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

Training Building of Long Shan Shu Yuan

Shaoxing

ENGLISH VERSION

JULY 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

让我们共同打造气候中和的未来
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

Design and layout:

Intep-Skat

Cite as:

Lu-Pagenkopf, F., Wojtas, W., Stulz, R., Zhu, J., Wang, X. (2024). Training Building of Long Shan Shu Yuan Shaoxing. Sino-Swiss Zero Emissions Building Project Demonstration Project Report. Intep-Skat: Zurich

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 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.

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

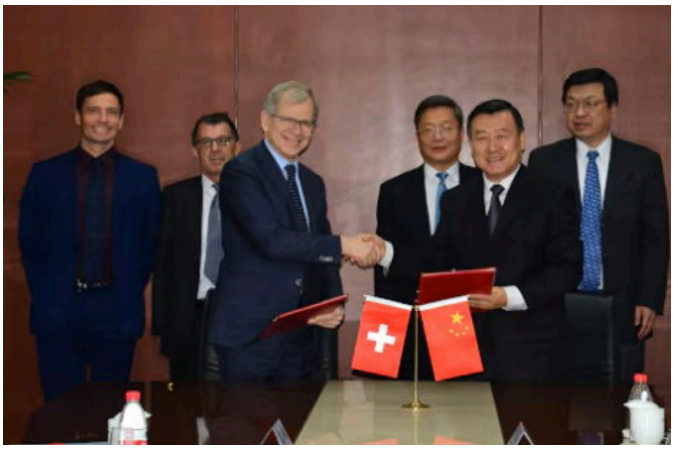


Figure 1. Ambassador Bernardino Regazzoni and Vice Minister Ni Hong, sign the project agreement. Image: Swiss Embassy in Beijing

ZEB China project duration:

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

Project impact on climate protection:

Reduce CO2 emissions in China's building sector.

1.2. Selecting of Demo Projects

Demo project goals

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

Evaluating committee and the selecting 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.

Selecting 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%), light-house 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

- Shaoxin/Zhejiang is very liberal and known for being supportive for green technologies and innovative projects. So, we expect a positive polit-

ical commitment

- The project could become a good example for public building like school, lecture building and office building in the climate zone of Zhejiang province and its surrounding provinces.
- Usage: The only school campus in the selection.
- Climate: at the selection moment it is the only one in summer-hot-winter-cold climate zone
- If the planning and realization of the building and the district would be postponed by one or two years the entire campus could be designed as a ZEB district.
- The number of potential direct and indirect of beneficiaries likely is very high
- Even if not a high-profile project, if there was enough time to optimise the project' s energy related design, the Campus could well serve as attractive model for a Zero Emission District

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.

Project Duration

May 2021 – August 2024

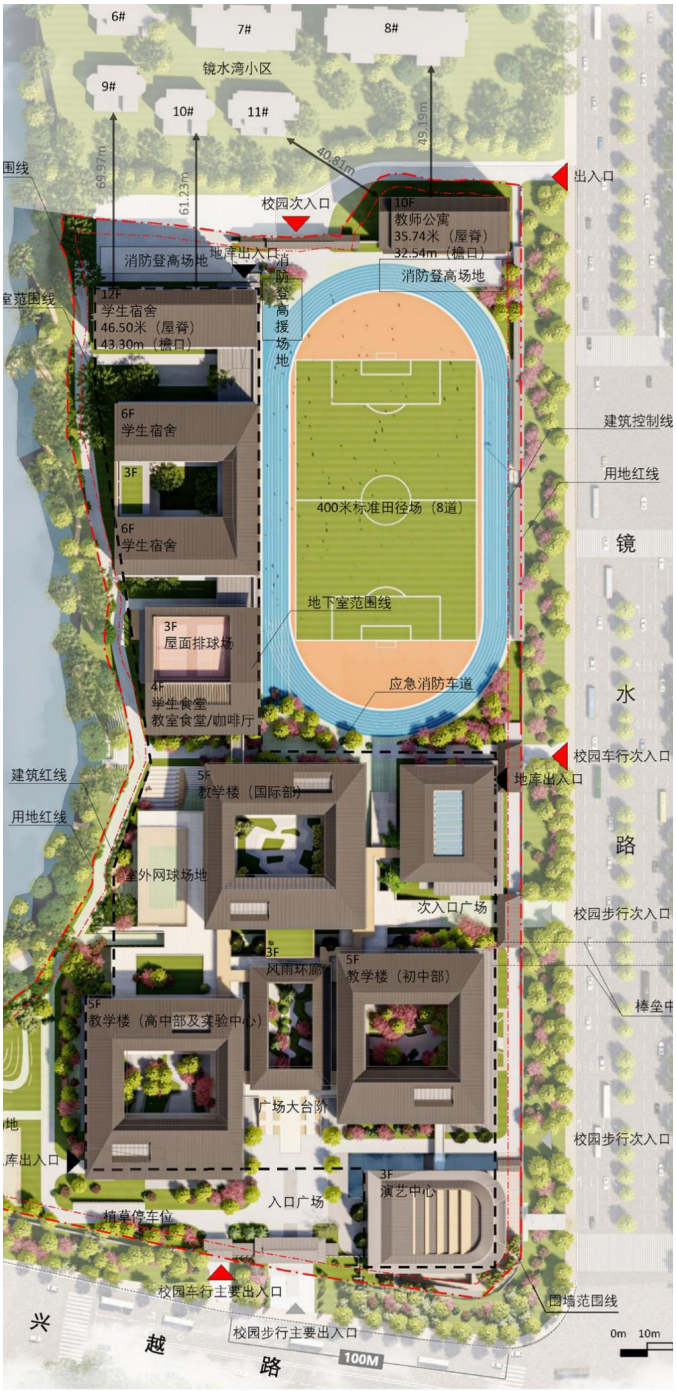


Figure 2：Aerial view of the whole campus with the demonstrations building in red-dashed line. Source: Project Presentation 22.06.2022 ©CABR

2. PROJECT INITIAL STATE

2.1. Project organization

In March 2022, the “Training Building(4#) of Long Shan Shu Yuan Middle School in Shaoxing, Zhejiang” 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 May 2021 and, after more than two years of joint efforts by Sino-Swiss teams, is expected officially completed with its construction in June 2024.

