Acta Universitatis Danubius
ŒCONOMICA

Energy Efficient Innovations and Market Acceptance: A Revealed Preference Approach

Christopher Tarisayi Chikandiwa[1]

Abstract: Green energy innovations such as microgeneration technologies could be the vital cog in combating climate change and its impact, mainly due to their non-damaging effect on the environmental ecosystem. Previous studies on market acceptance of housing energy efficiency are very scant in the African region, and little is known about the acceptance and adoption of green energy technologies in residential spaces in the African region. Therefore, this article seeks to establish the extent of market acceptance of energy-efficient innovations in the residential sector, particularly in South Africa. The revealed and implied priority approach was employed in a sample of housing advertisements in KwaZulu-Natal, a province of South Africa. The study's findings show that the market does not prioritise energy-efficiency innovations. Specifically, the enquiry showed that energy-efficiency innovations are characteristic of the local housing stock in the province. Still, participants in the housing property market do not seem to value them. This article is valuable as it not only conceptualises and demonstrates the applicability of the revealed approach and the implied priority methods in portraying the actual choices made by individuals with regard to energy efficiency technologies, but it also suggests some strategies as an effort to improve green energy innovation adoption by homeowners in the province.

Keywords: microgeneration; green product innovation; implied preference; house owners; housing advertisements

JEL Classification: according to the JEL Classification System

[1] Senior Lecturer, University of KwaZulu-Natal, Durban, South Africa, Address: University Road, Westville, Private Bag X 54001, Durban 4000, South Africa, Corresponding author: chikandiwa@ukzn.ac.za.

1. Introduction

Green energy technology is the gem of the twenty-first century, a source of hope to the planet's greatest threat. Energy-efficient innovations like solar panels, solar water heaters and micro wind turbines, which could be installed in homes, can be categorised as green energy technologies (Guo et al., 2021; Baskaran, Managi & Bendig, 2013; Claudy, Michelsen & O'driscoll, 2011) that reduce or cause no harm to the environment (Balcombe, Rigby & Azapagic, 2015). Energy-efficient residential buildings that are designed to maximise performance and occupant health and to reduce long-term operating expenses, are not just a matter of a good investment for the owners but it is also predominantly good for sustainability reasons (Kong & He, 2021; Bickerstaff, Devine-Wright & Butler, 2015; González, Riba, Puig & Navarro, 2015). Previous studies indicated that investing in microgeneration is an economically feasible way of shrinking energy costs and carbon dioxide release, the process of which could help elicit positive changes in the consumption patterns of energy (Allen et al., 2008; Brandoni et al., 2014; Elmustapha, Hoppe & Bressers, 2018). In addition, greening buildings on a widespread scale can help cultivate niche markets for green buildings, as well as green products and technologies (González et al., 2015).

However, ensuring wide acceptability and participation in sustainable energy technologies and practices is complicated. The acceptance of sustainable energy technologies is not just an issue of individual characteristics, as well as potential risks and benefits, but it is predominantly a "social process" often influenced by a myriad of factors, which influence public participation in the sustainability arena (Elmustapha et al., 2018; Bondio, Shahnazari & Mchugh, 2018). The process is neither straightforward nor standardised. At the center stage of the housing sustainability acceptability lie the human factors (such as the real estate market compromising the professionally involved actors, the buyers and sellers) and the "composite good", the house to add to the complications.

Although a significant body of literature from energy studies exists, little is known about the market acceptability of energy-efficient innovations in the residential sector of South Africa, with many studies focusing on renewable energy in other sectors and fields (Alcock, 2012; Joubert, Hess & Van Niekerk, 2016; Nethengwe, 2022; Ngcobo, Akinradewo & Mokoena, 2024). Evidence from the international arena may not be applicable to judge the case of energy-efficiency innovations in South Africa, because the response of consumers to sustainability depends on the specific characteristics of the consumer, as well as the climate and culture of the country in question. In that view, any result from earlier studies in other countries might not reveal the preferences of the South African housing market. This article, therefore, aims to shed light on the market acceptability of energy efficiency features and, in particular, energy-efficient innovations. To achieve the aim of the article, the

revealed approach and the implied priority methods were deemed suitable to provide some understanding and insights into whether the current South African housing market values energy efficiency innovations. Thus, the residential sector, particularly the housing property market, was the context for the study. As such, a rigorous analysis of the existing housing stock that exhibits the residential preferences of a given society was empirically explored.

