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Toward Sustainable Housing:
A comparative study of examples
in China and Sweden

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Abstract

Although sustainable housing is a relatively new term, many efforts have been made by governments, organizations and researchers to develop sustainable housing in most countries. However, as the context of sustainability varies with time and locality, the implications and practices toward sustainable housing also differ. This study is carried to investigate the different practices toward sustainable housing development in China and Sweden by comparison. Government, housing customers, developers (contractors) and architects (researchers) are considered as primary stakeholders for developing sustainable housing. Their views and contributions are studied as the background of sustainable housing development. Two sustainable housing projects—Beiluchun and Myrstaken are investigated as examples in China and Sweden.

Through comparisons and analysis, some similarities and differences are found. Both China and Sweden put economic and social aspects of housing such as providing adequate housing for all as the policy priority. But Sweden has a much more integrated policy approach toward sustainability than China especially in the environmental dimension. Both the architects are keen to develop sustainable housing while developers have no much incentive in the two countries. The higher environmental awareness in Sweden is better for sustainable housing marketing than in China. The practices of the two sustainable housing projects have much to do with their country background. Sweden has better practices in energy and resource use and waste management than China. But in other aspects such as land use pattern, the two countries takes quite different approaches toward sustainability.

To further promoting sustainable housing, both the two countries need to develop related technology and give incentives for building industries. China needs more integrated and far-sight sustainable housing policy, environmental education for higher environmental awareness. More sustained use of energy and natural resources and better national wide waste treatment should be promoted in China. Sweden needs to consider the dense urban pattern for urban planning where insufficient housing needs to be resolved.

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Chapter 1. Introduction

Housing, as human beings' basic need, is a very important issue of people's everyday life. Therefore, the issue of housing is also a central political concern for each country and government as it has critical social, economic and environmental implications. From the social dimension, housing has great impact on the social interaction. From the economic dimension, housing takes up a large proportion of the average family's budget and the construction sector is a large economic sector, so that it affects the economic situation of each household and the whole country. From the environmental dimension, housing consist a large part of the build environment. It has great environmental impacts of resource input and waste output resulted from both its construction and use. This thesis is to deal with the sustainability issue of housing from the social, economic and environmental aspects. In this chapter, the unsustainable feature of the housing and the definition of sustainable housing are described, the research objective, methods and material used and the analytical framework in this paper are given.

1.1. Unsustainability within Housing Sector

Housing has profound effect on human beings' daily lives and well-being. However, there are still many problems within the housing sector worldwide. The foremost problem is the insufficient housing. According to UN-HABITAT (1996), there are still 1 billion people lacking adequate shelter and some others have various sanitation problems with their housing which creates various problems for individuals and society. Since the recent decades with growing population and urbanization progress, the environmental impacts of housing has also becoming more and more serious. During the life cycle of construction and use phase of building, it has to take in energy, water, materials from the environment and release waste back and therefore create great ecological impact. It is estimated that 40% of raw materials by weight are used in building construction globally each year; 36%—45% of a nation's energy input is used in buildings; 20%—26% of landfill trash is construction trash and 100% of energy used in building is lost to the environment. (Yeang, 1999) Therefore, to develop the housing sector in a sustainable way has becoming an important issue worldwide. In the Habitat II Conference held in 1996, "adequate shelter for all" and

“sustainable human settlements development in an urbanizing world” have been set as the two themes for the development of human settlement. (UN-HABITAT, 1996)

1.2. Sustainable Development and Sustainable Housing

To develop the housing sector in a sustainable way, the concept of sustainable development needs to be understood first. Sustainable development has many definitions. The most common and widely used one is in the report “Our Common Future” by the World Commission on Environment and Development (WCED). It states “sustainable development is the development that meets the needs of the present without compromising the ability of future generation to meet their own needs”. (WCED, 1987) Sustainable Development is classically been regarded as the integrated development of economic, social and environmental dimensions. Disregarding any dimension will be regarded as not sustainable or partially sustainable with negative impact for the current or future generation.

When applying the concept of sustainable development into the building sector, sustainable buildings are defined as “those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global settings”. (OECD, 2002) For housing that make up a great proportion of building, sustainable housing could be defined as housing practices, which strive for integral quality (including economic, social and environmental performance) in a broad way. (John, Croome & Jeronimidis, 2005) From the ecological perspective, sustainable housing should first be of good quality with long life span and adaptability which is the basis for eco-efficiency. Furthermore, sustainable housing should be eco-efficient by rational and efficient use of natural non-renewable resources (energy, construction materials, space, etc.) both in the construction and the use phase while increase in well-being. From the economic perspective, the sustainable housing should be affordable and decrease the indirect cost such as transportation for the occupiers. From the social perspective, the sustainable housing should consider the physical, psychological and social function of the occupiers. (Novem, 2002)

Although sustainable housing is a relatively new term, the social and economic dimensions of housing have long been a policy concern for every government. Many countries have also begun to exert efforts for high environmental performance buildings recently. The efforts are mainly initiated by national or local government and authorities, architects and researchers to make more sustainable policy, design and technology. Some labeling system for sustainable building and sustainable housing are established. However, most of them are voluntary such as LEED in the US and BREEAM in Britain. (Yun and Tang, 2004) Denmark has set a mandatory labeling system to improve the eco-efficiency (energy and water consumption) of all new and existing buildings in the country and proved to be successful in significant energy savings. (Novem, 2002)

While the term of sustainable development is well known and widely used, there is no common understanding and approach for it. The perception of sustainability especially when it comes to what “needs” is regarded as important varies much by different nation and even different people with different points in time, economic, social and cultural backgrounds. (Zinkernagel, 2001) What is sustainable to one person can mean despoliation, degradation and exploitation to another. (Dahl, 1997) So that the detail of what comprises sustainable development is very context-specific and the same condition and practice cannot apply everywhere. (Bell and Morse, 2003) Therefore, sustainability has its diverse implications in every corner of the world and in every sector of a society.

The housing sector is one of the sectors trying to integrate the sustainable development ideas. However, according to the different context of each locality, the approaches and practices for developing sustainable housing also vary because of the various climates, cultures, conventions, economic development level, and social situations. Some developed countries already gained some experience in the sustainable housing research, design and operation. But these experiences could not be practical to other countries, especially developing countries that have big differences with the development priorities, research and technology level, government and related industry capacities and etc. The best practice of sustainable housing would be that all three dimensions of the

sustainable housing could be achieved simultaneously according to the local situation. Therefore, taking a look at the efforts to develop sustainable housing in different countries with different backgrounds would be interesting and practical to understand the specific sustainability context of those countries and find ways for further development.

1.3. Research Objective and Scope

The previous studies and researches of sustainable housing are mostly about the policy and technology possibilities and solutions. This study is to take a broader perspective to examine the different practices toward sustainable housing development of different countries according to their own specific context. The cases of China and Sweden are selected as two examples for the sustainable housing development patterns for the developed and developing countries. Comparison of the two countries and their practices is to be made to give a clear picture of each case and find the way toward sustainable housing development in each country. The reason why Sweden and China is chosen is given below.

