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

南京大学建筑与城市规划学院
School of Architecture & Urban Planning, NJU

中华人民共和国
住房和城乡建设部

IBE 环能科技
中国建筑节能协会

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

intep
skat Swiss Resource Centre and Consultancies for Development

# Sino-Swiss ZEB Project - Capacity Building at Nanjing University

# 中瑞零碳建筑项目 – 南京大学能力建设活动

## Interdisciplinary for Zero Carbon Buildings

## 跨学科促进零碳建筑

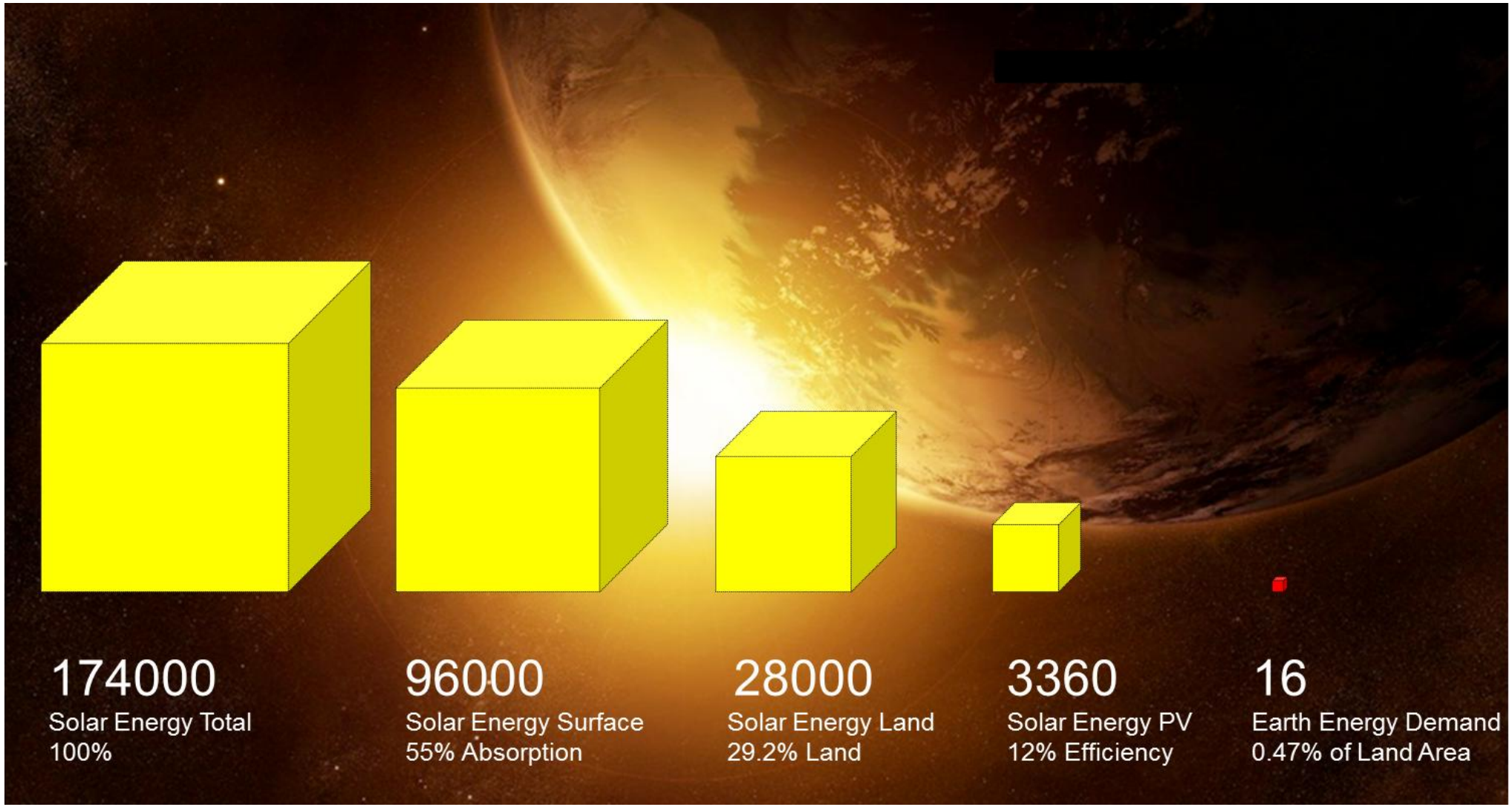
April 18th 2025， 2025年4月18日

Prof. Adrian Altenburger, HSLU

**Adrian Altenburger教授， 卢塞恩应用科技与艺术大学**

# 目录 Table of content

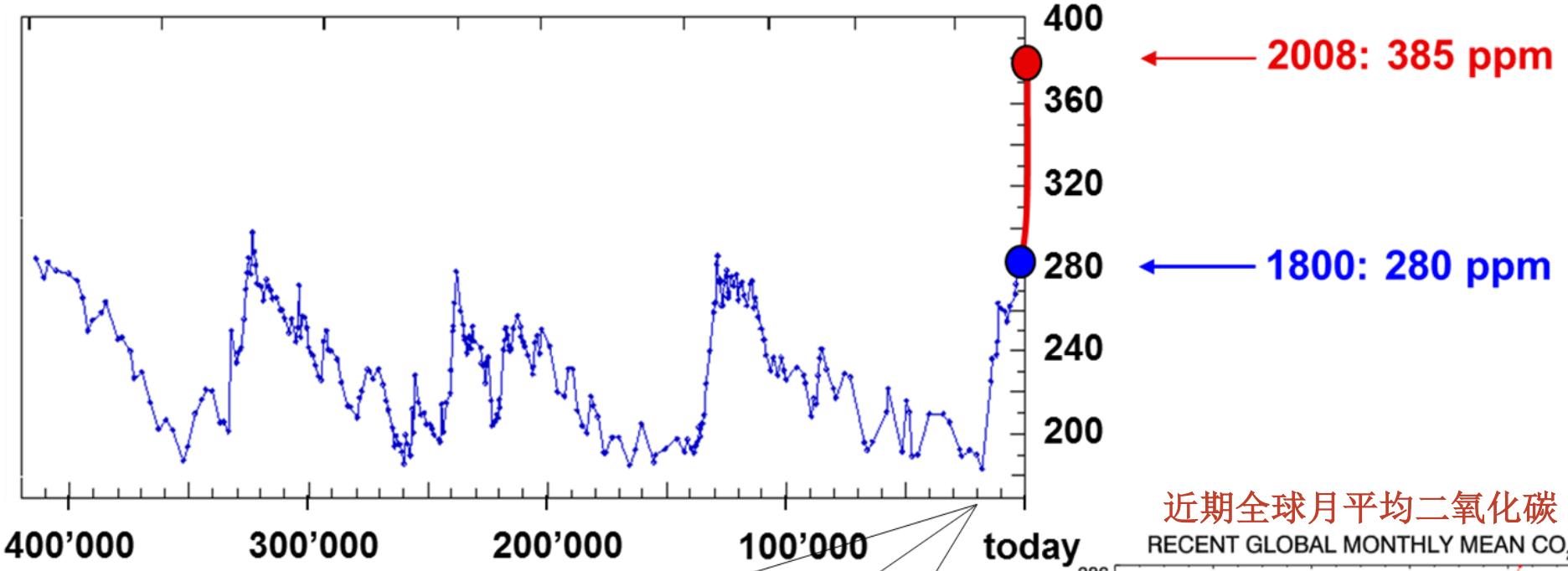
# 01 简介 – 能源不是问题（太阳能系数 10000）



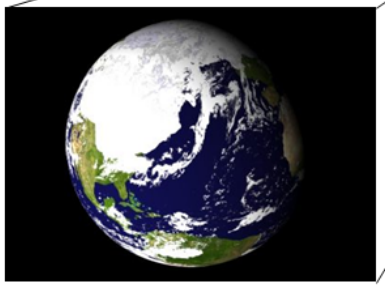

INTRO – ENERGY IS NOT THE PROBLEM (SOLAR ENERGY FACTOR 10000)

# 01 简介 – 问题：二氧化碳排放（气候变化风险）

INTRO – PROBLEM: $CO_2$ EMISSIONS (RISK OF CLIMATE CHANGE)