The rest of the article is organised as follows: theoretical basis and empirical studies, the research methods employed and data analysis. Subsequently, a discussion of the findings and their implications is provided. Finally, the last section provides a conclusion and future research guidelines.

2. Theoretical Literature and Literature Review

This article is underpinned by three theories, which will help us to appreciate how market acceptance of green energy technologies should be studied in the context of sustainability and the lived realities of society. The section provides a detailed background on preference models and their underlying theoretical foundations. Furthermore, a discussion of the real estate market is also provided alongside the implied priority method. The theories are elucidated below.

2.1. The Social Acceptance Theory

The concept of social acceptance has to do with consent, approval and endorsements of technology (Flynn & Bellaby, 2007). According to Raven et al. (2009), social acceptance is not just acceptance by the citizens but by a number of stakeholders, such as the experts and policymakers in full support of the technology. The consumers should be well-informed, positive, willing and ready to adopt the technology in its own context (Raven et al., 2009). Consumers often base their technology acceptance on trust and endorsements made by specialists or experts through advertising. In some instances, consumers may not make any decisions in adopting technologies because the options would not have been offered or presented to them.

The notion of adopting innovations in their own context highlights the fact that these new technologies have various characteristics or features which distinguish them from conventional energy technologies. The former often calls for the users to actively engage with them (Sauter & Watson, 2007). This is important as it shows the extent to which consumers are willing to trust and accept new technology. (Amy et al., 2002) developed the public acceptability of controversial technologies (PACT) framework, which determines how consumers make decisions in adopting technologies. The framework differentiates between public acceptance and public

acceptability, with the former referring to the formal decisions made to execute the proposal. At the same time, the latter implies the individuals' willingness to consider the technology seriously. (Amy et al., 2002) noted that acceptability entails the extent to which the perceived technology conforms to societal norms and values in order to be accepted as a feasible alternative.

2.2. Economic Value

Another strand of theoretical debate, which lends support to the concept of the acceptability of new technology, revolves around the economic value theory. By definition, value refers to goods or services that are of importance or usefulness (Barnes-Mauthe, Oleson & Zafindrasilivonon, 2013). Value can be associated with goods or services, regardless of whether there is a market (monetary transaction taking place) or in the absence of a market. The private market goods (not traded on the traditional market) are not always easy to value. However, the Total Economic Value (TEV) framework can identify and categorise the use and non-use values of green product innovations and practices (Barnes-Mauthe et al., 2013; Grant et al., 2013). Although several techniques have been developed to compute the TEV, the process of identifying and categorising the non-monetary values is not always straightforward. The next section discusses some of the methods used to capture the value of non-tradable goods.

2.3. The Revealed Preference Theory

The choices that individuals make reveal their preferences (Alvarez, Larkin, Whitehead & Haab, 2014; Blow & Blundell, 2018). The revealed preference approach provides evidence of the actual choices made by individuals or a society. Numerous media (without any need for experimental manipulations) portray the actual choices made by individuals. From a residential housing perspective, a rigorous analysis of the existing housing stock could reveal the residential preferences of a given society (Christie, 2010). Numerous players, such as owners, estate agents, buyers, developers and policymakers (Christie, 2010; Storper & Manville, 2006; Myers & Gearin, 2001) over an extensive time, shape the housing landscape of a given area. A house is a "composite good" that reveals the features and price of the house as dictated by the housing market (Arnott, 1987; Coolen, Jansen & Goetgeluk, 2011; Wang & Xie, 2022). As such, house prices are not appropriate sources of preference information in the real estate market, as they are often influenced by multiple factors such as neighbourhood qualities, size and construction method. For example, a house characterised by green energy efficiency features in Seaview, Durban South, might have a lower price than a house without

energy efficiency features in Umhlanga, Durban North. This demonstrates that a multitude of factors determines the pricing of the house.

Although the revealed preference approach cannot capture the non-use values, such as social costs associated with a specific microgeneration technology (Balcombe, Rigby & Azapagic, 2013), its applicability in non-market valuation provides the basis for the present study. The approach provided a balanced way of gathering the value placed on housing energy-efficiency features by studying the existing stock of houses in the residential sector.

