Zhonghai Heshandaguan project

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Primary energy need :

55.92 kWhpe/m².

(Calculation method : Experimental calculation method (China))

ENERGY CONSUMPTION

Economical building *Building*

< 50	A
51 à 90	B
91 à 150	C
151 à 230	D
231 à 330	E
331 à 450	F
> 450	G

Energy-intensive building

Building Type : Collective housing > 50m
Construction Year : 2019
Delivery year : 2023
Address 1 - street : 010000 ,
Climate zone : [Dfb] Humid Continental Mild Summer, Wet All Year

Net Floor Area : 165 520 m² Other
Construction/refurbishment cost : 1 334 000 000 ¥
Number of Dwelling : 820 Dwelling
Cost/m2 : 8059.45 ¥/ m ²

Certifications :

General information

This project is the first ultra-low energy residential building cluster in the extremely cold region that is heated without using fossil fuels, and it has explored a feasible technical path for achieving the dual carbon goals of residential buildings in extremely cold regions. The project has also achieved the green building design label with three stars and the platinum level of healthy building design standards, aiming to create a new era of technology-based demonstration project for low-energy, low-carbon emissions, green and healthy, comfortable and durable living. The project uses passive energy-saving technology and efficient active energy sources to control the building's operating energy consumption (excluding cooking and sockets) at 55.92 kWhep/m2/a, which is much lower than the national standard for ultra-low energy consumption limit of 65 kWhep/m2/a. The project was approved by the Ministry of Housing and Urban-Rural Development as a "Zero-carbon Building Technology Demonstration Project" in 2022, and only 5 such demonstration projects were approved nationwide, with this project being the only residential project. It participated in the 2021 China Building Science Conference in Tianjin, and the "National Spirit Shines in Hong Kong" theme exhibition, and was nominated for the 2021 Guangsha Award in Inner Mongolia. Based on the research output of the project, it has produced 12 national patents, 3 autonomous region work methods, 2 outstanding QC, 3 high-quality papers, and 2 standards, making positive contributions to promoting the high-quality development of the industry.

The technical measures of this project are as follows:

1. High-performance building envelope structure: The insulation thickness of the exterior walls and roof is 2.5 times that of conventional projects, with a U-value of 1.0 W/m2·K for the windows. The insulation and heat preservation performance of this project has been improved by about 45% compared to traditional buildings.
2. Well-designed air tightness: The project uses air tightness films, mortar, gypsum and other materials to strengthen the air tightness of openings and other parts. The N50 air tightness index of this project is about 40 times higher than that of conventional projects.
3. Thermal bridge-free design and construction: Fine thermal bridge-free design has been established, and a number of construction technology systems such as ultra-low energy consumption thermal bridge-free construction and embedded passive window installation have been created. 12 patents, 3 work methods, and 2 outstanding QC have been obtained through innovative construction processes.
4. Efficient ventilation and heating/cooling system: User-type ventilation and heat pump integrated machine is adopted, with a total heat recovery efficiency of 70%. The unit ensures a comfortable and healthy indoor environment with minimal energy consumption.
5. Utilization of renewable energy: Solar photovoltaic power generation system is installed on the roof, and the generated electricity is used for lighting in the underground garage. The electricity generated (using the example of Building 1) is 2.91 kWh/m2/a.
6. Other technical applications: Advanced technology systems such as direct drinking water system, healthy building and community, smart community, residential industrialization technology, aluminum film construction, and BIM technology are also applied.

The innovative technologies adopted in this project are as follows:

1. A complete set of key technologies for ultra-low energy consumption buildings suitable for extremely cold regions have been developed and successfully applied on a large scale, achieving a heating energy consumption savings rate of over 92% compared to buildings constructed in the 1980s. This project serves as a model for achieving the dual carbon goals of buildings in extremely cold regions.

2. For the first time in a residential project in an extremely cold region, municipal heating was eliminated and a clean energy heating system was implemented. The system consists of user-type ultra-low temperature air source heat pumps and carbon nanometer electric heating film backup heating systems, fully ensuring heating demand during extreme weather conditions. The system achieves high comfort guarantee for heating, personalized temperature control, and unrestricted heating time. At the same time, energy consumption, costs, and carbon emissions are significantly reduced, opening up a new path for low-carbon or zero-carbon heating in residential buildings in extremely cold regions.

Data reliability

3rd part certified

BIM approach

At the design stage of the project, BIM was mainly used to analyze the integrated pipelines in the basement to ensure that the net height of the pipelines meets the specifications and ensure aesthetics. Strict control of home access lines such as horse hall (front court of underground lobby) and net height of underground lobby has improved the comfort of space use.

Photo credit

Hohhot HaiWei Property Co.,Ltd.

Stakeholders

Contractor

Name :

Construction Manager

Name :

Stakeholders

Function : Developer

https://o.coli688.com/

Function : Thermal consultancy agency

http://www.cabr.com.cn/
The China Academy of Building Research team provided design and consulting services for the project. Among them, the Fu Shaopeng team provided construction drawings design for the project. The Gaocai Feng team of the Ultra-Low Energy Business Department o

Contracting method

General Contractor

Allocation of works contracts

Macro packages

If you had to do it again?

(1) At the hole openings of the wall pipes, it is necessary to add 50mm rock wool pipe insulation, which is an effective measure to reduce thermal bridges. This makes the hole opening diameter 100mm larger than the conventional opening diameter, which affects the structural design and window position design around the hole opening. The project team comprehensively considered the impact of these factors in advance and optimized the design many times to avoid structural defects and the impact of pipeline holes on the window openings around. The project is located in a severely cold area with high requirements for thermal bridge-free design. The consulting team preliminarily simulated and calculated the details of each thermal bridge in detail, coordinated the communication between various professionals, ensured that the local thermal bridge treatment met the standards, ensured the feasibility of construction, and avoided unnecessary rework.
(2) The original decoration drawings of the LED lights on the kitchen ceiling were designed to be installed in the center. Because the new fan unit needs to replace the filter element regularly, a maintenance door needs to be reserved. The size of the maintenance door is larger. If the construction is carried out according to the decoration drawings, the maintenance door cannot be opened. Therefore, the installation position of the lamp needs to be changed. During the construction drawing process, the project team needs to pre-review the drawings and circulate the drawings. At the drawing stage, foresee problems and solve problems. Pay attention to the sample first. Not only consider the feasibility of construction, but also the convenience of later maintenance.