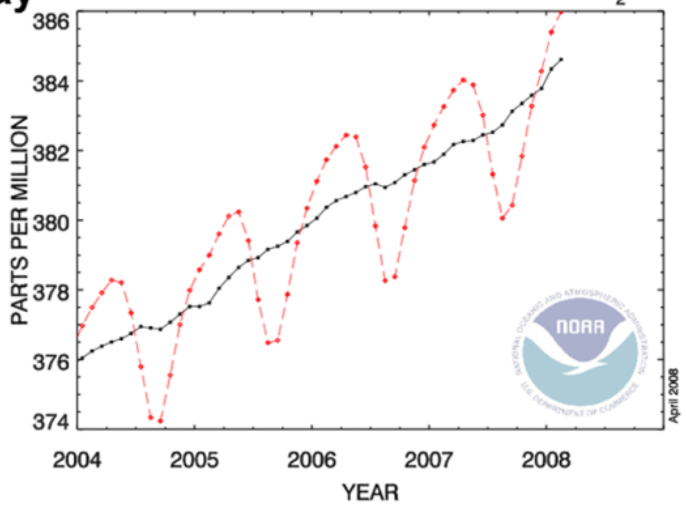



Last Ice Age Peak:
- Sea Level = -120m
- Temperature = -8K



近期全球月平均二氧化碳

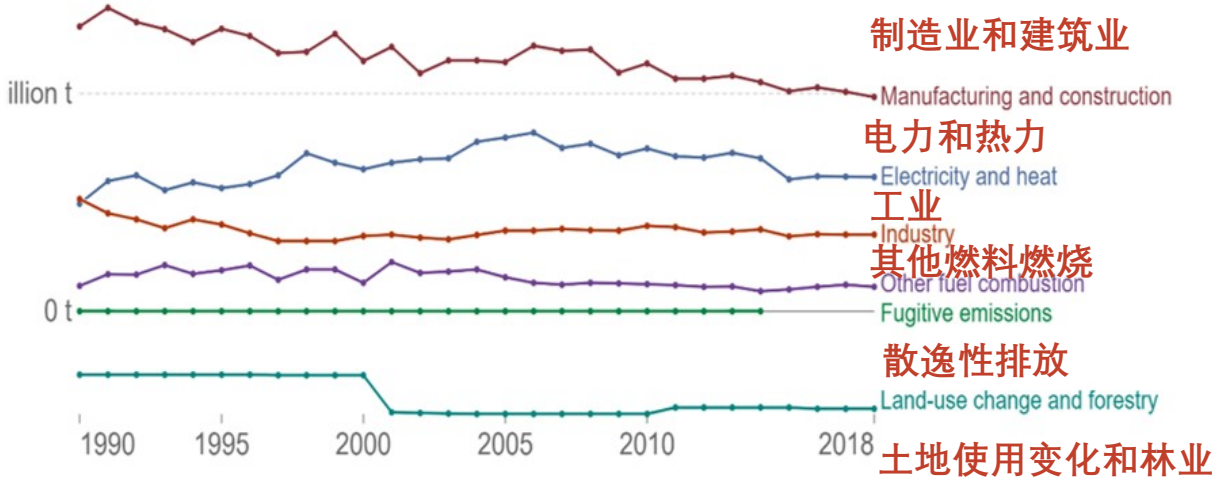
RECENT GLOBAL MONTHLY MEAN $CO_2$



# 01 简介 – 问题：二氧化碳排放（瑞士的发展）

INTRO – PROBLEM #1: $CO_2$ EMISSIONS (DEVELOPMENT SWITZERLAND)



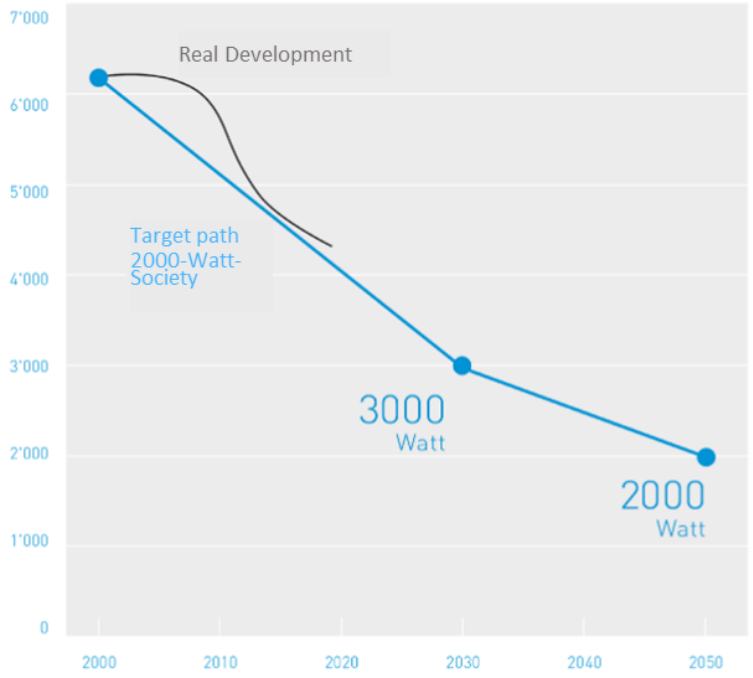


# 01 简介 – 解决方案：脱碳（瑞士到 2050 年实现净零排放）

INTRO – SOLUTION: DECARBONISATION (SWITZERLAND NET ZERO BY 2050)

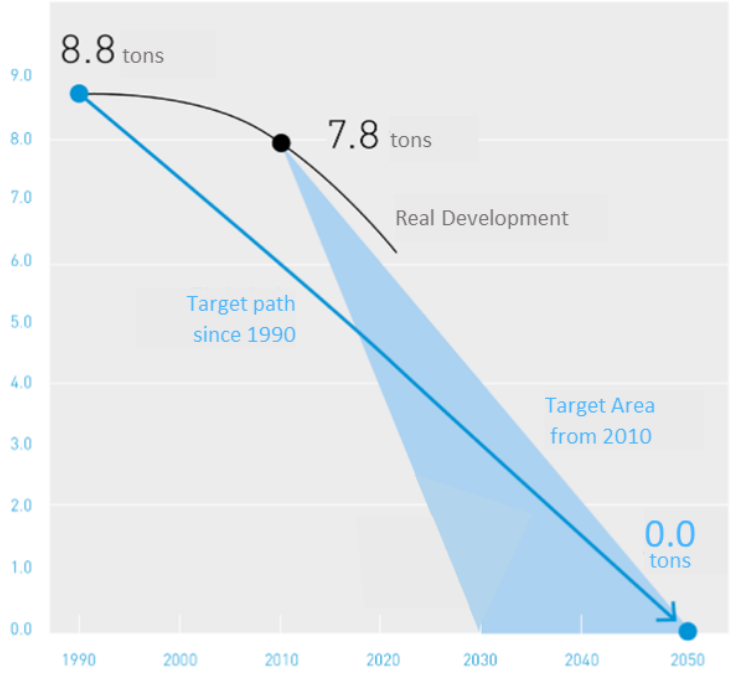
## 目标1：能效

Objective 1: Energy Efficiency
2000 Watt primary energy
Continuous output
**2000瓦一次能源持续输出**



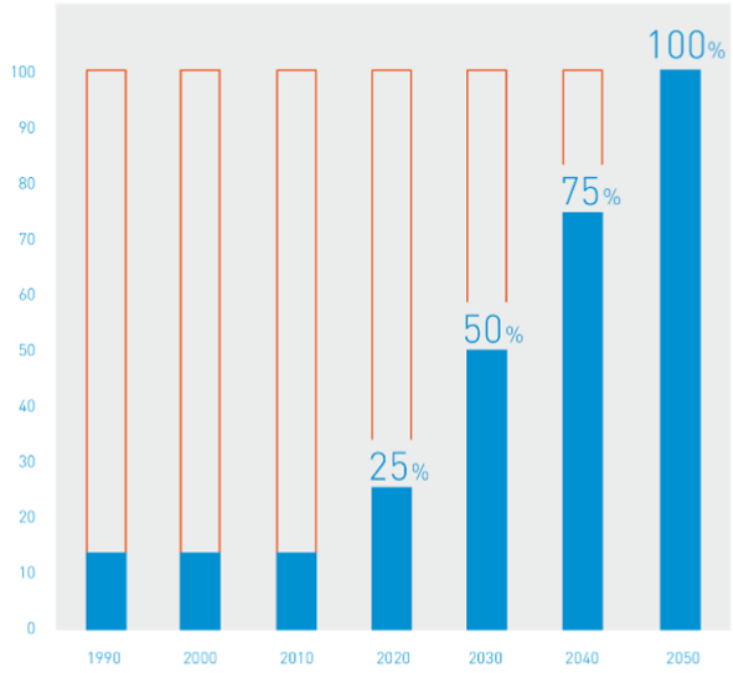

## 目标2：气候中和

Objective 2: Climate neutrality
Zero energy-related greenhouse gas emissions
**与能耗相关的温室气体零排放**



