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Exploring the link between vulnerability of energy systems and social acceptance of renewable energy in two selected districts of Uganda

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Abstract

Purpose – This paper aims to show preliminary evidence of the link between the perceived low vulnerability of vital energy systems (LVRE) and social acceptance of renewable energy (SARE) while treating environmental opportunities and threats (EOPT), renewable energy technological innovations (TECH) and business model innovations as possible antecedents.

Design/methodology/approach – The objectives are delivered through a survey of 199 households (potential and actual customers/suppliers of electric power and renewable energy gadgets in Kampala and Wakiso districts of Uganda), and the data obtained were analysed using ordinary least squares (OLS) regression.

Findings – Both LVRE and EOPT, on their own, significantly predict SARE. TECH significantly mediate in the relation between EOPT and SARE. The highest form of SARE is market acceptance. Also, the current state of vulnerability of vital energy systems in the two Ugandan districts seems to espouse energy security as the real value of renewable energy. The study further finds that to deliver high SARE, there is a need to encompass potential user performance expectations of renewable energy technologies.

Research implications/limitation – Because the current results are from only two cities (districts) of Uganda and also based on a non-probability sample, generalizing them can be considered remote. In other words, it appears that more complex models need developing and testing in the future concerning LVRE and SARE. The present preliminary results are offered as a stimulus to such efforts. Well, it is expected, and, consistent with the diffusion of innovations theory (Rogers, 1995), that the population in Kampala and Wakiso districts are potential change agents (i.e. capable of influencing others in rural areas of Uganda).

Originality/value – The study estimates the direct and indirect effects to show how strongly TECH operate. Basing on OLS regression coefficients, the indirect effects are larger. Using the medgraph, we find

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probably for the first time, the adoption of technological innovation explains a significant part of the link between EOPT and SARE in the current study setting.

Keywords Social acceptance, Renewable energy, Mediation, Vulnerability of energy systems

Paper type Research paper

1. Introduction and motivation

The current level of social acceptance of renewable energy (SARE) does not assure us of affordable and clean energy consistent with the UN Sustainable Development Goal 7. Yet, the need and usefulness of renewable energy (technologies) is well documented (Thiam, 2012; Longo *et al.*, 2008; Economou, 2010; Zografakis *et al.*, 2010), and the ills of renewable energy (technologies; Zoellner *et al.*, 2008; Zografakis *et al.*, 2010; Stigka *et al.*, 2014, for a review). The advantages and disadvantages elevate the issue of SARE which is largely predicted to hinder the achievement of renewable energy targets (Wüstenhagen *et al.*, 2007).

The purpose of this paper is to show that to increase the SARE (until recently, a neglected issue), there must be a perceived low vulnerability of vital energy systems (LVRE), the antecedents of which are (we claim) business model innovations (BMI), environmental opportunities and threats (EOPT) and renewable energy technological innovations (TECH). Although early scholars on SARE such as Carlman (1982) found that social acceptance issues were perceived as residual questions habitually taken as "non-technical", already such studies showed that neither public support nor support of crucial stakeholders at varying scale levels could be taken for granted (Wüstenhagen *et al.*, 2007). According to Wüstenhagen *et al.* (2007), many of the ills vitiating successful renewable energy projects at the implementation level can be considered as a manifestation of lack of social acceptance: socio-political, community and market acceptance. These authors pioneered the concept of SARE innovation especially by introducing its three dimensions: socio-political, community and market acceptance. The study aimed to contribute to this stream of literature by going further to explore the factors that could enhance the SARE. For example, beliefs, principles and behaviours that a person maintains on issues related to the environment formulate their mental attitude (Schultz *et al.*, 2004). Defining environmental attitudes in a precise fashion is not easy, and thus it is quite difficult to use them to predict environmentally friendly (often referred to as ecological) behaviour (Bamberg, 2003).

Stigka *et al.* (2014) review several literature that indicates that inputs to the planning and decision-making process include expert opinions as well as public feelings and perceptions and suggests that rational individual behaviour and the common good may conflict and prevent the efficient public resources' usage. The authors also observe that this was legendarily pointed out by Hardin (1968) in his influential work, Tragedy of the Commons, and also revealed in the prisoner's dilemma, a game-theoretic model where the equilibrium solution (which is central for individual players) is different from the cooperative solution (which is best for society). Stigka *et al.* (2014) argued thus: "Still, if feelings and perceptions (i.e. attitudes) did (*do*) not determine behaviour, this would not matter [. . .] is behavior connected to attitude?" (p.103), emphasis not in the original. Attitude relates to an evaluative decision on a particular concept or entity by a person (Eagly and Chaiken, 1993).

The theories of reasoned action (TRA; Ajzen and Fishbein, 1980) and planned behaviour (TPB; Ajzen, 1985) suggest strong correlation between environmental attitude and ecological behaviour intention. Research studies link environmental values and ecological behaviour, through mediation of a third variable and according to TPB, this is ecological behaviour intention (Dunlap and Van Liere, 1978). Identifying attitudes of electricity (renewable energy) consumers, as their attitudes establish their resulting behaviour, is crucial (Ek, 2005). Three parameters appear to accentuate public behaviour:

(1) information possessed by the public;
(2) the public's perceptions and positions; and
(3) fear, i.e. danger or anxiety that intensifies with ignorance (Nomura and Akai, 2004; Assefa and Frostell, 2007; Zoellner *et al.*, 2008).

As to whether these are responsible for the low (uptake) or SARE in some settings is an empirical question.

We also know that the role of complex value has been investigated in BMI in electricity supply markets specifically in the UK (Hall and Roelich, 2016). The business model (innovation for sustainable energy) concept has also been studied in German utilities and renewable energy (Richter, 2013). In both of these studies, it is highlighted that business models shape energy transitions and are crucial to master energy transitions. Regarding the SARE, nascent economic settings need to adapt to renewable energy technologies, but the most appropriate models remain largely unknown. Considerable discussion of technology transfer together with the adoption of renewable energy innovations overlooks the crucial role of social acceptance (Mallett, 2007). However technology acceptance model (TAM) provides a basis for unveiling the impacts of external variables on adoption decisions, with its basic postulates resting firmly on economic, utilitarian and attitudinal grounds (Awa *et al.*, 2015). Following from this, perceived usefulness (PU) and perceived ease of use (PEOU) may be fundamental determinants of renewable energy adoption (akin to social acceptance). However, TAM is not without critics (Awa *et al.*, 2015). Thus the strengths of Rogers (1995) diffusion of innovation and Ajzen's (1991) TPB had to be explored to enrich TAM by adding usage and placing a premium on the study setting and external variables that influence a social acceptance or adoption process. The role of complex value, therefore, was mirrored through the business model concept since, as Awa (2015) has indicated, TAM and TPB are routed to the TRA as to incorporate the influences of psychological, social and interpersonal variables on renewable energy adoption.

Partly, the hype for renewable energy is its potential in ensuring energy security. Energy security is therefore a positive element in the SARE. According to Cherp and Jewell (2014), the influential approach – the "4As" of energy security tetrahedron (availability, accessibility, affordability and acceptability) does not address three questions of security for whom, security for which values and security from what threats? These authors proposed an alternative framework; LVRE – vulnerability being a combination of exposure to risks and resilience capacities. Going ahead, this paper advances this thinking by examining whether vulnerability explains any significant variances in the SARE (Figure 1).

The reported results are significant for a number of reasons. First, probably for the first time, the study examined Cherp and Jewell's (2014) proposed concept "LVRE" that they proposed to replace a set of polysemic/tautological terms (the 4As of energy security –availability, accessibility, affordability and acceptability) representing an influential scheme of classifying energy concerns and subjected it to a preliminary empirical analysis. So this research potentially contributes to this stream of literature by generating empirical evidence on the efficacy of the concept, perhaps, for the first time. Second, the study addresses the concept of complex value by incorporating a range of theories and hence answering the question of value to whom? Third, this study addresses two questions regarding the SARE:

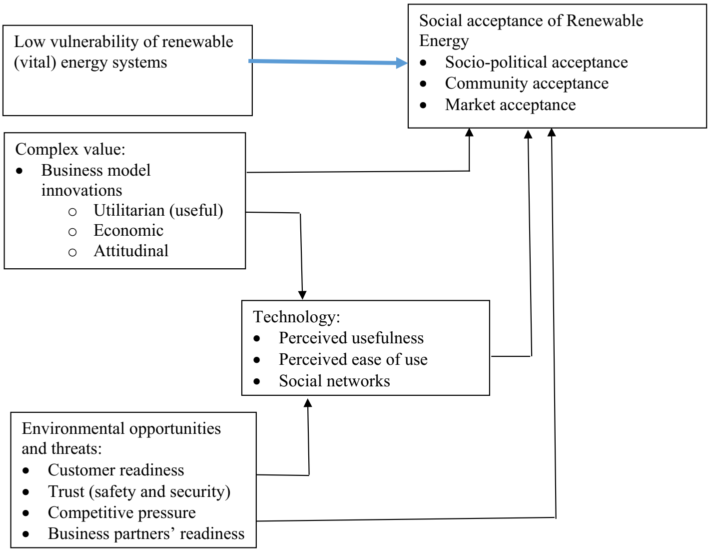


Figure 1.
The conceptual framework (developed from the review of the literature

- What are the socio-technical barriers to renewable energy technologies' adoption? and
- How much influence does LVRE have on the social acceptance decision?

