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The Role of Household Consumers in Adopting Renewable Energy Technologies in Kenya

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Abstract: In transition to a low-carbon economy, the adoption of renewable energy (RE) technologies by energy investors, power utilities and energy consumers is critical. In developing countries like Kenya with a high rate of urbanization, this transition requires urban and rural residents' proactive responses to using renewable energy sources. In this regard, a better understanding of residents' perceptions about renewable energy investment, RE sources availability, climate change, environmental conservation and other factors can lead to more efficient and sustainable implementation of renewable energy policies. This study investigates the role Kenya's household energy consumers in urban and rural areas can play in adopting renewable energy technologies. To achieve this, a questionnaire survey was administered among 250 household consumers in Nairobi County, Makueni County, and Uasin Gishu County. Our survey analysis shows that about 84% of the respondents were interested in adopting renewable energy for their entire energy consumption mostly because of solving frequent power outages and high energy cost from the grid system. This perception did not have any correlations with income levels or any other socio-economic factors we identified. Furthermore, about 72% of the respondents showed their interests in producing and selling renewable energy to the national or local grids if government subsidies were readily available. Rural residents showed strong interests in adopting renewable energy technologies, especially solar PV solutions. However, the main impediment to their investment in renewable energy was the high cost of equipment (49%) and the intermittent nature of renewable energy (27%) resources.

Keywords: 100% renewable energy; Kenyan electricity consumers; environmental conservation; adoption of renewable energy

1. Introduction

Residential energy consumption reduction can play a significant role in mitigating climate change [1]. Residential emissions particularly from urban areas, account for 30%–40% of the global greenhouse gases (GHGs) emissions [2,3]. Since 2012, Kenya's residential power consumption has grown by 28%. This growth occurred mainly as a result of urbanization and improved electricity access in the rural areas [4]. Currently, the residential sector accounts for 31% of the total electricity consumption [5]. In 2018, hoping to dramatically change this energy consumption outlook, the Kenyan government announced that it would supply 100% of its energy from renewable resources. Despite this noble attempt, the question remains as to the extent to which household energy consumers are willing to adopt renewable energy technologies in developing countries like Kenya that has suffered from chronic poverty conditions but is endowed with a high renewable energy generation potential.

Kenya's renewable energy market was established as early as the 1970s mostly by foreign investments. The country soon became known as a "donor hub" for solar photovoltaic (PV) facilities [6].

Currently, however, only about 1.2% of Kenyan households have installed home solar systems [4]. Some communities have undertaken community-level hydro projects while other individuals have invested in wind power generation.

In an international context, studies found that consumers' decisions to adopt renewable energy technologies were influenced by motivational, contextual, and habitual factors [7]. Some studies emphasized that residents adopted renewable energy technologies because of prospects for economic benefits or social pressure from their peers and neighbors [7–9]. Others suggested that environmental motivations induced people to adopt renewable energy [9]. Some research found a strong link among household environmental attitudes, energy consumption and investment patterns [10]. Government incentives would also induce the adoption of renewable energy as the cost appears to be a strong barrier to adoption [7,10–13]. Although several studies examined residential consumers' perceptions on renewable energy, these were mainly carried out in developed countries.

This study attempts to investigate regional contexts of residential consumers' decision-making for adopting renewable energy technologies in Kenya. Previous studies [14–16] demonstrated that consumer perceptions about renewable energy often vary by country. Even within a country studies [17,18] showed that those in rural areas are more likely to invest in renewable energy than those in urban areas. Other studies [19,20] noted that different lifestyles affect technological choices. In order to grow the building integrated photovoltaics (BIPV) market leading to economic and social progress, education of urban residential consumers' is crucial [19]. Despite these studies, scant attention has been paid to residential consumers' attitudes and willingness to adopt renewable energy technologies in Kenya. In addition, we know little about motivating factors and challenges that Kenya's household consumers face in investing in renewable energy technologies.

2. Materials and Methods

2.1. Study Areas

This study targets household electricity consumers in both urban and rural areas of Kenya. Considering climatic conditions, urbanization level, household power demand, economic activities, and renewable energy potential, we selected Nairobi County (urban), Makueni, and Uasin Gishu counties (both largely rural) (Figure 1). These counties have differences in electricity access rates, population distribution, electricity usage, and climatic conditions. The government has focused on renewable energy projects for rural areas [20]. However, the grid extension has progressed relatively slowly in rural areas. The two rural counties of Makueni (south-east) and Uasin Gishu (north-west) are located on the opposite sides of the capital city (Nairobi) with different climatic conditions. The eastern part of the capital city generally receives less rainfall than the western part does. The three counties, therefore, are a good representation of urban and rural areas in Kenya.

Nairobi County is the most populous county in Kenya with a population of 3,138,369, according to the 2009 census. Kenya's capital is located here. It has a total surface area of 697 km^2 and is classified as 100% urban. It receives an average annual precipitation of 926 mm with annual average maximum and minimum daily temperatures of 25.3 °C and 12.6 °C, respectively [21]. Currently, Nairobi County has the highest power consumption (45%) and is projected to remain so in the next 20 years. Nairobi county hosting the capital of Kenya has benefitted from a World Bank funded project of public/street lighting program [22]. In addition, it was the main beneficiary of slum electrification project [23]. Demographically, Nairobi residents can be clearly classified as low, middle-high-income groups by residential areas [24]. The main economic activities are manufacturing, tourism, commercial, and financial services. The average annual photovoltaic (PV) electricity output is 1530 kWh/kWp. The average annual wind power density ranges from poor to marginal (0–165 w/m^2) although some spots are very good (425–615 w/m^2) [25,26]. The County has no known hydro power generation potential [27].