Building users opinion

After the completion of the building, it received high praise from the market. Against the background of the downturn in the real estate market, the project sold 60% of 504 suites as soon as it opened. According to the feedback from the sample room operation, most of the time only the low gear of the heating function needs to be turned on. In winter, the heat pump heating is mainly used, and the backup system is almost unnecessary to start, which is economical. According to the describers, the indoor temperature and humidity in the project remain constant in winter and summer, the temperature distribution is uniform, there is no cold radiation from the outer windows, there is no condensation or mildew without thermal bridges indoors. The whole house has very good air tightness. In winter, there is no feeling of cold air penetration. When the windows are closed, the sound insulation effect of the room is very good. The new air system equipped with the building has a filter device. When someone smokes, it can automatically increase the air volume. At the same time, you can see that the PM2.5 value is decreasing and the overall air quality is good. Users' overall satisfaction with the indoor comfort, energy consumption level, green health performance, building roof and underground insulation, door and window construction quality, and neighborhood landscape of the building reached more than 98%.

Energy

Energy consumption

Primary energy need : 55,92 kWhpe/m^2.

Calculation method : Experimental calculation method (China)

Breakdown for energy consumption :
In terms of terminal energy consumption, according to the energy consumption calculation of the project, the total annual energy consumption of Buildings No. 1 and No. 2 is 21.28 kWh/(m2·a), and the total annual energy consumption of Buildings No. 2 and No. 3 is 22.05 kWh/(m2·a). The total annual energy consumption of Buildings No. 5, No. 6 and No. 7 is 21.53 kWh/(m2·a), and the total annual energy consumption of Buildings No. 11 and No. 12 is 21.19 kWh/(m2·a). The average energy consumption of all buildings in this project is 21.51 kWh/(m2·a), which is far below the limit of 25 kWh/(m2·a) for terminal electricity consumption in the ultra-low energy consumption national standard for buildings.

Envelope performance

Envelope U-Value : 0,14 $W.m^{-2}.K^{-1}$

More information :
The insulation thickness of the outer wall and roof of this project is about 2.5 times that of ordinary buildings. The overall building envelope adopts high air tightness and thermal bridge-free design.
(1) Outer wall
The insulation material of residential buildings No. 1, 5, 6, 7, 8, 11 and 12 of the project consists of 250mm graphite polyphenyl board and rock wool isolation belt. The insulation material of residential buildings No. 2 and 3 consists of 260mm graphite polyphenyl board and rock wool isolation belt. Rock wool fire barrier is installed, and the average heat transfer coefficient of the outer wall is 0.14 W/m2·K.
(2) Roof
The roof part adopts reinforced concrete 120mm + extruded polystyrene board 250mm, and rock wool fire barrier is installed. The average heat transfer coefficient is 0.14 W/m2·K.
(3) First floor slab
The first floor slab part adopts reinforced concrete 200mm + extruded polystyrene board 100mm, with an average heat transfer coefficient of 0.3 W/m2·K.
(4) Outer windows and doors
The outer windows and doors all adopt high-performance doors and windows. Aluminum-clad wood windows are used for outer windows. The opening mode of the opening sashes is inward opening. The glass is three glasses and two cavities: 5L+16Ar+5L+16Ar+6 Cesium Potassium (two layers of Low-E film are located on both sides of the inner cavity of the glass), and the spacer system is warm edge. The heat transfer coefficient is 1.0 W/m2·K.
The air tightness level of the outer window product is level 8.
The installation nodes of the outer windows are designed according to the thermal bridge-free installation method required for nearly zero energy buildings. They are manufactured and installed as a whole by the system door and window manufacturers with experience in implementing ultra-low energy zero-carbon buildings.
The SHGC value of the outer windows of this project is greater than or equal to 0.45 to ensure that as much outdoor radiation heat as possible is introduced into

the room in winter to reduce the indoor heating load, while not significantly increasing the summer cooling load.
The heat transfer coefficient of unit doors and outer doors is 1.2W/(m2·K), and the air tightness is level.
(5) Thermal bridge treatment
The outer wall insulation material of the project consists of 250mm to 260mm thick graphite polystyrene board and rock wool isolation belt, which realizes the maximum possible reduction of the heat transfer coefficient under the condition of limited total insulation thickness. Thermal break fixings are used on the outer wall. Sleeves and sufficient insulation gaps are reserved for pipe penetrations through the outer wall. All thermal bridge areas have been precisely and carefully treated.

Building Compactness Coefficient : 0,25

Indicator : n50

Air Tightness Value : 0,60

Real final energy consumption

Real final energy consumption/m2 : 21,51 kWhfe/m^2.

Renewables & systems

Systems

Heating system :

- Heat pump
- Electric heater

Hot water system :

- Other hot water system

Ventilation system :

- Natural ventilation
- Double flow

Renewable systems :

- Solar photovoltaic

Renewable energy production : 11,30

Solutions enhancing nature free gains :

This project adopts the performance-based design method, strictly controls the building envelope coefficient, window-wall ratio, and improves the lighting conditions of the building. First, in terms of building form, considering that the overall style of the park tends to be regular, orderly and rational, the design of this project adopts a layout form harmonious and unified with the overall form of the park, chooses a simple building form, and reduces the building type coefficient; secondly, by reducing the building depth and increasing open space, increasing the opening of north and south facades, the indoor lighting coefficient is improved; thirdly, the architectural design of the project strictly controls the window-wall ratio, and the window-wall ratios in the east, south, west and north are conducive to the energy saving goals. In the design process, while reducing the summer cooling load, as much radiation heat as possible is introduced in winter.

