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**Abstract.** With increasing focus on achieving energy access for all by 2030, and working towards the Sustainable Development Goals, in particular SDG 7, there is further interest in the role of Information and Communication Technologies (ICTs). This paper explores the ways in which ICTs are used in the context of initiatives to support electricity access in urban and peri-urban communities in a developing country, Jamaica. A survey of 2,082 households and focus group discussions in 10 communities, along with interviews with key stakeholders, support the data collection for the study. Kleine's Choice Framework, which operationalises Sen's capability approach, is used to analyse individual and collective choices related to ICTs and electricity access, and the associated development outcomes. Implications for research, policy and practice are discussed.

**Keywords**: ICTs · electricity · energy access · Choice Framework · sustainable development · SDGs

## 1 Introduction

Access and use of energy have been key components of both the Sustainable Development Goals (SDGs), and the earlier Millennium Development Goals (MDGs). In September 2015, the members of the United Nations adopted the SDGs with targets to be fulfilled by 2030. SDG Goal 7 advocates that all members put in place strategies that ensure access to affordable, reliable, sustainable and modern energy for all. A key target for SDG 7 is highlighted by Indicator 7.1.1 which looks at the proportion of a country's population with access to electricity [1].

Universal access to modern energy services by 2030 is also one of the primary goals of the Sustainable Energy for All (SE4ALL) initiative which aims to fulfil objectives of ending poverty and increasing shared prosperity. The Energy Sector Management

Assistance Program (ESMAP) sponsored by the World Bank helps countries make informed choices and develop energy sectors that will be sustainable into the future. As part of its support for the SE4ALL initiative, ESMAP supported the development of a multitier methodology for measuring energy access. The new framework defines access as "the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive enterprises, and community institutions" [2, p.4].

Through collaboration with ESMAP, a research project was undertaken with the aim of measuring energy access for urban low-income communities in Jamaica. The main provider of electricity in Jamaica continues to seek to improve distribution and transmission, and support national development [3], while seeking to reduce losses, particularly for non-technical reasons [4]. While reports indicate that approximately 95% of Jamaicans have access to electricity [3], the utility company indicates that about 25% of connections are unauthorized [4]. As the country works towards achieving the SDGs, it is noted that those at risk of being left behind for SDG 7 include households without access to safe electricity supply. The utility company and social investment fund continue to collaborate on initiatives to provide safe and reliable electricity services for all [5].

There is recognition of the role of ICTs in supporting access to electricity services, as well as the impact of electricity access on ICT usage in developing countries [6, 7]. Further, the importance of electricity in supporting ICT4D initiatives, and the need for further research in this area is highlighted [6].

With increasing focus on achieving energy access for all by 2030, and working towards the Sustainable Development Goals, in particular SDG 7, there is further interest in the role of Information and Communication Technologies (ICTs). This paper explores the ways in which ICTs are used in the context of initiatives to support electricity access in urban and peri-urban communities in Jamaica.

The paper proceeds as follows: in the next section we explore the literature related to the role of ICTs in supporting electricity access, and also the connection between electricity service provision and the use of ICTs. Development is discussed in relation to the freedom to choose and the capability to choose from alternative functionings and outcomes [8, p.17]. The methodology for this study is then discussed, followed by a presentation of the findings and analysis using Kleine's [9] Choice Framework. The paper concludes with implications for research, policy and practice.

## 2 Related Literature

The ICT for development space continues to explore the ways in which ICTs have contributed and can contribute to achieving sustainable development outcomes. A key component of sustainable development relates to energy access, and the availability of electricity in developing countries. The prioritization of electricity and ICTs as basic needs have been part of the development discourse [10, 11]. Studies have explored areas such as the need for stable electricity supply to support ICT for development initiatives, panel data analyses on ICT growth and electricity consumption, and ICTs to support electricity

management systems and reduce theft [12]. It has been highlighted that increasing energy access centres around the physical infrastructure and critical social actors and norms [13]. In addition, measures of energy sufficiency and energy poverty (lack of access to energy services) have included access to ICTs [14, 15]. There are calls for further examination of the nexus between ICTs and electricity access [6, 16, 17], and the related capabilities in this space [18]. It is also noted that there is limited research on the usage of ICTs in low-income communities which may have challenges related to unauthorized connections to the electricity grid.

