让我们共同打造气候中和的未来
Building a climate-neutral future together

Sino-Swiss Cooperation on Zero Emissions Building

Zero Emissions Building Demonstration Project Report

Taixing Development Zone Waterworks Phase II

ENGLISH VERSION

MARCH 2024

中华人民共和国
住房和城乡建设部

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC

IBEE 环能科技 intep skat

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Building a climate-neutral future together

This report has been produced within the framework Sino-Swiss Zero Emissions Building Project; an international collaboration funded by the Swiss Agency for Development and Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development.

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The Sino-Swiss Zero Emissions Building Project is an international collaboration funded by the Swiss Agency for Development Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development. The project aims to reduce greenhouse gas emissions and enable carbon neural development of the building sector in China by sharing Swiss know-how on sustainable and zero emission building.

Implementation partners:

Intep Integrated Planning

Skat Consulting

China Academy of Building Research

WeChat:

Web:
zeb-china.org

Cover image: Taixing Development Zone Waterworks Phase II

Contents

Executive summary

The Taixing City Development Zone Water Treatment Plant Phase II Comprehensive Building Project is one of the second batch of demonstration projects of the Sino-Swiss ZEB Programme. The Taixing demonstration project is located in Taixing City, Jiangsu Province, and the complex is situated in the vicinity of the Taixing Water Supply Plant. The core of the design is to make effective use of the water supply facilities in the area, with the aim of improving the building' s energy efficiency in terms of heating, cooling and power supply. In response to the hot summer and cold winter climate, the project has specifically developed four core strategies and a fusion of technology and spatial design. The total floor area of the project is approximately 2' 687.35 square metres, and it is proposed that a series of low-carbon technological measures will make the project a model zero-emission complex (office, dormitory and canteen) in the hot summer and cold winter regions of China.

1. PROJECT BACKGROUND

1.1. About the Sino-Swiss ZEB Project

To jointly address global climate change and to strengthen cooperation between China and Switzerland in the field of emissions reduction in the construction industry, the Ministry of Housing and Urban-Rural Development of the People' s

Republic of China and the Swiss Federal Ministry of Foreign Affairs signed a Memorandum of Understanding (MoU) on 24 November 2020. The Memorandum focuses on fostering international cooperation in the field of building energy efficiency. Within the framework of this MoU, the Swiss Agency for Development and Cooperation (SDC) initiated and funded the Sino-Swiss Zero Emission Building (ZEB) Project. The project aims to support China in formulating the technical standard for zero carbon buildings and long-term roadmaps for reducing carbon emissions in the construction industry. Switzerland contributes by sharing know-how, showcasing demonstration projects of zero emission buildings in four different climate zones, and carrying out various forms of capacity building activities to promote the carbon-neutral development of China' s construction industry.

Duration of Sino-Swiss ZEB China Project:

Phase I: 15. Mar. 2021 – 28. Feb. 2025

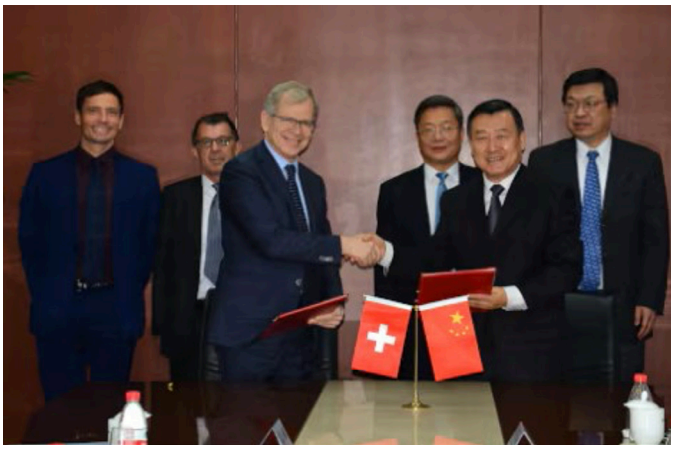


Figure 1. Ambassador Bernardino Regazzoni and Vice Minister Ni Hong, sign the project agreement. Image: Swiss Embassy in Beijing

Project Purposes:

- Upgrading existing building energy efficiency standards to Zero Carbon technical Standards
- Implementing demonstration projects (DP) in four typical climate zones to test the new ZEB standards and finding potential for optimization
- ZEB capacity building and knowledge dissemination

Project impact on climate protection:

Reduce CO2 emissions in China' s building sector.

1.2. Selecting of demo project

Demo project goals:

- To reach the requirements of China' s national technical standards for zero carbon buildings.
- To serve as case study to guide and educate more projects in achieving the ZEB standard

Evaluation committee and selection process:

- CABR collected applications for potential demonstration projects by an official call.
- Prior to the evaluation of applications, a project presentation with Q&A was held, in which Chinese and Swiss experts participated.
- A separate evaluation based on selection criteria was carried out by Chinese and Swiss experts.
- With Sino-Swiss joint feedback and recommendations, Mohurd announced the selected demo projects.

Selection criteria:

- ELIGIBILITY CRITERIA: Political commitment, Funding commitment, Possibility of intervention, Potential for affordability and replicability, Visibility and Accessibility, Diversity
- RATING CRITERIA (Evaluation Weight): CO2 emissions reduction potential and other environmental benefits (40%), Number of beneficiaries (20%), Lighthouse potential (20%), Incentives by local government (20%)
- PILOT- PROJECT SUITABILITY (1st Batch): Quick-Starter, Compatibility with Draft ZEB-Standards, Pilot Characteristics, Availability of Data

Selection time:

March 2022

Selection justification:

Potential for designing and technical improvement, as well as emission reduction:

- This is a solid, well thought out project with good multiplicability. Based on exiting good ideas in energy solution concept, the project can be surely optimized well.
- Even though the construction is scheduled to start in April 2023, the plan-ning team shows flexibility and possibility to adjust the construction schedule for receiving Swiss inputs.
- Good possibility to integrate energy solutions like PVs and shading on the roof and facade.
- Well managed air circulation in the building center and through the corridor between the building parts as well as the windows.
- Considered embodied energy with selecting low-carbon materials and prefabricated construction.
- The architectural geometry (either the whole building or each building unit) could be more compact, in order to avoid too much cold/warm bridges.