Smart Building

BMS :

Intelligent BMS inside the building
Air quality monitoring system: real-time monitoring and display of CO2 concentration, PM2.5 concentration and VOC concentration in indoor air.
The fresh air system is integrated into the fresh air heat pump unit.
Control of the fresh air system:
1. According to the indoor CO2, PM2.5 and VOC concentrations and indoor temperature, adjust the start and stop of the fresh air system equipment, fan speed and fresh air damper opening;
2. Set differential pressure sensors to detect changes in filter pressure drop and remind to replace filter cores;
3. Bypass valve control of fresh air heat recovery;
4. Provide a convenient human-machine interface with touch screen for automatic and manual control.
Sub-metering system:
The cold and hot sources, fresh air, lighting and socket electricity of the typical floors and typical households of all the buildings in the project have achieved sub-metering.
Intelligent management system for residential quarters (supplementary information)
The patrol system uses advanced automatic identification technology. During patrol work, the patrollers carry patrol devices with them. When they arrive at key places that need inspection, they check in at the patrol points on site, conduct on-site inspections and sign in, and automatically and accurately record the patrol time, location and conditions.
It is an electronic device for scientific and standardized management of the patrol inspection work of patrollers. The patrol system accesses the middle sea property management platform, which can realize functions such as viewing the patrol situation in real time through the patrol system mobile APP, and facilitate property management.
It is an effective and scientific management solution for security management in civil air defense and technology defense.

Users' opinion on the Smart Building functions :

The project adopts Caisson 2 in 1(heat recovery ventilation + heat pump) to provide cooling, heating and fresh air. The equipment has a user-friendly control

panel. Users can personally set and adjust the fresh air volume and indoor temperature. Users have a high satisfaction with the equipment control system.

Environment

Biodiversity approach

There are 189 plant species and 89 wild animal species commonly found in Hohhot and Greater Xing'an Mountains. Based on field surveys of parks, squares and road greening, this project analyzes the ecological connectivity and concludes that the plant distribution system is incomplete, the landscape diversity of plants is low, the number of fish and birds is small and urgently needs protection. Therefore, in the green space planning, various plants suitable for the residential quarters of this project are adapted.

There are a total of 29 species of plants and trees and several species of animals in the green space of this project. The green space plants should meet the requirements of urban and rural planning in the local area. Plants such as octagonal sun saxifrage, clustered sophora, ruby sun saxifrage and beauty plum can adapt to the climate and soil in Hohhot, and should be non-toxic, easy to maintain. The soil depth and drainage capacity in the planting area meet the plant growth needs and protect the local biodiversity.

Mitigation actions on soil and biodiversity :

The main soil and biodiversity protection measures of this project are as follows:

(1) During green festivals such as Arbor Day, the community actively carries out social education and publicity to enhance the importance of ecological diversity protection among community residents and reduce man-made damage as much as possible.

(2) There are no substandard or excessive gaseous, liquid or solid pollutants within the construction site of this project. Domestic sewage and wastewater are discharged into the urban sewer system without polluting the soil.

(3) Domestic waste should be classified and collected, the distribution of collection points should be reasonable, and the containers should be corrosion-resistant to prevent domestic waste from polluting the soil and destroying biodiversity.

(4) During the planning and design stage of the construction project, investigations should be carried out on the natural resources available on the site. The original topography and landform should be fully utilized for site design and building layout to minimize the amount of earth and stonework, reduce changes to the site and surrounding ecological environment during development and construction, including existing vegetation, water bodies, mountains, etc. The green space and green belt in the site are adapted to the urban ecological connection, which can break the ecological isolation island and is conducive to species survival and biodiversity protection.

Urban environment

The construction site of this project is located in the district of Miandi Town, Xincheng District, Hohhot City, Inner Mongolia. It is located east of Tianjiao Road, west of Qinyuan Road, south of Sanjing Road, and north of Fengzhou North Road. The project is located about 1 kilometer north of the North Second Ring Road in Xincheng District, Hohhot, Inner Mongolia Autonomous Region. It leans against the Greater Xing'an Mountains in the north and faces the East River in the east. The project has convenient public transportation and is about 4 kilometers away from the city government, about 5.5 kilometers away from Hohhot East Railway Station and about 11 kilometers away from the airport. There are several parks such as Genghis Khan Park and Beishan Park within 3 kilometers nearby. There are several bus stops near the project, such as Dingxiang Road North Entrance, Xingfuli and Runfu. There are various service facilities nearby, such as Rose Town Farmers Market, Miandi Town Agricultural and Sideline Products Wholesale Market, Industrial and Commercial Bank of China (Hohhot Shangdong Sub-branch), Rudong Fitness (Ziguangyuan Store) and Huamai Xiang (Rose Town Store).

The residential planning of the residential area is in the form of high-rise buildings facing due south, with a hundred-meter double-center garden landscape created in the south and north to ensure lighting while allowing more owners to enjoy the good landscape garden. All the residential buildings in the project meet the three-star green building and healthy building standards. This project creates an intelligent community. By configuring a variety of smart facilities such as perimeter alarms, license plate recognition, video surveillance, face recognition access control system, intercom, visitor system, sensor night lights, and one-button emergency call system, it provides meticulous care for the owners and protects the privacy and personal and property safety of the owners. At the same time, it brings more convenience and interaction to life.

Land plot area

Land plot area : 69 535,70 m^2

Green space

Green space : 36 090,00

Products

Product

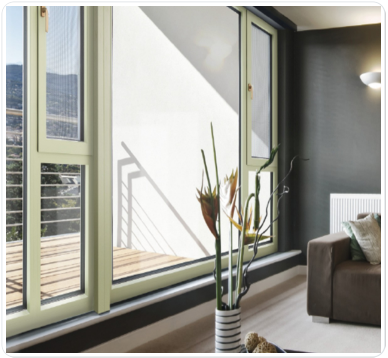
Zehnder

http://www.zehnder.com.c

Product category :

SAYYAS Passive Window

SAYYAS



http://www.sayyas.com

Product category :

SAYYAS Factory has applied for 300+ patents and is a leading wooden window enterprise in China with the most patents. It is a pioneer in the research and development of passive windows in China, and nearly 20 products have obtained PHI certification from Germany. The outer windows of this project adopt high-performance aluminum-clad wooden windows. The opening mode of the opening sash of the windows is inward opening inward. The glass is 5L+16Ar+5L+16Ar+6 cesium potassium (two layers of Low-E film are located on both sides of the inner cavity of the glass), with a warm edge spacer system, a heat transfer coefficient of 1.0 W/m2·K, an air tightness grade of 8, and a glass SHGC value of 0.45.