Makueni County is one of the semi-arid counties located in the eastern part of Kenya about 130 km from Nairobi [28]. It has a total population of 884,527, according to the 2009 census [24]. It has a total surface area of 6806 km^2 with urban areas covering about 1% of the total land area. It receives an average annual precipitation of 596 mm with an annual average maximum and minimum temperatures of 28.2 °C and 16.8 °C, respectively [29]. To increase electricity access in rural areas, in 2012, the government set up a 13.5 kWp solar plant, battery storage, and canopy at the Kitonyoni village trading center. This solar project supplies electricity to about 3,000 residents [28]. The main economic activities here are agriculture (especially animal husbandry) and commerce. The average annual photovoltaic electricity output is 1573 kWh/kWp [28]. The average annual wind power density ranges from poor to marginal (0–165 w/m^2), although some spots are classified as good (275–425 w/m^2) [25,26]. Given the arid and semi-arid nature of the County, it has little hydro power generation potential [27].

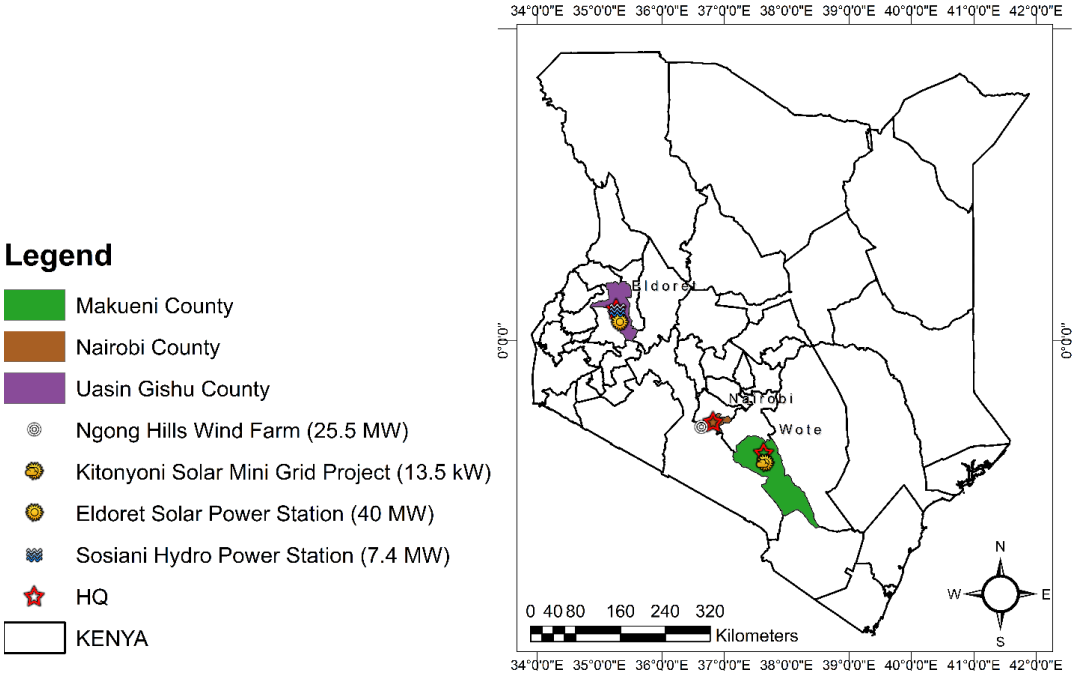

Figure 1. Map showing the study areas Source: Ministry of Devolution and ASAL Areas.

Uasin Gishu County is located on a plateau in the western part of Kenya about 310 km from Nairobi [24]. It has a total population of 818,757, which is evenly distributed across the County, according to the 2009 census. It has a total surface area of 3351 km^2 with urban areas covering about 6% of the County. It receives an average annual precipitation of 1100 mm with an annual average maximum and minimum temperatures of 23.3 °C and 11.3 °C, respectively [30]. The average annual photovoltaic electricity output is 1793 kWh/kWp [28], while the average annual wind power density ranges from poor to marginal (0–165 w/m^2) with some high density spots (275–425 w/m^2) [25,26]. This County also has potential for small hydroelectric generation and is one of the main catchment areas of Lake Victoria [27,31]. It benefited from a World Bank funded project of public/street lighting program [22].

2.2. Data Collection

The primary data was collected through the questionnaire survey that was administered between October and November 2018. Prior to this, a preliminary survey was conducted to make sure that the respondents could understand all the questions. A revised multiple choice questionnaire was then administered to 250 household heads through random sampling in the three counties of Nairobi, Makueni, and Uasin Gishu. We targeted 50 household heads in each county evenly distributed to cover

different parts of the country according to the local conditions. Considering Nairobi County is very diverse, we obtained cooperation from 100 residents from both low-income households (Kibera and Mukuru kwa Reuben slums) and middle-high-income households (Roysambu, Karen and Westlands estates). In addition, we had 50 respondents from the Nairobi County city center. This ensured that the survey captured a representative sample of all income levels and diversities in the County.

Since most household heads were either working or had some other errands during weekdays, the questionnaire was administered mainly during weekends except for shops and the Nairobi County city center respondents. The questionnaire was administered to adults only. The questionnaire was formulated after reviewing similar studies on perceptions of renewable energy [7,32–34], renewable energy acceptance and policies [35–37], and specific renewable energy technology studies [38–40]. In addition, an extensive review of government publications on rural and urban electrification projects [7,24], energy generation and transmission [41], energy planning [5], and reports on energy generation and supply [42,43] was carried out.