Sweden, as one of the world's leading countries in environmental protection and welfare, is also a pioneer in sustainable development. By the development under a mixed system of high-tech capitalism and extensive welfare benefits for many decades, Sweden has achieved an enviable living standard. (CIA, 2004, B) Efforts toward sustainable housing also started early as decades ago. However, there is still a long way to go to achieve Sweden's goal of making sustainable human habitat. Therefore, Sweden could be a very good case to study the development of sustainable housing sector as a case of developed country. China, as the biggest developing country with rapid economic growth, just started the modernization and industrialization since decades ago. Economic growth has long been the first priority for development while other dimensions such as environmental protection is somehow overlooked for many years. Poverty was got rid of by the price of resource depletion and environmental degradation. Realizing the fault of the previous type of development, the concept of sustainable development started to spread into many sectors of the society including the housing sector since several years ago. The initiative and trend of sustainable

housing development in China could also be a good example for studying as a case of developing country.

The objective of this paper is to bring understanding of sustainable housing development with specific context in China and Sweden and find ways to promote sustainable housing development in the two countries by comparison. However, the problems in construction phase are generally omitted because the problems in use phase are much greater because of the long life span of housing.

The main research question is raised according to the objective:

1. What is the good point and what needs to be improved for the sustainable housing development in both China and Sweden?

The following questions are made to answer the main research question:

2. What is the general housing situation in China and Sweden?
3. Who are the main stakeholders for sustainable housing development and what are their perception and behavior toward sustainable housing development in China and Sweden?
4. What have China and Sweden done as practices for sustainable housing?
5. What are the similarities and differences of sustainable housing development in these two countries? Why? Is there anything they could learn from each other?

1.4. Methods and Materials

According to the research objective, qualitative method is chosen for this study. Qualitative data could give depth and detail of program situations, events, people, interactions and observed behavior to reveal how all parts work together to form a whole. (Patton, 1987) Therefore, a qualitative research method is suitable for this study to meet the research objectives.

In this research, literature study, interviews and direct observation is carried out for information collection. The literatures are obtained from Lund University libraries and the library of Qingdao

Architecture Design and Research Institute, databases such as ELIN, ScienceDirect and other websites of governments and authorities. Besides literature study, interviews are considered as a quick targeting means for information collection and a supplementation for sources where literature study is difficult to cover. Two semi-structured interviews were made on August, 26th, 2004 with Ting Lu and Heng Jiang, two architects from Qingdao Architecture Design and Research Institute concerning about the situation of sustainable housing development in China. Several interviews and discussions were made with Krister Wiberg (my supervisor), an architect and professor from Lund University, about the sustainable housing development in Sweden. Direct observation is also carried out for better understanding the case of the housing project—Myrstaken in Sweden.

Although attempts are made to get plenty right and unbiased information, there are still limitations of the study generated from the methods and materials choosing. First, the author's conceptual framework (personality, knowledge etc.) could affect the choice of literature, questions asked during interview and the way of analysis. (Åberg, 2001) Second, the information collected from interviews is obviously affected by both the interviewer and interviewees conceptual framework which may include some biased information. Third, due to my language capacity and culture background, many information in Swedish is omitted which obviously create the limitation in understanding the Swedish practices.

1.5. Analytical Framework

Sustainable housing development is a very broad and complex issue, to analyze requires a large number of interacting factors to be addressed. While housing issue is quite connected to local realities, this paper only tries to analyze at the country level in general. Because this paper is to take a comprehensive view of the status and trends of sustainable housing development, narrative assessment is used for analyzing sustainable housing development from the primary stakeholders' perspective.

Stakeholders are those people, groups or institutions who have specific rights and interests in an

issue of system, and related powers, knowledge and skills. (Clayton and Bass, 2002) In such sense, stakeholder may cover a wide range of groups of people and it is impossible and impractical to involve all the stakeholders into the analysis. Therefore, the primary stakeholders (who are likely to be affected by the issue or a potential response to it, either positively or negatively (*ibid*)) are identified as the government, potential housing customers (the mass), developers (contractors) and architects (designers). Their opinions and behaviors are directly related to and affect the development of sustainable housing. Therefore, these stakeholders' perceptions and behaviors toward sustainable housing are studied through literature and interviews in the two countries and compared and analyzed later. In this paper, policy part reveals the governments' perceptions and actions toward sustainable housing. Social factors are referred to the other stakeholders besides the governments.

The stakeholders' perspective and action serve as the development background for the two housing projects (Beiluchun in China and Myrstaken in Sweden) and the two projects serve as the specific examples to illustrate how the housing projects developed under such circumstances as technologies are based on the background stakeholders created. Comparisons are to be made between the two projects and analyze what sustainable measures have been done and what need to be improved. Comparisons and analysis are made mainly from the energy, water and land use issues.

1.6. Thesis Outline

The first chapter of the paper is the introduction part of the paper where the reason for selecting the topic, background information, research objectives, theoretical and analytical framework is given. In Chapter 2 and 3, descriptions are given to understand the political, social backgrounds and the two examples for sustainable housing development in both Sweden and China. The comparison and analysis are made in Chapter 4 for the two countries from the policy, social factors and technology perspective. In Chapter 5, discussions, conclusions and recommendations are made for the two countries.

Chapter 2. Sustainable Housing Development in China

2.1. China's housing sector and its environmental impacts

China, as the most populated developing country in the world, many adverse environmental impacts has becoming more and more serious during the developing process. Since the economic reform beginning in 1978, China's GDP has been quadrupled while the environment has been deteriorating and many problems emerging. (CIA, 2004, A) The housing sector has also developed rapidly since the economic reform. There are significant increase in per capita floor area (from 3.5 square meters in 1978 to 8.8 square meters by the end of 1997) and remarkable improvement of housing quality. (UN-HABITAT, 2000) However, because of the rapid growth of industrial production and the urban population, the infrastructure development still lags behind. Environmental pollution and insufficient housing are two obstacles for sustainable urban development. (UN, 2002) In 1996, the Chinese government adopted housing reform and established the market oriented housing supply system to replace the welfare supply system which speeded up the housing construction and promoted the development of housing industrialization. During 1996 to 1999, an annual average of 570 million square meters of housing in urban areas and 706 million square meters in rural areas was constructed. Housing sector has reached 6.1% of GDP in 1999. (UN-HABITAT, 2000) Per capita floorage in urban areas had increased to 22.8 square meters by the end of 2002. (UN, 2004, A) However, the housing standard could just be well-to-do in most areas in China and needs for well-being shall be met. It is estimated the new housing construction in China will continue increasing every year on average of 220 million cubic meters to meet the demand of people. (Sun, 2003)