Possible inputs for improvement of Swiss experts:

- Suggestion on improving the building geometry more compact, with special advisory by Swiss architects who with strong experience in ZEB Design
- Optimizing the selection and combination of the energy solutions
- Support on precision of the energy and ession calculations, especially with consulting and monitoring by Swiss ZEB standards- and calculation expert
- Suggestion on the material selection and circular construction for saving embodied energy, with special support by Swiss team

1.3. Working process

Sino-Swiss team:

The Sino-Swiss expert team is composed of Swiss and Chinese specialists. The Chinese DP team first proposed design prototypes and zero-carbon design strategies. After reviewing the design features of the project, the Sino-Swiss expert team gave tailored feedback to the design team on the design prototype and strategical concept, which the design team will integrate as they adapt the project. The Swiss team also arranged webinars to exchange on specific zero-carbon topics based on the questions from the DP team. The ideas contributed by the Swiss experts are based on their international experience from Switzerland, Europe, and other similar climate zones around the world.

The goal of Sino-Swiss cooperation:

The goal of Sino-Swiss cooperation is to jointly monitor and improve the quality of the demonstration project and support the project to meet the ZEB-standards. The cooperation is mutually beneficial – the Swiss team brings experience and expertise to China, while the Chinese colleagues can share their experiences for the Swiss to learn from. Jointly the Swiss and Chinese teams discover what the best solutions are to develop a successful zero emission building.

Working process:

Webinars, online workshops, RTIPs, Charrettes, WeChat discussions and site visits were held to turn ideas into constructive proposals. The transparent exchange is very helpful for determining the project' s feasibility.

Demo project duration:

Sept. 2022 – June 2025

2. PROJECT INITIAL STATE

2.1. Project organization

In March 2022, the Taixing Development Zone Waterworks Phase II Comprehensive Building, Jiangsu" was selected as one of the 2nd batch Demonstration Projects of Sino-Swiss ZEB Project. This project is a ministerial-level international cooperation project initiated by the Chinese Ministry of Housing and Urban-Rural Development and the Swiss Agency for Development and Cooperation. The project commenced in Apr. 2023 and is planned to be completed with its construction in June 2025.

Investor

China Construction Eco-Environmental Group Co., Ltd

Lead planning team

Tianjing Tenio Architecture and Engineering Co., Ltd

Sino-Swiss ZEB international joint consulting team

Intep, Skat, CABR, low-tech, UAD, HSLU, EMPA etc.

2.2. Project overview

Location

Taixing, Jiangsu, China

Climate zone

- Hot Summer Cold Winter; Solar Resource Area III.
- sultry in summer, cold and dry in winter, sunlight is sufficient, typical plum rain season

Building type

New construction

Building category

The building serves as a Building Complex (office, dormitory and canteen)

Area

- Building Footprint Area: 1347.66 m2 total
- Gross Floor Area: 2687.35m2
- Building Height: 16.65m (3 floors above ground)

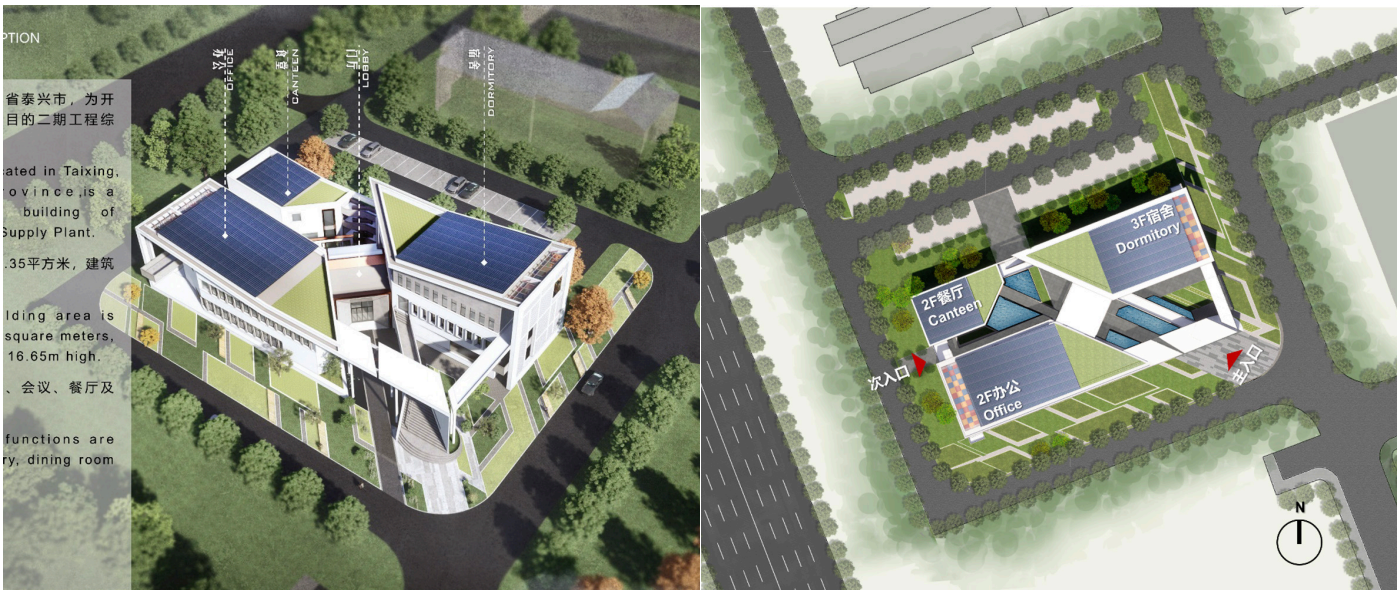


Figure 2: Project located in the water treatment plant site of the development zone, Source: Project Presentation 10.01.2023 ©Tenio

Investment costs

19 million RMB

Energy reference area

2687.35m2

Time Schedule

- Begin of construction: 04.2023
- End of construction: 06.2025

Highlights of architectural concept

(see plans in Annex A.1)

Highlights of Energy concept

(see schematic principle in Annex A.2)

- Building-integrated photovoltaics (BIPV) on Façade and PV on the roof
- Space heating and room cooling with VRF system
- Water treatment technology
- Building Intelligent Control system

Other sustainability concepts

- Shading and heat insulation. By setting up a large balcony and a horizontal visor, the radiation effect could be reduced.
- Passive Ventilation Cooling