2.4. The Real Estate Market

The real estate market is an important secondary market which facilitates the trading of dwellings between buyers and sellers, such as developers and homeowners. Although the theory of market efficiency suggests that the price of a good traded in a free market fully reflects all currently available information (Fama, 2014; Cochrane, Moskowitz & Fama, 2017), the prices of houses in the real estate markets are influenced by a multitude of factors. The real estate market is often characterised by information asymmetry, and the real estate agents are, time and again, more informed than the clients who hire them. Hence, they may exploit this informational advantage (Levitt & Syverson, 2008). A well-informed real estate agent is strategically well-positioned to sell houses to homebuyers and knows what interests homeowners and what they value in real estate advertisements. In reality, those seeking a home do not typically have concrete, well-defined information, and consequently, the search process can generate unanticipated outcomes. Thus, real estate advertisements can be considered the leading indicator of market priorities (buyers and sellers of housing properties) (Christie, 2010). Therefore, the real estate market investigation is an important part of society`s housing sustainability acceptance analysis.

2.5 The Implied Priority Approach

The implied priority approach can be used to study the revealed preferences. Advertising by real estate agents can be argued to reflect the homeowners' preferences (Christie, 2010). Advertisements can be viewed as expressions of the values placed by the housing market. It is in the best interest of the real estate agent to carefully select the words and images which must position the features of the house that they represent (Johnson & Young, 2002) to make a quick and easy sale (Christie, 2010). This implies that the words and images that appear in the advertisement are carefully chosen to reveal what is essential and of value to the market participants, in particular, the estate agents and the homebuyers. The approach requires the researcher to focus on the available and visual information and

process it accordingly. The following section provides a brief analysis of the empirical studies.

Previous studies on housing advertisements directed to house buyers clearly show that energy efficiency features are not receiving the value and attention they deserve in the traditional housing market (Christie, 2010; Roberts, 2016). Roberts (2016) found that two houses can be similar and adjacent to each other, with the exception that one of them might have sustainable features, but they are typically apportioned the same value.

On the other hand, Gavin's (2007) study revealed that there is a need to raise awareness among the public regarding global warming, and this can be reflected by the amount of media attention given to this topic compared to other media topics. In addition, the level of media coverage seems to play a crucial role in pushing green living and behaviour (Gavin, 2007; Johnson, Hershey, Maszaros & Kunreuther, 1993).

It is against this backdrop that the study underlying this article analysed selected housing advertisements to establish the energy efficiency features in the residential sector, using a unified approach of the revealed preference technique and the implied priority method. The next section discusses the methodology that was applied in the study.

3. Methodology and Research Methods

3.1. The Revealed Preference Approach

In light of the above discussion, the revealed preferences approach was deemed the most appropriate method for this study. The technique provides a way to gain some insights into the currency of sustainability and energy efficiency features, without imposing the limitations of the stated preference approach. Based on the revealed preferences approach, the housing property advertisements were chosen to investigate the implied preference given to energy-efficiency innovations. Thus, the residential sector and particularly the housing property market was the context for the study, which critically examined the online and magazine advertisements for potential house buyers in order to determine the extent to which the words and images that are used make green energy an attractive and meaningful category for selling houses. In line with Christie's (2010) study, the assumption was that if energy-efficient features matter to homeowners, then the market (property market) should reflect this. Another assumption was that an analysis of this nature would reveal whether South Africa has a market for energy-efficiency innovations.

3.2. Study Design

In this article, the most relevant data retrieval to fulfil the aim of the research was conducted through several steps. Firstly, the words and images used in housing advertisements were analysed using qualitative and quantitative approaches. The analysis was done to assess whether energy-efficiency innovations were regarded as being among the most important features used in housing advertisement communication. Housing advertisements were chosen for various reasons: houses are among the most expensive properties that households buy; they are a "composite product" most susceptible to sustainability elaboration and green segmentation and they are the currency of development progress and, therefore, the foundation for the desire to buy a house with the green product innovations available.

In line with the previous studies, the decision was based on the assumption that what is being advertised is a clear indication of the potential housing buyers' preferences and that the priority, they put on certain housing characteristics, can be reflected by the amount of media coverage that it receives (Christie, 2010; Alvarez et al., 2014). To ensure the representativeness of the South African housing market, two different sources of communication media, namely online and printed advertisements, were selected. The assumption was that online advertisements allow the advertiser/ real estate agent the flexibility to design advertisements for the property without concern for space, which is the case with printed advertisements. The hypothesis is that the more space is limited, the less important characteristics will be ignored.