Although there are many achievements, China is still at a low level of housing development overall due to the huge population, weak foundation and vast differences in socioeconomic development across different regions. At present, 1.56 million households are still in need of housing and 350,000 households' per capita floorage is less than eight square meters. (UN, 2004, A) Housing construction is still at a resource depleting stage. The environmental impacts caused by building sector have becoming more and more obvious. First, many arable and unexploited lands have been

replaced as housing area. Second, the production of construction materials also has tremendous environmental impacts, for example making bricks from clay destroyed many arable lands and many material production industries are heavy pollutant resources. Third, the construction sites are heavy polluting sources especially for particles in urban areas. Forth, energy consumption during the life cycle of buildings is enormous. Since the construction boom in 1990s, the rapid improvement of living standard of people and bad compliance of energy efficiency design standards in most areas, building energy consumption is accordingly going up year by year. Statistics shows that the proportion of building energy consumption to the total energy consumption in China's terminal-use sectors is amounting to 27.8% in 1999 and will inevitably amount to 35% or so according to the experience of developed countries. (Zhu and Lin, 2004) Fifth, many construction materials contain pollutants which affect the indoor air quality and health of the habitants. Sixth, households consume huge amount of water and generate huge amount of waste including both sewage water and solid waste and some of them are left untreated which create problems for municipalities. All of these leads to the further deterioration of environment such as air pollution, land erosion, deforestation, waste generation and so on. The trend may become more severe as the housing sector will continue booming in the near future.

2.2. Policies related to promoting sustainable housing in China

Facing those unsustainable problems, how the Chinese government place and perceive the issue involved in housing decides the future trend of housing sector to be sustainable or not. By studying the literatures such as government reports, books and papers, it could be seen that the issue to develop housing sector in a sustainable way has becoming on the agenda.

Facing the problems of insufficient housing especially for the low income people, to build affordable and appropriate housing for all is still the main theme for housing policies in China. In the series of Five-Year Plan for National Economic and Social Development, the government set the goal to increase the per capita floorage continuously and aims at making each household owned a flat with all the basic amenities. (UN, 2004, A) Measures such as activating the housing market,

building low cost housing and providing housing for lease are implemented to meet the goal. Since 1998, the government launched the "affordable housing" program aiming at providing medium to low income households with low cost housing. (UN-HABITAT, 2000) Government helps to reduce the cost for housing by waiving land compensation fee and reducing half of the administration fee for the real estate business. In addition, limits are placed on pricing, buyer eligibility and profit margin for developers. (UN, 2004, A)

Besides addressing the issue to provide adequate shelter for all, the government also has the goal to meet the growing needs of people to live a better life. The goals written in the 10th Five-Year Plan for National Economic and Social Development (2001-2005) include: increasing urban water-supply, increase the capacity to treat waste and waste water, increase energy supply of natural gas and liquefied petroleum gas, increase the urban central heating capacity, increase the green coverage over 35% in cities and promoting transport by infrastructure construction. (UN, 2004, A)

Being specific to building itself, energy conservation in building has been started since the beginning of 1980th by introducing the directives from the developed countries and setting up the first standard in China to save 30% energy in the house heating. However, this standard still stayed at the research stage until the first mandatory one was pushed into practice in Beijing in 1991. Since then, energy conservation directives and practices have been spread to the main cities. Energy conservation was also been written down in the Law of Energy Conservation in 1998. In addition, from 1992, a new tax policy was set to eliminate the investment adjustment tax for housing that complied with the directive of energy conservation. This tax policy to a large extent fostered the progress. (Yang, Lang & Tu, 1999) As the insufficient energy supply in many parts of China now, measures to mandate the directive are being more and more important. Great efforts have been exerted from both the central and local governments to force the energy conservation into practices.

In addition, land use is another problem and main concern in China. As one of the densest countries in the world, producing enough food is considered a vital topic for both the economic and social

safety in China. Therefore, reserve enough land for agriculture is regarded the foremost concern for sustainable development. However, as the acceleration of industrial progress and deterioration of environment, the total area of arable land becomes less and less each year. Conserving and saving land in the building industry is another basic topic for the development of sustainable housing. So the housing in China is mostly densely planned as multi-story or high rising apartment buildings. However, spaces are also the basic need for people for light, public spaces and ecological services in the housing area which should also be met. Nowadays there are regulations about the maximum density for different types of housing areas. Green spaces in the housing area should not be lower than 30%.

2.3. Social factors of promoting sustainable housing in China

After being able to get housing, more and more people in China begin to consider to have a better living environment. Especially after SARS, many people realized the importance of the health effect of the built environment. Combined with the propaganda of the real estate companies, to live close to nature and in a good environment have becoming to be the dream of many people. However, due to the limitation of the knowledge, when it comes to “green” housing, only 30% of the informants know what it is according to a survey. (Ye, 2004) Price and location are still the two most important factors for choosing housing. Especially in some cities where there are insufficient housing and continuously rising housing price, people tend to be anxious to get housing while blind at other aspects such as quality and environment. Besides, when it comes to environment, most people just begin to consider the direct and visible “environment” related to them such as green area coverage, water saving, heating measures and noise. But when it comes to the deeper content of green housing such as energy use and environment protection, most of them have no idea or don’t care much. (*ibid*)

For the developers, after they smell the changing need of people toward better living environment and realize it would be promising and profitable for “green” housing market, some of them already started to cater to the customers and get their place in the market. Some projects are called “green”

because of their low density in the countryside, some are called “green” just because of higher green coverage and some are called “green” just because it use no contaminant building materials Only few developers really developed green housing but was still very cautious and reluctant to the higher investments. (Ye, 2004) To deal with the mixed-up situation in real estate business, the Ministry of Construction is working on the related law and standard for green building which will be expected to come out in the next year. (Hong. Y. J, 2004)

Interested architects, as well as the related researchers, are the most knowledgeable group of the far reaching impact of developing sustainable housing. However, they have to comply with both the requirements from the government and from the developers. Therefore, even though they have the desire to design with green ideas beside the scope of the requirement from government, it is impossible to realize if the developers are reluctant to make the investment.

2.4. Beiluchun—the first ecological residential area in China

Under the political and social background, several green housing projects have been developed recently in big cities in China. One or more environmental features are used in each project such as energy conservation, water recycling, local waste treatment, adjustable heating system and signing environmental contract with habitants. Among these projects, Beiluchun is the first ecological residential area (commonly used in China as environmental conscious housing) built in China which also complied with the idea of sustainable housing.

The initiative of this project is from the architect’s environmental awareness. Witnessing the environmental degradation in Beijing and the high energy consumption in buildings, Ms. Huang Hui, a prestigious architect had the idea to build ecological housing for a long time. As a people's representative, she brought up the idea at the People's Congress and raised the interest of Beijing Government. Through the coordination of government, Ms. Huang got the right to plan and design the housing development in Fangshan, a satellite town of Beijing and found a developer to invest and coordinate with her. The first ecological residential area, named Beiluchun was built and

finished in 1996.