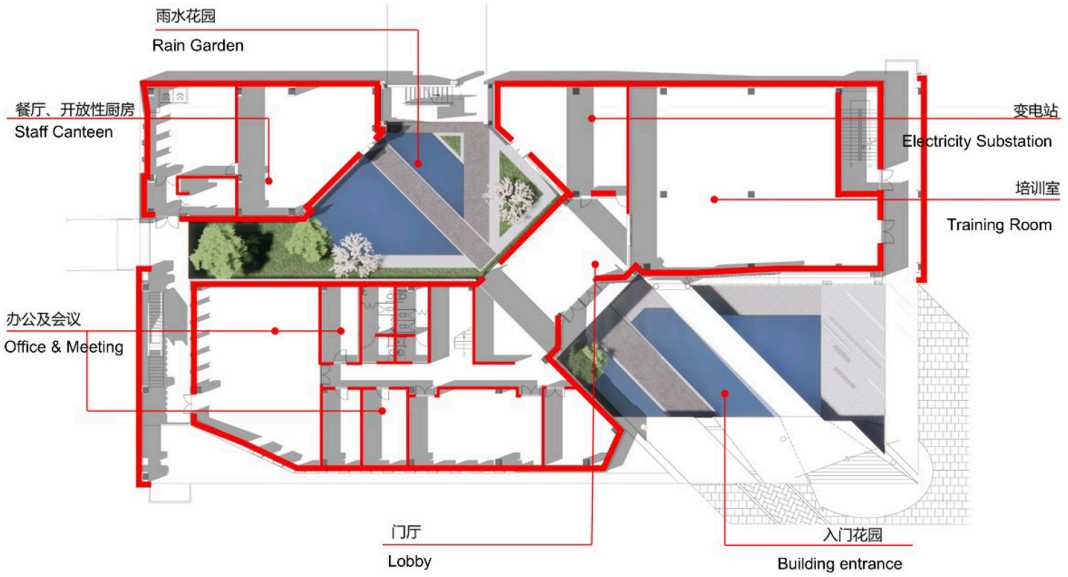


Figure 3: Functional Partition of buildings, Source: Project Presentation 10.01.2023 ©Tenio, see also Annex A.1

