Demand side contextual drivers of inclusive innovation: the case of Kenya's energy efficient appliances sector

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Abstract

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; (iii) 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

Introduction

The term 'inclusive innovation' was first used by the World Bank in the late 2000s to refer to value addition that was focused on the needs of the poorest. 'Inclusive innovation' in this vain was defined as "knowledge creation and absorption efforts that are most relevant to the needs of the poor" (Dutz, 2007: xv). Since then the term has been taken up by several other development agencies, notably the IDRC and UNDP, to place renewed significance on (i). the importance of innovation in the growth trajectories of developing countries and (ii). the importance of focusing that innovation on the needs of the poorest in society to enhance income generating opportunities.

Alongside this has been a set of allied, more academic debates that have discussed issues of inclusive and pro-poor growth (Kaplinsky, 2009) and the power of the 'fortune at the bottom of the pyramid' (Prahalad, 2005). Much of this literature, while appearing to focus on individual agency of the poor is, in fact, actually more interested in macro-economic policy and has not focused on the dynamics of innovation and the social and political issues affecting the poor. There are exceptions to this, such as the Capturing the Gains global research network activities. There have also been recent efforts by innovation theorists to energise the inclusive innovation debate with an emphasis on poverty and inequality; highlighting the impact of innovative activity on individuals, households and communities (Heeks et al, 2014; Cozzens and Kaplinsky, 2009).

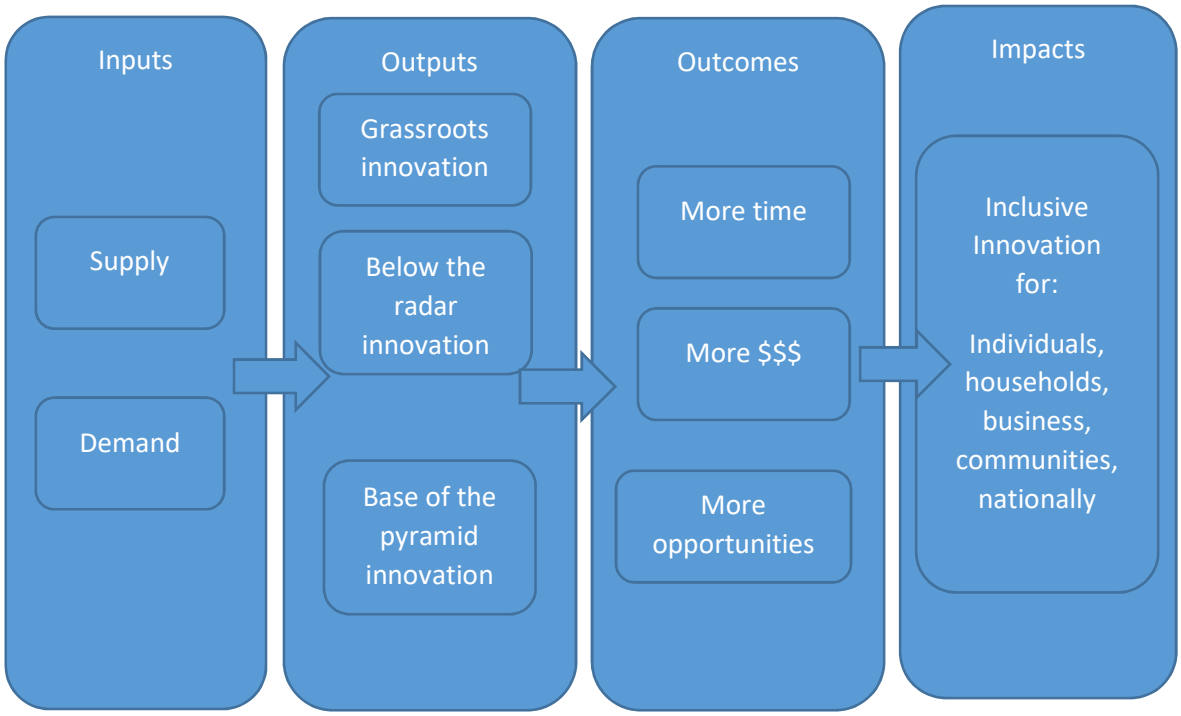
The result of which is multiple meanings for the term inclusive innovation (Heeks et al, 2014; Chataway et al, 2009) with differing emphases on outcomes and outputs for policy, donor projects and business activities. Kaplinsky et al (2014) have outlined the need for a stronger policy framework within which to understand inclusive innovation. This paper takes this as its starting point and argues there is a need to also assess innovation activities more widely to understand fully issues of 'inclusivity'. This is important because different stakeholders in innovation activities are likely to have different takes on what makes a project inclusive, and as outlined above, predominately the policy literature is focused on the supply side impacts of innovation on inclusivity and particularly that in relation to economic growth at a macro level. Less work has focused on marrying demand and supply based needs and wants – further recognising that needs and wants aren't always one and the same thing.