The questionnaire was divided into six sections. The first section attempted to find out the socio-demographic characteristics of the respondents, including the current source of electricity. The second section focused on respondents' concerns about environmental conservation, air pollution associated with diesel power generation plants, and the types of power they used. The third section investigated their willingness to accept 100% of their power supply from renewable energy sources, and their perceptions about government support for this purpose. The fourth section attempted to find out what renewable energy technologies the respondents would be willing to adopt and invest in. The fifth section looked into the motivations to invest in renewable energy technologies. The sixth section assessed the challenges residents faced in installing renewable energy technologies. The collected data were coded and entered into Microsoft Excel 2016. The data were analyzed by using Microsoft Excel Analysis ToolPak. The data was summarized using both descriptive and inferential statistics.

3. Results and Discussions

3.1. Socio-Demographic Characteristics

The first part of the questionnaire on socio-demographic characteristics identified age, gender, household size, educational level, and monthly income (Table 1). In addition, we asked the respondents to state their current electricity power source. Here we found that about 61% of the respondents were males. Three-quarters of the respondents fell within an age bracket of 20–39 years old. Only 3% of our respondents had no formal education and 89% had at least attained high school education. About 77% of those with postgraduate qualifications were from the middle and high-income category in Nairobi County. Those in Uasin Gishu, a rural county, tended to be less educated. Regarding the household size, 70% had four or less persons [21]. Those who had more than five persons tended to be in Uasin Gishu County (39%). About 63% of the respondents earned monthly income of between KES10,000 to 50,000 (US$1 = KES101.2986 on 1 January 2018). About 73% of those who earned less than KES20,000 per month lived in rural counties of Makueni (22%), Uasin Gishu (15%), and the low-income areas of Nairobi County (36%).

On the question of their current electricity power source, about 74% of the respondents obtained their electricity solely from the national grid, while 16% did from the combined sources of the national grid and solar PV. About 7% had electricity from a solar mini-grid, while 3% had all their electricity supplies from household solar PV with battery. All the respondents in Nairobi County were connected to the national grid. The majority of those who got power supply from both the national grid and solar PV were from rural counties of Uasin Gishu (48%) and Makueni (32%). All those who received power from a solar mini-grid were from Makueni County. Three-quarters of the households who had all their electricity from household solar PV with battery were from Makueni County while the rest were from Uasin Gishu County.

3.2. Concern on Environment and Power Generation

The second section of our survey focused on respondents' concerns about environmental conservation, renewable energy sources and other power sources the respondents used. We asked the respondents about the extent to which they cared about (1) environmental conservation, (2) air pollution associated with diesel power generation, and (3) the type of power sources they used (renewable or non-renewable sources).

Table 1. Socio-demographic characteristics of the respondents in the three counties.

Characteristics	N	%
Age		
Under 20	7	3
20–29	126	50
30–39	63	25
40–49	39	16
50–59	12	5
60 and above	3	1
Gender		
Male	152	61
Female	98	39
Household size		
1–2	73	29
3–4	103	41
5–6	61	25
7–8	11	4
9–10	1	0.4
Over 10	1	0.4
Education Level		
No formal education	8	3
Primary	20	8
Secondary	75	30
Diploma	71	29
Bachelors'	63	25
Postgraduate	13	5
Monthly income (KES)		
Less than 10,000	38	15
10,000–20,000	81	32
20,001–50,000	77	31
50,001–80,000	23	9
80,001–100,000	8	3
100,001–150,000	9	4
150,001–200,000	7	3
Over 200,000	7	3

The results show that about 98% of the respondents either strongly cared or cared about environmental conservation (Figure 2). Similarly, about 96% either strongly cared or cared about air pollution that was associated with diesel power generation. About 84% of the respondents strongly cared or cared whether the energy they used was generated from renewable sources or not. Previous studies [44–46] similarly showed high environmental concerns among household consumers. These consumers depicted other pro-environmental behaviors like adopting green electricity and energy conservation for air pollution control.

Here we also tried to find if there are regional variations in response to these three factors. An analysis of variance on environmental conservation (p-value = 7.93×10^{-11}), air pollution associated with diesel power generation (p-value = 1.75×10^{-8}), and power generation source (p-value = 3.34×10^{-8}) showed significant statistical differences among the three study areas. Those who strongly cared about environmental conservation were mostly from Makueni County (72%), low-income category (56%), middle and high-income category (54%), and Nairobi County city center (50%). In Uasin Gishu County 84% cared about environmental conservation.

The respondents who strongly cared about diesel power generated air pollution were from Makueni County (64%), Nairobi County city center (56%), middle-high-income category (52%) and low-income category (50%). About 94% of those in Uasin Gishu County stated that they cared about it. Those who strongly cared about power generation sources were from Makueni County (54%), low-income category (48%), middle-high-income category (44%), and Nairobi County city center (44%). In Uasin Gishu County 68% of the respondents cared about it and 30% said they were not sure.

These results show that the respondents in Makueni County strongly cared more about the three environmental issues compared to the other two counties. This can be understood from their geographical location in arid and semi-arid areas where the residents have experienced adverse environmental impacts like drought. In addition, their livelihoods (agriculture and livestock keeping) are directly connected to the environment [21]. Although the respondents in Uasin Gishu County also depended on farming, this County received higher rainfall with more forest cover [30].