Investor

Shaoxing Future Community Development and Construction Co.

Lead planning team

China Academy of Building Research Ltd.

Local Near Zero Energy Consultant

Centre for Science, Technology and Industrial Development, Ministry of Housing and Construction, Beijing Kangju Certification Centre Co.

Sino-Swiss ZEB international joint consulting team

Intep, Skat, Martin Menard, UAD, HSLU, EMPA, etc.

Economic goals

Non-profit private middle school, private institution

2.2. Project overview

Location：

Shaoxing, Zhejiang Province (Southeastern China)

Climate zone:

Hot summer and cold winter areas, subtropical monsoon climate, distinctive monsoon, four distinct seasons, mild, humid and rainy climate

Solar Irradiance Levels: III

Building type:

New construction

Building category:

School (Education)

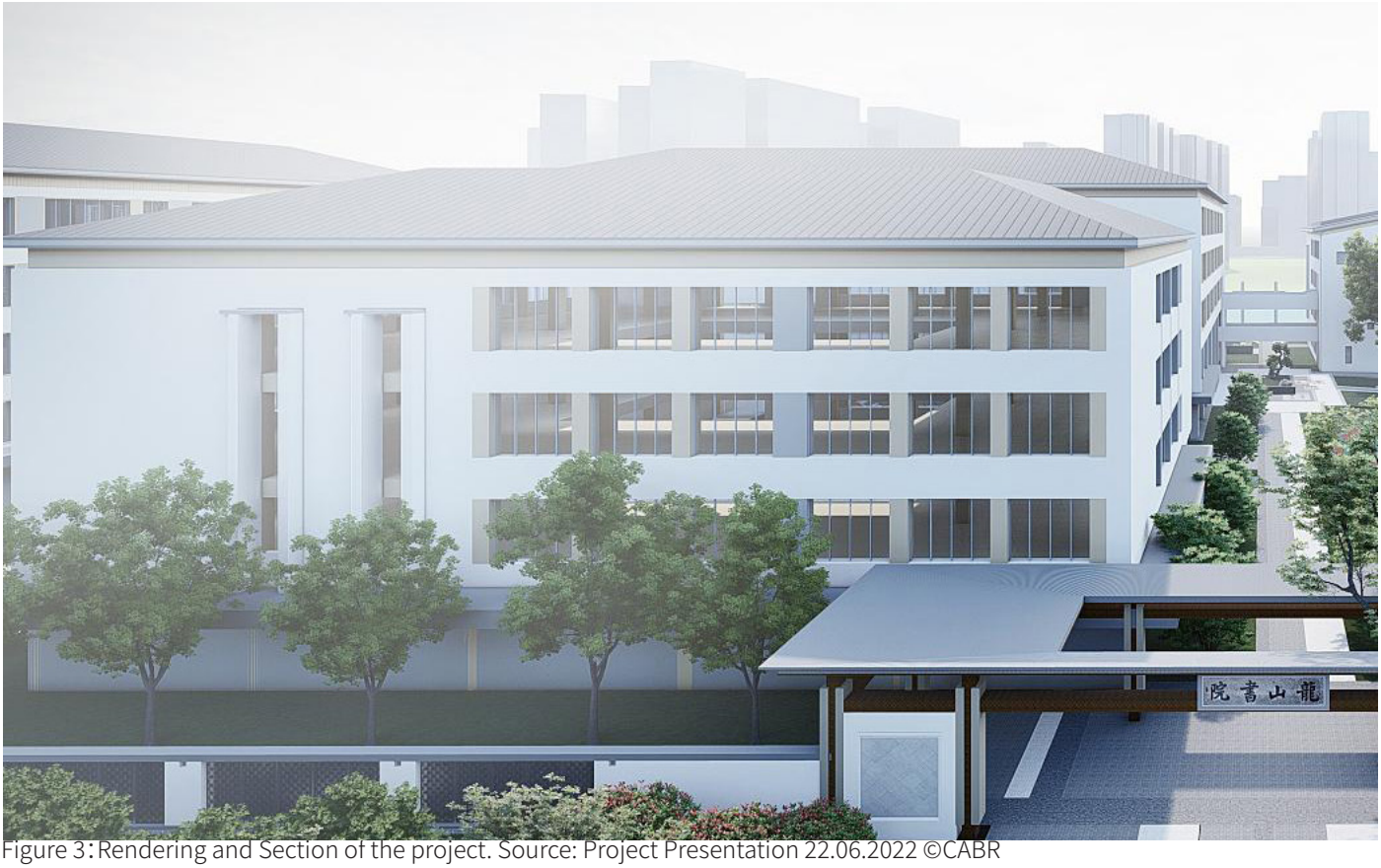


Figure 3：Rendering and Section of the project. Source: Project Presentation 22.06.2022 ©CABR

Investment costs:

1.22 billion RMB

Project scale (area index)

- Total planned land area 69’ 689.2 m2
- Total construction area of 140’ 877.99m2 (105’ 837.90 m2 above ground and 350’ 040.09 m2 underground)

Demonstration Building: 4# Training Center

- Building Size: 5’ 299.68m2
- Building Height: 19.8m(4 floors above ground)
- a multi-story teaching building with a capacity of 935 occupants.

