Abstract: Worldwide, households’ consumption of electricity contributes to a substantial proportion of total national energy demand. Thus, the residential sector is a major entity in efforts to define and achieve global sustainability goals. Understanding electricity use behaviour and factors underlying behaviour is critical for designing behaviour change interventions, particularly in contexts characterised by fast-growing economies, burgeoning number of high-income households, and consumption growth. However, relative to developed economies, very little is known on this subject in South Africa. Using structured questionnaires, this study examines electricity use behaviour among high-income households in Johannesburg, South Africa. Findings indicate evidence of electricity-saving behaviour, but the proportion of households doing so was less than 50% for many actions, indicative of widespread wasteful habits. Other particular wasteful electricity use habits include leaving electronic gadgets and appliances on ‘standby’ mode, not turning off electric water heaters and not defrosting fridges without automatic settings. The findings lend support to the positive and negative influence of self-transcendence and egoistic values respectively on environmental behaviour, but other value orientations did not yield significant relationships. The implications of the findings on practical interventions for and theoretical constructs underlying strategies for environmentally-sustainable behaviour are discussed.

Keywords: electricity use behaviour; high-income households; standby load; interventions; South Africa

1. Introduction

Worldwide, households are major consumers of energy, and in many countries, the share of households in final energy consumption accounts for more than 20% [1,2]. While energy use is essential for meeting basic human needs, unsustainable use has serious negative impacts on the environment and human well-being. Globally, household consumption of energy products and services accounts for up to 20% (2007 levels) of GHG emissions [3]. In the US, the residential sector alone is responsible for about 20% of GHG emissions (2005 levels), and electricity consumption is responsible for a substantial proportion of these emissions [4]. In some contexts, unsustainable electricity use may result in grid instability and energy insecurity, which can disrupt local economies and lives [5]. In response, governments and city authorities are examining pathways towards promoting electricity sustainability in the residential sector [6,7]. Particularly for countries that are dependent on fossil fuels for electricity production, stakes on encouraging sustainable electricity usage are at an all-time high due to climate change and global warming-related effects of fossils [6,8,9].
Consistent with some of the ‘emergent’ economies: Brazil, Russia, India, China and South Africa (BRICS), South Africa’s electricity production is heavily reliant on low-cost coal [8]. BRICS countries are faced with challenges of ensuring rapid economic development and prosperity, while reducing greenhouse gas emissions. South Africa is a major player in the global energy debate. The country is in the top 20 highest carbon emitters in the world but is also energy-insecure [10], with frequent power cuts through load shedding, which means the country should be a key player in behaviour change debates for climate change mitigation and energy security. Nearly 20% of all the electricity generated in the country is consumed by the residential sector and up to 31% in major cities [11]. Further, peak electricity demand generally exceeds supply, which has resulted in persistent power supply interruptions via load reduction mechanisms at a significant cost to the economy [5,12]. Addressing electricity shortages through investment in infrastructure, such as building of more power stations, may provide only a short-term reprieve given prediction of growth in the economy, increasing number of high-income households and the associated increase in electricity demand, consistent with BRICS economies [13]. Further, with the primary provider of electricity (ESKOM) in a financial crisis and thus unable to maintain existing power stations, building of more power stations or transitioning to renewable energy options is not a priority [12]. Therefore, reducing electricity through behaviour change interventions could be a cheap and sustainable option.

However, despite the obvious need for promoting electricity savings in the residential sector [14], there is insufficient literature on household electricity use practices in South Africa with a few notable exceptions [15,16]. The few available studies are either generic and do not focus on specific electricity use behaviours [15] or focus on the use of individual appliances [5,11] or low-income households [16], which does not provide a wholesome understanding of electricity use behaviour. Consequently, there are limited investments in promoting sustainable electricity use in the residential sector [17] and benchmarking our understanding of the subject using developed country perspectives may not work due to contextual differences. Relative to low-income households, high-income households are large consumers of electricity [18,19]. High disposable incomes may mean there is no incentive for high-income households to engage in electricity saving practices because the monetary value for doing so might seem negligible [20,21].

In South Africa, high-income households are disproportionate users of electricity. [19] show that though high high-income households in the city of Cape Town constitute about 25% of all the households, they account for approximately 50% of residential energy demand, compared to 25% for low-income households who represent about half of all households. This means high-income households are an important target group for managing electricity demand and promoting electricity-saving efforts through behaviour change strategies [18]. Within this context, the aim of the study was to examine the electricity use behaviour of high-income households in Edenvale, Johannesburg, South Africa. Key research questions included: What is the reported electricity use behaviour among high-income households, which electricity use habits are wasteful, what factors influence electricity use behaviour, and based on the findings, what are the implications on assumptions underlying and practical strategies for promoting sustainable electricity use behaviour? The value of our study lies in that it can help identify wasteful electricity use practices as a basis for designing context-specific interventions for promoting electricity conservation. Further, the findings can be used to test the notion that high income is positively related to pro-environment actions. In doing so, the research can help advance the generation of theoretical constructs that are context-specific.

The rest of the paper is divided as follows: We provide a brief conceptualisation of habits and behaviour and discuss determinants of behaviour in Section 2. Section 3 describes the participants, data collection methods and data analysis procedures. Sections 4 and 5 present and discuss the findings, respectively. Finally, Section 6 details the conclusions and policy implications of the findings.
2. Understanding Electricity Use Habits and Behaviour

Wasteful electricity use at the household level is partly entrenched in human behaviour [1,9,22]. Everyday electricity use actions influence electricity demand, with adverse repercussions, including high electricity bills, interruptions to electricity supply where demand exceeds supply, and adverse environmental impacts. Thus, reducing these impacts can partly be addressed by promoting environmentally-sustainable actions such as switching off lights and electronic appliances completely when not in use. Many electricity-saving actions require repeated performance to achieve a meaningful reduction in electricity consumption, with some actions (e.g., turning off electric water heaters (geysers)), resulting in more electricity savings than others (e.g., degreasing a microwave or boiling just enough water for a cup of tea or coffee). The repeated nature of certain electricity use actions can be understood as habits. [23] (p. 1) define habits as “behaviour that has been repeated until it has become more or less automatic, enacted without purposeful thinking, largely without any sense of awareness”. [24] argues that exposure to a cue (or context) will automatically trigger an impulse to act in a non-conscious way because links between a cue and the action would have been activated. Thus, repeated and frequently practiced habits or everyday actions can be understood as a type of behaviour. Actions that result in sustainable and wasteful electricity use can be understood as good and bad environmental behaviour, respectively. Thus, it can be said that since electricity use actions are context-dependent, where stronger influences favouring promotion of alternative electricity-saving actions (behaviour change) are absent, the habit impulse will translate smoothly and non-consciously into wasteful actions without considering the socio-economic and environmental impacts.