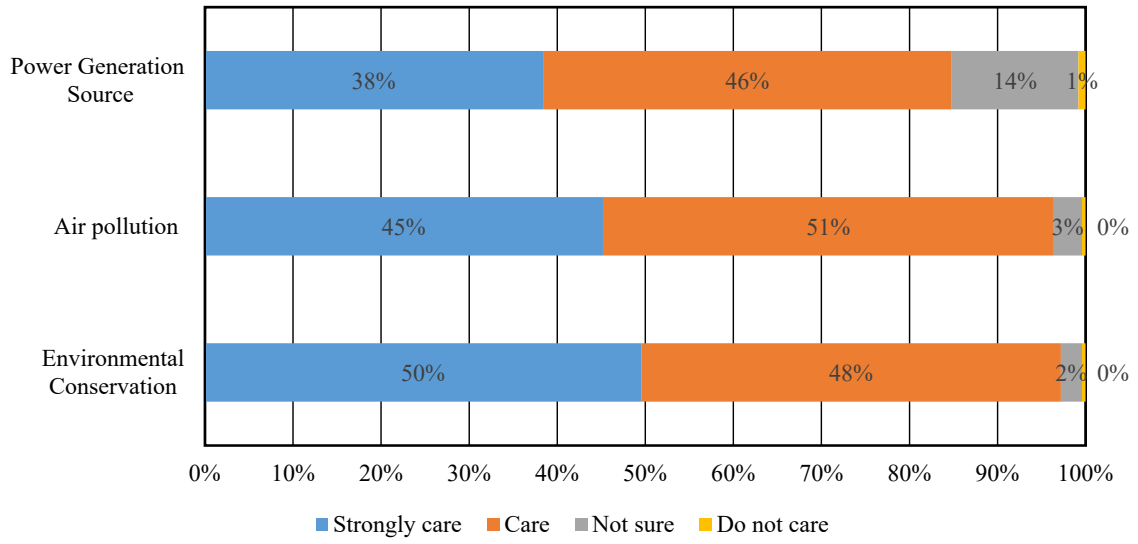

Figure 2. Perceptions on environmental conservation and power generation source.

Regarding responses from different regions, we additionally conducted a multiple regression analysis to find the connection between the three identified environmental problems and the respondents' socio-demographic characteristics. The analysis result shows that education (p-value = 2.42×10^{-2}) and income (p-value = 1.8×10^{-3}) significantly affected their perceptions about air pollution from diesel power. However, the two demographic characteristics of education and income had no significant effect on their perceptions about environmental conservation and power generation sources. Interestingly, the household size had a significant impact on perceptions of environmental conservation (p-value = 2.19×10^{-2}) and power generation source (p-value = 2.85×10^{-2}). However, age and gender had no significant effect on the respondents' perceptions. We found that the households with less than three persons and those with more than six persons showed their strong concerns about environmental conservation and energy sources whereas the households with three to five persons cared less about the environment and energy issues.

3.3. Power Supply from Renewable Energy Sources and Government Support

The third part of the questionnaire aimed to assess the extent to which consumers perceived the importance of adopting renewable energy. We tried to find out if household energy consumers wanted to receive all their domestic electricity needs from renewable energy sources. We also sought to find whether these consumers would like to sell energy they generated to the national or local grid. Additionally, we wanted to know how the respondents would respond to government subsidies for household customers' renewable energy adoption.

The result shows that about 84% of the respondents either strongly agreed or agreed that they wanted to receive all their electricity demand from renewable sources (Figure 3). An analysis of variance (p-value = 2.48×10^{-4}), indicated regional variations, in which we found that 92% of the respondents in Makueni and 100% in Uasin Gishu demonstrated their positive responses. In Nairobi County, middle- and high-income respondents (86%) showed more positive response compared to those in low-income ones (66%) and in the city center (76%). This is probably because among the surveyed households in Makueni County, about 12% had all their electricity demand from household solar PV with battery while about 34% had from a solar mini-grid. In Uasin Gishu County, about 4% obtained electricity from household solar PV while 44% from both the national grid and solar PV. This finding largely corresponds with an Australian study [36], in which home ownership was found to be an important factor for households to adopt renewable energy sources. A multiple regression analysis of the respondents' socio-demographic characteristics of age, gender, household size, education, and income levels did not show any significant effect on their willingness to obtain all their power demand from renewable energy sources.

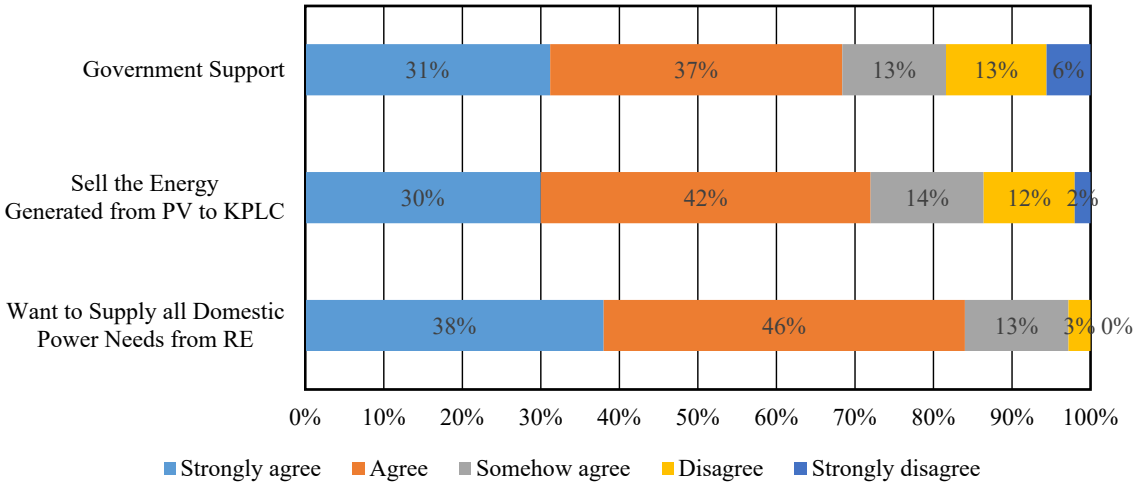

Figure 3. Perception on power supply from renewable energy sources and government support.

Regarding the second question about respondents' interests in selling energy to grids, about 72% of them either strongly agreed or agreed to this idea while about 12% disagreed. An analysis of variance (p-value = 2.53×10^{-7}) of their responses showed regional and income-level differences. All the respondents in Uasin Gishu County demonstrated their interests in selling power to grids. In Makueni County, about 72% showed their interests. In Nairobi County, about 74% of those in the middle-high-income level showed high interests while about 64% of those in the low-income level answered positively. A multiple regression analysis of the respondents' socio-demographic characteristics of age, gender, household size, education, and income levels did not show any significant effect on their interest to sell energy to the grids. These findings support previous similar studies in Germany, France, Italy, and Australia [47,48].