Architectural concept highlights

(see plans in Annex A.1)

The building serves as a training center with class-rooms, labors, offices

Energy concept

- Air source Variable refrigerant flow (VRF) multi-connector units for space heating and cooling
- Mechanical ventilation with heat recovery, variable frequency fan with air volume adjustment
- No domestic hot water systems
- Lighting with efficient LED lights and automatically adjust function.

Other sustainability concepts

Roof mounted photovoltaic systems (BIPV)

Access to public/private transport

Jingshui Road (main road) on the east side, Xing Yue Road (main road) on the south side, close to the underconstruction Hang Shaotai Expressway Jingshu Interchange and the entrances of Jingshui Road and High Education Park Subway stations. (Bus station direct close to school, Subway station <1km)

Parking

588 parking spot (provide for the society, nearby there are Asian Olympic games stadiums, which also the city planning request), 500 bicycle parking spot (for student)

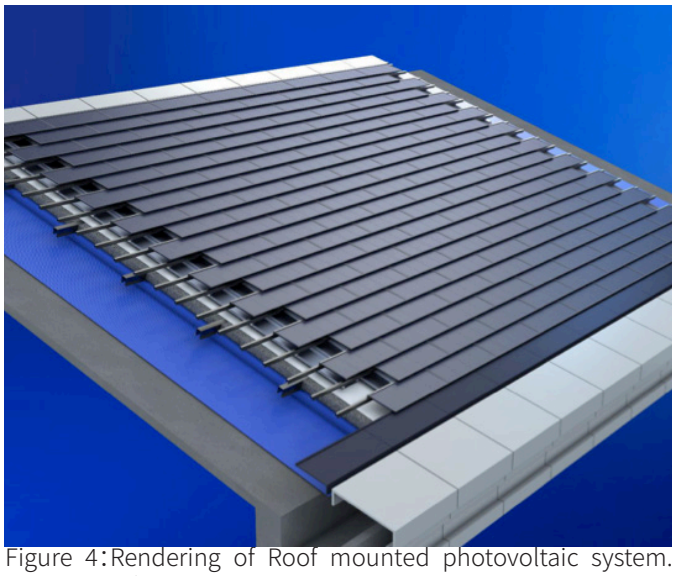


Figure 4：Rendering of Roof mounted photovoltaic system. Source: PV design Presentation 19.07.2023 ©CABR

3. SINO-SWISS COOPERATION

3.1. About the design team of demo project

As the main design unit of this project, the China Academy of Building Sciences has rich technical experience in ultra-low energy building design. As the leading unit, it jointly researched and compiled the national standard <<Technical Standard for Near-Zero Energy Building>> GB/T15350- 2019.

3.2. First evaluation of Swiss team

General evaluation by Swiss team

The special achievement of this building that it is already close to ZEB. Reasons are the simplistic and classical design as well as the lower shape coefficient (surface-area-to-volume ratio). Thus, this building functions very well as a Zero-Emission lighthouse project for similar buildings (other schools, universities, etc.) and has a great potential for replication throughout China and beyond. The building under consideration is part of a district of 70’ 000 m2 land area and 140’ 000 m2 floor area. Therefore, it could be considered as a Zero Emission District (ZED). The connection to the public transport (bus, subway) is very good.

3.3. First inputs and suggestions

- Consideration the use of the river water on the west side of the project as a source of heat and cooling for the HVAC system.