Daily use habits, for example, not switching off lights when not needed, putting hot foods and uncovered liquids in the refrigerator, not cleaning vacuum cleaners and degreasing microwaves regularly and not switching off appliances completely when not needed might result in unconscious electricity wastage through unnecessary consumption, inefficiencies and standby power loss. For example, evidence suggests that generally, people do not completely switch-off electronics such as desktop computers, laptops, televisions, musical instruments, microwave ovens, computer speakers and set-top boxes (satellite decoders), or unplug chargers when not in use [16,25], which can result in varying levels of hidden electricity losses [26–28].

In some contexts, such as the EU, US and Australia, hidden electricity loss has been curtailed substantially due to strict regulations for implementing appliance energy efficiency standards and labels for appliances with standby power functions [29,30]. However, although technical interventions are helpful in reducing electricity wastage, they do not address wasteful electricity use habits [31] and efficiency gains can be offset by consumption growth [32]. For example, [33] found that some UK households owned up to 85 electrical appliances with implications on electricity usage and carbon footprint. Therefore, beyond technical fixes, changing behaviour remains a sensible pathway towards achieving sustainable behaviour [14,16,22]. The challenge is to develop, initiate and maintain habit-change interventions that can sustain new environmentally relevant behaviours as habits and routines embedded in people’s lives over time, even when the motivation to do so is low due to minimal incentives for doing so or the presence of unanticipated costs to electricity users [34].

Determinants of Behaviour

The determinants of behaviour are generally grouped into person-specific (socio-demographic and psychological factors) and situational attributes (contextual and structural factors) [35]. It has been found that older individuals are more likely to exhibit electricity saving practices than younger people [25] though in some contexts, young individuals can also exhibit sustainable actions [36]. Concerning gender, those who identify as females tend to be more knowledgeable about the environmental consequences of their actions and hence are generally more environmentally-friendly than males [37], although opposite accounts of this relationship have been reported [25,38]. A high level of education (and related high income) is often associated with sustainable environmental actions owing to general
awareness about the environment and impacts of one’s actions on the environment [39,40], but this does not always translate into sustainable actions [41].

Values, defined by [42] as key life goals or standards that act as guiding principles in people’s lives, may also influence the way people act. Assessment of personal value orientations can be achieved through measurement of the importance assigned to 22 Quality of Life (QoL) aspects [42]. These QoL aspects can be summarised into 10 clearly interpretable value domains (universalism, stimulation, hedonism, achievement, self-direction, security, power, benevolence, conformity and traditionalism), and are broadly divided into two dimensions following [43–45]. “The first dimension, openness to change versus conservatism, differentiates values that stress independence (e.g., stimulation and self-direction) from values that emphasise conservatism” (e.g., traditionalism and conformity) [46] (p.9319). The second dimension distinguishes self-transcendent and altruistic values (e.g., benevolence) from egoistic (e.g., power) and self-enhancement (e.g., security) value orientations [44,46]. Theoretically, it is assumed that people who are open to change and altruistic are more likely to exhibit environmentally-friendly behaviour because they tend to be receptive to new ideas and experiences and value environmental protection, respectively, than people with a strong disposition to conservatism and self-enhancement values [35]. The latter group of people is less likely to engage in environmental-friendly behaviour because they tend to be comfortable in habitual routines and schedules, and value immediate personal gains (e.g., comfort, security) over societal benefits [47]. The importance assigned to these values by individuals can help explain people’s propensity to act in an environmentally-sustainable way or not [42–46]. For instance, people are unlikely to switch off electric water heaters if they perceive it would compromise the warmth of water needed in cold environments [5]. While the meaning of these values may vary in different settings, their structure tends to be universal [43,46].

Though personal attributes can engender positive attitudes, they may be insufficient to translate into environmentally-sustainable behaviour in the face of external constraints [48,49]. Actions that are easy to do generally promote sustainable behaviour, while those that are difficult to implement can discourage it. According to [44] (p. 416) “the more difficult, time-consuming, or expensive the behaviour, the weaker its dependence on attitudinal factors”. Further, individuals can engage in sustainable practices if supporting infrastructure and conditions are in place to do so since this minimises the need for extra effort required to act in environmentally-friendly ways. It has been found that people tend to not switch off lights if the light switch is not within reach or there is insufficient natural light, which makes rooms dark and uncomfortable [49].

Taken together, these personal and situational factors can help in explaining behaviour, but there can be complex interlays between them [14,25,47,49–51]. Thus, understanding these factors may be as complex as the behaviour they try to explain, highlighting the need to understand the contextual settings to tailor interventions for specific contexts.