Epitomizing the general question: Does perceived LVRE potentially improve the SARE? Using a survey administered to actual and potential customers of renewable energy and suppliers (and/or producers/investors/innovators) of electric power and renewable energy gadgets, the study categorizes perceptions and preferences to identify the barriers to widespread SARE in the two Ugandan cities. The task of comparing the attitudes and perceptions of our sample with the general population is left to future research.

The remainder of this paper is a follows. Section 2 is literature review, and in this the explication of the concepts of SARE and LVRE is done so too are hypotheses developed. The third section is the methodology adopted for this study to deliver the objectives. The fourth section is a presentation of the results. The penultimate section is the discussion and last section is conclusions.

2. Literature review

2.1 The concept of social acceptance

The study by Mallet (2007) adopted the definition of social acceptance offered by Rogers (2005): "something more active – namely use, or adoption of a technology versus just the "passive" approval of a technology, or intention to use it" (Mallet, 2007, p. 2791). The authors also noted other definitions of the concept, but Wüstenhagen *et al.* (2007) contribute to our understanding of the concept of social acceptance by distinguishing three dimensions of social acceptance, namely, socio-political acceptance, community acceptance and market acceptance. Subsequently, Hosseini *et al.* (2018) report the results of social acceptance level in Iran using the social acceptance pyramid. According to Hosseini *et al.* (2018) socio-political acceptance is the most general dimension of social acceptance that includes how actors (people and organizations) make decisions, resolve conflicts, form partnership, respond to governmental policies and accompany with social problem. Several indicators show that policies and renewable technologies in lots of countries have high social acceptance. The sub-indicators here include public acceptance, key stakeholder acceptance and policy makers' acceptance.

According to Hosseini *et al.* (2018), community acceptance means acceptance of decisions related to locating and establishing of power plants and renewable energy projects by public stakeholder's especially local residents. This is where a phenomenon called NIMBY (not in my backyard) is shown. The sub-indicators here include procedural justice, distributional justice and trust. The authors suggest that market acceptance is a kind of acceptance that refers to accepting a new technology in market or processes by which actors accept and support a new innovation.

2.2 The concept of vulnerability of vital energy systems

The vulnerability of modern energy systems is a function of their complex characteristics. Well, modern energy systems and modern economies need a constant energy supply (the need for constant security of supply) as world energy demand steadily increases in the future (Supersberger, 2006). To ensure low vulnerability of energy systems, Supersberger (2006) suggests:

- reduction of relative (and absolute) import dependence to an "acceptable" level through development of domestic energy sources;
- decentralization of the energy systems, especially the generation of electricity;
- reduction of absolute energy demand by introduction of strong energy efficiency measures; and
- development of a new understanding of international cooperation in the field of energy supply.

Cherp and Jewell (2014) suggest that energy security is an instance of security in general and any concept of it should address three questions: "Security for whom?", "Security for which values?" and "Security from what threats? This approach of "LVRE" by Cherp and Jewell (2014) opens the way for detailed exploration of vulnerabilities as a combination of exposure to risks and resilience and of the links between vital energy systems and critical social functions. As such the questions of energy security for users and providers of renewable energy, security for their values and security from their threats need to be answered. As argued earlier we reason in this paper that EOPT, BMI and TECH provide relevant antecedents of LVRE and SARE, the exact mechanism by which this is possible is explored herein.

2.3 Technology and social acceptance of renewable energy

Because of the advantages of renewable energy technologies, it can be expected that their perceived adoption is positively correlated with their social acceptability. PU defines a prospective user's subjective probability that using a specific application improves operations (Lu *et al.*, 2003). Relatedly, technology such as that relating to renewable energy that is perceived easier to use can be adopted very quickly by consumers (Featherman and Pavlou, 2003). Some technology consumers believe that technology ease of use helps to integrate the technology into their lives (Taylor and Todd, 1995). The physical and emotional effort to use technology can be part of the reasons why a consumer may socially accept renewable energy. In terms of diffusion of innovation theory (Rogers, 1995), technology innovations are frequently talked about among a consumer's social network such as friends and family and these could include those early adopters of the technological innovation (Ratten, 2015) or those who are first to hear about it. Considering that Kampala and Wakiso districts of Uganda are highly affluent and technologically savvy relative to others in this setting, the following hypothesis was stated:

H1. Appropriate renewable energy technologies (in terms of perceived usefulness, ease of use and beneficial social networks) is positively associated with SARE.

2.4 Perceived environmental opportunities and threats and social acceptance of renewable energy

Awa *et al.* (2015) offer the following propositions in their paper on integrating TAM, TPB and technology–organization–environment (TOE) frameworks and expanding their characteristic constructs for e-commerce adoption by small and medium enterprises (SMEs):

- The extent of consumer readiness/exposures to e-commerce determines SMEs' speed of adoption.
- Perceived trust in terms of safety and security of transactions will affect the adoption of e-commerce by SMEs.
- Customers attempt to leave the websites when they fear that their transaction details could be intercepted or accessed without authorization.
- Competitive pressures from rivals positively affect the likelihood of adopting e-commerce by SMEs.
- Trading partners' (dealers, consumers and suppliers) readiness to use E-Commerce facilities will significantly impact on SMEs' intention to adopt it.

Using the same suppositions suggests that when individuals are ready or exposed to renewable energy (technologies), the resulting exposure can increase their proclivity to their SARE. Similarly, when individuals perceive that renewable energy technologies can be trusted in terms of their safety and security, this can enhance their proclivity to SARE. At the same time, at a supplier's or innovator's level, competitive pressure can positively influence the SARE (market acceptance). Yet, similar to customers, suppliers and/or dealers' perceived readiness may positively relate to SARE:

H2. Environmental opportunities and threats (in terms of perceived customer readiness, trust, completive pressure and business partner readiness) are positively associated with SARE.

2.5 Business model innovations and social acceptance of renewable energy

A business model describes the benefits an enterprise will deliver to customers, how it will do so and how it will capture a portion of the value it delivers (Teece, 2010; Chesbrough and Rosenbloom, 2002). Therefore business models offering complex value should be related to SARE. According to Osterwalder (2004) and Osterwalder and Pigneur (2009), the business model is conceptualized along the four pillars: value proposition (the bundle of products and services that creates value for the customer and allows the company to earn revenues); customer interface (comprising the overall interaction with the customer and consisted of customer relationship, customer segments and distribution channels); infrastructure (describes the architecture of the company's value creation and includes assets, know-how and partnerships); revenue model (represents the relationship between costs to produce the value proposition and the revenues that are generated by offering the value proposition to the customers). We argue that these value systems in aggregate can increase the perception of the technologies used to support them for example in terms of perceived usefulness which in turn improves the SARE. Accordingly, the following hypotheses were stated:

H3. BMI are positively associated with SARE.

H4. BMI are positively related to TECH.

H5. TECH mediate the relationship between BMI and SARE.

H6. TECH mediate the relationship between EOPT and SARE.

2.6 Low vulnerability of renewable energy systems and social acceptance of renewable energy. The overarching argument of this study was that to increase the SARE, there must be an increased perception of the low vulnerability of renewable energy systems. As the approach of "LVRE" by Cherp and Jewell (2014) opens the road for detailed exploration of vulnerabilities as a combination of exposure to risks and resilience and the links between vital energy systems and critical social functions, this paper seeks to answer more specifically the questions of energy security for users and providers of renewable energy, security for their values and security from their threats. According to Supersberger (2006; 2007), the strategic relevance of renewable energy has gone largely unnoticed due to an underestimation of their potential to contribute to national energy supply and the belief that renewable energies are much more expensive than fossil fuels. However, there is growing evidence showing that the potential for renewable energies in combination with energy efficiency measures is large enough to reduce carbon dioxide to globally acceptable levels. We argue that this could be accomplished with BMI that capture the complex value of renewable energies. For example, the belief that renewable energies are much more expensive than fossil fuels could be countered a business model that revises the cost regime of different energy types: external costs have to be factored into energy prices. That would mean that costs arising from energy use – which are not part of nominal energy prices – are included in energy cost calculations. External costs arising from energy use include expenses for repairing environmental damages (local and global), for curing negative health effects, but also for increased security efforts throughout the whole supply chain. Supersberger (2006; 2007) believes that internalizing these costs would lead to a price increase – reflecting "real" energy costs and that under such changing price conditions, the market will need to re-examine the available energy options by recalculating cost effectiveness. Factoring in external costs, e. g., for electricity, can shift the cost balance in favour of renewable energies and therefore improving the prospect of their social acceptance. Moreover, the proper harnessing of EOPT potentially indicates an LVRE.

Given the importance of renewable energy, the world is better assured of constant supply. We believe that the requirement for constant supply is a major cause of vulnerability. Addressing the underlying indicators (antecedents) of the LVRE such as appropriate BMI can be predicted to cure renewable energy vulnerability, and we would argue that perceived LVRE should trigger their social acceptance. Accordingly, the following hypothesis was stated:

H7. The perceived LVRE is positively related to SARE.

The conceptual framework in Figure 1 epitomized the research suite.

