Proceedings of the 7th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/43/20232147

Research on the Factors Influencing Residential Energy Consumption Behaviour

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Abstract: In accordance with the double carbon target proposed in 2020: to achieve "carbon peak" by 2030 and "carbon neutrality" by 2060. The background of this research is how to optimize the industrial structure and guide low-carbon consumption through energy production and consumption restructuring. In the post-epidemic era, a series of changes in people's consumption concepts and behaviour have taken place, which made positive or negative impacts on low-carbon consumption. The research focus here is to adopt the survey analysis method, collecting primary analysis data through data collection, questionnaires, and interviews. This paper focuses on the validation and practice of this research method. Researches have found that the current direct energy consumption behaviours of residents concentrated in the household scenario and the travel scenario. The low-carbon nature of these scenarios is influenced by two main decisions: the choice of consumption mode at the first consumption stage and the choice of consumption mode at the ongoing consumption stage. The factors that influence these decisions vary from stage to stage, and different strategies can help guide residents' low-carbon consumption behaviour.

Keywords: carbon emissions, low carbon consumption, energy consumption behaviour, factor analysis method

1. Introduction

In response to global climate change, 2020 the Chinese government proposed to achieve carbon peaking by 2030, i.e., to achieve the historical peak of carbon dioxide emissions by then and to achieve the inflection point of the change trend from increase to decrease [1]. To achieve this goal, a series of policies and measures were formulated.

In the same period, studies on low-carbon and green energy consumption have emerged, involving residents at the social life level. Herendeen's analysis shows that the total energy demand of households is curvilinear across households, while Bin et al. conclude that more than 80% of energy consumption is to meet various household needs [2, 3]. Further studies have focused on consumption data and preferences in terms of food, clothing, housing, and transport, to refine the level of carbon emissions. The Chinese Urban Household Survey (UHS) data, combined with Golley et al.'s method, shows that the top three consumption behaviours in terms of carbon emissions are housing consumption, food consumption and transport consumption [4].

It can be concluded from these studies that the various types of human consumption behaviours are one of the critical variables that influence the level of carbon emissions in the population. The results

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of the study on the composition of energy consumption behaviours are summarised as the main reasons for the differences in energy consumption levels due to people's lifestyles, behaviours, and habits, especially their energy consumption behaviour. Based on the research mentioned above, this paper will further analyze the factors influencing the choice of these main consumption components, the results of which can be more targeted in practice to assist in policy formulation, guide consumption choices, and refine low-carbon publicity.

2. Methodology

2.1. Theoretical Basis

Based on the previous research, we have developed a general view of the level of carbon emissions in the population. The next step is to explore the decision-making factors behind these consumption behaviours and to develop strategies to guide them toward the dual-carbon goal. The concept of "low-carbon economy" was introduced in the UK government's 2003 Energy White Paper, which could be extended to the concept of "low-carbon consumption" at the residential level [5].

Studies have proposed that demographic factors, individual psychological factors, group psychological factors, and external situational factors should be considered to promote low carbon consumption behaviour among residents. Specifically, demographic factors include personal and household characteristics such as age, gender, income level, family structure, education level, and concern for the environment; individual psychological factors include the sense of responsibility, values, attitudes, and subjective norms; group factors include social norms, reference groups, and social status; and external situational factors include policies and regulations, information feedback and economic costs. These factors are mainly focused on sociology and economics, and the application of quantitative methods in specific studies is relatively rare [6].

2.2. Research Design and Implementation Process

This led the author to consider a social and economic approach to this topic. Several research reports on household energy saving behaviour, low carbon consumption behaviour, and energy consumption behaviour were all based on the cities in the same area as the author's home city. Thus the result of the local population will be comparable [7, 8, 9]. The analysis also found that the above low carbon consumption and energy consumption behaviour boils down to economic purchasing behaviour, and that both traditional and emerging economic principles are theoretically applicable to the main subject of this paper, according to the logic of the relationship from purchasing intentions to purchasing behaviour.

A questionnaire survey and in-depth interviews were conducted with the residents of the author's neighbourhood on a household basis. The questionnaires were used to obtain primary data on the subjects of the study, which included basic information and the main part subjects. The basic information includes the household population composition, a specific age range, household quarterly electricity bills, household energy appliances and their use, household transport travel expenses, transport travel modes and related situations, etc. The main subject part includes the pre-designed hypothetical factors involving four aspects of quality, price, habits, and special considerations (including environmental considerations) that have an impact on energy consumption behaviour. It involved 16 specific research questions. In order to match the analysis method described later, questions were taking the form of the Likert 5-point scale format. To improve the replicability and scalability of the research methodology, the data pre-processing script of the questionnaire was prepared in advance. During the data analysis, the extraction and rotation were done through SPSS using principal component analysis and maximum variance analysis method respectively, and the main factors were obtained to confirm the rationality of the design by comparing with the

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hypothetical characteristics; Relevant conclusions were extrapolated, after the reliability and consistency verification. It was also revised according to the in-depth interviews with a randomly selected sample group.