Figure 4: Building-integrated photovoltaics (BIPV) on Façade and PV on the roof

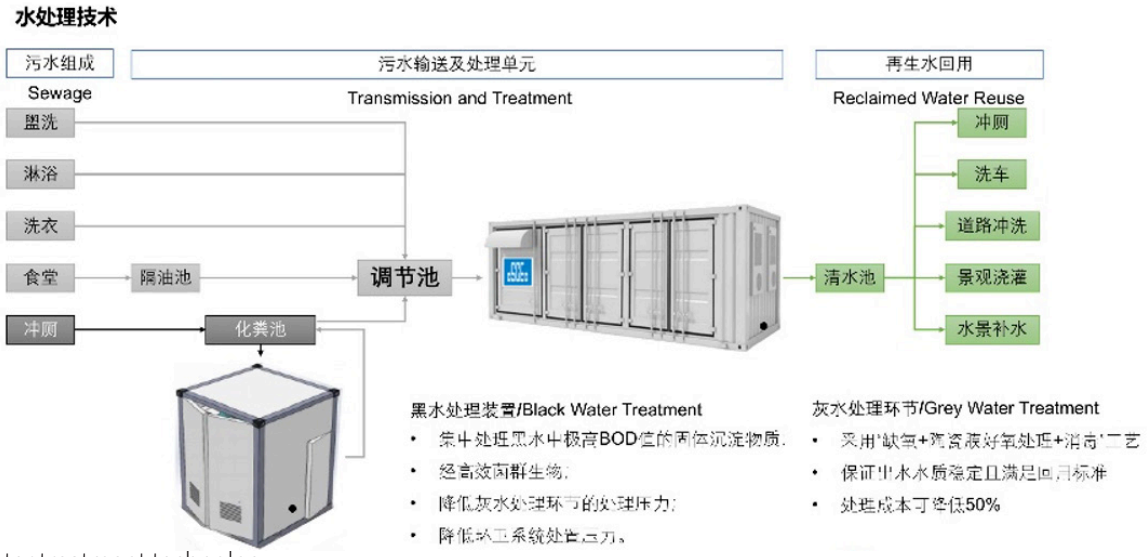


Figure 5: Water treatment technolog

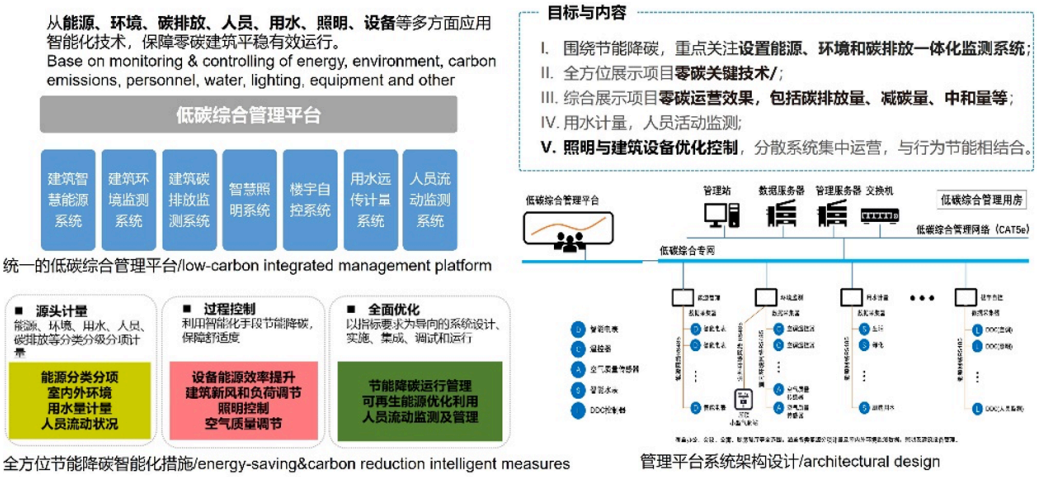
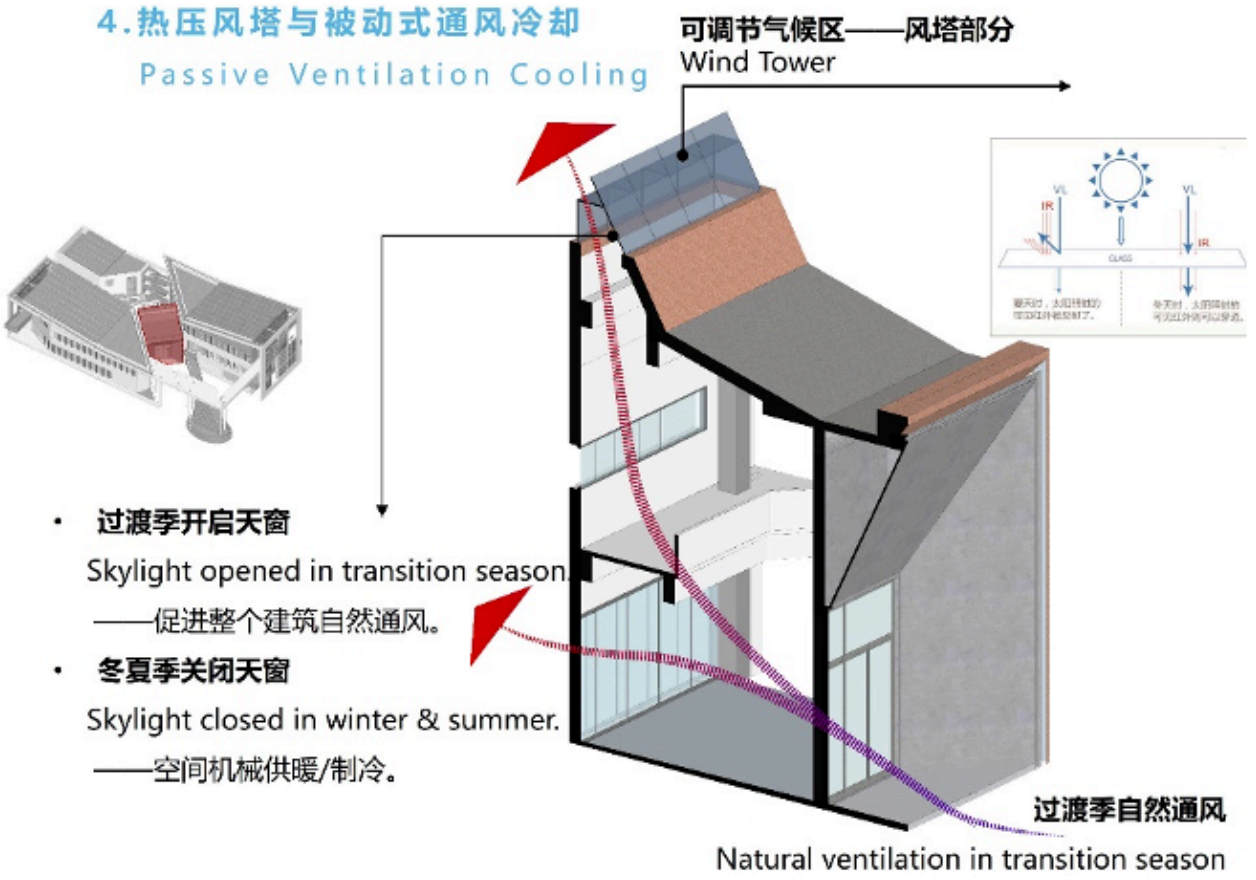