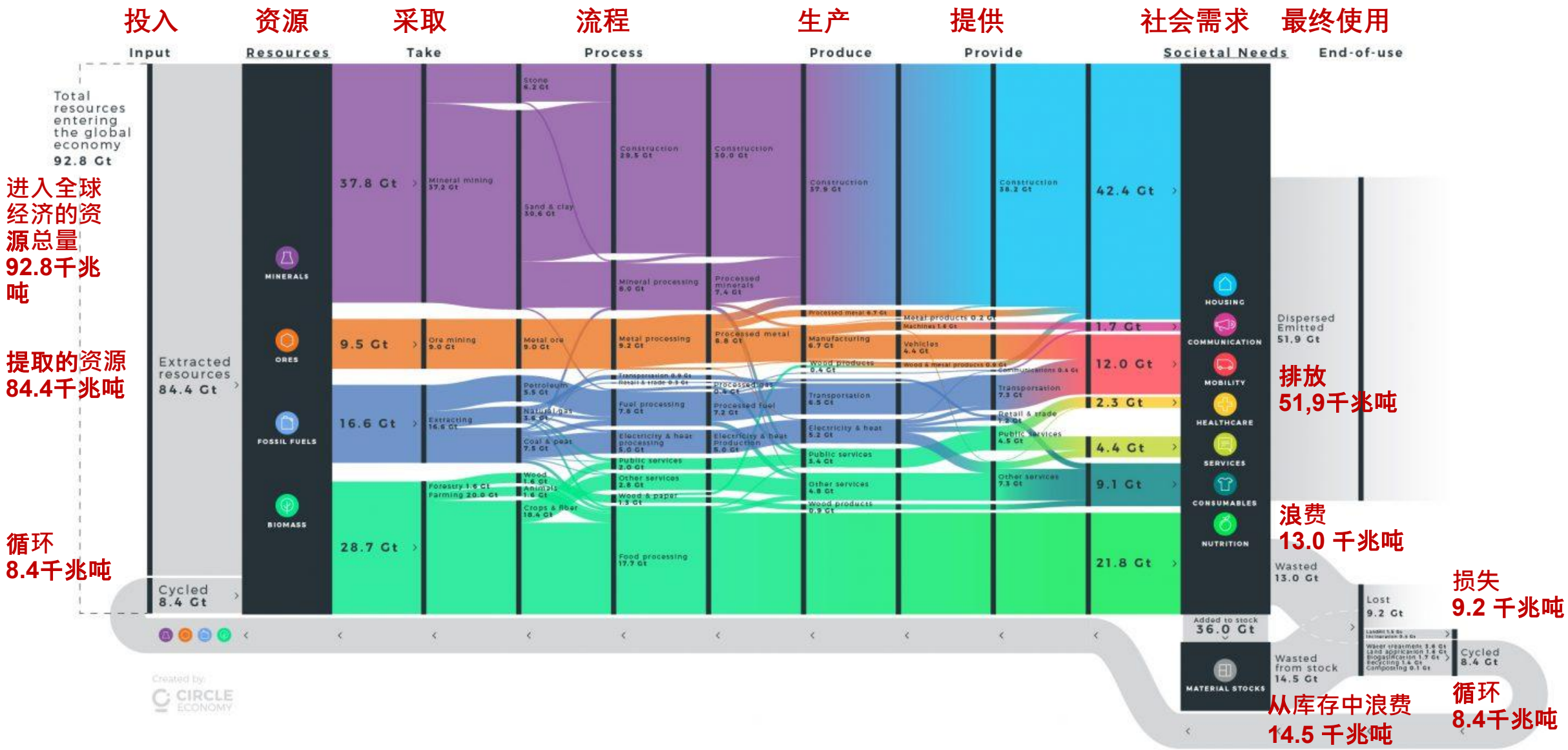

## 目标3：可持续性

Objective 3: Sustainability
100% renewable energy
**100%可再生能源**



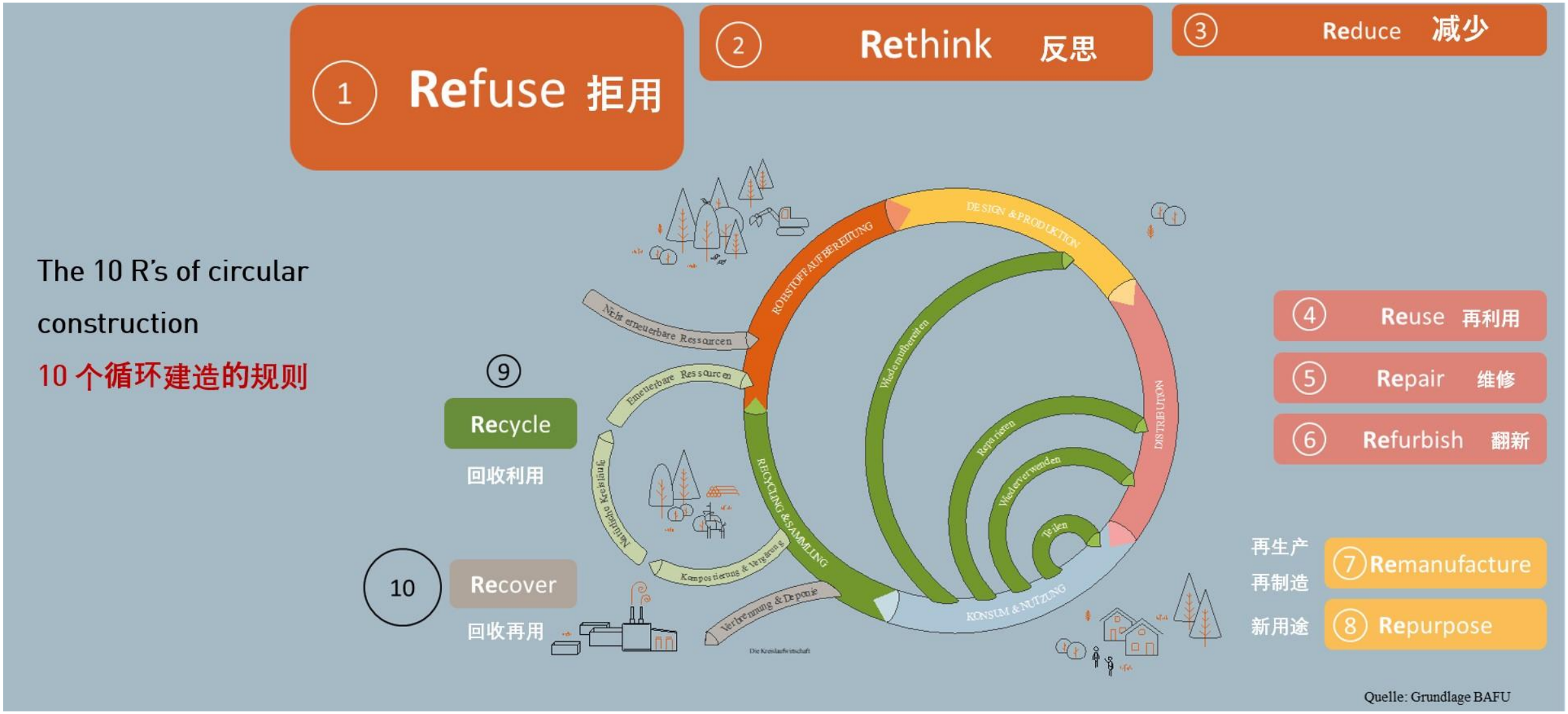
# 01 简介 – 问题：资源消耗（全球建设：46%）

INTRO – PROBLEM #2: RESOURCE CONSUMPTION (GLOBAL CONSTRUCTION: 46%)



# 01 简介 – 解决方案：循环建造

INTRO – SOLUTION #2: CIRCULAR CONSTRUCTION ECONOMY



# 02 跨学科促进零碳建筑（以少胜多）

Interdisciplinary ZEB
less can be more

团队 1
TEAM

**团队：基于任务和能力组建团队，包括资深建筑师、土木工程师、建筑服务工程师以及建筑物理、幕墙规划等领域的专家。**

Team Composition: Depending on task and competences (core disciplines architecture, civil engineer, building services engineer and specialists such as building physicists, facade planners, etc.)

要求 2
PREMISES

**要求： 必须为所有人所知，并如实声明。要求必须全面合理（也针对客户）。**

Premises: Must be known to all and declared as such. No premises without comprehensible justification (also vis-à-vis the customer).

