



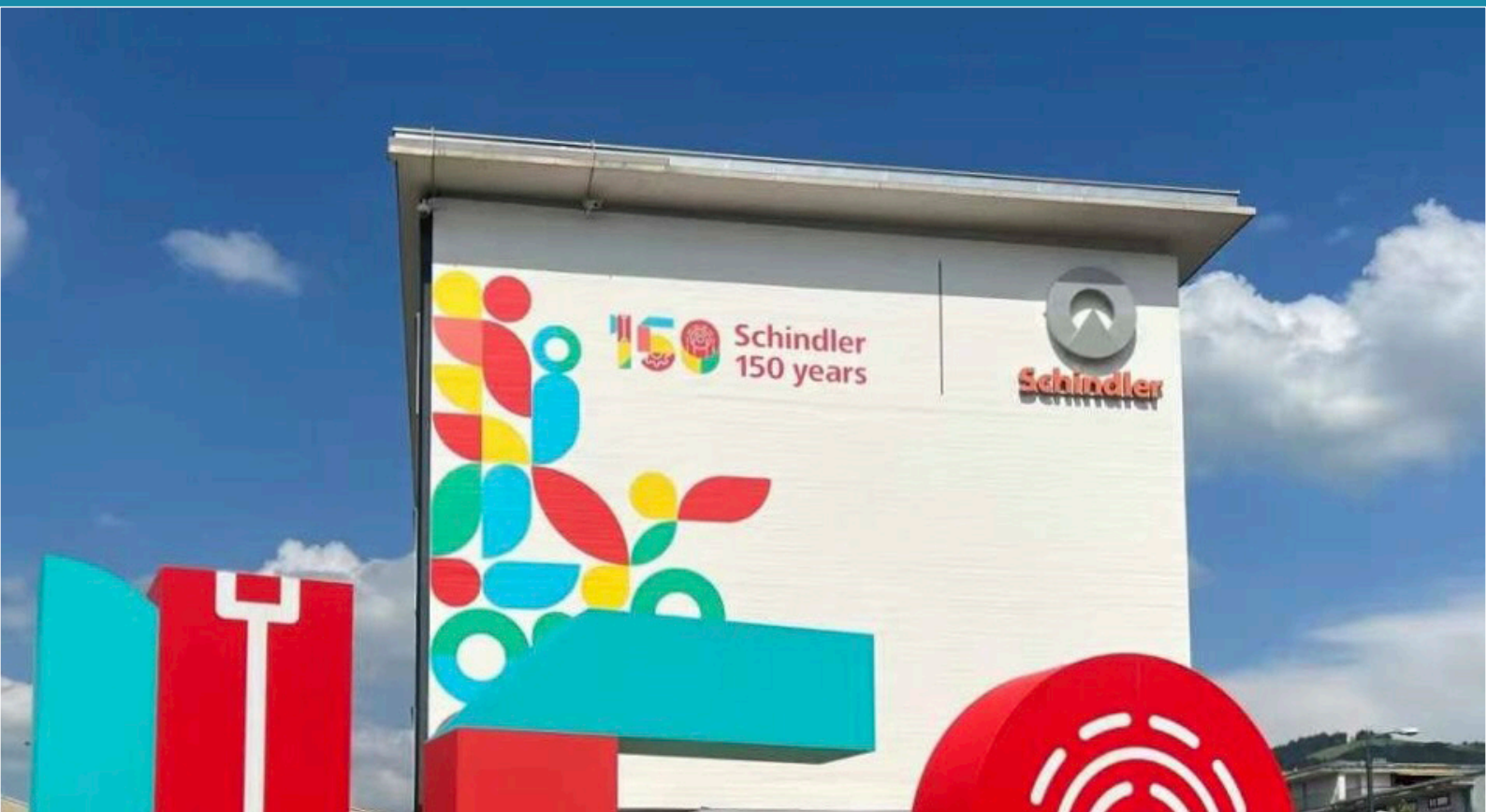
让我们共同打造气候中和的未来
Building a climate-neutral future together