The design team believes that the outer windows are configured with multi-layer laminated glass and multi-layer sealant strips, which are strictly controlled layer by layer to achieve an extremely silent effect. More than 90% of argon is filled in the glass cavity, which, combined with LOW-E glass, improves the insulation performance of the outer windows. This window type meets the requirements of ultra-low energy consumption buildings for the k value, SHGC value, air tightness, water tightness and wind pressure resistance level of outer windows.
Construction workers believe that passive windows are heavy, and frame embedded installation can reduce safety risks.
Users believe that the sound insulation and thermal insulation performance of these outer windows are good. There is no condensation on the indoor side, and in winter, the glass does not feel freezing when touched from the indoor side.

SIGA airtight membrane materials

SIGA

https://www.siga.cn/

Product category :

SIGA high-performance waterproof and vapor-permeable adhesive tape is suitable for the outdoor side of door and window openings. It can be directly plastered and quickly adhered to window frames without adhesive to achieve 100% airtight adhesion. It has a perforated nonwoven fabric, suitable for plastering, and plastering is easier to adhere to masonry structures. The Sd value (equivalent diffusion air layer thickness) is 2 m and the tensile strength is 210 N/50mm 220.
SIGA high-performance waterproof and vapor barrier adhesive tape is suitable for the outdoor side of door and window openings. It can be directly plastered and quickly adhered to window frames without adhesive to achieve 100% airtight adhesion. It has a perforated nonwoven fabric, suitable for plastering, and plastering is easier to adhere to masonry structures. The Sd value (equivalent diffusion air layer thickness) is 20 m and the tensile strength is 220 N/50mm 220.

The design team believes that the waterproof vapor-permeable membrane and waterproof vapor barrier membrane Sd values of this product meet the design requirements.
Construction workers believe that the airtight adhesive tape has strong adhesion during construction and is easy to plaster in subsequent decoration work.
Users believe that this product belongs to concealed materials and cannot feel its effect separately to evaluate it separately, but the whole house feels well sealed with no air leakage. Fresh air is mainly provided by the fresh air heat recovery unit.

Carbon Nanotube Electric Heating Film

https://www.hnnabo.com/

Product category :

Carbon nanotubes are one-dimensional nanocarbon materials with excellent conductivity, thermal conductivity and high-efficiency electrothermal conversion efficiency. The nanoelectric heating film adopts carbon nanotube surface heat source patented technology and is laid in non-furniture floor areas. In the case of extremely low temperatures in winter, the electric heating film can be started to assist in heating, which can quickly increase the room temperature and improve comfort. The electric heating film transfers heat in the form of infrared radiation with a conversion efficiency of up to 83% (72% for hospital physiotherapy equipment).

The design team believes that this product can provide an additional reliable heating source when the air source heat pump heating is insufficient in extremely cold areas to ensure comfort during the heating season.
Users believe that this product adds an extra insurance for heating in winter. The heating is comfortable and reliable. Because of its high heat transfer efficiency, the electricity bill is not as high as imagined.

Dongbang Fireproof Passive Door

http://www.dongbanglvjiankeji.com

Product category :

The passive door is grade B fireproof with a thermal conductivity k value of 1.2 W/m2k and an air tightness grade of level 8.

The design team believes that this product can ensure the airtightness of buildings in extremely cold areas and reduce cold air penetration.
Construction workers believe that this product is sturdy and stable, but a little labor-intensive to install.
Users believe that the passive door has good sealing and sound insulation performance, but it is a little labor-intensive to open or close.

Costs

Construction and exploitation costs

Renewable energy systems cost : 1 400 000,00 ¥

Cost of studies : 20 973 000 ¥

Total cost of the building : 1 334 000 000 ¥

Subsidies : 73 700 000 ¥

Energy bill

Forecasted energy bill/year : 1 415 000,00 ¥

Real energy cost/m2 : 8.55

Real energy cost/Dwelling : 1725.61

Circular Economy

Reuse : same function or different function

For each batch : Reused Materials / Products / Equipments :

The recyclable materials used in this project mainly include steel bars, copper, aluminum profiles, glass, gypsum, wood flooring, etc. The cost of recyclable materials accounts for about 4.9% of the total cost.

Environmental assessment

Impacts avoided : water, waste, CO2 :

The recyclable materials used in this project mainly include steel bars, copper, aluminum profiles, glass, gypsum, wood flooring, etc. The recycling of these materials can greatly reduce carbon emissions. According to preliminary statistics, the reduced carbon emissions can reach 23,600 tons.

More details on the avoided impacts :

Before the construction of this project, the project site was wasteland. As a new project, it was unable to obtain usable waste materials that meet the performance requirements on the original site. However, about 5% of the building materials used in this project are recyclable.

Recyclable materials refer to civil and decorative building materials that can be recycled by changing their physical form, such as steel bars, copper, aluminum profiles, glass, gypsum, wood flooring, etc. In the process of project construction, a lot of building materials will be involved, and the quality of materials is directly related to the final completion effect of the project, and also affects the reuse possibility of the materials themselves. Therefore, controlling the quality of recyclable building materials is critical and can effectively improve project management quality, fully reduce unnecessary waste in project construction, and maximize benefits.

The management methods adopted in this project mainly include:

1) Improve the management awareness of building materials in the project, arrange professional management personnel to personally manage. On the one hand, scientifically classify and arrange various building materials according to their usage. On the other hand, choose appropriate storage environments for building materials. Building materials need to be arranged by special personnel. The materials entering the warehouse should be classified and stacked in designated locations according to their models and varieties according to the construction organization plane layout diagram, numbered and marked flammable and explosive materials should be stored separately, and there are strict fire prevention and explosion prevention measures. Inventory materials with a shelf life should be regularly checked to prevent expiration and properly marked. Materials with moisture-proof requirements should take moisture-proof measures and proper markings.

2) Standardize material procurement. Formulate a detailed procurement list to clarify the performance parameters and prices of procured materials. The material department and the project department established a detailed material model database. When reporting materials, the project department management personnel compare the specifications of materials with the database. New materials are promptly added to the database. All materials in the database indicate construction scope, material usage costs and other information. This not only solves the shortcoming that on-site management personnel are not familiar with material models, but also gives on-site management personnel a clearer understanding of project costs.

3) Formulate and improve building materials management systems. Clarify the management methods and ways of building materials and improve the management level.

