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KENYA

Making mobile solar energy inclusive

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Introduction

The Africa Sustainability Hub (ASH) has been running since 2015 and has aimed to showcase a model of transformative partnership that harnesses research and policy on the kinds of sustainable technologies and innovations which could inform Africa's actions in the post-2015 Sustainable Development Goals (SDGs). In a crowded global research environment, the hub is a platform of international, trans-disciplinary action-oriented work with a strong focus on practical responses – including the development of new concepts, tools and methods. ASH has accumulated experience in low carbon transitions and expertise in low carbon innovation, as well as environmental policy and governance. ASH has also established strategic linkages with a wide array of stakeholders and actors, including the research community, civil society, government and development partners.

For the 'Pathways' transformative knowledge network (TKN) work, ASH has been pursuing action research focussed on enabling sustainable and equitable access to Solar Home Systems (SHS) for all via mobile-based payment systems, including those who cannot participate in micro-financing schemes. ASH, hosted at the African Centre for Technology Studies (ACTS) together with the other members of the Hub – the Africa Research and Impact Network, African Technology Policy Studies (ATPS) network and the Stockholm Environment Institute (SEI) – has continually aimed at gathering socially inclusive evidence on various sustainability pathways and sustainable technologies and innovations for low-carbon energy transitions that meet the needs of the poor. There has been a focus throughout on research that interrogates whether dominant business models create 'pathways' (towards enhanced access to clean lighting and cooking solutions for the poorest in Africa) (Ockwell et al. 2019).

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The basis of the ASH work is built on fundamental sustainability questions in Africa's energy transition journey. Despite efforts around renewable energy alternatives, these technologies have been limited in their penetration into the everyday life of society and especially the poor. For example, bio-digesters in Kenya and Rwanda had been installed at a rate of just 0.3% of the technical potential by 2010, mainly for cooking (Tigabu et al. 2015). This and several other projects are usually characterized by failures to attend to the social aspects of local cultural practices around energy consumption (standing up to cook, using specific-sized pots, etc.), or linked energy services (heating and lighting homes, repelling insects, etc.). With regard to lighting/electricity, even though there is increasing grid connectivity aided by the key government programmes such as the Last Mile Initiative, affordability and reliability of these connections remain a challenge to most people especially in rural areas (Atela et al. 2020). The off-grid solar home systems market has been growing fast, with the Kenyan solar energy market becoming one of the most advanced in Eastern Africa; however, the country is still not sufficiently exploiting its solar energy resources and associated utility pathways (Muok et al. 2015). As of 2015 (at the inception of this project), the leading mobile SHS firm in East Africa (M-KOPA) had just 180,000 households across Kenya, Tanzania and Uganda as customers (Fox 2015). The solar energy has mainly been promoted to replace some of the lighting options such as kerosene, but has not focussed on other utility options such as cooking, where a number of sustainability concerns still exist, given that most people, i.e. more than 70% of Kenyans still using biomass for cooking (Karanja & Gasparatos 2020).

In most of the energy transition efforts, large amounts of resources have been spent on assisting those at the bottom of the economic pyramid to transit from inefficient to efficient energy use, but with numerous sustainability concerns (Ockwell et al. 2019; Negro et al. 2012; Bhattacharyya 2012). We see the key issue here as the relatively techno-centric approaches to promoting the various renewable options in ways that create a path dependency of business models combined with a poor understanding of the socio-cultural and political contexts of these technologies in Africa (Gigante 2016). A pathway to a low carbon economy must be socially responsive and inclusive. More broadly, these technologies need to be integrated into the political economy of low carbon development at both national and regional levels (Newell et al. 2014).

This gives a broad problem space of the access to and payment of SHSs, in particular for low income households, with a goal of distributing and financing models that enhance the equitable access to SHSs. The technological innovations towards renewable energy access in Kenya have continually evolved, bringing about dynamic and varying framings of the problem space and associated transformation.