3. Research methodology

3.1 Design, population and sample

The research design for this study is cross-sectional and correlational. The study setting is Kampala and Wakiso Cities. The population of interest is actual and potential customers (households of renewable energy and suppliers [and/or producers/investors/innovators]) of electric power and renewable energy gadgets. This approach is consistent with that of Egbue and Long (2012) who analysed consumer attitudes and perceptions regarding barriers to widespread adoption of electric vehicles and targeted a population comprised mainly of current owners of conventional vehicles with the intention of capturing opinions, perceptions and attitudes of individuals who are prospective owners of conventional vehicles. Following this precedent, this study covered households in greater Kampala and its surrounding district of Wakiso. This approach based itself on a convenient snowball sampling approach in addition to time and cost savings (Ratten, 2015). Kampala and Wakiso were chosen as the cross-cultural comparison of how an actual or potential customer for renewable energy perceives renewable energy (technologies). Kampala is the central business district and capital of Uganda but also the most polluted and compared to Wakiso, it is less populated. Wakiso, while not the capital of Uganda, is home to most people who work in Kampala city; it is the most populous district. Much of the electricity for home consumption is distributed in Wakiso while the dealers (suppliers/innovators, etc.) were expected to operate within the business district. Table 1 indicates respondent characteristics.

The choice Kampala and Wakiso districts was also dictated by knowledge requirements. In terms of knowledge considerations, we considered the vast majority of the sample population as renewable energy technology enthusiasts. Renewable energy technology enthusiasts are individuals that are better connected with global technology development, have high level of quantitative skills and are more equipped to sort out the many technological, financial and environmental differences between renewable energy sources and conventional non-renewable energy sources. For this study, we considered these individuals to likely early-accept renewable energy (technologies/systems) only if they perceived them to possess more value compared to non-renewable energy sources. Moreover, Kampala and Wakiso households of renewable energy and suppliers (and/or producers/investors/innovators) are, as Bunders *et al.* (1999) suggest for crucial players, active players who define and decide on appropriate technology for their circumstances. We also chose the two cities because International Renewable Energy Agency (2016) has indicated that cities will drive the transformation of the global energy system in the 21st century, that cities already account for nearly two-thirds of global energy use and an even larger share of energy-related carbon-dioxide emissions, and that as the urban population grows to a projected two-thirds of the world's total by 2030, that demand is reaching staggering proportions. Insofar as increasing the share of renewable energy sources is essential to the long-term sustainability and wellbeing of cities, it is critical to establish the current state of social of SARE the two Ugandan cities. As such while a more rural area in Uganda could have also been considered in the sample, such an area potentially suffers devoid of these crucial characteristics.

In deriving the sample, our study population was considered either infinite or so large that for practical purposes, as Anderson *et al.* (2007) have recommended, it was treated as infinite. In literature, several propositions exist that provide a guide on determining a sample. The Economist (1997) recommends a minimum of 30 in every category (in our case 58 and 141 responses were obtained from Wakiso and Kampala, respectively) within the overall sample as a rule of thumb. Sekaran (2000) suggests a rule of thumb of between 30

		F	(%)	Valid (%)	Cum. (%)
How many people live in your current home?					
Valid	1	22	11.1	11.1	11.1
	2	13	6.5	6.5	17.6
	3	22	11.1	11.1	28.6
	4	27	13.6	13.6	42.2
	5	36	18.1	18.1	60.3
	More than 5	79	39.7	39.7	100.0
Do you own your current home?					
Valid	No	101	50.8	50.8	50.8
	yes	98	49.2	49.2	100.0
What is your age?					
Valid	Adult	83	41.7	41.7	41.7
	Youth	116	58.3	58.3	100.0
What is your gender?					
Valid	Female	93	46.7	46.7	46.7
	Male	106	53.3	53.3	100.0
What is your yearly income?					
Valid	Lower than Ugx.25,000,000	130	65.3	65.3	65.3
	Ugx.25,001,000-Ugx.50,000,000	47	23.6	23.6	88.9
	More than Ugx.50,000,000	22	11.1	11.1	100.0
Do you supply any energy gadget?					
Valid	No	131	65.8	65.8	65.8
	Yes	68	34.2	34.2	100.0
You live in					
Valid	Wakiso	58	29.1	29.1	29.1
	Kampala	141	70.9	70.9	100.0
	Total	199	100.0	100.0	

Source: Primary data

Table 1. Respondent characteristics

and 500 samples (our valid responses are 199). Field (2009) in reference to sample size in regression analysis indicates the most common rules of thumb being 10 or 15 cases per predictor in the model. Given our predictor variables, the 199 valid responses satisfy this requirement.

More than half (about 58 per cent) of the respondents had five or more people living in their homes and about 51 per cent of the respondents being non-home owners. The youth constituted about 58 per cent of the respondents and about 53 per cent of the respondents were males. In terms of annual income, the majority respondents (about 65 per cent) earned below Ugx.25,000,000 and 11 per cent were earning about Ugx.50,000,000 annually. About 34 per cent said they supply some energy gadgets while the rest do not. In terms of where the respondents live, about 71 per cent live in Kampala and the rest live in Wakiso.

3.2 Questionnaire and measurements

Data on dependent and independent variables were collected from respondents using a questionnaire with close-ended questions. The observed variables for LVRE, SARE, EOPT, TECH and BMI were anchored on a six-point Likert scale ranging from strongly disagree (1) to strongly agree (6), allowing the respondent to register the degree of agreement. As regards the measurement of variables, the questionnaire depicts the measurement items largely drawing from the works of (Tong, 2010; Cherp and Jewell, 2014; Midttun, 2012; Awa, 2015; Strupeit and Palm, 2016; Chen and Chang, 2013; Table A6). The latent variables and the manifest variables are in appendix (Tables A1, A2, A4 and A5) together with tests of factorability. For the explanandum (see appended Table A3), we operationally defined its constructs consistent with Hosseini *et al.* (2018).

3.3 Reliability and parametric tests

We used Cronbach's α (Table 2) and exploratory factor analysis (EFA) based on principal components (see Tables A1, A2, A3, A4 and A5) to examine the validity and reliability of the scales as measures of SARE, LVRE, BMI, EOPT and TECH. EFA was also performed to identify patterns in data and to reduce data to a manageable level (Field, 2009). To establish convergent validity, the principal components for each variable are extracted by running principal component analysis using varimax rotation method, and factor loadings below 0.5 coefficients were suppressed to avoid extracting factors with weak loadings. Prior to performing the principal component analysis for scales, we assessed the suitability of the data for factor analysis based on sample size adequacy, the Kaiser–Meyer–Olkin (KMO) and Bartlett tests. The results show the KMO values: TECH = 0.875, BMI = 0.894, SARE = 0.838, LVRE = 0.807 and EOPT = 0.870. Bartlett's test of sphericity in all scales reached statistical significance ($p < 0.05$) (significant value was 0.00 for each scale). Collectively, these results supported the factorability of the correlation matrices (correlation matrices are significantly different from the identity matrices in which the variables would not correlate with each other). The determinants for all the three matrices were greater than 0.01, implying that there were no multicollinearity or singularity between variables. Similarly, the Cronbach's α coefficients in Table 2 suggest that the measures are considerably reliable. Prior to carrying out tests of hypotheses, even with non-probability sample, we checked the data for normality to determine the applicability of parametric tests. This was done by use of skewness and kurtosis statistics. The skewness scores for all variables were close to 0, and kurtosis results were all within the range of −2 and +2 (Tables 3 and 4). Therefore normality was tenable.

Variable	Cronbach α coefficient
Perceived usefulness	0.871
Perceived ease of use	0.750
Social networks	0.574
General business model indicators	0.644
Attitudinal	0.866
Economic	0.833
Utilitarian	0.811
Customer readiness	0.870
Perceived trust	0.781
Competitive pressure	0.735
Trading partner readiness	0.613
Social-political acceptance	0.697
Community acceptance	0.713
Market acceptance	0.725
The vulnerability of renewable energy systems	0.812
Customer side business model	0.729

Source: Primary data

Table 2.
Reliability statistics

The study used ordinary least squares (OLS) regression in investigating the main effect of the LVRE on SARE. The preference for OLS is dictated by the nature of the outcome variable. Namely, given that the dependent variable is not a binary indicator, i.e. not taking on values of 0 and 1, applying the OLS estimator would not produce biased estimates. Therefore, we did not need to use a discrete choice model, either probit or logit (logistic). To examine the association between the LVRE and SARE, we tentatively specified the following main regression model:

$$\text{SARE} = \beta_0 + \beta_1 \text{LVRE} + \varepsilon \text{j}$$

where:

SARE = is social acceptance of renewable energy;
β_0 = is the intercept;
β_1 = is the gradient;
LVRE = is the low vulnerability of renewable energies; and
εj = is the error term.

From this, we specified the expanded model as follows:

$$\text{SARE} = \beta_0 + \beta_1 \text{BMI} + \beta_2 \text{EOPT} + \beta_3 \text{TECH} + \varepsilon \text{j}$$

where:

BMI = is the appropriateness of business model innovations;
EOPT = is the appropriate harnessing of environmental opportunities and threats; and
TECH = is the appropriate technology perceived as useful, easy to use, and secondable.

4. Empirical findings

4.1 Descriptive statistics

We first begin by describing the data used in the analysis. Table 3 and Table 4 show the descriptive statistics. Table 5 shows some cross-tabulations.