Economic assessment

Total cost of reuse : 40 264 000 ¥

Communication

Project visit : Yes

Social economy

Social economy and professional integration :

This project provides an ultra-low energy consumption, green building, and healthy building professional integration solution for large-scale residential buildings in extremely cold areas. On the basis of greatly reducing building energy consumption, it creates a healthy and comfortable five constants system: constant oxygen, constant quiet, constant cleanliness, constant temperature and constant humidity. It studies the refined construction methods and techniques in the ultra-low energy consumption building technology system.

As the first large-scale ultra-low energy consumption, green building and healthy building cluster demonstration project in extremely cold areas, this project integrates and applies high-performance building envelope technology, efficient energy system technology, efficient fresh air heat recovery technology, high air tightness and thermal bridge-free technology suitable for extremely cold areas. It has successfully built the first large-scale green, healthy and low-carbon residential building park in extremely cold areas.

During the construction process, the project was implemented strictly in accordance with the standards of three authoritative certifications. The design, construction and material selection were implemented according to high standards. Its building materials and decoration materials used a large amount of recyclable materials, providing research samples and practical cases for studying low-carbon high-level green building technology systems in extremely cold areas. It opens up new channels for extremely cold areas to respond to the call for "double carbon" in China's construction industry and promote the large-scale development and development of low-carbon and zero-carbon heating for residential buildings.

At the same time, the promotion of such high-quality buildings brings a lot of demand for high-performance building products, materials and components, which can effectively promote the transformation of the construction industry towards high-quality development, and quickly drive the industry output value, creating new economic growth points for enterprises. Rough estimates show that promoting such buildings in Inner Mongolia can drive the development of dozens of high-quality building component manufacturers, with an annual industry output value of hundreds of millions of yuan. On the basis of controllable costs, it is of great significance to promote industrial upgrading and drive industry output value.

Health and comfort

Water management

Consumption from water network : 160 000,00 m^3

Consumption of harvested rainwater : 1 830,00 m^3

Water Self Sufficiency Index : 0.01
Water Consumption/m2 : 0.97
Water Consumption/Dwelling : 195.12

Comfort

Health & comfort :

The indoor fresh air unit has an automatic dehumidification function. Independent humidifiers are used in each room as needed to maintain indoor humidity between 30% and 70%.

The indoor thermal and humid environment evaluation level is Level II. The estimated average thermal sensation index (PMV) in winter is -0.932 to -0.875, and in summer it is -0.752 to -0.501. The estimated percentage of dissatisfied people (PPD) in winter is <21.9% and in summer <22%. The estimated adaptive average thermal sensation index (APMV) for the human body is -0.638 to -0.120. It meets the limit value of the Level II standard for the overall evaluation of the indoor artificial cold and heat source thermal and humid environment.

When the building heating and air conditioning are adjusted, the local dissatisfaction rate (LPD1) caused by cold air blows in winter is 1.5% to 3.1%, in summer it is 0%. The local dissatisfaction rate (LPD2) caused by vertical temperature difference is <1%. The local dissatisfaction rate (LPD3) caused by floor surface temperature in winter is 6% to 7.2% and in summer is 6.2% to 8%. They all meet the limit value of Level I standard for local evaluation of indoor artificial cold and heat source thermal and humid environment.

The project is equipped with fresh air heat pump units to meet the needs of indoor fresh air, summer cooling and winter heating. The unit itself has a total heat recovery device with a sensible heat recovery efficiency ≥75%. In the heating and cooling seasons, fresh air is provided through the unit for ventilation.

The household types in the project are open and penetrating from north to south, and the main functional rooms have outer windows. In the transition season when the integrated unit is not turned on, natural ventilation can be achieved by opening windows to meet the indoor thermal and humid environment as well as human comfort.

Acoustic comfort :

The outer envelope structure of the project has a 250mm graphite polystyrene insulation layer, high-performance doors and windows, and high air tightness design to effectively isolate outdoor noise. The indoor integrated unit is arranged in the kitchen ceiling with shock absorbers. Soft connectors are used for air ducts to effectively reduce equipment noise.

According to calculation, the sum of the weighted sound insulation amount and the traffic noise spectrum correction amount of the outer wall is greater than 53.5dB, and the sum of the weighted sound insulation amount and the traffic noise spectrum correction amount of the living room outer windows is 33.7 dB, which is significantly better than conventional buildings.

Between the households, the structure layer has two layers of 15mm expanded glass microbeads insulation mortar respectively, and the sum of the weighted sound insulation amount and spectrum correction amount of the partition wall is 48dB. The floor slab is equipped with 20mm extruded polystyrene insulation board and 5m thick shock-absorbing pad. The sum of the weighted sound insulation amount and pink noise spectrum correction amount of the floor slab is 51dB, and the weighted normalized impact sound pressure level is less than 63 dB, which is significantly better than conventional buildings.

The indoor integrated unit is installed in the kitchen ceiling away from the main rooms. High-efficiency and low-noise equipment is used with shock absorbers. Suspended air-conditioning units and fans all use elastic supports and suspension frames. Flexible connections are installed at the connecting points of air ducts and equipment. Equipment rooms such as fire pump rooms, sewage pump rooms and air-conditioning equipment rooms are set up in the basement. Appropriate sound insulation, noise reduction and vibration reduction measures have been taken for equipment with large vibrations and noise such as fans and pumps. Therefore, the impact of this noise source is not obvious.

According to calculation, considering the effective sound insulation of the combined wall under the conditions of sound insulation at low frequency, medium frequency and high frequency, combined with the consideration of indoor sound absorption and the analysis of the influence of indoor air conditioning noise, it is known that: The noise value of this project during the day is 57.1dB, and the night noise value is 48.8dB. Due to the good sound insulation performance of the rooms in the project, the indoor noise value of the project during the day with the windows closed is 29.9 dB(A), and the night noise value with the windows closed is 28.4dB(A). The environmental noise value of this project is greater than the standard limit of Category I acoustic environment functional area and less than or equal to the standard limit of Category III acoustic environment functional area.

Visual comfort :

The bedrooms, living rooms and kitchens in this project have direct natural lighting. At least one living space in each household meets the daylighting standard requirements. The outdoor public area lighting LED has multiple lenses to meet the requirements of different road conditions.