This paper therefore outlines a typology matrix that could be used to interrogate the different definitions of inclusive innovation of different stakeholders. It outlines the typology based on current dominant arguments in the literature, practice and policy fields. It then goes on to discuss the need to include new drivers of inclusive innovation into the typology based on an initial analysis of aspects of the Kenyan cookstove market.

Inclusive innovation debates

Figure 1 provides a graphical overview of the different ways in which the academic, practitioner and policy debates have discussed the concept of inclusive innovation over time. There are three types of inclusive innovation usually discussed. Bottom of the pyramid innovations (Prahalad, 2005), increasingly considered as base of the pyramid innovations (Hart and Christensen, 2002; Cañeque and Hart, 2015) are based within a supply driven approach corresponding to innovations that are imported and distributed into the country such as cheap thin-film solar or LED lighting. Grassroots innovation (www.grassrootsinnovation.org) on the other hand acknowledges the existence of alternative demand driven innovation often frugal or indigenous and small scale in nature. These are developed and distributed within the community such as bottle lights or artisan cooling techniques. In between these is 'below the radar' innovation (Kaplinsky et al, 2009) which is often more formal sector orientated being developed in country and distributed in country but which often go unnoticed. These include innovations such as fuel-efficient stoves or micro wind technologies.

Figure 1: The currently dominant 'storylines'1 inclusive innovation debates



Source: authors

These types of innovation are deemed to meet various user needs. These can be grouped together into three overarching analytical foci: (i) More time – enabling faster or more efficient activity providing opportunities for additional activity. The much used example here is women who are able to spend more time selling produce at the market by spending less time cooking at home; (ii) More money – this is both about providing the ability for new or improved income generating activity through improved energy supply as well as the creation of cheaper products (because they take less time or labour to produce) resulting in the creation of surplus household or business income; (iii) More opportunities – relating to skills and competence building of adults and children through the providing more conducive study environments in the home, creating opportunities for access to ICTs, enhanced employment opportunities or on-the-job training in new energy utilising equipment.

The specifics of these arguments will now be introduced.

Inclusive innovation definitions

As outlined above the first use of 'inclusive development' can be pegged to a World Bank publication edited by Dutz (2007) on inclusive innovation in India. Specifically, a chapter by Utz and Dahlman (2007) discusses inclusive innovation as going beyond science and R&D to include grassroots innovation that occurs from the bottom up. They specifically discuss the importance of networks and partnerships between different stakeholders as being essential for inclusive innovation defined as innovation activity that is most relevant to the poor. Since then staff at the Bank and those working closely with them have developed this concept further so that at a Forum on Inclusive

[1] The concept of storylines here is used to reflect different storyline refers to 'ways of explaining' situations (Hajer, 1997). Similar to the concept of rhetoric, metaphor or narrative, it is the idea of the creation of overarching notions that people identify with, contribute to, and use to bring others together towards a common understanding

Innovation held in Beijing in June 2012[2] an emphasis was put on case study examples that highlighted mechanisms to support the development of partnerships and grassroots innovation such as an Indian grassroots innovation acquisition fund (aimed at funding commercialisation of inventions developed in rural areas and science and technology advisors who go out seeking such inventions and providing support to rural communities to help them develop the entrepreneurial skills necessary to successfully innovative these ideas.

The World Bank interest in inclusive innovation stems from earlier debates around inclusive growth and pro-poor growth. Kuznetsov, a senior economist at the Bank has defined inclusive growth as "growth that provides and improves the consumption patterns and employment opportunities for large segments of the population." He argues innovation is key to inclusive growth and particularly innovation that isn't necessarily new to the world but "new to a given context" arguing that context and adaptation are key to ensuring inclusive growth arises from innovative activity in developing countries; conceptualising more fully the original arguments made by Utz and Dahlman.

Such an emphasis though (a marrying of inclusive innovation and discussions of inclusive and pro-poor growth) has led to the frequent assumption that 'inclusive innovation' should focus its interests on – what Altenburg (2008) from an innovation perspective defines – "increased numbers in work and businesses involved" raising incomes and employment opportunities. However, as Altenburg goes on to argue inclusive innovation actually needs to also include a "poverty orientation" (p.5). By extension such a perspective needs to focus on the needs and wants of the poor themselves and not simply dominant policy actors.

Work by the UNDP has focused more specifically on this latter aspect of the inclusive innovation debate. Their International Policy Center for Inclusive Growth based in Brazil introduces discussions of inclusive growth from the premise of equality and recognise that inclusive growth is about outcomes (everyone shares in the results of growth) and processes (everyone is given opportunity to participate in growth process). In so doing they recognised the need for a multi-faceted approach to dealing with growth, inequality and poverty.

