The Low Carbon and Recycling Theory of "Cradle to Cradle" Applied in Community Planning in Germany and Its Inspiration to China

After Copenhagen Climate Conference, low-carbon and recycling development has become a very hot topic in China. Currently, China stands at the stage of fast industrialization and urbanization. The balance of maintaining sustainable economic growth and reducing CO2-emission faces enormous challenges. From the point of view of operation, the "community" is the right place and planning level to practice the low-carbon cycle theory. Hence, "cradle to cradle" theory will find their particular suitable application in the community planning and building construction in China in terms of protection of ecological environment, improvement of the community conditions and promotion of sustainable community development.

1. "Cradle to Cradle" Theory

"Cradle to Cradle" theory is initiated by the American Architect William McDonough together with the German environmental scientist Michael Braungart. The cross-disciplinary theory is based on the old thinking of low carbon development and recycling economy. The design model has found its application in Germany and many other European cities and communities.

1.1 Brief Introduction of the "Cradle to Cradle" Theory

"Cradle to Cradle" theory takes its inspiration from nature. It can be simply explained with the example of the lifecycle of a cherry tree. Cherry trees draw nutrients from the environment, bloom and scatter leaves, which nourish the surrounding plants meanwhile. Hence, the nature does not tell a linear growth model ("cradle to grave"), but a "cradle to cradle" cycle development model. Lessons learned from the cherry tree, with the right products, services and systems, the buildings, the communities and even the entire city can create an interdependent and synergistic relationship with the surrounding ecosystem.

"Cradle to Cradle" design is based on the old thinking of natural energy flow, that solar energy heats in the winter and breeze through the gallery creates a pleasant micro-climate in the summer. Natural energy flow means to rebuild the relationship between things on Earth and the sun. "Cradle to Cradle" sets the goal of creating recycling system of natural resources and physical materials. Renewable energy, such as the sun, wind, and water, provides on the one hand power to meet the needs of human beings, and reduces the environmental and energy problems on the other hand.

1.2 Baseline and principles of the "cradle to cradle" Theory

The traditional design methodology focuses on cost, function and aesthetic. In practice, people treat the economic effects as the first priority, and social and ecological benefits as a remedy. Hence, "cradle to cradle" theory has three principles: equity, economy and ecology.

Equity means social justice. All have the same right to life and access to natural resources. It is not fair, if the neighborhood live in a toxic environment, the product affects the health of our next generations or the factory pollutes a river or the air.

Economy is the wisdom of the market. Is this product is a consumer's need and can be afforded? Is community development acceptable to the most residents? Is cost controllable? How many economic benefits are there? How to gain greater economic returns through improvement of sustainability?

Ecology is the wisdom of nature. Whether the material is a biological or a technical nutrient? Whether the development is to follow nature's standards?

The development principles suggested by "Cradle to Cradle" theory are:

(1) "Use Current Solar Income" illustrates the use of renewable resources and clean energy, such as solar, wind, geothermal energy.

(2) Double circle of social and economic systems (see Figure 1) describes the use of biological or technical recycling, that the waste involves into the metabolic system. The material flow of nature can be divided into natural material flow and technological material flow (or industrial material flow). If properly designed, all of the urban development, product and service will be able to integrate into the both metabolic system.

Figure 1: Double circle of social and economic systems
From:http://www.epea.de

(3) "Celebrate Diversity" preserves natural environment and biodiversity, respects cultural diversity and improves urban and community development.

(4) With the help of the life-cycle assessment and management, the product design concentrates on the entire process of the product in order to maximize the use of functions, to ensure the comfort, and promote social and cultural inheritance and development, while minimizing the cost of construction. There is a strict certification system for the full life-cycle tracking in Germany.

1.3 The Assessment and Certification System

First of all, the assessment and certification system determines the type of the "protection object" (dt. Schutzgüter). Then, "protection goals" (dt. Schutzziele) will be developed for each type. Finally, an evaluation criteria system will be created, in order to measure the ecological, economic, social and functional goals.