According to Table 3 and Table 4, the small standard deviations relative to the mean suggests that data points are close to means and hence the calculated means highly represent observed data. Skewness and kurtosis statistics which assess normality among single variables are tenable. According to Table 3 of the five purposes of renewable technologies, making life at home more convenient ranked highest with a mean of 4.88 on a scale of 1-6 [strongly disagree (1) – strongly agree (6)] and is followed by “managing energy use” with a mean of 4.11 – meaning that “making life at home more convenient” ranked highest among perceived drivers of SARE.

Table 4 shows on a scale of 1-4 [Does not exist (1) – Exists and is highly used (4)], large hydro-grid connected, Pv (solar electric) – stand-alone and small hydro ranked highest with means of 3.29, 3.26 and 3.12, respectively. This means that “large hydro-grid connected” used for residential and industrial electricity, supplementing the mains supply is known to exist in Uganda and highly adapted for use. Overall these results suggest that Ugandans are mostly aware and use hydro-electric power and solar power for their energy needs.

The cross-tabulations in Table 5, where the respondent resided, their gender, age or income and whether these had any bearing on proclivity to supplying any energy gadget (a proxy for being knowledgeable in usage of renewable energy technologies and gadgets). Of interest in Table 5, 130 (about 65 per cent) respondents said they earned less than Ugx.25m and 90 (69 per cent) of them do not supply energy gadgets. A total of 22 respondents said they earned above Ugx.50m and of these 11 (50 per cent) supply renewable energy gadgets. This result suggests

Table 3.
Descriptive statistics

Variables	*N*	Min.	Max.	*Mean*	SD	Skewness Statistic	Skewness Std. error	Kurtosis Statistic	Kurtosis Std. error
SARE	199	1.00	5.83	4.04	0.78	−0.56	0.172	0.48	0.343
Socio-political acceptance	199	1.00	6.00	3.97	0.80	−0.55	0.172	0.69	0.343
Community acceptance	199	1.00	6.00	4.02	1.01	−0.65	0.172	0.14	0.343
Market acceptance	199	1.00	6.00	4.13	0.97	−0.41	0.172	0.01	0.343
TECH	199	1.17	6.00	4.38	0.86	−1.02	0.172	1.37	0.343
Perceived usefulness	199	1.00	6.00	4.77	1.09	−1.23	0.172	1.40	0.343
Perceived ease of use	199	1.50	6.00	4.42	0.96	−0.63	0.172	0.20	0.343
Social networks	199	1.00	6.00	3.95	1.02	−0.38	0.172	−0.25	0.343
EOPT	199	1.00	6.00	4.21	0.80	−0.96	0.172	1.41	0.343
Customer readiness	199	1.00	6.00	4.22	1.00	−0.52	0.172	−0.05	0.343
Trust	199	1.00	6.00	4.11	1.04	−0.38	0.172	−0.13	0.343
Competitive pressure	199	1.00	6.00	4.30	1.03	−0.63	0.172	0.14	0.343
Business partner readiness	199	1.00	6.00	4.23	1.02	−0.81	0.172	0.26	0.343
BMI	199	1.00	6.00	4.50	0.95	−1.18	0.172	1.42	0.343
Attitudinal	199	1.00	6.00	4.67	1.06	−1.22	0.172	1.59	0.343
Economic	199	1.00	6.00	4.55	1.00	−1.08	0.172	1.42	0.343
Utilitarian	199	1.00	6.00	4.27	1.10	−0.69	0.172	0.07	0.343
CSBM	199	1.00	6.00	4.10	0.80	−0.50	0.172	0.70	0.343
LVRE	199	1.00	5.94	4.11	0.71	−0.58	0.172	2.00	0.343
Purpose of renewable energy technologies									
Making life at home more convenient	199			4.88	1.47	−1.50	0.172	1.31	0.343
Managing energy use	199			4.11	1.65	−0.71	0.172	−0.73	0.343
Controlling appliances	199			3.65	1.60	−0.21	0.172	−1.26	0.343
Controlling heating systems	199			3.38	1.52	−0.07	0.172	−1.13	0.343
Detecting faulty appliances	199			2.91	1.60	0.25	0.172	−1.25	0.343
Valid *N* (listwise)	199								

Source: Primary data

Table 4. Descriptive statistics – renewable energy area of technology

Renewable energy area of technology	N	Min.	Max.	Mean	Std. error	SD	Skewness		Kurtosis	
						Statistic	Statistic	Std. error	Statistic	Std. error
Large hydro-grid connected	199	1.00	4.00	3.29	0.07	0.98	−1.19	0.17	0.21	0.34
PV (solar electric) – stand-alone	199	1.00	4.00	3.26	0.06	0.89	−1.14	0.17	0.60	0.34
Small hydro	199	1.00	4.00	3.12	0.07	0.95	−0.81	0.17	−0.34	0.34
Solar thermal – water heaters	199	1.00	4.00	2.98	0.06	0.90	−0.76	0.17	−0.02	0.34
PV (solar electric) – grid-connected	199	1.00	4.00	2.97	0.08	1.10	−0.73	0.17	−0.80	0.34
Solar PV pumps	199	1.00	4.00	2.88	0.07	0.98	−0.67	0.17	−0.47	0.34
Solar thermal – cookers	199	1.00	4.00	2.80	0.06	0.90	−0.48	0.17	−0.44	0.34
Solar thermal power plant – grid-connected	199	1.00	4.00	2.65	0.07	1.04	−0.35	0.17	−1.04	0.34
Solid biomass	199	1.00	4.00	2.60	0.07	0.94	−0.40	0.17	−0.73	0.34
Village-scale	199	1.00	4.00	2.52	0.07	1.05	−0.10	0.17	−1.19	0.34
Solar thermal – dryers	199	1.00	4.00	2.43	0.07	1.00	−0.10	0.17	−1.10	0.34
Wind pumps	199	1.00	4.00	2.42	0.07	1.06	−0.08	0.17	−1.25	0.34
Wind turbines – stand alone	199	1.00	4.00	2.39	0.08	1.10	0.06	0.17	−1.32	0.34
Liquid biofuel	199	1.00	4.00	2.39	0.08	1.06	0.03	0.17	−1.25	0.34
Solar thermal – cooling	199	1.00	4.00	2.39	0.08	1.07	−0.04	0.17	−1.29	0.34
Geothermal	199	1.00	4.00	2.19	0.07	1.01	0.30	0.17	−1.05	0.34
Wind turbines – grid connected	199	1.00	4.00	2.11	0.08	1.10	0.34	0.17	−1.34	0.34
Valid N (listwise)	199									

Source: Primary data

that supply of renewable energy gadgets is contingent upon ones' level of earning or that renewable energy gadgets are expensive to deal in. This appears consistent with Mallett's (2007) finding that for persuasion to bear fruit, the cost of the equipment is important. Whereas the youth were more inclined to supplying renewable energy gadgets, their effectiveness or uptake in supply was perceived limited by their earnings.

4.2 The current state of social acceptance of renewable energy in the two cities

Table 3 shows that on a scale of 1(strongly disagree) – 6 (strongly agree), the respondents perceive positively (mean = 4.04) of SARE in Uganda. The highest SARE is in the market acceptance component (mean = 4.13) followed by community acceptance component (mean = 4.02) and lastly the socio-political acceptance dimension (mean = 3.97). These latent items account for over 50 per cent (Table A3 as appended) of the variance in SARE in Kampala and Wakiso Districts/cities in Uganda.

4.3 The current state of vulnerability of vital energy systems in the two cities

Among others, the costs of renewable energy systems have to be assessed well and made known in Kampala and Wakiso districts (Table A4). Table A4 suggests what has been done or needs to be done to ensure a LVRE in this setting. In terms of what needs to be done, for instance, "the potential risks associated with renewable energy systems have to be assessed well and made". In terms of what has been done, for instance, "the country has identified its vital energy systems". This latter point corroborated results in Table 4. In general, the current state of vulnerability of energy systems in this setting seems to espouse energy security as the real value of renewable energy. Table A4 shows that energy prices can disrupt (be a threat to) normal social and economic activity; lack of spare production capabilities, stockpiling, energy emergency plans and diverse suppliers can threaten energy security; and failure to identify vital energy systems by a country can threaten Her energy security. Together, these define this setting's resilience capabilities. Favourable commercial policies regarding renewable energy, appropriate political will, and technologies, for example, define exposure to risks.

4.4 The workings of the business model concept – value to whom?

Results offer a first step towards conceptualizing the workings of a business model concept, as an analytical tool to analyze the complex value in SARE hence answering the question of "value to whom?" The principal component analysis results reported in Table A2 show that the complex value in SARE can be summed as value to the user, hence answering the question of "value for whom". In the alternative, the customer side business model, although less complex, can be indicated by:

- Companies dealing in renewable energy (might) provide customized solutions to our energy needs.
- It (might) allow hosting a renewable energy generation system and share the benefits with the utility.
- Renewable energy systems should be closer to the point of consumption.
- Renewable energy systems should be numerous but on small scales.
- Renewable energy providers interact with their customers.

As will be seen from the ensuing correlational analysis results, this unidimensional model appears to hold in this setting.