规则 3
RULES

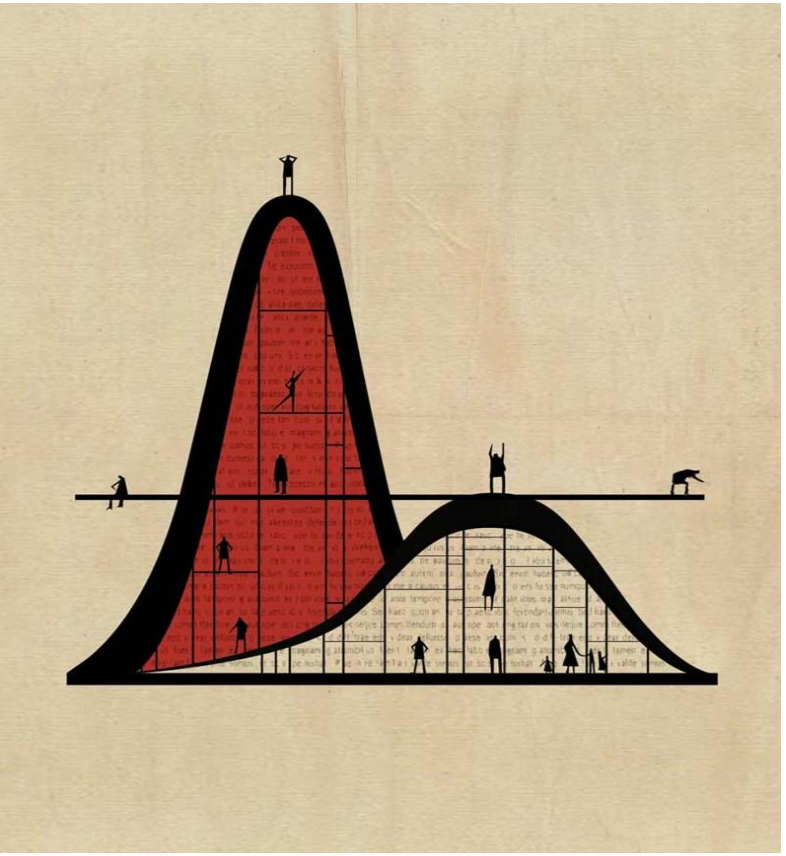
**规则：必须明确能力和责任。最佳的解决方案需要过程中的灵活性（反复寻找最优解决方案）。**

Rules: Competencies and responsibilities must be clear. Optimal solutions require flexibility in the process (iterative solution finding).

# 02 基于专业学科能力的跨学科解决方案

**Interdisciplinary solutions are based on disciplinary competences**

# 1 团队构成
TEAM COMPOSITION



## 零碳建筑涉及到以下任务

INVOLVEMENT FOLLOWS TASKS FOR ZEB

**建筑 – 基于零碳建筑的建筑设计和建材选用**

Architecture – ZEB mainly related to design and materials

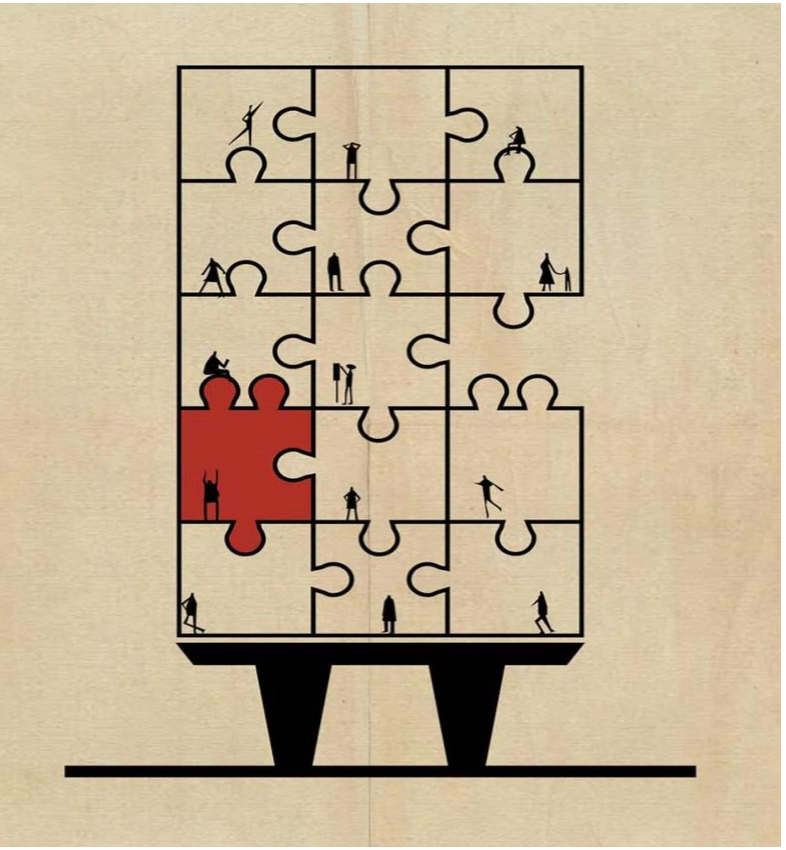
**结构工程 - 基于零碳建筑的材料和结构**

Structural Engineering – ZEB mainly related to materials and structure

**建筑技术工程 - 基于零碳建筑的能源来源和系统效率**

Building Technology Engineering (MEP) – ZEB mainly related to energy sources and efficiency of systems needed

# 2 要求
PREMISES



## CLEAR AND IN LINE WITH ZEB OBJECTIVES – DUTY BOOK

**明确并符合零碳建筑目标–责任手册**

ZEB design phase - e.g. target values for energy efficiency, comfort parameters, degree of self-sufficiency, etc.

**设计阶段 – 比如能源效率、舒适度参数、自给自足程度等目标值**

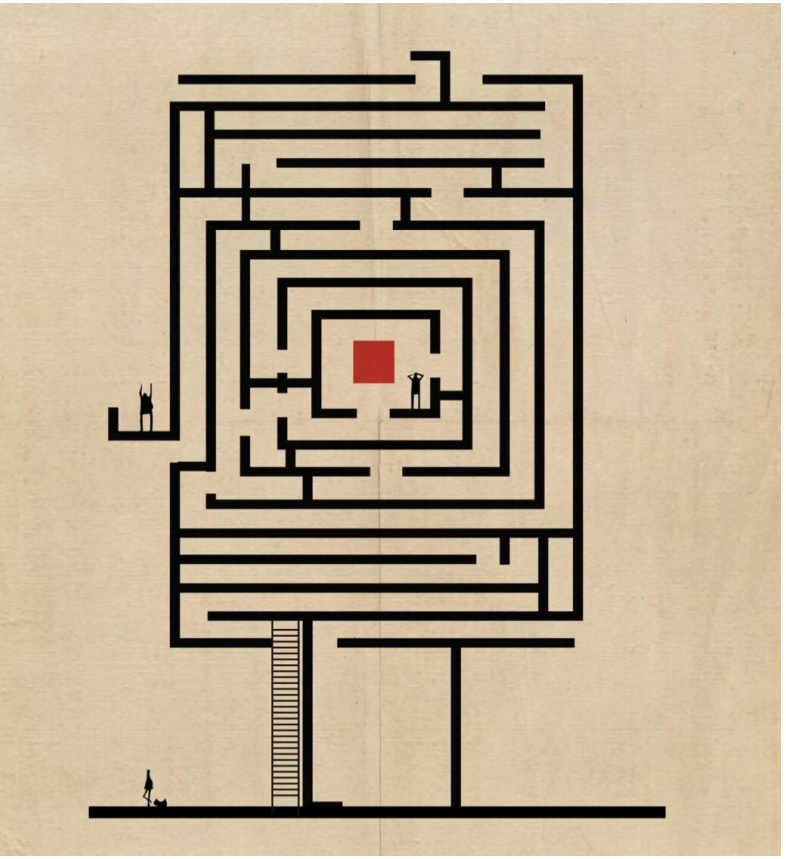
ZEB construction phase - e.g. target values for percentage of re use for materials and components, ongoing quality controls in prefabrication and on site etc.

**建造阶段 – 比如材料和部件再利用百分比的目标值，预制件和现场施工的质量控制等**

ZEB operational phase - e.g. tolerance values compared to planning, monitoring data, periodicity of optimizations, etc.