There has been a broad social recognition of the existence of a problem concerning pro-poor access to solar PV. However, according to the general public,

there has been a limited social imaginary of the diversity of possible sustainable and equitable pathways, closing down futures across civil society. This is reflected in the wider media interest in pro-poor solar PV, which has only been addressed in generalities. There has also been a significant research gap around pro-poor solar PV initiatives, with a focus on just a handful of sites (Millan & Atela 2017), without attendance to mobile-payment systems. Likewise, the private sector has only approached pro-poor solar PV initiatives with a limited focus, generally failing to leverage research to assess model effectiveness, in particular around alleviating energy poverty.

The emergence of Pay-As-You-Go (PAYG) micro-finance enterprises is an extension of the pico-solar market, which has developed within the already prominent solar PV market in Kenya that has been present since the late 20th century (Muok et al. 2015). Unsurprisingly, the benefit structure of the technology and business models has generated conflicts – should the entrepreneur or the low-income customer benefit, or both? And how, if at all, should SHS articulate with government strategies for grid-based electricity systems?

There has been little research on this problem space, but the Africa Sustainability Hub has had a long-standing reputation of mediating between research and policy dimensions, providing evidence-based research and policy analysis to enable the engagement of diverse actors. This means that ASH continues to support inclusive low carbon innovations in the space of a Kenyan population with low electricity access, high costs and low reliability. It has been our hope all along that providing a robust evidence base upon which to explore this challenge will facilitate the generation of innovative approaches.

Theory, research and action

ASH started this research process with a Participatory Impact Pathways Analysis (PIPA) exercise to outline the key stakeholders concerned with pro-poor mobile payments for solar PV. This exercise outlined the sorts of actors involved in the problem space, as well as their relative power to effect change and their alignment to ASH's proposed solution. As can be seen in Figure 7.1, the PIPA (carried out at the inception workshop in April 2016) identified a high number of concerned government actors, who alongside the private sector were identified as the most powerful stakeholder sectors.

Like other hubs, ASH applied the transformation laboratory (T-Lab) approach throughout the research, which involved a diverse cross-section of stakeholders. This aimed to generate rich and diverse insights into what needs to be done or changed to enable equitable and sustainable access for all to solar PV systems via mobile-based payment systems. The T-Lab process in particular was seen as critical to the project because of its key focus on transformation. This challenges the dominant approach of holding discussions that usually end up as 'talk-shops'. Additionally, the Kenya hub from the outset planned and integrated cross-learning with the China Hub (Chapter 8).

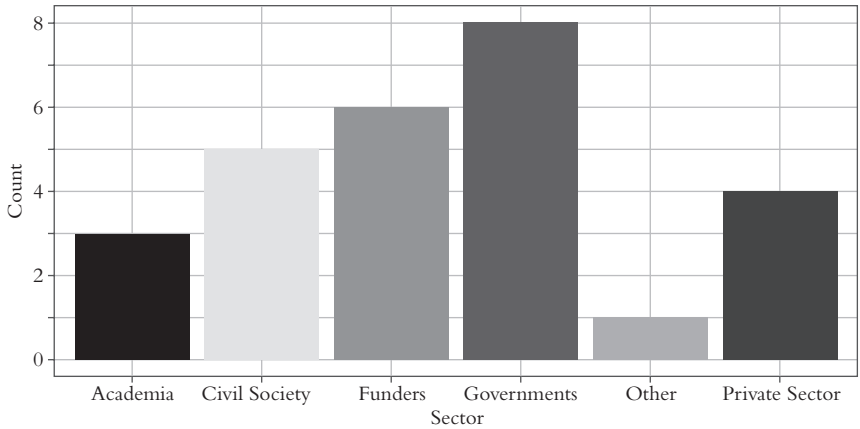

FIGURE 7.1 Envisaged stakeholder engagement in the PAYG solar market, based on a PIPA exercise (April 2016).

To achieve the aim of generating an evidence-base on whether mobile-based payment systems for SHSs as an innovation can be transformative, a broad process methodology was outlined. This process aimed to start with a baseline field study that included mapping out the problem space and initiating a process of participatory engagement, "opening up" pathways to transformation, interacting to cross-pollinate perspectives, and closing down on possible futures to guide to the core issues. Eventually, a build-up of insights from the first T-Lab workshop in Kenya evoked a process of iterative evaluation that led to the presentation of a synthesis of the evidence base, in which stakeholders would enrich the process.