The actual questionnaire survey was conducted through an internet link distributed by the community property in the community management system. 317 responses were collected, accounting for 0.68% of the number of households in the whole community, of which 263 were valid samples, with a sample validity rate of 83%. Another 60 households were interviewed in depth by means of secondary questionnaires and telephone calls, accounting for 22.8% of the valid feedback sample. The age of the respondents to the questionnaire was mainly in the age range of 31-50 years old, accounting for 68.9%, while those aged 51 years or above accounted for 13.8% and those aged below 30 years for 17.3%. For the household size composition, 62.7% were 2-3 persons households, 4.9% were four or more persons households, and 32.3% were single-person households.

The results of the manipulation to obtain Cronbach α coefficient and KMO and Bartlett's sphericity showed that the questionnaire sample data had good reliability and validity and met the conditions for further factor analysis. The results of the SPSS data manipulation showed that the factor loading coefficients of each variable were all above 0.55, and convergence was completed after six iterations of rotation. The extracted principal factors were consistent with the design hypothesis factors.

3. Analysis

According to the previous research results, the top three carbon emitters are residential consumption, food consumption, and transport consumption. As the carbon emissions from food consumption are mainly allocated to production and logistics, there is less carbon CO_2 directly generated. The following research analysis is based primarily on energy consumption in the household scenario, which is mainly housing consumption, and energy consumption in the travel scenario, which is mainly transport consumption.

3.1. Analysis of Energy Consumption in the Household Scenario

The statistics of the total household electricity costs seasonally are as Table 1:

Table 1: Total household electricity costs.

Electricity tariff range	Spring	Summer	Autumn	Winter
<100	45%	15%	49%	28%
100-300	34%	40%	31%	43%
300-400	16%	24%	14%	23%
400-700	4%	14%	4%	4%
>700	1%	5%	2%	2%

Further data analysis and interviews on the usage habits of air conditioning equipment, heating equipment, lighting, and other equipment revealed that the household scenario energy consumption is concentrated in heating and cooling consumption. Two key points affect the consumption decision: the first-time consumption decision and the long-term consumption choice. The analysis needs to distinguish between the decision factors on these two points.

A look at the main factors of consumption decision/choice and the research data shows a clear subgroup of users who choose to focus on price and other considerations. Probably, those who focus on price tend not to focus on other factors, such as energy efficiency, and the proportion of such residents is more prominent at 36%. We conclude that the current social awareness of energy

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efficiency and low carbon in the household scenario is inadequate or ineffective, and this was also verified in the in-depth interviews: over 58% of users are unaware of the relevant policies or can not get the authoritative information publicly. This situation influences the first consumption decision significantly.

Further analysis of the duration of use of air conditioners and heating equipments in the long-term consumption phase shows that, the popularity of household air conditioners and the miniaturisation of the family room area simutaneously bring an increase in the number of air conditioners. Data analysis showed that more than 87% of households use air conditioners in summer longer than 1 hour, compared with 13% of those who do not use air conditioners and those who use them for less than 1 hour. In winter, less than 32% of households use air conditioning for less than one hour. The reason for this is the variety of heating options available in winter. An analysis of the heating options in winter shows that only 37% are air conditioning. The others are water heaters (27%), others (electric heaters, etc.) (13%), and the proportion of those who do not use heating also reaches 23%, which is significantly greater than the proportion of those who do not use air conditioning for cooling in summer. Habit and price are the main influencing factors at this stage.

In-depth interviews also led to a topic worth considering: in the first-time consumption decision for this type of energy consumption, people expressed a preference for low-carbon or energy-saving factors, but in reality, it was the price that was the main factor. The reason for this may be that there are very few options available for cooling in summer, while the difference in effectiveness between the various types of heating in winter is not significant and differs greatly from the manufacturers' claims. The current industry-level evaluation of the effect is the energy-rating, but its interpretability is not high and the verifiable effect is not transparent. This results in a lack of perceived credibility when residents choose, with the energy rating only converted into an additional purchase cost. The impact of this problem is of particular concern to society due to the chronic dependence on long-term energy consumption.

