Innovation and Renewable Electrification in Kenya (IREK)

Revised excerpt of original proposal, January 2019

Researchers

Dr. Rasmus Lema
Prof. Bengt-Åke Lundvall
Dr. Margrethe Holm Andersen
Prof. Arne Remmen
Prof. Poul Alberg Østergaard
Senior researcher Ulrich Elmer Hansen
PhD Cecilia Gregersen
Dr. Rebecca Hanlin
Dr. Ben Mouk
Dr. Ann Kingiri
Dr. Charles Nzila
Prof. Michael Korir
PhD Faith Wandera
PhD Dominick Samoita

Collaborating institutions

Aalborg University, Denmark
African Centre for Technology Studies, Kenya
Moi University, Kenya

Innovation and Renewable Electrification in Kenya

1 Project summary

As the global climate change regime moves ahead towards 2020, there will be increasing investments related to climate change mitigation and adaptation in poor countries. Ensuring that the most adequate technologies are selected and that they are diffused and used in such a way that the outcome is better living conditions for the population is a major challenge. This project studies two specific low-carbon technologies – solar photovoltaic and wind power – and it takes as its starting point the role international sources of knowledge can play for Kenya. It will explore whether or not actors originating from China have the potential to provide particularly relevant low carbon technologies that bring benefits to the poor in Africa as compared to actors from Denmark and Germany. As the next step it will study what kind of public policies, institutional settings and participatory organisational forms are necessary to realise such a potential and thereby contribute to fulfilling the sustainable energy for all imperative. The project will combine quantitative analysis including use of survey data with qualitative analysis and case studies. Interactive learning with policy makers and other stakeholders is an integral part of the project design.

2 Objectives

Overall objective: This project has as its ultimate aim to contribute to the creation of universal access to modern energy services, thus contributing to the reduction of energy poverty (UNGA, 2011). The project seeks to enhance knowledge on North-South and South-South cooperation in deployment of renewable energy. The goal of the project is to examine how outcomes of international cooperation on low carbon technologies can be shaped and transformed to become efficient in terms of energy production and social inclusion. It seeks to equip stakeholders with a better foundation for selecting and deploying available technologies in a way that increases inclusiveness and contributes to poverty reduction. (Pueyo et al., 2013; Yadoo & Cruickshank, 2012).

Hypotheses: The project will combine two analytical approaches – the global value chain approach and the innovation system approach – and explore two research-guiding hypotheses which are based on a series of recent research contributions:

H1: The first hypothesis is that emerging economies are in a particularly strong position to advance relevant and affordable technologies because conditions in BRICS are more similar to those in poor countries. There is a growing notion in academic circles that 'frugal innovation' (Nocera, 2012), cost innovation (Zeng & Williamson, 2007) or 'below the radar innovation' (Kaplinsky, 2011) from BRICS countries may be particularly relevant because of similarities in initial conditions (Kaplinsky, 2013). At the same time new research suggests that Northern producers systematically underestimate the economic potential of innovating for 'bottom of the pyramid' users (Prahalad, 2012). The resulting underinvestment and lack of adaptation to the African rural context by western producers provide an alternative explanation of why Asian technologies may seem more attractive for less developed countries.

H2: The second hypothesis is that even the most 'relevant' technologies developed abroad will need to go through a process of transformation in order to become both efficient and inclusive in the specific context of Kenya. According to this hypothesis, the source of the technology has

little to do with the degree to which solutions are 'appropriate'; rather it depends on the contextualisation and adaptation of the technology into the local innovation systems (Arocena & Sutz, 2000). While global value chains may act as vehicles for technology transfer, the local innovation systems determine how technologies are absorbed and deployed and with what impact (Lundvall et al., 2009).

Main research questions: This project brings together the fields of development studies and innovation studies to address the problem of sustainable energy access. It seeks to examine two renewable electrification technologies, including technologies that contribute to small scale energy production with special relevance for rural access to electricity. It contributes to answering two groups of questions about renewable electrification that maximises the creation of widely shared benefits in terms of new employment opportunities, income generation and household access to electricity.

- **The role of global technology collaboration**: Where will the most relevant technologies for wind and solar driven electrification in Kenya come from? Is South-South technology collaboration more relevant in this respect compared to North-South collaboration? How important is the 'software' element of this technology cooperation (business models and capabilities) compared to 'hardware' element (equipment)?
- **The role of local policies and institutions**: What policies will be needed to ensure that the process of renewable electrification in Kenya is shaped to maximise local job creation and income generation? What incentives will be necessary to increase the relevance of these technologies? What types of capacity building are most urgently needed?

3 Project's methodology

Theoretical base: To understand the potential for Kenya of renewable electrification we will combine two analytical perspectives related to two key concepts: Global Value Chains (GVCs) and Innovation Systems. Firm *strategies* will be analysed in terms of governance of value chains with a focus upon the division of labour between firms in Kenya and firms in China, Germany and Denmark. The national and regional *capacity* to engage in such activities will be analysed through the perspective of innovation system (Lundvall, 1992; Lundvall et al., 2002).

