adjoining cities make the emissions calculations complicated, hence, it is important to keep tabs on local and global emissions measurements. It was concluded that surveys are important in order to know the data, which helps in building the model for the GHG emission calculation. The flash point was that, *"once you have an inventory and the diagnostic, you are half way through in your strategy development"*. The afternoon session covered issues on mitigation, energy access, adaptation strategy development and approaches facilitated by Ian Turner of SEA. Key elements to a strategy development were discussed with perspectives shared from Ghana (Innocent Agbelie - ISSER) and COM-SSA (Sylvia Rivas – JRC). Cross-cutting issues with respect to strategy development were discussed by a panel of representatives from Cities of Kampala, Cape Town and Dakar later that afternoon.

In parallel session two, Megan Euston-Brown (SEA) facilitated the discussion on adaptation to climate change by first of all giving an overview. Together with Belinda Mills (ICLEI), they shared insights on the key elements to adaptive strategy development, which include among other factors, *infrastructure development; green belt protection, and strategic location of settlements and people*. It was made known that major urbanization planning should include *sorting of urban tenure issues and raising of awareness of problems*. Abdoul Gafarou Tchalaou (COM-SSA) shared some of the functions and achievements of Covenant of Mayors SSA (COM-SSA) in supporting cities capacity-wise to tackle climate change. The processes and the requirements needed to become a member of the COM SAA were shared and the participants were encouraged to take the message back to their Mayors to work towards becoming COM SSA members.

The afternoon session of parallel session two was dedicated to the LEAP Modelling Tool training. Training and exercises took place on how to use the LEAP model to explore future city energy and emission scenarios. This session was facilitated by Adrian Stone (SEA).

## DAY THREE: IMPLEMENTATION – MITIGATION, ACCESS AND ADAPTATION

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The activities outlined for the third day of the ESUDA CPD course were intended to introduce the participants to some of the sustainable energy strategies being implemented in various cities across SSA. Three parallel sessions took place in the morning; parallel session one covering issues on renewable energy options – distributed solar PV, waste to energy potentials and projects – facilitated by ISSER. Parallel session two covered issues on energy efficiency in the built environment –energy efficiency in buildings and household energy efficiency and appliances-- facilitated by Uganda Martyrs University; while parallel session three covered issues on transport and spatial evolution of our cities – planning, mobility and transport—facilitated by Adrian Stone (SEA).

In parallel session one session, Mr. Out-Danquah (Energy Commission of Ghana) gave the perspectives of renewable energy development in Ghana while Mr. Raymond Ategbi Okrofu shared the experience of Safi Sana Ghana Ltd in electricity generation using waste. The third presenter, Dr. John Idan also gave the empirical evidences and lessons on biogas development in Ghana, while Mark Borchers rounded off the parallel session with a presentation on solar PV decentralized generation, and its importance in the fast growing RE options in SSA. The presentation drew some important questions from the participants, key among them being *“how is the off-taker risk managed by the private electricity generators? “What is the ownership agreement of Safi Sana and can Ga East Assembly be considered on the next phase of the project? What specifications of solar PVs are needed in industrial areas?* In addressing these concerns, Raymond (Safi Sana Ghana Ltd) revealed that the company will own the plant for 18 years after which ownership will shift to Ashaiman Municipality. He also mentioned environmental assessment was a pre-requisite by the Environmental Protection Agency before such a project could be allowed to operate. Mr. Out-Danquah mentioned that, there are policy actions in place to purchase power from independent producers.

Meanwhile the Government of Ghana’s small-scale Solar PVs roof-top programme has targeted moving all lighting and TV loads onto the Solar in order to reduce the peak loads at night. John (Biogas Technology in Ghana) pointed out the economic and environmental advantages of biogas technology including cheap, available and durable raw materials for construction as well as

employment for the local people. Mark concluded by saying that interested individuals and institutions should contact experts for the best specifications and encouraged municipalities to engage in joint pilot projects with private institutions such as Solar PVs for municipal buildings.