Regarding the importance of government incentive for household consumers to invest in renewable energy, about 68% either strongly agreed or agreed while about 19% either disagreed or strongly disagreed. An analysis of variance (p-value = 1.99×10^{-4}) indicated regional variations. In rural counties

of Uasin Gishu and Makueni, 94% and 85% of the respondents showed their interests in government support, respectively. In Nairobi County, 56% of the middle-high-income respondents and 65% of low-income people wanted government support. In the city center 50% showed interests. Some facts can explain the reasons behind these differences. For example, in the past the government support on renewable energy projects (especially off-grid) has been in the rural areas. The multiple regression analysis of these responses in connection to respondent's socio-demographic characteristics indicates that education (p-value = 1.62×10^{-2}) significantly affected their perceptions about government support.

3.4. Renewable Energy Technology Choices

The fourth section of the questionnaire asked the respondents about what renewable energy technologies they would like to invest in. The question in this particular section targeted only those households (74%) that obtained all their electricity needs from the national grid. The result shows that about 85% would invest in solar PV, while only 2% and 1% showed interests in wind and small hydro, respectively (Figure 4). About 6% would invest in the combination sources of solar PV, wind, and small hydro. The rest had no interest in any form of renewable energy technologies.

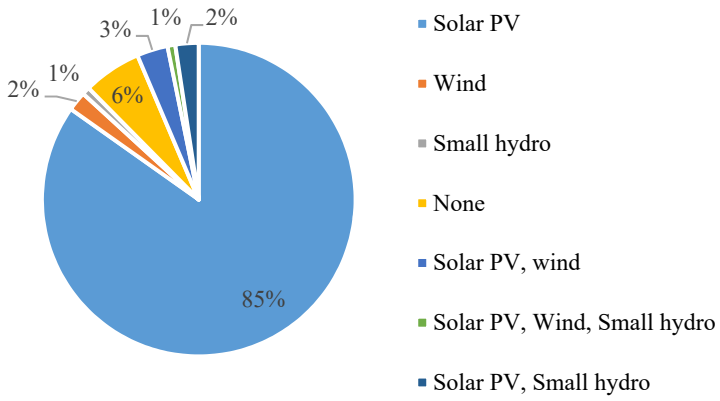

Figure 4. Households' renewable energy technology choices.

Here we found different responses by regions. In terms of investment in solar PV, the respondents in Makueni (94%) and Uasin Gishu (90%) wanted to invest in solar PV systems. In Nairobi County, the higher percentage of the middle-high-income group (86%) showed interests in solar compared to those in the low-income group (80%) and in the city center (72%). Those respondents who showed interests in wind power were from Makueni County and the Nairobi County city center while all those who wanted to invest in small hydro were from Uasin Gishu County. The tendency of residents to show interests in solar energy can be found in other developing countries like Qatar [33] and Yemen [15].

We found that respondents' interests in investing in renewable energy was also influenced by financial and climatic factors. In Kenya, solar PV is relatively easy and affordable technology compared to small wind and hydro technologies. On the other hand, only limited areas in western, central, and eastern parts of the country have potential for small and large hydro generation [31]. This explains why all respondents who showed interests in small hydro developments were from Uasin Gishu County. Currently, most of the households who have invested in small hydro have done so through community projects which are relatively larger [31].

3.5. Motivation to Invest in Renewable Energy Sources

The fifth section of the questionnaire attempted to understand residents' motivations to invest in renewable energy technologies. The survey results revealed that the respondents were largely motivated to prevent electricity supply problems, such as frequent power outages (42%), high power cost (37%), and lack of connection to the national grid (11%) (Figure 5). Additionally, environmental

concerns (6%) and low cost of renewable energy equipment (4%) motivated some respondents. Previous study [6] depicted the three issues as the main challenges in Kenya's energy sector.

Within a regional context, we found that frequent power outage was an important factor for the respondents in the Nairobi County city center (48%), while the high cost of power was more problematic for the low-income respondents (52%) in Nairobi County. For the respondents in Makueni County, lack of connection to the national grid was the main motivator (30%). Interestingly, environmental concerns were not considered as a motivation factor by the respondents of Makueni County, Uasin Gishu County, and Nairobi County's low-income group even though 98% of the respondents indicated that they strongly cared or cared about environmental conservation. Previous studies [44–46] similarly found that pro-environmental concerns did not always translate into actual actions.

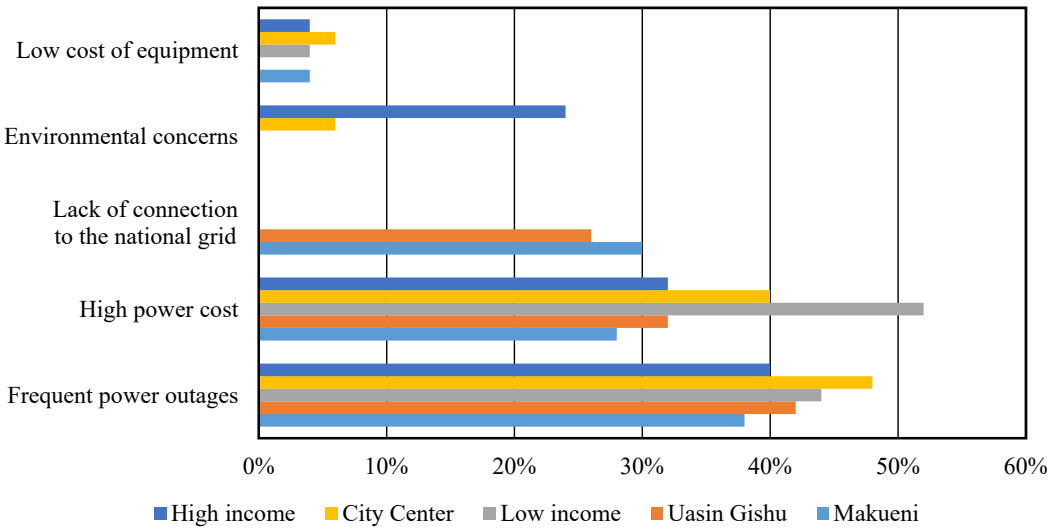

Figure 5. Motivation to invest in renewable energy sources.