Sen's [19] Capability Approach provides a platform by which inputs and resources can be examined to identify the resulting capabilities. Kleine [9], in developing the Choice Framework to operationalize Sen's approach, provides an analytical frame which is useful in exploring community-based initiatives which include ICTs. Kleine [9, p.110] calls for further analysis using the framework in individual and collective contexts. The framework includes the following elements: assessing the primary and secondary development outcomes and choices, examining the agency-related resources which influence the choices, including social and cultural resources, material and financial resources, natural and geographical resources, information and educational resources, and psychological and health resources.

A further component discusses the structural-related inputs including the related institutions and organizations, policies, laws and norms, and access, availability and support for the use of ICTs. These in turn influence the dimensions of choice, where existence is identified, and there is awareness, the use and achievement of choice. We have selected this framework to guide the analysis, given the elements it articulates which relate to the assessment of the various choices that stakeholders make in the area of electricity access and the associated usage of ICTs.

## 3 Methodology

The survey approach and methodology have been guided by the objectives of the study, and in discussions with project partners – the utility company, the social investment fund, University of Chicago and the World Bank. The research team utilized quantitative and qualitative research approaches, with the following methods of data collection being adopted. The quantitative approach included a face-to-face survey with a representative sample of households in ten communities; including households within the utility company's project area and outside of the project area, and households that had been recently regularized (formally added as a customer) or are not yet regularized. The qualitative approach involved focus group discussions with community members and key informant interviews with other stakeholders, along with community walkthroughs and observation, and a stakeholder workshop.

### 3.1 Quantitative Survey

The quantitative approach entailed a face-to-face survey with a representative sample of households in ten communities. The utility company had on-going project interventions in seven of the communities, while interventions had just started or were about to begin in the remaining three communities. The sample selection in each community was guided by the number of households within the community, and the number of households within the specified project areas. The questionnaire focused on a number of areas including community life, household demographic information, household energy sources, usage of ICTs, perceptions of electricity access and regularization, social support initiatives. Questionnaires were pre-tested in 2 communities with similar characteristics to the 10 communities participating in the survey.

The questionnaires were administered by interviewers using mainly tablets, and paper-based questionnaires in a few instances. Consent was sought from the respondents. Confidentiality was assured to all respondents by informing them that all data analysis would be presented in an aggregated and anonymous form so that individual responses would not be identified.

The sample design sought to identify a representative sample through a combination of sampling techniques. A census of the recently regularized households in the project areas of seven communities that have been involved with interventions was conducted, as this was a smaller group of households. A systematic sampling approach was taken in the project area, as well as in areas within the intervention communities that were outside the designated project area. Table 1 below provides a summary of the communities and number of respondents for the questionnaire.

**Table 1.** Percentage Distribution of Respondents in the Survey and Number of Focus Groups Held in each Community

| Community | Actual Number of respondents | Percentage of sample | Number of Focus Groups Held |
|---|---|---|---|
| Community 1 | 195 | 9.4 | 1 |
| Community 2 | 153 | 7.3 | 1 |
| Community 3 | 227 | 11.0 | 1 |
| Community 4 | 335 | 16.2 | 2 |
| Community 5 | 134 | 6.5 | 1 |
| Community 6 | 229 | 11.0 | 2 |
| Community 7 | 142 | 6.8 | 1 |
| Community 8 | 205 | 9.8 | 1 |
| Community 9 | 188 | 9.1 | 2 |
| Community 10 | 274 | 13.2 | 2 |
| Total | **2,082** | **100.0** | **14** |

### 3.2 Qualitative Data

Key informant interviews and focus group discussions were also conducted. Stakeholder interviews were held with a number of persons from key organizations: Community Renewal and Customer Relations teams from the utility company, Social agencies, Community representatives and Government representatives.

Focus group discussions were arranged with community members within the ten communities participating in the study. The focus group protocol included key discussion areas related to the ongoing and planned interventions in the communities, and perceptions of energy access, use and support from the utility company. Individual and collective choices and decision-making processes were also discussed in the focus groups and interviews. The findings from the quantitative survey, and current events in the communities related to energy access, also guided areas to be discussed in the focus group sessions. Focus group respondents were invited based on a quota sampling methodology so that key characteristics were represented within the groups. There were 14 focus groups within the 10 communities. Table 1 above shows the number of focus groups held in each community, where each community had at least one focus group session. Two focus group sessions were conducted in four communities to further explore specific characteristics and interventions identified. The focus group sessions were planned for a duration of about 1 hour, with 8 to 12 community members in each focus group. The second focus group in selected communities comprised persons experiencing challenges or barriers to regularization. Emphasis was placed on key demographic characteristics for the second focus group in each community – for example, in Community 9, the second focus group included only women given the profile of households indicating unauthorized connections had female heads. In Community 10, there was an older age profile, and the second focus group invited primarily elderly persons to participate. The composition of focus groups looked at characteristics such as gender, age, specific interventions, and stage in the regularization process.

