Stakeholder Behavior Analysis of Low-carbon Housing Promotion

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Abstract: The construction field is one of the key fields of energy conservation in the whole society. China has become the world's second largest energy consumer and the largest CO2 emitter. China's total energy consumption from building operation reached 22% of the total national energy consumption, of which residential buildings accounted for about 45.7%. The proportion may further increase with the progress of urbanization and growth of population. Therefore, It is believed that the development of low-carbon housing market is important for energy conservation and emission reduction. Due to different positions and interests, low-carbon housing has not been effectively promoted by various stakeholders involved in the development of low-carbon housing in China. This paper discussed how to encourage stakeholders to accept, participate and promote the development of low-carbon housing on the base of analyzing the behavior and interest demands of all stakeholders. The paper take Guangzhou city as the case, the research shows the Guangzhou government has issued relevant policies to encourage that real estate projects implement green building two-star or above standards, both commercial housing and affordable housing have provided low-carbon housing products nowadays, but there are only a few projects and few real estate enterprises involved. Most consumers hold a supportive attitude towards the supply of low-carbon housing products, but it is hoped that low-carbon housing can improve the living comfort without too high a price. The paper suggested that the government should improve policy design and incentive mechanism, build a quality assurance system for the whole life cycle of low-carbon housing, cooperate with real estate developers and strengthen publicity to improve the recognition of low-carbon housing in the whole society.

1. Introduction
The construction field is one of the key fields of energy conservation in the whole society. China has become the world's second largest energy consumer and the largest CO2 emitter. In 2018, China's total energy consumption from building operation reached 1 billion standard coal, accounting for 22% of the total national energy consumption. Carbon emissions related to building operation accounted for 20% of China's total social carbon emissions, of which residential buildings accounted for about 45.7%[1]. With the advancement of China's urbanization process, the expansion of urban built-up areas and the growth of population, the proportion may further increase. Therefore, in order to achieve the goal of carbon peak and the vision of carbon neutrality, we should accelerate the pace of energy
conservation and emission reduction in the building field and strengthen the promotion of low-carbon housing.

Low-carbon housing is a subcategory of low carbon buildings. It is the residence that adopts low-carbon materials and technology to reduce the use of fossil fuels, improve energy efficiency and reduce carbon dioxide emissions during its entire life cycle of construction and using. It is generally believed that low-carbon design, low-carbon energy use, low-carbon construction, low-carbon operation, low-carbon emissions, low-carbon construction, low-carbon materials and increasing carbon sink eight are the characteristic elements of low-carbon housing[2]. In the context of global warming, energy conservation and emission reduction, some countries have begun to promote and develop low-carbon housing. Britain, the United States, Japan, the European Union and other developed countries formulate the relevant building codes, specifications and green building assessment systems. According to different national and climatic conditions, various places actively carry out the application research of low carbon housing, such as the passive housing in Europe, SI housing in Japan and low-carbon public housing in the United States have been gradually advocated and accepted by the market[3]. While the development of low-carbon housing in China is relatively late, there is no universally recognized evaluation system yet. Although some local governments support the construction of energy-saving buildings strongly, and some real estate enterprises carry out practice in the field of low-carbon housing constantly, the proportion of low-carbon housing in the residential real estate market is still relatively low. Many subjects are involved in the development of low-carbon housing. Due to different positions and interests, low-carbon housing has not been effectively promoted by various stakeholders. Therefore, it is of great significance to discuss how to encourage stakeholders to accept, participate and promote the development of low-carbon housing on the base of analyzing the behavior and interest demands of all stakeholders.

2. Definition of stakeholders
According to the stakeholder theory, the stakeholders of low-carbon housing promotion can be defined as: individuals or groups that have contractual relationship or administrative legal relationship with low-carbon housing projects, participate in project construction activities and make special investment, and expect to obtain benefits directly or indirectly from it[4].

2.1. The government
The promotion of low-carbon housing can help to reduce urban energy consumption, achieve carbon emission reduction targets, regulate urban climate, and enhance the ability of sustainable development of cities. In order to maximize the social benefits, the government plays the role of facilitator and manager in the promotion of low-carbon housing. First of all, the government formulates the programmatic documents for the promotion of energy-saving buildings, and the industry standards and energy-saving building evaluation standards issued by relevant departments directly affect the construction quality of low-carbon housing. Secondly, the government formulates incentive and preferential subsidy policies, such as energy saving incentives, low-interest loans, tax exemptions, fee exemptions, etc., to enhance the enthusiasm of both supplier and demander of low-carbon housing. In addition, local governments also play the supervision role which is indispensable. Units that do not implement or reduce the operating standards of low-carbon housings will be subjected to fines, suspension of business, and reducing corporate qualifications according to the seriousness of the case. The established supervision and management system is conducive to the stable and healthy development of the low-carbon housing market.