In Germany, there are over 50 evaluation criteria, which related to the following six aspects: ecological quality, economic factors, social and functional quality, technical quality, process quality and site quality.

2 . Application of "Cradle to Cradle" Theory in the Community Planning and Construction

In Germany, There are many best practices of the applications of "cradle to cradle" theory in the planning and construction of the low-carbon communities. The most well-known examples are Vauban District in Freiburg and Kronsberg Community in Hanover. Low-carbon cycle planning concept was applied from the beginning, in order to change people's behavior, to reduce energy consumption and to realize low carbon development.

2.1 Definition of the Low-carbon Community

Low-carbon community adopts comprehensive methods, including energy, resources, transportation, land use, construction, landscaping, project management and monitoring, to reduce carbon emission during planning, construction and management process. In this way, double circle of social and economic systems is build with the focus of zero-energy-consumption.

2.2 Construction Strategies of Low-carbon Communities

(1) Compact development

One of the most important criteria of low-carbon communities is compact development, which emphasizes mixed land use, higher density of housing, pedestrian-friendly transportation. Hence, the sustainable development goals can be explained here as achievement of energy saving resources, less environmental pollution, protection of the natural environment.

(2) Low-carbon emission, use of green energy

Low carbon communities are built on the base of nature, including

- retaining the original topography, vegetation, rivers and other natural forms;
- according with spatial layout, the road system, and local seasonal wind;
- rational combination of various resources and eco-technologies;
- use of renewable energy.

(3) Reduction of carbon emissions and environmental pollution

In general, within the low-carbon communities, the use of motorized vehicles is prohibited or restricted. Instead, clean and environmentally friendly transportation is implemented and external transport is mostly connected with public transport system. The "shared spaces" are nowadays popular, that traffic signal signs, the road divider, Stop and other signs, the border between sidewalks and roadways are abolished. In addition, leisure facilities are increased,

so that streets play role of part of the square.

(4) Achieving of eco-cycle through re-use

With the help of using water-saving equipment and use of rainwater and grey water, about half water consumption can be saved. On the parking space, porous materials are paved to reduce surface water run-off. Wastewater produced in the community is treated through small-scale processors in situ. The treated sewage is used for plant watering. Garbage collection is mechanized, standardized and diversified.

(5) Public participation and community interaction

Public participate is another important factor of low-carbon community. Most of the residents should be involved in the community planning, construction and management. Many low-carbon strategies are the outcomes of public discussions. Residents gain sense of ownership and self-confidence in the process of communication and coordination.

2.3 Case study 1: Vauban District

Freiburg, the southern German city, is the most eco-conscious city in Europe. Vauban District, which is a suburban neighborhood in Freiburg, is well known as the benchmark for low-carbon sustainable communities in Germany. The community covers an area of 38 hectares and has population of around 5'000. "Learning oriented plan" builds the foundation of successful development of Vauban community, which combines the public participation and co-governance. The community planning enjoys more flexibility, because the residents have access to attend decision-making process.

"Vauban sustainable model" has already made very successful experiences in energy conservation, reduction of traffic, social integration and creation a sustainable neighborhood unit. For example, high efficient cogeneration, which uses 80% sawdust and 20% efficient natural gas, provides for the community central heating in winter. By good isolation and efficient heating supply reduce approximately 60% of carbon monoxide emissions. The transport concept under the motto "living without car" reduces 35% of the cars. There are no parking spaces in the core area of the community. The tram lines outside the community, private car sharing, as well as some efficient commercial assess build an efficient traffic network. In addition, narrow U-shaped paving road guarantees the priority of pedestrians and bicycles.

The "Vauban forum" played a decisive role in the operation. From the beginning of the community planning, the residents participated in the whole operation of the community. They are the decision-maker of the building forms, open spaces and detail designs.

2.4 Case study 2: Kronsberg Community in Hanover

Kronsberg community (see Figure 2), which is located southeast of Hanover, is close to the site of Expo 2000. If the construction would be finished, 6,000 housing units will be provided for 15,000 residents, with a total area of 140 hectares.