3.3. Sampling Strategy and Data Gathering

Secondly, the criteria reminiscent of the one proposed by Christie (2010) were used to select the most appropriate data sources. As such, samples of online and print advertisements in the residential property genre were accessed from commercial online networks; Property24[1], Private property[2] websites, as well as the hard copy versions of The Neighbourhood and The Home (KZN) magazines, during the period from March-August of 2016, 2017 and 2018. The periods to collect and analyse the data were chosen such that the sample included advertisements from various houses that were on the market at different times of the year. The 2018 sample was included in the original two-year sample to check for any disparities in terms of the coverage and appearance of housing energy efficiency innovations in the advertisement.

While there are a number of property advertisement websites, the chosen websites and magazines, as described above, were considered the most comprehensive. It was believed that most buyers would consider these websites, as they are easily

[1] www.propoerty24.com.

[2] www.privateproperty.co.za.

accessible. The magazines were weekly publications made freely available and easily accessible in common areas (often by the entrances of popular supermarkets in the shopping malls). The Neighbourhood was distributed on Sundays as an insert in the Sunday Times newspapers, while The Home was distributed on Sundays as an insert in the Sunday Tribune newspapers. In addition, it was deemed sufficient and efficient to derive samples from these sources, mainly due to time and resource restrictions. However, it should be pointed out that The Neighbourhood was dropped from the study in 2018 as it contained very few housing advertisements, which, from a personal analysis, was an expensive strategy to advertise in a national newspaper.

Using procedures similar to Christie (2010), the data collection process for the study encompassed different sequential stages. The first stage involved a systematic linear quota sampling approach, which was employed to sample the regions that appeared on the Private Property website. The website was used as the initial sampling frame to build the study sample. Overall, eight main regions were sampled, namely Dolphin Coast, Drakensberg, Durban, KwaZulu-Natal Midlands, KwaZulu-Natal North Coast, KwaZulu-Natal South Coast, Northern KwaZulu-Natal and Pietermaritzburg.

The sampling process included the online search and collection of advertisements with energy-efficient features. A predefined list of keywords, such as energy, green, sustainability, and solar, was used in the search process. However, the list of keywords used for the search process was considered ongoing to ensure a clear representation of the current market of energy-efficient innovations in housing. Additional new terms were added as they appeared in the advertisements. The advertisements were then screened to meet the requirements for energy-efficient features. Secondly, a control group was created to reduce the disparities caused by the sampling (search and selection) process adopted. The control group for the online version was created using a systematic linear quota sampling method. The 10 advertisements that appeared first for each region in the online advertisement were placed in the control group. To ensure a random sample of "typical" property advertisements was placed in the control group, no screening of any sort was done. It is striking to mention that only five advertisements in the control group made reference to energy efficiency features.

Finally, a manual search process of advertisement in The Neighbourhood and The Home (KZN) magazines was conducted to locate the print versions of the online advertisements identified in the Property24[1] and Private Property[2] websites. Any advertisement that did not appear in the print version was dropped from the final sample. The final sample consisted of the advertisements that appeared in both the online and printed versions. The online and print versions of the advertisement were selected to enable the analysis of the implied space restrictions and the implied

[1] www.property24.com.

[2] www.privateproperty.co.za.

priority of energy-efficient features. An overall sample of 107 advertisements (56 "case sample" and 51 "control group"), was achieved and deemed sufficient to compute the statistical analysis. Similar to Christie (2010), the researcher could not find all of the online advertisements in the printed version. However, the impact of bias on the representativeness of the final sample was reduced by the fact that this applies to both the case and control groups.

3.4. Content and Discourse Analysis

The advertisements that formed part of the final sample were analysed based on the content and discourse that was evident in the different media platforms. Table 1 provides the three categories that were formulated for the case sample. The housing advertisements in the case sample were categorised by their energy efficiency features orientation as indicated below:

- Advertisement in which conventional energy efficiency features were depicted;
- Advertisement in which green energy efficiency innovations were depicted;
- Advertisement in which either conventional and innovative energy efficiency were featured or were more focused on general: green building/ home.

Table 1. Sustainability orientation of housing advertisements

Energy efficient orientation	2016	2017	2018	Combined
Conventional oriented	34% (79)	29% (67)	37% (85)	54% (231)
Green oriented	25% (17)	34% (23)	41% (27)	16% (67)
General; building/home-oriented	33% (43)	32% (42)	35% (45)	30% (130)
Total	n=139	n=132	n=157	n=428

Overall, conventional-oriented energy feature advertisements exceeded general building/home-oriented features, and there were relatively few advertisements containing green-oriented energy innovations. Differences in sustainability orientation, however, appeared in the sampled years. It was interesting to note that there was a general increase in the number of advertisements featuring green energy innovations. However, since the focus of the study was on energy efficiency features in words and images, and not on sample year attributes, all advertisements were grouped together for further analysis. Overall, the most striking result which emerged from the data was that microgeneration technologies appeared in some of the housing advertisements.