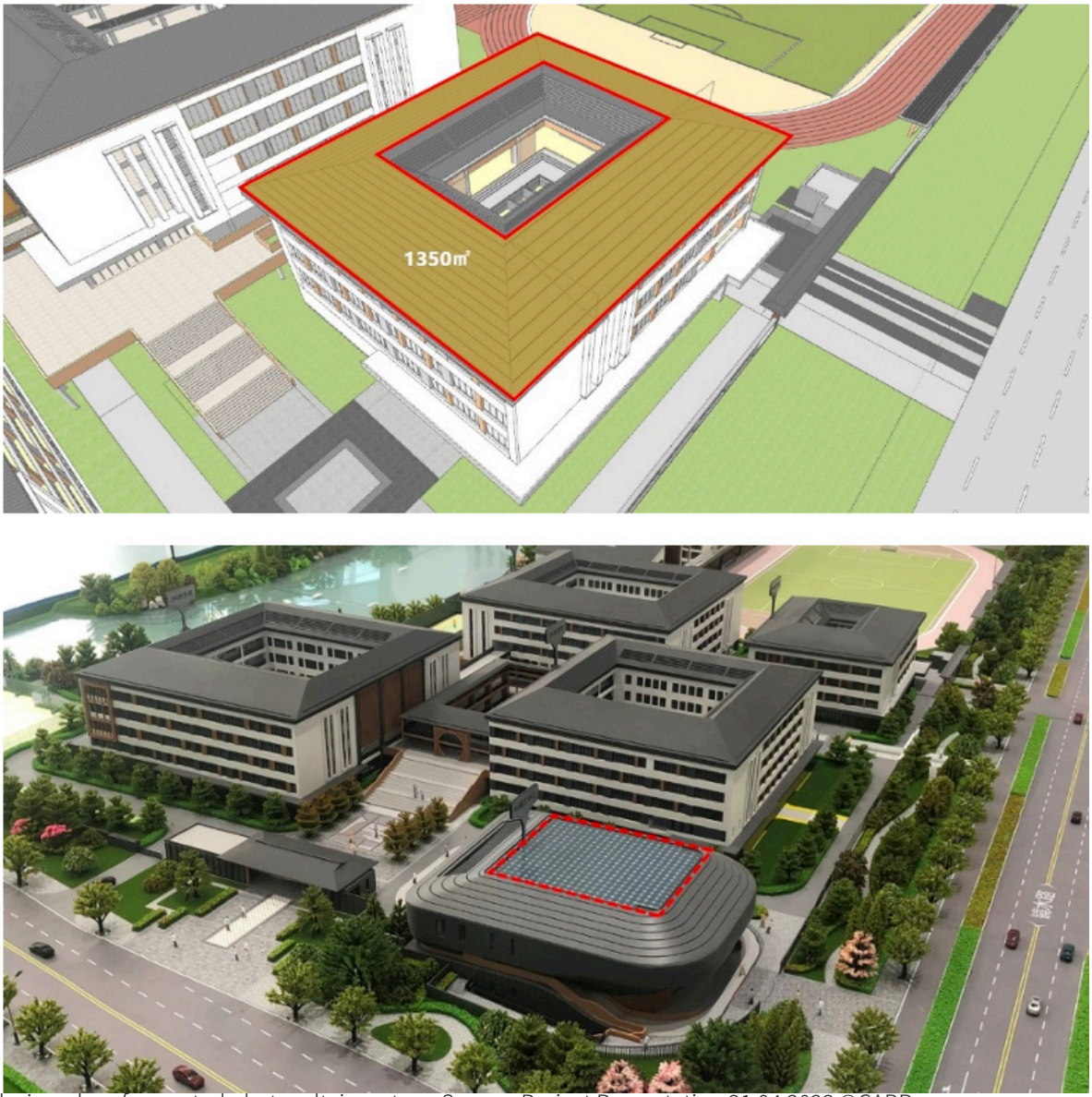


Figure 5：designed roof mounted photovoltaic system. Source: Project Presentation 21.04.2023 ©CABR

- The planning team could consider the use of a duty book.
- The ventilation and cooling of the atrium could be examined more closely.
- More data related to the indoor summer temperature and humidity could be researched as this is very important for the energy efficiency of the building.
- Solar protection and the long-term quality of the windows needs clarification.
- Natural ventilation (energy consumption) and low CO2 concrete structure (CO2 emission and embodied energy) for the large underground parking space could be considered.
- White PV-modules for façade cladding could be considered
- Consider heat recovery from cooling/dehumidification for domestic hot water.
- Low carbon materials (e.g. bamboo) could be considered.
- PV module products recommendations suitable for the demonstration project (PV tile module for Chinese roof and CdTe thin film PV module for exterior wall)

3.4. Reaction of DP team and concept improvement

After receiving the first inputs of Swiss team, the DP team gave the following responses:

- According to the authority, the river on the west side cannot be used for nature conservation reasons. Therefore, the outside air is used as a heat source and sink.
- The design team decide the installation of PV tile product modules on the roof of the project building. In addition, more PV modules decided to be installed on the roof of the art center (1#).
- The design team has considered the use of white panel thin-film photovoltaic modules in the wall area between Windows on the exterior wall of the building, which does not affect the aesthetics of the facade design while complementing the photovoltaic area. And also tried to combine the photovoltaic modules installed on the landscape structures in the project park site to supplement the photovoltaic area requirements of the demonstration building. In the end, considering the difficulty of construction and the progress of the project, white panel thin-film photovoltaic modules were not used.

3.5. Further Swiss inputs and suggestion

- BIPV (Building Integrated Photovoltaic) for the roof including recommendation of local products and contacts
- High performance window/door production with better K-Value (glass and frame)
- The calculation of energy consumption from Chinese expert is overvalued for a school building, which leads this project a huge demand on PV panels on a restricted roof area.
- The “SIA 2024 Merkblatt” for the use of classroom is provided as Swiss reference.

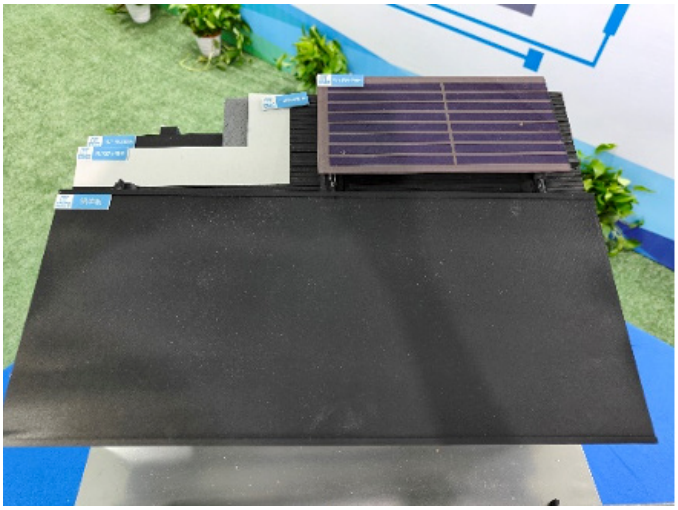


Figure 6：Construction technology of photovoltaic system. Source: technology exchange meeting 28.07.2023 ©CABR

3.6. Further improvement and knowledge received

- BIPV: Cooperation with Chinese producer, design of the suitable construction technology, considering the balance between technical performance and aesthetic quality.
- It was figured out that the difference is on occupation days: 354 occupation days for a year is not realistic for a school. Chinese team admits it but this factor was defined by clients, architects and energy experts in an early time as a user agreement in early stage. After the discussion, the Chinese team present this issue to client and refine the user agreement to reduce those factors to a realistic value.