The global value chain approach has been used to analyse successful catching up of Asian economies (Gereffi & Korzeniewicz, 1994).The *national innovation system* concept was introduced by Lundvall (1985) and it has been used to understand the systemic nature of innovation in the context of economic development (Lundvall et al., 2009). The two concepts have developed in parallel and both are increasingly used to analyse economic development (Bolwig et al., 2010; Ponte & Ewert, 2009).

The innovation system perspective points to the need to establish domestic linkages while the value chain perspective is concerned with alignment of and power relationship between global lead firms and domestic actors. We see it as a promising line of research to combine them. Although initial theoretical attempts have been made in this regard (Pietrobelli & Rabellotti, 2011), few prior studies have brought these approaches together in an operational way for empirical analysis.

Research gap: Three main groups of research focus on electrification with low-carbon energy sources in the African context: (1) studies about the potential of particular technologies, i.e. the fit between technology, context and the potential benefits that can be generated (Viebahn

et al., 2011; Clulow et al., 2012; Mukulo et al., 2014); (2) Studies comparing the relative advantages of different renewable technologies and energy sources (Szabo et al., 2013; Lay et al., 2013; Dekker et al., 2012); (3) Studies that investigate the financial aspects involved in disseminating renewable energy technologies (Wheeler et al., 2005; Tomaschek et al., 2009; Lemaire, 2011; Abdullah & Markandya, 2012). While drawing on these literatures, this project seeks to fill a void when it comes to understanding the learning and innovation aspects of these technologies with particular reference to the international dimension.

Engaging with current debates: Two important debates have arisen in the literature. The first one concerns grid extension versus the promotion of off-grid technologies (Lay et al., 2013; Pueyo et al., 2013). The second debate discusses whether the promotion of energy access does in fact fulfil its acclaimed poverty alleviation mission (Jacobson, 2007; Lay et al., 2013; Pueyo et al., 2013). The existing studies have not examined the influence of technology sources and associated characterises; nor have they dealt specifically with this project's second hypothesis – that local adaptation of technologies and systemic capability-building are key to successful technology transfer and collaboration – despite being increasingly accepted in the general innovation literature (Ockwell et al., 2009; Fu et al., 2011; Lema & Lema, 2012). There is a lack of studies that deal with local competence building and technology adaptation in this context. It is this gap that this proposal aims to fill, bringing light to significant less-tangible aspects of accessing and diffusing energy technologies.

Selection of country and sectors: The project will use these perspectives to explore the two key hypotheses of the project. It will do so through an empirical investigation of electrification through solar photovoltaic (solar PV) and wind energy in Kenya. There are several good reasons to select Kenya as the country of analysis. The solar PV market in Kenya is among the largest and most dynamic in the developing countries. It has the highest per capita growth in this field; over 10% per year over the past decade. Solar home systems (stand-alone photovoltaic systems) have been widely used to indirectly create business opportunities and jobs and directly create jobs in system maintenance. It is estimated that at least 150,000 households are connected to stand alone solar systems in Kenya (Byrne, 2011). For wind, hybrid small-scale wind systems (typically combined with diesel generators) are used to secure off-grid power supply in regions across the country. At the moment, only 5MW of wind power is fed into the grid. However, the government recently announced that wind energy will be a substantial part of Kenya's 5GW electrification expansion over the next four years (Miller, 2013). Small scale wind power generation systems for household electricity supply and water pumping have mostly been implemented by the private sector (Kiplagat et al., 2011). In 2013 The Ministry of Energy and Petroleum (MoEP) completed an Investment Plan for mini-grids which entails retrofitting diesel power stations with solar and wind generated power, and developing green sites using solar PV and wind technologies.

Selection of value chain locations: China is a major source of renewable energy equipment in Kenya (Kemp & Ndichu, 2013). Chinese solar energy firms have the larger market share in Africa; Chinese wind firms have so far focused mainly on the domestic market, but the African market is seen as a the key entry-point for breaking into export markets (Lema et al., 2013). Denmark is the world leader in wind energy technology (Lema et al., 2011) and Danish Vestas was chosen as a supplier for the major Lake Turkana project (Africa's largest wind power plant when complete and with investment from the Danish Industrialisation Fund for Developing Countries) which is currently under installation in Kenya. Germany was the world's

biggest producers of solar panel technology, until recently when China took over as the world's number one exporter (Fischer, 2012) and there are numerous trade ties between Germany and Kenya in this sector (Disenyana, 2009).