Going one step further, the Canadian International Development Research Centre (IDRC) instituted a short-lived programme3 to fund research on inclusive innovation predominantly concerned with the inclusion of informal sector producers. Thus recognising the nature of innovation as being beyond formal R&D or even formal manufacturing activities. The project also focused on the importance of social innovation around the role of intermediaries. This program developed a very broad definition of innovation as "processes that improve people's lives by transforming knowledge into new or improved ways of doing things in a place where or (by people for whom) they have not been used before". This was however closed as a consequence of cuts to the IDRC's budget, reflecting the low priority given to the innovation component of exclusionary growth.

Burgeoning business and entrepreneurship literature

Much of the recent World Bank literature especially makes reference to the opportunities availed for, and by, the 'fortune at the bottom/ base of the pyramid'; drawing on an increasingly popular set of business and entrepreneurship literature and practical toolkits, such as the BoP Protocol (Simanis et al, 2008) often provided by bottom of the pyramid outreach hubs that are concerned with similar issues, sometimes using the same terminology of inclusive innovation.

Starting from a concept of 'inclusive capitalism' (Prahalad and Hart, 2002), the BoP literature and activities focused predominately in its first five years and even now at times still heavily focuses on the opportunities availed to formal businesses (often large multi-national corporations) from doing

[2] http://www.worldbank.org/en/news/feature/2012/06/21/beijing-forum-promotes-inclusive-innovation-for-sustainable-growth

[3] The Innovation for Inclusive Development Program was initiated in 2011 but was suspended in 2012 (Santiago, 2014)

business with the poorest segment of the population (very crudely put, because of its sheer size in countries such as India which outweigh the loses on profit margins). Following a series of critiques, the BoP community embraced a second generation version of BoP approaches (optimised by the publication in 2008 of the BoP Protocol) that outlined the importance of 'co-creation' between business and communities with case studies showing the success of, again, often, large scale formal industry and again often MNCs such as SC Johnson working with communities to develop new product, process and business model innovations. Simanis et al (2008) term this a movement from 'finding a fortune at the bottom of the pyramid' to 'creating a fortune with the base of the pyramid' to emphasise the importance of market creation activities. More recently Cañeque, and Hart (2015) have started talking about a third wave of BoP studies focusing on open innovation and beyond co-creation.

In addition, scholars involved in entrepreneurship studies (George et al, 2012) have considered the ways in which entrepreneurship, strategy and marketing influence inclusive innovation but this analysis is primarily concerned with theoretical and research implications. They do however distil much of the above debate, which we might call the 'Inclusive Innovation 1.0' debate into a single question for future research which has been a starting point for discussions in the innovation field in recent years: who does more inclusive innovation? MNCs or small entrepreneurial firms?

Inclusive Innovation 2.0

Thus there is evidence of a new set of discussions and activities, which might be termed, Inclusive Innovation 2.0, which are taking stock of the macroeconomic and business debates around inclusive innovation and its various sister terms and considering the dynamics of innovation and how it actually works and how it can be 'pro-poor' or inclusive in nature – to individuals and communities from the bottom up rather than simply from the top down. An early example of this was the work of the Capturing the Gains global research network (http://www.capturingthegains.org/) which addressed (and continues to address) the role of poor producers in serving global markets, utilising the global value chain and global production networks analytical schema. There is also a growth of arguments about the importance of users in the innovation process following on from work by Von Hippel (2005) which particularly looks at innovation in and by communities – so called 'grassroots innovation' (Smith et al, 2016) – much of which is focused on 'frugal innovation' (Radiou, Prabhu, and Ahuja, 2012) and 'innovation in the informal sector'. Much of this is the result of having to innovate as a result of scarcity (making the most of what you have) (Cozzens and Sutz, 2014; Srinivas & Sutz, 2008).

More recently, innovation theorists have contributed to the inclusive innovation debate by bringing scrutiny to the way innovation, poverty, growth and inequality are discussed. In particular, Cozzens and Kaplinsky (2009) have highlighted that negative as well as the positive influence of inequality on growth as well as the co-evolutionary nature of innovative activity and inequality. They argue that there is a need to move – in a similar way to that proposed by the National Systems of Innovation literature (Freeman, 1987; Lundvall, 1995) – towards the competence building that takes place or the 'learning and skills renewal'.

A key element of this discussion is focused on the need to consider how to get appropriate knowledge and skills to those who are most responsible for innovation that is most likely to positively impact the poorest in society (Adwera, Johnson and Hanlin, 2013) but also the importance of building knowledge and skills at the policy level to ensure the right mix of incentives are created to enable effective inclusive innovation (Hanlin, 2008).