4. Data Analysis and Results

This section of the study highlights and discusses the results of the analysis that was done to assess the acceptability of energy-efficiency innovations in the housing market using the data that were collected. The discussion of the results is divided into three sections. The first section provides the results of the Paired Samples Tests and the Independent samples test. The second section contains the results of the non-parametric tests. The third provides results of the energy-efficient innovations and an overview of the current sustainability technologies and systems in the province.

4.1. Implied Space Restriction

4.1.1. Sample Statistics

The mean-variance evaluation of the implied space restriction in the housing advertisement was conducted using the Paired sample t-test. This measure is calculated using the sample mean and standard deviation of both the online and print versions of the housing advertisement. The results were then compared against each other and are presented in Tables 2 and 3.

Table 2. Sample Statistics

	Control sample (Typical) (N=51)		**Case sample (Energy efficiency) (N=56)**	
	M	***SD***	***M***	***SD***
Words Online	204.90	69.81	228.73	70.53
Words on the Print versions	32.61	8.93	39.11	11.44
Picture Online	25.65	13.77	28.30	12.59
Picture on the Print versions	1.39	0.7	1.14	0.44

The information in Tables 2 and 3 shows that the online advertisement had significantly more information (words) than the printed versions. Both the control sample and the case sample show a significant difference; the control group ($t(50) = 17.93$, $p<.0001$) Mean (M) = 205 (online), M = 33 (print) and the case sample ($t(55) = 20.59$, $p<.0001$) Mean M = 229 (online), M = 39 (print)). Similar tests were performed for the pictures/ images in the control group ($t(50) = 12.57$, $p<.0001$) M = 26 (online), M = 1 (print)) and the case sample ($t(55) = 16.32$, $p<.0001$) (M = 28 (online), M = 1 (print)).

Table 3. Paired samples test

		t-value	**Degrees of freedom**	**p-value**
Words	Case sample	20.59	55	0.0001
	Control group	17.93	50	0.0001

Images	Case sample	16.32	55	0.0001
	Control group	12.57	50	0.0001

The results presented in Table 2 also show that, on average, in the case sample, the online advertisements had 189 more words and 27 more images than the hard copy "printed" versions. In addition, the results for the control group show that the online advertisements had, on average, 172 more words and 24 more images than the "printed" versions. Analogous to Christie, (2010), the results presented seem to support the notion that there is an implied pressure to select the features and the words carefully when moving from the online to the print version.

4.1.2. Independent Sample Test

Further analysis was computed using the independent sample test to assess whether the housing market gave priority to energy-efficiency innovations. The results of the independent samples test for the online advertisements in words and images are presented in Table 4 and Table 5, respectively.

Table 4. Independent samples test (online words)

	t-value	**Degrees of freedom**	***p*-value**
Equal variances assumed	1.75	105	0.083
Equal variances not assumed	1.75	104.26	0.082

**Hartley test for equal variance: F = 1.021 and p-value =0.47*

Table 5. Independent samples test (online images)

	t-value	**Degrees of freedom**	***p*-value**
Equal variances assumed	1.04	105	0.301
Equal variances not assumed	1.03	101.56	0.303

**Hartley test for equal variance: F = 1.20 and p-value =0.25*

Contrary to expectations, the results did not reveal any significant difference between the online; case sample and control group, as far as the number of words (t (105) = 1.75 *p*-value = 0.083) and images (t (105) = 1.04 *p*-value = 0.301) is concerned. The analysis did not confirm any significant differences between the case sample and the control group, as far as the number of words is concerned. The results seem to imply that the online version of the case sample and the control group are similar.

4.1.3. The Implied Lack of Priority

The study found that the case sample, which contained energy-efficient features, dropped 83% of the words when moving from the online to the print version. Similar

to Christie (2010), the mean difference of the overall sample (181.4 words) was used as the proxy. The advertisement was coded as 1 if it dropped more words than the overall sample average and 0 if dropping fewer words than the overall sample average. As previously highlighted, the words were expected to have been dropped when moving from the online version to the print one.