Research design: The research project adopts a two-way method that integrates: *the view of users*, reverse reconstructing of diffusion stories starting from critical projects in Kenya and *the view of producers,* sectoral and national comparisons starting from producers from China, Denmark and Germany delivering wind and solar technology and services directly or indirectly to end users in Kenya. The two-way method where two kinds of tracing are combined is a way to get a better understanding of barriers than one that starts either from the producer side or one that only takes an end user perspective (Lema, 2009). This method will be reflected both in the design of case studies and in the design of the survey.

Case study research method: For each sector, data will be collected on the structural and technological characteristics of the industry and the main public and private organisations and their various contributions to advances in the sector. Deep qualitative analysis will then be pursued at the level of 'critical projects'. The project will examine particular 'events' (projects) of rural electrification with the chosen technologies and then 'backtrack' from these events through value chains to the points of technology origin. Projects will be selected based on sampling from Kenyan solar and wind projects completed in 2014. The analysis of the critical projects as cases will be a unique feature of the project and will allow us to (a) make systematic comparisons within and across the two sectors, (b) understand the role of the wider innovation systems in supporting innovative projects and (c) trace concrete global value chains from the end-users in Kenya to technology providers abroad and back again.

Survey: The project will derive at preliminary conclusions based on secondary data and qualitative case study work. These will be used to revise and specify the hypotheses. On this background a survey will be conducted within Kenya in order to analyse to what degree the preliminary conclusions can be generalised. This survey will go beyond the critical projects and address the entire population of solar and wind power projects compiled from information received from the Ministry of Energy and Petroleum, the Energy Regulatory Commission of Kenya and the Kenya Renewable Energy Association.

4 Expected outputs and outcomes

Outputs: The project will produce a number of *tangible outputs* that will act as milestones for the project activities. These are:

1. *Working papers*: Six working papers will be published by ACTS on the project website: (a) theoretical framework, (b) case study analyses of renewable electrification using solar PV in Kenya, (c) electrification using wind power in Kenya, (d) Wind and solar GVC's connecting Europe and Kenya, (e) Wind and Solar GVC's connecting China and Kenya and (f) survey results.
2. *PhD theses*: Three associated PhD students will graduate within the five year project, each producing a thesis which will be made available open access.
3. *Final edited book*: One edited book will bring together the insights from the various project elements, synthesising material from working papers.
4. *Journal articles:* Each PhD student associated with the project and each researcher will be expected to contribute to a minimum of two additional academic publications during the

course of the project. The project will result in at least six journal articles as direct and discrete outputs from the project.

5. *Workshop hand-outs:* For presentation of preliminary findings to policy makers at three stakeholder seminars conducted during the course of the project.
6. *Policy briefs*: To be produced in year 1 and year 5. A situational analysis report highlighting current gaps will be produced at the end of year one. The policy brief at the end of year five will include recommendations to both national policy makers and to donor agencies. The policy briefs will be published by ACTS.
7. *Progress reports:* Progress reports will be made at the end of each year. These reports will also function as internal project documents, specifying roadmaps for work packages, PhD studies etc.

Outcomes: The cumulative results of these outputs and the activities more generally will lead toward four main *outcomes* from the project:

1. Policy makers in relevant ministries (Ministry of Energy and Petroleum in particular) will be equipped with a better foundation for selecting and deploying available technologies in a way that increases 'inclusiveness'.
2. Producer and user stakeholders (Climate Innovation Centre, the Kenya Renewable Energy Association, and suppliers in China, Denmark and Germany, consumer groups in Kenya etc.) will be equipped with a better understanding of concrete and efficient ways to combine efforts of electrification with management of international interactive learning between actors in the value chains.
3. Stronger research capacity and domain expertise will be built at ACTS, Moi and AAU in the field of 'innovation and development' with particular reference to low-carbon development. This will come about through learning by interacting among the scholars and from the PhD-training.
4. New theoretical understanding of how new technologies developed abroad can be transformed into inclusive innovation and applied studies that combine value chain with innovation system perspective will be reflected in the literature.

Research capacity strengthening: There are a number of direct and indirect beneficiaries from research and PhD training capacity building activities:

1. Direct and targeted training of three PhD students in innovation and development. These students will benefit from a range of established support systems and practices in AAU and Moi University, including access to existing Ph.D. training programs and procedures for giving systematic and regular feed-back on thesis work.
2. Direct and targeted training of ACTS and Moi University staff in a number of areas, including PhD supervision, research design and the use of quantitative tools. Indirectly this individual capacity building will enhance institutional capacity in PhD research supervision, innovation and development research project capabilities at ACTS and Moi University.
3. There will be indirect impacts that extend beyond these two institutions to other universities and policy think-tanks in Kenya or East Africa as both institutions show good practice examples (Marjanovic et al., 2013). It is expected that the project and the procedures developed will be made public in open source mode and that experiences will be shared with other relevant organisations.

PhD students and supervisors involved in the project will participate in AfricaLics network activities, including PhD academies and activities for PhD supervisors.