2.2. Real estate developers
Real estate developers are the suppliers of new low-carbon housings, which are constrained by government administrative regulations and guided by incentive policies, and influenced by consumers' housing demand as well[5] Their investment behavior affects the popularization of low-carbon housing directly. As a profit-making enterprise, the real estate developer's interest appeal is to maximize the
marginal production benefit. At present, the construction of low-carbon housing means the increase of investment. If the market demand is insufficient and the government's incentive measures for the low-carbon housing cannot meet the requirements of developers to obtain expected profits, the real estate developers may choose to lower the energy saving design standards or turn to develop non-energy saving buildings in the pursuit of profit maximization. At the same time, developers' marketing strategies also have a huge impact on consumers. Appropriate and effective marketing promotion can improve consumers' cognition and acceptance of low-carbon housing. Low-carbon residence itself has many advantages, such as good ventilation, lighting, heat preservation, sound insulation, etc.\footnote{6}. If real estate developers can successfully use the living comfort of low-carbon residential buildings as a selling point, give consumers the impression of upscale residence and a better life, then convert potential consumers with medium and high incomes into actual buyers, a good demonstration effect can be formed in the whole society and win more consumers for low-carbon residential products. Therefore, real estate developers play a key role in the promotion of low-carbon housing.

2.3. Consumers
Consumers are the buyers and users of low carbon housing, and they are also the important subjects of the promotion and dissemination of low carbon housing. Without their recognition and acceptance, there will be no market demand, and real estate developers will lose their enthusiasm to invest on low-carbon housing, which would impede the promotion of low-carbon housing and makes the low-carbon housing market unable to develop\footnote{7}. The interest demand of consumers is maximize the welfare of individual. When it comes to buy a house, a comprehensive consideration is given to housing location, supporting facilities, living comfort and housing price etc.. Compared with the possible living comfort experience brought by low-carbon housings and the reduced cost during the future holding period, consumers are more likely to make a choice based on the utility maximization principle of the current period.

2.4. Others
The property management company is the maintainer in the operation of low carbon residence. The attitude to energy saving and management level of the property management company will affect the energy saving effect in the operation process of new low-carbon residences. Building energy saving service agencies are technical supporters of low-carbon housing design and energy saving transformation. By providing technical services, they can improve the energy saving efficiency of residential buildings, ensure the energy saving effect. Their professional and technical level will also affect the energy saving effect of the operation of low-carbon residential buildings \footnote{8}. It can be seen that these two types of subjects are both suppliers of low-carbon housing-related services. Like real estate developers, they are constrained by government administrative laws and regulations and guided by incentive policies, as well as influenced by consumer demand. As market-oriented enterprises, they aim to obtain benefits from their main business activities.

In addition, media organizations have the role of supervision and dissemination of the promotion of low-carbon housing. By positively reporting the advantages and analyzing the problems existing in the development of low-carbon housing, the attention of all society is aroused, then the benign development of the low-carbon housing market is promoted.

According to the stakeholder theory and definitions stated above, It can be known that stakeholders in the promotion process of low-carbon housing include the government, real estate developers, consumers, property management companies, building energy conservation service agencies etc, and the first three are the most important.

3. Stakeholders Behavior Analysis -A Case Study of Guangzhou City

3.1. The government
Guangzhou municipal government promulgated the "Twelfth Five-year Plan for Energy Conservation
and Emission Reduction" in April 2012. In 2017, the Guangzhou government issued "The 13th Five-Year Plan for Energy Conservation and Carbon Reduction of Guangzhou". In addition, Guangzhou issued a series of policy documents, such as "Guidelines on vigorously developing low carbon economy" and "Implementation Plan of Guangzhou Low-carbon City Pilot Work". All the policy documents required that efforts should be made to improve energy conservation and carbon reduction in key areas and more attention has been paid to building energy efficiency. In terms of building construction standards, Guangzhou issued "Guangzhou Green Building and Building Energy Conservation Management Regulations" in 2013, and "The Three-year Action Plan for the Quantity and Quality Improvement of Green Buildings in Guangzhou (2018-2020) " was issued in 2018. It can be seen that Guangzhou has issued relevant policies to implement building energy conservation and quota management of building energy consumption, to strengthen building process control and retrofit of existing energy-efficient buildings and to increase the proportion of newly built green buildings. It is encouraged that real estate projects implement green building two-star or above standards but there is no specific supporting incentives yet.

