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

Shenzhen Nanshan Energy Ecological Park Zero Carbon World

Shenzhen, Guangdong

ENGLISH VERSION

MARCH 2024

中华人民共和国
住房和城乡建设部

Schweizerische Eidgenossenschaft
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Confederazione Svizzera
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Swiss Agency for Development and Cooperation SDC

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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.

Authors:

Dr. Feng Lu-Pagenkopf, Intep

Wesley Wojtas, Skat Consulting

Roland Stulz, Intep

Jilong Zhu, Intep

Xinyu Wang, Intep

Contributions and review:

Dr. Shicong Zhang, China Academy of Building Research

Dr. Xinyan Yang, China Academy of Building Research

Yin Li, Architectural Design & Research Institute, Zhejiang University

Jiayan Wu Architectural Design & Research Institute, Zhejiang University

Yiqi Hu Architectural Design & Research Institute, Zhejiang University

Tianchi Yu, Jianxue Architecture and Engineering Design Institute Co., Ltd.

Yi Zheng, Jianxue Architecture and Engineering Design Institute Co., Ltd.

Design and layout:

Intep-Skat

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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:Shanghai Jiading Future City, Market Building

Contents

1. PROJECT BACKGROUND

1.1. About SDC ZEB Project

In order to jointly address global climate change and to strengthen cooperation between China and Switzerland in the field of emission 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 is about the development of cooperation in the field of building energy efficiency. Within the framework of this MoU, the Swiss Agency for Development Cooperation (SDC) initiated and funded the Sino-Swiss Zero Emission Building Project. The project aims to support China in formulating the technical standard of zero carbon buildings and long-term roadmaps for reducing carbon emissions in the construction industry. Switzerland contributes by sharing know-how and use cases of zero emission building demonstration projects in different climate zones, while carrying out various forms of capacity building activities, so as to ultimately promote the carbon-neutral development of China's construction industry.

Project Purposes:

- Upgrading existing building energy efficiency standards to Zero Carbon technical Standards
- Implementing demo projects in 4 typical climate zones for testing the new ZEB standards and finding optimization potentials
- ZEB capacity building and knowledge dissemination

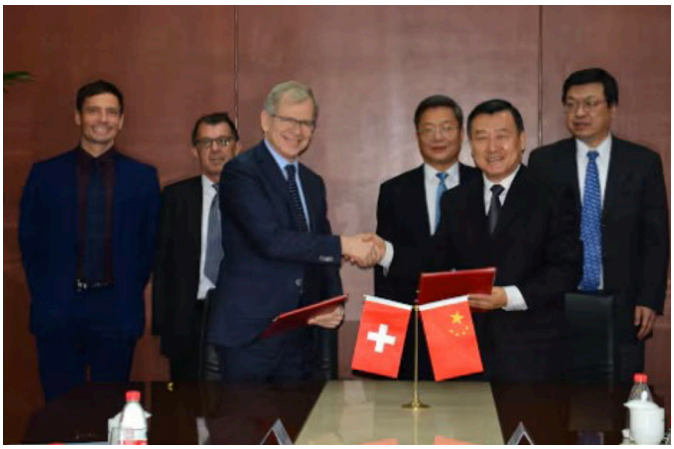


Figure 1. Ambassador Bernardino Regazzoni and Vice Minister Ni Hong, sign the project agreement. Image: Swiss Embassy in Beijing

Project duration:

Phase I: 15. Mar. 2021 – 28.Feb. 2025

Project impact on climate protecting:

Reduce CO2 Emission in building sector.

1.2. Selecting process of Demo Project

Demo project goals

- to reach the requirements of China's national technical standards for zero carbon buildings.
- Serve as case study to guide and educate more projects to achieve the ZEB goal
- Evaluating and the selecting process
- CABR collected applications by an official call
- A project presentation meeting with Q&A and afterwards evaluation, participated by Chinese and Swiss experts
- Separately evaluation with selecting criteria by Chinese and Swiss experts
- With Sino-Swiss joint Feedback and recommendation, 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

Selecting time:

March 2022

Why selected – ZEB potential

- The project is located in Shenzhen with very good municipal political willing and engagement
- The project seems to be strongly supported by

private and public decision makers

- The project seems to be already fully "marked" to relevant decision makers, who likely have very high expectations on its performance
- Significant capital seems to be available and committed for a green high-profile lighthouse building
- The project is at a good stage for Swiss inputs
- Fundamental ZEB features are already designed and marketed
- The project has landmark character and some ZEB technical solutions such as the use of sweepings for energy use in buildings is very interesting and can be replicated in principle in all climatic zones and for different uses. But even if there are many waste incineration plants in China, that could copy the proposed solution, many might not be located at a place where high profile swimming facilities are the most obvious choice for the use of the waste heat, generated.
- It is likely that the visibility will be very high, given how prominently the project has been presented so far, even if it is still at a concept stage.
- Usage: The only public building / sports facility
- Climate: the only demo project in climate zone S-h, W -m/h
- The System Boundary will have to be discussed, since in principle, the energy from waste incineration should be used for a district wide use and not for a single building. The CO2 reduction potential depends on which CO2 factors are used to calculate the energy production. This can be defined scientifically or politically.
- The head count of direct beneficiaries (visitors) might be high.
- The project is government financed project of public use
- Availability of data seems to work
- The project has the classic characteristics of a Lighthouse project: high visibility, attractive architecture, public use and financing, and political support. It also serves to clarify important issues regarding the application of the ZEB standard, such as system boundaries, CO2 factors, energy prices, etc.