**运行阶段–比如与规划、监测数据和优化阶段相比的允许偏差等**

# 3 规则
RULES



## 规则为提高流程效率服务

RULES SERVE PROCESS EFFICIENCY

**第一步：规范规则，背景分析，团队确认**

Step 1: Disciplinary order and context analysis and confirmation in the team

**第二步：定义零碳建筑目标及权重（责任手册）**

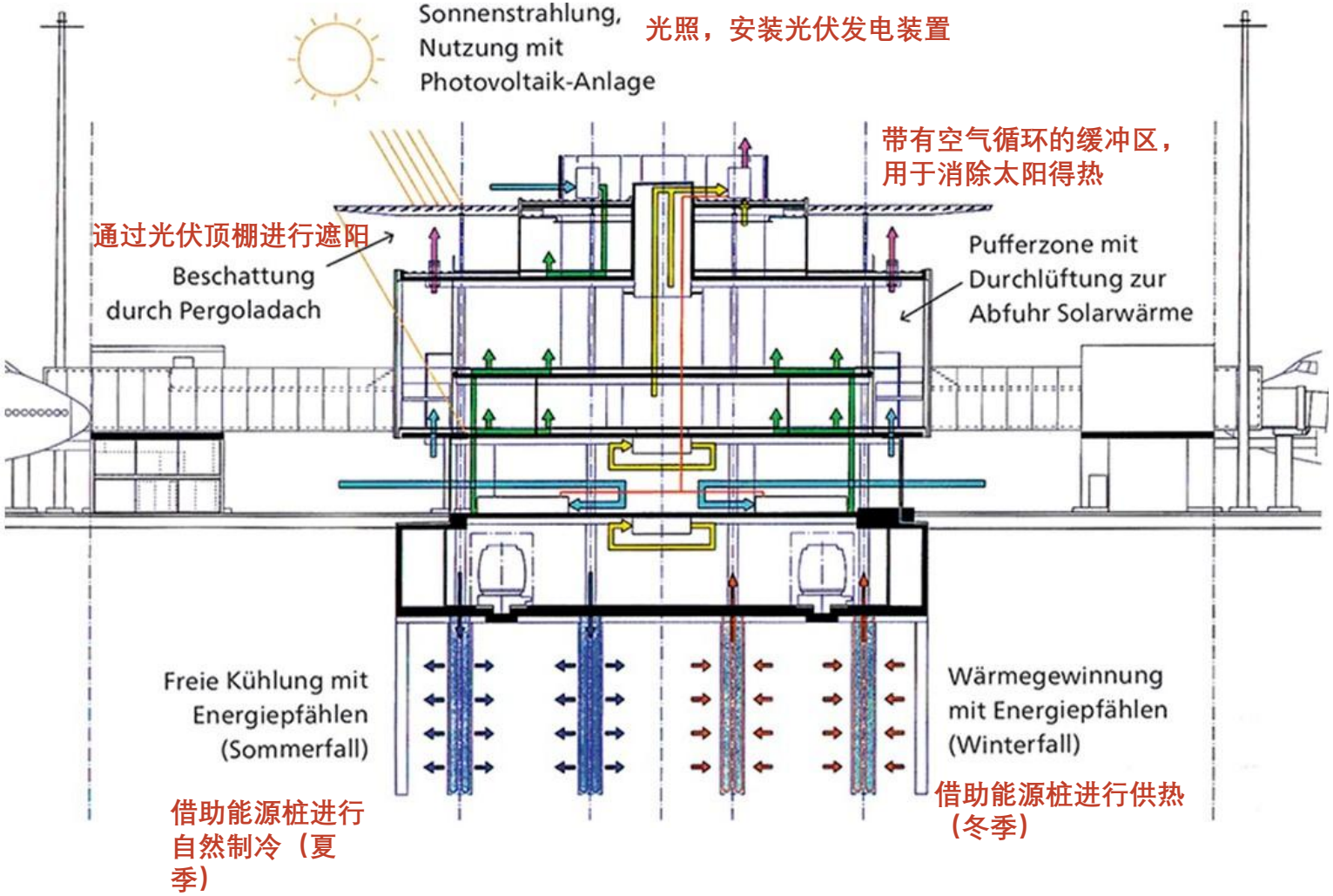
Step 2: Definition of ZEB objectives and their weighting (Duty Book)

**第三步：确定可能的备选方案并进行效用分析，包括敏感性分析，如能源价格、资本利息等**

Step 3: Definition of possible variants and utility analysis including sensitivity analysis (e.g. energy prices, capital interest, etc.)

# 03 案例：苏黎世机场–新航站楼E

EXAMPLE – ZURICH AIRPORT
NEW DOCK E TERMINAL




**规划/建设周期：1996-2003**
**成本：3.5亿瑞士法郎**
**建筑面积：8万平方米（500米长）**

Planing/Construction Period: 1996-2003
Cost: 350 Mio. CHF
Floor Area: 80’000 m2 (500 m long)

**能量来源：300个能源桩用于供暖和制冷,屋顶集成了300kWp的光伏发电系统**

Energy Sources: 300 Energy Piles for heating and cooling, 300 kWp PV with integrated pergola roof

**协同效应：登机通道的幕墙缓冲区，结构桩，光伏遮阳，家居一体化的新风供应**

Synergies: Façade Buffer for boarding ramps, Structural Piling, Shading with PV, supply air integrated in the furniture

**建筑技术工程 - 基于零碳理念的能源来源和系统效率**

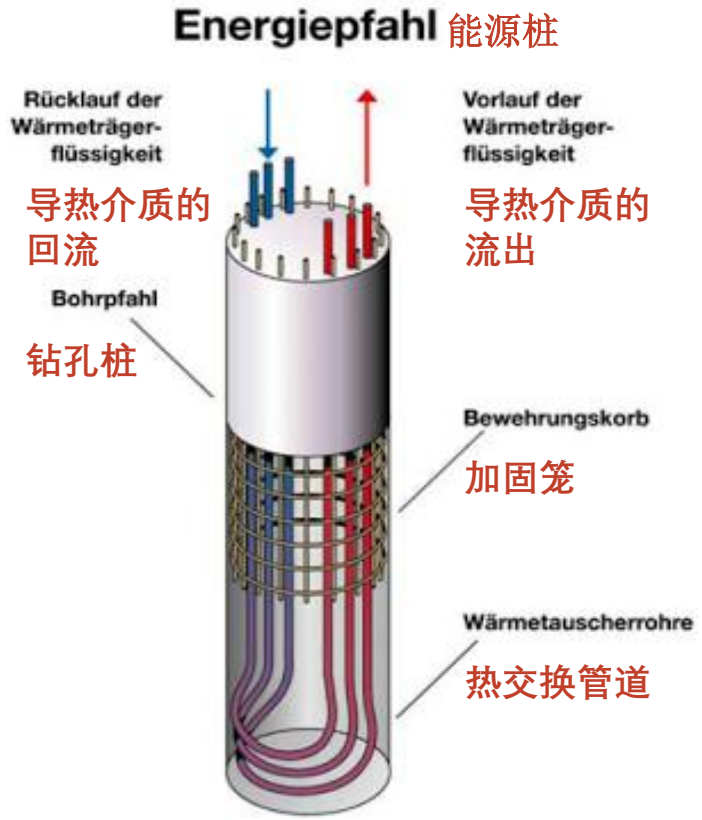
Building Technology Engineering (MEP) – ZEB mainly related to energy sources and efficiency of systems needed

# 03 案例：苏黎世机场–新航站楼E

EXAMPLE – ZURICH AIRPORT
NEW DOCK E TERMINAL

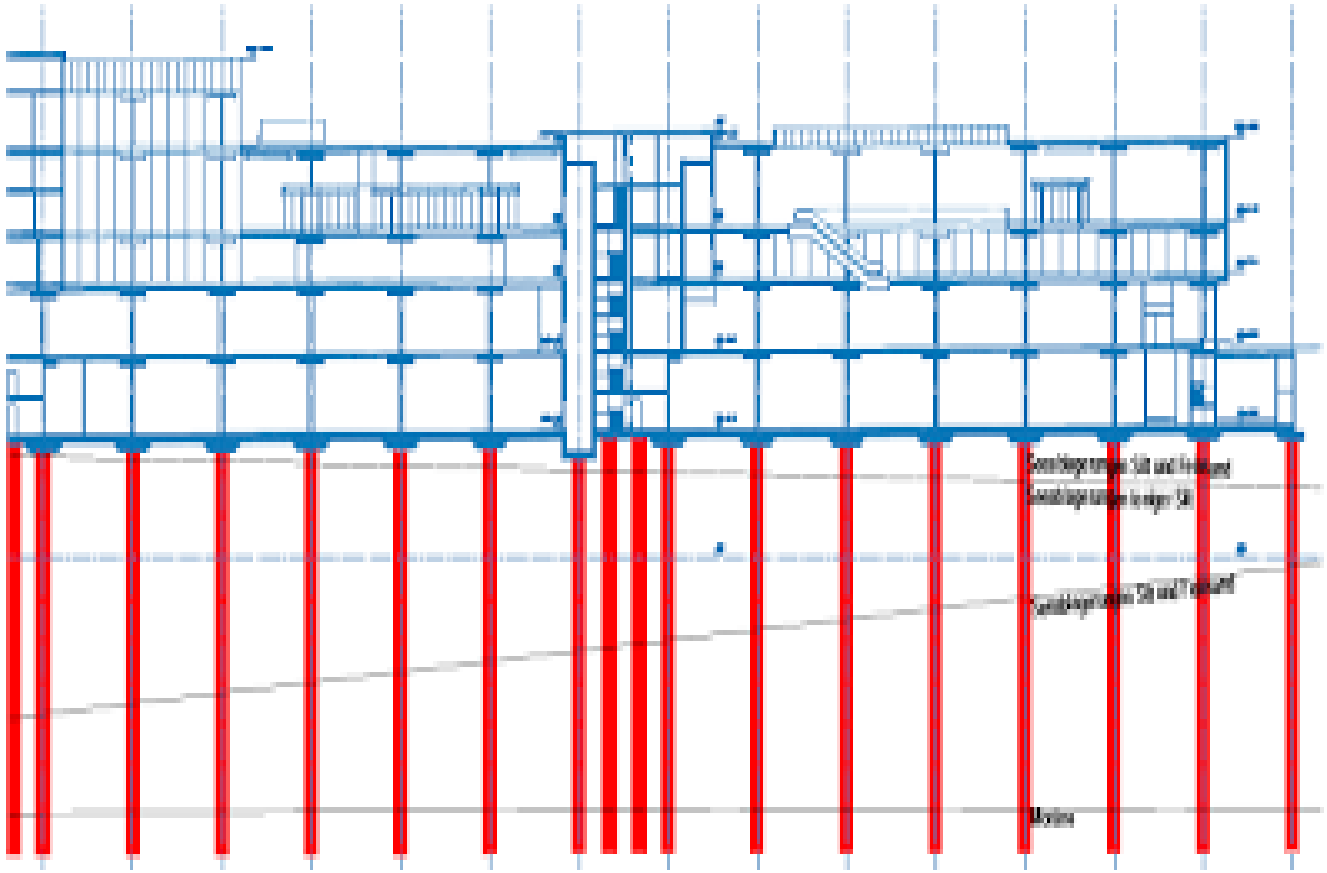
能源桩（40米长，带集成管道）

Energy Piles (40 m length with integrated piping)