		Do you supply any energy Gadget? No	Yes	Total
You live in * Do you supply any energy Gadget?				
You live in	Wakiso	42	16	58
	Kampala	89	52	141
Total		131	68	199
What is your gender? * Do you supply any energy Gadget?				
What is your gender?	Female	61	32	93
	Male	70	36	106
Total		131	68	199
What is your age? * Do you supply any energy Gadget?				
What is your age?	Adult	50	33	83
	Youth	81	35	116
Total		131	68	199
What is your yearly income? * Do you supply any energy Gadget?				
What is your yearly income?	Lower than Ugx.25,000,000	91	39	130
	Ugx.25,001,000-Ugx.50,000,000	29	18	47
	More than Ugx.50,000,000	11	11	22
Total		131	68	199

Source: Primary data

Table 5. Cross-tabulations

4.5 Correlation results

The correlation results in Table 6 indicate bivariate association of SARE with LVRE, BMI, Customer Side Business Model (CSBM), EOPT and TECH. The correlation results show that LVRE is significantly correlated with SARE at 1 per cent level, BMI is significantly correlated with SARE at 1 per cent level or better, CSBM is significantly correlated with SARE at 1 per cent level or better, EOPT is also correlated with SARE at 1 per cent or better and TECH is correlated with SARE at 1 per cent level or better. These univariate test results provide preliminary evidence ($r = 0.537, p < 0.01$) in support of *H1*, *H2* ($r = 0.705, p < 0.01$), *H3* ($r = 0.614, p < 0.01$), *H4* ($r = 768, p < 0.01$), *H7* ($r = 0.715, p < 0.01$). Gender is positively correlated with SARE ($r = 0.221, p < 0.01$), TECH ($r = 0.174, p < 0.05$), EOPT ($r = 0.153, p < 0.005$), CSBM ($r = 0.149, p < 0.05$) and BMI ($r = 0.177, p < 0.05$).

4.6 Regression results

As further tests of the hypotheses, Tables 7-9 show the results. Table 7 regresses the predictor variables onto dependent variable SARE without the control variables. Table 8 includes both hypothesized independent variables control variables regressed onto SARE. Table 9 is hierarchical regression analysis results showing six models, the first model (Model 1) with only control variables. Both in Table 7 and Table 8, BMI and TECH are not significant although significant relationships between them and SARE can be discerned in Table 6. This conundrum is partly solved by results Table 9, a table which also shows test results for the sensitivity of the results to the control variables and the contribution of each dependent variable. Except for gender the other control variables not significant and hence do not confound the results. Results in Models 2, 3, 4, 5 and 6 show that the *F* is significant at the 1 per cent level or better with LVRE (standardized $\beta = 0.776, p < 0.01$), BMI (standardized $\beta = 0.258, p < 0.01$), CSBM (standardized $\beta = 0.226, p < 0.01$) and EOPT (standardized $\beta = 0.267$,

Table 6. Correlations (with control variables)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
How many people live in your current home?(1)	1												
Do you own your current home? (2)	0.108	1											
What is your age? (3)	−0.352**	−0.288**	1										
What is your gender? (4)	−0.021	0.016	0.004	1									
What is your yearly income? (5)	0.253**	0.076	−0.417**	0.022	1								
Do you supply any energy Gadget? (6)	−0.039	0.053	−0.100	−0.005	0.138	1							
You live in (7)	−0.088	−0.010	0.108	−0.025	−0.105	0.089	1						
LVRE (8)	0.036	0.051	−0.084	0.130	0.097	−0.015	−0.017	1					
BMI (9)	0.067	0.162*	−0.093	0.177*	0.062	−0.016	−0.104	0.555**	1				
CSBM (10)	0.025	0.017	0.096	0.149*	0.011	0.004	0.028	0.622**	0.513**	1			
EOPT (11)	0.070	0.032	−0.145*	0.153*	0.054	−0.076	−0.058	0.697**	0.718**	0.546**	1		
TECH (12)	0.064	0.115	−0.049	0.174*	0.064	−0.019	−0.046	0.514**	0.768**	0.466**	0.597**	1	
SARE (13)	−0.031	0.029	0.002	0.221**	0.001	−0.022	0.004	0.715**	0.614**	0.638**	0.705**	0.537**	1

Notes: **Correlation is significant at the 0.01 level (two-tailed); *correlation is significant at the 0.05 level (two-tailed)

Variables	Unstandardized coefficients B	Std. error	Standardized coefficients Beta	t	Sig.
(Constant)	0.107	0.221		0.486	0.628
LVRE	0.341	0.073	0.310	4.690	0.000
BMI	0.094	0.064	0.114	1.456	0.147
CSBM	0.223	0.056	0.229	3.990	0.000
EOPT	0.262	0.071	0.268	3.691	0.000
TECH	0.021	0.062	0.023	0.334	0.739
F Statistic = 68.479					0.000^b

Notes: R = 0.800; R^2 = 0.640; adjusted R^2 = 0.630; Std. error of the estimate = 0.47197; Durbin-Watson = 1.879; VIF 1.778

Table 7.
(a). Regressions

	Unstandardized coefficients B	Std. error	Standardized coefficients Beta	t	Sig.
(Constant)	0.188	0.270		0.697	0.487
How many people live in your current home?	−0.024	0.021	−0.054	−1.162	0.247
Do you own your current home?	−0.012	0.072	−0.008	−0.166	0.868
What is your age?	0.036	0.084	0.023	0.427	0.670
What is your gender?	0.130	0.068	0.083	1.897	0.059
What is your yearly income?	−0.036	0.055	−0.032	−0.654	0.514
Do you supply any energy gadget?	0.013	0.072	0.008	0.179	0.858
You live in	0.039	0.075	0.023	0.521	0.603
BMI	0.097	0.065	0.119	1.484	0.140
CSBM	0.204	0.058	0.209	3.543	0.000
LVRE	0.348	0.073	0.317	4.767	0.000
EOPT	0.267	0.073	0.273	3.658	0.000
TECH	0.015	0.062	0.016	0.240	0.811
F statistic = 29.348					0.000^b

Notes: R = 0.809a; R^2 = 0.654; adjusted R^2= 0.632; std. error of the estimate = 0.47075; Durbin-Watson = 1.916; VIF = 1.890

Table 8.
(b). Regressions with control variables

$p < 0.01$), as significant predictors of SARE. In essence, Model 6 presents the combined effect of all the predictor variables on the outcome variable, and the results show that LVRE is the best and significant predictor variable of SARE (standardized β = 0.348).

Surprisingly, BMI that had been significant in Model 2 through to Model 5 is not significant in the presence of TECH in Model 6. This also suggests Model 5 is the better fitting model with the combined variance explained at 63.7 per cent. Nevertheless, we extend the analysis to test for mediation as the initial position of this study was that TECH is significantly correlated with SARE and also related to BMI and EOPT and suggested a possible mediation effect of TECH in the relationships between BMI, EOPT and, SARE.

Going ahead, as recommended by Baron and Kenny (1986), the mediation of TECH was assumed in the relationship between BMI and SARE (*H5*). It was also assumed in the relationship between EOPT and SARE (*H6*). As a mediating variable is one which specifies "how (or the mechanism by which) a given effect occurs between an independent variable (*in our case BMI or EOPT*) and a dependent variable (*in our case SARE*)" (Holmbeck, 1997,

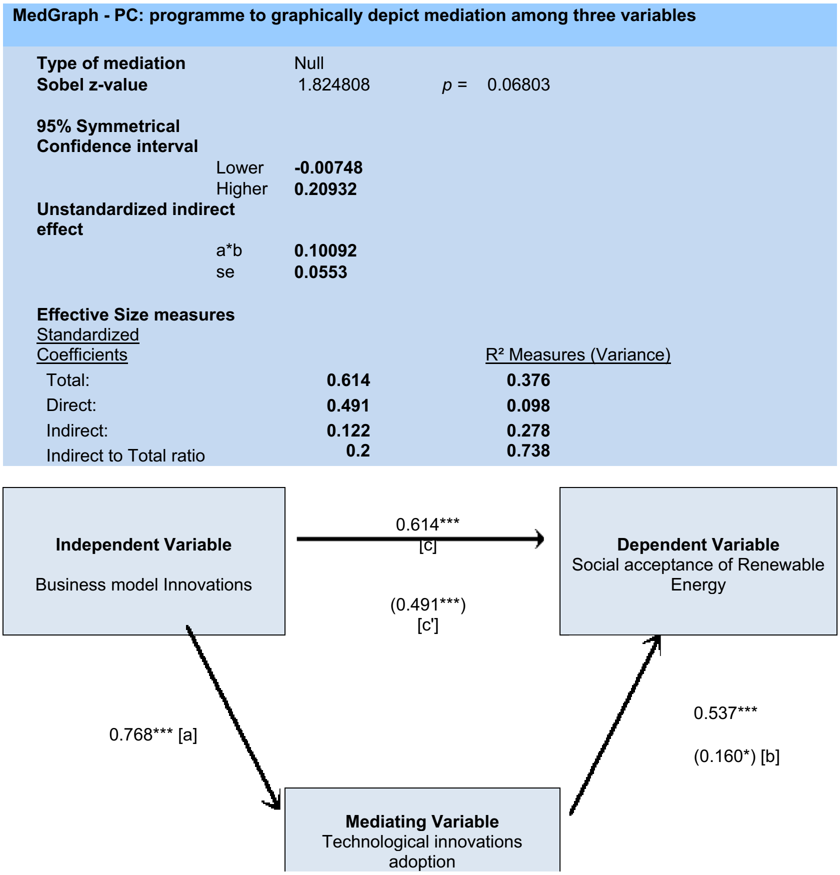
Table 9.
(c). Regressions (hierarchical)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	3.896**	0.839**	0.478**	0.373	0.198	0.188
Control variables						
How many people live in your current home?	−0.014	−0.014	−0.018	−0.025	−0.024	−0.025
Do you own your current home?	0.044	0.010	−0.054	−0.052	−0.012	−0.01
What is your age?	−0.006	0.047	0.046	0.021	0.037	0.037
What is your gender?	0.342**	0.202**	0.151**	0.135**	0.130**	0.129**
What is your yearly income?	0.006	−0.056	−0.049	−0.051	−0.036	−0.036
Do you supply any energy garget?	−0.042	−0.005	−0.004	−0.016	0.013	0.013
You live in:	0.017	0.014	0.062	0.044	0.040	0.039
LVRE		0.776**	0.591**	0.465**	0.350**	0.348**
BMI			0.258**	0.211**	0.106**	0.097
CSBM				0.226**	0.204**	0.204**
EOPT					0.267**	0.267**
TECH						0.015
Model F	1.471	27.327**	31.527**	31.918**	32.173**	29.348**
R	0.225	0.731	0.775	0.793	0.809	0.809
R^2	0.05	0.535	0.599	0.629	0.654	0.654
Adjusted R^2	0.026	0.52	0.584	0.613	0.637	635
F change	1.471	197.709**	30.818**	14.770**	13.497**	0.058
R^2 change	0.051	0.484	0.065	0.029	0.025	0.000
df1	7	1	1	1	1	1
df2	191	190	189	188	187	186
VIF	0.052	1.151	1.494	1.695	1.890	1.890
Durbin-Watson						1.916