The regression analysis of respondents' socio-demographic characteristics on motivations indicates that income levels (p-value = 1.8×10^{-3}) significantly affected their motivation. Low-income respondents were motivated by frequent power outages and high energy cost. On the other hand, for the middle-high-income respondents frequent power outages, high energy cost, and environmental concerns were equally worrisome.

3.6. Challenges Facing Adoption of Renewable Energy Technologies

The sixth section assessed the challenges the respondents faced in case they decided to install renewable energy technologies. About 46% said that the high cost of equipment was the main challenge (Figure 6). This was followed by intermittent nature of renewable energy sources (31%) and lack of qualified personnel to install (16%). Previous studies on Kenya's renewable energy sector similarly found that high equipment cost was one of the major challenges for Kenyan consumers [6].

In terms of regional variations, those in the middle-high-income 58% found this important, whereas 54% of those in the city center and 52% of those in the low-income groups showed their concerns over the cost. On the contrary, the cost was less important in Makueni (38%) and Uasin Gishu (30%). In these two rural counties, the intermittent nature of renewable energy was challenging whereas less than 30% of the respondents in all groups of Nairobi County indicated this as their challenge. The lack of skilled persons who can install solar PV was pronounced in Uasin Gishu County (36%) and Makueni County (18%). In Nairobi County, this is a challenge for a certain number of the middle-high-income group (14%).

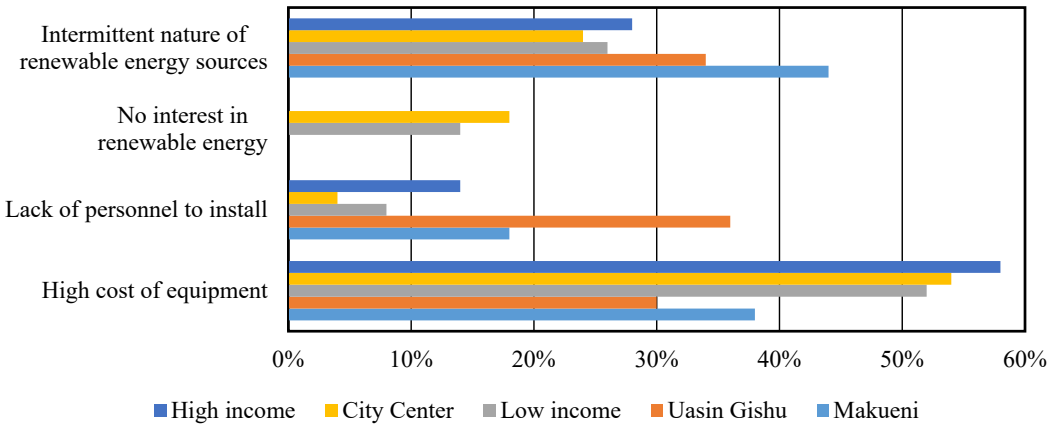

Figure 6. Challenges facing adoption of renewable energy resources.

4. Conclusions

This paper examined Kenya's household residents' perceptions about renewable energy supplies. We also investigated factors that motivated and hindered the adoption of renewable energy technologies in three different regions of Kenya: Nairobi (urban county), Makueni, and Uasin Gishu (rural counties). Even though about 98% of the respondents showed their concerns about environmental conservation, this reason alone did not appear to motivate the respondents to invest in renewable energy. Instead, the respondents mainly wanted to secure the steady energy supply as they had often experienced power outages. The high and fluctuating energy cost from the grid system also motivated them to invest in renewable energy. In rural areas, the respondents were largely motivated by lack of connection to the national grid. These rural residents expressed their needs to receive government support in adopting renewable energy technologies.

What hindered the respondents most in adopting renewable energy technologies was the high cost of equipment and intermittent nature of renewable energy resources. The latter reason was particularly prevalent for rural residents. About 96% of the rural respondents and 76% of the urban respondents preferred to have all their power supplies from renewable energy sources. In addition, about 84% (86% rural and 63% urban) expressed their wish to sell electricity they generate to the national grid. The main renewable energy technology that the respondents preferred to invest in was solar PV (85%).

Overall, this paper showed that Kenyan urban and rural residential consumers were highly interested in renewable energy. Kenya's national policy to have its 100% electricity supply from renewables can be further expedited with better understanding about regional differences in household consumers' needs. As the past studies showed the importance of understanding regional differences in terms of consumers' perceptions about adopting renewable energy, this study can shed light on this topic through a case study in Kenya. This paper also demonstrated that some of our findings corresponded with past studies about Europe and Australia. Within a policy improvement context, the findings of this paper can better inform Kenya's development partners like the US, EU, China, and Japan. These countries provide funding for major energy projects in Kenya.

Author Contributions: Conceptualization, Design of Questionnaire, Visualization, Methodology, Formal Data Analysis, Writing—Original Draft Preparation, E.K.; Questionnaire Review and Revision, Writing—Review, Revision and Editing, Supervision, Project Administration, K.M.; Data Collection, Writing—Review and Editing, N.M., E.K. Served as the corresponding author. All the authors read and approved the final manuscript.