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 discussion and site visits were hold to make these ideas to constructive proposals. The transparent exchange is very helpful for figuring out its implement ability.

Project Duration

May. 2021 – construction started in April 2024 and is planned to be finished in July 2025

2. PROJECT INITIAL STATE

2.1. Project organization

In March 2022, the “Energy Ecological Park Zero-Carbon-World in Shenzhen” was selected as one of the 1st 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 Mar. 2024 and is planned to be completed with its construction in 2024.

Investor

Shenzhen Energy and Environmental Protection Group

Lead Planning team

Jianxue Architecture and Engineering Design Institute Co., Ltd

Sino-Swiss ZEB international joint consulting team

Intep, Skat, CABR, Low-Tech, UAD, HSLU, EMPA, etc.

2.2. Project overview

Project Location:

Shenzhen, China (Hot Summer Warm Winter; Solar Irradiance Level: IV)

Building Area:

Building Energy Reference Area: 8’ 162.18 m2

Architectural concept highlights

(see plans in Annex A.1)

The building serves as a Sport Center including Zero-Carbon exhibition hall, Meeting center, fitness center, table tennis room, 8 lane swimming pool)

Energy concept

(see schema in attachment)

- Utilising waste heat steam from waste incineration power plant, waste heat gradient utilisation in multiple scenarios in the project. Lithium bromide air-conditioning cooling and dehumidification in summer, and constant temperature water heating for swimming pools in winter.
- use of the relatively high solar altitude angle in Shenzhen, the roof photovoltaic is set with 8° tilting angles in the east, west, south and north, which links the photovoltaic with the sea and creates a romantic picture of ‘PV-waves on the sea’. Chromium telluride (CdTe) power generation glass curtain wall is set behind the wa-

Figure 2: project location in Shenzhen, Source: Project Presentation 22.06.2022©Jianxue Design

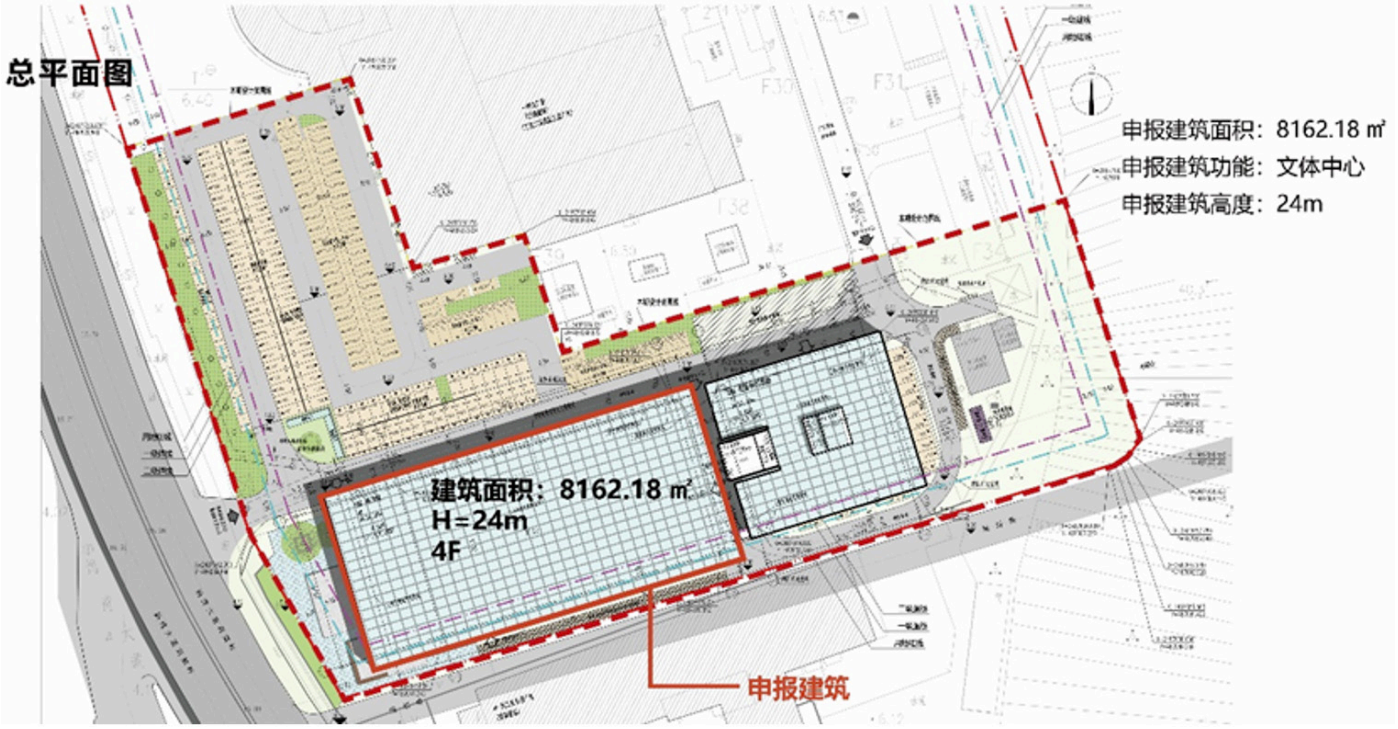


Figure 3: Project located in Shenzhen Nanshan waste power plant, Source: Project Presentation 22.06.2022©Jianxue Design

Figure 4: Rendering of the project in early planning phase. Source: Project Presentation 22.06.2022 © Jianxue Design

ter curtain on the west façade of the building, orange CdTe power generation curtain wall is set on the south and north façades, and CdTe power generation railing panel is set on the east façade.