3.2. Analysis of Energy Consumption in the Travel Scenario

This scenario is statistically analysed regarding household travel cost per person, daily commuting patterns, daily commuting distances, and forms of energy used in household vehicles. The total per capita household expenditure on transport is as Table 2:

Table 2: Total per capita household expenditure on transport.

Range of travel costs per person	Percentage
<100	38%
100-300	28%
300-500	13%
500-1000	11%
>1000	10%

When comparing this scenario with the household scenario, there is a clear indication of low carbon and energy efficiency, both in terms of user selection considerations and actual results. In other words, the proportion of users choosing to do so is significantly greater than in the household scenario.

Analysis result shows that when users choose to travel by car, the proportion of those choosing new energy vehicles is as high as 21%, due to energy efficiency and ecological protection. This indicates that people tend to buy cars, with new energy, and the amount is increasing rapidly, both in terms of environmental concepts and practical results. This coincides with the current market sailing

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results and promotional policy priorities. If the comprehensive energy consumption situation of new energy vehicles can be genuinely addressed, it will make a better contribution to the low-carbon goal.

4. Conclusion

This research results that the primary energy consumption behaviours of housing energy consumption and transport energy consumption are both influenced by people's considerations such as quality, price, habit and energy saving. However, the degree of influence of these four factors differs, with housing energy consumption being more influenced by price and habit, and transport energy consumption being more influenced by other considerations such as habit and energy efficiency.

There are two important decision points that influence both types of consumption: at the time of initial consumption and at the time of long-term consumption. The initial consumption of both is influenced by considerations such as quality, price and energy efficiency. But the reality differs between the two types of consumption. Energy-efficiency considerations are partially transformed into price factors in housing energy consumption, while they do take effects in transport energy consumption.

Comparing the above differences, from an economic point of view, while making a short-term decision, there is a lack of rooting and anchoring effects. When making the long-term choice, the sunk costs are not effectively addressed. Specific suggestions are: First, how to objectively evaluate the comprehensive energy consumption of various methods in residential consumption, how to formulate clear government policies to encourage low-carbon, and how to set up anchoring targets and product promotion in a standardised manner. This requires all parties to do their part, with regulation and self-regulation. Secondly, the need for well targeted research on user sunk costs in policy formulation, strengthening pre-planning and post-guidance, and encouraging the stimulation of low-carbon consumption choices on the consumer side. Thirdly, optimize the slogan about energy-saving and environmental-protection publicity, reaching all parts of our society. Form a multi-level guidance, Make low-carbon consumption awareness deeply rooted in policies, enterprises, and culture.

The limitations of this study can be solved by optimizing the question variables in the main part of the questionnaire, improving the questionnaire procedure and the quality of the questionnaire returns, refining the classification of scenarios and conducting specific special surveys. The study can be further engineered using core python libraries such as factor_analyzer for factor analysis. Furthermore, designing an interactive UI to promote self-service analysis services, will undoubtedly help community governance pay attention to and guide residents to achieve low-carbon consumption, thereby achieving corresponding social value.

References

[1] *State Council, (2021), the carbon Dafeng operation plan before 2030. https://www.gov.cn/zhengce/content/2021-10/26/content_5644984.htm.*

[2] *Herendeen R.T. et al.,(1976)Energy cost of living. Energy, 1(2):165-178.*

[3] *Bin S. et al., (2005)Consumer lifestyle approaching to US energy use and the related CO_2 emissions. Energy Policy,33(2):197-208.*

[4] *Golley J. et al.,(2008) Chinese urban household energy requirements and CO2 emissions. Brooking Institution Press, Asia Pacific Press at Australian National University, and Social Science Academic Press,2008:334-366.*

[5] *Great Britain Parliament House of Commons Environmental audit Committee,(2003)Our Energy Future: Creating A Low Carbon Economy [R]. TSO(The Stationery Office),*

[6] *Colin F.C. et al.,(2004) Advances in Behavioral Economics, Princton University Press.*

DOI: 10.54254/2754-1169/43/20232147

[7] *Tao Shipeng. (2022). Under the background of "Double Carbon", the study of low-carbon consumption behavior in Shanghai college students. https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202301&filename=1022647612.nh*.

[8] *Liu Shuang. (2020). The research of the energy-saving willingness of the households in the urban residents of Jiangsu Province. https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202102&filename=1021541916.nh.*

[9] *Chen Lishun. (2009). Urban residents' energy consumption behavior research .https://kns.cnki.net/kcms/detail.aspx? Dbname = CDFD0911 & FILENAME = 2010021262.nh*.