3. Materials and Methods

3.1. Sample and Data Collection

A questionnaire survey was used to collect data for the study. The participants in the study were individuals from high-income households of Edenvale, a medium-sized suburb in Johannesburg, South Africa located at 26°28’S 25°28’E. Typically high-income households earn at least four times higher income than the average national household income of US$10,389 per year [52]. High-income households in South Africa often live in gated communities or homesteads with high security walls and controlled access. As it is generally difficult to access high-income homesteads due to relatively high levels of crime targeting high-income areas [53], and subsequent suspicion of strangers, the study sample was strategically and purposefully selected based on prior knowledge of the area and ease of access. One hundred and twenty participants were initially invited to participate in the study after the purpose of the research was explained, out of which 91 responded positively. The sample size was
relatively small relative to the population size of high-income households in Johannesburg. However, as one of the few studies on this subject in South Africa, the aim of the study was narrow to allow sample specificity for achieving information power [54]. For this study, we were interested in participants with particular characteristics (high-income status) and how these characteristics relate to well established theoretical constructs on values and behaviour [55]. Further, where there is adequate literature and theoretical grounding on a given subject, insufficient information power due to small sample size is not a major concern [54]. Taken together, the study aimed to explore a complex and subjective issue (electricity use behaviour), hence, its utility lies in its transferability (i.e., being interpretive) [56], which could form the basis for further studies.

Data collection took place between January and February 2017. Household heads were targeted for the surveys and, in their absence, adult members of the household who had a good understanding of household profiles and day to day electricity use in their respective homes. Though the questionnaire was pretested in a previous study [16], it was pretested again in this study due to different socio-economic settings. Sixty-one questionnaires were completed face-to-face with one of the researchers, with each survey taking between 45 min and one hour to complete. Thirty-one participants opted to complete the questionnaires on their own due to work and family commitments, and, at collection of self-completed questionnaires, a quick scan was undertaken to check completeness and quality of responses. Since all questions were closed-ended, respondents’ answers were limited to a fixed set of responses such that no substantial variation in responses was expected between administered and self-completed questionnaires.

3.2. Measures

3.2.1. Socio-Demographic Factors

The questionnaire was designed to collect socio-demographic information of the participants and their households, including age, gender, education level, employment status, household size, number of dependents, number of rooms in house and ownership of electronic appliances.

3.2.2. Habitual Electricity Use Behaviour

Electricity use behaviour was measured using multiple-scale items, drawn from the literature [1,2,5,16,25,49] and adopted to suit the current research setting. Individual’s electricity use behaviour was measured using a list of electricity use actions related to the use of household electronic appliances such as air conditioners, fans, heaters, fridges, washing machines, dishwashers and electric water heaters among others, following [25]. Participants were asked to indicate how often they engaged in a given electricity use action, e.g., How often do you keep windows and doors closed when the heater is on, with responses measured on a five-point scale (1 = “never”; 2 = “rarely”; 3 = “sometimes”; 4 = “usually”; 5 = “always”). Habitual electricity use behaviour was computed from the 26 self-reported electricity use actions, with an average action score close to 1 depicting poor electricity use behaviour and 5 good electricity use behaviour.

3.2.3. Personal Value Orientations

To measure personal values, participants were asked to indicate the level of importance attached to a range of personal value (QoL) factors (Appendix A.1). Responses were made on a five-point scale (1 = “unimportant”; 2 = “less important”; 3 = “important”; 4 = “very important”; 5 = “critical”) following [42]. These value orientations were then divided into nine value domains, namely universalism, stimulation, hedonism, achievement, self-direction, security, power, benevolence, and traditionalism and four high-order values (Appendix A.1) following [43,45]. All individual item scores were aggregated under each category, with a score closer to 1 and 5 depicting a low and high disposition, respectively, towards the personal value orientation and the respective value domain.
3.3. Data Analyses

Data was first captured in an excel spreadsheet and then coded and categorised. The statistical programme STATISTICA (Version 13) was used for statistical analysis. Before statistical analysis, data screening was performed to ensure the data met assumptions and identify any outliers and error problems. Descriptive statistics in the form of tables and proportions were used to summarise socio-demographic data and the proportion of participants who engaged or not in a given electricity use action. To indicate electricity use behaviour, mean scores for each action item were calculated. Modal responses were used to indicate the frequency a given electricity use action was reported, and proportions of participants engaging in the action. Non-parametric tests were used for analytical statistics due to the use of coded data.

Small sample sizes are prone to Type II errors, that is, the non-rejection of a false null hypothesis or a false negative finding, partly due to multicollinearity among independent variables and existence of variables that are not normally distributed. Therefore, a Generalized Linear Model (GLM) was used to estimate the influence of socio-demographic variables and personal value orientations on electricity use behaviour because it allows modelling of correlated and non-normally distributed data with flexible accommodation of covariates [57]. To test for the robustness of regression coefficients (consistency of p-values) [58], we used the Restricted or Residual Maximum Likelihood approach (Appendix A.2).

A Mann–Whitney test was computed to find out if there were significant differences in reported electricity use behaviour scores between male and female participants. To explore the relationships between socio-demographic variables and electricity use behaviour, a Spearman’s rank correlation coefficient was performed. Since the sample size was well-above the absolute minimum recommended (N = 50) for behavioural research data [59], a factor analysis (maximum likelihood extraction method) was performed to identify which set of 22 personal (QoL) values were more important in explaining the observed variance in electricity use behaviour.

4. Results

4.1. Socio-Demographics

Just above half (54%) of the participants were males (Table 1). The average age of participants was 48.8 years. The mean household size for the sample was 3.4, with children (0–18 years) making up about half the total population. Education levels were generally very high, with at least 75% of participants having earned either a diploma or a university degree. About 91% of all the participants and approximately two people per household were employed. A substantial proportion (95%) of households reported receiving an average monthly income of at least R30,000—a figure that, if extrapolated for a year, is at least twice the average annual income (ZAR138,168) of South African households [51]. Very few households (3%) received government social grants (Table 1), which shows the majority of households were generally well-off. The mean number of rooms per house was 9.4, ranging from 3 to 17. More than three-quarters of the households owned electrical gadgets such as televisions, refrigerators, washing machines, dishwashers, tumble dryers, pool pumps and cell phones and iPads except for instant type water heaters and electric blankets.
Table 1. Socio-economic characteristics of participants and households.