建筑剖面：300根能源桩（红色）

Building Section with 300 Energy Piles (red)

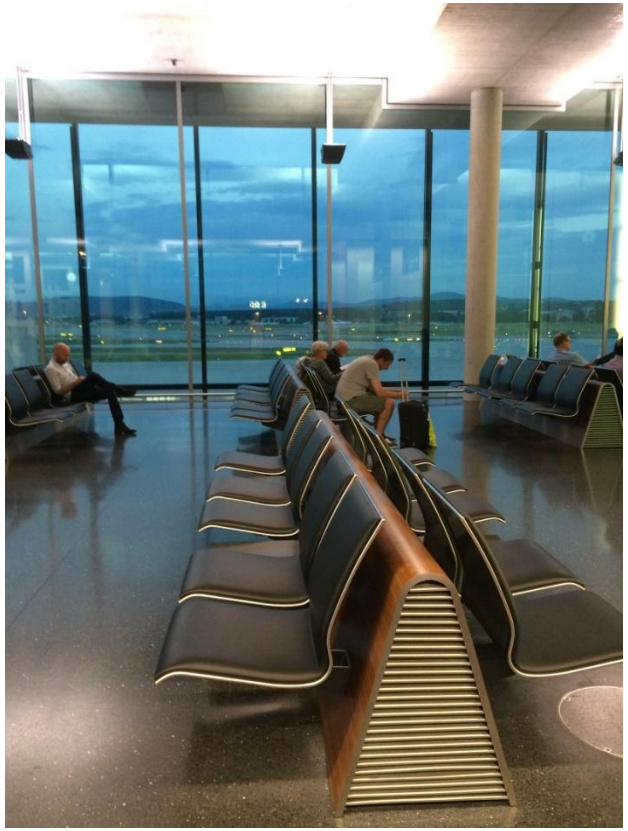


# 03 案例：苏黎世机场–新航站楼E

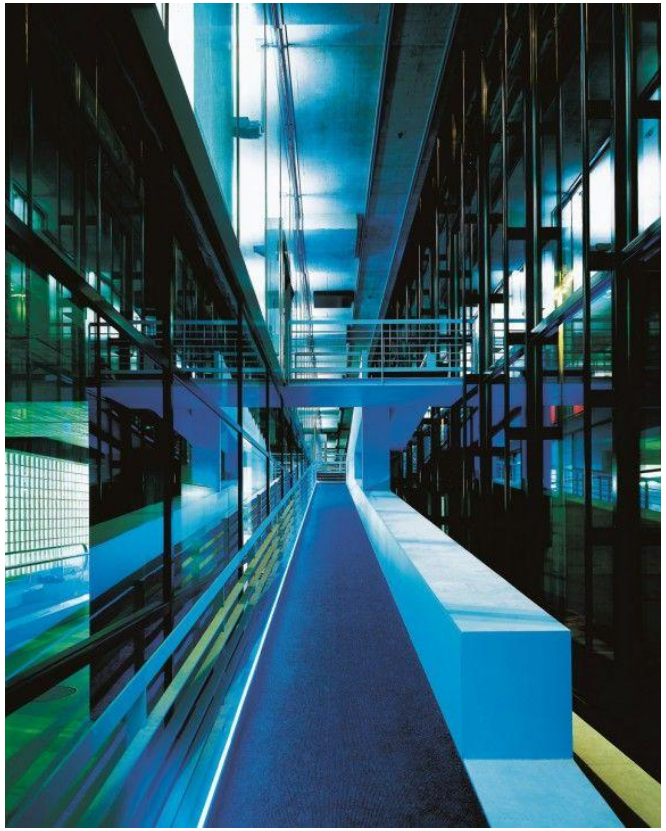
EXAMPLE – ZURICH AIRPORT
NEW DOCK E TERMINAL

光伏屋顶（300kWp，集成遮阳）
PV Roof (300 kWp, integrated shading)

家居一体化的新风供应
Supply Air integrated furniture



集成登机通道的双层幕墙
（气候缓冲区）
Double facade (climate buffer)
with integrated boarding ramps



# 03 案例：苏黎世机场–新航站楼E

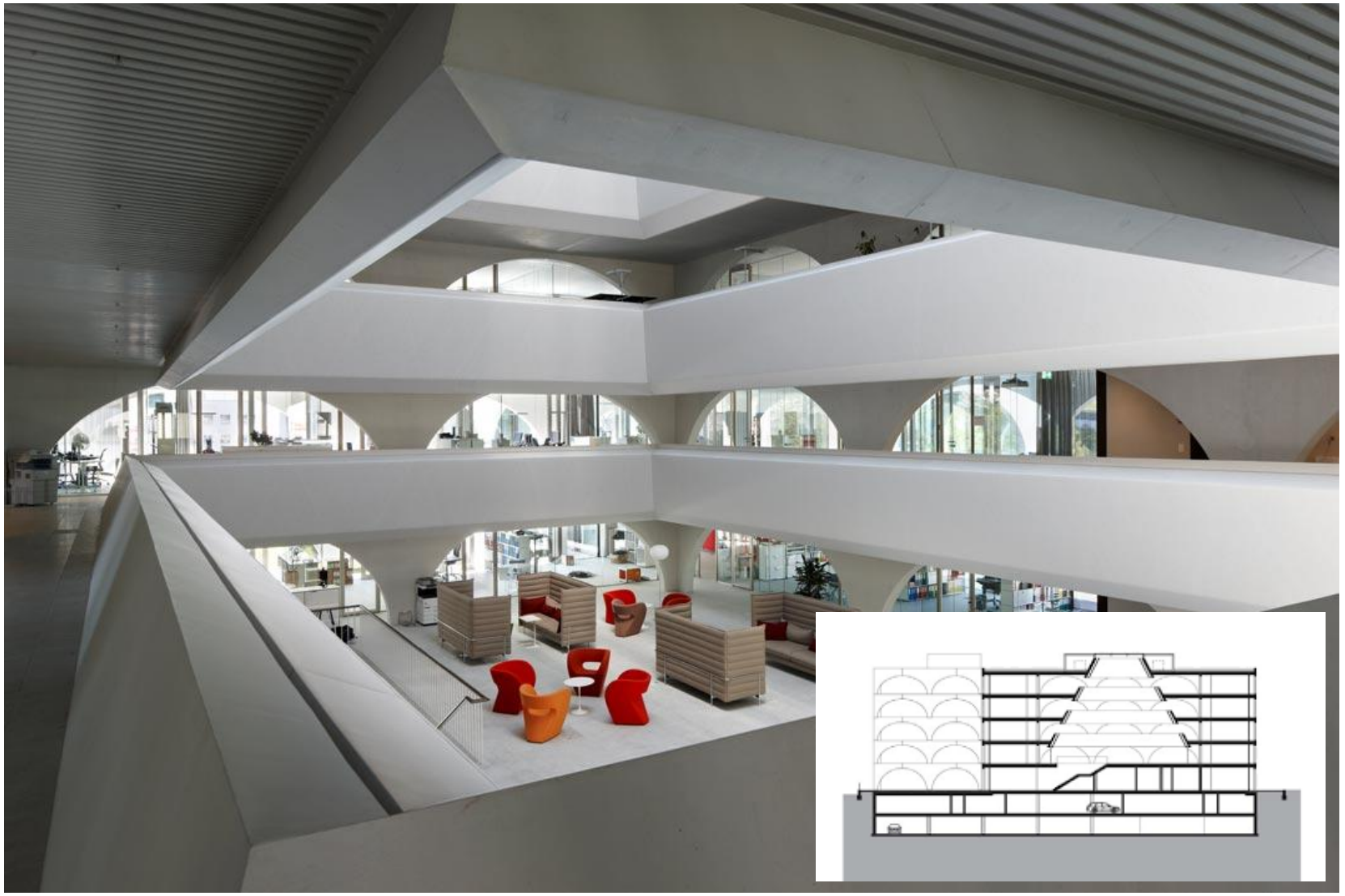
EXAMPLE – ZURICH AIRPORT
NEW DOCK E TERMINAL


Planning Team:
Architect: Bearth & Deplazes Arch., Chur
Structural Engineering: Fanzun AG, Chur
Energy & Building Technologies: Amstein + Walthert AG, Zurich