Figure 6: Building Intelligent Control system

Figure 7: Natural lighting& Sunshade



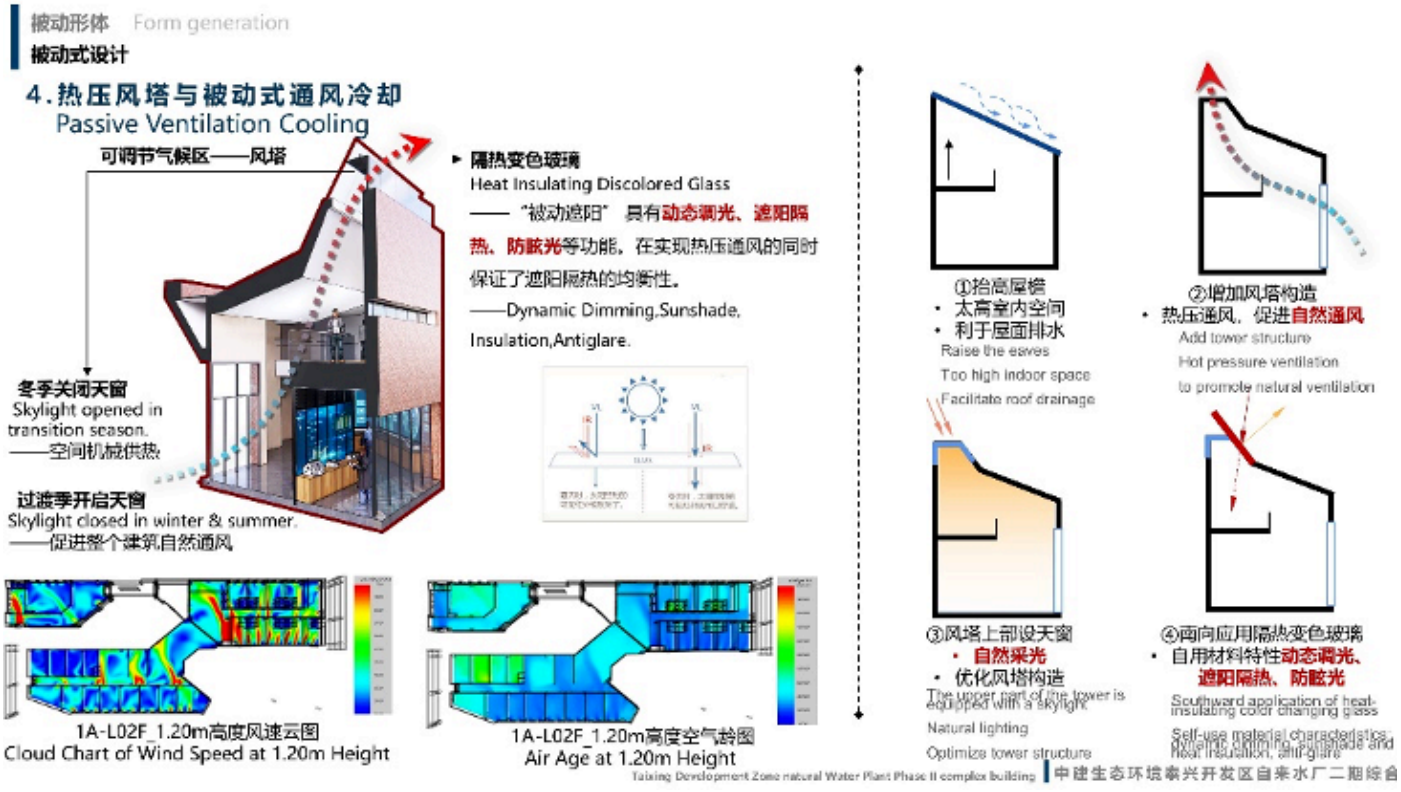


Figure 8: Passive Ventilation Cooling

剖面原则 Section principle

- 沿主导风向划分形体，形成风廊
- Divide the shape along the dominant wind direction to form a wind corridor
- 半围合式布局，形成微气候，舒适度
- Semi-closed layout, forming microclimate and comfort
- 置入通风塔，行成气候缓冲区。
- Put it into the ventilation tower to form a climate buffer zone.
- 增设风塔上增设屋面天窗，改善内区采光效果
- Add roof skylights on the tower to improve the lighting effect in the inner area
- 屋顶延伸形成二层自遮阳挑檐，同时增大光伏铺设面积；
- The roof extends to form a two-layer self-shading cornice, while increasing the photovoltaic laying area;
- 光伏一体化遮阳
- Photovoltaic integrated sunshade

- 东西向外扩形成冷风巷及隔热墙，降低夏季制冷负荷
- Expanding from east to west to form cold air lane and thermal insulation wall, reducing cooling load in summer

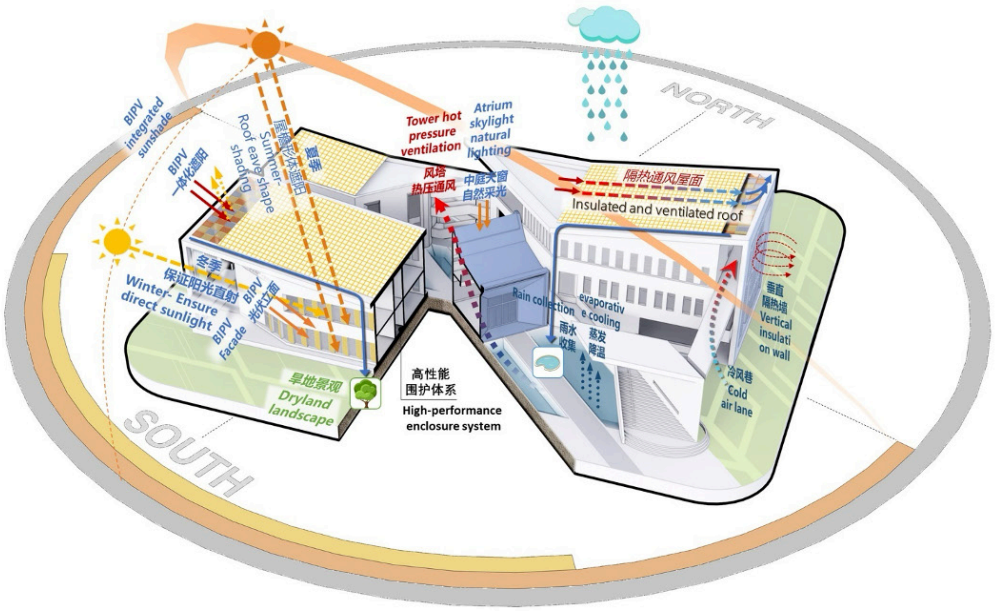


Figure 9: Low carbon design creativity

3. SINO-SWISS COOPERATION

3.1. About the demo project design team

Tian经Tenio Architecture is a comprehensive civil architectural design institution in China that features sustainable architecture. The design team for this project is led by the team of Dr. Ren Jun, director of the Tianyou Architecture Near-Zero Energy Consumption Building Research Institute. The Near-Zero Energy Building Research Institute is a leading green and low-carbon building design team in China. It has excellent design practices in the fields of ecological cities, green buildings, ultra-low energy buildings, near-zero energy buildings, zero-carbon buildings, and productive buildings. Experience, the project covers a variety of building types such as green offices, green campuses, green villages, and green renovations. It has won dozens of domestic and foreign green design awards such as the Asian Institute of Architects Sustainable Architecture Gold Medal, and has participated in the compilation of a large number of green and low-carbon projects. Construction industry standards.

3.2. First impression of Swiss team

General impression

The project is well developed and contains many great and smart features. One topic of great visibility could be, to better integrate the fact that this is a water supply facility, which means to make use of the water distribution setup in the area for the energetic performance of the building (heat, cooling and electricity). Making use of this energy would even more underline the “lighthouse character” of this ZEB Demo Project. The design explores the contemporary translation and application of traditional green technologies in architecture in Jiangnan water towns in China. Especially, attractive, good architecture with a great nature related philosophy: water, wind, environment. This is a mature project including water, wastewater, rainwater and kitchen waste aspects.

3.3. First inputs and suggestions

A list of inputs and consulting activities that delivered by Swiss team (see rapid technical inputs sheets, webinars, workshops and special coordination etc.):

- For the embodied energy assessment, detailed information on the building materials is required.
- For the windows triple glazing with a U-value of about 0.8 should be used.
- The shading of the windows is done with a fixed overhang. It should be examined whether an additional movable sun protection is necessary for glare protection.
- Natural ventilation has a decisive influence on the design and operation of the building, the conduct in-depth research and analysis on its wind environment could be used.
- Facility Management during planning and construction could be adopted.
- Suggested high performance window products from the above mentioned RTIS will be used

3.4. Reaction of DP team and concept improvement

After receiving the first inputs of Swiss team, the DP team gave the following re-sponses:

- Natural ventilation has a decisive influence on the design and operation of the building, the conduct in-depth research and analysis on its wind environment could be used.
- Facility Management Facility management during planning and construction could be adopted.
- Suggested high performance window products from the above-mentioned RTIS will be used.