Sino-Swiss Cooperation on Zero Emissions Building

Technical Report

Energy Efficient Vertical Transport

ENGLISH VERSION



JULY 2024





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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:

Kurt Steiner, Schindler

Contributions and review:

Team intep-Skat

Team CABR

Team UAD

Team Demo Project Wuxi

Team Demo Project Dalian

Team Demo Project Harbin

Design and layout:

Intep-Skat

Cite as:

Wang, X., Stulz, R., Zhu, J., Scherer, J. (2024). Anergy Networks - Shaping a low-carbon energy system. Sino-Swiss Zero Emissions Building Project Technical 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 neutral 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:

SinoSwissZEB

**Web:**

zeb-china.org



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1. PROJECT BACKGROUND

About Sino-Swiss 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 purpose

- 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

Project duration

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

Project impact on climate protection

- Reduce CO₂ Emission in building sector

Introduction of Schindler and its contribution to ZEB Project

Schindler is a global leader in urban mobility solutions, with a history of innovation and customer service since 1874. Schindler Elevator has a comprehensive range of products, mainly including elevators, escalators and moving walks, freight elevators and special purpose elevators. Schindler elevators cover from low-end residential elevators to high-end commercial elevators. Schindler Elevator adheres to advanced design concepts, focusing on safety, comfort and energy saving.

Schindler is collaborating closely with the ZEB team and advising the Chinese planning teams of the selected Demo projects. Schindler committed to support with vertical transport expertise the important initiative to reduce energy consumption on buildings in China from an elevator point of view. The inputs, as well the analysis of the demo projects was based on Schindler experience but transformed in a universally valid language.

2. EFFICIENT ELEVATORS

2.1. Introduction

The energy consumption of an elevator in a building is quite low, especially compared to heating, cooling and lightning systems. But as more energy efficient installation of Heating-, Ventilation-, Air Condition- (HVAC) and lighting systems comes, as more the energy consumption of the VT installations plays a role.

Technology perfectly suited to the environment. Elevators should be Class A rated, according to ISO 25745-2. To assess the ecological performance of elevators throughout their life, it should be provided by Environmental Product Declarations (EPD).

The overall elevator system needs to be compact, lightweight and in a durable design that optimizes material usage. Many components feature an ECO or Standby mode to reduce energy consumption by up to 40%. Gearless machine for smooth ride quality without requiring oil for lubrication, regenerative frequency converter returns energy to the grid for future use of the elevator operation are the most important components for energy optimization. Stable start without high peak current, quickly reaching a low energy consumption level. Different traction media (rope, belts, etc.) have dif. characteristics and can have benefits in energy usage or lifetime. State of the art elevator positioning system eliminates unnecessary trips to reset the system. Control system should switch car lights and ventilation into stand-by mode. Smart operation, down collective and selective collective controls for efficient passenger transportation are key. Car ceiling lights, car indicator and landing indicators feature LED technology which last 20x longer and consume less energy than standard lights. Door drive with stand-by mode for safety and energy conservation are important. Light-weight interior materials improve operational efficiency and energy usage as well.

Regenerative drives return energy a building's power grid to be used for the operation of the elevator. Available with geared - and gearless traction equipment. Benefits less net power usage means lower monthly utility bills for customers. Reduced heat generation means reduced cooling requirements in the elevator machine room. Heat generation can be reduced up to 50% depending on size of equipment. Possibility of rebates from government sponsored and local utility programs potential to earn points toward Green Building certifications.

2.2. ISO 25745 (GB/T 30559)

Energy efficiency calculation and classification follows international standards. ISO 25745 series:

- ISO 25745-1:2023 > GB/T 30559.1-2014 Energy measurement and verification
- ISO 25745-2:2015 > GB/T 30559.2-2017 Energy calculation and classification for lifts (elevators)
- ISO 25745-2:2015/Amd 1:2023 (new) Amendment 1: Express zones
- ISO 25745-3:2015 > GB/T 30559.3-2017 Energy calculation and classification of escalators and moving walks

Energy classification of elevators, escalators and moving walks are defined to compare same/similar application and calculation of estimated annual energy consumption. Assessment of single unit only possible, useful for comparison, but group algorithm is not considered

In Scope: All components necessary for intended and safe use.