Key moments in the T-Lab process

The T-Lab process was identified as a useful methodology for this problem space because of: a) its complexity; b) conflict over the space; c) an urgency for solutions; and d) the chance to build a practical transformation. Its complexity derives from the diversity of divergent actors, often with similar overall missions but differing policy solutions. This has emerged as a central conflict, with governmental preferences for on-grid expansion clashing with a private sector focussed on fiscal policy. Nonetheless there is a strong sense of urgency, with government stakeholders taking seriously their obligations to low-income households, and a vibrant private sector keen to do business and enhance access to energy.

While there is a general consensus on the need to scale access to electricity, especially to low-income households, there has been little effort towards making existing initiatives complementary. For instance, the national government funded and supported a project to instal SHSs in public schools but was

ambivalent about developing robust policies to support the broader solar sector. This was primarily so due to the fact that it involved a project implemented to support the rollout of solar laptops in schools (Standard 2016). On the other hand, the private sector has been working on enhancing access to electricity through mobile payment systems, but the government has not made any explicit engagement to support such projects, within a broader antagonism to solar energy. This was a central paradox that ASH aimed to unravel at the T-Lab workshops, facilitating dialogue on how the different approaches can be made more mutually beneficial.

ASH integrated the T-Lab process into her other existing initiatives, in particular those related to energy access and the broader political economy of low-carbon transition. The hub aimed at using the T-Lab process to unearth the barriers and opportunities to transformative change in access to energy, thus informing the design of other projects.

T-Lab workshop 1

The first T-Lab workshop for the Africa Sustainability Hub was held over two days in early 2017 in Nairobi, Kenya, engaging 18 participants/actors drawn from across different sectors such as the government, academia, NGOs, private sector, technology agencies, end users, and the media. These actors were identified based on broad criteria including institutional diversity, experience and capacity, influence and networks.

Open discussions were first held as an attempt to frame the overall problem by bringing stakeholders into the same space. This was followed by a process of opening up the discussion using two rounds of the *World Café* method (Estacio & Karic 2016). This is a creative, simple, effective, and flexible process for leading a collaborative dialogue with a large group of participants, where knowledge is shared within smaller groups. Participants are invited to discuss a topic of mutual interest in three or more rounds of conversations, with each member of the group moving to a different new table at each round. This method is effective in bringing together individual ideas into one comprehensive message.

The first *World Café* allowed for a more detailed discussion among groups of participants, thus generating more insights into the sustainability challenges facing mobile enabled SHS, but also allowed for building consensus on various issues towards closing down. The second *World Café* generated options for addressing these challenges and the institutions and actors relevant to pursuing these options through a Participatory Impacts Pathways Analysis (PIPA) process. After each group outlined their understanding of the problem and attendant solutions, they moved around other tables at timed intervals to make inputs on the different aspects. This allowed for a final deliberation at the end of the workshop to identify divergent and convergent perspectives, upon which concrete steps of engagement could be outlined. Concurrently, PIPA exercises were

deployed throughout the workshop. The outcomes of such options were documented in various forms (written and digital outputs) thus forming the basis for the subsequent T-Lab workshop.

Overall, the first T-Lab workshop provided a number of preliminary insights into the problem space, explored in detail in the technical report that emerged from the event. This included an appreciation of the broader policy landscape for solar in Kenya (and a list of policy documents relevant to solar energy in Kenya – see Table 7.1) and an exhaustive menu of sustainability challenges and concerns facing mobile-enabled SHS. The workshop identified no less than seven perspectives on transformation, illustrating the breadth of discussions. A community of practice emerged from these discussions and was sustained throughout the T-Lab process.