A recent addition to this literature has been a refocusing on debates that became prominent originally with the 'appropriate technology movement' of the 1970s. Some (Hanlin and Kaplinsky, 2016) have argued that we are now seeing a move towards appropriate technology 2.0 which

recognises (i) the changes in innovation dynamics globally, and particularly the rise of Southern technology producers and (ii) the creations by these new actors that do not suffer from the inefficiencies of the first wave of appropriate technology. Specifically that Southern based firms – particularly those in China, India and other emerging economies – are designing technologies that are better suited for other Southern environments than technologies made in the North i.e. Europe and North America. These are often designed to be more robust, less complex and therefore require more accessible forms of know-how and be more suited to the budgets of consumers in Southern economies. Such innovation often takes place 'below the radar' (Chataway et al, 2014) as a result of general business and entrepreneurial activities as a process of 'fiddling' and 'playing around' i.e. having not been a deliberate process of innovation from the get-go.

Inclusive innovation and low-carbon energy technologies

One area where these issues can be easily seen is in the low carbon energy sector. There is a recognised demand for new and existing low carbon technologies to be innovated in ways that meet the needs of the poorest in society (Mitchell and Maxwell, 2010; Practical Action, 2010). Such innovation is increasingly termed 'inclusive innovation' and often defined in terms of new or adapted products, processes, business models introduced into a context that meet the needs of the poor (OECD, 2013; Utz and Dahlman, 2007). But questions remain insufficiently answered as to what really are the needs of the poor. The inclusive innovation discussions in the low carbon energy sector are often discussed in terms of economic growth and income generation opportunities availed through innovative activity (both for businesses and individual consumers) (see e.g. de Mello and Dutz, 2012). There is however growing recognition – as outlined above – of the need to think about inclusivity in terms of poverty reduction, equity and competence building (Altenberg, 2008; Kaplinsky, 2011) recognising a wider range of needs and demands of users.

Many national policies and programmes initiated by governments in developing countries tend to regard the access challenge from a supply perspective only and to focus on only a few technologies or energy carriers. The dominant technology solution favoured by such governments tends to be grid electrification (Rehman et al, 2012; Bhattacharyya, 2012). This is problematic because it is often an inadequate technology solution to meet all household demand for energy services and has been found to have poor economic developmental impacts (World Bank, 2008). Grid electrification is often ill-suited to rural conditions which have dispersed settlement patterns raising the cost of distribution infrastructure (Bekker et al, 2008). Households also often lack the ability to pay for electricity services, requiring state subsidies. Supply is also often unreliable and of poor quality making it an insufficient solution to displace other fuel use, particularly for cooking (Bhattacharyya, 2012). Thus, there is a need to open up the policy discourse on alternative fuels and technologies.

Another reason to look beyond the electricity supply paradigm is that there is increasingly also an awareness of the importance of aligning energy access objectives with low-carbon development goals. It is acknowledged that there are poverty alleviating co-benefits that can be harnessed from introducing more climate friendly technologies.

Innovation for sustainability is usually driven by market demand and firm-level competitiveness, often mediated by regulatory measures (e.g. taxation to internalise external costs) (Rennings, 2000). When sufficiently large markets exist (e.g. in the BoP model), innovations are seen as inclusive because of their diffusion. These same drivers may be absent, or at least weaker, when more diverse needs of the poor are considered that constrain demand aggregation to create significant markets. Inclusive innovation (which addresses the needs of the poor in diverse contexts), therefore relies on a wider range of mechanisms to drive improved technologies, business models or value chain governance – beyond the market.

Many studies have focused predominately on enablers and barriers to diffusion of clean energy technologies (and often those that are imported into the country by companies focusing on the 'bottom of the pyramid' markets (Prahalad, 2005). For example, a systematic review of barriers to modern energy services (Watson et al 2012) has pointed to economic, technical, political, cultural and social barriers.

However, demand is not only triggered by access issues in diffusion of technologies. Technology and product design must be based on a thorough understanding of the local context and the needs and aspirations of target populations. A common and pervasive shortcoming of many improved cook stove projects for example is rolling out stoves that are too small to fit all the pots that people in the community commonly cook with (Gifford, 2010). Energy access programmes may also need to overcome negative perceptions or cultural and traditional customs that serve as barriers to adopting new technologies. For example roll-out of solar home systems across Africa have battled from negative perceptions of solar as an inferior technology to grid electrification (Brown and Sumanik-Leary, 2015). New technologies may require behavioural changes by users, which can be a challenge to sustain in the long term (Kees and Feldman, 2011). Target populations also typically have low ability to pay for services and require financing support schemes. Project design and implementation therefore needs to be innovative to find new ways of addressing these challenges to ensure long-term and sustained outcomes.

Other work (Ockwell et al, 2009) has for example highlighted the importance of indigenous innovation capabilities in enabling the identification, adoption, adaptation and improvement of technologies in developing countries. This work points to the complexity of demand requirements of the urban and rural poor based on differing needs that often – and therefore do often relate to access barriers – go beyond the market.