Implications for poverty alleviation*:* Like other Sub-Sahara African (SSA) countries, Kenya faces the challenge of increasing demand for modern energy services in the face of its high population growth. Less than 18.1% of the total Kenya population has access to electricity (MoEP/SE4ALL, 2013) and successful electrification depends on innovation in core technologies as well as deployment models (Lema et al., 2014). This project's theory of change asserts that access to better and more relevant knowledge regarding the opportunities afforded by low carbon technologies can be used to inspire more appropriate policy and decision making by users, producers, governments and other stakeholders. In particular, we expect this project to highlight how solar and wind technologies can be more effectively introduced at a range of scales (household, community and nationally) to promote business opportunities, job creation and other factors that can lead to more sustainable livelihoods – resulting in policies that contribute to universal energy access and reduction of energy poverty in Kenya (Yadoo and Cruickshank, 2012).

5 Relevance

Key stakeholders: We will draw on network partners and specific stakeholders in Kenya, Denmark, Germany and China. We will work with these stakeholders – public and private, national and international – throughout the project through interaction with them during the project fieldwork, through their membership of the project's reference groups and during dissemination workshop activities:

1. *Existing and potential users of the relevant technologies*: Research will help consumer groups and organisations to identify with whom to work and how to enhance energy access for the poor. Clearer characterisation of the idea of appropriate low carbon technology will help them refine the ways in which they develop technologies and business models to increase energy access.
2. *Technology producers and their associations along the production to market value chain*: The project will seek to show opportunities and organisational models relevant for private sector firms and public organisations engaging in low carbon innovation. It will show ways in which Asian and European low carbon technologies and business models can be adapted to the East African/Sub-Saharan context.
3. *Governments, inter-governmental bodies and donors*: The project will generate new knowledge about consumption patterns, business models and policies in relation to relevant technologies and both North-South and South-South technology collaboration. This will address the question of how to accelerate the pace of technology collaboration to match the increasing demand of relevant technology and to address climate change issues in developing countries.

Relevance to development problems and national priorities in Kenya: Like other Sub-Sahara African (SSA) countries, Kenya faces the challenge of increasing demand for modern energy services in the face of its high population growth. Lack of modern and affordable energy services and the high population growth is a challenge for the national economic development. Electrification has often been promoted as one of the backbones of economic development translating to improved quality of life.

Kenya Vision 2030 (2008) identifies energy as key in achieving its goals for economic development and poverty alleviation. The Vision estimates that for Kenya to achieve its goal, its electricity generation must grow from the current level of 1,500 MW to 19,200MW by 2030. Kenya is currently highly dependent on hydro-power (which accounts for about 49% of installed electricity generation capacity). However, this energy source is non-scalable and highly intermittent due to floods and draughts. To increase electrification and adapt to climate changes, the Energy Act 2006 and Energy Bill 2012 strongly emphasise development of other renewable energy sources to diversify the national energy mix. Among the renewable energy sources given high priority are solar and wind (Odongo, 2014).

Relevance to the theme Green Economy, inclusive growth and employment: The project aligns closely with the 'Right to a better life' strategy for Denmark's development cooperation (Danida, 2012), particular with regard to identifying appropriate ways forward in the following areas: (a) enhanced access to energy which contributes to local development and learning, (b) innovative technological and financial solutions in the area of energy and (c) framework conditions for green growth which benefits poor. As reflected in the budget, the project has set aside substantial resources for working out the implications of the results for policy makers, donor organisations and business organisations as well as for end-users.

6 Project plan

The five year project will be organised in 8 work packages. The packages are described below and in the log frame matrix where responsibilities and activities are further specified.

WP 1: *Conceptual framework and methodology:* Based on a literature review, a conceptual framework integrating insights from innovation systems research and global value chains theory will be developed. A three-day kick-off workshop will be held in Nairobi. All participating researchers will meet to discuss the conceptual framework and to develop a detailed methodological approach for sector case study that ensures strict comparability.

WP 2: *National-sectoral innovation system studies.* Two national studies on wind energy and solar energy will be carried out on the wind sectoral innovation system in Kenya and the solar sectoral innovation system in Kenya. The main drivers and mechanism of innovativeness will be explored as will the outcomes in a comparative perspective.

WP 3: *Global value chain studies.* Two global value chains analyses will be made. They will comprise: comparisons of wind energy lead firms in Europe and China and their exports to Africa (Kenya) and comparisons of solar value chain lead firms in Europe and China and their exports to Africa (Kenya). This step will gather information on the entire population of wind and solar power firms exporting equipment or services to Kenya and inter-firm relationships along the chain will be examined and compared.

WP 4: *Critical projects*. Case studies will be made of critical projects in each sector. Industry experts will be consulted in order to identify the most innovative solar and wind energy projects in Kenya over the last five years. Interactions in national systems and global chains will be retraced.