TABLE 7.1 Policy documents relevant to solar energy in Kenya (2016)

Policy	*Focus*
Kenya's constitution, 2010	Clean and safe environment as a basic right
Kenya Sustainable Energy 4 All action agenda	Clean and sustainable energy for all social groups with 80% from renewable sources such as solar
Kenya Climate Change Action Plan 2013–2017	Targets renewable energy, e.g. solar wind to meet as one of the priority low carbon development pathway.
Kenya Nationally Determined Contributions	Prioritizes renewable energy, e.g. solar wind to meet mitigation commitment under the Paris Agreement
Kenya Climate Change Act, 2016	Supports energy conservation, efficiency and use of renewable energy
Feed-In-Tariffs Policy on Wind, Biomass, Small-Hydro, Geothermal, Biogas and Solar Resource Generated Electricity, Revised in 2012	Provides tax incentives for imports on renewable energy
Second Medium-Term Plan (MTP) of Vision 2030	Supports investments in renewable energy, i.e. 70% of energy investments from renewable sources
Kenya Green Economy Strategy and Implementation Plan (GESIP), 2016	Prioritizes solar energy and other renewables as part of green economy transition
Least Cost Power Development Plan (LCPDP), 2011–2031	Highlights that solar is suitable for off-grid but not on-grid electricity generation
Energy Act, 2006	Supports a diversity of energy sources including renewables to meet Kenya's energy demand
Rural Electrification Master Plan	Aims to connect all Kenyans to electricity
National Environment Policy, 2013	Supports clean energy such as solar – supportive to clean environment

Enhancing the reach and scale of the mobile solar payment systems was found to be critical to having a bigger impact footprint. It was crucial to bring in sector players and stakeholders across different levels of the private and civil society actors, to broaden engagement up and outward from their initiatives. In the same breath, engaging universities, innovation centres and technical education facilities helped to tap into home-grown research knowledge and innovations, to enhance the mobile payment systems and increase the transformative footprint. Broadening out to include regulatory agencies such as the National Environment Management Authority (NEMA) allowed the hub to shape effective policy and innovation interventions around specific issues such as e-waste. The end user involvement beyond usage was noted as critical in enhancing the transformative impact of the mobile solar payment systems. Constant engagement with device distributors and other private sector actors such as solar solutions providers and the end users helped to sensitize the local communities to the products and broaden the discourse to include access to clean energy. It was found that this enhanced the acceptability and ownership of the initiatives. Towards this end, efforts to enhance interventions through inculcating innovation systems among the community of practice provided solid ground for the preparation of the second T-Lab, as well as allowing the hub to translate transformative narratives into concrete interventions that can be evaluated and measured.

Initial insights from the first T-Lab focussing on the case of M-KOPA (M meaning 'mobile' and KOPA meaning 'to borrow') revealed that the mobile PAYG approach, within a period of less than five years, had so far connected about 330,000 homes (mainly the rural poor) in East Africa to solar power and about 500 new homes were being added every day. The second T-Lab was therefore designed with M-KOPA in mind, to suggest piloting the changes suggested, analysing more pay-as-you-go systems, and having more field research. The T-Labs are a process rather than just events, and it was important to engage stakeholders throughout the process. The hub developed different outreach and publicity platforms and approaches, including writing articles in a leading daily newspaper.

At the mid-point survey (carried out between the two T-Lab workshops), three key developments were identified. The first was a change in attitudes, whereby most, if not all, of the participants expressed interest in mutual collaborations, or at the very least engaged in learning the problem space. The second was a more specific set of participant to participant engagements, such as a county government official negotiating with a PAYG merchant on the use of the products in their county. Third, there was a growth in the understanding of various socio-economic contexts and applications, as well as a commitment in principle to exploring them within their own specialist systems. It was established that bringing otherwise disconnected stakeholders together helped bridge perspectives although more structural changes would take time.

T-Lab workshop 2

The guiding approach of the second T-Lab workshop in June 2018 was around combining rigorous academic ideas and analysis with real-world challenges and stakeholders. Particularly important was the recognition and identification of the private sector in the solar energy transformation in Kenya, with an emphasis on the challenges and transformative impact of PAYG services to low-income households in Kenya. Participants were drawn from various sectors including the private sector, civil society, the government – both national and county government entities, academia, research organizations, the media and even M-KOPA, who deliberated on the various perspectives of transformation and sustainability in the context of the SHS space.