Further analysis of the number of words in the online advertisement was performed using the Chi-Square test and the Mantel Haenszel Common Odds ratio test (OR) for the case group and the control group. The results of the Chi-square tests presented in Table 6 did not find a statistically significant difference between the case group and the control group. The results of the OR tests (OR = 1+/-95% CI: 0.20 - 50.40) revealed that the advertisement that dropped more words than average favoured removing energy-efficiency features by 0.2 times the odds of not removing the energy efficiency words and vice versa.

Table 6. Chi-square tests

	Statistic	**Degrees of freedom**	**p-value**
Case	0.643	1	0.423
Control	3.314	1	0.069
Case vs control	0.458	1	0.499

Furthermore, there was no significant difference between the case and control group, in terms of the number of words in the online advertisement. The results demonstrate that the advertisements, which contained more words than the average, were treated equally, regardless of whether the advertisement had reference to the "energy efficiency innovations", or not as far as space restriction is concerned. Additionally, there was no significant difference between the case and control group, in terms of the number of words in the print advertisement.

5. Discussion of Findings

The article highlights several lessons, as expounded below.

The findings demonstrate that some homeowners have already integrated microgeneration technologies into their houses. Advertisements mentioned Solar water heaters more frequently than other types of green heat and electricity technologies. This finding concurs with previous studies (Alcock 2012; Joubert, Hess et al. 2016). The findings demonstrate a movement from electric geysers (mainly powered by energy from coal and other fossil fuels) towards green energy technologies. Solar power and solar panels were also mentioned in the advertisements. The findings of the study offer support to the notion that the acceptance and adoption of more visible microgeneration technologies could be partly due to the crossover effect and the spillover effect from the combined efforts

of different stakeholders to use green energy (González et al., 2015; Schmid, Knopf & Pechan, 2016). The results also present an indication that some house owners and developers are prepared and ready to invest in green energy technologies. The finding concurs with the (Walwyn & Brent, 2015) results, highlighting that renewable energy is gathering momentum in South Africa.

Secondly, the initial expectations were that the advertisement for the case sample (with reference to energy features) advertisement to be relatively longer than the control group in online advertisement. However, the Chi-square tests and OR tests reveal no significant difference between the case group and the control group. This finding suggests that the online version of the case sample and the control group were categorised in the same bracket, which implies that a similar number of words could be dropped when moving from the online to the print media. This outcome seems to suggest that energy-efficient features (be they conventional or innovative) are not considered a priority in the housing market. This finding is in tandem with the previous results that support the notion that energy efficiency characteristics are not appreciated in the traditional housing market concur with (Christie, 2010; Roberts, 2007). However, there could be several possible explanations for this finding.

Finally, a brief viewing of the online housing advertisement revealed the centrality of images as a source of meaning. These housing images display appearances and characteristics associated with the main features of what people would call home. A more careful analysis revealed that the images also presented diverse meanings that reinforce the more visually obvious housing representations, some salient, while others are more subtle. However, it was interesting to note that one online advertisement and two print versions of the advertisements in the case sample had a clear image of a solar water heater on the roof of the house, but the advertisement did not mention or describe the features. This underlines how green energy characteristics are under-valued in the market. This result has further strengthened the notion that green energy technologies are not valued in the housing market.

6. Theoretical Contributions and Practical Implications

The present article contributes to the literature in several ways. First, it assesses the robustness of the integration of energy efficiency features in the residential sector in the KwaZulu-Natal region. Second, it assesses the value placed on green energy innovations by participants in the real estate markets. Third, the article conceptually demonstrates the applicability of the revealed approach (an approach without any need for experimental manipulations) and the implied priority methods in portraying the actual choices made by individuals (Christie, 2010; Alvarez et al., 2014; Blow & Blundell, 2018), as it provides a rigorous analysis of the existing housing stock that

exhibits the residential preferences of the given society. In addition, this might prompt further research into the value placed on green energy innovations in the residential and commercial sectors.

Practically, the article highlights several implications for different stakeholders in the housing sector. First, since the data are not supportive of the hypothesis of the implied priority of energy-efficient features, potential buyers who wish to contribute to sustainable living by "investing in green energy features" must have a full appreciation of what is involved in the property market. These findings imply that potential house owners should not entirely depend on print media advertisements when making decisions to buy a home or in an effort to contribute to sustainability in the living areas. Housing advertisements may not provide all the information necessary for sustainable homes. Identifying green homes is a much more difficult task than it is sometimes thought to be. Thus, potential house buyers are recommended to search, observe and analyse many variables using different sources of information, as opposed to simply relying on housing advertisements.