f. Dependent Variable: Social acceptance of renewable energy

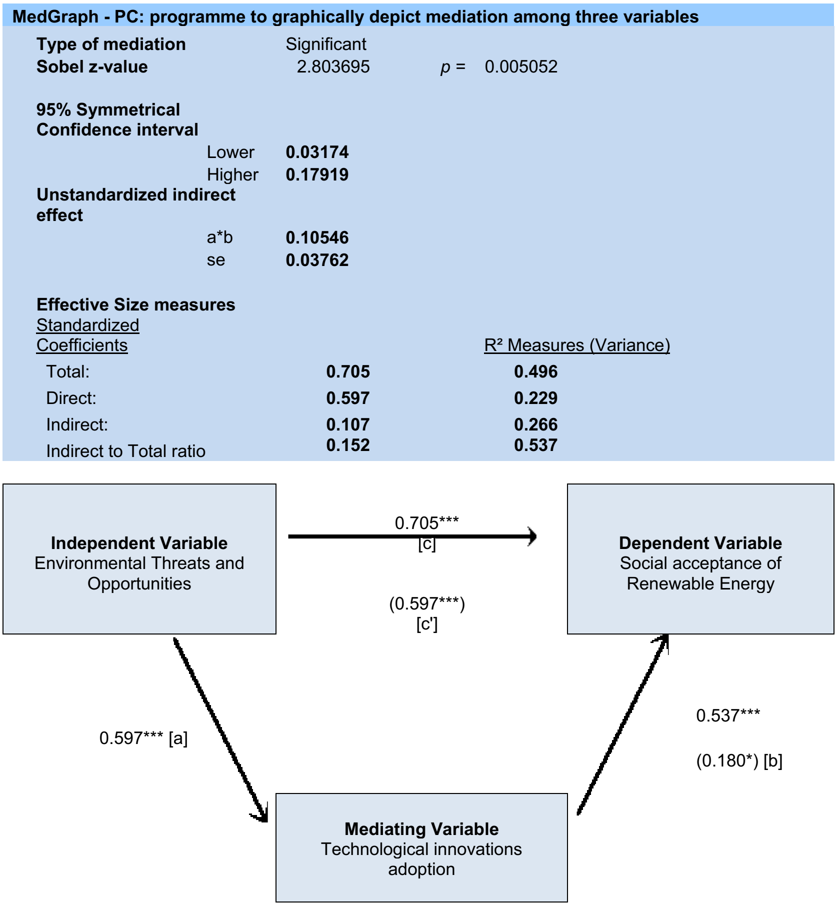
Note: **Significant at the 0.001 level

p. 599), the question we wished to answer is whether the effect of the independent variable(s) on the dependent variable is at least partially mediated by a third variable (TECH). According to Figure 2, the mediation between BMI and SARE by TECH is null, and according to most mediation cognoscenti, there is no mediation. At this level of analysis, *H5* is rejected. According to Figure 3, the mediation between EOPT and SARE by TECH is significant. The indirect/total ratio computed based on unstandardized coefficients refers to 0.107/0.705, or 0.152. This ratio varies from 0 to 1 and shows how much of the original basic relationship is explained by the indirect effect; in this case, it turns out to be 15.2 per cent. The R^2 estimates (based on variances), were generated by using the semi-partial correlations of the EOPT and the TECH with the outcome variable SARE. The proportion of the variance of the indirect effect on the variance of the total effect is 53.7 per cent. This suggests that just over one half of the variance of the in the total effect is composed of the indirect effect. At this level of analysis, *H6* is accepted.



Note: The numerical values in parentheses are beta weights taken from the second regression and the other values are zero-order correlations

Figure 2.
Depiction of the mediation among the three variables: Business model innovations, technological innovations adoption and social acceptance of renewable energy



Note: The numerical values in parentheses are beta weights taken from the second regression and the other values are zero-order correlations

Figure 3.
Depiction of the mediation among the three variables: business model innovations, technological innovations adoption and social acceptance of renewable energy

The results of the MedGraph in Figure 3 tell us that TECH acts as a significant mediator between EOPT and SARE. The basic relationship is significantly reduced by the introduction of TECH. The path through the mediating variable accounted for about 15 per cent of the basic relationship between the predictor and the outcome, and the R^2 estimate of the indirect effect tells us that just more than half of this relationship was explained by the indirect effect. These results suggest that if there are more EOPT facing an individual household, he/she is likely to exhibit more willingness to socially accept renewable energy. This relationship can be partially explained by TECH. In essence, households that reported more EOPT reported TECH, and, in turn, households adopting TECH reported a higher willingness to socially accept renewable energy. These results make intuitive sense and we are not aware of any existing study that includes all the three variables in this particular fashion, so this may be a preliminary novel finding.

The estimates of direct and indirect effects show how strongly TECH (mediator) operated. The indirect effect which is relatively larger (in the case of regression coefficients) of the EOPT are explained by the mediating variable of TECH. In other words, a considerable amount of the shared variance between EOPT and SARE is explained by the indirect route through TECH. As noted by Jose (2013), researchers say that mediation tells us about the operating mechanism that exists among three variables, and this interpretation is relevant here in that we can say that we have found that TECH seems to explain a significant part of the relationship between EOPT and SARE.

4.7 Sensitivity analysis

To test for whether the above model is sensitive to potential endogeneity arising from biases of the respondents, we run an independent samples *t*-test. An independent-samples *t*-test was conducted to compare the SARE for males and females. There was a significant difference in scores for males (M = 4.1996, SD = .77749) and females [M = 3.8561, SD = .73683; t(197) = 3.197, p = .002]. The Eta squared is 0.049 and this is trivial according to Cohen (1988). An independent-samples *t*-test was conducted to compare the SARE for youth (0-35 years of age) and adults (above 35 years of age). There was no significant difference in scores for youth (M = 4.0401, SD = .84392) and adults [M = 4.0376, SD = .64809; t (197) = 0.023, p = .982]. The eta squared was 0.0000268. Similarly, we compared the SARE for home ownership and non-home ownership. There was no significant difference in scores for home ownership (M = 4.0615, SD = .67142) and non-home ownership [M = 4.0173, SD = .86856; t (146) = 0.400, p = .688]. Eta squared was 0.000811. The overarching purpose of this study was to show that to increase SARE, there must be perceived LVRE. In Table 7, TECH is not significant and so we test for $SARE = \beta_0 + \beta_1 BMI + \beta_2 EOPT + \varepsilon j$ in its truncated form as $SARE = \beta_0 + \beta_1 LVRE + \varepsilon j$ where BMI + EOPT translate to LVRE. Table 10 show the tentative results.

Table 10 suggests that LVRE explains about 51 per cent of the variances in SARE. When the perceived LVRE improves, it can be expected that SARE will also.

5. Discussion

The results suggest that of the seven hypotheses only one (*H6*) is not substantiated. This study, therefore, has offered a preliminary and partial solution to the ills vitiating successful renewable energy projects implementation. We first identify that if renewable energy technologies do not make life at home more convenient, that will be a negative element in perceived SARE. This single manifest variable accounts for about 6 per cent of the variance in SARE in this study setting. Since we proposed to identify factors for SARE, the following factors have been found significant for SARE in this study setting:

- economic (behavioural intentions), utilitarian (useful)/performance expectancy and attitudinal dimensions – all indicating BMI;

Table 10. Low vulnerability of renewable energy with SARE

Variables	Unstandardized coefficients B	Std. error	Standardized coefficients Beta	t	Sig.
(Constant)	1.095	0.273		4.008	0.000
LVRE	0.677	0.049	0.705	13.713	0.000
F Statistic = 34.708					0.000[b]

Notes: R =.721; R^2 = 0.520; adjusted R^2 = 0.505; std. error of the estimate = 0.54587; VIF = 1.000; Durbin-Watson = 2.077

- customer readiness, perceived trust, competitive pressure, and trading partner readiness – all underpinning environmental threats and opportunities;
- social networks, perceived ease of use and usefulness; all underpinning TECH; and
- making life at home more convenient.