| Household Socio-Economic Factors                        | Value (n = 91) | Max (min) Values |
|----------------------------------------------------------|----------------|-----------------|
| Gender of household head                                 |                |                 |
| Female                                                   | 46%            | -               |
| Male                                                     | 54%            | -               |
| Mean age of household head                               | 48.8           | 82 (19)         |
| Mean household size                                      | 3.4            | 7 (1)           |
| Adults                                                   | 1.7            |                 |
| Children                                                 | 1.7            | 6 (0)           |
| Education of household head                              |                |                 |
| University degree and above                              | 63%            | -               |
| Diploma                                                  | 13%            | -               |
| Matric                                                   | 24%            | -               |
| Proportion of household heads employed                   | 91%            |                 |
| Mean number of employed individuals in household         | 1.9            | 5 (0)           |
| Average monthly income                                   |                |                 |
| <R10,000                                                 | 1%             |                 |
| R10,000–30,000                                           | 4%             |                 |
| +R30,000                                                 | 95%            |                 |
| Proportion of households receiving social grants         | 3%             | -               |
| Mean number of rooms                                     | 9.4            | 17 (3)          |
| Mean number of bedrooms                                  | 3.9            | 6 (3)           |
| Ownership of appliances                                  |                |                 |
| Air conditioner/fans                                     | 76%            |                 |
| Heaters                                                  | 79%            |                 |
| Refrigerator                                             | 100%           |                 |
| Instant type water heater                                 | 44%            |                 |
| Electric jug                                             | 99%            |                 |
| Home electrics (TVs, DVDs, Cell phones, iPads)           | 100%           |                 |
| Electric water heater                                     | 98%            |                 |
| Tumble dryer                                             | 80%            |                 |
| Pool pump                                                | 95%            |                 |
| Washing machine                                          | 99%            |                 |
| Dishwasher                                               | 93%            |                 |
| Electric blanket                                         | 58%            |                 |

4.2. Self-Reported Electricity Use Actions

The participants were asked to indicate how often they engaged in different electricity use actions in their households. Table 2 presents the mean action scores, modal responses and proportion of household citing the modal response. Mean scores were generally high (at least 4) for actions such as keeping windows and doors closed when the heater is switched on, the general use of the refrigerator (not overloading it, cooling foods and covering liquids before storage), making use of daylight, switching off lights when not in the room, not keeping the tumble dryer on long enough to dry clothes and using dishwashers and washing machines on full load. For these electricity use actions, the participants reported either ‘Usually’ or ‘Always’ doing so in their households (except for tumble dryer use with reverse coding for good environmental behaviour). However, it is important to note that the proportion of participants who reported always practicing environmentally-friendly actions was less than half for 8 out of 15 electricity-saving actions, suggesting that not everyone acted in environmentally-friendly ways.
Table 2. Mean reported action scores and modal responses.

| Electricity-Saving Action                                           | Number of Participants (n = 91) | Mean Action Score | Modal Response | % of Households |
|--------------------------------------------------------------------|---------------------------------|-------------------|----------------|-----------------|
| Keep windows and doors closed when air conditioner/fan is on       | 74                              | 3.4               | Always         | 31              |
| Keep windows and doors closed when heater is on                    | 84                              | 4.3               | Always         | 35              |
| Not overloading refrigerator                                       | 91                              | 4.5               | Always         | 77              |
| Cool down hot food before storing in refrigerator                  | 91                              | 4.3               | Always         | 65              |
| Cover liquids stored in the refrigerator                           | 91                              | 4.6               | Always         | 62              |
| Defrost refrigerator (if no automatic setting function)           | 91                              | 2.6               | Never          | 29              |
| Heat just enough water for bathing (instant type water heating)    | 40                              | 3.3               | Usually        | 41              |
| Only boil water needed for a cup of tea or coffee                  | 91                              | 4                 | Usually        | 49              |
| Make full use of daylight during the daytime                       | 91                              | 4.4               | Always         | 60              |
| Turn lights off when nobody is in the room                         | 91                              | 4.3               | Always         | 46              |
| Use task lighting for activities requiring small amount of focus   | 91                              | 3.7               | Usually        | 49              |
| Turn off home appliances (TVs, radios, DVDs) instead of leaving on standby | 91                              | 2.9               | Usually        | 27              |
| Allow computer to be in hibernation mode after 10–15 min.         | 91                              | 3.7               | Always         | 37              |
| Switch off the computer completely when not in use for more than 30 min | 91                              | 3.5               | Always         | 36              |
| Unplug chargers after use                                          | 91                              | 2.9               | Rarely         | 27              |
| Turn off electric water heater when not in use                     | 91                              | 2.3               | Never          | 52              |
| Use tumble dryer only on full loads                                | 90                              | 4.2               | Usually        | 51              |
| Keep tumble dryer long enough to dry clothes (-)                   | 74                              | 1.9               | Rarely         | 42              |
| Use washing lines if the weather is okay                            | 91                              | 4.6               | Always         | 77              |
| Turn off pool pump when not needed (when pool is clean)           | 86                              | 3.5               | Always         | 35              |
| Use washing machine only on full loads                             | 90                              | 4.2               | Usually        | 51              |
| Use cold water for washing machine                                | 85                              | 2.9               | Always         | 25              |
| Use dishwasher only on full loads                                  | 85                              | 4.5               | Always         | 60              |
| Use cold water for dishwasher                                     | 85                              | 2.9               | Always         | 25              |
| Switch electric blanket on only when in bed and off when warm     | 51                              | 4                 | Always         | 51              |
| Set electric blanket on minimum setting                            | 51                              | 3.4               | Sometimes      | 37              |

Low scores were reported for electricity use actions like defrosting the refrigerator to make it more energy-efficient, heating just enough water for bathing, turning off electronic appliances completely instead of leaving them on standby, unplugging chargers from power sources, turning off electric water heaters when not in use, using cold water for washing machines and dishwashers and setting electric blankets on minimum settings. Out of all actions with low scores, a sizeable proportion of the participants said they ‘Never’ defrost the refrigerator (29%), ‘Rarely’ unplugged chargers after use (27%) and ‘Never’ turned off electric water heaters when not in use (52%).
4.3. Factors Influencing Electricity Use Behaviour

A GLM analysis was performed to investigate the relationship between electricity use behaviour and socio-demographic factors and personal value orientations (Table 3).