7. Conclusions

Using the revealed preference approach, this article has enhanced our understanding of the market acceptance of green product innovations in the residential sector. The study revealed that the appearance of microgeneration technologies, as portrayed by housing advertisements, is still very sketchy for various reasons, but several possibilities seem likely. First, it could be that most houses that were advertised did not install the microgeneration technologies and systems. Second, it could be the fact that the characteristics of energy efficiency are undervalued in the housing market. Hence, they are not prioritised in most advertisements. It is also fundamental to note that most of the advertisements that contained microgeneration technologies did not retain the words that mentioned the technology when moving from online to print versions. Online advertisements and photo galleries play a big role in positioning a house "as a composite good" in the real estate market. Furthermore, the findings of this study seem to postulate that energy efficiency features, particularly "microgeneration technologies," are not valued in the housing market.

However, the current study was not designed specifically to collect the views, preferences, and opinions of numerous players in society regarding energy-efficient innovations. Thus, the broader picture of green product innovation progressiveness in KwaZulu-Natal province, South Africa, might not be generalised to other contexts and geographical areas. Nonetheless, future research is therefore recommended to broaden the scope of our knowledge in this area. A potential and interesting area of research is comparing the distribution of green energy technologies across the

different provinces. Such research may also include comparisons of stated preference studies.

Overall, this article has gone a long way in demonstrating that microgeneration technologies are the twenty-first-century gem, which many participants in the housing market have not yet valued. The article provides a springboard for new ways to contribute to the "green province" and livable cities.

References

Alcock, N. (2012). "Green Street" retrofit for Cato Manor: housing sustainability. *IMIESA*, 37, 18-21.

Allen, S. R., Hammond, G. P., Harajli, H. A., Jones, C. I., McManus, M. C., & Winnett, A. B. (2008). Integrated appraisal of micro-generators: methods and applications. *Proceedings of the Institution of Civil Engineers-Energy*, 161(2), 73-86.

Alvarez, S., Larkin, S. L., Whitehead, J. C., & Haab, T. (2014). A revealed preference approach to valuing non-market recreational fishing losses from the Deepwater Horizon oil spill. *Journal of Environmental Management*, 145, 199-209.

Amy, K. W., David, J. B., Milton, R., & Nichole, D. K. (2002). A Framework for Analysing Dialogues over the Acceptability of Controversial Technologies. *Science, Technology, & Human Values*, 27, 134-159.

Arnott, R. (1987). Economic theory and housing. *In Handbook of Regional and Urban Economics, Elsevier*, 2, 959-988.

Balcombe, P., Rigby, D., & Azapagic, A. (2013). Motivations and barriers associated with adopting microgeneration energy technologies in the UK. *Renewable and Sustainable Energy Reviews*, 22, 655-666.

Balcombe, P., Rigby, D., & Azapagic, A. (2015). Environmental impacts of microgeneration: Integrating solar PV, Stirling engine CHP and battery storage. *Applied Energy*, 139, 245-259.

Barnes-Mauthe, M., Oleson, K. L. L., & Zafindrasilivonona, B. (2013). The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance. *Fisheries Research*, 147, 175-185.

Baskaran, R., Managi, S., & Bendig, M. (2013). A public perspective on the adoption of microgeneration technologies in New Zealand: A multivariate probit approach. *Energy Policy*, 58, 177-188.

Bickerstaff, K., Devine-Wright, P., & Butler, C. (2015). Living with low carbon technologies: An agenda for sharing and comparing qualitative energy research. *Energy Policy*, 84, 241-249.

Blow, L., & Blundell, R. (2018). A Nonparametric Revealed Preference Approach to Measuring the Value of Environmental Quality. *Environmental and Resource Economics: The Official Journal of the European Association of Environmental and Resource Economists*, 69, 503-527.

Bondio, S., Shahnazari, M., & McHugh, A. (2018). The technology of the middle class: Understanding the fulfilment of adoption intentions in Queensland's rapid uptake residential solar photovoltaics market. *Renewable and Sustainable Energy Reviews*, 93, 642-651.

Brandoni, C., Arteconi, A., Ciriachi, G., & Polonara, F. (2014). Assessing the impact of micro-generation technologies on local sustainability. *ECM Energy Conversion and Management,* 87**,** 1281-1290.

Christie, L. H. (2010). *Understanding New Zealand Homeowners Apparent Reluctance to Adopt Housing-Sustainability Innovations*. Doctoral dissertation, Open Access Te Herenga Waka-Victoria University of Wellington.

