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How Can the Gradual Development of More Sustainable Energy Systems Be Integrated in Urban Planning in China?

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Abstract

Great efforts have been made in China to reduce coal consumption over the last decade. However, the energy transition to more sustainable energy systems will be gradual and take a longer time than expected. This paper discusses how sustainable development of energy systems on the local level can be gradually achieved. A challenge will be to develop smaller scale projects on the local level where participatory planning processes with cross sectoral planning can be implemented. Another challenge is to bring transdisciplinary academic research closer to the practice.

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Keywords: Sustainable Development; Sustainable Energy Systems; Urban Planning

1. Introduction

Many researchers have pointed out the central role of cities in sustainable development. This is not only a spatial boundary but also an important platform for development where people are involved. At the Rio meeting in Brazil, 21 June 2012, the UN Secretary General Ban Ki-moon stressed the importance of city development in developing more sustainable pathways, i.e., "Local is global and global is local".

China has witnessed a remarkable economic growth during the last decades. This growth has been partly driven by a high rate urbanization at a price of environmental pollution, which has affected water, air and soil quality and severe effects on people's health. A very important factor concerning environmental impacts is the energy system based on fossil fuels mainly coal. Great efforts have been made by the Government to reduce coal consumption over the last decade in China. However, adjusting

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the fuel mix in a country, whose energy needs still grow fast, is not easy. The energy transition will be gradual and take a long time.

The development in China shows clearly that sustainable development is a process involving conflicts between different aspects of sustainability and between different actors' interests. Sustainability cannot be achieved by only using scientific methods but has to involve processes for conflict resolution between all involved actors. This paper will discuss how these processes can be developed on the local level in order to find pathways towards more sustainable energy systems in China.

2. Aims, objectives and method

The aim of this paper is to outline the processes for integrating participatory sustainable energy planning rather than presenting the specific results from those cases.

The objectives are:

- To identify central problems concerning long-term sustainability in existing urban energy systems, which depends mainly on fossil fuels
- To identify institutional, technical and other barriers for developing sustainable energy systems in China
- To discuss how academic research can play a more important role in developing sustainable energy systems in practice
- To outline the processes for gradually developing more sustainable energy systems through integration in urban planning in China

The methods used in the paper consist of a literature survey together with an in-depth analysis of selected urban development projects in China and Sweden. The paper is built upon an assumption that electricity will be the dominating energy carrier in future urban areas. This includes heating, ventilation, and air conditioning (HVAC) for buildings and transport. Another assumption is that the change of energy system towards higher degree of sustainability will have to be gradual and take place over a long time.

3. The energy situation in China

3.1. Background

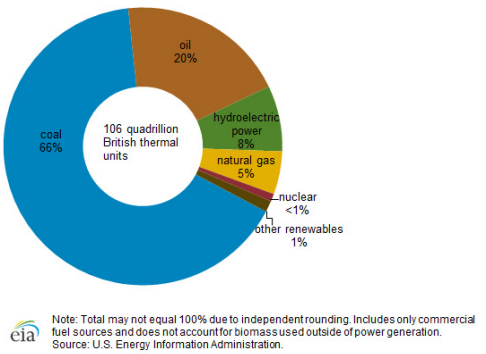

Fig. 1. Primary energy consumption in China, 2012

In 2010, China overtook the US as the world's largest CO2 producer. Over the past decades, China's energy transition has moved towards a lower-carbon structure: less coal and oil, more gas and more renewables. However, the transition is slower than what is expected. In 2012, coal, the most polluting form of energy at the moment, still accounted for 66% according to the EIA data (around 60% according to China's statistics) in China's fuel mix (Figure 1). However, the relatively lower carbon fuels, including gas, non-hydro renewables and nuclear energy, still remain marginal [1].

Per-capita energy consumption in China, which has risen by over 5% each year over the last decade, will inevitably continue to rise in the coming decades, probably longer. The share of renewables like wind and solar will continue to be very marginal in the short- and medium-term. Many scenarios predicting a fast increase in renewables, e.g. Teske [2], are just not anchored in reality.

3.2. The future development of energy in China

China is in a phase of growth, of which neither the size nor the speed can be predicted from history. We can just qualitatively reason about options and there is no guarantee that the shortest pathway towards long-term sustainability will be eventually chosen.

Three fundamental questions we can ask are:

- Will China consume energy like Europeans or follow the more excessive American model?
- Will China's energy consumption continue to be dominated by fossil fuels?
- Can a change towards a low-carbon society be initiated by integrating sustainable energy systems into urban planning?