Other sustainability concepts

- The Nanshan Energy Eco-Park in Shenzhen can handle all the domestic waste in Nanshan District on a daily basis, which plays a significant role in improving the urban environment and reducing urban carbon emissions. The heat and slag produced after waste incineration is cooled by recycled water, which is an important technological innovation of this project, as the 'three wastes' (waste steam, waste water and waste slag) of the power plant are efficiently reused.
- The West Entrance Plaza retains two mango trees and one large banyan tree, which retains both the natural ecology and the memory of the site; the combination of large trees and water screen design creates a natural environment with a unique cave, and the Rooftop Zero-Carbon Park, which is open to the public 24 hours a day, is an infinite view of the sea, and at the same time provides a venue for the public's activities, and is a platform for the display of modern photovoltaic art. Multi-level three-dimensional greening on the north and south elevations leads greenery from the ground to the air and to Xiaonan Mountain, creating a symbiosis between architecture and nature, creating a picture of 'Qianhai Mountain Dwelling', a zero-energy friendly neighbourhood, and a different kind of nature.
- For the climatic characteristics of 'wet, hot and stuffy' in Shenzhen, as well as the situation of large noise interference in the environment of the site, a climatic buffer layer of traffic space and roof photovoltaic is set up on the south and north sides of the building.
- 0.5cm water film is used on the glass outside the lobby on the first floor and on the west side of the swimming pool on the fourth floor, which, after design simulation, reduces the temperature of the glass outside surface, thus reducing the air-conditioning load of the swimming pool.
- The 12.8m eaves on the west façade provide shade to the lower space; the building's south and north façades are designed with multi-level picket platforms and planted with three-dimensional greenery, which not only provide shade, but also soften the building. More than 25% of the building façade is green, which brings pleasure to people's view.

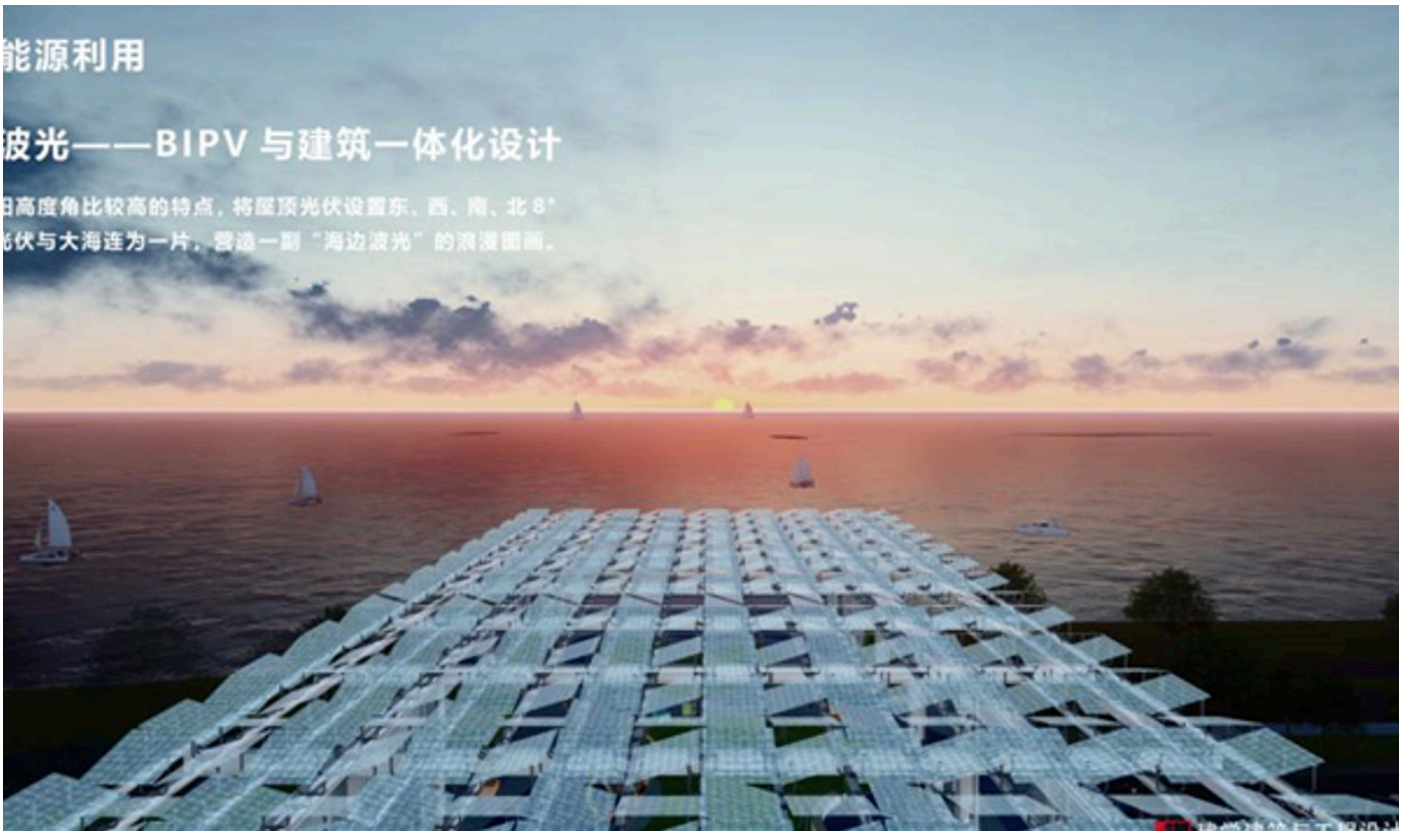


Figure 5: PV on the roof, with Art design. Source: Project Presentation 22.06.2022 © Jianxue Design