Table 3. Determinants of electricity use behaviour.

|                                | Estimate | Std. Error | Wald Stat. | p    |
|--------------------------------|----------|------------|------------|------|
| Intercept                      | 1.140    | 0.137      | 69.646     | 0.000 ** |
| Age of household head          | 0.001    | 0.001      | 0.956      | 0.328 |
| Gender of household head       | -0.017   | 0.012      | 1.905      | 0.168 |
| Education level of household head (1 = tertiary; 0 = no tertiary education) | -0.023 | 0.014 | 2.60 | 0.107 |
| Household size                 | 0.007    | 0.015      | 0.257      | 0.612 |
| Number of dependents           | -0.009   | 0.0124     | 0.502      | 0.478 |
| Number of members employed     | -0.030   | 0.014      | 4.832      | 0.028 * |
| Self–direction                 | -0.022   | 0.036      | 0.373      | 0.541 |
| Stimulation                    | 0.018    | 0.044      | 0.167      | 0.683 |
| Achievement                    | -0.0211  | 0.059      | 0.122      | 0.727 |
| Hedonism                       | -0.117   | 0.150      | 0.609      | 0.435 |
| Power                          | -0.060   | 0.024      | 6.420      | 0.011 * |
| Universalism                   | 0.234    | 0.083      | 8.015      | 0.005 ** |
| Benevolence                    | 0.008    | 0.030      | 0.077      | 0.782 |
| Security                       | -0.017   | 0.026      | 0.424      | 0.515 |
| Traditionalism                 | 0.002    | 0.011      | 0.025      | 0.874 |

**; * indicate 1% and 5% level of significance, respectively.

It was found that people with a disposition to universalism (valuing aesthetic beauty, environmental quality and social justice) tended to engage in good electricity use behaviour while the number of people employed in households and individuals with a disposition towards power yielded negative relationships. Factors such as gender (being male), number of dependents, self-direction, hedonism, achievement and security yielded expected (negative) but non-significant relationships with electricity use behaviour. Similarly, the age of the household head and stimulation and benevolence value orientations showed expected (positive) but non-significant relationships.

Correlation results show that the age of the respondent yielded a significant positive relationship with good electricity use behaviour, while household size, number of dependents and number of people employed in a household showed significant negative relationships (Table 4). Mean behaviour score was not significantly different between females (3.6) and males (3.5) ($Z = -0.78; p = 0.438$).
Table 4. Spearman’s Rank Correlation analysis between electricity use behaviour and socio-demographic factors. * Denotes significant difference.

| Variable                                           | Spearman R (rho) | p−Value |
|----------------------------------------------------|------------------|---------|
| Socio−Demographic Factors:                         |                  |         |
| Age of respondent                                  | 0.303            | 0.003 * |
| Household size                                     | −0.249           | 0.017 * |
| Number of dependents                               | −0.239           | 0.022 * |
| Gender of respondent—1 = Female; 0 = Male          | 0.082            | 0.438   |
| Education level of household head                  | 0.147            | 0.166   |
| Education level of household member mostly at home | −0.055           | 0.604   |
| Number of people employed in household             | −0.275           | 0.008 * |
| Number of rooms in house                           | 0.116            | 0.274   |

The results of the principal component analysis (Table 5) show that the top six Quality of Life (QoL) factors with eigenvalues greater than 1, cumulatively explain about 66% of the variance in electricity use behaviour. Therefore, the 22 selected variables can be grouped under and explained by only six independent factors.

Table 5. Initial eigenvalues of 22 QoL factors derived from factor analysis.

| Factor | Eigenvalue | % Total Variance | Cumulative % |
|--------|------------|------------------|--------------|
| 1      | 7.0019     | 0.318            | 0.318        |
| 2      | 2.1971     | 0.100            | 0.418        |
| 3      | 1.6204     | 0.074            | 0.492        |
| 4      | 1.3944     | 0.063            | 0.555        |
| 5      | 1.1964     | 0.054            | 0.610        |
| 6      | 1.1311     | 0.051            | 0.661        |
| 7      | 0.9798     | 0.045            | 0.706        |
| 8      | 0.8434     | 0.038            | 0.744        |
| 9      | 0.7232     | 0.033            | 0.777        |
| 10     | 0.6412     | 0.029            | 0.806        |
| 11     | 0.6232     | 0.028            | 0.834        |
| 12     | 0.5668     | 0.026            | 0.860        |
| 13     | 0.4744     | 0.022            | 0.882        |
| 14     | 0.4445     | 0.020            | 0.902        |
| 15     | 0.4196     | 0.019            | 0.921        |
| 16     | 0.3783     | 0.017            | 0.938        |
| 17     | 0.3176     | 0.014            | 0.952        |
| 18     | 0.3054     | 0.014            | 0.966        |
| 19     | 0.2428     | 0.011            | 0.977        |
| 20     | 0.2000     | 0.009            | 0.986        |
| 21     | 0.1545     | 0.007            | 0.993        |
| 22     | 0.1438     | 0.007            | 1.000        |

Table 6 shows the factor loading for all the 22 QoL aspects and the respective grouping under the six value factors and the inferences are as follows:

1. People who valued education were likely to value environmental quality (Factor 1, explaining about 32% of the variance).
2. People who valued freedom were likely to value privacy (Factor 2, explaining about 10% of variance).
3. People who valued challenging lifestyles were likely to value change (Factor 3, explaining 7% of variance).
4. Those people who valued work were likely to value family and safety (Factor 4 that accounts for 6% of variance).
5. People who valued material beauty were likely to place importance on their social status (Factor 5 that accounts for 5% of variance).