In the next section, following a profile of the ICT access and usage environment of community members, we discuss the analysis facilitated by the Choice Framework.

## 4 Analysis and Discussion

### 4.1 Survey Profile of ICT Access and Use by Community Residents

Community members who responded to the survey indicated that approximately 96% of households had at least one mobile phone, while 34% reported having access to at least one computer or laptop in the household. Approximately 40% of households reported having access to the Internet, with 32.6% reporting Internet access via a home computer, and 83.3% indicating access via a mobile phone. Households with authorized connections to the grid were more likely to have Internet access, than households with unauthorized or shared connections.

In analysing the responses by type of household electricity connection, it is observed that households with authorized, independent connections are more likely to have one or more desktop computers or laptops than households with shared or unauthorized connections. As seen in Table 2 below, 49% of respondents reporting authorized, independent electricity connections indicated that there were one or more computers/laptops in their households. This relationship was moderately significant ($\chi^2$ = 99.448, p = .000, c.c. = .304).

**Table 2**. Percentage of Respondents with Computers/Laptops in Household by Type of Electricity Connection

| Number of Computers / Laptops in Household | Authorized, Independent Connection | Shared Connection | Unauthorized Connection | Total |
|---|---|---|---|---|
| None | 51.0 | 60.5 | 81.9 | 64.7 |
| One | 39.6 | 34.9 | 16.4 | 29.5 |
| Two or more | 9.4 | 4.7 | 1.7 | 5.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

A similar analysis was explored for responses related to mobile phones, as shown in Table 3. It was also observed that households with authorized connections were more likely to have a higher number of cell phones and chargers than households that had unauthorized or shared electricity connections. This relationship was significant ($\chi^2$ = 66.943, p = .000, c.c. = .206), but weaker than the relationship for computers and laptops.

**Table 3**. Percentage of Respondents with Mobile Phones/Chargers by Type of Electricity Connection

| Number of Mobile Phone Chargers in Household | Authorized, Independent Connection | Shared Connection | Unauthorized Connection | Total |
|---|---|---|---|---|
| None | 2.1 | 3.2 | 4.6 | 3.2 |
| One | 35.6 | 54.1 | 51.3 | 44.1 |
| Two | 28.0 | 26.8 | 24.9 | 26.6 |
| Three or more | 34.3 | 15.9 | 19.2 | 26.1 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

It was interesting to note that while households with authorized connections were likely to have more ICT devices available, households with unauthorized connections were likely to report usage of the devices for a greater number of hours per day.

Approximately 5% of respondents indicated that they receive an e-bill for the electricity service provided, and similarly 5% of respondents reported that they pay their bills online.

Corresponding to the high prevalence of mobile phones, 52% of respondents indicated that they received their bills via text messages.

Households that received bills via text messages were more likely to be aware of the utility company's social interventions and meetings within the community, however no significant difference was found in relation to their views on pre-payment for electricity.

### 4.2 Choice Framework Analysis

Community members had both individual and collective choices to consider in relation to electricity access and their interaction with ICTs in relation to these choices. Based on the data collected through the survey, focus groups, interviews and observation, we assess this case using the components of Kleine's [9] Choice Framework.

**Development Outcomes.** The primary development outcome was the capability of individual community members, and the community as a group to choose between authorized, stable electricity connections, or unauthorized connections with the associated risks. "Having electricity" was seen as a desired functioning. In general, most community members saw the authorized electricity connection as a good option, once it was affordable. Key stakeholders also highlighted the related development outcomes. A summary of the outcomes includes first level: choice, second level: to have electricity, third level: type of electricity access. The second level also included: freedom from fear, sense of empowerment, increased knowledge, easier communication and time savings.