设计团队：
建筑师：Bearth & Deplazes Arch., Chur
结构工程：Fanzun AG， Chur
能源与建筑技术：Amstein + Walthert AG，苏黎世

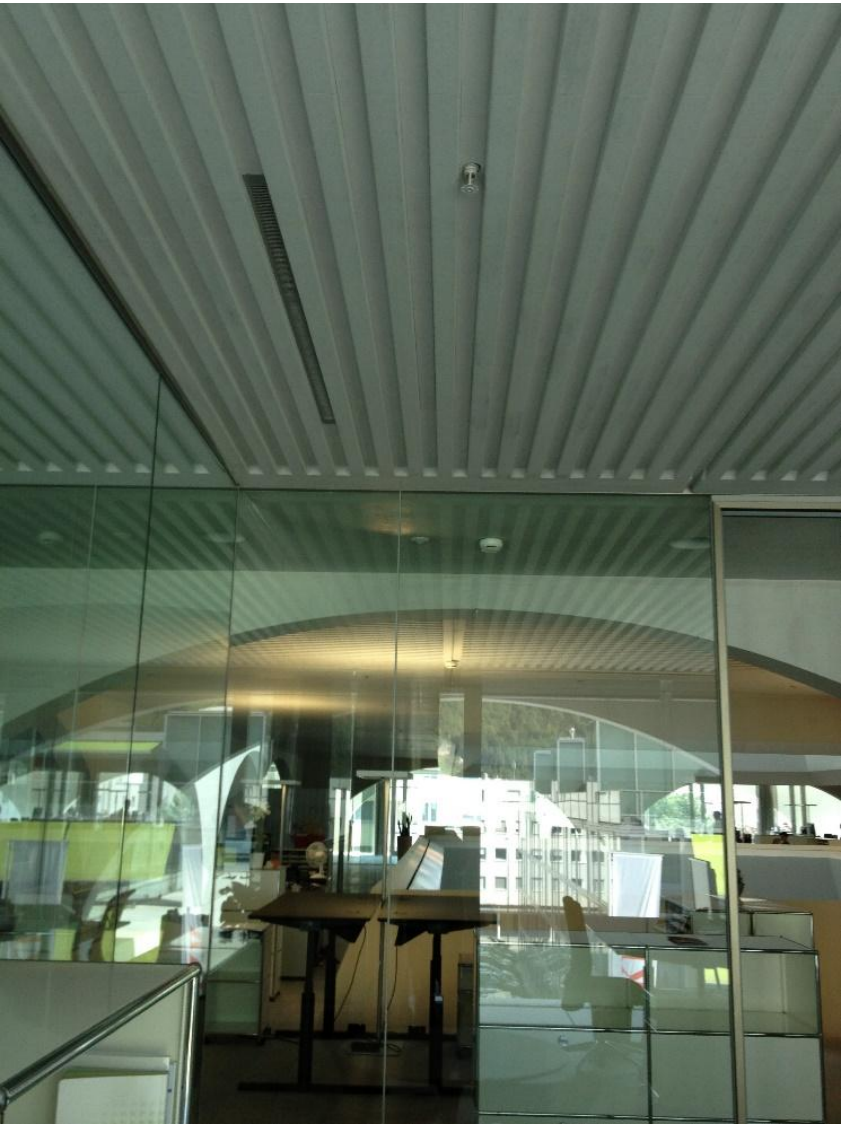
# 03 案例：ÖKK 总部 – 建造一体化

EXAMPLE – ÖKK HEADQUARTERS
CONSTRUCTION INTEGRATION



# 03 案例：ÖKK 总部 - 建筑一体化

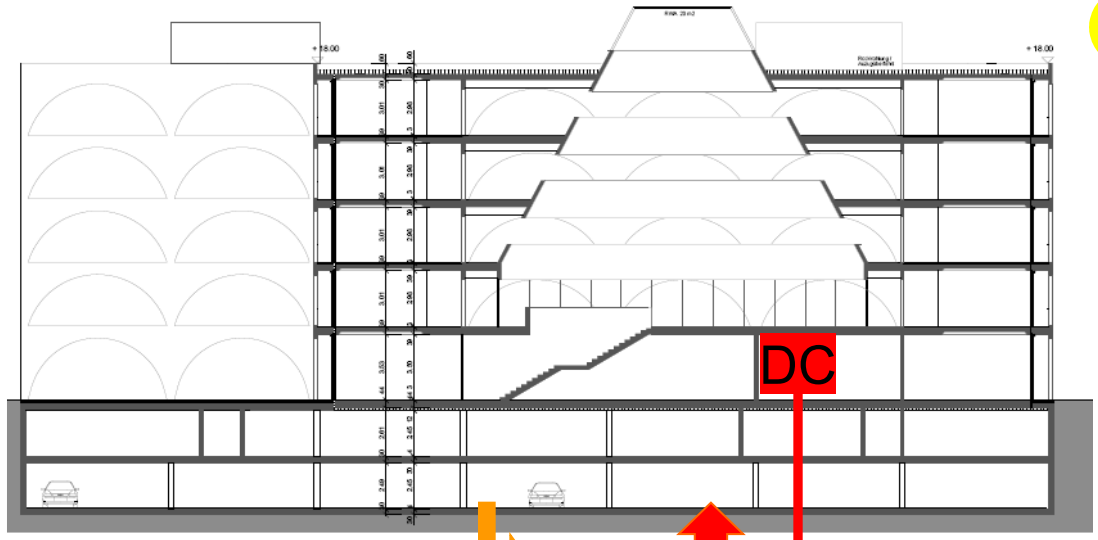
EXAMPLE – ÖKK HEADQUARTERS
CONSTRUCTION INTEGRATION




EXAMPLE – ÖKK HEADQUARTERS
CONSTRUCTION INTEGRATION

# 03 案例：ÖKK 总部 - 建筑一体化

Feature: 100% renewable and $CO_2$-free, Low Exergy Optimization and potential for zero-energy house (options)
特点：100% 可再生能源和无二氧化碳排放，低能耗优化和零能耗建筑的潜力（可选）




