Probe into the Creation of Ecological Residential Communities by Using Low-carbon Technologies

—— A Discussion on the Detailed Planning for Dayou Garden, an Demo Ecological Residential Community

1. Concept of low-carbon technologies

"Low-carbon technologies", which is put forward under the background of "low-carbon economy" and "low-carbon city", is a technical term with new concepts involving many domains. The essence of the low-carbon economy is the efficient utilization of energy, development of clean energy, aiming at a higher "green" GDP, and its core contents are the innovation of energy technology and emission-reducing technology and that of industrial structure and system, as well as the essential change in ideas about the existence and development of human beings. It is just under this background that "low-carbon technologies" are put forward.

With the gradual deepening of economical globalization, reducing consumption of energy resources and emission of greenhouse gases has become a severe challenge that the international communities have to face, at the same time, the "low-carbon economy" that is based on low consumption of energy resources and less pollution has become a buzz word internationally and another new trend that may have significant effect on the global economy since the Industrial Revolution and the Information Revolution. Creation of low-carbon cities is becoming our new constructional goal.

Involving a wider range of fields, "Low-carbon technologies" mean a lot, to put it simply, they are innovative technologies that are developed and applied for reducing the emission of greenhouse gasses like CO_2 and efficient utilization of clean energy. "Low-carbon technologies", which are available in such fields as energy conservation, clean and efficient utilization of coal, exploration and development of petroleum resources and coalbed gases, renewable resources of energy, utilization of new energy, capture and storage of CO_2, is a new kind of effective technology used for control over the emission of greenhouse gases, involving such sectors and lines of business as electric power, traffic, architecture, metallurgy, chemical industry, petrochemical industry and automobiles, for example, the technologies for the utilization of solar energy and wind energy.

2. Applications of low-carbon technologies in ecological residential communities

Both "low-carbon technologies" and "ecological residential communities" are getting more and more popular in the present urban planning and construction, so it is greatly

significant to make a deep study on the application of low-carbon technologies in urban planning. Creating the low-carbon society and cities is just the most material and forceful practice for adhering to the scientific outlook on development and creating a harmonious society.

As the basic living unit in cities, the ecological residential community is a place for people's daily residence, so its ecological improvement and management pattern featuring sustainable development is representative and worth promoting. All the environmental technologies available for ecological residential communities are worthy of our in-depth research so that they work well to reduce the emission of greenhouse gases from residential communities. In respect to the probe into the creation of ecological residential communities by using low-carbon technologies, its core objective is to make efforts to improve the adaptability of residential communities to climate while reducing the emission of greenhouse gases, making it an ideal dwelling space for people. Viewed from the present construction, low-carbon technologies have the following applications:

2.1 Planning and construction of residential communities

The applications of low-carbon technologies in urban planning on all levels are prospective and practical, while the urban planning exerts a long-term structural effect on urban development, playing a role of pilot and integral planning, in particular, cities have become a key link to facilitate energy conservation and emission reduction and accommodate themselves to the change in climate. The land conservation that is put forward in the detailed planning for residential communities is just for the purpose of utilizing land resources in an efficient way, thus achieving the purpose of low-carbon emission and land conservation per unit area.

2.2 Architectural design of residential communities

Low-carbon technologies have a wider range of applications in architectural design, especially for the modern architecture, which features "ecological architecture" and "green architecture", with a new trend of energy conservation and emission reduction. The low-carbon development is a new trend of development of energy-saving technologies, and the idea about development with low-carbon emission is closely associated with the ecological architecture and the green architecture. The core of ecological architecture and green architecture, which has the same goal as low-carbon technologies, is just the applications of ecological compensation technology, and those of energy conservation and low-carbon energy systems. The essence of low-carbon technologies is an integration of these technical strategies and means, which are then applied to practice in the form of a new type of low-carbon technology. During the constructional design of ecological residential communities, we can achieve a better effect of energy conservation and emission reduction by using low-carbon technologies, since the technologies tend to be sophisticated and are worth promoting to a wider range.

2.3 Design of ecological environment of residential communities

Low-carbon technologies are mainly applicable to the conservation and utilization of the ecological environment of residential communities. Available for ecological conservation, restoration and compensation, low-carbon technologies may be used to improve the ecological service function of the natural ecological system in residential communities, achieving the purpose of absorbing more greenhouse gases and reduce the emission of carbon. In the environmental design of ecological residential communities, we should formulate our planning according to the practical conditions so as to enable the environment of residential communities to be more ecologically natural by using proper and effective low-carbon technologies, preventing the original ecological foundation from being damaged caused by the construction of artificial landscape, reducing the emission of greenhouse gases and thus notably improve the quality of living environment of residential communities

3.Discussion on part of low-carbon technologies applied to ecological residential communities