There are several secondary development outcomes that emerge at various levels. For community members who made the choice to regularize and maintain authorized, independent electricity connections, they indicated a sense of empowerment. For example, a focus group participant indicated "*We can take the printed bill to the bank or when making a purchase*", signifying the importance of the document. Others in the focus group agreed. There was also the removal of fear associated with unauthorized connections as they no longer had to be continuously looking out for the utility company's teams or security forces who would visit the communities to remove connections and potentially charge persons for theft. A focus group participant noted that "*we no longer hav to be runnin to tek down light wen police comin*" [We no longer have to run to remove the illegal connections when the police are coming].

Secondary development outcomes also included increased knowledge based on information shared by the stakeholders, through text messages and online social media options such as Facebook and Instagram. Easier communication, based on the choices available to interact with the utility company, was another secondary development outcome. These outcomes also supported savings in time, due to knowledge of communication options, and savings in energy consumption due to the information shared. Communities that maintain regularized connections also benefitted from special social, economic and technical interventions and initiatives to support individuals and the

community, including health, education and employment opportunities, and energy usage assessments.

**Agency.** The Choice Framework utilizes Sen's [20] concept of resources, which are capability inputs that are agency-based. In this section, we explore the type and availability of resources that community members and stakeholders that may support or influence the choices made.

Given the nature and history of electricity access initiatives within low-income urban and peri-urban communities, social and cultural resources play important roles in choices made by community members and other stakeholders. A culture of 'sharing' or 'borrowing' electricity may be prevalent and passed down through generations within the communities, while a cultural shift was also observed by some residents. One focus group participant indicated that "*Is long time we get free light, so we understand it's time for us to pay now*". Social resources included family, friends and neighbours within the community, who would share information to support the decisions on the available options for electricity access. This was noticed also in relation to community members lobbying for support for the elderly, as noted by one focus group participant who indicated "*The elderly really need help with the bills*". Some elderly community members indicated that they received updates via text messages, but others only used mobile phones to make calls, and this depended on whether they had phone credit available, sometimes purchased by family and friends locally and overseas. Further, elderly persons relied on the younger generation to share information circulated by the utility company through social media. This also reflected age-related agency inputs. Gender was also observed as a decision influencer in the choices related to the development outcomes.

While natural resources provide an option in for energy access in the form of solar energy, the material resources of community members did not facilitate the immediate uptake of this option. Material and financial resources also played a role in the choice related to development outcomes. A focus group participant from Community 9 indicated "*A lot of people want to pay but the bills are too high*". Mobile phones were also material resources which could facilitate information and payment activities.

Geographical resources also influenced the choices available and decisions made in relation to electricity access. The proximity of an individual's home to a power line would assist in whether they would be able to afford the process of regularization. Community members who have to pay to run lines to their homes may opt to acquire the connection and service through unauthorized means. Geographical resources also were key in supporting information sharing and communication. Physical proximity to a community centre with Internet access and a representative from the utility company was seen as useful, which also reflected the usage of time as a resource. Similarly, being close to a Wi-Fi hotspot within the community, would facilitate the use of social media and updates from the utility company.

Psychological resources were observed in responses from participants in the study, with one focus group participant from Community 7 indicating that "*we can show our bill when we go to get loans, we feel a part of society now*". This reflected the development

outcomes of empowerment, social and cultural capital. The psychological influence in choice of approach was also observed in the preference for printed bills, in comparison to the electronic options of text messages and e-bills. While the advantages of the paperless choices are highlighted, a focus group participant from Community 9 noted that "*We want paper bills just like the 'uptown' customers get delivered to their house*".

**Structure.** The institutions and organizations which are involved in the efforts to facilitate affordable and safe electricity access, can provide some of the inputs to enable individual and collective choices. The utility company's partnership with the national social investment agency provided the opportunity for the development of a Community Renewal Programme to assist with development projects, including ICT for development initiatives in participating communities. Policies and programmes sought to regularize authorized electricity connections, however there were instances where informal laws within communities were not supportive.

Access to ICTs in the areas of availability, affordability and necessary skills were important components. Mobile phones are the most readily available ICT devices. The affordability of the different types of devices to support enhanced communication, knowledge sharing, bill payment and financial inclusion are areas that need to be considered. Similarly, additional training and demos may be needed to develop the skills required to utilize the devices to support the development initiatives. These elements reflect some of the inter-relationships between agency and structure.

