Obstacles of and Countermeasures for China’s Low Carbon Community Construction

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Abstract. Urban communities, as the most basic unit of the human systems on Earth, are important areas for mitigation and adaptation actions in climate change. However, with a lack of deep understanding of the status quo and composition of community carbon emissions, as well as of the issues in low-carbon actions, the measures taken are often superficial and not targeted, which makes low-carbon activities difficult to implement. This study selected different types of communities for questionnaire surveys online, and conducted field interviews and in-depth surveys afterwards in typical communities. Key data such as community energy consumption, transportation, garbage disposal, and the status of community low-carbon actions were collected, based on which the potentials of carbon reduction were analysed, the obstacles in low-carbon community construction were discussed and corresponding countermeasures were proposed.

1. Introduction
In response to climate change, the Chinese government has adopted a series of policies and financial support measures to promote the construction of pilot low-carbon communities. In 2014, the Chinese National Development and Reform Commission (NDRC) issued the “Notice on Pilot Low-Carbon Communities”, which proposes to construct low-carbon communities in cities above prefecture level, aiming at 1,000 low-carbon pilot communities by the end of the “Twelfth Five-Year Plan”. [1] In order to guide this action, the NDRC further issued the “Guidelines for the Construction of Pilot Low-Carbon Communities” in 2015, clarifying the construction goals, contents and standards of “low-carbon communities”. [2] In 2016, the NDRC, the Ministry of Housing and Urban-Rural Development jointly formulated the “Action Plans for Urban Adaptation to Climate Change”, which proposed that by 2020, the climate change-related indicators will be universally taken into urban and rural planning systems, construction standards and industrial development plans, and that the goal of 50% green buildings in the climate change adapting pilot cities will be reached. [3] However, compared with the rapid progress of green buildings in new communities, the low-carbon actions in the existing communities seem to be difficult to implement. Only scattered information on relevant pilot projects and their effects of existing communities could be found on the Internet and other media.

Meanwhile, researches on low-carbon communities have been extensive in recent years, covering the issues of goals and principles, land use and spatial layout, energy, transportation, water systems, green landscapes, public services and infrastructure, technical measures, planning tools, and practice studies, etc. [4-6] Some scholars explored holistic and systematic approaches for carbon reduction or zero carbon achievements. [4-6]; Other scholars studied low-carbon strategies in different fields, such
as reducing building and transportation energy consumption by compact and mixed land use patterns, or focusing on the use of renewable energy. [7-9] With the deepening of research and practice in low-carbon communities, international researchers have begun to quantify the carbon emissions of communities and use carbon emission baseline as a prerequisite for follow-up study. [10-12] Chinese scholars in recent years have also begun to investigate the relationship between carbon emissions and energy consumption, transportation, food, waste generation, and demographic characteristics of community residents, and proposed adaptive strategies for low carbon community construction. [13-15]

However, theoretical and practice researches are currently still not adequately connected. As there is a lack of comprehensive understanding of the current carbon emissions and the problems, community action has been mainly based on some symbolic technical measures, with no targeted measures for certain communities with specific carbon emission features. For one thing, there is insufficient data of the actual community carbon emissions, for another, most of the existing surveys focuses on data such as energy consumption and transportation while neglecting the willingness and problems faced by the key actors - community residents and managers. In this context, this study makes investigation of the status quo of the carbon emissions and current low-carbon community actions in China, analyses the potentials and the problems faced by low-carbon community actors, and further proposes countermeasures for low carbon community construction for policy makers, planners, and community residents and managers in China.

2. Research method
The study first distributed questionnaires online according to a long list of potential communities selected through literature and Internet searches. Based on the quality of the finished questionnaires, participants’ intentions and accessibility, a short list of 27 communities was identified for further field interviews and in-depth questionnaires. With the collected data, the current status of carbon emission and low carbon community activities were examined. And based on the NDRC’s indictors, the carbon emission reduction potentials and features were calculated, and the major difficulties for communities were analyzed. On the basis of the study, countermeasures were proposed and verified with the opinions and feedbacks of the participating communities.

2.1. Survey questions
The interviews and questionnaires focused on two objectives: 1) Key data directly related to the carbon emission of communities. Based on the existing research priorities, transportation, energy consumption (electricity and gas) and garbage disposal were investigated; 2) Status and problems of low-carbon community actions, including specific actions, relevant technical measures and achievements, problems and difficulties.