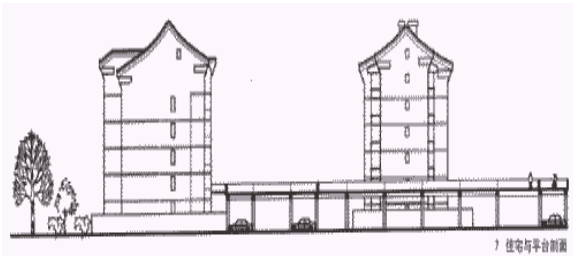
The total area in Beiluchun is 14.46 hm² with 30 multi-story buildings for 1500 households. (Graph 1) The key concerns for the design are as follows. First, make the housing suitable for different needs. Second, make convenient transportation and other services for the habitants. Third, ensure the saving of land use and energy. Forth, ensure good indoor air quality. Fifth, save water resources and make use of waste water. Sixth, minimize the solid waste and treated with no adverse effect. Seventh, control the noise from outside. Eighth, allocate appropriate amount of green space. (Huang, 1998) Then practices were made to put the ideas into practice. Some eco-features of the design are described as follows.



Graph 1. Beiluchun

The vertical land use is one of the most striking features in the design. As the site in Beiluchun is low lying land, the most common measure to make it useful for buildings is to fill in the site by soils. However, it will destroy other lands and cost a lot of money as well. Considering these, the architect decided to build pedestrian bridges between different sites for walking. The underground was utilized for vehicles and it could serve as good parking lots under the bridges as well. (Graph 2) This design enables the separation of pedestrian and vehicles and in other aspects saved a lot of soil and money to fill in the site, to allocate other sites for parking. This design method created another 2.6 hm² land for use and is a good example for land saving. To achieve the energy saving goals, good insulation and energy saving doors and windows were used. In addition, adjustable heating utility was installed to give habitants economic incentive to save energy according to their own needs. To save water, a water recycling center (Graph 3) was built. All the waste water generated in the households are treated to recycled water to use for cleaning the public spaces, watering the grass and plants and etc. To minimize the solid waste, a waste incineration (Graph 4) was installed in the area. As there is no systematic waste recycling system in China and all wastes will go to the landfill,

it is of great help to minimize the amount of waste generated. They chose a high efficient incineration stove, after the burning of the waste to a very high temperature, the volume could be minimized by 99% and the emission is only 1/10 of the national standard. Meanwhile, the energy generated from incineration could provide heating for the household use. As there was heavy air pollution in Beijing, a 60 meter's wide green belt between the housing area and the road was planned to reduce the effect from air pollution and noise.



Graph 2. Vertical Land Use



Graph 3. Water Recycling Center



Graph 4. Incineration

It is estimated at that time to build an ecological residential area needs quite a big amount of extra money. However, by the efforts of the architects and many researchers, the housing was made "affordable housing" with normal price as other similar type of housing. Although the developer showed interesting to invest at first, while the architect presented her uncommon ideas such as to build the pedestrian bridges, they still felt they would lose money for those measures. The architect then tried to persuade the developer with her calculations. For instance, if the pedestrian bridges was not built and common measure was used to fill in the low site and to build 1.9 hm² parking lots, the investment should be twice as much as the amount for bridges. Also, the payback time for water recycling and waste incineration would be 15 years and 3 years during operation respectively. At last, the price of this housing area is set as almost the same with other housing in this region and become one of the "affordable housing" in Beijing.

Due to the low price, 80% of the housing was sold out right after one month of the end of construction. (Chen, 2004) The developer became notable because of this while making enough

profits. Now Beiluchun got a lot of awards and was set as an example for the sustainable construction for the "green" Olympic Games held in Beijing in 2008. However, during the designing and construction, the architects and researchers contribute a lot. As the hub of the design and research team, Ms. Huang utilized her own power and relationship to ask the scientist to develop the environmental technology for Beiluchun. The design institute of Ms. Huang lost 600,000 Chinese Yuan for this project. The water recycling system and the waste incinerator were both got for free from the scientists. (*ibid*)

Chapter 3. Sustainable Housing Development in Sweden

3.1. Sweden's housing sector and its environmental impacts

Compared to China, Sweden started the modern housing development much earlier. The first housing policy programs focused on the most disadvantaged groups were developed in 1930s when the housing conditions were poor from both quantity and quality. In 1940s and after the World War II, many housing policies were set aimed at providing good standard housing for all. Three of every four dwellings today were built since then especially after the mid 1960s when the “Million Homes Program” was launched to solve the shortage for housing. Higher housing standard were set that each person could have at least one room to live in besides kitchen and living room. In the 1970s, the production of single family houses increased while multi-dwelling buildings fell and large amount of vacant housing appeared. Modernization of the existing housing stock began in the 1980s and then new construction increased again till 1990 when almost 70 000 dwellings were built. During the 1990s, vacant dwellings increased sharply and housing construction declined dramatically because of the effect of economic crisis. However, since 2000, the situation improved a bit but great regional differences emerged. Small and medium-sized municipalities with declining populations still have large number of vacancies while in other municipalities as the growth area there is a shortage of housing which curbs the economic growth. Swedish government has made several attempts to solve the differences. Housing construction is strongly concentrated in the metropolitan regions and some major cities. (Swedish Ministry of Finance, 2004)

Nowadays, there are approximately 4.3 million dwellings in Sweden which means the average size of each household is just above two persons. For all the households, 40% consist of one person and 30% consist of two persons. The average size of dwellings in single-family and multi-dwelling housing is 5.2 room units and 3.2 room units respectively. The population density in Sweden is 22 people/km² and the population growth is rather slow. As the shrinking of the households' sizes, the average total useful floor area per dwelling in the newly built dwellings in 2000 decreased to 83 m² from 89.8 m² in 1997. (Swedish Ministry of Finance, 2004)

Within the building sector, some 30 to 40 per cent of Sweden's total consumption of materials and energy go into constructing, maintaining and using buildings. Thus environmentally harmful impacts of the built environment also constitute a major share of the total environmental impacts of Swedish society. (KTH, 2004) Besides, the bad indoor environment led to many health problems of inhabitants. In Sweden in 1999, almost a million people were judged to have various symptom of ill health related to problems in their indoor environment. (UN, 2004, B)

3.2. Policies related to promote sustainable housing in Sweden

As a welfare society with high environmental awareness and stringent environmental standards, efforts have been made toward sustainable housing in several areas by the government. In 1987, Management of Natural Resources Act was introduced to give directions on proper land use and good management as overall guiding principles for about 15 other laws. The act was incorporated into the Environmental Code in 1999. The Planning and Building Act, replace the earlier Building Act aims at stimulate a suitable use and good management of available land and water resources and the man-made environment with due consideration given to providing a proper frame for development. (Boverkett, 2004)