6. People who valued social justice were likely to value social relations (Factor 5 that explains 5% of the variance).

Table 6. Pattern matrix showing the factor loadings of all the 22 QoL factors.

| QoL Aspects (Variable) | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 |
|------------------------|----------|----------|----------|----------|----------|----------|
| Education              | 0.538    | −0.171   | −0.218   | 0.189    | 0.183    | −0.110   |
| Environmental quality  | 0.679    | −0.191   | −0.176   | 0.215    | −0.117   | −0.178   |
| Freedom                | 0.396    | −0.538   | −0.060   | 0.031    | 0.131    | −0.294   |
| Privacy                | 0.164    | −0.756   | −0.193   | 0.210    | 0.167    | −0.135   |
| Challenge/excitement   | 0.084    | −0.121   | −0.709   | 0.068    | 0.179    | −0.160   |
| Change                 | 0.102    | −0.124   | −0.984   | 0.036    | 0.064    | −0.025   |
| Work                   | 0.171    | −0.072   | −0.178   | 0.706    | 0.251    | −0.235   |
| Family                 | 0.334    | −0.199   | −0.056   | 0.601    | 0.135    | −0.139   |
| Safety                 | 0.194    | −0.372   | −0.010   | 0.506    | −0.055   | −0.235   |
| Material beauty        | 0.053    | −0.102   | −0.206   | 0.094    | 0.760    | −0.016   |
| Social status          | −0.271   | −0.179   | −0.198   | 0.408    | 0.507    | −0.180   |
| Social justice         | 0.033    | −0.301   | −0.108   | 0.202    | 0.001    | −0.733   |
| Social relations       | 0.073    | −0.123   | −0.123   | 0.230    | 0.226    | −0.641   |
| Identity               | 0.443    | −0.385   | −0.112   | 0.103    | 0.398    | −0.262   |
| Comfort                | 0.157    | 0.191    | −0.400   | 0.029    | 0.429    | −0.403   |
| Leisure time           | 0.462    | −0.131   | −0.065   | 0.274    | 0.378    | −0.309   |
| Money/income           | 0.207    | −0.039   | −0.104   | 0.025    | 0.472    | −0.300   |
| Aesthetic beauty       | 0.371    | −0.066   | −0.032   | 0.116    | 0.185    | 0.052    |
| Nature                 | 0.430    | −0.439   | −0.252   | 0.170    | 0.032    | −0.003   |
| Health                 | 0.319    | −0.395   | 0.031    | 0.369    | −0.135   | −0.254   |
| Security               | −0.107   | −0.483   | −0.146   | 0.348    | 0.096    | −0.102   |
| Spirituality/religion  | −0.044   | −0.046   | −0.243   | 0.172    | 0.187    | −0.345   |

* indicates 5% level of significance.

5. Discussions

This study examined reported electricity use behaviour and factors influencing it among high-income households. These questions have implications for our understanding of theories, constructs and assumptions underlying environmentally significant behaviour. At a practical level, the findings can contribute to policies and strategies aimed at initiating and maintaining behaviour change for climate change mitigation, grid stability and reliable electricity supply.

5.1. Reported Electricity Use Behaviour

The findings show that reported electricity use behaviour was varied among households. Environmentally sustainable behaviour reported includes keeping windows and doors closed when the air conditioner or fan or heater is on, not overloading the refrigerator, not cooling down hot food in the refrigerator, covering liquids stored in the refrigerator, making use of daylight instead of switching on lights, turning off lights when they are not needed, switching off computers completely, turning off swimming pool pumps when not needed, use of washing lines instead of dryers when weather permits, and using washing machines and dishwashers only when on full loads. However, the proportion of participants who reported ‘always’ practicing good environmental behaviour ranged
from 25% to 77%. Only two out of 15 behavioural actions were ‘always’ practiced by at least 75% of the participants, suggesting that a sizeable number of people did not always use electricity in environmentally sustainable ways.

From the findings, it emerged people ‘never’ or ‘rarely’ practiced pro-environmental actions when using home gadgets and appliances such as refrigerators, TVs, DVD players, notebooks and chargers for computers, cell phones and iPads. Low scores were reported for actions such as defrosting the refrigerator to increase efficiency, completely turning off home entertainment appliances such as TVs and DVD players, unplugging chargers after use, and turning off electric water heaters when not in use. Many households reported not switching off these gadgets completely, which means that electricity was consumed even when not needed.

From a practical perspective, the findings are consistent with a study in low-income households [16] and in university settings [49,51] where actions such as unplugging electric chargers and switching off electronic devices completely when not in use were not always practiced. These actions have key implications for electricity use. For example, research has shown that electric gadgets including TVs, satellite TV boxes, DVD players and chargers for cell phones and laptops consume substantial but varying amounts of electricity while on ‘standby mode’. It has also been reported that many households may not be fully aware of the energy consumption rate of electronic gadgets and appliances on standby mode [60,61], which may result in wasteful usage and irrationally high electricity bills [15], high carbon emissions [62] and electricity shortage [5].

The hidden electricity loss from appliances on standby mode can vary due to contextual realities [27], ranging from as low as 4% in Turkey [26] to as high as 44% in Nigeria [28] of total household electricity use. In a study of South African households at the national level, [5] found that users did not understand the energy consumption of their electric water heaters. This can result in electricity wastage, which, if avoided, could lead to substantial electricity savings given electric heaters can account for about 20% of total household electricity demand [63]. Taken together, a key contribution to the behaviour literature is that well-off households do not always act in the interest of the environment, which is inconsistent with the social-class hypothesis that posits that high income and education are generally related to environmental concern and good environmental behaviour.