WP 5: *Survey:* A survey will be devised to examine the general validity of conclusions derived from WP 2-4 regarding projects' insertion in global value chains and embeddedness in national and local innovation systems in relation to project outcomes. The survey will address

management and experts in user organisations involved in solar and wind energy projects throughout Kenya. The survey will ask questions about collaboration with domestic and foreign suppliers and with local and international knowledge institutions, public agencies and local community organizations as well as questions about project outcomes. On the basis of cluster and network analysis patterns of interaction will be related to project outcomes. Special attention will be given to the national origin of foreign technologies used and to outcomes in terms of inclusive development.

WP 6: *Synthesis of research results:* This package starts with a workshop to address comparative perspectives. Subsequently we will draft analytical papers comparing findings across sectors and value chains. Three main comparisons will be made: (1) System vs. system: Kenyan sectoral innovation systems in solar and wind. (2) Chains vs. chains: value chains connecting EU (Germany and Denmark) with Kenya versus chains connecting China with Kenya. (3) Systems vs. chains: The role of global value chains versus national-sectoral innovation systems in shaping technological outcomes.

WP 7: *Interaction with policy makers and stakeholders:* This package will explore opportunities and make recommendations for local policy and for technology collaboration between countries. This will take place throughout the project period but will be most intense in year 5. Project impact will be reviewed through a rapid survey exercise: In year one, interviews with stakeholders will include KAP (knowledge, attitude and practice) questions that will be used for baseline measurement of behaviour change across the duration of the project. At the end, in year five, a second KAP survey will be conducted on those stakeholders initially interviewed to gauge the extent of change that has taken place (potentially as a result of the project). At the end of the research process, after publication of the policy brief, the project will organise a final conference with attendance of policy makers, firms, trade organisations etc.

WP 8: *Project coordination:* All packages will have a designated leader but will involve collaborative activities between Southern and Northern partners to enable sharing of experiences, and cross fertilisation of ideas and learning. A key task in this package is to establish management tools and common procedures including a detailed roadmap for each package. The project coordinator is also responsible for the synergy between individual PhD studies and the overall project.

Workshops and conference: Internal project workshops will be held annually to coordinate between packages. In year 1, 3 and 5 these will be held back to back with mini workshops with external invitees. Mini workshops will be set up over at least two days with a section for a stakeholder group and a section for a scientific advisory committee consisting of world leading scholars set up to ensure quality and novelty. Core stakeholders will be invited to provide feedback on the relevance of project activities in terms of meeting stakeholder requirements. In year five a final conference will be held which will also engage key international stakeholders from relevant UN agencies, the EU, World Bank, African Development Bank etc. to ensure maximum exposure to project results.

PhD studies: There is a clear division of labour between the three PhD studies focusing on sectoral study of wind in Kenya (Odongo, currently employed at the Ministry of Energy and Petroleum), sectoral study of Solar in Kenya (Samiota, currently employed at Moi University and with private sector experience from the solar industry) and global value chains and

implications for solar and wind suppliers in Europe (Gregersen). Substantial time has been set aside for fieldwork including joint fieldwork with supervisor attendance. The three PhD studies will be designed as to have maximum overlap with the project so that project outputs constitute the bulk of the PhD theses to be submitted. The PhD studies constitute core activities of WP 2 and 3, but they will also draw on and contribute to remaining WPs. The three PhD projects will form an integral part of the work-packages. The PhD students from Kenya will obtain joint degrees from AAU and Moi and will receive training in both locations over the course of their studies (sandwich model approach). Department of Business and Management has in March 2014 successfully completed a joint degree with University of Quilmes in Argentina.

Resource allocation and accounting: The budget is divided with around 53% in Kenya and 47% in Denmark including DFC expenses. Substantial time is allocated to the first PhD supervisors/project co-ordinators Lema (Gregersen), Hanlin (Odongo) and Nzila (Samoita). The role as secondary supervisors and research fellows will be undertaken by Lundvall and Mouk and an additional senior project participant at Moi's Business and Economics School, Korir. Additional specialist supervision and project tasks will be undertaken by Anna Kingiri at ACTS (policy communication). As part of the co-funding from AAU additional specialist supervision will be undertaken by Arne Remmen and Poul Alberg Østergaard at AAU. Co-funding is also provided by Moi University in terms of additional staff time from Nzila. AAU and ACTS have already established elaborate budgeting and accounting procedures in relation to the establishment of the AfricaLics Secretariat at ACTS, funded by AAU (with Sida grants) which will support administrative interaction.