3.7. Calculations

Improved Calculation

- Reference Building: 58.4 kWh/m2a
- Design Building after optimization: 39.5 kWh/m2a (68% of baseline)
- Yield of PV system: 24.06 kWh/m2a (Only for roof PV from DP Project 4# Training Center, the nearby building 1# can produce another 99’500 kWh, which is not calculated here)
- Carbon intensity Indicator: 7.72 kg/m2a

Figure 7 : the built BIPV (two pictures above) Source: Site Visit ©CABR

4. OUTCOME/REACHES

4.1. Confirmation of ZEB Demo Project

The experts of Sino-Swiss ZEB Project team can confirm that the project is able to achieve the Nearly Zero Carbon Building as required in ZEB Standards, especially in the operational phase.

The experts of Sino-Swiss ZEB Project team can 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.

4.2. Testimonials from demo project team

Chief Architect: Cheng Yanwei, China Academy of Building Research Co., Ltd.:

The Sino-Swiss ZEB Project team demonstrated a unique understanding of architectural design and energy solution. Through various forms of design guidance and training, they enabled architects to gain more insights and apply them practically in their designs, which has significant demonstrative and promotional value.

Project Architect: Li Ning, China Academy of Building Research Co., Ltd.:

Zero carbon is not only a mission for the construction industry but also a subject for us as individuals in the community of a shared future for all mankinds. With the increasing environmental awareness in society, the development of science and technology, and the promotion of various new energy sources, I believe that zero-carbon buildings, with their unparalleled advantages, will become the trend and future of the construction industry!

Energy Consultant: Yuan Xue, Beijing Kangju Certification Center Co., Ltd.:

This building integrates diverse elements such as nature, environmental protection, and culture into its design, which endows it with profound social impact.

Constructor: Shen Yiwen, Shaoxing City Transportation Investment Group Co., Ltd.:

Adhering to the principle of technology-enabled construction, the Longshan Academy project adopts a zero-carbon building structure, utilizing ultra-low energy consumption buildings, prefabricated technology, renewable energy utilization, fully electrified buildings, and green low-carbon transportation projects. This promotes the realization of 'dual carbon' goals in the Baseball Future Community and serves as a strong model in the Shaoxing region.

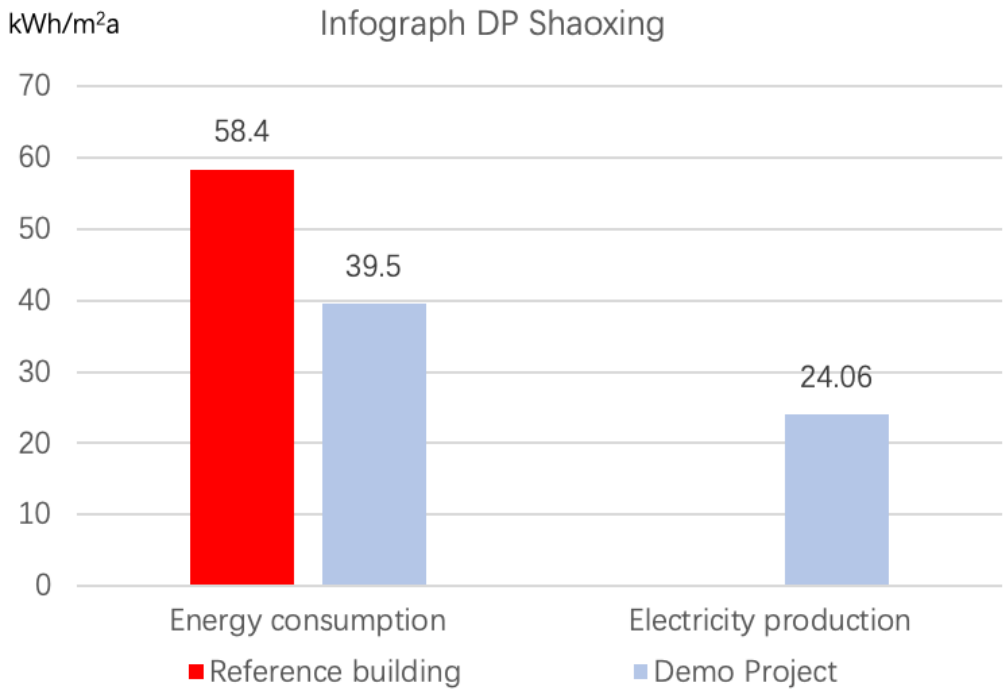


Figure 8: Comparison energy consumption with reference building, Source: Sino-Swiss ZEB Project

5. LESSON LEARNED

5.1. Management and Organization

The short design phrase in China is very challenging for Swiss expert team. The intensive and constant communication with DP team is crucial for project development. The Swiss team needs to response DPs team as soon as possible and give quick inputs so that the ideas can be adapted into the project in such a short time.

Concrete factors and numbers are more persuading that any other word or theory. With calculation tool developed by Swiss expert for example, the Swiss team can communicate with DP team in a very constructive way.

5.2. Technical Solutions

BIPV is developing and very suitable for ZEB in the future. Shaoxing project communicate with local PV producer and decide to use the PV tile product modules on the roof of the project building considering the balance between technical performance and aesthetic quality. This product should be widely spread in China with Chinese-style architecture roof concept.