The main functional rooms of this project, including living rooms, bedrooms and kitchens, have windows. The SHGC value of the outer window glass is ≥0.45, the visible light transmittance is high, and the indoor lighting effect is good.

According to the simulation analysis results of the indoor light environment, the proportion of areas where the daylighting illuminance values in the main functional areas of the standard household types A, B, C and D are not less than 300lx for an average of no less than 4h/d are 97.5%, 97.2%, 97.1% and 93.3% respectively. The indoor natural lighting conditions are good.

The indoor artificial lighting of this project adopts high-efficiency and energy-saving light sources. By controlling various indoor lighting parameters, a comfortable and healthy lighting environment is obtained indoors, which is conducive to regulating the mood of users and improving the health of the space environment. The color temperature of the main indoor light sources in the project is 4000K, the general color rendering index is 80, the special color rendering index R9>0, the color tolerance of light sources is ≤5 SDCM, the lighting flicker ratio is ≤6, and the photobiological safety group of lighting products does not exceed RG0.

The design illuminance of the living room is 100LX, that of the bedroom is 75LX, that of the dining room is 150LX, and that of the kitchen and bathroom is 100LX. The average illuminance of the indoor walls is ≥50LX, and the average ceiling illuminance is ≥30LX. The lighting power density of each room meets the target value requirements.

Ergonomic design :

The layout, handle and showerhead design of the bathrooms in the project are reasonable. This project has carefully considered the space layout of the bathrooms. The shower room is equipped with safety handles and the height of the showerhead can be freely adjusted.

The activity space in front of the washbasin is not less than 700mm wide and 500mm deep. The activity space in front of the toilet is not less than 700mm wide and 350mm deep. It can effectively ensure comfort during use.

Quality of life and services

The community is equipped with leisure spaces across the border. The site has barrier-free access to meet the needs of people of all ages. Activity sites avoid sharp protrusions and are equipped with areas for the elderly and children's activity areas.

The project reasonably sets up outdoor communication places and children's playgrounds. The project has set up two children's playgrounds. An Ice and Snow Wonderland Playground is set up near Building 2, and a Magic Block Playground is set up between Buildings 6, 7 and 8. The Ice and Snow Wonderland Playground is equipped with large children's recreational facilities such as gyroscopes, rocking horses, interesting walls, etc. for children to play in the venue. Seats for no less than 6 people are set up in both playgrounds. Trees such as white wax and sun plum are planted around the playgrounds to provide shade for the venues.

The daylighting time of the two children's playgrounds on the coldest day of the year is 2 to 5 hours, meeting the daylighting standard requirement of no less than 2 hours per day. The barrier-free design of the site and buildings meets the requirements of the current national standard "Barrier-free Design Specifications" GB 50763. The activity areas for the elderly are flat, and the surrounding areas are flat or sloping, with a slope of within 0.5%. Wheelchair parking areas are also provided.

The project reasonably sets up outdoor fitness areas and fitness trails. On the east side of Building 1, a football field is set up. On the west side of Building 1, a badminton court is set up. On the east side of Building 3, a basketball court is set up to provide outdoor fitness and activity venues for teenagers and middle-aged people. On the north side of Building 5 and the west side of Building 7, interesting mazes and hopscotch sandbag venues are set up respectively to provide outdoor fitness activities for teenagers.

A 663.53m long and 1.25m wide fitness trail is set up around the project site. The pavement material is red EPDM plastic pavement and anti-slip hot-melt paint lines. The length of the runway accounts for 61.7% of the total length of the red lines. The fitness trail signs include slow down tips, mileage tips, fitness slogans, etc. marked with anti-slip hot-melt paint lines.

The project sets up outdoor communication places such as secondary entrance corridors, reception hall corridors, main entrance opposite leisure spaces, Tree Array Square One, Tree Array Square Two, leisure platforms, etc., with a total area of 1,013.32 square meters, accounting for not less than 0.2% of the total land area. Each communication platform is equipped with seats, benches or rattan sofas for more than 10 people.

Each building is equipped with 1 to 2 barrier-free elevators with a complete barrier-free system.

Anti-slip tiles are paved on all floors of the project.

The signs are obvious and complete. Large font signs indicating floor number and unit number are installed outside the lobby on the first basement floor of the building. Arrow signs indicating routes to specific places and facilities are installed at the main and secondary entrances of the park and important road junctions. Large metal signboards with embedded or wall-mounted large fonts are installed in conspicuous locations relative to the elderly activity areas, leisure areas, civil air defense stairway entrances, etc. Embedded large-font safety warning signs are placed in the main entrance water feature area, central axis leisure space water feature area, all step areas in the park, elderly activity areas, charging piles and distribution boxes. Considerate signs are placed in lawn planting areas.

*There are no sharp protrusions on the walls of public areas and rooms for the elderly in the building, meeting the needs of the elderly for safe and convenient movement.

Carbon

General infos

(1) Building Energy Conservation Planning and Design

1) Building Form Selection

In terms of building form, considering that the overall style of the park tends to be regular, orderly and rational, the layout form of this project is harmoniously unified with the overall form of the park during design. While choosing a simple building form that is conducive to the design of ultra-low energy consumption building nodes, the shape coefficient is reduced.

2) Natural Lighting and Ventilation

The overall planning of the building complex where the project is located considers the reasonable use of natural ventilation and creates a suitable microclimate. The building complex faces south, so that natural ventilation can be effectively utilized in summer and transition seasons.

Through the careful design of the surrounding landscape greening of the building, the amplification coefficient of the local wind speed in the pedestrian area between the buildings is effectively reduced, avoiding the feeling of cold wind blowing in winter, and forming a comfortable shady area under the trees in summer.

The indoor plane layout of the single building fully considers the effective use of natural ventilation, and the positions of doors and windows are reasonably arranged to facilitate the formation of through ventilation indoors, thereby effectively reducing air conditioning energy consumption in summer and transition seasons.

By reducing the depth of the building, increasing open space, increasing the number of windows on the south and north facades, and improving the indoor lighting coefficient, the parametric design method is applied. Design optimization is achieved through interactive simulation calculation and form design.

3) Shape Coefficient Control and Window-Wall Ratio Control

The architectural design of the project strictly controls the window-wall ratio. The window-wall ratios of the east, south, west and north are in line with the relevant requirements of the current residential building energy conservation design standards. In the design process, the introduction of radiant heat in winter is maximized while reducing the cooling load in summer.