7 Participants, organisation and management

Participating organisations and researchers: The research group was established among the following three organisations:

1. Aalborg University,
2. Moi University and
3. African Centre for Technology Studies.

Organisation and management: The project will be led by Lema (associate professor with research experience in the development and use of low carbon technologies in China, India and Europe). Lema will be assisted by Lundvall who has 30 years of experience managing major international projects, as well as two support staff. Moi University runs a multi-disciplinary, cross-faculty Renewable Energy Centre housed in the Faculty of Engineering led by Nzila who is an expert in transition theory and renewable energy. The centre is actively involved in both local and international research cooperation. ACTS has strong research expertise both in low carbon innovation and development research. Hanlin is a world leading expert on 'below the radar innovation'. Muok is centrally placed in several low carbon projects with collaboration covering East Africa and Kingiri has years of experience with stakeholder dialogue in Kenya and East Africa. ACTS is a Kenyan NGO focused substantially on undertaking scientific research on the policy aspects science and technology for sustainable development. In relation to this application ACTS is defined as a South based Research Institution.

Synergies with existing activities: Lema and Lundvall have developed close collaboration with ACTS (Hanlin, Muok and Kingiri) in the connection with a major network building project (AfricaLics) supported by Sida. This network will be used to diffuse research results from the

project to other parts of Africa. Muok and Kingiri have worked with Moi University – including as PhD supervisors – for several years. Moi University started actively working with ACTS and AAU through the AfricaLics network on the development of Masters level innovation and development teaching modules since late 2013.

8 Projects' international dimension

The project is inherently international, both in its subject focus and with field work examining lead firms and value chain actors outside Kenya. In addition the project will set up an international Scientific Advisory Committee which will include seven key international scholars in the field. As mentioned, the project dissemination activities will focus not only on Kenya but also on the implication for Denmark's, China's and Germany's manufacturing sectors, and for international stakeholders supporting technology transfer and collaboration. The project will disseminate its results through the AfricaLics and Globelics networks.

9 New knowledge

The project will give rise to new knowledge at three different levels important for designing sustainable development strategies in Kenya and other African countries: (1) It will test the hypothesis that South-South collaboration has a special relevance for inclusive development. (2) It will develop an understanding of the prerequisites for realising the potential in international technological learning. (3) It will develop new theory and new concepts by combining the national innovation system perspective with global value chain approach and through combining the innovation studies perspective with the science, technology and society perspective.

10 Publication and dissemination strategy

Academic publications and interaction: Project staff will attend relevant conferences and workshops in Kenya, East Africa and internationally in order to present the project's finding to academic audiences. This will be in addition to the publication of papers in academic journals and the publishing of an edited book.

Policy outputs and interaction: The project will actively integrate policy dissemination and capacity building into the project as a core activity. It will contain a mix of activities for dissemination of results and learning. In addition to workshops with stakeholders mentioned above, one final conference will be held after the policy paper has been produced and will bring together policy makers and academics in two sectoral tracks.

11 Strategy for phasing out of the project

There are three elements to the phase out strategy of this project. **1.** Two PhDs in Kenya will re-enter current job positions, in the Ministry of Energy and in Moi University, with improved knowledge base and capacity to make informed decisions and influence others. **2.** Senior members of the project team are integral members of stakeholder's fora including the AfricaLics network, East African Climate Innovation Network (EACIN) and the Kenya Climate Innovation Centre (CIC). In the last two years of the project, efforts will be made to ensure that any potential new or continued areas of research or policy analysis that are highlighted from this project are followed up for funding and/or discussion in policy fora by these stakeholder groups. **3.** At the final conference one session will be organised to distil the new research questions and to launch new proposals.

12 Main references

Abdullah, S. & Markandya, A. (2012). Rural electrification programmes in Kenya: Policy conclusions from a valuation study. In: *Energy for Sustainable Development,* 16(1), 103-110. https://doi.org/10.1016/j.esd.2011.10.007

Arocena, R. & Sutz, J. (2000). Looking at National Systems of Innovation from the South. In: *Industry and Innovation,* 7(1), 55-75. https://doi.org/10.1080/713670247

Bolwig, S., Ponte, S., du Toit, A., Riisgaard, L. & Halberg, N. (2010). Integrating Poverty and Environmental Concerns into Value-Chain Analysis: A Conceptual Framework. In: *Development Policy Review,* 28(2), 173-194. https://doi.org/10.1111/j.1467-7679.2010.00481.x

Byrne, R.P. (2011). *Learning drivers: rural electrification regime building in Kenya and Tanzania.* Doctoral thesis (DPhil), University of Sussex. http://sro.sussex.ac.uk/6963/

Clulow, A.D., Everson C.S., Mengistu, M.G., Jarmain, C., Jewitt, G.P.W., Price, J.S. & Grundling P.L. (2012). Measurement and modelling of evaporation from a coastal wetland in Maputaland, South Africa. In: *Hydrology and Earth System Sciences,* 16(9), 3233-3247. https://www.hydrol-earth-syst-sci.net/16/3233/2012/hess-16-3233-2012.pdf