2.2. Survey respondents
The survey was conducted in 27 communities in the more developed provinces of the southeast coast area in China, including existing communities, such as Xincangxiang in Yangzhou old city, Xiaolan Town North District in Zhongshan city, Longwuli Community in Guangzhou, Zibo Keyuan Community in Shandong; and some newly developed communities, such as Hefu Aoyuan, Langshi Green Street in Nanjing, Wanke Langrunyuan in Shanghai. The spatial scales and community population sizes are various, including both communities with multiple blocks operated by neighbourhood committees, and the singular block communities of newly developed green buildings managed by specific property companies. Interviews and questionnaires were conducted with community residents and key personnel (e.g. neighbourhood managers). Considering the current community management models, in some communities, especially urban new communities, the survey also involved property management companies.
3. Data and discussion

3.1. Community Residents’ Consumption Data

3.1.1. Travel of residents
The questionnaires show the average number of private cars owned by residents has reached more than 80 per 100 households. Residents’ private car travel is 47%, and their bus travel is 25%. And in newly developed urban communities, where residents’ private car ownership is higher (with some communities as high as 100 vehicles per 100 households, mostly in newly developed urban areas), car travel is 65%, while the bus travel is only 14%. The construction of public facilities in newly developed areas relatively lags behind, thus bus travel being inconvenient. The number of private cars in the old existing communities is relatively lower, at 67 per 100 households, thus the bus travel rate being relatively higher at 31%. Such communities are generally located in inner cities, where after years of construction, different kinds of public services have been equipped, which adequately meets the need to reduce travel and bus travel requirements. For the convenient locations and restricted parking, the proportion of bicycle and walking trips in the existing communities is also higher, which is 32%. In this aspect, newly built communities are of only 21%.

3.1.2. Household energy use
The survey found the annual household electricity consumption at about 2550Kwh. But different living habits and consumption levels cause a big difference in the consumption. In 67% of the communities, the average annual electricity consumption per household is 1000-2000 Kwh; in 24% of the communities, it is 2000-4000 Kwh; while in another 24% of the communities, the consumption is above 4000 Kwh. The consumption in the old communities is significantly below the average level, e.g., in Xincang Xiang community of Yangzhou old city, the average annual household electricity consumption is only 1000Kwh.

Most residents in the surveyed communities use natural gas, with few exceptions in old blocks using liquefied petroleum gas. The average annual gas consumption per household is about 338m$^3$ per year, ranging from 100 to 400m$^3$ (59% of the communities). Some of the communities use household boilers which makes the gas consumption much higher (e.g. 1400 m$^3$ in Shanghai Renheng Xijiao Garden).

3.1.3. Garbage collection and disposal
The overall garbage collection and disposal at the community level is low, especially for kitchen wastes. 50% of the communities have no classification of recyclable wastes. The proportion of kitchen waste collection is very low, with only 11% of the communities that have piloted on the classification and reuse of kitchen wastes. Even in the pilot communities, garbage collection is difficult. The collection of recyclable waste such as paper and glass is better: the recycling has reached a high percentage of above 80% in 14% of the communities, and 41% in 60%-80% of the communities. Such recycling has certain economic returns for residents, which encourages their action for recycling.

3.2. Low carbon community actions
The low-carbon actions in the surveyed communities can be divided into two categories. One is of the urban new communities. In the early stage of development, the developers have normally acquired green building designing logo for the entire community or certain buildings, for which focuses are on the application of green low-carbon technologies, such as energy-saving technologies, renewable energy (solar hot water, ground heat), and rainwater harvesting and utilization, in accordance with the requirements of national green building evaluation standards. However, in later operation stage, most residents are unaware of the existing green buildings or the green buildings to be registered. And as there are no obvious returns for residents, plus difficulties to get continuous support and guidance, neither community managers nor residents are much involved in low carbon actions.
In existing communities, community managers of various pilot projects can usually get financial and technical support from government and international organizations, but such is often one-time support for short-term implementation thus lacking sustainability. The actions taken are limited in the promotion of energy-saving lamps, solar hot water and photovoltaic street lamps, improvement of community environment and green space and small areas of photovoltaic roofing. And a few communities advocate residents to participate in energy-saving behaviour and low-carbon travel. For most communities without pilot projects, there are hardly any low-carbon measures and actions, or relevant policy and financial support.

4. Potentials and Problems
The annual carbon emissions of each household being calculated based on the survey, the status quo and composition of the emission were then analysed.

The calculation is made based on the carbon emission factor tools by the Intergovernmental Panel on Climate Change (IPCC). The annual community household carbon emissions from transportation, electricity, gas, and waste disposal are 2.880 (tCO₂/a), 1.785 (tCO₂/a), 0.731 (tCO₂/a) and 0.396 (tCO₂/a) respectively, with a total of 5.792 (tCO₂/a).

However, the “Guidelines for the Pilot Construction of Low-Carbon Communities” by NDRC set a goal of reduced annual carbon emissions of community households from transportation, electricity, gas, and waste disposal at 1.214 (tCO₂/a), 1.607 (tCO₂/a), 0.362 (tCO₂/a), and 0.15 (tCO₂/a) respectively, and a total of 3.333 (tCO₂/a). Thus the total emission needs to be reduced by 42.5%, of which transportation should contribute 28.8%, electricity 3.1%, gas 6.4% and waste 4.2%. And the carbon emission from transportation that has accounted for nearly half of the total household emission should be the most potential area for carbon reduction (see Figure 1).