A typology of current thinking on drivers of inclusive innovation

From the above, it is possible to develop the typology matrix outlined in Figure 2. This provides a means to understand the factors influencing success or failure to meet the outcomes demanded by different stakeholders involved in inclusive innovation processes. Specifically the typology is based on the recognition that there is in fact a feedback loop between inputs and outcomes in storylines discussed and outlined in Figure 1 which co-influence each other over time. More specifically, that stakeholders have different desired outcomes that are determined both by 'needs' and 'wants' which don't always align and which are mediated by various technological, social and contextual factors that come into play.

Predominately the discussions to date in the field of inclusive innovation have focused on the importance of technological and social drivers in determining the success of different types of innovation in meeting the desired outcomes of those developing the innovations (which may or may not be aligned to the needs and wants of the end users). However, as outlined above, there is increasing recognition of the importance of contextual factors that are important in explaining whether a technology is successfully diffused i.e. that the innovation process is completed in an inclusive manner. As others have acknowledged: 'technological innovation is a contextual process whose relevance should be assessed depending on the socio-economic condition it is embedded in' (Srinivas & Sutz, 2008: 129).

Figure 2: Modified typology of drivers of inclusive innovation

	Supply Demand									
	Technology factors				Social factors		Contextual factors			
Output	Scalability	Complexity	Expertise and knowledge	Cost	Collaboration	Motives	Usability	Environment	Habits	Outcomes
Grassroots innovation										Cheaper/ increased disposable income More accessible More empowering Technological superior in a given environment Flexible Upgradable
Below the radar innovation										
Bottom of the pyramid innovation										

Source: authors

Work from the LCT project by the authors highlights the importance of three specific contextual drivers: usability of the technology, environmental factors and what we are calling habits of users.4 Usability is often equated with technological design features such as those related to robustness or complexity. Usability is mediated by the technological design features but its also a function of external contextual forces such as family size in the case of stove size. Environmental factors relate to issues such as access to electricity or availability of free wood stock for example. Perhaps the least understood – and therefore less acknowledged or considered area – is that of habits or the ways of doing things that are handed down through generations or mediated by experiential learning directly or indirectly (through the experiences of neighbours and friends). In the area of cookstoves this relates to everything from people's attitudes to smoke to the type of payment plans someone is willing to accept. We will now discuss the importance of these three factors in the context of the Kenyan cookstove debate.

The case of Kenyan improved cookstoves

Figure 3: Kenya's cookstove sector outlined

Improved Solutions		Clean Cooking Solutions		
Legacy and Basic ICS	**Intermediate ICS**	**Advanced ICS**	**Modern Fuel stoves**	**Renewable Fuel Stoves**
Example: Kenya Ceramic Jiko, KuniMbili stove	*Example:*Ecozoom, Burn stove, Jikoupesi	*Example:*Gasifier	*Example:* LPG	*Example:* Biogas, ethanol gel stove
Key features: Small functional improvement over baseline technology; artisan produced	*Key features:* Rocket principal to enhance combustion efficiency; some with high end materials and good finishing	*Key features:* Fan jet or natural draft gasifier with very high combustion efficiency and reduced emission; often attain tier 3-4	*Key features:* Relies on fossil fuel or electricity; zero emission with very high efficiency	*Key features:* Derived from renewable non-woody fuel; some are supplement energy sources
What is included: • Basic efficient charcoal • Basic efficient wood	*What is included:* • Portable rocket • Fixed rocket chimney • Highly improved	*What is included:* • Fan gasifier • Char stove	*What is included:* • LPG • Electric cooker • Kerosene	*What is included:* • Biogas • Ethanol • Solar oven • Fireless cookers

Source: KCIC, 2017: 12

[4] We are specifically avoiding the word 'culture' here due to its contested nature.

Kenya has a long history of trying to introduce improved cookstoves, i.e. stoves which are designed to reduce or remove emissions and are non-harmful to human health. Traditionally Kenyans cooked on '3-stones'; a wood fire where the cooking pot was placed over the fire by sitting on three stones. Since the 1980s various international and local non-governmental organisations and increasingly private sector companies have been trying to encourage Kenyans to purchase and utilise 'improved cookstoves' such as the Kenyan Ceramic Jiko or KCJ through to 'clean cooking solutions' including LPG and electric. The overview of improved cookstoves and clean cooking solutions that are on the market in Kenya is provided in Figure 3.

It has long been a known problem that kitchen emissions from woodfuels and charcoal are harmful to the household's health, particularly to women who make up the majority of cooks. There have been extensive educational campaigns, and much of the work on improved charcoal cookstoves aims to reduce this effect. Recently ESMAP and GACC acknowledged that unless an improved charcoal cookstove has forced gasification, the reduction in emissions in improved stoves do not cause a "significant health benefit" (Putti, Tsan, Mehta, & Kammila, 2015).