3. SWISS EVALUATION AND INPUTS

3.1. About the design team

The leading design team for the Shenzhen Demonstration Project is Jianxue Architecture and Engineering Design Institute Co., Ltd, led by Chief Architect Mr Tianchi YU, who actively explored positive green design to adapt to the climate characteristics. In view of the climatic characteristics of 'wet, hot, stuffy and windy' in the Lingnan region, the design measures such as sun shading, heat insulation and three-dimensional greening are adopted to 'create nature', and photovoltaic and architecture are combined artistically to explore the architectural design adapted to the climatic characteristics of the Lingnan region, creating a new aesthetic of zero-carbon buildings and creating a new aesthetic of zero-carbon buildings. It explores the architectural design to adapt to the climate characteristics of the Lingnan region, and creates new aesthetics, new space and new perception of zero-carbon buildings. Relying on the Nanshan Waste-to-Energy Plant, the project makes deep use of the plant's waste steam, waste water and waste residue, an important way to reduce carbon emissions. The project's cultural and sports facilities and rooftop zero-carbon gardens are free to the public, and will become an urban living room for zero-carbon publicity and experience on the waterfront of Qianhai.

Architecture, landscape, interior design and sustainability consultancy were provided by Jianxue Architecture and Engineering Design Institute Limited, with support from the China Academy of Building Research's Institute of Environmental and Energy Sciences in energy efficiency measurement.

3.2. 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.):

- This project impresses with excellent architecture and an interesting mix of uses.
- Due to the proximity to the waste incineration plant, there is the possibility for an interesting energy network and a Zero Emission District (ZED) solution.
- This project is particularly suitable as a lighthouse project because its architecture and public use are highly visible. It can also serve as a model for many district solutions in the country with waste energy producers and energy consumers.
- The glacing proportion of the façade could be reduced: as the façade will cause a high demand for energy, The Swiss team recommended to check the façade construction for optimization possibilities.
- For the interior design, the Swiss team suggest to use eco-friendly and long lifespan material. For example, bamboo has less embodied carbon emission compared with metal or wood, but it has a similar appearance as wood.
- All relevant energy data could be researched by the project team.
- Increase the number of PV modules where possible, e.g. as shading device on south façade
- Use waste heat from cooling and dehumidification for shower and pool water heating.
- Swiss team suggested to check, is district heating (and cooling) form the waste incineration plant available?

3.3. Reaction of DP team and concept improvement

In consideration of different situation of neighborhood, the façades are specific designed:

- The south facade uses cadmium telluride photovoltaic panels (40% transparency, can be regarded as sunshade components) and vacuum insulated glass
- West façade with 4mm water curtain wall and vacuum glass/aluminium thermal frame, meanwhile cantilever on 4th floor as shading system
- The building for organic waste in the south will be moved in the future, so that the south façade is designed to open up the building in the future. The library on the roof top of dormitory building is covered by thermochromic glass, which can adjust transparency rate according to natural light. This product is a newcomer on the market. The sports center has a double roof with a PV panel roof on top and a park roof with greeneries below (500mm thick earth) combined with light tube for lighting of swimming pool. There are two corridors in the north and south parts of the building, considered as air insulation layer.

3.4. Further Swiss inputs and suggestion

- Absorption chillers for cooling in help with waste heat from incineration plant Simplification of construction and lowering cooling demand through the simplified design.
- Charging piles for electrical vehicles on parking lots.
- BIPV solution incl. façade PV and Photovoltaic tiles (光伏瓦), Strong recommendation for using local product and manufacturer.
- Exsamples and Ideas for Landscape Planning.

3.5. Calculations

Final calculations

- Reference Building: 101.5 kWh/m2a
- Design Building: 83.9 kWh/m2a
- Total energy demand: 735 ‘700 kWh/a
- Yield of PV system:91.5 kWh/m2a
  or 802’ 000 kWh/a
  (incl. PV of neighboring dormitory building within the same building perimeter)
- Carbon intensity indicator: 0.00 kgCO2eq/m2a

Figure 6: Absorption Chiller for Waste Heat. Source: Swiss consulting team Presentation 22.08.2022

Figure 7: Final Rendering after design optimisation. Source: ©Jianxue Design, April. 2024

Figure 8: Final Rendering after design optimization, Source: ©Jianxue Design, April 2024