Out of Scope: Additional customer specific components like air con, CCTV, information screens, air purifier, etc. For estimation of the annual energy consumption, they need to be individually added. Their contribution may be substantial as they tend to be running all day.

Usage categories are used to anticipate different application and intensity of use. Comparison of energy performance is only possible within the same usage category. Good understanding of the intended use of the elevator in the building is essential to determine the appropriate usage category for efficiency assessment and estimation of energy consumption.

The application area and the applied usage category impact the energy efficiency class and the estimated energy consumption. Energy optimization focus depends on application and intensity of use. If travel is dominant, drive system efficiency and moving mass is important. If standstill is dominant, efficiency of permanent running components, standby/sleep modes, tuning off are key.

In addition, appropriate dimensioning of car dimension/load, weight of car interior decoration (moving mass), which optional equipment is really needed, installation quality impacts friction. maintenance quality impacts system losses due to deterioration over time.



Effects of lift group dispatching are not considered with ISO 25745-2. Traffic calculations for designing the group and intelligent group traffic control may bring additional savings up to 40%, due to switching off elevators in low use phase or on weekends.



Figure 2: Rendering of demo project Wuxi, focus on public building only (marked with a red circle). Source: DP Wuxi

3. ANALYSIS OF THE DEMO PROJECTS

All three demo projects had high estimated energy consumptions or other special effect. The inputs were shared by ZEB project and analyzed by Schindler based on experience with similar projects/applications.

3.1. Demo project Wuxi

3.1.1. Project initial data

- Location: Wuxi, Jiangsu province
- Climate: hot summer and cold winter
- Size: Gross building area Building 1#: 14' 900 m²(3 above-ground floors and 1 below ground floor)
- Function: Mix functions with office, conference, exhibition, education

3.1.2. Inputs

- Elevator #1: single lift, probably a VIP elevator, 11.9m travel height, 3 stops
- Elevator #2: single lift, probably a service elevator, 6m travel height, 2 stops
- Elevator #3 & #4: duplex lift, public person transport, 11.9m travel height, 3 stops
- Elevator #5: duplex lift, mix used for service and person transport, 6m travel height, 2 stops
- Elevator #6: duplex lifts, mix used for service and person transport, 11.9m travel height, 3
- Escalator #7 & #8: duplex ESC (one in upwards the other in downwards direction), 6m vertical distance, 35° inclination, 1m step width, 13.378 horizontal distance
- Annual energy consumption for the 6 elevator, estimated by ZEB team 16' 502 kWh

3.1.3. Analysis

- Load 1' 000-1' 350 kg (1' 250kg is quite unusual for this market), speed 1.0 m/s, number of stops 4-6 (estimation, based on the picture), tips per day 125 (based on our experience, fits quite good with the 0.5h/day running).

- We'd get 730-850 kWh/annual/unit, with 6 units this would then be 4' 380-5' 100 kWh/annual for the lifts, this would be then 3-4 times lower than ZEB team's estimation.
- The Schindler estimation is based on similar application and according to ISO, options that are not part of the ISO calculation are not considered.
- In addition, there is a potential, depends on the usage of the elevator, the layout of the elevator group, etc. with smart group controller/traffic management system to reduce 30% on top.
- the escalator needs to be considered as well, this estimated with 3' 435 kWh/annual/unit in the highest energy class.

3.1.4. Lessons learned

To minimize the energy consumption of the elevator and escalator in a public building like the demo project in Wuxi, the layout of the building and the access to the vertical transport equipment is important. For example, if an attractive staircase is prominent positioned in the entrance hall to move-up only one floor, the elevator can be a bit behind and only for handicapped or material transport, so the demand of usage will be low.

In case of elevator group to serve several floors, a smart group controller should be considered, to optimize performance in high traffic time and reduce energy consumption in low traffic slots.