After the first T-Lab workshop ("seeing the system" stage), it had been realized that certain issues had to be looked into in-depth to make the whole transformation process successful. In designing the "innovation" stage, the key questions were generated. These questions were not just limited to understanding the broader benefits, governance and horizons and gaps of the space, but they were also concerned with the specific forms of innovations needed, the actually existing policies on the ground, the challenges of scaling up the space and delving into the participants' understanding of a transformative space.

One outstanding feature for the second T-Lab workshop was its focus on the specifics pertaining to the innovation needed. This specificity in research would later see participants in this T-Lab workshop generate specific socio-technical innovation ideas, specific governance approaches, etc., all of which were centred on improving the space.

The methods of engagement in the workshop unfolded constructively, incorporating individual presentations, breakouts, plenaries and *World Cafés*. These created a platform for a great deal of knowledge transfer and idea generation as the expert and diverse groups shared perspectives.

Lessons from the T-Lab process

The project demonstrated the importance and significance of combining innovative and rigorous academic ideas and analysis with real-world challenges and stakeholders. Even seasoned actors in the sector found the workshops insightful and revelatory at times. The T-Lab approach broadened out the research process by including diverse actors with different expertise and experiences within the space, and diversity and heterogeneity of factors was a major feature of both T-Lab workshops.

The T-Lab process moved through four discrete phases. In trying to produce a collective sense of the need for change, there were thorough engagements and interactions between stakeholders at the T-Lab workshops. This was both to keep stakeholders aware of what changes were needed in the space, and to help elicit the views and ideas that underpinned T-Lab agendas. From this, ASH

was able to make visible alternative views about the space through stakeholder consultations. These alternative views also helped in "designing the innovation", with some possible solutions given in the second T-Lab workshop. A consensus was then encouraged by managing the different fields of view of the stakeholders, merging their ideas and different schools of thought.

Interestingly, an alignment between research organizations, civil society and academia with the private sector (more than expected from the initial PIPA) was noted. The private sector was seen to have accomplished a lot in the space despite numerous challenges such as a lack of policy support, import taxes, cost effectiveness and the quality of products/standards. The national government and policy-makers were more reluctant in their support of the private sector in the space. This sparked positive criticism of the policy-makers who were challenged to identify good initiatives in the private sector and support them.

Co-production through the T-Lab process was evident from the workshop participation which was drawn from a wide variety of stakeholders ranging from national and sub-national government entities including regulatory bodies; the private sector involved in the mobile-enabled solar trade and energy practitioners; major universities such as Strathmore which hosts an energy research centre, a UK university represented by a research student and other research organizations; civil society; the media; and PAYG business representatives and end users. This brought together perspectives and competing interests, especially between both the national and county governments and the private sector. Overall, this positively affected the knowledge produced by enriching the diversity of stakeholders and industry players.

Contribution of the T-Lab to outcomes and pathways

The Transformation Pathways project managed to spur dialogue among the various stakeholders in the energy sector, with many of them (including ASH) committing to follow up on aspects of the project closest to their interests. Other than creating alliances, there was recognition of the role of the private sector in the solar energy transformation in Kenya: the T-Lab was a revelatory experience which led to the realization of how challenging and transformative the PAYG initiative had been to the majority poor in Kenya. Although the national government was making some strides in enhancing energy access through grid extension, the private sector was seen to have accomplished a great deal, despite the numerous challenges listed above. As of January 2018, MKOPA had connected over 600,000 homes to affordable solar power (as noted in the second T-Lab workshop report). While the hub did not note a significant change in the stakeholders it did not engage with, alternative views about the space emerged through consultations between the stakeholders. These alternative views also helped in 'designing the innovation' – a series of proposals discussed later in this chapter.

Most participants were very appreciative of the process and described it as transformative in itself, given that it provided a forum for academia, research and

policy and industry actors to put their perspectives on the table for a more collective solution moving into the future. The forum opened up opportunities for various stakeholders involved to understand and acknowledge the various transformative work going on in the solar industry, including a diversity of products such as SHS units, solar roofs, solar panels and new stoves. Most participants were therefore of the view that engaging people from different fields helped to unlock the potential for shaping transformation.