Claudy, M. C., Michelsen, C., & O'driscoll, A. (2011). The diffusion of microgeneration technologies - assessing the influence of perceived product characteristics on home owners' willingness to pay. *JEPO Energy Policy*, 39, 1459-1469.

Cochrane, J. H., Moskowitz, T. J., & Fama, E. F. (2017). *The Fama portfolio: selected papers of Eugene F. Fama*, University of Chicago Press.

Elmustapha, H., Hoppe, T., & Bressers, H. (2018). Understanding stakeholders' views and the influence of the socio-cultural dimension on the adoption of solar energy technology in Lebanon. *Sustainability*, 10(2), 364.

Fama, E. F. (2014). Two Pillars of Asset Pricing. *The American Economic Review*, 104, 1467-1485.

Flynn, R., & Bellaby, P. (2007). *Risk and the public acceptance of new technologies*. Houndmills, New York: Palgrave Macmillan.

González, A., Riba, J.-R., Puig, R., & Navarro, P. (2015). Review of micro- and small-scale technologies to produce electricity and heat from Mediterranean forests wood chips. *RSER Renewable and Sustainable Energy Reviews*, 43, 143-155.

Grant, S. M., Hill, S. L., Trathan, P. N., & Murphy, E. J. (2013). Ecosystem services of the Southern Ocean: Trade-offs in decision-making. *Antarctic Science*, 25(5), 603-617.

Guo, R., LV, S., Liao, T., XI, F., Zhang, J., Zuo, X., CAO, X., Feng, Z., & Zhang, Y. (2020). Classifying green technologies for sustainable innovation and investment. *Resources, Conservation and Recycling*, 153.

Jansen, S. J., Coolen, H. C., & Goetgeluk, R. W. (2011). The measurement and analysis of housing preference and choice. *Springer Nature*, 272.

Johnson, E. J., Hershey, J, Meszaros, J., & Kunreuther, H. (1993). Framing, Probability Distortions, and Insurance Decisions. *Journal of Risk and Uncertainty, Springer*, 7(1), 35-51.

Johnson, F. L., & Young, K. (2002). Gendered voices in children's television advertising. *Critical studies in media communication*, 4(S), 461- 480.

Joubert, E. C., Hess, S., & Van Niekerk, J. L. (2016). Large-scale solar water heating in South Africa: Status, barriers and recommendations. *Renewable Energy*, 97, 809-822.

Kong, F., & He, L. (2021). Impacts of supply-sided and demand-sided policies on innovation in green building technologies: A case study of China. *Journal of Cleaner Production*, 294.

Kulviwat, S., Bruner II, G. C., Kumar, A., Nasco, S. A., & Clark, T. (2007). Toward a unified theory of consumer acceptance technology. *MAR Psychology & Marketing*, 24, 1059-1084.

Levitt, S. D., & Syverson, C. (2008). Market Distortions When Agents Are Better Informed: The Value of Information in Real Estate Transactions. *The Review of Economics and Statistics*, 90(4), 599-611.

Myers, D., & Gearin, E. (2001). Current Preferences and Future Demand for Denser Residential Environments. *Housing Policy Debate*, 12(4), 633-659.

Nethengwe, N. S. (2022). *Green economy in the transport sector: a case study of Limpopo Province, South Africa*.

Ngcobo, N., Akinradewo, O., & Mokoena, P. (2024). Evaluating the Measures to Promote Sustainable Transport Infrastructure: A Case of City of Johannesburg, South Africa. *Journal of Engineering*, 2024(1).

Raven, R. P. J. M., Mourik, R. M., Feenstra, C. F. J., & Heiskanen, E. (2009). Modulating societal acceptance in new energy projects: Towards a toolkit methodology for project managers. *Energy*, 34(5), 564-574.

Roberts, T. (2007). Appraising Green in Vancouver. *Environmental Building News*, 16(5), 4-5.

Sauter, R., & Watson, J. (2007). Strategies for the deployment of micro-generation: Implications for social acceptance. *Energy Policy*, 35(5), 2770-2779.

Schmid, E., Knopf, B., & Pechan, A. (2016). Putting an energy system transformation into practice: The case of the German Energiewende. *Energy Research & Social Science*, 11, 263-275.

Storper, M., & Manville, M. (2006). Behaviour, Preferences and Cities: Urban Theory and Urban Resurgence. *Urban Studies*, 43(8). 1247-1274.

Wang, P., & Xie, D. (2022). Housing dynamics: Theory behind empirics. *National Bureau of Economic Research*.