3.1 Energy-saving and emission-reducing technologies

3.1.1 Utilization of solar energy

The utilization of solar and wind energy mentioned herein by the writers means that in the buildings within residential communities. Solar energy is a kind of clean and renewable resource of energy featuring abundant sources and pollution-free to environment, at the same time, solar energy technology has been widely applied, therefore, it is a type of low-carbon technologies indispensable to the creation of ecological residential communities. According to the difference in the thermal systems adopted, solar energy architectures can be classified into two types, active and passive. The former requires power for thermal circulation, featuring complex equipment and much investment, and simultaneously, an auxiliary power supply is required. The later can be constructed by using local materials, with the advantage of simple architectural technology and without consumption of any other resources of energy, so this technology can be used as an auxiliary means of energy supply to residence in ecological residential communities.

In the planning for ecological residential communities, such passive heating technologies as attaching sunspace, building a heat-collecting wall and the use of insulating curtains and window cover plates in the night are available. Viewed from the rate of energy conservation of ecological architecture, the net indoor height should be 2.8m and the depth should be not more than 2.5 times of its story height, which has also been proved by practice.

3.1.2 Utilization of ground source heat pumps

In the planning for ecological residential communities, the emission of greenhouse gases can be greatly reduced by using ground source heat pumps as the energy supply. The ground source heat pump, as a new type of energy utilization technology

for heating and cooling by means of geothermal energy, is a type of heat pumps, capable of transmitting heat or cold energy under ground to the required places. In general, heat pumps are used for the refrigeration or heating of air conditioners. The ground source heat pump, by using the powerful heat and cold energy storage capacity of underground soil, transmits heat and cold energy under ground to buildings in winter and summer respectively, forming an annual cold-heat circulation.

Compared with air source heat pumps, the ground source heat pump with proper design for ecological residential communities may save at least 30 percent of electric power, and save at least 70 percent of electric power compared with electric heating.

3.2 Design of ecological residence with low-carbon emission

As the principal building, the ecological and low-carbon design technologies for ecological residence are worthy of our in-depth research. First, in the low-carbon design of ecological residence, so many links as overall planning, individual design and environmental control system need to be arranged for as an integral system by using of such a technical strategy that such technologies for architectural design, planning, sound, light and heat of residence, as well as wind field should be integrated so that they are applied as a whole to the implementation of energy conservation and emission reduction

Second, the energy conservation of ecological residence means the overall rather than a certain respect of energy conservation, and the energy conservation of whole architectural system more than that of outline and inner structure, i.e. whether the doors and windows or the architectural details of residence shall be designed following the principle of organic circulation.

Third, the design of ecological residence shall be featured by definite genius loci, that is, different energy-saving strategies, technologies and solutions shall be adopted according to the differences in natural climate features, regional cultures and traditions, materials and technologies owned in different areas.

Fourth, the ecological residence is designed for low-carbon emission, so consideration should be given to the effect arising from the local environment and the construction should be guided on the principle of ecology so as to better coordinate the relations of humans, architecture and resources, achieving the purpose of co-existence, mutual benefit and harmonious development of artificial and natural environment through rational circulation between them. In respect to the basic constructional elements, we should concentrate on the following:

① proper utilization of natural resources; ② planning and designing according to the local practical conditions; ③mitigating environmental pollution at the residential community; ④Attaching importance to enjoyable residence; ⑤ proper selection of green construction materials; ⑥ creating green landscape environment.

3.3 Planning and design of low-carbon ecological residential communities

The constructional goal of ecological residential communities that we are advocating is “comfortable, healthy, efficient and harmonious”, which is consistent with the goal of low-carbon emission in the ecological residential communities that we will construct, and both goals are put forward for the creation of the living space suitable for residence. In the planning and design of low-carbon ecological residential communities, attention should be paid to the overall planning and layout so as to control the emission of tail gas from vehicles by improving the flow efficiency of vehicles in the residential community, thus reducing the emission of greenhouse gases.

In respect of the planning and design, we can establish a road network unfavorable to the flow of cars within the residential community, i.e. the road system may be arranged for in the form of cul de sac or grid; short zig-lines may be adopted as the road alignment to control the speed of vehicles, which may further limit the flow of cars within the residential community, thus minimizing the effect of cars on the residential community. Next, paving footways and bikeways within the residential community for ease of residents’ walking and riding so as to meet their need for short-distance traffic. Third, a road network connecting the public traffic, track traffic and bike flow between the residential community and downtown shall be planned outside the residential community, at the same time, other services like the public vehicle system shall be provided for ease of residents’ traffic.

In addition, in the design of the wide open space of ecological residential communities, we should also attach importance to the low-carbon design and the harmony with local natural resources. E.g. local plants should, in accordance with the site design, have priority to be adopted; the planning for landscape of the ecological residential community should be based on the natural landscape, with less artificial facilities, thus we will create an ambient closer to the nature. Moreover, we can reduce the emission of carbon within residential communities by using low-carbon technologies featuring energy and water efficiency, e.g. establishing a rainwater collecting system and a reclaimed water reuse system to collect sewage for recycling so as to reduce the consumption of resources of energy.