**Dimensions of Choice.** Given the structure and resource-based agency, community members and the communities were able to identify the possible choices, and drawing on supporting resources use the available choices to make a decision. Based on the choices made, these would lead to particular development outcomes.

In the next section, we discuss implications of the findings of this study.

## 5 Conclusion

Based on the discussion and analysis related to the usage of ICTs in communities exploring improved electricity access, and the role of ICTs in influencing and supporting this access, we discuss implications for research, policy and practice. If increased usage of ICTs can support the process of accessing and maintaining affordable, safe electricity supply, and if the presence of such a supply increases the use of ICTs, then investments in facilitating choices which lead to these development outcomes would be useful.

Further research would be useful in exploring the adjustments and transitions in ICT usage as access to affordable and safe electricity increases. The analysis of the case using the Choice Framework also contributes to the literature in this area. Practitioners may also be guided by the development outcomes, agency, structure and dimensions of choice involved in community members and other stakeholders making decisions in relation to energy and electricity access and SDG 7. Some implications for policy are also discussed.

Analysis of the data highlights several broad societal and community issues. Participants in the focus groups, the key informant interviews, and stakeholder workshop were asked to discuss their policy recommendations. In conjunction with the policy recommendations of the research team, the suggestions of other stakeholders are synthesised and discussed in this section. The policy recommendations are related to the development outcomes, desired functioning and related choices and resources.

**Macro.** At the macro level, poverty issues and access to energy are linked to the country's own economic situation. There is the expectation that governments in developing countries should provide a package of minimum basic social services. For example, residents in Community 8 wanted increased access to land titles, birth certificates, taxpayer registration numbers, water, electricity, community centre/Internet access point and early childhood education facility, as part of a holistic intervention. Respondents from Community 10 also lamented the lack of street lights in the community; while recognizing that this is not directly the utility company's responsibility, they felt an integrated approach would provide better results.

Community renewal and empowerment were recurring issues throughout the study communities suggested that the utility company implement or continue to implement social interventions that aim to reduce unemployment among the youth; educate and feed community members and also provide access to social goods. Communities where these interventions were underway expressed high levels of satisfaction with the interventions. Implementation of these mechanisms requires partnerships among key stakeholders: Government, private sectors, development partners, NGOs, CBOs and the residents themselves.

**Meso (Institutional).** Two main types of communities were identified for this study: - high need and high loss. The former includes those in areas where improved access to energy would necessitate major infrastructural adjustments. Respondents were of the view that a combination of interventions (social/good and enforcement) is needed to improve access to energy. These include community-based social interventions along with affordable payment plans, reliable service, better communication with representatives of the utility company and more stringent measures such as the removal of the illegal connections and take legal actions.

Community empowerment has been effective, as evident in Community 4 and Community 7 where there was great communication, via ICTs and face-to-face, along with community spirit. Having an active Representative on the ground and allowing that representative more ability to resolve some the more routine problems, was also recommended by increasing autonomy with facilitating resources such as internet access.

There was a general consensus that prepaid metering was the best payment option for electricity but there was a general yearning for their own meters or ability to read their own units (without the perceived additional expense of plugging in the Customer Display Units (CDUs)) to be like "up-town folks." More payment locations, closer to the

community would also increase timely payment. Respondents also suggested special rates for the elderly; those on conditional cash transfer programmes; persons with disabilities and the chronically ill. It was felt that ICTs could also facilitate ease of payments and sharing of information for these vulnerable groups.

In general, residents sought more interactions, and across communities, residents wanted more information on the pre-paid system. Information on estimated usage and the amount for first payment would be useful prior to sign up.

There were high levels of conservation resultant from the utility company's own educational campaign strategies via electronic and face-to-face interactions. Public education on the conservation of electricity should continue and be more targeted towards those communities which are still unaware of the conservation messages. Respondents expressed that their preferred methods of communication included text messages on phones, television and radio broadcasts.

**Micro.** Residents expressed a willingness to pay regularly once the service was affordable and reliable and the customer service was "respectful." As evident in Community 7, consumers and the utility company can enjoy a mutually beneficial relationship when the interaction between provider and client is one of mutual respect.

When the process of increasing access to energy is participatory and consultative, including the facilitation of the use of ICTs, the community members become guardians of the service and will even be agreeable to the disconnection of service for those community members who violate the parameters of an established good relationship and continue to steal electricity.

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