3.5. Further Swiss inputs and suggestion

- Take additional external blind slats with recycled building material as sun and glare protection into consideration.
- The use of the large volume of water in the immediately adjacent Water dis-tribution center as a heat source and sink for the heat pumps/ cooling ma-chines (possibly freecooling) instead of outside air.
- To optimize direct use of the generated PV output – especially regarding the current plan – the storage capacity (electric vehicles) and maybe some addi-tional capacity have to be precisely defined. The support of surrounding buildings with the overproduction should be taken into consideration.
- The no-mix toilet system from Eawag to the demonstration project team.

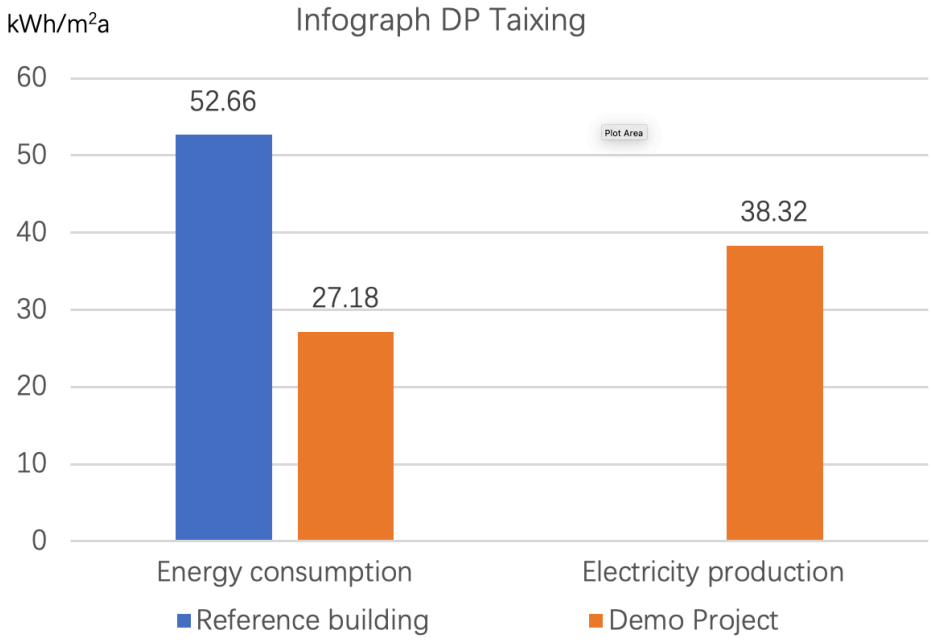
3.6. Further improvement and knowledge received

The Taixing demonstration project is a technical and spatial design that addresses the four core strategies of the hot summer/cold winter climate zone, and the form generation draws on a contemporary translation of the energy-saving concepts of the traditional dwellings in Jiangnan. The Swiss team and Chinese experts discussed further about the progress of the project, the design concept, the challenges of achieving zero emission, and more technical support available from Switzerland. Discussions covered the feasibility of using the waterworks as the heat source for the water source heat pump, temperature-controlled colour-changing glass materials, water recycling, natural ventilation in the breezeways, distributed HVAC system, and cooling of the water feature in the atrium. In the end, the application of energy storage technology and the reasonable design of battery capacity were clarified in the in-depth improvement.

3.7. Calculations

Energy demand calculation after optimization: (Jun. 2024)

- Reference building: 52.66 kWh/m2a
- Design building: 27.18 kWh/m2a
- Total energy demand: 63’ 674.59 kWh/a
- Yield of PV system: 89’ 772.26kWh/a
  or 38.32kWh/m2a
- Carbon intensity indicator (operational phase):
  0 kg/m2a



4. OUTCOME/REACHES

4.1. Testimonials from DP side

From chief architect: Mr. Ren JUN, Tenio Architecture and Engineering Co., Ltd.

We hope that the Taixing Water Plant project will be inspired by the local climate, integrating zero-carbon technology with the energy-saving concepts of traditional Jiangnan residences. The goal is to create a zero-carbon building that combines contemporary technology with regional culture.

From energy consultant: Mr. Bing LIU, Tenio Architecture and Engineering Co., Ltd.

The energy solution for the Taixing Water Plant project is designed to quickly and accurately adapt to changes in building load. By choosing a heat pump system with variable frequency and variable refrigerant flow, we have achieved energy efficiency, low carbon emissions, and environmental friendliness.

From investor side: Mr. Hao ZHANG, China Construction Eco-Environmental Group Co., Ltd.

The zero-emission building project significantly reduces the carbon footprint over its entire lifecycle, leading the way for future construction trends. Its keen insight into emerging market opportunities and emphasis on sustainable development provide investors with a new perspective that balances economic benefits and social responsibility, making it a promising new sector in the investment landscape.

4.2. Confirmation of ZEB Demo Project

Confirm, that the project reached or, it is still in construction, has potential to achieve the ZEB-goal as required in ZEB Standards, especially in the operational phase.

Confirm, that the project considered the carbon emission throughout the whole life cycle and did its best to reduce the embodied emission as much as possible.

5. LESSON LEARNED

5.1. Management and Organization

The short design phase in China is very challenging for the Swiss expert team. Effective and continuous communication with the DP team is crucial for the development of the project. The Swiss team was required to respond promptly to the DP team' s enquiries and provide quick inputs to ensure swift integration of ideas into the project within the limited timeframe.

Concrete factors and numbers are more persuasive than words or theory. For instance, through the utilization of a calculation tool developed by a Swiss expert, the Swiss team communicated with the DP team in a very constructive way. The project effort is a common achievement of Sino-Swiss joint team.

5.2. Technical Solutions

Guided by the core ZEB strategies for hot summers and cold winters climate zone, this project uses green design principles, focusing on insulation, ventilation, shading, and an efficient fresh air heat recovery system as its four central elements. For the exterior walls, roofs, and skylights, advanced facade building materials and rooftop photovoltaic technology are utilized to efficiently harness renewable energy, enhancing the building' s energy efficiency.

The design of courtyards and open corridors provides natural ventilation and lighting for the building complex, creating a comfortable and pleasant indoor environment. Additionally, the project incorporates recyclable building materials for external louvers, effectively preventing direct sunlight and glare, offering both environmental and practical benefits.

Moreover, the project integrates a water courtyard at the building entrance, employing sewage treatment devices and rain chains to collect roof rainwater into a rainwater collection pool. Purified by filtrationsystems, the rainwater is utilized in water feature displays, blending technology with art and facilitating recycling of water resources.