Overlook of Dayou Garden

4. Creation of Ecological Residential Communities by Using Low-carbon Technologies

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4.1 Status quo in brief

Located at Lingshui Town west of Dalian, Dayou Garden looks out upon the sea on one side and is surrounded by mountains on the other three sides, higher in the north and lower in the south, known as a geomantically auspicious spot with better natural and cultural environment. The project occupies a land area of 0.166 million square meters with a total building area of about 0.2 million square meters, of which there are 0.17 million square meters for residence and 30,000 square meters for public use, with a floor area ratio of 1.2. Dayou Garden awarded the title of National Environment-friendly Project, which is the top award granted by the country to the constructional projects for their environmental protection work, and is the only real estate project among national top ten awarded projects. It was in its initial construction stage that Dayou Garden established its idea on the ecological development, that is, water saving, energy saving, land saving and pollution control, which is in complete conformity with the constructional idea of " four savings and one environmental protection", realizing the constructional goal of low-carbon emission. The overall process of construction of the residential community was permeated with this idea of development, and a complete set of industrial system was thus established.

In addition, Dayou Development Company made an attempt at the ecological improvement of the residential community, making efforts to improve its adaptability to climate while realizing the low-carbon emission of greenhouse gases. According to the market demands and the fact that the residential community locates at the suburb, the company put forward the idea of "suburbanization of urban residence, ecologization of suburban residence, popularization of ecological residence and industrialization of popular residence", that is, creating a harmonious and low-carbon ecological residential community industrially by using low-carbon technologies.

4.2 Planned structure of the residential community

According to the planned structure, the residential community is constructed based on the topographic features of the hills, lower in south and higher in the north, on the face of landscape and mountains being in the back, known as a superexcellent geomantically auspicious spot. The residential community is designed with "two spots, one axis and multi groups, developed on a multi-phase basis. By two spots we mean the business service center at the entrance and the core landscape within the residential community. By one axis we mean the lengthwise landscape axial line in the center of the residential community, along which green and exuberant vegetation is grown and water rills down from the hills, just like the Xanadu. By multi groups we mean the dwelling groups comprising the low storied dwelling, multi-storied dwelling

and high-storied dwelling for the selection of different classes.

The programmed planning features rational layout, respect to the nature, proper mix with environment and co-existence with the nature, showing the constructional goal of the ecological residential community featuring harmony and co-existence.

Plan of the garden

A corner of the garden

4.3 Systemic energy-saving technologies

The systematic energy-saving technologies will not only improve the coefficient of utilization of energy, but reduce the emission of greenhouse gases, at the same time, cut down the costs of development and utilization. None but a complete energy-saving system allows your implement of energy conservation and emission reduction to the full in all respects. The complete set of energy-saving technical system includes following five respects:

4.3.1 Insulation system for single families

The heat insulation of residential structure is the basic requirement for energy-saving residence. Dayou Garden takes heat insulation measures not only for the external wall surface, roofing, external windows and entrance doors, but for the floor, staircase walls and partition walls, creating the “single-family closed insulation system”, reducing the consumption of resources of energy.

4.3.2 Heating system of low-temperature radiation floor boards

Low-temperature radiation floor boards feature efficient heating and energy accumulation as well as even dispersion of heat, therefore, when the water supply temperature is 40 ~ 45℃ and the return water temperature is 30 ~ 35℃, the requirement for the normal indoor heating temperature can be met, directly saving energy by 20% compared with the conventional heating means , i.e. heating radiators, which requires a water supply temperature of 90℃ and a return water temperature of 70℃.

4.3.3 Triune heating and energy-saving system

Such three subsystems as the heat source system, the transmission system and the heat receiving body compose a complete system, which has been proved to exceed the specified energy-saving rate of 50% through data capture and calculation during one heating period, achieving the optimal energy-saving effect of reducing consumption of coal.

4.3.4 Solar energy hot water system

Dayou Development Company attaches importance to the utilization of clean energy, providing each family with a 140L light/power bi-service pressure-bearing solar energy water heater, which can save electric energy by 95% compared with ordinary electric water-heating systems, at least saving 2 million kW hours per year for the whole demo community, with a considerable economic benefit.

4.3.4 Wall-reconstruction energy-saving system

In Dayou Garden, a special frame system is adopted as the residential structure, of which the enclosure and internal partition structures adopt new types of wall bodies design instead of solid clay bricks and hollow clay bricks. These new types of wall bodies improve the overall energy-saving effect of buildings through the improvement of their heat-insulation performances, at the same time, relieve the load on the building and reduce the consumption of steel bars, achieving the purpose of saving materials.