Bringing together some of the end users of the PAYG systems saw them discuss some of the challenges they face in the use of the product (e.g. tariff costs/charges associated with the PAYG service providers' customer care calls). These and other challenges identified by the users saw the push for a transformation within the space. In addition, an 'alliance' was formed by the stakeholders joining forces to counter the government's laxity to give the solar industry the due recognition and action it deserves. Beyond the project phase, the ASH research team has also continued to engage the community of practice established through the T-Lab process in other various initiatives that support transformative energy innovations through policy support and capacity building at the subnational government level.

Research methods

The research team had previously used policy analysis, dialogues and social scientific methods to address similar problems. Here, a primary method used was the T-Lab, incorporating the PIPA. During the research scoping, the hub identified key stakeholders with interest and influence in the mobile enabled SHS around policy, business and technology. This initial PIPA was used to form the trajectory for what pathways could be engaged with to enhance the uptake of research outputs.

By building a learner-centred model, stakeholders were engaged throughout. The application and use of *World Cafés* ensured that knowledge sharing and idea generation occurred throughout the process. Personal experiences with the PAYG models were shared, questions were directed to experts, and most importantly, transformative success stories were benchmarked.

The research team built on this with the use of *World Cafés* in which three core structured questions were tackled in rounds of interactive discussions – participants were split into small groups alongside a moderator for each group. The moderators then summarized the key points gathered in the discussions while the group members expounded on the key points and responded to questions from other groups. After all the groups had presented, a compilation of ideas, priorities and actions were made. PIPA exercises were also implemented to provide further insights.

Re-framing sustainability challenges

Throughout the research process, the ASH research team was attentive to the tension between the government's focus on grid solutions and other stakeholders'

focus on off-grid solutions. The first T-Lab workshop went a long way in diffusing these tensions as the different stakeholders present were in agreement that the system being discussed had a potential impact in alleviating problems around access to clean energy by low-income households. The process introduced many civil society groups to the problem space, and the research community were able to develop future research programmes based on the work. Further, the private sector actors acknowledged that they would be in a position to expand their scope of definition of impact of the PAYG products to include more socio-economic indicators. There was also a change in the problem recognition within the government. The county and national representatives were keen on supporting mobile payment systems, including pledging to explore with other government ministries how to support the innovation.

The shift from the first to second T-Lab included a clearer focus on the questions that arose from stakeholder engagement in the first T-Lab. This included questioning who the beneficiaries of mobile-enhanced SHS were, how these benefits and barriers were defined across the different stakeholders, and the technologies of governance and innovation that supported the space. The research team was also keen to find out whether there had been notable transformations since the first T-Lab.

A change in the participants' perception on the initial problem was also noted. Aside from the diverse transformational views between the government and the private sector regarding mobile-enabled solar PVs, it was interesting to note that the government, through a World Bank partnership, was spearheading the Kenya Off-Grid Solar Access Project (KOSAP) (KPLC & REA 2017), targeting 14 of 47 electrically marginalized areas. KOSAP serves as an off-grid electrification strategy (though it is not a comprehensive policy) designed to benefit "household, public and community institutions, enterprises and community facilities that cannot access electricity through the national grid and whose use of electricity will replace kerosene and other fuels". Even though the KOSAP project acknowledges the potential of the mobile-enabled PAYG SHSs, it was criticized for alienating the private sector. In light of this, the private sector was encouraged to support the government better in its efforts to advance solar energy access in Kenya.

Innovation and alternative pathways

The baseline study and T-Lab workshops allowed for refining the research questions and opening new lines of enquiry. However, within the broader project research questions, what was apparent was the need to take a comparative approach between the first and second T-Labs. A coherent network of T-Lab participants was created which established a stakeholder map to help refine future research on the same system.

The KOSAP project generated significant debate over whether the government was seeking to undermine or complement investments in SHS by the

private sector. Though hailed as a good initiative, the private sector viewed the project as an insecurity. Nonetheless, the second workshop found that this could be the best platform for harmonizing the various transformational views between the government and the private sector. The two could forge partnerships, since the private sector has been in the space for long enough to gain expertise and the government bears the capacity to finance the project and ensure the advancement of socio-technological innovations. A complementary rather than competitive relationship between these actors is needed.