(2) Low-carbon Technology of Envelope Structure

The insulation materials of residential buildings No.1, 5, 6, 7, 8, 11 and 12 of this project are composed of 250mm graphite polystyrene board and rock wool isolation tape. The insulation materials of residential buildings No.2 and 3 are composed of 260mm graphite polystyrene board and rock wool isolation tape. Under the condition of limited overall insulation thickness, the outer wall heat transfer coefficient is minimized as much as possible by selecting insulation materials with excellent performance parameters. It fully meets the index requirements of ultra-low energy consumption residential buildings in extremely cold climate zones in the "Near Zero Energy Building Technical Standard" GB/T51350-2019. High-performance doors and windows are used for outer windows and outer doors. Anti-thermal bridge and airtightness designs were carried out for key nodes.

The heat transfer coefficient of the outer windows of the project is 0.14 W/(m2·K), the heat transfer coefficient of the roof is 0.14 W/(m2·K), the heat transfer coefficient of the outer windows is 1.0 W/(m2·K), the SHGC value is 0.45, the heat transfer coefficient of the basement top plate is 0.3 W/(m2·K), the heat transfer coefficient of the partition floor slab is 0.8 W/(m2·K), the heat transfer coefficient of the stairwell partition wall is 1.01 W/(m2·K), the heat transfer coefficient of the partition wall is 0.98 W/(m2·K), the heat transfer coefficient of the unit door is 1.2 W/(m2·K), and the heat transfer coefficient of the household door is 1.3 W/(m2·K).

The construction drawings clearly mark the position of the airtight layer. The airtight layer is continuous and surrounds the entire building envelope. Simple shapes and node designs are used to reduce or avoid nodes that are difficult to handle airtightly. Outer doors and windows with high airtightness grades are selected. Components such as plastering layer, hard material boards (such as density boards, stone materials) and airtight films are used to form airtight layers. Suitable airtight materials are selected for node airtightness treatment, such as compact and complete concrete, airtight films, special expansion sealing strips, and special airtight coating materials. Node designs are carried out for parts that are prone to airtightness problems, such as door openings, window openings, electrical wiring boxes, and piping penetrations.

(3) High-Efficiency Heat Recovery Fresh Air System

The system uses sensible heat recovery devices with a total heat recovery efficiency of more than 70%. The power consumption of the heat recovery unit per unit air volume does not exceed 0.45W/(m3/h).

Fresh air ducts are installed with fresh air electric preheaters. When the outdoor temperature is lower than -5°C, the fresh air preheater starts up. Its output power is automatically adjusted proportionally between 0W and the maximum power (PID) to control the preheated fresh air temperature to -5°C, maximizing power saving and comfort for users.

(4) Ventilation Measures for Kitchens and Bathrooms

The exhaust and ventilation of the kitchen are independently controlled systems. The exhaust is discharged to the outside by the fume hood. Ventilation holes and electric control valves are installed on the outer wall of the kitchen. The valve and fume hood are interlocked. Usually closed, when the exhaust is turned on, the valve is interlocked to open, the ventilation hole is opened to achieve kitchen ventilation. When the kitchen exhaust and ventilation system are working, the kitchen door is closed to have no impact on room temperature and air volume.

The exhaust outlet of the fresh air exchanger in the room is set in the bathroom. After energy recovery, it is discharged outside to meet the bathroom exhaust.

(5) Cold and Heat Sources and System Forms of HVAC

A heat recovery fresh air system with cold and heat sources is used. Each household is equipped with a set of fresh air heat pump integrated machine equipped with an ultra-low temperature air source heat pump to meet the cooling and heating load requirements of the room all year round. The unit has an EER≥2.5 in cooling mode and a COP≥2.0 in heating mode. According to the test, when the outdoor temperature is -20°C, the COP of the unit is 1.69. The unit is controlled according to the indoor temperature to meet the indoor temperature requirements.

To prevent the efficiency decrease or unit failure of the cold and heat source fresh air integrated machine in extreme weather conditions in winter, this project has designed a carbon nanotube electric heating system that can utilize renewable energy power generation as a backup system.

The project uses only electricity to meet the heating and cooling needs of the building, exploring the feasibility of building energy independence from fossil fuels, and pioneering the transformation of large-scale residential building heating in extremely cold areas to clean energy.

(6) Lighting and Other Energy-saving Technologies

(1) The lighting design of this project complies with the requirements of lighting power density and illuminance in the "Standards for Building Lighting Equipment" GB50034-2013. The lighting power density of the main rooms is lower than the standard target value.

The standard illuminance of living rooms is 100 lx, bedrooms 75 lx, dining rooms 150 lx, kitchens 150 lx, and bathrooms 100 lx. The lighting power density of all rooms is ≤5 w/m2, which is 16.7% lower than that of conventional buildings (6W/m2).

(2) All light sources in this project adopt high-efficiency and energy-saving light sources. High-efficiency and energy-saving lighting devices (light sources, luminaires and accessories) and energy-saving control measures are used for the lighting of indoor public places such as staircases and corridors. Delay switches with sound and light control functions are selected in elevator halls, staircases, public corridors and other places.

(3) Natural lighting measures: The orientation of the building itself complies with the best orientation for natural lighting in the local area. As large outer windows as possible are used to improve the indoor lighting coefficient, subject to meeting the specifications and energy-saving indicators.

(4) Elevators: Products with energy-saving dragging and energy-saving control methods are used. They have linkage or group control functions when there are multiple elevators. The elevators should also have sleep functions.

(5) High-efficiency and energy-saving products such as water pumps and fans are used, and measures such as variable frequency control are taken to save electricity.

(7) Monitoring and Control

Each household in this project is equipped with an electric meter. Electric meters that can be used for energy management are installed in public parts. Air conditioning, lighting and socket electricity metering items are set up in typical floors and typical household types.

HVAC equipment control:

The system adopts variable air volume control mode. The outdoor unit uses a variable frequency compressor. Indoors, a thermostat and CO2 detector are installed. According to the return air temperature, CO2 concentration, etc., the start and stop and air volume of the unit and fresh air are controlled. All air outlets are electrically adjustable louvers.