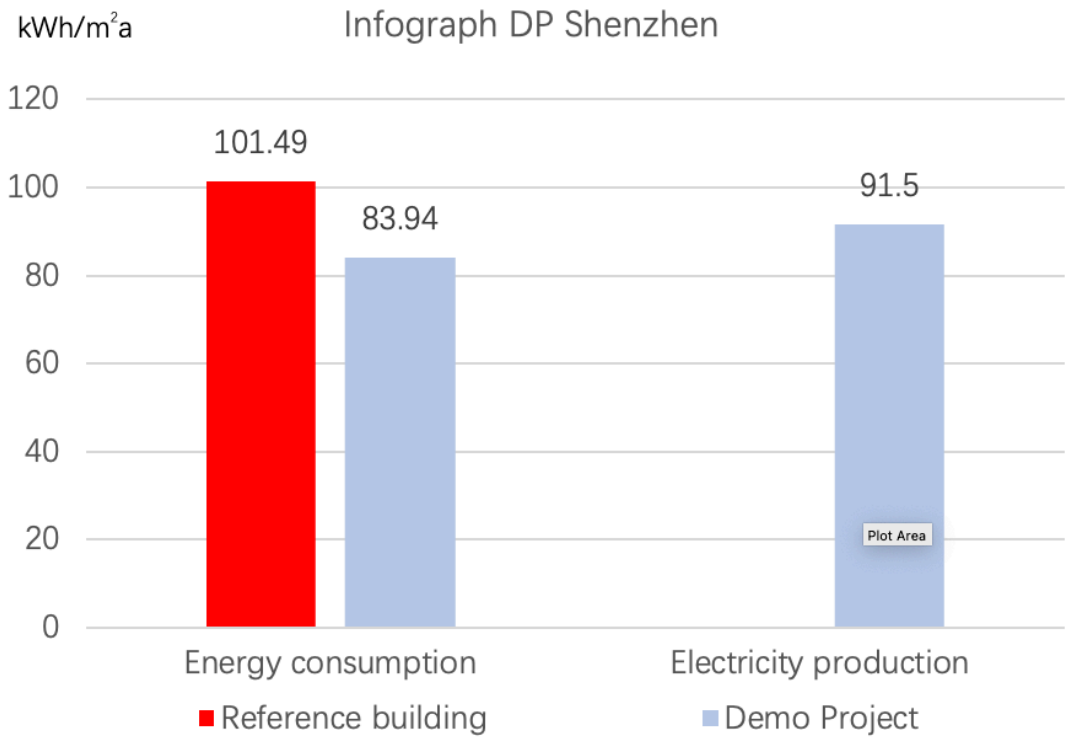


Figure 9: Infograph Energy Calculation DP Shenzhen, Source: Sino-Swiss ZEB Project

4. OUTCOME/REACHES

4.1. Testimonials from Demo Project Team

Chief Architect: Yu Tianchi, Chief Architect

Jianxue Architecture and Engineering Design Co., Ltd.

From addressing the hot and humid climate issues in the Shenzhen area, we fully utilize the “waste” (waste heat, waste material, etc.) from the incinaration plant to create a “new aesthetics, new space, and new perception” of zero-carbon buildings.

Project Manager: Zheng Yi, Project Manager

Jianxue Architecture and Engineering Design Co., Ltd.

This project, with an attitude of ‘shaping nature,’ builds a ‘zero-energy neighborhood’ sustainable demonstration base on the shores of Qianhai, Shenzhen. It will become the urban living room for Shenzhen’ s green and low-carbon development.

Investor: Qu Wenhao, Deputy of Investor

Shenzhen Energy Environment Engineering Co., Ltd

The Nanshan Energy Eco-Park Zero Carbon Campus project is a green practice by our company in the field of architecture to promote energy saving and carbon reduction. In the future, it will provide long-term value to society.

4.2. Confirmation of ZEB Demo Project

Confirm, that the project reached or, it is still in construction, is able/has big potential to be qualified as “Zero Carbon Building” 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.

Figure 10: On-site technical exchange in Shenzhen, 2023.04.27. Source: ZEB China Project Team

Figure 11: On-site technical exchange in Shenzhen, 2024.04.18. Source: Wechat Channel©Shenzhen Green Building Association

5. LESSON LEARNED

5.1. Management and Organization

The short design phrase in China is very challenging for Swiss ex-pert. The intensive and constant communication with DP team is crucial for project development. We need to response DPs team as soon as possible and give our inputs so that they can adapt our ideas in project in such a short time.

Concrete factors and numbers are more persuading that any other word or theory. With Martin' s calculation for example we can communicate with DP team in a very constructive way.

5.2. Technical Solutions

Usage of absorption chillers. This type of chiller uses a thermal heat fueled

absorbing and desorbing process instead of the usual electricity driven compressor. Instead of the considerably large amount of electricity, waste heat (high temperature) is used to power the chiller.

This type of chiller is perfect fit for the high temperature waste heat from the waste incineration plant. This kind of industrial application has already been applied and approved all over the world.

As in any other type of chiller, there will still be waste heat (low temperature) as a by-product that needs to be reused or dealt with.

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:

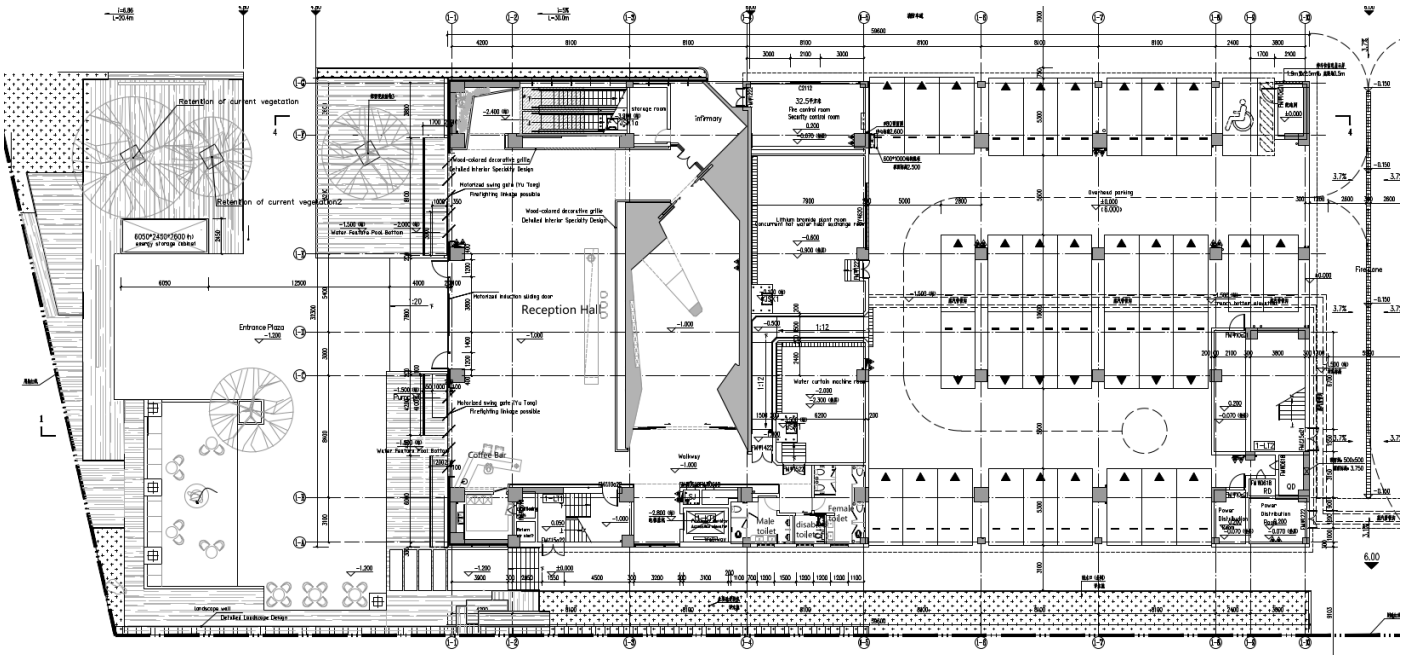
- ISO norm and SIA2040
- U-value / visible light transmission (VLT)
- Heat recovery / air handling unit / AC
- Earth tubes for ventilation system

Further performances:

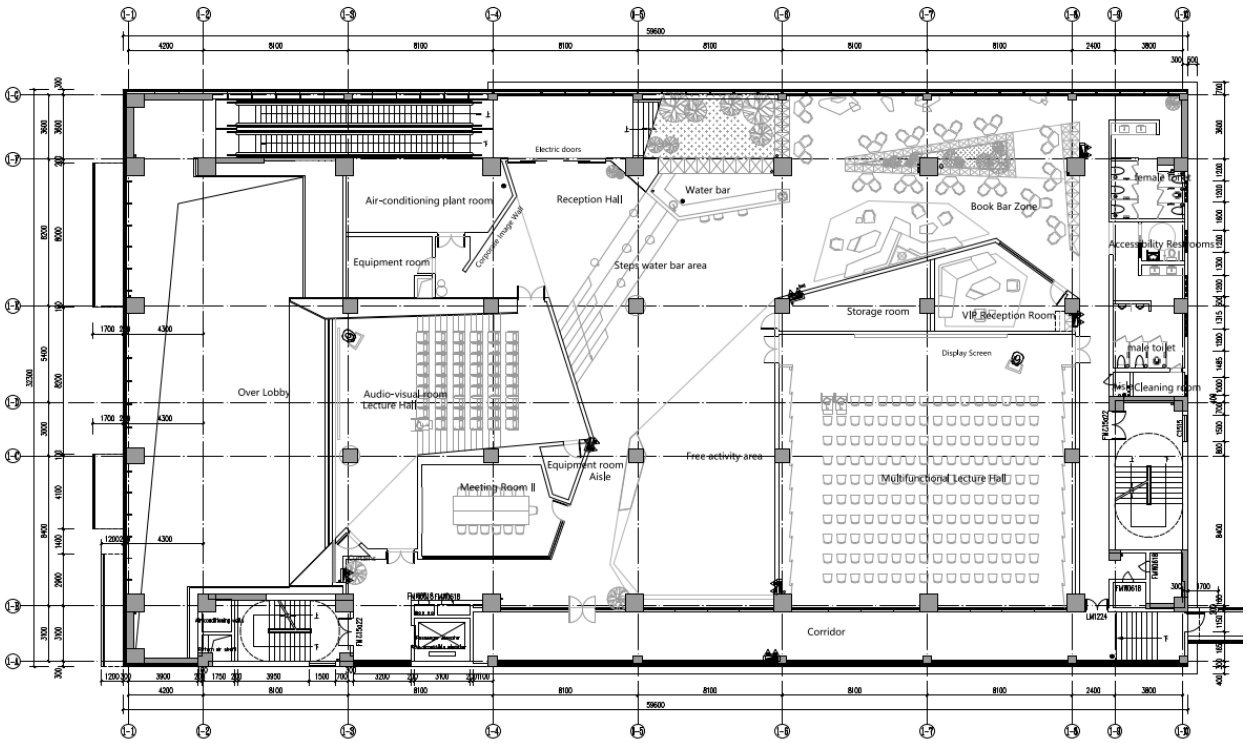
- ZEB Duty Book developed, shared and presented
- Regular exchanges and discussions per WeChat, telephone and email
- Site visit and technical exchange on construction site
- Public and internal ZEB Talks on various ZEB topics
- Booklet regarding ZEB policies, regulations, standards, concepts and techniques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