In 1998, Sweden adopted 15 national environmental quality objectives to be achieved within one generation and a good built environment is among the objectives. It is stated that a good built environment should "provides aesthetic experiences and wellbeing and offers a wide range of housing, workplaces, services and culture that give everybody the opportunity to live a full and stimulating life, while reducing everyday transport needs." "The use of energy, water and other natural resources is efficient, resource-saving and environmentally sound; the preferred energy sources are renewable." "People are not exposed to harmful air pollutants, noise nuisances, harmful radon levels or other unacceptable risks to health or safety." "The quantity and dangerousness of waste are decreasing." "Waste and residues are separated by categories and recycled on a cooperative basis by urban areas and the surrounding rural areas." The Swedish government will achieve these goals by amending or setting up new regulations such as the Planning and Building

Act and launching various programs. (Swedish Ministry of the Environment, 2001)

To achieve the goals, eight interim targets and strategies are set and series of programs are initiated. First, since long, providing adequate shelter for all is a high priority in Sweden. Second, the governments place the quality of housing as very important issue. A Forum for Building Costs was established to promote good quality, cost-efficient housing construction. Third, the government has initiated and invested many programs and projects for environmental consideration. A dialogue between the government and two sectors of the business society was initiated to raise environmental standards and ensure more efficient use of resources. “The Environmental Program for the Building Sector 2003” was developed by the Eco-cycle Council of the Swedish Building Sector with the aim of energy conservation, economizing with building materials, and gradual decrease of hazardous substances and encouragement of sound indoor environments. Under the cooperation between companies, municipalities and the Swedish Government, the project Building/Living for a Sustainable Building and Property Sector – in Trust for the Future is developed and aims towards the development of a sustainable building and property sector in Sweden. A voluntary Nordic Eco-labeling scheme was introduced in 1989 which covers housing construction. A number of local authorities have also developed their own guidelines and brochures addressing the local inhabitants. (UN, 2004, B)

3.3. Social factors of promoting sustainable housing in Sweden

Sweden has already achieved a desirable standard of living and people are more aware about the important of their living environment. Because of the high environmental awareness, some people started to struggle to build their own housing as “ecological” early in 1980th. Demand for environmental conscious housing is relatively higher than other countries. Some people chose to live in ecological housing for the sake of future savings of their bills for running cost; some other chose it with the aim of changing their life style and minimizing their impact on the environment. Many of the Swedish industries including the real estate would like to take their responsibilities to protect the environment and some of them had set environmental management systems. However,

costs are more important than performance are still the truth for developers. They seldom have the incentive to perform better than the required standard. Architects and researchers are the elite for sustainable housing development. Many researches and projects are done now and still many are yet to be done. Their contributions are mostly for the related technology development for sustainable housing.

3.4. Myrstacken—an eco village

Under such circumstance, there are about 30 eco-villages built throughout Sweden since 1980th. Generally speaking, besides the concern of socioeconomic aspects of housing, the environmental measures used in these eco-villages include: renewable energy use, energy conservation, waste water treatment, compost toilet, resource saving appliances and environmental friendly material use.

The construction of ecological housing in Sweden started quite early in 1980th. The first eco village (Solbyn) was built in Dalby in 1987. The incentive to build the village ecologically was mainly from the eagerness of the architect (Krister Wiberg) and the local villagers. Then the architect tried to gather a group of related people to start the design and construction according to his perception of eco villages. At that time, the idea of green building and related environmental technology is quite under developed, therefore, the ecological features in the village may be regarded not so advanced and comprehensive as nowadays'.

After several years in 1992, another eco village in Oxie, 10km outside of Malmo which is the third biggest city in Sweden, was built and named Myrstaken. (Graph 5) The design ideas of Myrstaken include: first, priority should be put on the social environment and opportunities for contact among residents; second, the neighborhood is planned as an ecological whole so that as many technical support systems as possible can be connected to local recycling (food, materials and products brought to and used in the village) , energy end-use is as efficient as possible and household energy is produced by renewable sources; third, siting is to make best use of existing infrastructure such as public transport; forth, the settlement should have at most 50 household and designed adaptable for

different groups of people. (Wiberg, 1998)



Graph 5 Myrstaken



Graph 6 Reed Bed

From ecological perspective, the design of Myrstaken is trying to be part of the natural process. The eco-features of it is described as follows. Active solar energy panels were installed on the roof of each house to supply the everyday use and also provide hot water for use and heating. During winter times when there is no enough sunshine, dried wood is burned to high temperature in the stove to be used to provide enough heating. Good insulation and small windows are used to keep the heat. The village also supply themselves with water from underground and they test the water by themselves in order to get clean water. Their waste water is treated in the reed bed (Graph 6) in their village and goes back to complement the underground water again. The solid waste are sorted and then recycled and treated by the municipality. Earth cellar were installed to use as a natural fridge. However, the cellars tend to be very moisture inside and are not suitable to use for everything. The temperature in the cellar is also a bit high to store food. Compost toilets were installed in each household to treat the feces locally. However, it didn't functioned well and created some hygiene problems and were uninstalled and changed back to normal toilets after eight years.

Although the developer would like to cooperate to develop such an ecological housing, during the design and construction they still feared for the higher investments. Therefore the architect tried hard to persuade them to adopt the ecological design ideas.



Graph 7 Wood Stove



Graph 8 Earth cellar

The eco village was built first and then got its habitants. It is the very time that Sweden suffered from the economic crisis when the construction of Myrstaken finished. So the price of the house was quite cheap. Some people moved to the village because they have an environmental mind and would like to change their lifestyle by living in eco village. Most of other people choose the eco village because they could save money for their energy bills of the running cost of housing.

Chapter 4. Comparisons and Analysis

4.1. From policy

It is obvious that different countries have different housing policies toward sustainability for the reason of different socioeconomic backgrounds. The focus of the policy and the aim of the policy vary.

4.1.1. Policy priority—adequate shelter for all

In China, the priority of housing policy is still to solve the problem of insufficient housing and to build affordable and appropriate housing for all which started in 1998. After the problem was released to some extent and many people began to ask for better life, new policy to meet the new need emerged in 2001. The needs includes increasing per capita floorage, water supply, energy supply, waste and sewage treatment capacity, central heating capacity, green coverage and transport.

In Sweden, to build good standard housing for all is a key concern in housing policy early since the 1940s. By several decades' effort, the goal was met and even there were vacant housing appeared in the 1970s. Because of the demographic and economic changes, new situation with vacant housing in some parts and insufficient housing in other parts occurred around the year 2000. Therefore, to provide adequate housing in some region were place again on the central agenda.