Elevator and escalator should always be ordered in highest energy efficiency class, the small cost adder will give a pay back after few years.

Elevator car deco should be selected carefully, every kilogram weight counts, must be transported up and down the full lifetime.

For special usage like this mix used building, a traffic simulation with focus on energy optimization could be a good investment already at the beginning.



3.2. Demo project Dalian

(This demo project will not to be realized)

3.2.1. Project initial data

- Location: Dalian, Liaoning province
- Climate zone: cold
- Size: Gross building area 160' 000m² (Example Building 1#-135: 3931m²), energy reference area 86' 050 m² (according to ratio of building 1#-135)
- Function: residential

3.2.2. Inputs

Single elevator per residential building, 1000kg load, 1.0m/s speed, 7 stops, 22m travel height.

3.2.3. Analysis

Annual anergy consumption, based on similar application 700-800 kWh. The Schindler estimate is based on similar application and according to ISO, options that are not part of the ISO calculation are not considered.

3.2.4. Lessons learned

Elevator should always be ordered in highest energy efficiency class; the small cost adder will give a pay back after few years.

Elevator car deco should be selected carefully, every kilogram weight counts, must be transported up and down the full lifetime.



Figure 3: Rendering of the project. Source: DP Dalian.

3.3. Demo project Harbin

DP Harbin is a renovation project; the ZEB team's energy estimation of the single elevator may base on an old existing installation.

3.3.1. Project initial data

- Location: Harbin, Heilongjiang province
- Climate zone: severe cold
- Size: Gross building area: 8' 610 m² (7 above-ground floors and 1 below-ground floor)
- Function: office building

3.3.2. Inputs

- Single elevator per residential building, 1350kg load, 1.75m/s speed, 8 stops.
- Annual energy consumption for the single elevator, estimated by ZEB team: 15' 019 kWh

3.3.3. Analysis

- Annual anergy consumption, based on similar application 1' 400-2' 700 kWh.
- The Schindler estimate is based on similar application and according to ISO, options that are not part of the ISO calculation are not considered.

3.3.4. Lessons learned

- Elevator can be modernized, and a new modern one would have factor less energy consumption.
- To decide a full replacement or a part modernization to be done, other factors as general condition of the elevator and the availability of spare parts needs to be considered as well

4. CONCLUSION

The collaboration between the demo projects and Schindler has shown, that there is quite a potential to optimize vertical transport installations in new and existing buildings in China.

The estimation of energy consumption from ZEB team may were too conservative but probably also consider options not calculated by ISO.

For buildings with single elevators, the energy efficiency class is the most important. All elevator (class A) and escalator (class A+++) companies should be able to calculate the annual energy consumption according to ISO and show they are able to reach highest energy efficiency class, in case of same usage category used, the calculations are comparable. Small additional cost for higher energy efficiency will give pay back after few years.

For more complex, mixed-use buildings, a traffic simulation will give a good base to optimize elevator and escalators. The layout of the building and the position of vertical transport systems also plays an important role. If an attractive designed and prominent positioned staircase in a lobby can reduce the one floor traffic dramatically.

Group of elevators in a bank should be managed by smart group and destination controller. This can optimize the number of elevators, give best performance during high traffic time, and optimize energy consumption during low traffic slots.

Regenerative inverter, permanent magnetic motors, LED car lights and indicators/screens should be state of the art, but nevertheless needs to be checked by the offer.

Heavy car interior should be prevented, as every kilogram on the elevator car needs to be moved up and down the whole lifetime of the elevator.

Beside the very energy efficient elevator and escalator during the usage phase, the embodied carbon should also be considered, what can make a big part of the environmental impact. This is usually detailed and transparent documented with an environmental product declaration and 3rd party verified.

Elevator and escalator are not the big energy consumer of a building, but as more efficient the HVAC and the lighting systems comes, as more the energy consumption of the VT installation plays a role.



Figure 4: project façade after renovation. Source: DP Harbin.



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