3.2. Real estate developers
In recent years, low-carbon housings gradually appeared in the commercial housing market in Guangzhou. At present, there are many residential districts in Guangzhou that have obtained the green residential design label, such as Vanke Fengjing, Donghui Garden, Guangzhou Asian Games City, Fangcun Garden, Vanke Xingfuyu, etc. In this paper, the details of some low-carbon housing products are further analyzed as follow.

Vanke Fengjing community is located in Baiyun District, Guangzhou City, It is a green, environment-friendly and low-carbon forest-style residential housing project, build by Guangzhou Vanke company jointly WOHA architectural design office and Guangdong academy of building science. The project utilizes the unique mountain scenery resources of Guangzhou Baiyun mountain to create a vertical greening ecological community, which is the first community to obtain the green three-star building design logo of the residential community in Guangzhou. The project use aerated concrete block and vertical greening in the outer wall, XPS insulation board and locally plant on the roof, high-performance coated insulating glass combined with comprehensive external shading and other means in the outside windows to meet the energy conservation standards. Under the same indoor thermal environment, the annual total energy consumption of air conditioning and heating can be reduced by more than 60% compared with the benchmark building in Vanke Fengjing, which greatly reduces the residential energy consumption.

Fangcun Garden (Phase II District) is an affordable housing project. It has signed the goal of creating the green building at the beginning of the project, and has been built into a green building demonstration project at the national level. The project realized natural ventilation, gave full consideration of building maintenance structure energy saving and improving air conditioning energy efficiency and adopted solar photovoltaic power generation technology, solar hot water and water source heat pump technology etc. The overall project has achieved significant achievements in saving energy and reducing carbon dioxide emissions by making the lighting power of the public part save more than half than under normal use.

To summarize the characteristics of existing low carbon housing products in Guangzhou housing market, it can be seen that building energy conservation mainly focuses on the cooling function in summer according to the geographical location and climatic characteristics of Guangzhou. In the supply side, both commercial housing and affordable housing have provided low-carbon housing products, which has a driving effect to expand the scale of low carbon housing. However, from the perspective of the overall low-carbon housing market in Guangzhou, there are a few projects and only few real estate enterprises involved. Most real estate developers still sit tight for the investment and construction of low-carbon housings.

3.3. Consumers
All the existing low-carbon housing projects have achieved a good evaluation from the perspective of
market, But does the low-carbon quality drive the purchase of these residential projects? This paper try to understand consumers' recognition and purchase intention of low-carbon housing through a questionnaire survey.

Considering that the young people will be the main house buyers in the next 10 to 20 years, with the development and the popularization of low-carbon awareness, the young generation is closely related to the development and promotion of low-carbon housing in the future. Therefore the selected respondents of this survey are mainly young people aged between 21 and 29 in Guangzhou. The survey was conducted online and offline. A total of 200 questionnaires were distributed and 183 questionnaires were effectively recovered. Among 183 samples, 81 were male, accounting for 44.3% and 102 were females, accounting for 55.7%. In terms of educational background, 154 were with bachelor degree or above, accounting for 84.1%. The questionnaire mainly sets up two modules: consumers' cognition of low-carbon housing and purchase intention.

The survey shows that 85.8% of the respondents heard of the term “low-carbon housing” mainly through media such as the Internet or news reports. But they only have a general understanding of the connotation of low-carbon housing (accounted for 55.7%) or do not know it (accounted for 44.3%), which shows that the public's understanding of the concept of low-carbon housing is still relatively lacking. And in the way of knowing "low-carbon housing", the way "through real estate introduction" only accounted for 17.5%, which also reflects that low-carbon housing is still relatively rare in the market to a certain extent. In terms of the recognition of low-carbon housing, even though most people are not very familiar with low-carbon housing, more than 80% respondents hold a supportive attitude towards the supply of low-carbon housing products, indicating that young people's awareness of low carbon is generally increasing, and the development of low-carbon housing has a good consumer base in the future. Further investigation of consumers' purchase intention through "Are you willing to buy low-carbon housing?" shows that 67.4% respondents are willing to buy low-carbon housing, 29.2% choose "not clear", and only 3.4% choose "not willing". Look from the decision-making influence factors (Table 1), consumers are most concerned about the factors of living comfort and housing prices, the case percentage were 80.9% and 73% respectively, preferential policies for house purchase have a strong guiding effect on consumers, the social advocacy of low-carbon housing and the richness of low-carbon housing products are also factors that some consumers consider. It can be seen that consumers have the same or even higher expectations for the housing quality and living comfort of the low-carbon housing than the ordinary housing. From the perspective of consumers’ personal welfare, it is hoped that the low-carbon housing could improve the living comfort without a high price.