The survey finds that insufficient policy encouragement and support and less public participation should be the major cause for the slow development of low-carbon communities. Most of the interviewees had no idea of the government’s incentive policies or possible financial support. Only 22% took initiative to learn relevant national policies and 11% to learn local policies. Community managers did not care about low-carbon actions except in the pilot communities, as there were no relevant annual assessment indicators. Residents’ participation was generally low, with little environmentally friendly awareness, as lacking low-carbon action guidance. Most communities did not have relevant goals or action plans. 86% of the surveyed managers admitted no practical information or technical knowledge on community low-carbon development. Although the NDRC aims at about 1,000 pilot low-carbon communities nationwide at the end of the “Twelfth Five-Year Plan”, the information available on the pilot communities is scarce and scattered.

5. Countermeasures and recommendations
In view of the current status, potentials as well as existing problems, countermeasures should be taken to promote community low-carbon actions. The proposed countermeasures that have been verified after feedbacks from participating communities are summarized as follows:
1) Low-carbon action strategies based on individualized carbon emission features of communities

According to the first-hand data from this survey, transportation is the most potential area of carbon reduction. The key is to improve the accessibility and convenience of public transportation. Meanwhile, low carbon travel awareness and behaviour are also important. On the other hand, because of the differences of living styles and travel modes in different types of communities, in practice, individualized measures should be taken based on their carbon emission features.

2) Countermeasures for new communities and existing communities

Low-carbon construction in new communities has achieved remarkable results through the government’s promotion of green buildings. The present problem is how to solve the disconnection between designing and operation phases. Developers are interested in green building certification at the designing stage, but few communities care about actual energy consumption for operation certification. Community management and residents lack a basic understanding of green, low-carbon communities. Therefore, it is necessary to enhance green and low-carbon guidance for community residents and property managers during the operation phase. And public travel awareness should be the focus for action, with high car ownership and car travel in newly built communities.

Compared with new communities, there are great potentials for low-carbon actions in existing communities because of their large numbers and the large population. These communities that are usually not up to energy-saving standards pose great potentials for energy-saving renovation for existing buildings. Technical measures such as energy-saving renovation and strategies for community travel and behavioural guidance should be adopted. However, the renovation and the environment improvement will involve complicated work with different activities, big investment and residents’ participation. Except for a small number of communities that have been included in the pilot projects of low-carbon construction, a large number of common communities have been neglected. In the current social, economic and management context, it is difficult to expect spontaneous low-carbon actions by communities. Instead, it is necessary to formulate incentive policies or financial support measures targeting at the low-carbon construction of existing communities.

3) Combine top-down approach with bottom-up approach

Although various levels of government have issued a series of policies, low-carbon community activities are still limited to a small number of pilot communities. Top-down and bottom-up actions should be combined. For the government, it is important to improve policies and funds to support the low-carbon actions in existing communities, and have more guidance in the operation of new communities. In order to make scientific policy decisions on carbon reduction targets and measures, a clear baseline of community carbon emissions is essential. This calls for a wider survey on community household energy use and travel, including data from energy supply sectors (electricity and gas), which will ensure more accurate scenario of community emissions.

At the community level, community managers and residents’ understanding of low-carbon community is limited to the macro-level goals and policies, lacking overall concepts and systematic knowledge for low carbon construction with clear implementing tools and technical measures. Residents’ participation awareness about low carbon actions is weak. Therefore, it is necessary to encourage community residents and managers’ participation and build their capacity at the community level. In the case of traffic behaviour, as the private car ownership in some newly built communities has reached a percentage over 100%, in order to achieve the goal of 60% of public transport, residents’ low-carbon travel awareness is indispensable.

4) Integrate low-carbon community actions with holistic community development plan

Whether the pilot communities or the large number of common communities, most of them lack guidance for unified planning, and therefore the low-carbon actions lack sustainability and consistency. While the major obstacle to the low-carbon community construction is the lack of funds, the funds from different government departments (such as NDRC, housing and construction, environmental protection and civil affairs departments) are often fragmented or overlapped with low efficiency. Short-term activities and the arbitrariness of technical measures without holistic planning or clear goals and paths are key issues. Therefore, it is necessary to make holistic plans with clear long-term
goals for communities and develop systematic and practical step-by-step action plans, by taking low-carbon actions as indispensable solutions for community development, and integrating policy and fund as a joint force.

6. Conclusion

Urban communities are important areas for mitigation and adaptation actions in climate change. For more appropriate actions, it needs a better understanding of the nature of the emissions from urban communities and the issues concerning current community low carbon activities. This study collected first-hand residents’ energy consumption data and calculated households’ annual carbon emissions. The results show that residents’ transportation which has accounted for nearly half of the total household emission should be the most potential area for carbon reduction, and that residents’ electricity, gas and waste emissions also pose potentials to be cut down. The survey also examined and analysed the obstacles in low-carbon community construction. The key findings have suggested that top-down and bottom-up approaches need to be combined and that low-carbon community actions need to be integrated with holistic community development plan, with consideration of different emission features of different communities and divided issues of new and existing communities.

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