In general, addressing standby power loss should be a key policy issue for initiating electricity savings given the growing ownership of and reliance on electronics, appliances, and other equipment plugged into or permanently connected to electricity for day to day living. It is important for BRICS nations to forge legislation that can facilitate trade of and support buying eco-friendly appliances and timer power plugs for gadgets that use power when not in active use (e.g., microwave ovens), and installation of programmable timers to shut off devices such as TVs, satellite TV boxes, stereos, video game consoles, etc., at night, which has translated in significant electricity savings and subsequently reduced carbon footprint in the US, EU and elsewhere [27]. However, the potentially high number of ‘energy-efficient gadgets’ in well-off households may mean the combined electricity usage might be substantial [27,32] and wasteful behaviour maybe persistent [31]. Consequently, long-term solutions lie in addressing wasteful electricity use practices at the household level via behavioural interventions. However, behaviour change interventions require that their initiation is supported with programmes for sustaining the new behaviours given the tendency of people to fall back to habitual tendencies when initial motivation dwindles.

In designing electricity-saving interventions, well-off households should be principal stakeholders for two reasons. First, they have relatively high disposable income, which may mean they can afford to buy more ‘energy-leaking’ electronic gadgets and appliances, which ultimately results in significant electricity wastage. Even though purchasing energy-efficient appliances may partly address household electricity wastages, consumption growth can outweigh the savings. Second, the position that electricity-saving motivations may be rooted in financial drivers [64] may not apply to well-off households because electricity is relatively cheap to them, which can promote unsustainable use [21].
Further, considering the expected growth in the number of upper middle-class households in BRICS nations, it is plausible to argue that if not addressed, wasteful electricity use behaviour may have serious repercussions on grid stability, energy security and the environment. It is plausible to suggest behavioural approaches may be very desirable in South Africa, given predictions of a growing proportion of urban households who cannot afford the costs of electricity and replacing old electronic appliances with new eco-friendly ones. However, for a comprehensive overview of household electricity use and points of wastages, systematic inventories of household appliances, estimates of standby and baseload power consumption, and daily use habits of the appliances (length of time spent) are needed at the national level.

5.2. Factors Influencing Environmental Behaviour

Out of the aggregated personal value factors, only universalism yielded a significant positive relationship with good environmental behaviour, suggesting people who are understanding, show concern for nature and exhibit concern for the welfare of others were likely to act in a pro-environmental way. The literature shows positive linkages between pro-environmental actions and empathetic attributes and environmental concern [37,48]. Concerning the number of people employed in the household, poor electricity use behaviour may be explained by increased disposable income to buy more electronics and other household gadgets. It may also be that employed people have busy schedules and limited time to devote to electricity-saving measures such as unplugging chargers and switching off appliances completely when not in use.

The results also showed that people with a disposition to power were less likely to act in environmentally-friendly ways. The power orientation value taps from money and influence (social status) and reflects egoistic tendencies for self-enhancement. Self-enhancement values are known to oppose environmentally-friendly behaviour [43,45], and in our case, people who are egoistic may pursue success and influence at the expense of others and the environment. Other value domains did not yield significant relationships with electricity-saving behaviour perhaps due to potential variation in meanings attributed to different value orientations by the participants. That is, there may have been difficulty in translating the sense of own values into scales and problems of self-representation because in everyday life, people seldom think about what is important or not important to them, and may not have clear answers [45]. Therefore, behaviour change interventions should aim to highlight clearly the linkages between people’s value orientations to everyday sustainable electricity use practices.

Concerning correlation analysis results, age yielded a positive relationship suggesting that older individuals were likely to engage in environmentally sustainable behaviour consistent with findings by [37]. In our study, older individuals were likely to engage in electricity saving behaviour because they either directly incur the financial costs of electricity wastage or do not have young dependents who consistently need to use electricity for day to day activities like cooking or use of entertainment gadgets. Bigger households and a higher number of dependents were likely to result in poor electricity use behaviour, perhaps because of the sheer number of individuals using electricity. Bigger households may also mean that the number of electronic gadgets owned is high, which may make it difficult to assign responsibility for practicing good environmental behaviour such as switching off electronic and household gadgets when not in use. For example, the literature suggests it is difficult to achieve good environmental behaviour in large groups because of the perception that someone else will do it [25,48]. Further, dependents may spend most of the time within the household, and often do not directly incur the costs of wasteful behaviour, and as such, may not have the motivation to use electricity sustainably.

Factor analysis showed that highly educated people were likely to value environmental quality consistent with the pro-environmental behaviour literature, but this did not translate into good environmental behaviour. This finding re-emphasises the complexity of theoretical constructs or assumptions underlying behaviour [25,37]. A possible explanation is that due to the need for personal safety and security, households may not switch off lights at night for security reasons, a common practice in crime-ridden neighbourhoods in South Africa. This lends support to the notion that
despite good environmental intentions, people may not act pro-environmentally due to external factors (in this case sense of insecurity) [49]. Another plausible explanation for this is that households may not be aware of the magnitude of electricity loss via standby gadgets [60], such that the links between their stated electricity use habits and electricity wastage might be unclear. It may also be that many households could not see how their daily electricity use habits were related to the context of environmental quality. This suggests that behaviour change interventions that harness the aspects valued by people as a basis for initiating and sustaining new electricity use habits might yield positive behaviour changes. For example, linking environmental quality (the context) with individual environmentally-friendly actions like switching off electric water heaters, unplugging chargers after use and switching off appliances completely when not in use, may trigger behaviour change.

6. Conclusions

In examining electricity use behaviour among high-income households in South Africa, several key issues with relevance to our understanding of environmental behaviour and development of locally relevant interventions for promoting behaviour change emerge. This study highlights that despite evidence of varying levels of good environmental behaviour, poor environmental behaviour is prevalent among well-off households. A particular area of concern is wasteful practices relating to the use of electronic gadgets and equipment with ‘standby mode’ function and electric water heaters. While in some contexts (e.g., Europe, Australia, USA), loss from ‘standby’ power consumption has been addressed through legislating production and sale of energy-efficient appliances, the extent to which this is applicable in South Africa is little understood. Further, given the predicted rapid growth in the urban population in BRICS nations, growing disposable income and affordability, there is going to be an unprecedented growth in the number of electronic appliances in homes. This will result in a growing electricity demand in the residential sector. Obviously, the level of intensity in electricity use and carbon emissions will vary considerably in different countries, owing to differences in the energy mix, structure and efficiency of economies. However, with 75% of the energy being derived from fossils in South Africa, the impacts of unsustainable household electricity use on the environment can not be underestimated.