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References

1. Azizalrahman, H.; Hasyimi, V. A model for urban sector drivers of carbon emissions. *Sustain. Cities Soc.* **2019**, *44*, 46–55. [CrossRef]
2. Nejat, P.; Jomehzadeh, F.; Taheri, M.M.; Gohari, M.; Muhd, M.Z. A global review of energy consumption, CO_2 emissions and policy in the residential sector (with an overview of the top ten CO_2 emitting countries). *Renew. Sustain. Energy Rev.* **2015**, *43*, 843–862. [CrossRef]
3. Hinnells, M. Technologies to achieve demand reduction and microgeneration in buildings. *Energy Policy* **2008**, *36*, 4427–4433. [CrossRef]
4. Energy Regulatory Commission. *Least Cost Power Development Plan 2017–2037*; Energy Regulatory Commission: Nairobi, Kenya, 2018.
5. The Kenya Power and Lighting Company Limited (KPLC). *The Kenya Power and Lighting Company Limited: Annual Report and Financial Statements 2016/2017*; Kenya Power and Lighting Company Limited: Nairobi, Kenya, 2017; p. 63.
6. Boampong, R.; Phillips, M.A. *Renewable Energy Incentives in Kenya: Feed-in-Tariffs and Rural Expansion*; University of Florida: Gainesville, FL, USA, 2016.
7. Kowalska-Pyzalska, A. What makes consumers adopt to innovative energy services in the energy market? A review of incentives and barriers. *Renew. Sustain. Energy Rev.* **2018**, *82*, 3570–3581. [CrossRef]
8. Zheng, M.; Meinrenken, C.J.; Lackner, K.S. Agent-based model for electricity consumption and storage to evaluate economic viability of tariff arbitrage for residential sector demand response. *Appl. Energy* **2014**, *126*, 297–306. [CrossRef]
9. Palmer, J.; Sorda, G.; Madlener, R. Modeling the diffusion of residential photovoltaic systems in Italy: An agent-based simulation. *Technol. Forecast. Soc. Change* **2015**, *99*, 106–131. [CrossRef]
10. Masini, A.; Menichetti, E. The impact of behavioural factors in the renewable energy investment decision making process: Conceptual framework and empirical findings. *Energy Policy* **2012**, *40*, 28–38. [CrossRef]
11. Negro, S.O.; Alkemade, F.; Hekkert, M.P. Why does renewable energy diffuse so slowly? A review of innovation system problems. *Renew. Sustain. Energy Rev.* **2012**, *16*, 3836–3846. [CrossRef]
12. Khambalkar, V.P.; Katkhede, S.S.; Dahatonde, S.; Korpe, N.D.; Nage, S.M. Renewable energy: An assessment of public awareness. *Int. J. Ambient Energy* **2010**, *31*, 133–142. [CrossRef]
13. Qu, M.; Ahponen, P.; Tahvanainen, L.; Gritten, D.; Mola-Yudego, B.; Pelkonen, P. Chinese university students' knowledge and attitudes regarding forest bio-energy. *Renew. Sustain. Energy Rev.* **2011**, *15*, 3649–3657. [CrossRef]
14. Halder, P.; Prokop, P.; Chang, C.Y.; Usak, M.; Pietarinen, J.; Havu-Nuutinen, S.; Pelkonen, P.; Cakir, M. International Survey on Bioenergy Knowledge, Perceptions, and Attitudes Among Young Citizens. *BioEnergy Res.* **2011**, *5*, 247–261. [CrossRef]
15. Baharoon, D.A.; Rahman, H.A.; Fadhl, S.O. Publics' knowledge, attitudes and behavioral toward the use of solar energy in Yemen power sector. *Renew. Sustain. Energy Rev.* **2016**, *60*, 498–515. [CrossRef]
16. Balta-Ozkan, N.; Watson, T.; Mocca, E. Spatially uneven development and low carbon transitions: Insights from urban and regional planning. *Energy Policy* **2015**, *85*, 500–510. [CrossRef]
17. Balta-Ozkan, N.; Le Gallo, J. Spatial variation in energy attitudes and perceptions: Evidence from Europe. *Renew. Sustain. Energy Rev.* **2018**, *81*, 2160–2180. [CrossRef]
18. Hori, S.; Kondo, K.; Nogata, D.; Ben, H. The determinants of household energy-saving behavior: Survey and comparison in five major Asian cities. *Energy Policy* **2013**, *52*, 354–362. [CrossRef]
19. Tabakovic, M.; Fechner, H.; Van Sark, W.; Louwen, A.; Georghiou, G.; Makrides, G.; Loucaidou, E.; Ioannidou, M.; Weiss, I.; Arancon, S.; et al. Status and outlook for building integrated photovoltaics (BIPV) in relation to educational needs in the BIPV sector. *Energy Procedia* **2017**, *111*, 993–999. [CrossRef]
20. Bawakyillenuo, S. Deconstructing the dichotomies of solar photovoltaic (PV) dissemination trajectories in Ghana, Kenya and Zimbabwe from the 1960s to 2007. *Energy Policy* **2012**, *49*, 410–421. [CrossRef]
21. Kenya National Bureau of Statistics (KDHS). *The 2009 Kenya Population and Housing Census. Counting Our People for the Implementation of Vision 2030. VOLUME IC Population Distribution by Age, Sex and Administrative Units*; Kenya National Bureau of Statistics (KDHS): Nairobi, Kenya, 2010; Volume IC.
22. Kenya Power. *Monthly Report to the MoE on the Power Supply Situation and Progress in Implementation of Priority Projects Coordinated by KPLC*; Kenya Power: Nairobi, Kenya, 2018.