Comparing the policies in China and Sweden, it could be seen that although providing adequate housing are both the central issue for them, the socio-economic background behind are different. China, with its large population and increasing developing needs, lack of housing has always been a serious problem since decades ago. The need for adequate housing and better housing standard including larger living space and higher quality are still continuing uprising. However, Sweden has already passed and maintained for some while a stage of adequate and good standard housing for all during its developing. In such a case, it seems that the Chinese story now is already a history of Sweden. Therefore, it is possible that China will face the situation as what Sweden face now with big regional differences of vacant and insufficient housing. Therefore, China should be cautious of

the trend of demographic and economic shift of the different regions within the country and its implication of housing demand and supply. The housing policy shall be edited to promote the adaptability of housing to meet the different and changing need of people in addition to just increasing the floorage area.

4.1.2. Policy toward sustainability

Concerning the three aspects of sustainability, Sweden's policy approach is much better integrated (Novem, 2002) than China's. Besides to meet the basic need for housing, the government also has a relatively comprehensive policy to create a good built environment. It is a good integration of the three sustainability aspects of housing with its aim to promote wide range of housing toward the habitants' well being and sustainable environmental performance. It could be seen from the goal of "a good built environment" that social, economic and environmental aspects are all taken into consideration and it comprehensively covers many issues toward sustainability. In addition, the consequence analysis is well adopted in the Swedish policy making so that future risk of generating other problems is minimized. However, in China, the policy approach now could hardly be regarded as integrated from the three sustainability aspects. As the coming forth of amount of problems during developing, the policy making are generally problem driven, especially for the environmental aspects of housing. As insufficient land and energy are the two most important factors hindering the development of such a densely populated country since decades ago, it is also of the central concern in the policy issue to conserve energy in buildings and arable land. However, other problems related to the housing have not been addressed seriously such as indoor air quality. Therefore, although series of specific policies are developed to tackle the different problems such as insufficient housing (socio-economic perspective), energy use in buildings (environmental perspective), no comprehensive one is found to cover wider perspectives. And problem solving could not be considered sustainable as other problems may appear after one is resolved. So it is vital that to develop sustainably, more integrated and far sight policy should be set first for China.

When it comes to the specific regulations about environmental impact of housing, there are also

differences of the policy to regulate the same problem in the two countries. For energy issues, Sweden has a much more sustainable policy than China. Sweden has been trying to promote the use of renewable energy such as solar and wind power and minimize the use of nonrenewable energy such as oil and natural gas. Sweden also developed an energy strategy to decrease the very high amount of electricity used in heating by substitute of using bio-energy in combined plant for production of heating. (UN, 2004, B) However, in China, where there is a tradition to use coal as the main energy resource and suffered serious air pollution because of it, are trying to promote the use of cleaner energy such as natural gas. To promote the renewable energy is still not on the agenda yet. Therefore, the current policy toward energy use is far from sustainable in China. Being specific on the energy use in buildings, both Sweden and China have exerted great effort on the policy to regulate the energy conservation in buildings.

As for the land use of housing, there is a quite big gap between China and Sweden because of the different of population density. China, with the densest population living in the most arable land in the eastern part, has been trying to save enough arable land as possible and therefore developed the policy and style of densely planned housing. The high density patterns was regarded both ecologically and economically sustainable as it means less ecological footprint¹ and therefore more natural space is reserved, less road networking and energy for transportation. (Xu, 2000) In addition, the higher density could reduce the per-unit infrastructure costs and improve affordability. (Yeang, 1999) Therefore, it could be one reason that the price of Beiluchun could keep normal for the good vertical land use. Sweden, with its sparsely populated characteristic, has less pressure for land saving. The low building density could create better condition for adapting housing development to ecological cycles as the supply of renewable energy such as solar collector and the natural waste treatment systems require relatively more land per habitant. (Zhu and Lin, 2004) Therefore, the Swedish style is also ecological sustainable from this viewpoint. But from the socio-economic perspective, to save land for enough food production is much more important especially for China with one forth of the world population. For Sweden, the sparse land use creates more transport need

¹ Ecological footprint is the amount of land needed to produce the resources needed by an average person in a country. Largely as a result of increased human land use and resource use per person. (Miller, 2004)

and it is important to coordinate the transport system to reconcile these needs in order to achieve sustainability. (Boverket, 1995) The different land use pattern of the two countries could be seen as the different approach toward sustainability and the trade-off between the three sustainability aspects.

Concerning the waste and waste water treatment, China is aiming at increasing the treatment capacity while Sweden is aiming at decreasing the quantity of waste and promoting appropriate recycling. In such a case, the policy in China could only tackle the current problem of waste if the goal is met but Sweden tries to solve the problem from the root and then much more sustainable in the long run.

About the water and other natural resource use related to housing, China has not set up clear policy measures but Sweden has the goal to make efficient use of them. Although both China and Sweden has suffered the problem of unhealthy indoor environment created by material use of housing, there is no clear policy to regulate the indoor air quality right now in China while there is a policy goal to decrease the health risk in the built environment.

From the comparisons above, it is easy to conclude that Sweden has a much more comprehensive and integrated housing policy toward sustainability than China. Both China and Sweden has strong policy focusing on the social aspect such as provide adequate housing for all. However, China is much more underdeveloped in sustainable policy making than Sweden especially in the environmental aspect although with their different sustainable implications such as the land use issue because of different development stages and socio-economic background. It is evident that social housing policy is the starting point and focus for sustainability in China now. Further improvements needs to be made in the fields of more sustained use of energy, water and other natural resources, cutting the waste problem from the root and regulating for a healthy living environment. It is also of great important to integrate the three aspects of sustainability together in the housing policy.

4.2. From social factors

4.2.1. The customers' environmental awareness

The environmental awareness of people and their perception of “green” housing are quite different in China and Sweden. Although most people in China now tend to take more consideration of their living environment, generally speaking, they still have low level of environmental awareness and narrow perspective of built environment. Most customers care more about building form than environmental quality. To have some green coverage and less density in housing areas could be the image of green housing for many people. The desire to have better living environment and lack of right knowledge gives the chance for mal-propaganda and overstate of many housing projects as “green” and therefore creates a harder situation for the survival of real green projects which also generate problems for the housing market management. In the case of Beiluchun, if the price was much higher than other similar housing projects, the developer would lose the competitive advantage if the customers cannot understand or distinguish the green features and their benefits. Especially at the current development stage in China with the main goal to provide affordable housing for all, price is the foremost factor for the success of sustainable housing project such as Beiluchun. Therefore, to develop sustainable housing in China requires more careful design to lower the cost while not compromising the sustainability features which is a very hard work for the architects. In Sweden, there are much higher environmental awareness and willingness to pay and change than China. The environmental awareness of the villagers accounts as a most important reason for the construction of the first eco village. Many people are aware of the benefit of ecological housing at least the future saving of running cost. Although this reason cannot be regarded as the environmental awareness, it is still a good point for the society to promote sustainable housing successfully.