Overall, this study augments the following themes:

- The concern of Ugandans in Kampala and Wakiso districts is that of energy security (low vulnerability of energy systems). In turn, this accentuates their proclivity to SARE.

Among the concerns to be addressed relate to exposure to risks (accessibility and acceptability) and resilience capabilities (availability and affordability) consistent with the framework proposed by Cherp and Jewell (2014). For example, if the costs and benefits of renewable energy systems are not assessed well and made known, that will make renewable energy systems vulnerable. That vulnerability translates into a low SARE, consistent with the suggestions by Supersberger (2006; 2007) that real costs of fossil and renewable energy sources should be properly calculated and factored into prices and a comparison is made between the two sources. That author contends that the price of energy from fossils would be higher than from renewable sources tilting the balance of acceptance in favour of renewable usage. As well, if commercial policies are not favourable and there is a centralization of the energy system, that potentially makes renewable energy systems vulnerable. The lack of appropriate technologies for and awareness of renewable energy, lack of appropriate political will in favour of renewable energy development and usage and, lack of a framework for identifying, measuring, and managing renewable energy vulnerabilities make renewable energy systems especially vulnerable:

- The low vulnerability of renewable energy systems and EOPT are, individually, significant predictors of SARE.

LVRE as indicated by low exposure to risks and high resilience capabilities on their own significantly and positively explain SARE, hence advancing the theory of planned behavior in that LVRE is beyond willed control and predicts SARE (ecological behavior, in this case, of households/public) and supports the views of Kaiser *et al* (1999). Awareness (Nomura and Akai, 2004), for example, indicates information possessed by the public regarding renewable energy and this, in turn, influences their acceptance of renewable energy.

The findings also show that environmental opportunities (customer readiness/exposure, supplier readiness, competitive pressure) and threats, on their own, positively explain SARE. For example the fear (Zoellner *et al*., 2008) that climatic change could have negative impacts on humanity will force the public to embrace (planned behavioural change) the technology that promises to avert the effects of climate change such as usage of renewable energy. If the public perceives (Assefa and Frostell, 2007) that newer renewable energy sources will out-compete the currently available source(s), their proclivity to renewable energy will improve. Similarly, fear i.e. danger or anxiety that intensifies with ignorance (Zoellner *et al*., 2008) potentially makes the public more innovative and proactive in renewable energy technologies. This innovation and pro-activeness then trigger the SARE. The environment offers information on renewable energy sources, technologies, uses and understanding. Such opportunities seem to augment the SARE. So, it seems increasing information possessed by residents in the two cities studied, their perceptions of renewable energy and fear for the environment enhance uptake or SARE providing support for (Nomura and Akai, 2004; Assefa and Frostell, 2007; Zoellner, 2008) that found three parameters appearing to accentuate public behavior:

- TECH explains a significant part of the link between EOPT and SARE.

The present results advance the theories of reasoned action (Ajzen and Fishbein, 1980) and planned behavior (Ajzen, 1985). According to Dunlap and Van Liere (1978), the relation between environmental attitude and ecological behavior is probably through the mediation of a third variable. According to the current results, a considerable amount of the shared variance between EOPT (shaping environmental attitude) and SARE (ecological behavior) is significantly explained by the indirect route through TECH. This provides the value of the TAM as one of the models partly explaining SARE. So, TAM, TPB, and TRA which incorporate the influences of psychological, the social and interpersonal variables (Awa, 2015) are relevant frameworks for understanding SARE.

6. Conclusions and implications

The objective of this paper was to explore the preliminary evidence of the link between perceived LVRE and SARE while treating EOPT, TECH and BMI as possible antecedents The results of this study suggest that LVRE, EOPT and BMI, on their own may explain significant variations in the SARE. Furthermore, the link between EOPT and SARE may significantly be mediated by TECH. This exploratory study provides the initial address to the concept of complex value to answer the question of "value for whom" – which in this case is customer value. This indicates that the combination of TAM, TPB and TRA potentially provides a relevant framework for understanding the SARE. Also, the study's use of cross-tabulations shows that the supply of renewable energy gadgets is contingent upon one's income level or that renewable energy gadgets are expensive to deal in and that whereas the youth were more inclined to supplying renewable energy gadgets, their effectiveness/uptake in supply was limited by their level income. Although the dimensions of social acceptance put forward by Wüstenhagen *et al.* (2007) of market/socio-political/community continue to properly delineate the general approaches of studies in this field (Fast, 2013), this study shows that market acceptance has taken root in the studied two cities of Uganda relative to community and the socio-political acceptance. This calls for interventions specifically aiming to improve the other two dimensions in these two cities.

There is need for policymakers to empower the youth with seed money geared to the supply (dealership) in renewable energy gadgets. This potentially helps in increasing their energy gadgets' supply and certainly will increase the market share of renewable energy technologies and the resulting awareness. The evidence provided in this study also emphasizes the need to address barriers to SARE. The perceived lack of TECH suggests a failure to utilize the opportunities and withstand the threats that the environment has to offer and hence leading to less than adequate SARE. Policymakers wishing to improve the SARE must ensure that the vulnerability of renewable energy systems is low. To do this, they need to mitigate exposure to risks and building of resilient capabilities in renewable energy systems – that ensures accessibility, availability, affordability, and acceptability of those systems and hence SARE as a worthwhile imperative to the attainment of Goal 7 of the UN Sustainable Development Goals. The current evidence suggests that some of the uncertainty (LVRE) may be attributed to unfamiliarity or low perception with the EOPT which is magnified by the perceived low PU, ease of use and diffusion (social networks) of TECH. Potential users of renewable energy must be educated about renewable energy technologies' usefulness, how to use the technology and encouragement of social networks aimed at diffusing TECH. Since public opinion can be influenced through media and social networks (Egbue and Long, 2012) policy makers can use this medium to influence the public appreciation for benefits of using renewable (clean) energy sources such as reduction of environmental footmark. The connection of household characteristics to energy gadgets' supply will be useful in improving electricity services, designing better energy policies and increasing the demand for renewable (reliable) energy sources. Conclusions from this study are potentially useful for renewable energy (technologies') planning, policies, promotion, as well as investment programmes using renewable energy sources.

As with any study, there are some limitations worth mentioning. Because the current results are from only two cities (districts) of Uganda and also based on a non-probability sample, generalizing them can be considered remote. In other words, it appears that more complex models need developing and testing in the future concerning LVRE and SARE. The present preliminary results are offered as a stimulus to such efforts. Well, it is expected and consistent with the diffusion of innovations theory (Rogers, 1995) that the population in Kampala and Wakiso districts are potential change agents (i.e. capable of influencing others in rural areas of Uganda).

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Appendix

Item scales	Component 1	2	3
Using the renewable energy for my electricity needs would enable me to accomplish more tasks more quickly	0.850		
Using the renewable energy for my electricity needs would increase my productivity	0.827		
Using the renewable energy would make it easier to do my work/job	0.733		
Overall, renewable energy for electricity needs is advantageous	0.728		
Using renewable energy for my power/electricity needs would improve my home and business	0.702		
I will use renewable energy sources because I am influenced by my family and friends		0.803	
The people around me think I should use renewable energy		0.672	
I will discuss use of renewable energy for electricity needs with my family and friends		0.608	
Renewable energy for electricity to me is (maybe) easy to understand and clear			0.902
I would find renewable energy for electricity needs easy to use			0.670
Percentage of variance	33.61	17.00	15.27
Cumulative % of variance	33.61	50.61	65.88

Notes: Kaiser-Meyer-Olkin measure of sampling adequacy = 0.875; Bartlett's test of sphericity approx. chi-square = 753.254 ($p < 0.000$), determinant = 0.021. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in five iterations. Key: Components: 1 = perceived usefulness, 2 = social networks, 3 = perceived ease of use

Table A1. Rotated component for renewable energy technological innovations

Item Scales	Component 1	2	3
Using renewable energy for my electricity needs will improve my personal life and job performance	0.797		
Renewable energy technologies contain the application information needed for use	0.775		
Using renewable energy for my electricity needs will enhance my personal life and job efficiency	0.738		
I believe that using renewable energy for my electricity needs in my personal life and on the job is a good idea	0.716		
The usage of renewable energy sources can improve Uganda as a business location	0.678		
Using renewable energy for my electricity needs will bring convenience to my life, both on the job and outside the job	0.625		
If the price of renewable energy is reasonable, I want to use it	0.575		
I have heard that renewable energy use offers immediate cost savings on electricity consumption		0.837	
The advantages of using renewable energy completely balance the costs.		0.752	
Increased usage of renewable energy can reduce the price of energy		0.741	
To the extent possible, I will use the latest renewable energy technologies			0.828
I am willing to share renewable energy with my family and friends			0.778
Percentage of variance	30.90	18.39	17.70
Cumulative % of variance	30.90	49.29	66.99

Notes: Kaiser-Meyer-Olkin measure of sampling adequacy = 0.894; Bartlett's test of sphericity approx. chi-square = 1134.742 ($p < 0.000$), determinant = 0.003. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in five iterations. Key: Components: 1 = performance expectancy/utilitarian (useful), 2 = economic/behavioral intention, 3 = attitudinal