Biomass cooking is an important public health issue, and results in more deaths per year globally than malaria and tuberculosis combined (The World Bank, 2014). On the face of it, Kenya has done well in trying to encourage use of improved cookstoves. Approximately 80% of urban households use a KCJ as their main cooking source with an estimated 500,000 households using them in Nairobi (KCIC, 2017). In addition over half a million KCJs are "pushed into the market" every year in Kenya (KCIC, 2017). However, overall only 30-40% of all Kenyan households use an improved cookstove (USAID, 2011 in KCIC, 2017) and another study found that while virtually 100% of respondents knew about improved cookstoves, only 30% had adopted (Mtsami, 2010 in KCIC, 2017).

The most recent study on the Kenyan cookstove industry found that while there was a vibrant market sector with an increasing number of companies getting involved in the market place with innovative business models (e.g. pay as you go gas) there are regulatory hurdles (i.e. lack of clarity in standards) as well as access to finance (KCIC, 2017). However they concluded that consumer satisfaction was a key enabler for the industry moving forward as much as it was a challenge. They found that a significant number of those who didn't have an improved stove were willing to purchase one and those that used the stoves used them approximately 60% of the time. However, they found 'fuel stacking' a major activity across the country (the use of multiple stove types and fuel types) and a hindrance to achieving wider uptake due to the difficulty of ensuring primary use of a single (improved or clean) cookstove type. (KCIC, 2017)

The results of a discrete choice modelling experiment

A study completed by the authors in 2016 supports the findings of the KCIC study with regards the importance of recognising the importance of the demand side - and not just the supply side - in ensuring low carbon energy efficient technologies are designed in a way that consumers will buy them and continue to use them. Specifically, it found that contextual factors regarding how people use technologies – such as the importance of fuel stacking – is a key factor in people's decisions on choice of technology. Factors such as price are less important.

The study conducted aimed at answering two questions: (i) What are context and culture-specific design and operational parameters that will govern which levels of low-energy consumption of certain low carbon energy efficient domestic appliances? (ii) What are acceptable price points and how will the technologies be constructed and commercialized at those levels? The study answered these questions through the use of a discrete choice experiment (DCE).

Discrete choice experiments enable understanding of user priorities pertaining to selected products and with which the consumer need not be so familiar. It focuses on the parameters of design involved and asks respondents to make choices between two discrete types of technology with different design parameters. Essentially it asks would you like product A with these types of

characteristics or would you like product B which has one parameter the same and the rest are different. The methodology has become popular in the fields of marketing and transport studies. In the energy sector it has been used to consider consumer preferences with regards types of heating system, appliance efficiency levels, and fuel efficiency level of vehicles.

The domestic appliance survey targeted 400 respondents from across Kenya made up of randomly selected individuals shopping at local markets and a small sub-set of farmers from Central Kenya (because there were questions on solar water pumping which has an agricultural use). While not intending to be representative, the study respondent make-up fitted national demographics in terms of age and was a 50-50 split male-female. Respondents came from a range of soci-economic groupings. Each respondent was asked a series of initial background questions before being asked to make choices between a series of pairs of cards giving details of different designs of clean cookstove, solar powered water pump and solar powered fridge. An example of a pair of choice cards for the cookstoves is provided in Figure 4. Final parameters or attributes on domestic appliances related to: Size, Design, Doors, Cost, Maintenance and Financing. Based in the answers given a calculation can be made as to the relative willingness to pay for different design parameters thus providing an indication of which design parameters are more important than others for each technology.

Figure 4: an example of the choice cards used in the DCE

Parameter	Choice A		Choice B	
Cost per month	have to pay KSh1000 a month		have to pay KSh2000 a month	
Smokey Flavour to the food	no smokey flavour		no smokey flavour	
Number of people	can cook for 8 people		can cook for 4 people	
Number of meals	can cook one meal and reheat old meal		can cook two meals a day and boil water for tea	
Ability to simmer	Able to simmer for 5 hours	5	Able to simmer for 2 hours	2
Ability to bring to the boil	brings medium pot to boil in 20 mins	20	brings medium pot to boil in 20 mins	20
Smoke that people breathe	generates same smoke into the air as a wood fire		generates same smoke into the air as charcoal stove	

DCE cookstove findings

Of the 780 respondents of the whole survey 53% cooked with wood, charcoal or dung however, 27% used gas as their main cooking source. 66% of respondents had an electricity supply but less than 2% used electricity as their main fuel source. Among respondents mainly using wood or charcoal, 7% used an improved stove (N=30); this proportion was similar among wood users and charcoal users.