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 Building Automation/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

Figure 9：2022.09.06 Project on-site visits and on-site technical exchange, source: Sino-Swiss ZEB Project

Rapid technical input sheets (RITS) about

- BIPV solution incl. façade PV and Photovoltaic tiles, local product manufacture recommendation
- 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 about:

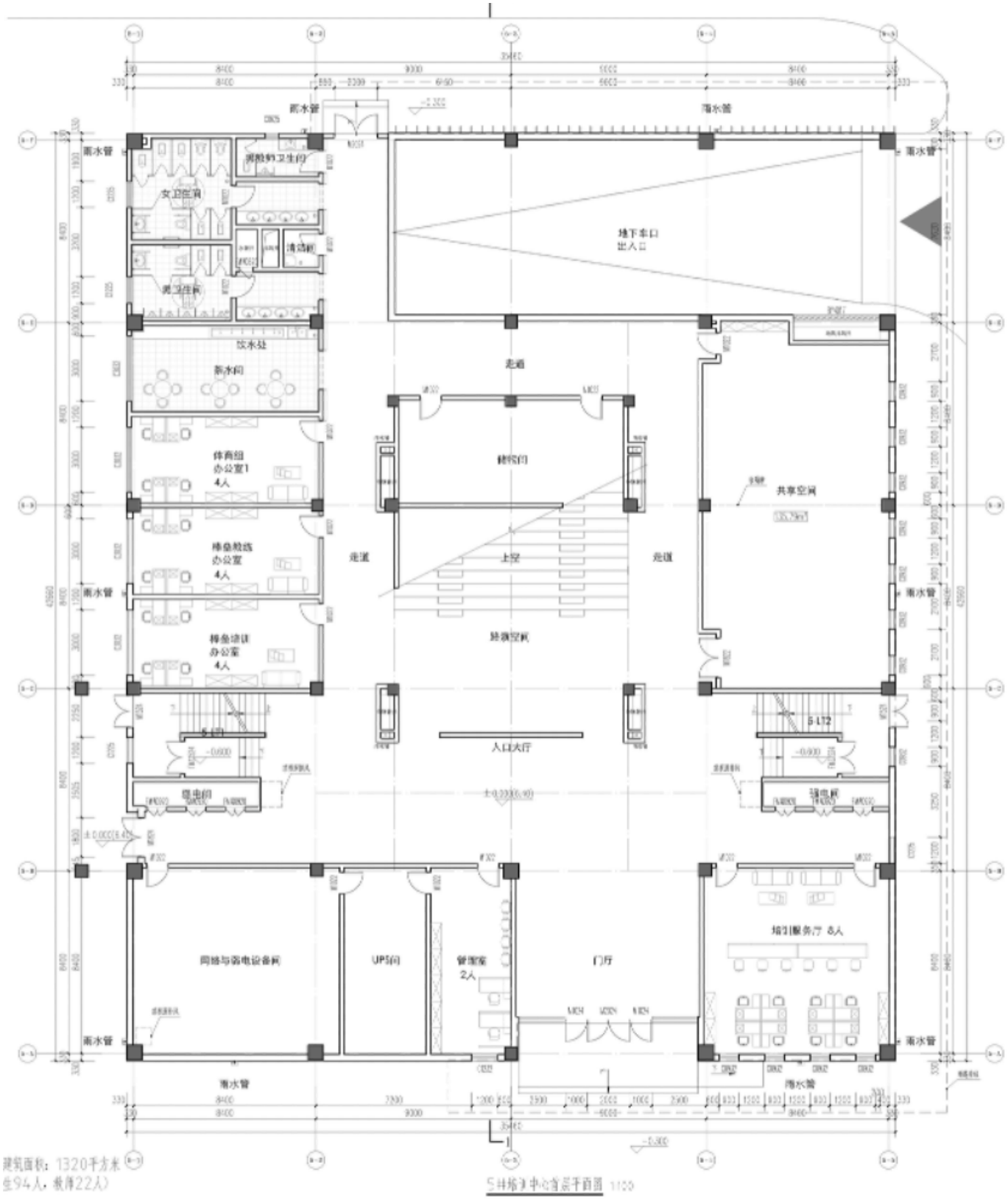
- ISO norm and SIA2040
- U-value / visible light transmission (VLT)
- Heat recovery / air handling unit / AC
- Earth tubes for ventilation system