Annex 1. Floor plans

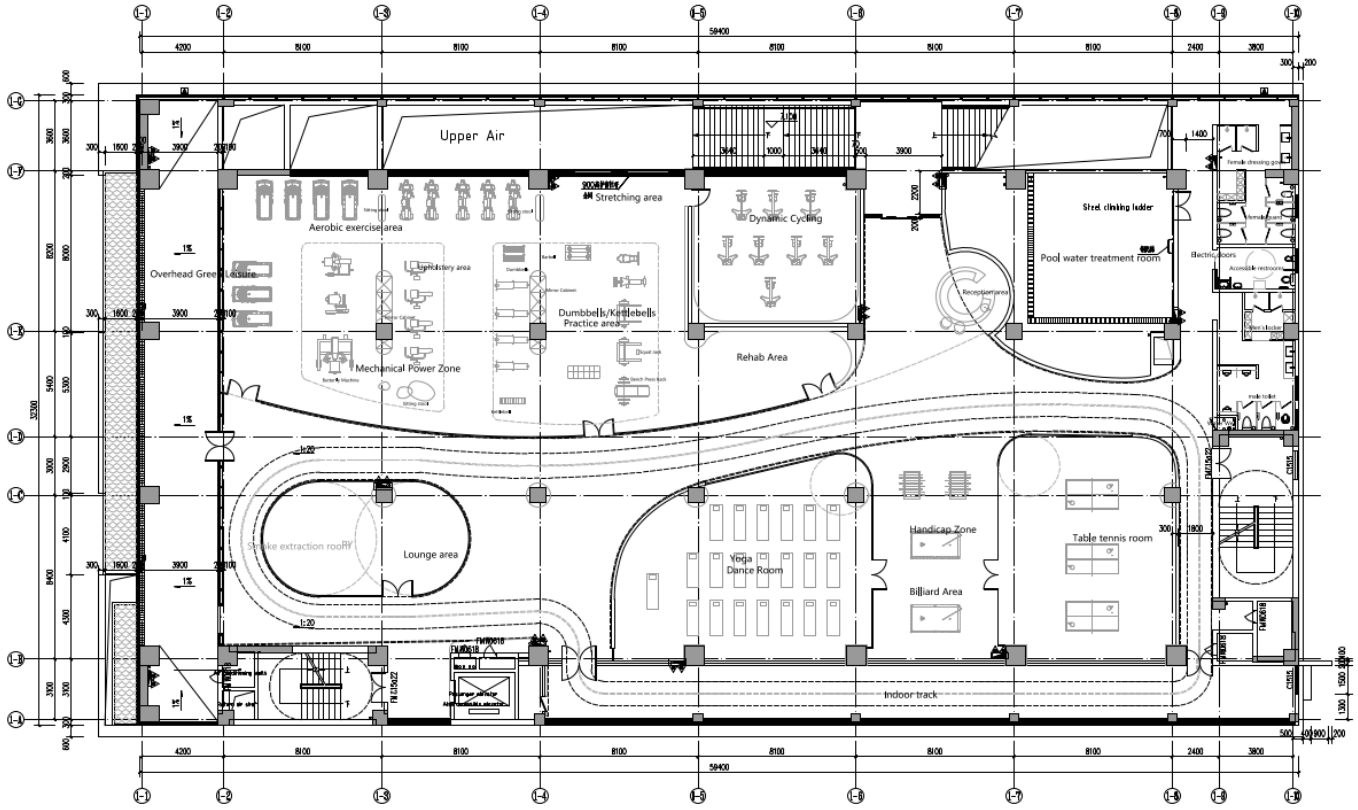
Ground floor



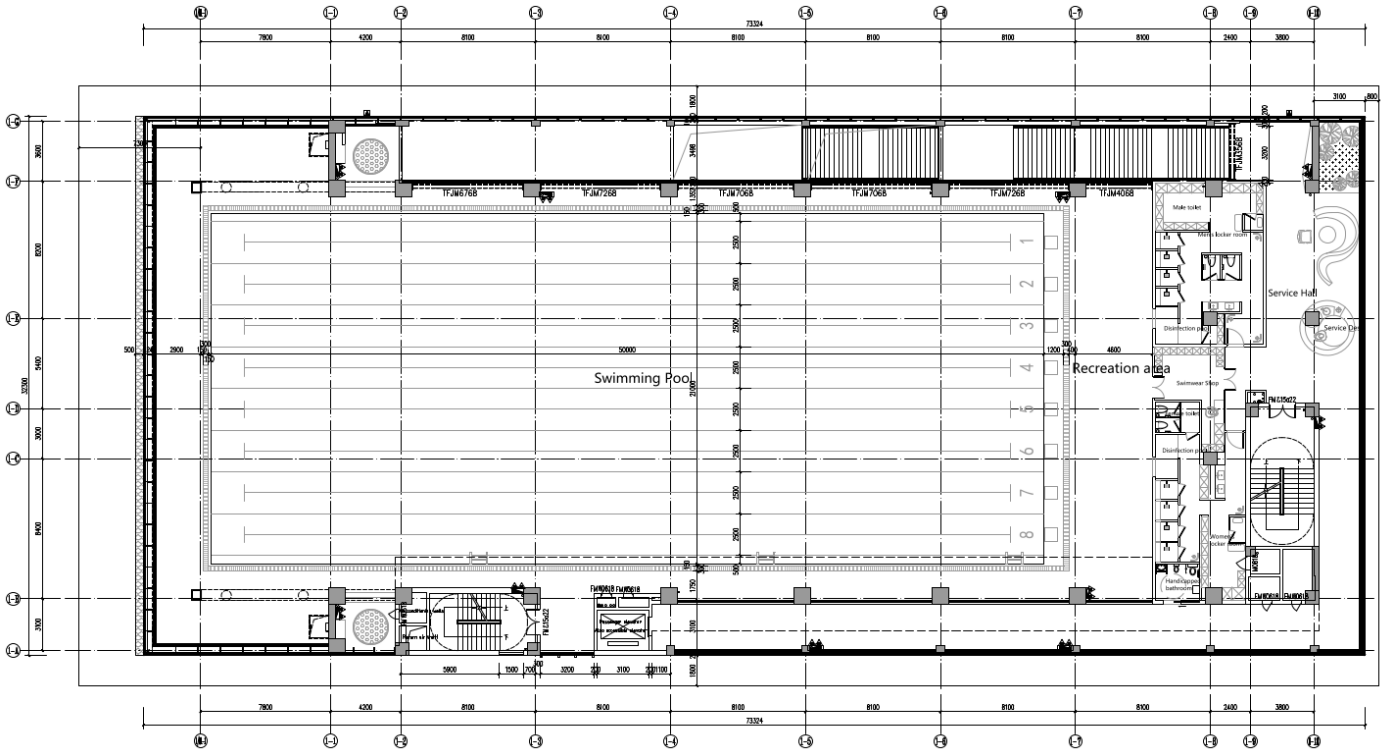
1st floor



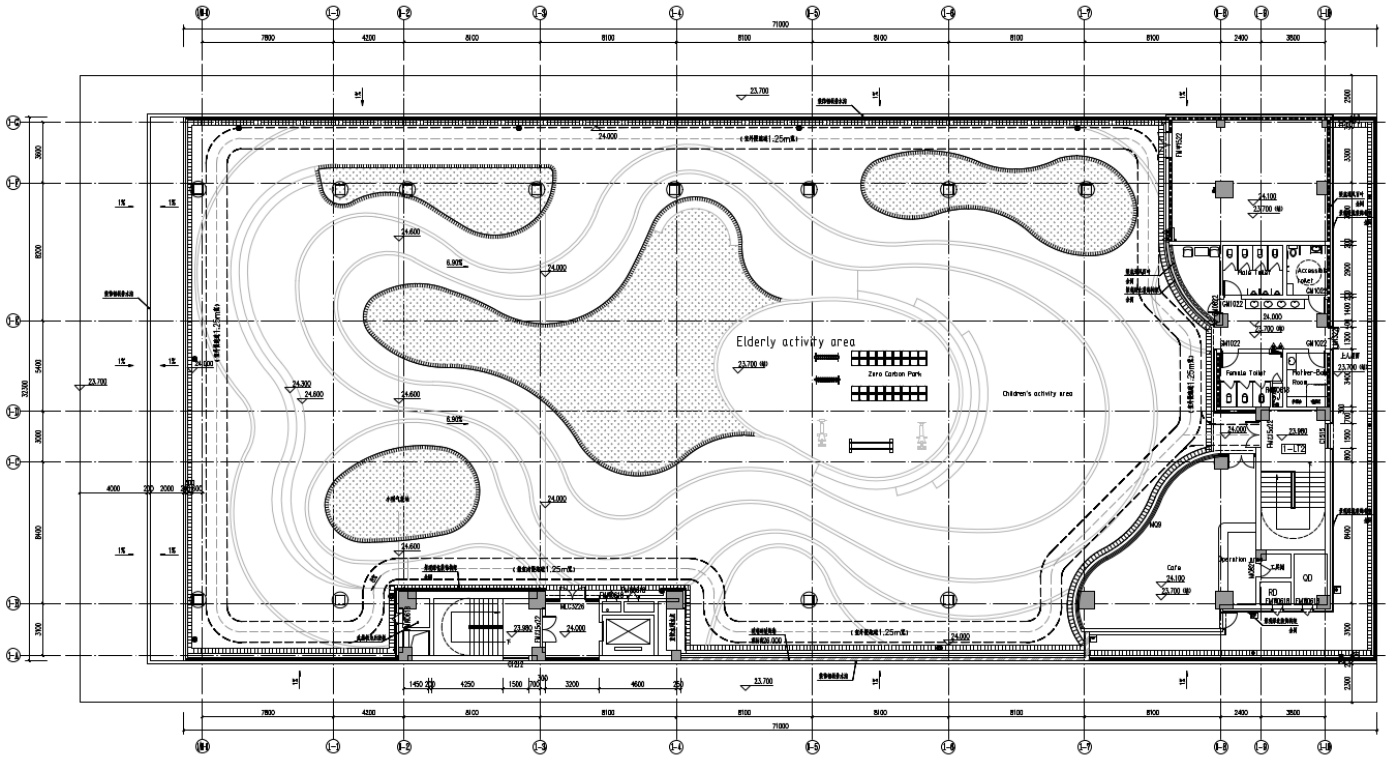
2nd floor



3rd floor



Roof


Elderly activity area
Zero Carbon Park
Children's activity area
Cafe

Annex 2. Energy concept

Waste heat cascade utilisation

Renewable energy

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中华人民共和国
住房和城乡建设部

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