Community plan focuses on the ecology and sustainable development, which includes compact residential structure, high building density; environmentally friendly transport strategies; mixed land use and service facilities layout. Kronsberg community is treated as a model of European ecological living neighborhood.

(1) Optimizing of low-carbon

The community fulfils the ecological living and building ideas. In the planning and construction phase, low-carbon always stands on the top of the list.

Energy consumption: local heating supply reduces 60% less CO2 emission than residential standards. In addition, solar power and wind turbines reduce CO2 emissions by 20%.

Rainwater collection: The drains collect rainwater on both sides of the street. Rainwater is re-used for landscaping. Compared with 165 mm/a unused rainwater in the ordinary residential area, the amount of Kronsberg community counts only 19 mm/a.

Garbage collection: The environment-friendly building materials are used. At the design stage, garbage processing is well considered.

Earthwork balance: In the early phase of construction, approximately 700m3 of earth were dug up, which were re-used for landscaping and agriculture.

Figure 2: master plan of Kronsberg community From:Hannover Kronsberg Handbook Planning and Realisation. Jutte Druck, Leipzig. March 2004

(2) Community as Garden

The community enjoys abundant ecological niche, including avenues, green spaces between buildings, public courtyard gardens, private gardens, etc. There are also two large communities square park full of native plants. Thanks to ingenious rainwater collection system, there are gurgling water and poetic landscape overall to see.

(3) Community as social living space

There are culture centers and art studios in the community, including libraries, multimedia centers, senior houses, youth activity center, art studios. Besides, the city provides 30 apartments for handicapped and 100 for senior citizens.

3. Reference and inspiration to community planning in China

China has beginned with researches and praxis of low-carbon communities, such as "Changxindian eco-city" in Beijing and "Dongtan Eco-City" on Chongming Island in Shanghai. On the whole, in the practice, it sill lacks theoretical and methodological supports.

3.1From the level of planning and design

(1) Land use and spatial structure

 mixed land use

Community planning should organize and integrate different functional plans like housing, commerce, office, recreation, education, green spaces. The mixed land use enhances diversity of the community and furthermore provides vitality and a sense of security.

 Compact development

The community layout should be compact, in order to save land as much as possible and maximize open space.

(2) energy plan

Clean energy should enjoy its priority with the principle of efficient use of renewable energy sources (such as solar, wind, geothermal energy, waste heat resources, etc.). The equipments within the building and energy supply should be optimized, in order to reduce conventional energy consumption and negative environmental impact.

(3) green trasportation system

The green transportation system suggests a transportation system based on public transportation, pedestrian and bicycles .

travel styles

Firstly, within the community, walking and bicycle lanes connect the neighborhood and the service facilities. Secondly, public transportation system should be expected as the first choice of external traffic by the residents. At present, there are some good practices, such as so-called "seamless four-level traffic hub" in Hangzhou, which including metros, busses, BRT and bicycles.

traffic network

The main motorized roads are located outside the community, while there are inside the community mainly bike paths, pedestrian areas and 30km/h zones..

(4) green space plan

optimizing green space layout

The goal of the green space plan is optimizing the structure of green space. According to the slopes, environmental conditions and the living styles, the landscape, neighborhood activities and mode of living should be combined, in order to form a green neighborhood.

three-dimensional Green system

Three-dimensional green system includes the first floor green, middle green, green roofs and green walls. The first floor green can be elevated to form a sky garden.

(5) Water plan

In wet areas, groundwater resources and surface water resources should be treated as important resources. They should be well considered in vertical design and rainwater collection and use of surface water.

Rainwater collection

Generally speaking, the process of the rainwater use can be divided into four main modules collection - storage - purification - use. Through the rainwater collection device, rainwater can be collected together. Through a simple filtering process, it can be used to build water features, water green fields, wash roads or wash cars and flush toilets.