Further performances

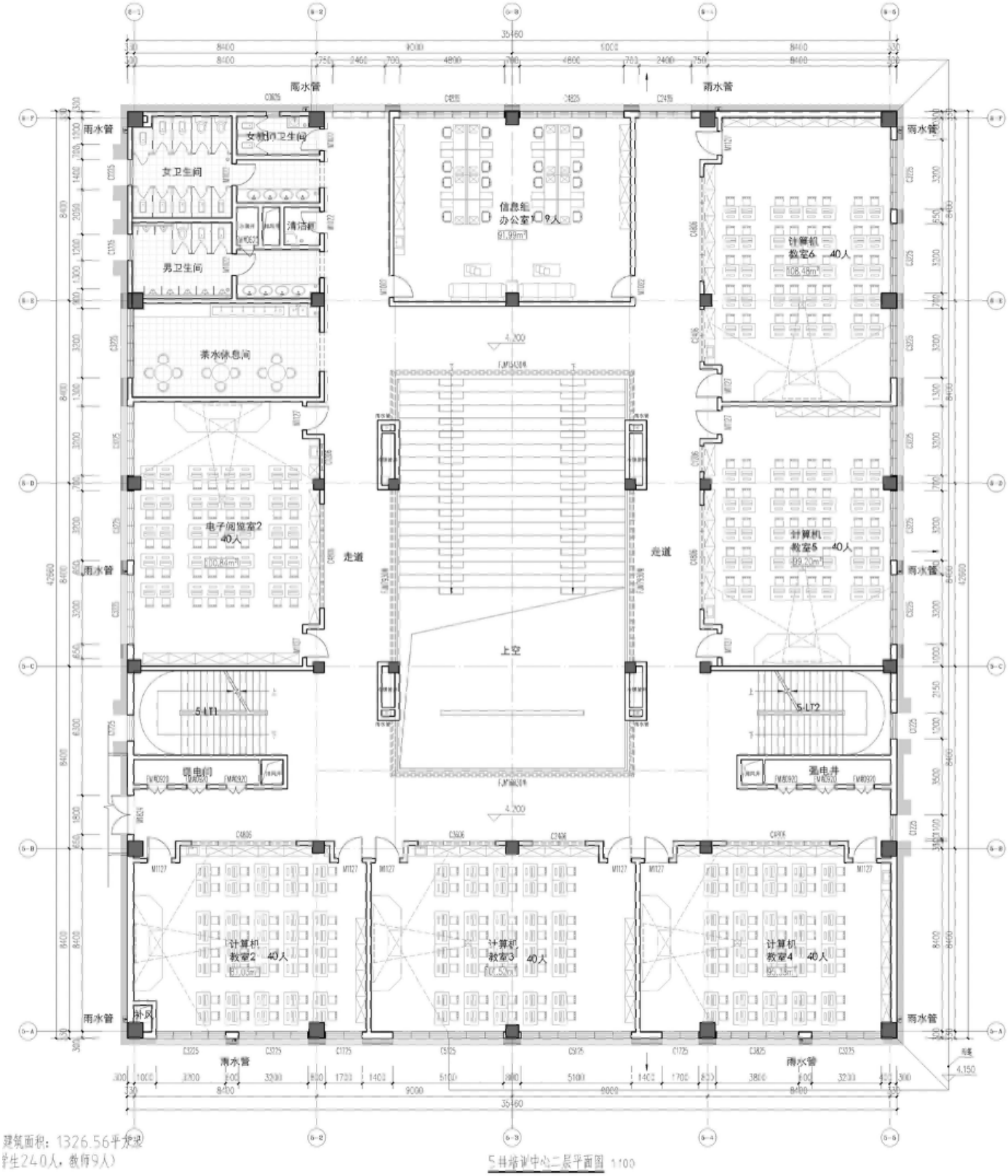
- ZEB Duty Book developed, shared and presented
- Regular exchanges and discussions per WeChat, Telephone and email
- site visit and technical exchange on construction site
- Public and internal ZEB Talks on various ZEB Topics
- Booklet regarding e.g., ZEB policies, regulations, standards, concepts and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

Figure 10：2023.04.21 Project on-site visits and on-site technical exchange, Source: Sino-Swiss ZEB Project