A major observation by researchers has been the poor coordination of activities and actions around renewable energy. Through this process and her networks, ASH established an innovative bridging platform to enhance skill development, capacity building and coordination of renewable energy access and mainstreaming efforts within the devolved county governments in Kenya, as well as in the SHS space. This platform known as the 'County Energy Access Platform' will be comprised of two major components: a virtual hub and a face-to-face forum for knowledge sharing. The platform will support research work, empower county governments in the development of county energy plans, and map out resources and gather energy information. While several renewable energy initiatives exist, there are questions as to the governance of those initiatives. Thus, the County Energy Access Platform will take a transformative approach and coordinate platforms beyond workshops to help counties build technical knowledge. Like other institutional innovations proposed or emerging from the 'Pathways to Sustainability' TKN, the County Energy Access Platform could bridge between different scales and framings in order to enhance uptake of more sustainable technologies and practices. The T-Lab community of practice pledged to support ASH through the platform.

Additionally, the ASH – through the community of practice – will also be keen on influencing policies and embed the pathways thinking via the emerging large energy projects working in Kenya. The idea it to use the thinking drawn from the T-Lab experience to spur a more opened up thinking around renewable energy – not just about access but also about utility options that speak to the energy needs of various social groups especially the poor. One key opportunity the hub is building on is the Modern Energy Cooking Services (MECS) programme – a £40 million (US$50.5 million) UK Aid-supported initiative aimed at promoting modern energy cooking services in the Global South. The hub is supporting this project in Kenya by strengthening the pathways to sustainability thinking through a more inclusive stakeholder engagement strategy that enables bottom-up approach to promoting clean cooking as a niche for strengthening socio-technical sustainability given the vast majority of the poor who still depend on biomass for clean cooking. The programme works through a multi-partner programme of activities – led by Loughborough University in the UK to catalyse the transformation of clean cooking that enables long-term use of MECS to generate inclusive environmental and development benefits for the poor by enabling technological, institutional and market innovations.

Networks, alliances and collective agency

Based on the stakeholder/network mapping in the original PIPA exercise, the first step in this research was to develop an informal network, which allowed for a maintenance of engagement throughout the project. The first T-Lab workshop brought some of this group – which became a community of practice – together. The second T-Lab engaged users of the PAYG models in discussing the challenges faced in the use of the products (including around user experience). These and other challenges identified by the users produced a push for transformation within the space. As is evident from the descriptions above, a number of alliances emerged from the networks involved in the T-Lab process. However, these were not investigated (or the associated changes in collective agency) in detail during this study.

Specific insights from the Kenyan context

This research generated a host of insights. The first T-Lab looked closely at the increased access to PAYG solar PV platforms, how to enhance access to similar investments, expanding the PAYG product range, and ways of increasing knowledge sharing. More broadly, widening the stakeholder engagement with the schemes was brought out to be of key importance.

Integrating more service providers by creating opportunities and platforms was identified as a vital next step. This would create a better environment for innovation, in particular with regard to the product packages available to end users. Further, enhancing access to investment incentives from national and county governments would be crucial for attracting actors in the private sector including solar energy service providers who could venture more into mobile solar service provision.

An organic review of government policies taking advantage of the devolved system is critical to enhancing the transformative reach and impact to the end users, where facilitative measures and interventions by national and county government actors could be used for advancing the actions of sector stakeholders including solar service providers, mobile solar payment actors and civil society. Across Kenya's energy policies, the distribution of functions and powers between the national and county governments creates two distinct, albeit connected spaces in which PAYG solar services can now operate. This structure informs the governance approaches that could potentially elevate the mobile-enabled PAYG SHS space. County governments are responsible for developing individual county plans, as well as reticulation of energy services and regulation of said services. Given the barriers to the integration of the mobile-enabled PAYG SHS sector into the national policy regime, the autonomy afforded to county government in terms of energy services is a great opportunity for the PAYG enterprises. The potential for partnerships between enterprises like PAYG businesses and county governments in expanding energy access is great, particularly with the drafting of the County Integrated Development Plans by each of Kenya's 47 counties.