Re-use of grey water

Dual water supply is the important factor of low-carbon community. The grey water can be used for plants watering, car wash and household.

artificial wetland system

Artificial wetlands provide many advantages for eco-communities: effective dealing with wastewater, such as daily domestic sewage, industrial wastewater, landfill leachate and rainwater, metal pollutions, and pathogenic micro-organisms and other pollutants. Meanwhile, the wetland is important element in the landscape design.

permeable paving

Permeable ground has many advantages, such as optimizing living condition of plants and soil micro-organisms, regulating urban micro-climate, reducing urban heat island effect and so on. In Germany, water-permeable paving is widely used on the sidewalk, plaza, bike paths and car parks, where the ground is not under huge pressure.

(6) Green Building Design

Green living and working spaces are provided by using of eco-friendly materials. Building and decoration materials should be involved in the double circulation system of "cradle to cradle".

3.2 From the level of management

In order to ensure planning and implementation of the low-carbon community, planning management must be changed to seek institutional solutions. In this case, urban design guidelines and appended plans are strongly suggested.

(1) Guaranteeing the community construction by involving in the regulatory planning system

It is difficult to guarantee the implementation of community planning in the framework of the existing planning and management system. Thus, innovations and changes are necessary. The existing regulatory plan, in general, provides the conventional control factors such as FAR, building height, building density, etc. However, these compellent factors lacks low-carbon planning goals, such as reducing energy consumption, use of renewable energy, rainwater recycling and waste management.

In Shanghai, "appended plan" is accepted as an innovative content of the regulatory plan, in which the key contents of urban design are transformed into the statutory plan and illustrated as plan. Many low-carbon communities can be planed and controlled in the form of "appended plan" with numerous indicators and regulatory indicators.

(2) urban design guidelines of low-carbon community plan

The low-carbon community, combined with urban design, should be established in the framework of urban design guidelines, which can be divided into several indicators such as land use, energy, ecology, water resources, waste, construction, etc. legislation is a proper way to establish technical foundation and promote low-carbon community construction.

3.3 Community Implement Mechanism

(1) management process based on the "life-cycle"

"Cradle to Cradle" planning and design focuses on the whole process of "life-cycle". On level of the community planning, including the pre-management, feasibility studies, planning and design, construction phase, maintenance, assessment and improvement, recycling and other processes. There are corresponding management mechanisms and evaluation mechanisms for each process.

(2) public participation

Low-carbon community needs urgently public participation. The organizations on the community-level organize events to enhance communication between residents, managers and experts, so that the residents participate actively in the entire process of planning, design management and decisions. The final goal is an active public participation and self-government.

4. Conclusion

The construction of low-carbon community is system engineering, including planning, management, and evaluation. It is necessary to strengthen inter-sectoral collaboration, attract broad participation, and change production and consumption pattern. From the planning point of view, innovation of planning and management is urgently necessary, to change our industrial society to an ecological one with the help of low-carbon community planning.

(The author thanks Michael Braungart and Qian Haixiang in EPEA for providing helpful materials.)

[Reference]

1. Zhangping, Xin and Yintai, Zhang(2008) "Low-carbon Community and Praxis", Urban Problems, Vol. 159 No. 10
2. Gu, Qian (2009) Research of ecological community based on low-carbon thinking. Dissertation of master's degree,Hangzhou: Zhejiang University
3. Anja Eckert, Kathrin Brandt, Gerhard Kier,etc(2004) Hannover Kronsberg Handbook Planning and Realisation, Leipzig: Jutte Druck
4. Website EPEA ,http://www.epea.de
5. Website Deutche Gesellschaft fuer Nachhaltiges Bauen e.V :http://www.dgnb-china.com/index.php?page=DGNB_deguo
6. Website DGNB Certificate: http://u.house.china.com.cn/blog/?uid-14578-action-viewspace-itemid-21153
7. Website Sustainable Architecture :http://www.arch.hku.hk/research

[About the author]

ZHOU Xiaojuan

Shanghai Urban Planning & Design Research Institute, China, senior engineer, Certified urban planner ,Master

Address: F13, 331, Tongren Road, Shanghai, China

Telephone:13641753998

Email：zxj@supdri.com