The answer to the first question is that in the short- and medium term it will probably follow the American model. It is partly because that the government supported such a pattern and partly due to an enormous accumulated desire for consumption among the population. China has very fast pulled millions of people out of poverty and the population is calling for a higher material standard. It will take many years before the increase levels out.

The answer to the second question may partly lie in what the Chinese Government announced for the Paris Summit 2015, i.e. the total consumption of non-fossil fuels will account for around 20% of the total amount of primary energy by 2030. The ratio of fossil fuels in 2013 was around 81%, very close to the target. Given the growth in the total amount of primary energy consumption, it means that the use of coal will continue to increase, even if the energy intensity and carbon emissions per GDP both fall down.

The answer to the third question is central for this paper. A short answer would be we don´t know for sure, but we have to try. As stated above, changes have to start from local initiatives on the urban level.

3.3. Considerations for the energy system on local level

From the arguments above, it is clear that what is not sustainable has to be answered very much on the local level among actors who also own the knowledge about the global situation. This process can be initiated by municipal planning departments together with other key actors. This paper will only discuss about some principles on how the process can be initiated, as well as the most central issues to handle on the local level.

General questions to answer are:

- Which are the most important environmental effects of our energy systems on local and global level?

Many pollutants to air, water and soil play an important role on the local level and the development of energy systems should not only consider CO2 emissions.

- How resilient is our energy system?

This answer relies on primary energy sources, commercial companies, energy carriers and energy distribution systems. It has been shown that China's focus on vulnerabilities of its oil supply chain is addressed at the expense of improving the reliability of domestic electricity supply [1].

- What are the strengths and weaknesses of the local/regional conditions, which can threaten or give opportunities for change?

Considering the answers to these questions can be the starting point for outlining changes in the energy system on short-medium-long term. Important aspects of this include:

- Primary energy sources
- Energy transformation technologies
- Energy carriers

Options for short-term changes include the use of clean coal processes, more natural gas, renewable energy and energy storage, and increasing energy efficiency. District heating can play an important role in cold areas, if the investments have already been made. It is highly questionable if more of district heating infrastructure should be developed.

This is because in the long run, energy systems have to rely less on combustion systems, since these generally have low thermodynamic efficiency and large environmental impacts. The most important energy carrier in the future will probably be electricity due to its high quality and good infrastructure for distribution. The development is supported by the changes in infrastructure where houses will need less energy input for HVAC and where transport systems will be based more on electricity.

Smart City and ICT development including smart grids can reduce peak loads and also increase resilience when electricity consumption can be prioritized more effectively [3]. Smart city development will also to a high degree rely on new business models, which can stimulate distributed and more resilient energy systems. However, it is doubtful that smart cities will reduce people's use of energy partly due to the strong rebound effects.

4. The urban planning context in China

The urban planning process and the establishment of sustainable cities in China are complex and somewhat opaque processes [4]. It is sometimes a mystery even for Chinese people, so it is necessary to shortly discuss how the planning system has developed in China and how it works today. The Urban and Rural Planning Law (2008) is the central law in China, which states the main principles, actors and tasks for the adoption, implementation and management of urban planning. The Municipal Comprehensive Plan, the Regulatory Detailed Plan and the Construction Detailed Plan are legally binding instruments for planning at the local level. These plans should be formulated by planners in qualified urban planning institutes or consulting companies. What the three plans can control is stated in the Urban and Rural Planning Law (2008).

Urban planners are more or less squeezed between Governmental regulations and directives on one side and market forces on the other hand. Cities in China and urban planning departments have a limited degree of freedom to control the planning process. This is partly because of the old Soviet type of top-down planning system and partly because of strong political influence on both the central and the local level. The planning system in practice is not really transparent. Although there are many principles written on papers, in reality, politicians and developers can always affect the planning process.

Therefore, a more transparent integrated urban planning is very difficult to implement and many rules and political decisions are often overlapping or even sometimes contradictory. It seems that the economy is still the most important criteria for development. This can be seen in how sustainability aspects are implemented in practice.

5. Low carbon eco-cities planning and implementation in China

At the beginning of the 1990s, China started its journey to find more sustainable ways of developing cities. Many city concepts, such as green city, national garden city, national environmental protection model city, eco-city, low-carbon city and low-carbon eco-city have been adopted and used by the central and local governments at different time in China [4].