Further, it is plausible to suggest that promoting electricity saving behaviour among high-income households could have a significant impact on minimising electricity load shedding, a common occurrence in South Africa, given their disproportionately high electricity consumption. High-income households have the resources to fall back on alternative sources, such as generators and solar energy during load shedding, which the poor seldom afford. Thus, from a moral standpoint, high-income households should be a key target for behaviour change interventions because their electricity use practices may disproportionately and unwittingly impact low-income households. Taken together, addressing wasteful electricity use practices through behaviour change interventions has the potential to assist the local city and national authorities in their efforts to achieve electricity demand management, emission targets and broader sustainability goals. The potential limitations of this study are threefold. First, the sample size is small, which may not allow generalisations of the findings. Second, there are possible discrepancies between reported and actual behaviour, as has been reported elsewhere [33]. Third and last, the questionnaire was completed by one member of the household, which could have resulted in self-reporting bias, but evidence suggests individual actions are often a representation of and provide insights into family values due to family socialisation [65]. Therefore, while the study can provide important insights into electricity use behaviour, the findings should be interpreted with caution.

Author Contributions: G.T. conceptualised the study. S.P.W. drafted the questionnaire, collected and analysed data, and wrote the first draft of the manuscript, under G.T.’s supervision and H.W.K.’s advice. All authors read and approved the submitted final version of the manuscript.
Funding: This work was funded by the National Research Foundation of South Africa under the Thuthuka Funding Instrument, Reference No. TTK15061119184, for which we are grateful. Any opinion, finding, conclusion, or recommendation expressed in this material is that of the authors and the NRF does not accept any liability in this regard. GT thanks the Oppenheimer Memorial Trust for a sabbatical grant that allowed time for writing paper.

Acknowledgments: We thank the residents of Edenvale for their participation in the project.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Grouping of Personal Value Orientations, Value Domains and High-Order Values

| Personal Value Orientation                  | Value Domains | High-Order Values |
|--------------------------------------------|---------------|-------------------|
| 1. Aesthetic beauty: being able to enjoy the beauty of nature and culture. |               |                   |
| 2. Environmental quality: having access to clean air, water and soil. Having and maintaining a good environmental quality. | Universalism   | Self-transcendence |
| 3. Nature: enjoy natural landscapes and assurance of the continued existence of plants and animals. |               |                   |
| 4. Social justice: having equal opportunities and rights as others. | Benevolence    |                   |
| 5. Social relations: having good relationships with friends, colleagues, neighbours. |               |                   |
| 6. Family: having a stable family life and good family relationships. | Stimulation    |                   |
| 7. Challenge/excitement: having challenges and experiencing pleasant and exciting things. |               | Openness to change |
| 8. Change: having a varied life, experiencing many things as possible. |               |                   |
| 9. Freedom: freedom and control over the course of one’s life, to be able to decide for yourself, what you do, when and how. | Self-direction |                   |
| 10. Private: having opportunities to be yourself and to do your own things. | Hedonism       |                   |
| 11. Identity: being able to develop one’s own identity. |               |                   |
| 12. Comfort: having a comfortable and easy daily life. | Achievement    | Self-enhancement  |
| 13. Leisure time: having enough time after work being able to spend this time satisfactorily. |               |                   |
| 14. Education: having the chance to get a good education and to gain general knowledge. | Power          |                   |
| 15. Work: having or being able to find a job and being able to fulfil it as pleasantly as possible. |               |                   |
| 16. Material beauty: having nice possessions in and around the house. | Security       |                   |
| 17. Money/income: having enough money to buy and to do the thing necessary and pleasing. | Conservesion   |                   |
| 18. Social status: being appreciated and respected by others. |               |                   |
| 19. Safety: being safe at home and in the streets. |               |                   |
| 20. Security: feeling attended to and cared for by others. | Traditions     |                   |
| 21. Health: being in good health and access to adequate health care. |               |                   |
| 22. Spirituality/religion: being able to live a life with an emphasis on spirituality and/or with your own religious persuasion. |               |                   |
Appendix A.2. Fixed Effect Test for Electricity Use Behaviour. Restricted Maximum Likelihood. Type II Decomposition

| Effect                      | Num. DF | Den. DF | F   | p      |
|-----------------------------|---------|---------|-----|--------|
| Age of respondent           | 1       | 74      | 0.90 | 0.346  |
| Gender of respondent        | 1       | 74      | 1.00 | 0.320  |
| 1 = female; 0 = male        |         |         |     |        |
| Education level of household head | 1      | 74      | 0.38 | 0.541  |
| Household size              | 1       | 74      | 0.11 | 0.739  |
| Number of dependents        | 1       | 74      | 0.14 | 0.707  |
| No of members employed      | 1       | 74      | 4.40 | 0.039  *|
| Self-direction              | 1       | 74      | 0.34 | 0.854  |
| Stimulation                 | 1       | 74      | 0.50 | 0.481  |
| Achievement                 | 1       | 74      | 0.11 | 0.731  |
| Hedonism                    | 1       | 74      | 0.88 | 0.351  |
| Power                       | 1       | 74      | 5.87 | 0.018  *|
| Universalism                | 1       | 74      | 6.56 | 0.012  *|
| Benevolence                 | 1       | 74      | 0.08 | 0.778  |
| Security                    | 1       | 74      | 0.17 | 0.681  |
| Traditionalism              | 1       | 74      | 0.09 | 0.769  |

* indicates 5% level of significance.

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