4.2.2. Developers

The developers' and contractors' willingness to develop sustainable housing in China and Sweden has some similarities and differences. Both the developers would like to develop sustainable housing if they feel it is profitable, but they are very cautious to the high investment for high

environmental performance. However, some real estate and construction companies have environmental management systems in Sweden but there are hardly any found in the Chinese counterparts. It is found that developers with environmental management systems are keener on working with sustainability issue than other developers in Sweden. (Åberg, 2001) Therefore, to promote the establishment of environmental management system in related business could be a way to help promoting sustainable housing both in Sweden and China. For the Chinese housing marketing with unreal propagandas of “green”, the government shall make proper policy to regulate and manage.

4.2.3. Designers and Researchers

It is evident that knowledgeable architects and researchers are the elite power to promote sustainable housing and make it into practice both in China and Sweden. The main architect for the design of the first eco-housing in both countries played the most important role in the project as a hub to organize the interest of related groups and try hard to sell their ideas of sustainability besides design. They are also the key person to realize the balance of the three sustainability aspects to make affordable ecological housing. Therefore, it is very important to recognize the potential power of architects and researchers to promote more of them to have more incentive to involve into the sustainable design.

From the comparison above, it is evident that Sweden has a relatively better social environment to promote sustainable housing from the customers’ environmental awareness than China but similar from the developers’ and designers’ perspective. Both China and Sweden have to better use and promote the incentive for sustainable design. Environmental management systems for related business shall be set up in China and extended widely in Sweden. More radically, it is a vital issue to promote the environmental awareness and provide environmental education in China.

4.3 From design and technology

In this part, the most common used environmental technology related to sustainable housing in

China and Sweden is compared mainly with the specific examples in Beiluchun and Myrstaken.

The energy issues in housing in these two projects are well complied with the government's energy policy in the two countries. In Beiluchun, natural gas from the municipality network is used for the energy resource for heating, cooking and hot water which is regarded as clean energy resource to prevent air pollution. In Myrstaken, solar energy is mainly used and dried wood as supplement in winter times. From the energy use, Myrstaken has more sustainable approach as it mainly use renewable energy. The reasons why Beiluchun does not take this approach are that the impossibility to set enough solar collectors on the limited land available per unit and the relative underdevelopment of solar collector technology and industry at that time. Both of the two housing project use sound design and technology to enable energy conservation in buildings and appliances. Besides, both the two projects enable the dwellers themselves to adjust the amount of energy they use in their households according to their own need. This design idea is considered very important to realize the sustainable ideas of housing during the use phase.

Different design and technology is utilized for the water system in these two projects In Beiluchun, a water treatment and recycling center is built to treat the waste water before releasing to the municipality sewage system and the recycled water is reused for irrigation and cleaning. In such case, the fresh water used in this area and waste water problem is minimized and economically reused as water shortage is always a problem in big cities such as Beijing in China. In Myrstaken, the water system is designed to comply with the natural cycle by using local underground water and biological treatment. There is no water shortage problem in Myrstaken and larger area of land is available to treat the waste water naturally compared to Beiluchun. From this sense, both the technology used of water system is adaptable to the local situation to have as high environmental performance as possible.

For the solid waste treatment in the housing, there is quite a big difference between these two projects. As solid waste is recycled and treated by municipality in Sweden while no such recycling

system in China, Beiluchun needs to take into consideration of the solid waste problem by its own while there is no such need for Myrstaken. Therefore, waste incineration is established in Beiluchun to minimize the waste generation. Under such circumstances, it could help to reduce the waste problem in this area. However, from the ecological cycle perspective, it would be better that the waste is sorted and recycled than just incinerated. The practice will not be possible to realize in just one or two housing projects but rather need the national wide policy and practice.

The vertical land use design aims at land saving is only found in Beiluchun. It is also complied with the policy issue of land use concern between the two countries. The use of earth cellar and compost toilet is only found in Myrstaken and the related technology is not so advanced at that time. Although the compost toilet was not functioned well and the earth cellar could hardly be used for all the stuff all year round in Myrstaken, they are quite good ecological practice if the technology problem could be solved. The earth cellar could help to save the energy for refrigerator and it is possible to install for each household in such sparse housing area compared to Beiluchun. The compost toilet could also make good ecological practice in Myrstaken to realize the idea of local recycling if it could function well as the compost could be used in the nearby farms and reduce the burden for the municipal sewage treatment. Nowadays, the technologies for earth cellar and compost toilet are much more developed and many are in good use. Therefore, it is important to promote of the ecological appliance technology in order to realize successful the sustainable housing.

Chapter 5. Discussions, Conclusions and Recommendations

5.1. Discussions and Conclusions

The main aim of the thesis is to investigate the ways to promote sustainable housing in China and Sweden. To fulfill this aim, the study of the related policy, social factors and two sustainable housing projects in each country were carried out by literature search, interviews and field work. The main findings are described in Chapter 2 and 3 for the situation in each country. Comparisons of similarities and differences are made in Chapter 4 and then analyzed for the implications of sustainability. The aim is therefore fulfilled by placing the different approaches in different countries and improvements could be seen by comparisons. In this Chapter, the main findings of the comparisons are summarized and recommendations for the two countries toward sustainable housing are made. As the sustainable features and technology used in the two housing projects of Beiluchun and Myrstaken are developed under the specific policy and social environment of each country, the discussions and conclusions from the design and technology used in these two projects are integrated into the corresponding policy and social environment parts to make the point much clearer.

5.1.1. Policy

For the housing policy in China and Sweden, it is no doubt that providing adequate housing is the priority in both countries. Sweden has already passed the age when there is need for housing national wide as China is facing today. The Swedish experience of having large regional difference of housing supply and demand after fulfilling the aim of providing sufficient housing in the first stage could be a field of policy consideration in China while developing large amount of housing for all. Good monitoring of demographic and economic shifts shall be developed for different regions and their implications on the housing demand and supply shall be considered well into the local housing policy.

The integration of different sustainability aspects of housing policy is much better practiced in Sweden than in China. The Swedish policy making utilizes the consequence analysis but in China

the policy making is generally problem driven and therefore sustainable aspects could hardly be considered well. In this aspect, it is crucial for China to develop far-sight policy making process and well integrated policy toward the economic, social and environmental development all together.

Being specific in the environmental considerations of housing, China and Sweden also developed different policy approaches according to their own situations.

In the energy field, China is promoting the use of cleaner energy such as natural gas and Sweden is promoting the renewable energy such as solar and wind power though heating but bio-energy is also in consideration to reduce the high amount of electricity. The case in Beiluchun and Myrstaken is well accord with such policy. Natural gas is used in Beiluchun and in Myrstaken solar energy and wood for heating in winter is utilized. Both of the two countries have regulations toward the energy conservation in buildings. The practices in Beiluchun and Myrstaken of energy conservation are also very important issue during the design process. As China is already facing the non-self-sufficiency of natural energy resources, developing policy to promote renewable energy as Sweden is of great importance now besides regulating the energy conservation.