5.3. Communication and Cooperation

The following formats and means of communication were actively used in the project procedure:

Charrettes incl. technical response by the Swiss team

- Kick-off charrette
- Update charrette
- Offline workshop and onsite visit
- Kick-off meeting on building automation and smart control

Joint charrettes with all three DPs from first batch

- ZEB Duty Book
- Circular construction
- Fire safety of timber structures
- Facility management and ZEB operation
- Zero Emission District
- Computational fluid dynamics (CFD) Simulation
- Green PV
- Swiss technologies and products

Rapid technical input sheets (RITS) about:

- BIPV solutions incl. façade PV and photovoltaic tiles, local product manufacturer recommendations
- KBOB – Swiss Coordination Conference of Building and Property Bodies of Public Sector Developers
- Low carbon cement LC3
- High performance windows and doors
- Facility management
- Shading systems and products
- Greenery and PV

Q&A sheet and further thematic inputs on:

- ISO norm and SIA2040
- U-value / visible light transmission (VLT)
- Heat recovery / air handling unit / AC
- Earth tubes for ventilation system

Further performances:

- ZEB Duty Book developed, shared and presented
- Regular exchanges and discussions per WeChat, telephone and email
- Site visit and technical exchange on construction site
- Public and internal ZEB Talks on various ZEB topics
- Booklet regarding ZEB policies, regulations, standards, concepts and techniques
- Exchanges and discussion on events like National NEZB Conferences and the Sino-Swiss Industry University Research Collaboration Forum on Zero Emission

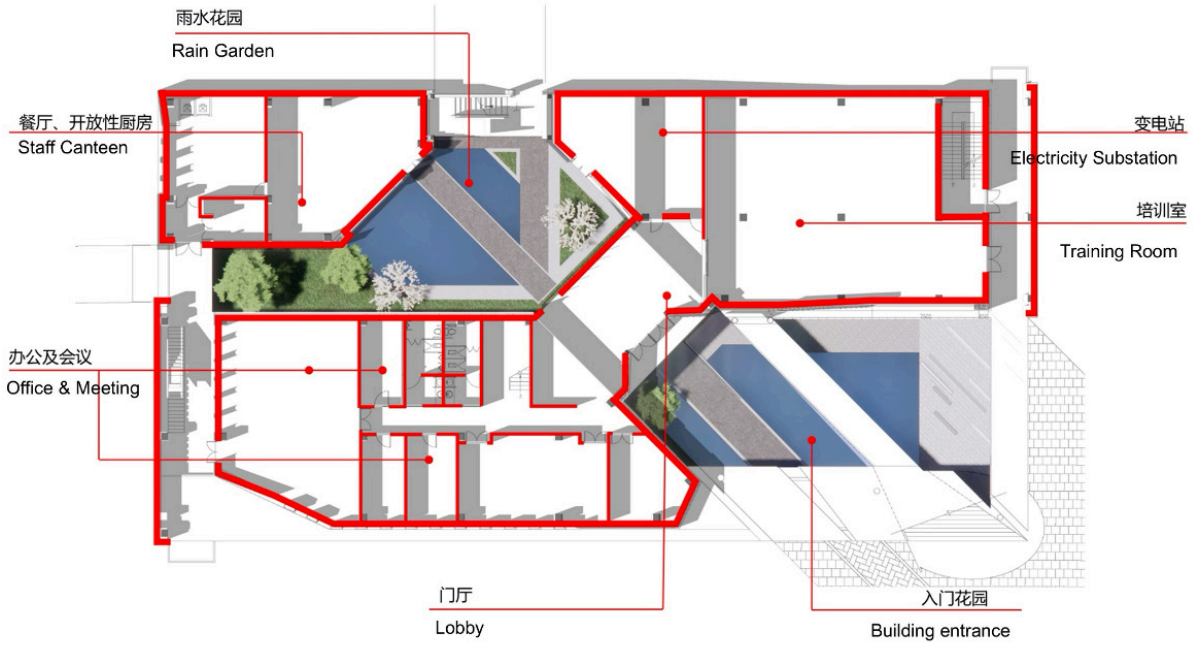
Individual tailored schedule

- Kick-off Charrette, 03.23
- Offline technical exchange in Beijing, 04.24
- Facility management during planning and construction Swiss experience 06.2023
- Prof. Daniel Kellenberger (FHNW) about Zero Emission District, 07.2023
- Prof. Pierre Jaboyedoff (Effin' Art Sàrl) about Computational Fluid Dynamics (CFD) Simulation, 07.2023
- Prof. G. Settembrini (HSLU) about Green PV, 07.2023
- Mr. Diego Salmeron (SGB) about Swiss technologies and products, 08.2023
- Dr. Shanshan Hsieh about E-Hub, 10.2023
- Schindler AG about efficient elevator, 10,2023
- Willers about PV and battery storage, 11.2023
- Anex about Anergienetz, 11.2023
- Adrian Altenburger about Compound ventilation system,01.2024

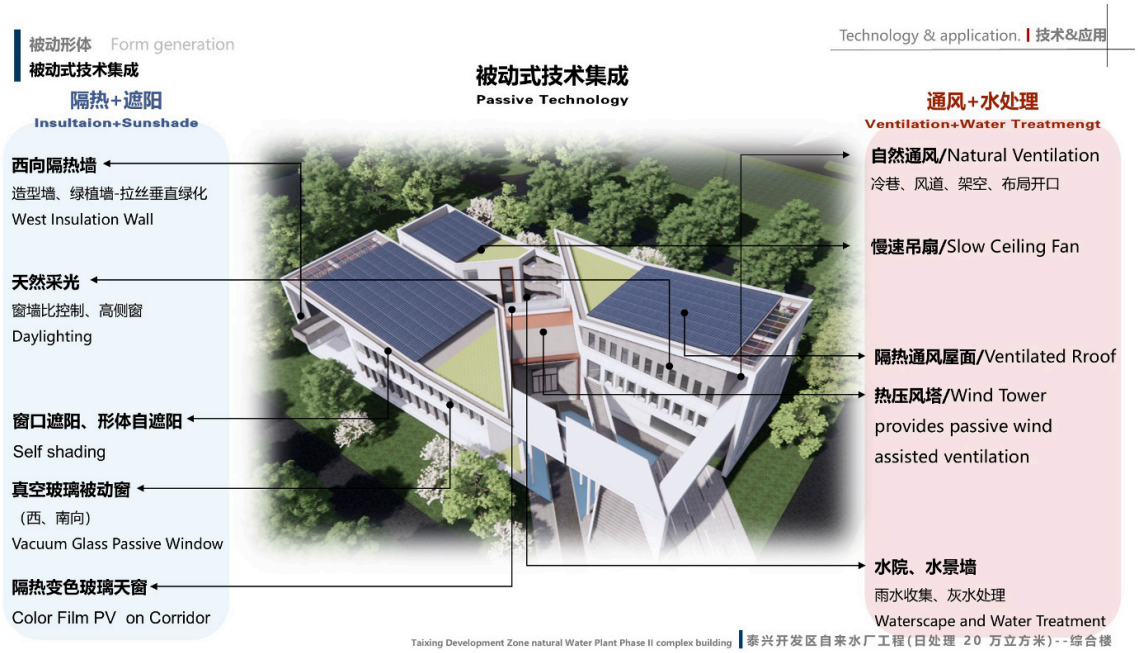
Figure 10: 2024.04.17 On-site technical exchange in Beijing