The median amount of money saved by improved cookstoves was 580 KSH/month, and the saving was similar between wood users and charcoal users. Despite a substantial number of people using wood, almost all respondents paid something for their cooking fuel. Only 5.4% of all respondents paid nothing, and these were mostly but not entirely wood users. The median amount spent on fuel (most recent purchase) was 1,000 KSH, and the median time that this lasted for was 30 days.

However, this is not very interesting, as it conceals different characteristics of how people purchase different fuels. When these are separated out, it can be seen that wood and kerosene are bought most frequently, whereas cylinder gas lasts longest. The ranking of fuel costs, in terms of per capita daily cost of cooking fuel, corresponds to fuel quality7 (i.e. cost of LPG is highest), although people appear to spend more on wood than they do on charcoal (bear in mind that these figures relate to 'main' cooking fuel, and in practice people will use multiple fuels).

Overall, over one third of all respondents felt that the decision to purchase a cookstove would be made by the female head of household; only 15% felt that this would be a man's decision. There is a clear gender divide here, with men more likely to feel that they would be involved in decision making (either solely or jointly), and women more likely to feel that they would make the decision ($\chi 2$ (4) = 50.3, p = 0.000).

There was a consensus that people would adopt modern cooking fuels if the cost was the same as their current expenditure on charcoal and wood8. There was also a consensus that any new device would need to accommodate very large pots (93% of all respondents agreed), and this feeling was stronger among women ($\chi 2$ (1) = 8.9, p = 0.003).

Following this general information, an overview of the main findings of the section of the DCE relating to clean cookstove designs is available in Figure 5 below. Two of these deserve significant attention: the degree of smoke created by the fire and the impact this has on the taste of food.

Figure 5: Design feature preferences for clean cookstoves

Design feature	Willingness to pay (KSH)
People have a strong preference for a cookstove that does not generate smoke like a wood stove. N.B. there is no preference for a cookstove that does not generate smoke over a cookstove that generates smoke from a charcoal stove.	1,080
People prefer NOT to have smoky flavour to food cooked on the stove	770
Ability to cook a meal for 8 (as opposed to a meal for only 4)	620
It appears that people prefer a cookstove to take a long time to come to the boil (compared with 60 mins to boil)	-460 (20 mins) -400 (40 mins)
Ability to cook 2 meals a day (rather than cook just 1 meal and reheat 1 old meal)	240

The parameter assigned the highest value by respondents was the smokiness of the cooking process, but no value was placed on eliminating the smoke emitted by a charcoal stove. It has long been a known problem that kitchen emissions from woodfuels and charcoal are harmful to the household's health, particularly to women who make up the majority of cooks. There have been extensive educational campaigns, and much of the work on improved charcoal cookstoves aims to reduce this effect. Recently ESMAP and GACC acknowledged that unless an improved charcoal cookstove has forced gasification, the reduction in emissions in improved stoves do not cause a "significant health benefit" (Putti, Tsan, Mehta, & Kammila, 2015). Of course for woodfuel stoves the smoke is often visible, for charcoal stoves the emissions are barely visible.

The response to the smokiness parameter is very insightful. If respondents do not value the difference between a clean stove and a charcoal stove, we can reasonably state that the educational campaigns on the dangers of charcoal stoves in confined spaces are not penetrating the public's awareness. Biomass cooking is an important public health issue, and results in more deaths per year globally than malaria and tuberculosis combined (The World Bank, 2014). Uptake of improved stoves has been frustratingly slow, and these respondents may have illustrated why. Even though it has only recently been shown that the health benefits of improved stoves are limited, the dissemination of the improved stoves is often sold on the basis of health benefits. The data in the DCE study is effectively saying that respondents do not acknowledge that charcoal stoves have a health implication.

If this is about messaging, and awareness of a public health risk, we might expect those better connected to wider society to be more aware. The disaggregated data showed that urban respondents value 'no smoke' (for wood fires) more highly than rural respondents, young people more than older respondents, the wealthier place higher value than the poorer households, and the strength of opinion is clearly liked to the level of education of the respondent. Interestingly gender differences in the data were small, with men and women placing similar values on the no wood smoke options, although head of household (which tends to be male) placed a greater value on this parameter than respondents who identified themselves as the spouse.

Eliminating smoke generated by a charcoal stove was not a significant component of models for any of the disaggregation options tested.

The above parameter attempted to include kitchen smoke emissions in the choice pairing. A different parameter with a picture of food next to it the choice pair graphics attempted to consider smoky flavour. This is an emotive parameter. In the literature, and particularly in focus group discussions, it is common to find a commentary on 'smoky flavour'. The lack of uptake of improved stoves is sometimes attributed to the idea that people like a smoky flavour in their food and that this desire for taste overrides the economic and health concerns of improved stoves.