Additionally, it is important to harness frameworks including legal and policy mechanisms that increase the space for engagement and innovation, helping to enhance traction and penetration of innovative renewable energy solutions including the mobile solar payment mechanisms among target communities. The *M-KOPA* solar energy company (among many other companies) comes out as a great case study that has transformed the energy innovation ecosystem in Kenya especially for the off-grid and low-income households. The system relies on the *M-PESA* (where M stands for mobile, *PESA* means money) technological platform, offered exclusively to *Safaricom* mobile network customers (*Safaricom* is a leading mobile network provider in Kenya, partially owned by the national government). The mobile money system leverages the increasing number of households owning mobile phones and being able to access financial services, especially in rural areas with limited banking services (Chengo et al. 2019).

The packages offered by the mobile solar payment service providers ought to be more product-oriented on top of focussing on household items, thus encouraging income generating activities, which would enhance the transformative capacity of the products. In this regard, expanding the product range in addition to the scope of users in order to spur income generating activities is necessary. This can be done through augmenting products that come with the device from household-oriented items to production-oriented items, while engaging critical players such as grassroots SMEs to spur transformation through poverty alleviation. Evidence from studies on the impact of these technologies within Kenya indicates that developmental benefits associated with solar electrification are linked to the use of "connective" devices (Byrne et al. 2014). The economically productive impact of off-grid solar PV in Kenya is generally marginal; however, the use of solar-generated electricity to power appliances such as televisions, radios or charging cellular phones increases the interconnections of people to markets and the cultural hubs of urban centres. Rolffs et al. (2015) claim that despite the growth of the sector and dissemination of mobile-enabled SHS, there has been relatively little impact on the energy access figures in Kenya, despite the country being one of the largest per capita markets for SHS in the world.

Enabling knowledge sharing by having cross-sector players engage is important in expanding the breadth and depth of these initiatives. This could spur innovative solutions among different actors in the value chain that would enhance the end user experience, involving clean energy entrepreneurs, innovation hubs and solar energy providers, institutions of learning, policy-makers and the end users in taking advantage of the knowledge and research that has been done in solar energy services to spur collaborative actions and initiatives which would have a bigger transformative impact.

It can be argued that clean energy entrepreneurs and sector players could also engage alternative funding mechanisms in order to enhance their involvement in renewable energy access and in particular solar energy solutions.

In terms of actors that are key to these innovations, interventions around the sustainability of solar PV systems through the T-Lab approach involved engaging state actors at national and county levels. This includes a range of state

departments such as environmental control agencies, safeguard agencies, energy regulatory bodies and climate change departments among others who are critical in regulating both domestic and international solar processes.

On the other hand, in the Kenyan context, non-state actors such as advocacy groups, the private sector, SMEs, NGOs, grassroots movement also have an enormous role in contributing to sustaining the transformations of mobile enabled systems. The private sector players are critical in supporting economic transformations and associated challenges through diversifying credit sources for poorer households, diversifying solar products to match the needs of all, including the poorest of the poor, in each setting. Also critical is the involvement of local grassroots end user communities who are the consumers of these products. Further, the media could also play a key role in bridging the information gap that exists between the users, producers, policy-makers, and distributers of solar PV systems to enhance transformation.

The Transformative Pathways to Sustainability research project brought out insights into the conflicts within transformative spaces, and the importance of decentralizing policy-making. Bridging the gap between policy-making processes and transformative initiatives in the SHS space thus becomes critical. The private sector needs to push for redress of policy frameworks to support the SHS space through existing forums such as the Kenya Private Sector Alliance (KEPSA). In one way or another, through KEPSA, initiatives spearheaded by the private sector would gain legitimacy and attract support from the national government.

Given that many other policy initiatives term the private sector as crucial to the successful expansion of the energy sector, and that the national government has been attempting to alienate the private sector through the KOSAP Project, factors that would create a complimentary environment between government and private sector, as opposed to a competitive one, need to be researched further.

The gap between policy-making processes and initiatives on the ground remains a subject of debate which can also be probed further. It is time to shift focus from the national government policy frameworks to those within county governments in Kenya which are better placed to address the pertinent issues on the ground around energy access. Nevertheless, it is the mandate of the national government to develop policies and other relevant statutes to which the county policy frameworks have to align with.

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