Table A2.
Rotated component for business model innovations

Item scales	Component 1	2	3
I can allow renewable energy installations in my back yard	0.752		
The costs and benefits of renewable energy installations are fairly shared among those who the installations affect	0.673		
All stakeholders that may be affected by renewable energy installations participate in the siting decision	0.661		
our local renewable energy initiatives are not overrun by the central government authorities	0.625		
Ugandans are demanding for more renewable energy sources for their electricity needs		0.784	
Current electricity users are willing to approve more renewable energy infrastructure		0.776	
Current electricity users are willing to approve more of their landscape for renewable energy infrastructure		0.695	
Governmental planning includes siting issues			0.723
Government supports spatial planning systems for decision-making in renewable energy			0.721
The planning at local government and central government is harmonized.			0.683
Percentage of variance	19.23	16.29	14.84
Cumulative % of variance	19.23	35.52	50.36

Notes: Kaiser-Meyer-Olkin measure of sampling adequacy = 0.838; Bartlett's test of sphericity approx. chi-square = 700.454 ($p < 0.000$), determinant = 0.026. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in five iterations. Key: Components: 1 = community acceptance, 2 = market place acceptance, 3 = socio-political acceptance

Table A3. Rotated component for social acceptance of renewable energy technologies

Item scales	Component 1	2	3	4
The costs of renewable energy systems have to be assessed well and made known	0.866			
The potential risks associated with renewable energy systems have to be assessed well and made known	0.858			
The benefits of renewable energy systems have to be assessed well and made known	0.835			
Generally the business model adapted by renewable energy investors and dealers should be value adding	0.795			
There should be high awareness levels and organization of renewable energy interest groups	0.673			
There is enough awareness regarding renewable energy		0.687		
There is appropriate technologies for renewable energy		0.665		
There is appropriate political will in favour of renewable energy development and usage		0.654		
In this country, a framework exists for identifying, measuring and managing renewable energy vulnerabilities		0.552		
This country has identified its vital energy systems			0.746	
Energy prices in this country are less disruptive to normal social and economic activity			0.718	
The energy sectors in Uganda has spare production capabilities, stockpiling, energy emergency plans and diverse suppliers			0.685	
Strong energy efficiency measures has been introduced in Uganda				0.763
The energy system in Uganda is especially decentralized				0.666
The commercial policies regarding renewable energy are favourable				0.558
%ge of variance	22.99	13.61	11.79	10.37
Cumulative %ge of variance	22.99	36.60	48.39	58.76

Notes: Kaiser-Meyer-Olkin measure of sampling adequacy = 0.807; Bartlett's test of sphericity approx. chi-square = 1058.674 ($p < 0.000$), determinant = 0.004. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in seven iterations. Key: Components: 1 = accessibility/exposure to risks, 2 = availability, 3 = affordability/resilience capabilities, 4 = acceptability

Table A4.
Rotated component for low vulnerability of renewable energy systems

	Component			
	1	2	3	4
I understand renewable energy	0.800			
I know the sources of renewable energy	0.776			
I have information about renewable energy technologies	0.774			
I know the uses of renewable energy	0.608			
Renewable energy dealers and suppliers will be more proactive		0.716		
There is likely to be more innovation in renewable energy technologies		0.675		
Training in renewable energy is crucial		0.640		
Renewable energy dealers and suppliers are more proactive		0.623		
Newer renewable energy sources will out compete the currently available source(s)		0.555		
Renewable energy suppliers need to constantly plan to avoid surprises in the sector		0.520		
Renewable energy billing systems are secure			0.801	
With renewable energy, you are sure no one will give you a wrong electricity bill			0.791	
Electricity/power generated using renewable energy cannot be stolen			0.766	
Using renewable energy ensures reliable electricity supply			0.509	
Using renewable energy meets your electricity needs 24/7			0.506	
I am prepared to do something to avert the impacts of climatic change				0.766
I am familiar with the renewable energy generation technologies				0.711
I am aware of climate change and its impacts				0.607
Percentage of variance	16.01	15.57	12.99	11.15
% of variance	16.01	31.58	44.57	55.72

Notes: Kaiser-Meyer-Olkin measure of sampling adequacy = 0.870; Bartlett's test of sphericity approx. chi-square = 1671.764 ($p < 0.000$), determinant = 0.000. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a. Rotation converged in eight iterations. Key: Components: 1 = customer readiness/exposure; 2 = supplier readiness/competitive pressure; 3 = perceived trust; 4 = environmental threats

Table A5. Rotated components for perceived environmental opportunities and threats

Table A6.
Variables and their measurements

Variable	Dimensions/ components	Measurements	Definitions	Sample scale items
Social acceptance of renewable energy (Dependent variable)	Community acceptance	Respondents' mean rank of the 10 items of information included in the questionnaire on a six-point Likert scale	The specific acceptance of siting decisions and renewable energy projects by local stakeholders, particularly residents and local authorities.	I can allow renewable energy installations in my back yard
	Marketplace acceptance		Accepting new renewable energy technologies in the market or processes by which actors accept and support new renewable energy innovation.	Ugandans are demanding for more renewable energy sources for their electricity needs
	Socio-political acceptance		The public support of changes associated with the development of renewable energy	Governmental planning includes siting issues
Low vulnerability of renewable (vital) energy systems	Accessibility/ exposure to risks	Respondents' mean rank of the 15 items of information included in the questionnaire on a six-point Likert scale	The uninterrupted accessibility of energy sources at an affordable price	The costs of renewable energy systems have to be assessed well and made known
	Availability		The extent to which people are aware of renewable energy sources (systems)	There is enough awareness regarding renewable energy (Midttun, 2012)
	Affordability/ resilience capabilities		The affordability of energy sources at stable prices, i.e. the relationship between the client's income and the cost of renewable or the profitability of renewable energy investments	Energy prices in this country are less disruptive to normal social and economic activity (Cherp and Jewell, 2014)
	Acceptability		The economic and environmental impacts of energy sources, i.e. comfort with, for example the physical attributes of renewable energy systems and neighbourhood	Strong energy efficiency measures has been introduced in Uganda (Supersberger, 2006)

(*continued*)

Variable	Dimensions/ components	Measurements	Definitions	Sample scale items
Business model innovations (Strupeit and Palm, 2016)	Performance expectancy/ utilitarian (useful)	Respondents' mean rank of the 12 items of information included in the questionnaire on a six-point Likert scale	The value proposition towards renewable energy customers	Using renewable energy for my electricity needs will improve my personal life and job performance (Chen and Chang, 2013)
	Economic/ behavioural intention		The relative advantage of using renewable energy (systems)	I have heard that renewable energy use offers immediate cost savings on electricity consumption
	Attitudinal		The extent to which energy customers are receptive to renewable energy (systems), i.e evaluative judgment of renewable energy sources (systems) by a person	To the extent possible, I will use the latest renewable energy technologies (Chen and Chang, 2013)
Environmental opportunities and threats (Spence *et al.*, 2012; Strazzera *et al.*, 2012; Thøgersen & Noblet, 2012; UNDP, 2010, Awa, 2015)	Customer readiness	Respondents' mean rank of the 18 items of information included in the questionnaire on a six-point Likert scale	The level of information possessed by the public about renewable energy (systems)	I understand renewable energy
	Business partner readiness/ competitive pressure		The network externalities with trading partners (customers, dealers and suppliers) to ensure renewable energy (systems) interactions and transactions along the value chain; also the extent to which renewable energy (systems) operate on the basis of retaliatory and endless vicious circle	Renewable energy dealers and suppliers will be more proactive
	Perceived trust (safety and security)		Private benefits such as security and safety of renewable energy (system). How private, safe and secure are the renewable energy sources/systems?	Renewable energy billing systems are secure
	Environmental threats		Individual behaviour modification in simple ways that serve to reduce personal environmental impact	I am prepared to do something to avert the impacts of climatic change

(*continued*)

Table A6.

Table A6.

Variable	Dimensions/ components	Measurements	Definitions	Sample scale items
Renewable energy technological innovations	Perceived usefulness	Respondents' mean rank of the 10 items of information included in the questionnaire on a six-point Likert scale	The degree to which an individual believes that using the renewable energy (system) will help him or her to attain gains in task performance	Using the renewable energy for my electricity needs would enable me to accomplish more tasks more quickly (Tong, 2010)
	Social networks		The degree to which an individual perceives that it is important that others believe that he or she should use renewable energy (systems)	I will use renewable energy sources because I am influenced by my family and friends (Chen and Chang, 2013)
	Perceived ease of use		The degree of ease associated with the use of renewable energy (systems)	I would find renewable energy for electricity needs easy to use (Tong, 2010)
Home ownership		Dichotomous variable, 1 if home own otherwise 0	Whether the respondent owned a home	Do you own your current home?
Age		Dichotomous variable, 1 if the respondent was aged up to 35year (Youth) and 0 if above 35 years	The age of the respondent	In which age bracket do you fall?
Gender		Dichotomous variable, 1 male and 0 if female	The gender(sex) of the respondent	What is your gender?
Energy gadget supply		Dichotomous variable, 1 if respondent supplied otherwise 0	Whether the respondent supplied any energy gadget	Do you supply any energy gadgets to customers?
Residence		Dichotomous variable, 1 if lived in Kampala and 0 if lived in Wakiso	The district in which the respondent lived.	You live in . . .(Kampala or Wakiso). Please tick.