In parallel session two, Mr. Agyarko gave an insight on the successes and challenges of the efficient refrigerator programme that ran in Ghana from 2011 to 2014. Megan Euston-Brown followed up with a presentation on efficiency in municipal infrastructure and low income housing before presentations from Cecile Gracy (ADEME) and Mark Olweny (UMU) who shared insights on energy efficiency in West African buildings and energy efficiency in the built environment in Uganda respectively. After a panel discussion on transport and mobility, and a panel with experiences from City Planners from Kampala, Accra, Cape Town, Polokwane and Dakar, Cecile Gracy (ADEME) rounded the morning session of parallel session three with a presentation on “Mobilize your city”.

The afternoon session’s activities were organized in two parallel sessions: **Access to energy** – facilitated by SEA-- and **Adaptation to climate** facilitated by Belinda Mills (ICLEI). In the energy access parallel session, household energy poverty and the gender dimensions of energy poverty were extensively discussed by Hlengiwe Radebe and Simisha Pather-Elias of SEA before Simon Batchelor (GAMOS Ltd) rounded the session up with a presentation on cooking and modern energy in SSA. In the other parallel session, SEA and ICLEI facilitated the discussion on adaptation to climate change, giving an overview of ICLEI Africa’s experience in SSA and various case studies of city adaptation plans and experience including valuable lessons from municipalities. Later in the afternoon, all participants regrouped for the final plenary session where participants were organized into small groups to discuss and give feedbacks on an exercise involving “*prioritizing and financing interventions within a municipality*”.

This session was facilitated by Simon Batchelor (GAMOS Ltd) who also summarized the key emerging issues from the small groups’ exercise. Some of his concluding remarks included the need for an all-inclusive city planning to achieve a common goal of sustainable development and the need for city authorities to plan for realistic projects that can easily appeal to funders.

The final session of Day Three programmes entailed summary and wrap-up of the three-day presentations, discussions and experiences facilitated by ISSER. This session was the closing ceremony where certificates were handed to participants. During the submission of closing remarks, a couple of participants gave insightful thoughts, take-away messages and messages of hope for local government practitioners to ponder over. They include the following:

*Partnership and synergy of strategies:* Simon Bawakyillenuo (ISSER) painted an image of looming climate change impacts on SSA and the world in general. The earth’s climate as we know has rapidly changed and if we do not sit up and become change agents, lives and properties will continue to be lost. There is the need for partnership and working together to create synergies between

academicians and policy makers so that all our research findings, for instance from projects such as SAMSET, will not remain on the shelves.

*Willingness to commit resources:* Prof. Felix Asante (Director, ISSER) commended the funders for supporting the SAMSET project. He acknowledged the wealth of knowledge and capacity building packages the project has developed, which he advised the local government practitioners to put to good uses. He emphatically reiterated that ISSER will be happy to commit resources and render any support to see SAMSET II springs to life. He also demanded commitment on the part of municipalities.

*Strategic opportunities:* Juliet Mekone (Regional Director, UCLGA) remarked that she doesn't agree with the fact that SAMSET is ending, rather, it is just starting. She wonders what will become of all the information and knowledge that SAMSET has uncovered if the project is not sustained. Instead, she suggested the need to start putting the findings into action as the real beginning of the SAMSET ideology. She beckoned the team to look out for strategic opportunities such as enrolling into the bigger global Covenant of Mayors whose ideology aligns with SAMSET's objective. She reiterated the need to work together for a common goal of sustainable development for African cities.

*Change agents:* Mark Borchers (SEA) was pleased to have developed such a great working relationship with all the partners and highlighted the importance of partnership and working together. He agreed with Juliet on strategic partnership and mentioned that SEA is already part of COM which can be an opening for future opportunities for SAMSET in creating more change agents.