Table 1 Response percentage and case percentage of low-carbon housing purchase decision factors

| Factor                        | Number of cases | Response percentage | Case percentage |
|-------------------------------|-----------------|---------------------|-----------------|
| Housing price                 | 134             | 22.90%              | 73.00%          |
| living comfort                | 148             | 25.40%              | 80.90%          |
| social advocacy               | 86              | 14.80%              | 47.20%          |
| preferential policies         | 132             | 22.50%              | 71.90%          |
| product richness              | 80              | 13.70%              | 43.80%          |
| others                        | 4               | 0.70%               | 2.20%           |

4. Conclusions and policy recommendations
The goal of carbon peak and carbon neutrality proposed at the 75th Session of the United Nations General Assembly, is a major declaration of China's climate and environmental policies. The promotion of low-carbon housing plays a important role in the whole society energy saving activity since the residential buildings’ energy consumption has accounted for more than 10% of the total national energy consumption. Due to different positions and interests, low-carbon housing has not been effectively promoted by various stakeholders involved in the development of low-carbon housing in China. This paper defined the main stakeholders and take Guangzhou city as the research case to analyze the stakeholders’ behavior. The results show that the Guangzhou goverment has issued
relevant policies. It is encouraged that real estate projects implement green building two-star or above standards but there is no specific supporting incentives yet. Both commercial housing and affordable housing have provided low-carbon housing products, but there are only a few projects and few real estate enterprises involved. Most consumers hold a supportive attitude towards the supply of low-carbon housing products, but it is hoped that low-carbon housing can improve the living comfort without too high a price. To promote the development of low-carbon housing more effectively, the policy recommendations are as follows:

In terms of top-level policy design, the government needs to speed up the road map design of "carbon neutral" and "carbon peak", specify the corresponding time point, and implement energy saving and emission reduction targets of various departments. Including energy conservation and emission reduction targets in the government performance evaluation indicators is very beneficial to the promotion of low-carbon housing development. In terms of implementation, it is necessary to strengthen the incentive mechanism for all stakeholders of low-carbon housing promotion, such as policy incentives and economic incentives. For real estate developers, economic incentives would be low-carbon housing financing support, subsidies and tax relief etc.; policy incentives can be simplifying the approval procedures for the investment. For consumers, economic incentives would be such as low interest loans for low carbon housing buyers and the policy incentives could be reducing the proportion of low carbon housing buyers down payment. Low-carbon housing can also be combined with talent housing, returned-housing and other projects for increasing the popularity. For energy-saving building service organizations and property management companies, energy conservation fundings or technological innovation fundings could be set to encourage them.

The procedures for the declaration, investigation and confirmation of building energy conservation projects, technologies, products and materials should be further improved, and so as the testing, appraisal and evaluation system for energy-efficient buildings. The government should strengthen the supervision during the construction process of low-carbon housing projects and establish a quality assurance mechanism for low-carbon housing. The building energy efficiency labeling or certification system should be improved and realize information publicity. At the same time, due to the residential product has a long service life, it is also necessary to improve the energy saving effect of low-carbon housing during the use period by standardizing the the property management and energy-saving performance of property management companies and further promote the development of energy saving organizations such as building energy saving service companies and energy saving research institutions, so as to provide technical guarantee for the good operation of low-carbon housings. Only by letting consumers to feel the improvement of life quality brought about by low-carbon housing can it stimulate the market demand and promote the development of low-carbon housing market.

The government can also make full use of medias to form energy-saving atmosphere by policies propaganda, knowledge dissemination, cases publicity so that the awareness of building energy conservation will be deeply rooted in people's hearts. Enhancing the real estate developers' awareness of energy conservation could increase their willingness of low-carbon housing supply while enhancing consumers' awareness of energy conservation could increase their purchase intention. And the behavior choice of low-carbon housing suppliers and consumers will affect the choice of other suppliers and consumers in the residential market, forming a benign social building energy saving atmosphere. In the meantime, the government can cooperate with real estate developers to promote consumers' in-depth understanding of low-carbon housing product knowledge. Not only understanding the facts of low-carbon housing such as product function knowledge(know-what), why do we need low-carbon housing(know-why), but also further publicize how enterprises build low-carbon housing, how the construction process is to achieve low-carbon, and how to maintain a healthy living environment after the occupancy (know-how). Through knowledge marketing to enhance consumers' recognition of low-carbon housing and purchase intention, and achieve a win-win of economic and social benefits.
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