Danida (2012). The Right to a Better Life: Strategy for Denmark's Development Cooperation. Copenhagen: Ministry of Foreign Affairs of Denmark. Retrieved from: http://amg.um.dk/en/policies-and-strategies/stategy-for-danish-development-cooperation/previous-strategy/

Dekker, J., Nthontho, M., Chowdhury, S. & Chowdhury, S.P. (2012). Economic analysis of PV/diesel hybrid power systems in different climatic zones of South Africa. In: *International Journal of Electrical Power and Energy Systems,* 40(1), 104-112. http://isiarticles.com/bundles/Article/pre/pdf/29050.pdf

Disenyana, T. (2009). Harnessing Africa's sun: China and the development of solar energy in Kenya. In: *South African Journal of International Affairs,* 16(1), 17-32. https://doi.org/10.1080/10220460902986206

Fischer, D. (2012). Challenges of low carbon technology diffusion: insights from shifts in China's photovoltaic industry development. In: *Innovation and Development,* 2(1), 131-146. https://doi.org/10.1080/2157930X.2012.667210

Gereffi, G. & Korzeniewicz, M. (1994). *Commodity chains and global capitalism,* Westport, Conn., Greenwood Press.

Jacobson, A. (2007). Connective Power: Solar Electrification and Social Change in Kenya. In: *World Development,* 35(1), 144-162. https://doi.org/10.1016/j.worlddev.2006.10.001

Kaplinsky, R. (2011). Schumacher meets Schumpeter: Appropriate technology below the radar. In: *Research Policy*, 40(2), 193–203. http://doi.org/10.1016/j.respol.2010.10.003

Kaplinsky, R. (2013). What Contribution Can China Make to Inclusive Growth in Sub-Saharan Africa? In: *Development and Change*, 44(6), 1295–1316. http://doi.org/10.1111/dech.12059

Kemp, R. & Ndichu, J. (2013). Status, barriers and drivers of Green Technology diffusion in Africa. *Workshop Report.* Vienna: UNIDO / UNU-MERIT / KEEI Workshop.

Kiplagat, J.K., Wang, R.Z. & Li, T.X. (2011). Renewable energy in Kenya: Resource potential and status of exploitation. In: *Renewable and Sustainable Energy Reviews,* 15(6), 2960-2973. https://doi.org/10.1016/j.rser.2011.03.023

Lay, J., Ondraczek, J. & Stoever, J. (2013). Renewables in the energy transition: Evidence on solar home systems and lighting fuel choice in Kenya. In: *Energy Economics,* 40, 350-359. https://doi.org/10.1016/j.eneco.2013.07.024

Lema, R., & Lema, A. (2012). Technology transfer? The rise of China and India in green technology sectors. In: *Innovation and Development,* 2(1), 23-44. https://doi.org/10.1080/2157930X.2012.667206

Lema, R. (2009). *Outsourcing and the Rise of Innovative Software Services in Bangalore.* University of Sussex. http://vbn.aau.dk/files/195306939/Thesis_RL_FINAL.pdf

Lema, R., Johnson, J., Andersen, A.D., Lundvall, B.Å. & Chaudhary, A. (2014). *Low-Carbon Innovation and Development.* Aalborg University Press. https://doi.org/10.5278/VBN/MISC/LCID

Lema, R., Berger, A., & Schmitz, H. (2013). China's Impact on the Global Wind Power Industry. In: *Journal of Current Chinese Affairs*, 42(1), 37–69. http://vbn.aau.dk/ws/files/195307300/Lema_et_al_2012_GDI_DP_Vol._2012_No._16_China_Wind.pdf

Lema, R., Berger, A., Schmitz, H. & Song, H. (2011). Competition and Cooperation between Europe and China in the Wind Power Sector. Institute of Development Studies. Working paper series, 377. Brighton: IDS. http://opendocs.ids.ac.uk/opendocs/handle/123456789/4225

Lemaire, X. (2011). Off-grid electrification with solar home systems: The experience of a fee-for-service concession in South Africa. In: *Energy for Sustainable Development,* 15(3), 277-283. https://doi.org/10.1016/j.esd.2011.07.005

Lundvall, B.-Å (1985). *Product innovation and user-producer interaction,* Aalborg, Aalborg University Press.

Lundvall, B.-Å. (1992). *National systems of innovation: towards a theory of innovation and interactive learning,* London, Pinter.

Lundvall, B.-Å., Chaminade, C., Joseph, K.J. & Vang Lauridsen, J. (eds.) (2009). *Handbook on Innovation systems in developing countries,* Cheltenham: Edward Elgar.