In contrast to this often anecdotal data, the respondents have attributed an extra value to NOT having smoky flavour. This does not preclude enjoyment of the occasional barbecue – but for day to day cooking it would seem that smoky flavour is actually a negative rather than a positive feature. Urban dwellers, men, the young, the educated, head of households, and the wealthier all assigned stronger value to NOT having smoky flavour than their counterparts. The picture that emerges is that those who are 'less traditional' assign stronger value to the lack of smoke flavouring. This is consistent with focus group discussions where younger people state that 'their grandmother' doesn't like the taste of food cooked with LPG, and only when pressed will acknowledge that they themselves like non smoke flavoured food.

Discussion

The survey findings have a significant baring on discussions that are strategic to inclusive innovation debates currently taking place relating to the 'appropriateness' of goods. Recent discussions on appropriate technologies have highlighted how technologies from other emerging economies (notably India and China) might be more relevant than Northern-origin technologies for African environments especially due to their low cost. However, the LCT survey results show cost isn't a key driver in the choices consumers make for domestic appliances. What is more important is the usability of the technology. The work by the LCT project provides important empirical data highlighting the importance of usability issues over and above cost as a determinant.

As such, this questions also many of the arguments within the bottom/ base of the pyramid inclusive innovation discussions. These have focused on the profits available for companies who focus on the poorest consumers by selling high quantities of goods at low prices. However, this survey highlighted the importance of context and habits as an important determinant of successful diffusion. Culture and context were found to be highly important in determining consumer decision making but not always in the ways in which people – and the literature – would expect. For example, despite many arguments that Kenyans like their food to taste smokey and hence prefer wood stoves for this reason. Our survey results suggest otherwise. As such, the survey highlights the significant effort that is still needed for those working in the improved cookstove arena to get across messages on the health hazards of any fossil fuel as a method of cooking.

The importance of contextual factors are also borne out by the findings of the DCE in relation to respondents' attitudes to design parameters for solar powered water pumps and fridges. We won't go into details on this here – as the focus of this paper's example is on cookstoves – but we found that similar issues of usability, environment and habits were key issues that were key choice factors for survey recipients. Of particular note were issues of payment plan choice for survey respondents. Our survey found that the nature of the consumer was important for business model choice. For example, the farmers in our survey did not need or prefer instalment based payment plans for solar water pumps but the majority of respondents generally did appreciate such payment plans for cookstoves. This is interesting given the different price points of the technologies being discussed. The DCE offered respondents point points of between 500 Kenyan shillings (5 US dollars) and 2,000 Kenyan shillings (20 US dollars) a month as a payback rate – including fuel – versus the solar water pumps which were costed (for the whole system) between 700 and 2,100 US dollars.

Finally, the DCE exercise within the LCT survey also highlights a further issue which is linked to but broader than the discussion on drivers of inclusive innovation. This relates to definitions of the poor. As noted earlier in this paper, the majority of these discussions on cookstoves in Kenya are focused on improving the lives of poor people but our study – and others – highlights how the issue of clean cooking is a matter for all income groups in Kenya. The DCE shows that over 50% of the 780 respondents to the whole survey mainly used wood or charcoal for cooking and only 7% (n=30) of the 400 domestic appliance survey respondents used an improved stove. However, the latest and larger study conducted in Kenya which found that found approximately 80% of *urban* households use a KCJ for cooking (KCIC, 2017). This challenges the need to focus discussions in this area on the poorest in society; as emphasised by much of the inclusive innovation debates – not just those focused on the base of the pyramid. The need for clean cooking messages and promotion of clean cooking technologies is a requirement across society; regardless of income bracket. This is borne out by the next phase of the LCT study which is asking a small unrepresentative sample of households in Nairobi and Mombasa to tell us how they cook over a six week period. Virtually all the families own a KCJ and anecdotally for now (analysis of the data will not start for another few weeks) many – even those in the highest income quintiles – still use a KCJ for cooking food that takes a long time e.g. beans; despite the cost of LPG being cheaper than charcoal in Kenya at this present time.

Conclusion

This paper is the first attempt – and very much a work in progress – to understand the findings of a discrete choice modelling exercise in relation to how to move forward inclusive innovation in the cookstove sector of Kenya. It provides an overview of current thinking academically and practically on inclusive innovation and relates this to debates in the renewable energy sector. The paper then proposes a typology of drivers of inclusive innovation as currently focused on by the inclusive innovation literature and suggests the need to concentrate on the area of contextual drivers. These have been acknowledged in the literature as playing a role in the successful diffusion of low carbon energy technologies. The paper provides evidence of these issues as being important in the case of cookstove design parameters in Kenya, notably issues of usability, environment and habits. More research is needed in this area. As acknowledged in this paper, there is little understanding of how people cook and what people cook and why this results in the activity of fuel stacking for example? As noted early, the next stage of the LCT project has been to conduct a study of cooking habits to try and understand this more effectively. This cooking study will be completed by July 2017.

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