About the land use issue, China and Sweden are two divergent approaches toward sustainability. China adopts the densely planned housing style while Sweden uses the sparsely planned housing because of their different characteristic of population density and availability of land. It could be clearly seen from the two examples of Beiluchun and Myrstaken while the design of Beiluchun exerts much effort in vertical land use while no consideration in Myrstaken is found. The Chinese style is more sustainable to minimize the ecological footprint in the life style and the Swedish style is easier to adapt housing development to ecological cycles such as the natural water cycle used in Myrstaken. However, as there is shortage of housing and land in some fast developing regions especially cities in Sweden, the Chinese style of dense housing would be of usage to solve the problem.

In the waste management field, China aims at increasing the treatment capacity while Sweden aims at decreasing the quantity of waste and promoting appropriate recycling which is more sustainable from the long run. Therefore, China also needs to tackle the problem of waste generation from its source like Sweden besides only increasing the treatment capacity. In the case of Myrstaken, composting of biological waste and local treatment of waste water could be regarded as good measures to decrease the quantity of waste and source separation is considered as the basis for the municipality level recycling and treatment. In the case of Beiluchun, incineration could be seen as a way to increase the local treatment capacity although national wide practice in the higher level needs to be set up.

For the natural resource use in housing and indoor air quality, Sweden has clear goal to make efficient use of natural resources and decrease the health risk in the built environment while no such policies are found in China. However, due to some economic reasons, efficient use of resources such as water is possible by self incentive in China. The recycling and reuse of water in Beiluchun is such a case. Both the design of Beiluchun and Myrstaken utilized the self monitoring of energy use and make the habitants adjust and save energy by themselves. Therefore, creating economic incentive by fully pricing the natural resource could be a way to stimulate the use of green measures. But China still needs to develop clear policy toward the sustainable use of natural resources in buildings and promoting healthy indoor environment.

5.1.2. Social factors

For the social factors affecting the promotion of sustainable housing, similarities and differences are also found in China and Sweden.

The general public environmental awareness in China is much less underdeveloped than in Sweden. Most people in China are lack of knowledge about green measures in housing and their benefit for habitants and society and therefore create chances for the misleading and confusion of the “green housing” market. Many people in Sweden know well of the benefits of sustainable housing for the

society or at least know the benefit for the habitants. A small amount of people with higher environmental awareness have willingness to change their life style by living in such housing as Myrstaken. So the marketing of sustainable housing would face a harsher situation in China than in Sweden. Therefore, to adapt the mass taste of housing especially lowering the price like Beiluchun is a key issue for the success of the sustainable housing marketing now in China. Radical improvements shall be made to increase the environmental awareness by proper education in China for the development of sustainable housing.

The developers and contractors in both China and Sweden have little incentive themselves to utilize green measures if higher investment is expected. This trend is well seen from the project of Beiluchun when the architect used economic benefit to try to persuade the developer to adopt her ideas. Sweden has more established environmental management systems in the real estates than China and it indicates better compliance and cooperation for the Swedish business to work on the sustainability issues than the Chinese peers. Therefore, stimulating the incentive to develop toward sustainability of the related business would be an effective way to promote sustainable housing. It would be helpful for the governments and authorities to create competitive advantage of related business by policy and financial support to sustainable housing projects and promoting market demand by raising environmental awareness of the mass. In addition, support the related research and industries simultaneously is also important in order to avoid the problems such as poorly functioned earth cellar and compost toilet in Myrstaken.

The architect and designer in both China and Sweden are the elite to promote sustainable housing. The main architect of Beiluchun, Solbyn and Myrstaken, Ms. Huang and Mr. Wiberg, played a most important role to initiate the housing projects and made the sustainable housing ideas into reality. Therefore, these elite powers should be reinforced by giving more support by the government and authorities and potential powers from large amount of architects and designers should be promoted by giving more educations and instructions.

5.2. Recommendations

It is evident that the sustainable features in the housing projects are well in consistent with the policy and related to the social environment no matter how sustainable it wants to be. Each housing project has its socio-economic background which affects the perception of value and sustainability. Therefore, the policy implications, design ideas and people's acceptance have much to do with the country or regions' situation. It is very difficult to be sustainable for only one housing area without the sustainable society as a whole. In such a case, the "sustainable housing" could rather be understood as "less unsustainable housing" under a specific society with its own sustainable approach and implications according to the development status. Therefore, to set up more sustainable policy and change the social environment is radical to promote sustainable housing. Recommendations for the changes in China and Sweden are listed as follows.

Recommendations for China:

- To make more sustainable housing policy with well integration of the economic, environmental and social aspects. The basis of the problem should be recognized and consequence analysis should be adopted and the changing of demographic and socio-economic situations should be monitored to make effective and far-sighted policy.
- Establish policy approach toward renewable energy use, efficient use of natural resources, decreasing the waste generation by recycling besides increasing treatment capacity, regulating health indoor environment. Economic instruments shall be used where it is possible to make efficient use of resources.
- Raise the environmental awareness of the mass is a radical way to promote sustainable housing for the sake of creating market demand and stimulating the business interest to develop sustainable housing.
- Supporting the development of sustainable housing by policy and financial means to create competitive advantage for related business.
- Supporting and giving further education and instruction for the architects, researchers and building industry to contribute to the design and technology advancement of sustainable

housing.

Recommendations for Sweden:

- Making the housing project localized according to the local situation and trying to utilize dense urban patterns in the cities and areas lacking of available land for housing.
- Developing related technique for the ecological systems and ecological appliances.
- Promoting more real estates and other related housing appliances business to establish the environmental management system.
- Creating more market competition of sustainable housing and pressure the companies and building industry to work on the sustainable issues.

5.3. Summary of the conclusions and recommendations

By comparisons for both the policy and social background and examples of sustainable housing in China and Sweden, both similarities and differences are found. Both China and Sweden consider economic and social aspects of housing such as providing adequate housing for all as the first priority. But Sweden has a much more holistic and systemized policy approach toward sustainability than China especially in integrating the environmental dimension. Sweden has better social environment to promote sustainable housing from the customers' perspective but similar with China when it comes to the architects' eagerness and developers' cautious to develop sustainable housing. The practices of the two sustainable housing projects have much to do with the political and social backgrounds. Sweden has better practices in energy and resource use and waste management than China. But in other aspects such as land use pattern, the two countries takes quite different approaches toward sustainability according to their own socio-economic backgrounds.

Recommendations for the two countries to further promote sustainable housing are made according to the comparisons and analysis. Besides the need to develop proper related technology and giving incentives for building industries in both two countries. China needs more integrated and far-sight sustainable housing policy, environmental education for higher environmental awareness which

could be learned from the Swedish experiences. More sustained use of energy and natural resources and better national wide waste treatment should be promoted in China. Sweden needs to consider the dense urban pattern for the planning in cities and regions where insufficient housing needs to be resolved where China's experiences of effective use of land could be learned from.

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