The concepts of eco-city, low-carbon city and low-carbon eco-city are now widely used all over China. According to a report published by the Chinese Society for Urban Studies, by February 2011, there had been 259 cities, accounting for 90% of China's cities, which aimed to establish an "eco-city" or a "low-carbon eco-city" [5]. However, since those concepts are not anchored in a scientific basis, it is difficult to reach a consensus on their definitions and there are still no widely accepted international or national guidelines for them.

The situation with many approaches developed by different governmental departments together with the influences from international projects has created a confusing situation on the local level. In general, there is a tendency to use indicators ad hoc without a comprehensive sustainability framework, which is specifically developed according to local conditions. There is a need for changes in the planning process in several ways. One is cooperation in an early stage among actors and another is more cross-sector planning than sector planning, which is the case today. Sustainable energy systems cannot be planned in isolation, but has to be connected to solutions for waste, water and transport etc. However, the sector planning tradition is deeply rooted in people's mind and in institutional routines, and thus very difficult to change. Why it is so and how it can be changed? The next section will take a closer look at the questions.

6. The need for holistic thinking and integrated planning

Integration of sustainability aspects in urban planning requires a holistic approach that incorporates a range of sector perspectives including energy use, renewable energy, waste treatment, water management, building material, transport, and urban and building design [6-8]. In the traditional system of public management, decision-making and implementation in different sectors are fragmented, but this is inconsistent with the requirements for a high degree of integration, coordination and communication between various actors [9], e.g. for cross-sector environmental issues in urban planning. Professional allegiances, skills and administrative bureaucracies in different sectors may also impact on cross-sector coordination for planning and implementing eco-cities [10]. Other conditions, such as current legal framework and enforcement and the environmental awareness and knowledge of actors also affect environmental integration in urban planning.

Real integration requires active coordination, communication and mutual understanding among actors in several sectors. For example, involving urban planners as well as energy experts in the planning of heating and cooling systems for buildings is more likely to result in an energy-efficient building environment than planning by an institutional structure with separate decision-making processes for land use and energy planning will [11]. In tradition, city planning departments often have the primary responsibility for urban planning. In eco-city development, diverse environmental issues can be well beyond the planning sector's capacity and need to be resolved by other authorities and agencies in areas such as energy, water and traffic. This may in practice require reframing certain institutions to ensure that

relevant sector authorities, scientific institutions and actors have responsibilities for integrated tasks and can effectively cooperate with each other [12].

Evidence in the Chinese cases in particular indicates that the weak understanding, knowledge and experience of officers and administrative actors regarding sustainable urban planning has been and is an obstacle for environmental integration.

In a case study for the city of Xuzhou, a bottom-up perspective was used from the beginning [4]. The overall aim of the case study was to develop and test a simplified framework that can guide urban planners for developing a master plan for a city, which aims to become an Eco-city. The developed framework was applied in devising a more comprehensive and integrated plan for the city of Xuzhou based on cross-sectoral planning. In order to avoid the problem of finding exact definitions for concepts, such as sustainability and Eco-city as used in China, an approach with three levels of ambition for sustainability and sustainable development was adopted. Each level of ambition requires different planning approaches. The framework will be refined and applied in other Eco-city projects in China.

Cross-sectoral planning can use different sector integration approaches. In order to support urban planning in a more cross-sectoral way, it is important to develop indicators for the core urban metabolism, which contain the driving forces for environmental impacts.

The planners in Xuzhou had problems formulating an Eco-city strategy when developing the new master plan in accordance with sustainability principles. The Eco-city concept is rather vague and many interpretations exist in China. In addition, there is still no serious focus on Eco-city development, but mainly only on the development of the economy in Chinese cities. This usually results in quite conventional spatial plans, where considerations about resource efficiency and the environment are mainly reduced to construction of green area and energy-efficient buildings.

In the short term fossil energy will be dominating, but the dependence on coal will decrease by gradually using more natural gas, solid waste and energy storage systems. In the long run the dominating energy carrier will probably be electricity where renewable energy will play an important role both in central and distributed energy systems.

The city can then in a participatory process choose indicators, which cover the main challenges for sustainability and fit into their ambition level. It is important to choose indicators in a later stage in the project, rather than in the beginning, which is often the case. Participants should also include the public. To encourage public participation in evaluation and monitoring, planning information can be uploaded to planning administrative websites, making it easier for the public to get relevant information. In addition, the public should be encouraged to attend all levels of evaluation meetings.