## DAY FOUR: FIELD TRIP

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Though in the early hours of the day it looked like the trip was going to be cancelled due to bad weather, the sustained interest of most participants to undertake the trip allowed the organizers to venture into the wet weather. The interested participants were taken out to witness some of the practical and sustainable energy projects implemented in parts of Accra. The field team made a first stop at the Sewerage Systems Ghana Ltd at Lavender Hill, Accra. After welcoming the team and giving a brief history and operational messages, the head of Process Department and Chemical Engineer, Eric Amofa-Sarkodie took the team round the plant to observe how liquid (fecal) waste is being converted into energy. The next and final stop was at the Zoom Pak Waste Transfer Station at Teshie, Accra. At this site the team was taken round the facility and educated on how solid waste collection and management has been enhanced in the surrounding of the city of Accra by the facility.

## 3.0 CONCLUSION

The four-year SAMSET project is an action-research project instituted in six pilot cities across three SSA countries with the aim of developing sustainable energy strategic actions to enhance access to affordable, reliable, sustainable and modern energy. The outcomes of the two events suggest that a lot has been produced in terms of knowledge, information and capacity building at the local government level. Therefore, the implementation of the strategies developed only begins the journey of SAMSET and so should be regarded as ‘important means to a desirable end’.

A key component of the SAMSET work package is “ongoing support for implementing elements of the sustainable energy strategies”. By this package, the research partners are encouraged to support the local government practitioners, either through the identification and application for funding to implement elements on the strategy, or offering technical advisory supports for implementing strategic actions. This support for implementation of elements of the sustainable strategies has been demonstrated a few times already and is set to be an activity that will continue in the future. How then, is it perceived that SAMSET has come to an end? Far from it! So far as municipalities and research partners jointly continue to hunt for opportunities to implement elements of the sustainable strategies, SAMSET is still running. City authorities are encouraged to show commitment, create synergies and partnership to unlock potentials and opportunities. In that sense, SAMSET cannot be regarded as having come to an end. In fact, it is only just beginning.

### FOLLOW-UP

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The final segment of the closing session of the conference focused on identifying future funding opportunities and collaboration to sustain the SAMSET project’s kind of action-research in future. Many participants aired their views including some session chairs. Ed Brown, first of all, outlined some important opportunities that can be tapped for future sustainability projects and collaborations. He suggested few guidelines that will enhance the chances of winning a grant including sending out a strong collaborative message from the success of the SETUSA 2017 Conference, showing evidence of local government inclusiveness in the action-research, indicating SDG Goals that will be targeted, willingness to invest in long term projects and showing evidence of the capability of measuring impacts of the projects.

While Simon Batchelor acknowledged the opportunities flagged by Ed Brown, he did, however, caution about the frustration involved in accessing little funds here and there. In addition, much cannot be achieved within 2-3 years period, hence it is important for the team to work towards

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landing a big funding supports in moving forward. He also pointed out to few other future funding opportunities including possible funding supports for Commonwealth Nations which might emanate from a possible Brexit Initiative that can be tapped. Sarah Ward and Mark Borchers re-echoed the importance of collaboration and the involvement of local governance practitioners which is a bargaining chip for the team to use to access future funding sources, but not forgetting that resource commitment, especially on the part of local government, is a sign of good faith and can enhance future opportunities.

Some participants also had a final say; one participant commended the team for organizing a successful conference and remarked that the solution to energy in urban Africa is multi-dimensional and needs to be looked at with a political lens because politicians could have a lot to say in achieving sustainable energy. Another participant, Dennis Mokoala (Polokwane Municipality, South Africa), challenged all local government practitioners to put into practice all the strategies discussed during the conference so that the research findings do not just gather dust on the shelves and also that SAMSET ideology will continue to grow. Hlengiwe Radebe, (SEA, South Africa) also challenged all participants to be champions in anything they do and not to quickly forget all the sustainable energy strategies that were discussed during the conference but to share the message of change in their various institutions. Another participant beckoned that SAMSET should not end just because of funding. Accordingly, there are opportunities that can bring SAMSET II alive, and developing the concept for, and with, the local entities to ensure that the interest of the local people align with the objectives of the project, will surely appeal to funders to support.

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