(8) Renewable Energy Utilization Technology

To make full use of renewable energy, the project has installed a solar photovoltaic power generation system on the roof.

The power station capacity of Buildings #1 and #8 is 28.16KWp, consisting of 88 pieces of 320Wp monocrystalline silicon components and connected to 1 set of 30kw inverter with an annual power generation of 39,424 kWh.

The power station capacity of Buildings #2 and #3 is 17.28KWp, consisting of 54 pieces of 320Wp monocrystalline silicon components and connected to 1 set of 20kw inverter with an annual power generation of 24,192 kWh.

The power station capacity of Buildings #5, #6 and #7 is 25.6KWp, consisting of 80 pieces of 320Wp monocrystalline silicon components and connected to 1 set of 25kw inverter with an annual power generation of 35,840 kWh.

The power station capacity of Buildings #11 and #12 is 17.28KWp, consisting of 54 pieces of 320Wp monocrystalline silicon components and connected to 1 set of 20kw inverter with an annual power generation of 24,192 kWh.

The total capacity of 9 buildings is 204.24KWp with an annual total power generation of 283,100kWh. The generated electricity is used for the lighting of the underground garage.

Carbon sink

This project only calculates the carbon sink of green space. The national standard GB/T 51366-2019 "Standard for Calculating Carbon Emissions from Buildings" does not provide a carbon sequestration factor for green space. The calculation of green space carbon sinks in this project is based on the "Guidelines for Calculating Carbon Emissions from Buildings" issued by the Guangdong Provincial Department of Housing and Urban-Rural Development and the "Report on Analysis of Carbon Emissions from Buildings (Template)" issued by the Chongqing Municipal Commission of Housing and Urban-Rural Development. The green space carbon sequestration factor Cp is 1.1606 kgCO2/m2/a. The green space area of this project is 36,090 m2. Considering a building service life of 50 years, the green space carbon sink of this project is about 12.77 kg CO2/m2 (this area refers to per square meter of building area), the total annual carbon sink is about 42 tons of CO2, and the cumulative carbon sink in 50 years is about 2,100 tons of CO2.

Initiatives promoting low-carbon mobility

The main transportation mode advocated by Heshang Daguangto serve people. It should not only meet the basic travel needs of residents, but also meet the needs of residents to choose the way they travel., and reduce the negative impact of travel to a minimum. A good road traffic system must be efficient, safe, comfortable, convenient and punctual. It does not sacrifice the "quality" of travel to meet the "quantity" of travel. Bicycle sheds are advocated and provided. Non-motor vehicle sheds and charging piles are set up at the main and secondary entrances respectively, so that property owners can travel easily and conveniently. The planning of the park adopts the concept of separating people and vehicles, and the centralized management of nearby parking. An efficient green transportation system should meet the needs of residents to choose various modes of transportation. For short-distance travel, residents can solve it by walking

and cycling. For long-distance travel, they can solve it through public transportation, rail transit, taxis and other means.

GHG emissions

GHG in use : 19,02 $KgCO_2/m^2$/

Methodology used :

The calculation of carbon emissions during the operation of this project is based on the "Standard for Calculating Carbon Emissions from Buildings" GB/T 51366-2019. The scope of carbon emissions calculation during the operation stage of the building includes carbon emissions from HVAC, domestic hot water, lighting and elevators, renewable energy, and building carbon sinks during the operation of the building. The carbon emission factor is 0.8843 kgCO2/kWh, and the design service life of the building is 50 years.

According to the calculation, the carbon emissions during the operation of Buildings #1 and #8 are 940.90 Kg CO2/m2. The carbon emissions during the operation of Buildings #2 and #3 are 974.94 Kg CO2/m2. The carbon emissions during the operation of Buildings #5, #6 and #7 are 951.95 Kg CO2/m2. The carbon emissions during the operation of Buildings #11 and #12 are 936.92 Kg CO2/m2. The total carbon emissions during the operation of the project are 2505.77 tons of CO2/year. The average carbon emissions during the operation of residential buildings in northern cities in China in 2015 were 3,737.5 Kg CO2/m2 (Xu Wei, et al., "Decomposition and Path Analysis of Carbon Peak and Carbon Neutrality Targets for Buildings in China"). The average carbon emissions during the operation of this project are 951 Kg CO2/m2, 74.6% lower than the average level in the north.

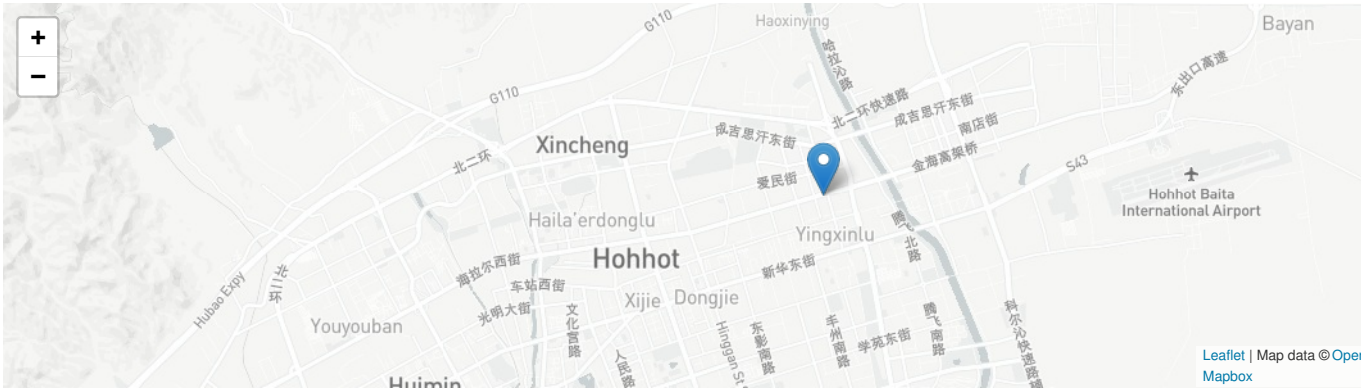
GHG before use : 255,80 $KgCO_2$ /m^2

Building lifetime : 50,00

, ie xx in use years : 13.45

GHG Cradle to Grave : 1 206,60 $KgCO_2$ /m^2

"Standard for Calculating Carbon Emissions from Buildings" GB/T 51366-2019



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