Annex 1. Floor plans - Ground floor

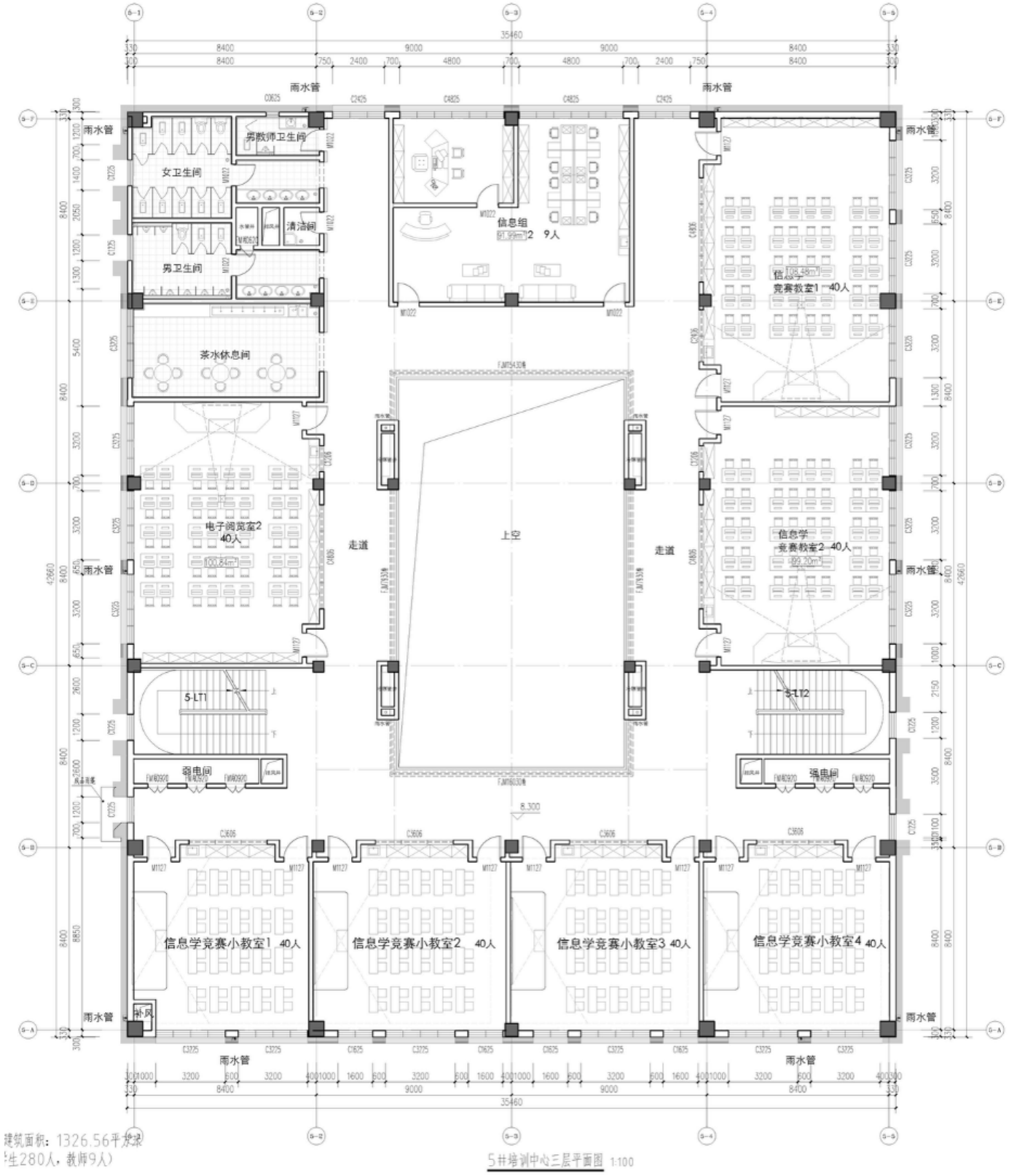


Annex 1. Floor plans - 1st floor



建筑面积：1326.56平方米
学生240人，教师9人）

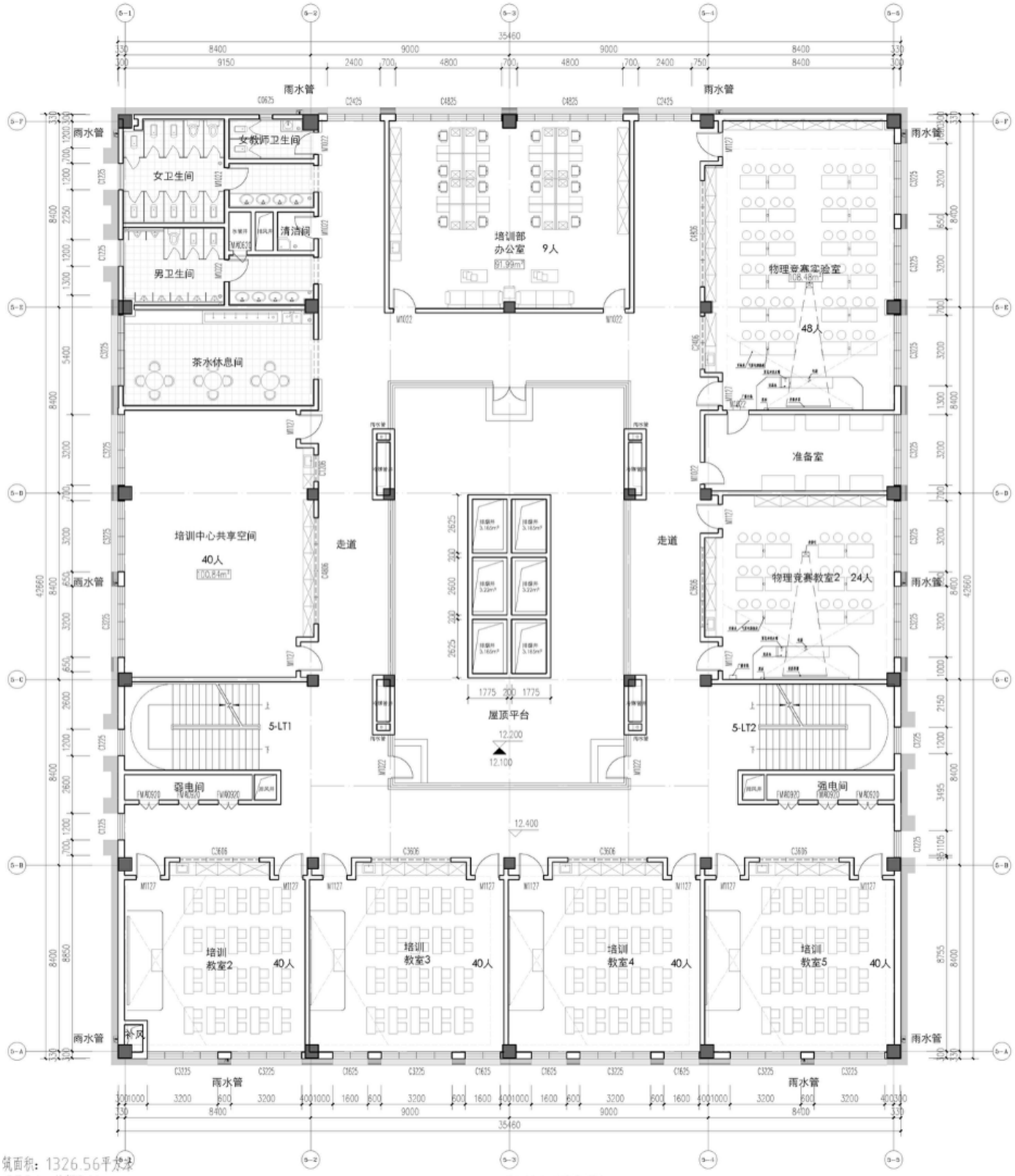
Annex 1. Floor plans - 2nd floor



建筑面积：1326.56平方米
生280人，教师9人）

5#培训中心三层平面图 1:100

Annex 1. Floor plans - 3rd floor



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
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC

IBEE 环能科技 intep skat