23. Kenya Power and Lighting Company Limited (KPLC). *Kenya Electricity Expansion Project Slum Electrification Component Social Management Framework*; The Kenya Power and Lighting Company Limited (KPLC): Nairobi, Kenya, 2016.
24. Kenya National Bureau of Statistics (KDHS). *Nairobi County Statistical Abstract*; Kenya National Bureau of Statistics (KDHS): Nairobi, Kenya, 2015.
25. Theuri, D. Kenya Country Report: Solar and Wind Energy Resource Assessment. *Kenya Ctry. Rep.* **2008**, 1–61.
26. Ministry of Energy and Petroleum. *Wind Sector Prospectus—Kenya*; Ministry of Energy and Petroleum: Nairobi, Kenya, 2013.
27. Ministry of Energy and Petroleum. *Hydropower Resources Atlas of Kenya with Emphasis on Small Hydropower Resources Department of Renewable Energy*; Ministry of Energy and Petroleum: Nairobi, Kenya, 2015.
28. Heap, B. *Smart Villages: New Thinking for Off-Grid Communities Worldwide*; Essay Compilation: Banson, UK, 2015.
29. Brown, T.W.; Bischof-Niemz, T.; Blok, K.; Breyer, C.; Lund, H.; Mathiesen, B.V. Response to Burden of proof: A comprehensive review of the feasibility of 100% renewable-electricity systems. *Renew. Sustain. Energy Rev.* **2018**, *92*, 834–847. [CrossRef]
30. Heuberger, C.F.; MacDowell, N. Real-World Challenges with a Rapid Transition to 100% Renewable Power Systems. *Joule* **2018**, *2*, 367–370. [CrossRef]
31. Kiplagat, J.K.; Wang, R.Z.; Li, T.X. Renewable energy in Kenya: Resource potential and status of exploitation. *Renew. Sustain. Energy Rev.* **2011**, *15*, 2960–2973. [CrossRef]
32. Chapman, A.; Itaoka, K. Curiosity, economic and environmental reasoning: Public perceptions of liberalization and renewable energy transition in Japan. *Energy Res. Soc. Sci.* **2018**, *37*, 102–110. [CrossRef]
33. Abdmouleh, Z.; Gastli, A.; Ben-Brahim, L. Survey about public perception regarding smart grid, energy efficiency & renewable energies applications in Qatar. *Renew. Sustain. Energy Rev.* **2018**, *82*, 168–175.
34. Zografakis, N.; Sifaki, E.; Pagalou, M.; Nikitaki, G.; Psarakis, V.; Tsagarakis, K.P. Assessment of public acceptance and willingness to pay for renewable energy sources in Crete. *Renew. Sustain. Energy Rev.* **2010**, *14*, 1088–1095. [CrossRef]
35. Musall, F.D.; Kuik, O. Local acceptance of renewable energy-A case study from southeast Germany. *Energy Policy* **2011**, *39*, 3252–3260. [CrossRef]
36. Sommerfeld, J.; Buys, L.; Vine, D. Residential consumers' experiences in the adoption and use of solar PV. *Energy Policy* **2017**, *105*, 10–16. [CrossRef]
37. Parkins, J.R.; Rollins, C.; Anders, S.; Comeau, L. Predicting intention to adopt solar technology in Canada: The role of knowledge, public engagement, and visibility. *Energy Policy* **2018**, *114*, 114–122. [CrossRef]
38. Herington, M.J.; van de Fliert, E.; Smart, S.; Greig, C.; Lant, P.A. Rural energy planning remains out-of-step with contemporary paradigms of energy access and development. *Renew. Sustain. Energy Rev.* **2017**, *67*, 1412–1419. [CrossRef]
39. Ozaki, R. Adopting sustainable innovation: What makes consumers sign up to green electricity? *Bus. Strateg. Environ.* **2011**, *20*, 1–17. [CrossRef]
40. Pickett-Baker, J.; Ozaki, R. Pro-environmental products: Marketing influence on consumer purchase decision. *J. Consum. Mark.* **2008**, *5*, 281–293. [CrossRef]
41. Government of the Republic of Kenya. *5000+ MW by 2016: Power to Transform Kenya*; Government of the Republic of Kenya: Nairobi, Kenya, 2013.
42. Republic of Kenya. *CBPR Database—Kenya*; Republic of Kenya: Nairobi, 2016; pp. 1–8.
43. The Kenya Power and Lighting Company Limited (KPLC). *The Kenya Power and Lighting Company Limited Five Year Corporate Strategic Plan*; The Kenya Power and Lighting Company Limited (KPLC): Nairobi, Kenya, 2016; Volume 1, p. 80.
44. Gadenne, D.; Sharma, B.; Kerr, D.; Smith, T. The influence of consumers' environmental beliefs and attitudes on energy saving behaviours. *Energy Policy* **2011**, *39*, 7684–7694. [CrossRef]
45. Dimeas, B.A.; Drenkard, S.; Hatziargyriou, N.; Karnouskos, S.; Kok, K.; Ringelstein, J. Smart Houses in the Smart Grid. *IEEE Electrif. Mag.* **2014**, *2*, 81–93. [CrossRef]
46. Morstyn, T.; Mcculloch, M.D.; Member, S. Multi-Class Energy Management for Peer-to-Peer Energy Trading Driven by Prosumer Preferences. *IEEE Trans. Power Syst.* **2018**. [CrossRef]

47. Mondal, M.A.H.; Kamp, L.M.; Pachova, N.I. Drivers, barriers, and strategies for implementation of renewable energy technologies in rural areas in Bangladesh—An innovation system analysis. *Energy Policy* **2010**, *38*, 4626–4634. [CrossRef]
48. Yaqoot, M.; Diwan, P.; Kandpal, T.C. Review of barriers to the dissemination of decentralized renewable energy systems. *Renew. Sustain. Energy Rev.* **2016**, *58*, 477–490. [CrossRef]