6.1. The barriers for cross sectoral thinking

In most of the Chinese cases, early involvement of different stakeholders was not common during the formulation of policies and plans. Efforts for consensus building were not within the scope of focus for local government and authorities, and they were seldom utilized to obtain environmental integration in the Chinese cases. According to a survey by Joss et al. [13], 105 of the 174 eco-cities under study mainly focus on technological innovations, while only 63 projects adopted a more integrated sustainability planning approach.

The institutional barriers, resulting in strict sectoral planning without cross-sectoral integration, can partly be explained by the knowledge division already in the educational system. Research around energy systems is technical-oriented, while social science is more oriented towards institutional aspects. There is little connection between them.

The World Bank developed an agenda for research on urbanization in developing countries. It recommended there should be a focus on the relevance to the practitioners' audience, rather than to an

academic audience. It is important, since there is a large gap between academic research and practical application in the area of urban development. As a result, many of the key findings of academic research have not found their way into practical application [14].

7. Conclusions

From the analysis of many eco-city cases in China and in Sweden, it was found there is a lack of a holistic integrated planning for future sustainable energy systems in China. It might be due to the lack of knowledge around energy systems among planners and to the difficulty to implement participatory planning methods, where experts from related areas are involved.

The present situation that China's economy growth is dependent on fossil fuels cannot be changed in a short term. Scenarios for future sustainable energy systems have to handle short-, medium- and long-term energy transition and material transformation. Based on scenarios, roadmaps can be developed, where incentives from key actors are reflected. For effective implementation and follow-up, the roadmaps have to be developed in a broad dialogue process involving key actors. The authors' experience from all kinds of areas, where the methodology described above has been applied, is that it is very satisfactory to work towards shared visions, when participants have access to a shared mental model informing dialogues and creativity and group dynamics.

A challenge will be to develop small-scale projects on the local level, where participatory planning processes with cross sectoral planning can be tested in practice by forming temporary project groups. Another challenge is to bring transdisciplinary academic research closer to the practice. This will not threaten the fundamental principle of independence, but making research more relevant and practical.

References

[1] Leung GC, Cherp A, Jewell J, Wei Y-M. Securitization of energy supply chains in China. Applied Energy. 2014;123:316-26.

[2] Teske S, Pregger T, Simon S, Naegler T, Graus W, Lins C. Energy [R] evolution 2010—a sustainable world energy outlook. Energy Efficiency. 2011;4:409-33.

[3] Shahrokni H, Årman L, Lazarevic D, Nilsson A, Brandt N. Implementing Smart Urban Metabolism in the Stockholm Royal Seaport: Smart City SRS. Journal of Industrial Ecology. 2015:accepted.

[4] Liu H, Zhou G, Wennersten R, Frostell B. Analysis of sustainable urban development approaches in China. Habitat International. 2014;41:24-32.

[5] Li X, Cao G, Zhao P, Xu W, Yang C, Song F, et al. China's Low-carbon Eco-city Development Strategy. Urban Studies. 2010;17:32-9.

[6] Birkeland J. Design for sustainability: a sourcebook of integrated, eco-logical solutions: Earthscan; 2002.

[7] Raydan D, Steemers K. Environmental urban design. In: Santamouris M, editor. Environmental design of urban buildings: An integrated approach: Earthscan; 2006.

[8] Mumovic D, Santamouris M. A handbook of sustainable building design and engineering: an integrated approach to energy, health and operational performance. Earthscan; 2009.

[9] Cars G, Healey P, Madanipour A, De Magalhaes C. Urban governance, institutional capacity and social milieux: Ashgate; 2002.

[10] Campbell S. Green cities, growing cities, just cities?: Urban planning and the contradictions of sustainable development. Journal of the American Planning Association. 1996;62:296-312.

[11] Owens SE. Land-use planning for energy efficiency. In: Cullingworth JB, editor. Energy, land, and public policy: Transaction Publishers; 1990.

[12] Volkery A, Swanson D, Jacob K, Bregha F, Pintér L. Coordination, challenges, and innovations in 19 national sustainable development strategies. World Development. 2006;34:2047-63.

[13] Joss S, Tomozeiu D, Cowley R. Eco-Cities — A global survey 2011. University of Westminster International eco-cities initiative. UK: University of Westminster; 2011.

[14] Annez PC, Linn JF. An Agenda for Research on Urbanization-a summary of findings from a scoping exercise. The World Bank; 2010.

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Biography

Dr. Qie Sun worked as a lecturer and researcher at the Institute of Thermal Science and Technology, Shandong University. He is working with sustainable energy systems and Industrial Ecology and also participating in urban planning projects in China to help urban cities to pursue low carbon and ecological development.