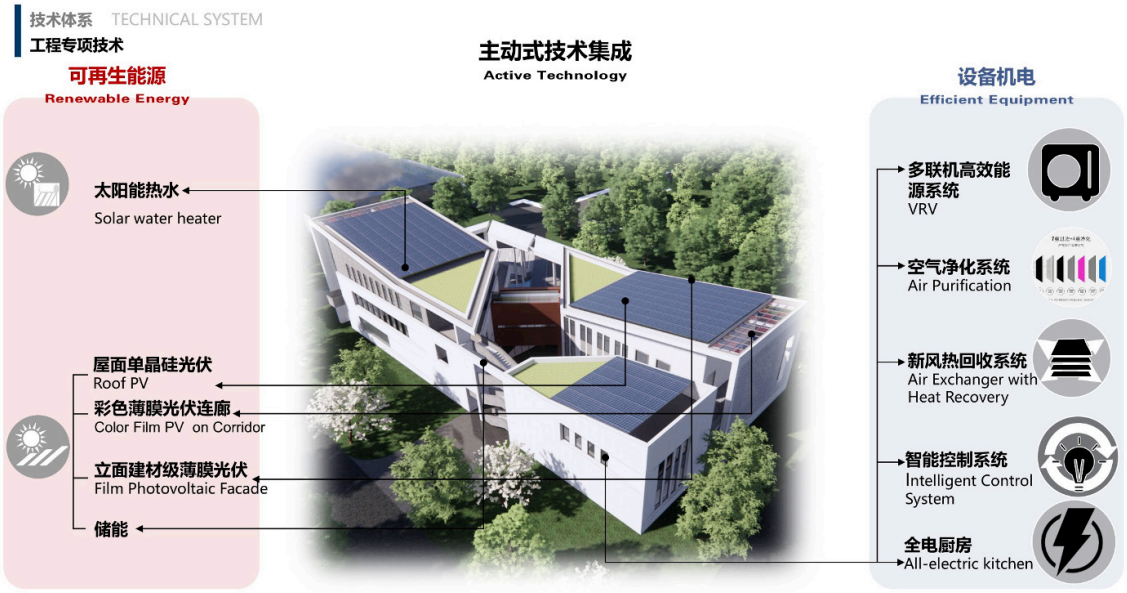
Annex 1. Floor plans

Ground floor



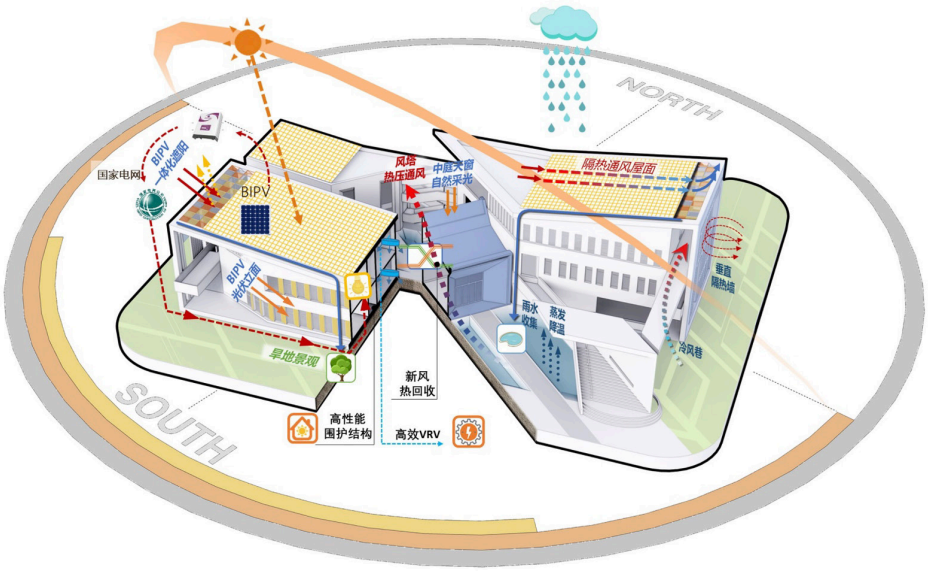
Annex 2. Energy concept





技术体系 TECHNICAL SYSTEM

技术集成体系



被动式节能技术体系
Passive energy-saving technology system

- 高性能围护体系
- High-performance enclosure system
- 天窗采光
- Skylight lighting
- 被动冷却+通风塔
- Passive cooling+ventilation tower
- 雨水收集&海绵景观
- Rainwater collection&sponge landscape
- **装配式钢结构**
- Fabricated steel structure
- **达标结论设计方法**
- Design method of reaching the

主动式节能技术体系

- Active energy-saving technology system
- **多联式空调（热泵）机组**
- Multi-connected air conditioning
- (heat pump) unit
- 新风热回收系统≥75%
- Fresh air heat recovery system ≥ 75%
- 能耗监测与展示系统
- Energy consumption monitoring and
- display system
- 节能照明
- Energy-saving lighting
- 全电厨房
- Fully Electric Kitchen

可再生能源利用

- Renewable energy utilization
- **太阳能光伏**
- Solar PV
- **储能**
- Energy storage

让我们共同打造气候中和的未来
Building a climate-neutral future together

中华人民共和国
住房和城乡建设部

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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