4.4 Systematic land-saving technology

Land conservation behaves as the increase in the rate of utilization of land per unit area, thus the landscape and greening areas will increase correspondingly, equivalent to a substitution for land functions. With the increase in green area in the garden, not only the landscape environment of the garden gets colorful and beautified, but is the carbon emission from the garden reduced as a result of plants' photosynthesis.

In Dayou Garden, planning and design are made in many respects to reserve land. Since the construction site is selected to locate at the hillside, so the company utilizes the slab staggering of mountainous landform to build underground garages, which increases the number of garages, raising the rate of utilization of land by 20.8% without any change in floor area ratio; the company also makes efforts to ask for benefit from underground space by using the part with a digging depth over 4m underground, increasing 15,160 square meters of underground area. In addition, the company also attaches importance to the conservation and utilization of land resource, i.e. the collection and rearrangement of surface soil. Soil covered on mountain surface is helpful to the growth of plants, therefore, the constructors of Dayou Garden have collected 40,000m^2 of surface soil and rearranged 25,000 m^2 for greening, at least saving capital 1.04 million yuan, achieving great economic and environmental benefits.

4.5 Systematic water-saving technology

Besides the water-saving devices used in the residence, the water-saving system of

Dayou Garden also includes following three subsystems, the reclaimed water artificial recycling system, the surface water semi-natural recycling system and the underground water natural recycling system, forming an ecological water environment featuring resource recycling.

The reclaimed water artificial recycling system: Dayou Garden's sewage treatment station has been put into operation with a design daily treatment capacity of 1000t (the present daily treatment capacity is 600t). The treated sewage first enters into a natural reservoir for a treatment and then a secondary treatment so as to reach the use standard for reclaimed water, which is mainly used for the purpose of toilet flushing of residents and greening of the residential community. Surplus reclaimed water enters into the surface circulation system. Through the reuse of reclaimed water in the residential community, 40% tap water is saved, of which 30% is used for toilet flushing of residents and 10% used for greening and landscape.

4.6 Systematic material-saving technology

The company's complete set of technologies for material saving are chiefly reflected by its industrialized decoration. In Dayou Garden, 800 houses are commercialized residential houses thoroughly decorated using industrialized production mode, that is, manufactured in the factory and assembled on site. This means of decoration is a change to the conventional means of decoration by handwork, realizing scale production and standardized supporting system, reducing the pollution caused by materials during individual decoration.

4.7 Environmental protection technology

Dayou Garden has a complete technical supporting scheme of its own on environmental protection, including: (1) sewage in the residential community shall be zero discharge, and sewage treatment shall meet the IV water body standard (sewage treatment capacity 600 - 1000t per day); (2) using treated and qualified reclaimed water for landscape and greening; to collect surface water and nourish underground water so as to achieve ecological water circulation to adjust the natural temperature and humidity of the residential community; (3) on-site reducing the quantity of refuse by using sorted refuse collection and bio-treatment technologies, reducing 250t of refuse needing to be removed out annually, with an estimated decrement up to 85%. (4) a nursery was built up three and a half years ago with a number of seeding up to 100,000. Some of the survived ones now have been transplanted to the residential community, thus a green coverage ratio of 50% is ensured, of which the tree coverage ratio makes up 50% of the total green area.

Through the integrative applications of low-carbon technologies and other design means, Dayou Garden has, viewed from the planning and construction of its Phase I

project, achieved the overall objective of optimizing the ecological environment of the residential community that was set up in advance, at the same time, the emission of greenhouse gases has been reduced by means of all possible measures, realizing a low consumption of energy by and less emission from the ecological residential community, blazing a new trail for the creation of the ecological residential community to the sustainable development by using low-carbon technologies, and is worth promoting to the planning and construction of residential communities.

5. Epilogue

Low-carbon technologies are a mix of a series of technologies throughout the planning, architectural design and project management, and simultaneously an open system used for the settlement of a certain problem. They don't have to stick fast to high or modern technologies, and may absorb from some conditional technologies with local features. The planning and construction of Dayou Garden is a good annotation of the above, offering an instructive reference for the probe into the creation of ecological residential communities by using low-carbon technologies.

Therefore, it is of practical significance to the creation of ecological residential communities by using low-carbon technologies. With the construction of ecological cities and low-carbon cities, low-carbon technologies will have a wider range of applications, not only to detailed planning of residential communities, but to overall macro planning, worthy of professionals' further speculation and researches. The discussion on the creation of ecological residential communities by using ecological technologies is only in its infant stage, we are looking forward to more research findings to better instruct our planning and constructional practice.

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Statement

It is declared that, the above paper was written and completed under the guidance of my advisor. Unless otherwise marked, no research findings that have been published or written by others are involved herein, so as to ensure the paper is original.

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