Lundvall, B.-Å., Johnson, B., Sloth Andersen, E. & Dalum, B. (2002). National systems of production, innovation and competence building. In: *Research Policy,* 31(2) 213-31. https://doi.org/10.1016/S0048-7333(01)00137-8

Marjanovic, S., Hanlin, R., Diepeveen, S. & Chataway, J. (2013). Research Capacity-building in Africa: Networks, Institutions and Local Ownership. In: *Journal of International Development,* 25(7), 936-946. https://doi.org/10.1002/jid.2870

Miller, B. (2013). Kenya plans wind energy expansion. *Wind.* Wind Power Monthly.

MoEP/Se4all (2013). United Nations Initiative on Sustainable Energy for All: Stock-taking and Gap Analysis Report on Sustainable Energy for All. Nairobi: Ministry of Energy and Sustainable Energy for All.

Mukulo, B. M., Ngaruiya, J.M. & Kamau, J.N. (2014). Determination of wind energy potential in the Mwingi-Kitui plateau of Kenya. In: *Renewable Energy: An International Journal,* 63, 18-22. https://doi.org/10.1016/j.renene.2013.08.042

Nocera, D.G. (2012). Can We Progress from Solipsistic Science to Frugal Innovation? In: *Daedalus,* 141(3), 45-52. http://dx.doi.org/10.1162/DAED_a_00160

Ockwell, D., Ely, A., Mallett, A., Johnson, O. & Watson, J. (2009). Low Carbon Development: The Role of Local Innovative Capabilities. *STEPS Working Paper 31.* Brighton: STEPS Centre and Sussex Energy Group, SPRU, University of Sussex. http://opendocs.ids.ac.uk/opendocs/handle/123456789/2459

Odongo, F. (2014). The status of small-scale solar PV and wind in Kenya. Mimeo: Ministry of Energy and Petroleum

Pietrobelli, C. & Rabellotti, R. (2011). Global Value Chains Meet Innovation Systems: Are There Learning Opportunities for Developing Countries? In: *World Development,* 39(7), 1261-1269. https://doi.org/10.1016/j.worlddev.2010.05.013

Ponte, S. & Ewert, J. (2009). Which Way is "Up" in Upgrading? Trajectories of Change in the Value Chain for South African Wine. In: *World Development,* 37(10), 1637-1650. https://doi.org/10.1016/j.worlddev.2009.03.008

Prahalad, C.K. (2012). Bottom of the Pyramid as a Source of Breakthrough Innovations. In: *Project Management Journal*, 45(2), 6–19. http://doi.org/10.1002/pmj.21409

Pueyo, A., Gonzalez, F., Dent, C. & Demartino, S. (2013). The Evidence of Benefits for Poor People of Increased Renewable Electricity Capacity: Literature Review. Institute of Development Studies (IDS). https://opendocs.ids.ac.uk/opendocs/handle/123456789/2961

Szabo, S., Bodis, K., Huld, T. & Moner-Girona, M. (2013). Sustainable energy planning: Leapfrogging the energy poverty gap in Africa. In: *Renewable and Sustainable Energy Reviews,* 28, 500-509. https://doi.org/10.1016/j.rser.2013.08.044

Tomaschek, J., Dobbins, A., Özdemir, E.D. & Fahl, U. (2009). Analysis of incentives using an energy system model for solar water heater installation in Gauteng Megacity Region, South Africa. In: ISES (The International Solar Energy Society), ISES Solar World Congress 2009. Johannesburg, South Africa, 2009, 587-599.

UNGA (2011). International Year of Sustainable Energy for All. Resolution 65/151 adopted by the General Assembly. United Nations General Assembly. Retrieved from: http://undocs.org/A/RES/65/151

Viebahn, P., Lechon, Y. & Trieb, F. (2011). The potential role of concentrated solar power (CSP) in Africa and Europe-A dynamic assessment of technology development, cost development and life cycle inventories until 2050. In: *Energy Policy,* 39(8), 4420-4430. http://dx.doi.org/10.1016/j.enpol.2010.09.026

Wheeler, D., McKague, K., Thomson, J., Davies, R., Medalye, J. & Prada, M. (2005). Creating Sustainable Local Enterprise Networks. In: *MIT Sloan Management Review,* 47(1), 33-40. Retrieved from: https://sloanreview.mit.edu/article/creating-sustainable-local-enterprise-networks/

Xiaolan, F., Pietrobelli C. & Soete, L. (2011). The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up. In: *World Development,* 39(7), 1204-1212. http://dx.doi.org/10.1016/j.worlddev.2010.05.009

Yadoo, A. & Cruickshank, H. (2012). The role for low carbon electrification technologies in poverty reduction and climate change strategies: A focus on renewable energy mini-grids with case studies in Nepal, Peru and Kenya. In: *Energy Policy,* 42, 591-602. https://doi.org/10.1016/j.enpol.2011.12.029

Zeng, Ming & Williamson, P.J. (2007). *Dragons at your door: how Chinese cost innovation is disrupting global competition,* Boston, MA, Harvard Business School Press.