Roof Top PV (Max. Option for Zero Energy)
屋顶光伏（零能耗的最佳选择）

Net 电网

热泵 **Heat Pump**

**Exergy:**
- Electricity
- Waste Heat Data Center

有效能
- 电
- 数据中心余热

**Heat Sources (Anergy):**
- Heat Recovery Exhaust Air
- Groundwater
- Waste Heat Cold Storage Cell

热源（低温余热）
- 热回收 废气
- 地下水
- 废热 冷藏室

**Exergy:**

**Electricity form renewable sources (Label)**

**DC Waste Heat direct use for Heating**

**Σ=0 !**

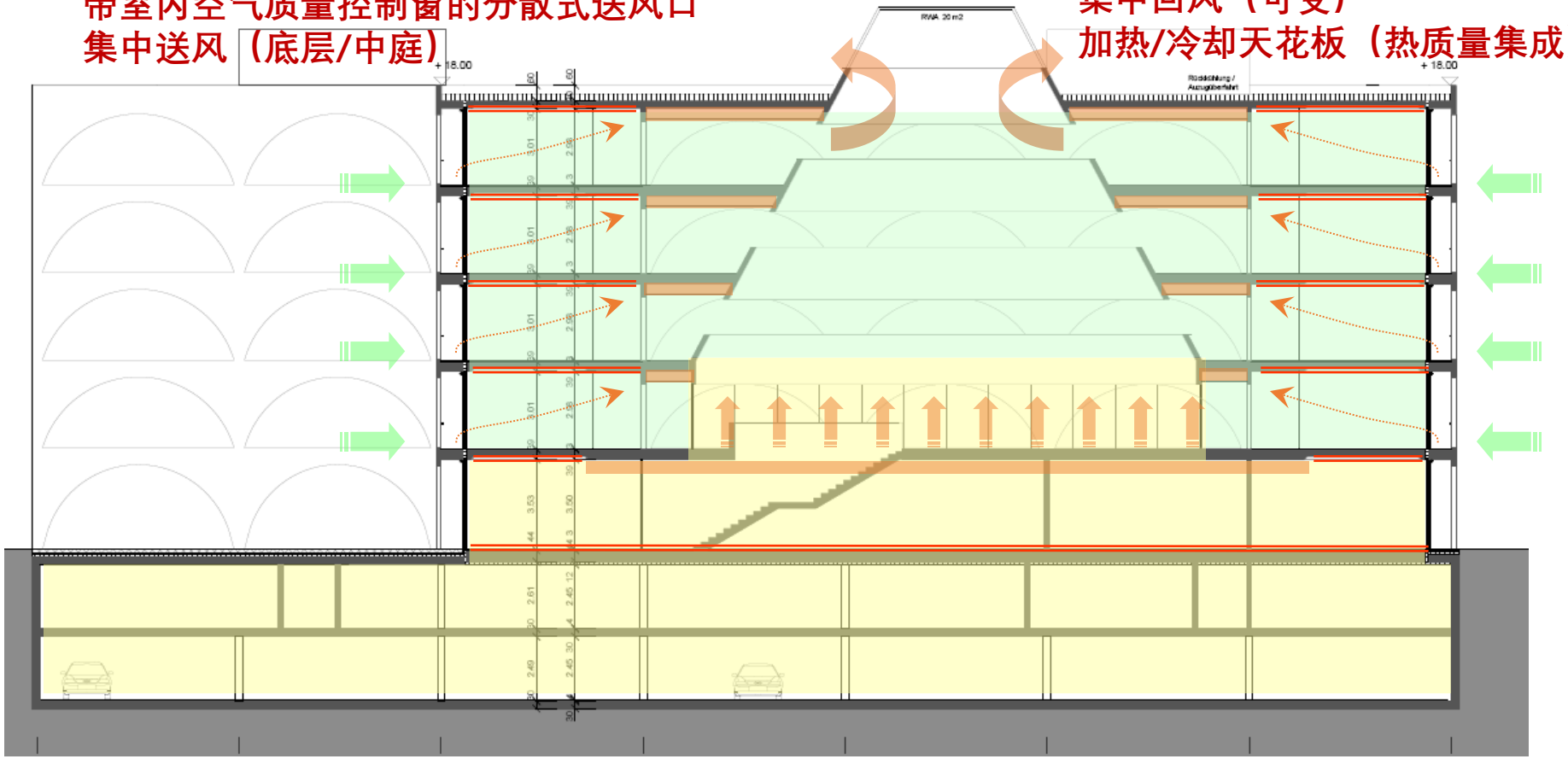
有效能

可再生能源发电（标签）
DC 废热直接用于供暖

# 03 案例：ÖKK 总部 – 建造一体化

Decentralized Supply Air with IAQ Controlled Windows
Centralized Supply Air (Ground Floor/Atrium)
带室内空气质量控制窗的分散式送风口
集中送风（底层/中庭）

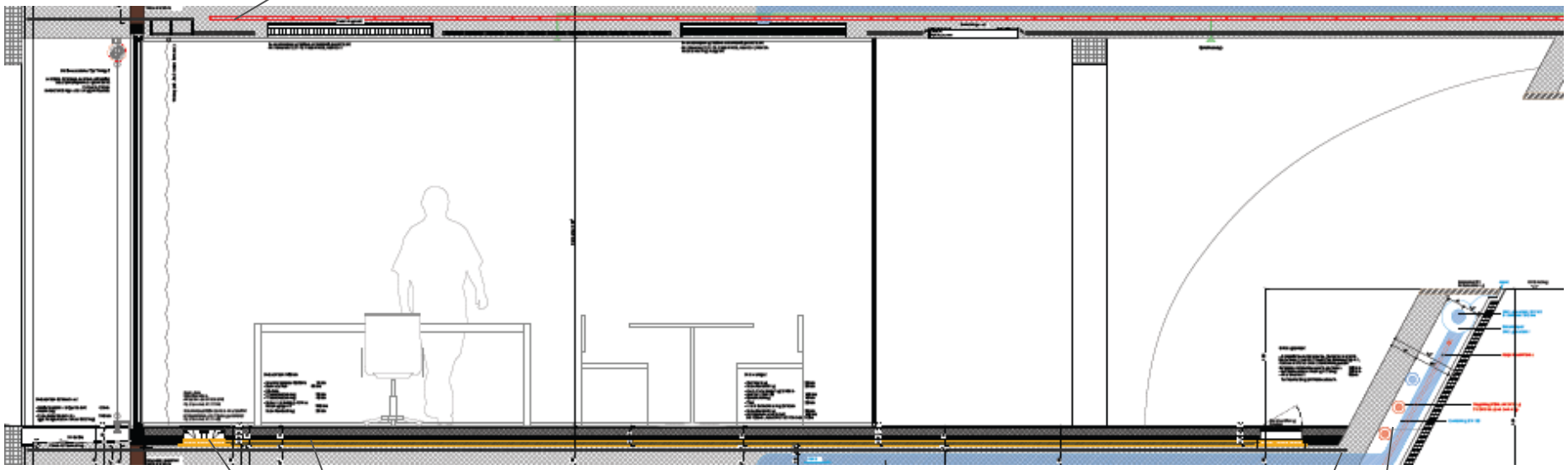
Centralized Return Air (Variable)
Heated/Cooled Ceilings (thermal mass integrated)
集中回风（可变）
加热/冷却天花板（热质量集成）



# 03 案例：ÖKK 总部 - 建筑一体化

EXAMPLE – ÖKK HEADQUARTERS
CONSTRUCTION INTEGRATION

Thermoactive concrete ceiling (prefabricated heating/cooling)
热活性混凝土天花板（预制加热/冷却装置）
Artifical Light 人造光源



配电 Electrical Distribution

地面电源插座 Electrical Floor Sockets

Return Air (Modular) 回风（模块化）

主要分配（加热/冷却/洒水装置） Main Distribution (Heating/Cooling/Sprinkler)

# 03 案例：ÖKK 总部 - 建筑一体化

EXAMPLE – ÖKK HEADQUARTERS
CONSTRUCTION INTEGRATION


## Self-sufficiency as a goal

2 wooden standard modules (40 m2)
Not used for living, but for research to investigate the interaction of all components in the building and optimization.

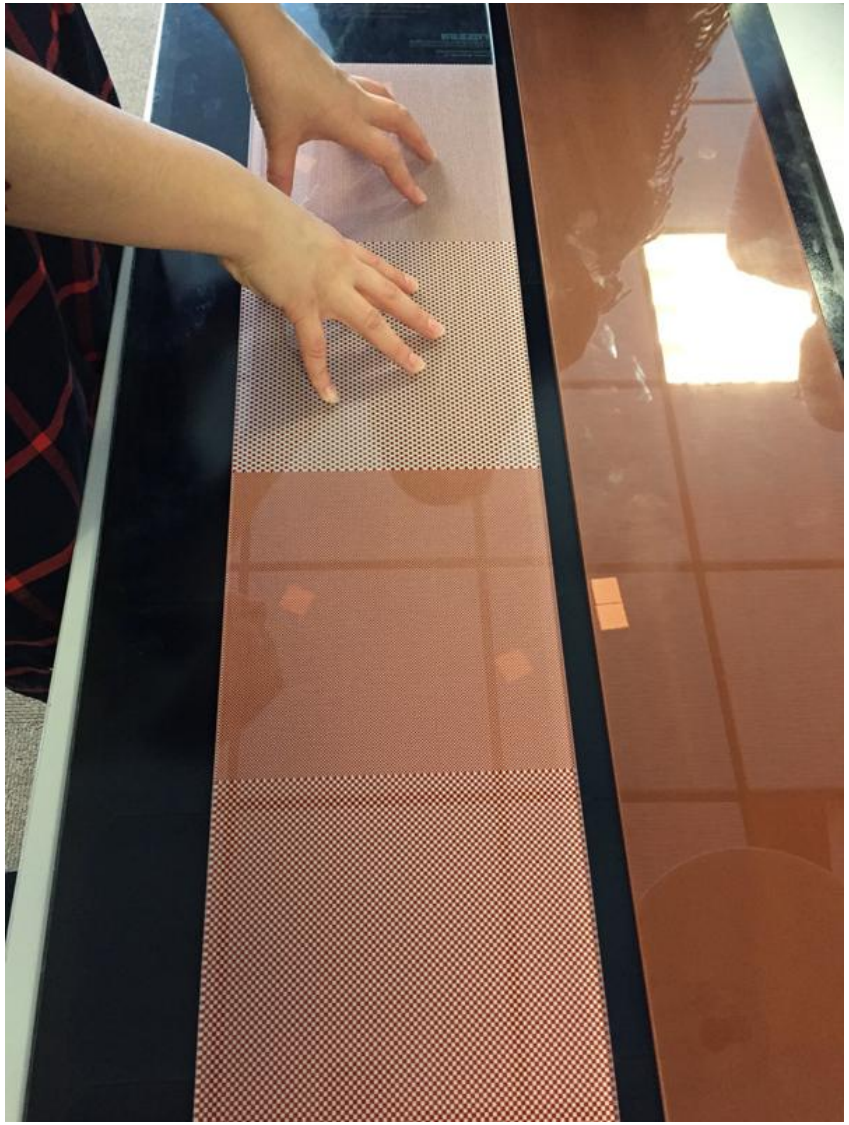
Main topics:

- Roof top PV/PVT and BiPV photovoltaic systems (12 kWp)
- Electromobility (22 kWp load)
- Energy storage (10 kWhe)

  Reversibel heat pump&AC
- Dynamic energy management

**EXAMPLE – GEE Live Lab HSLU**

案例：xxxx

EXAMPLE – GEE Live Lab HSLU

# 案例： xxxx


EXAMPLE – SELF Empa

# 案例：xxxx

**Live and work independently, anywhere and all year round**

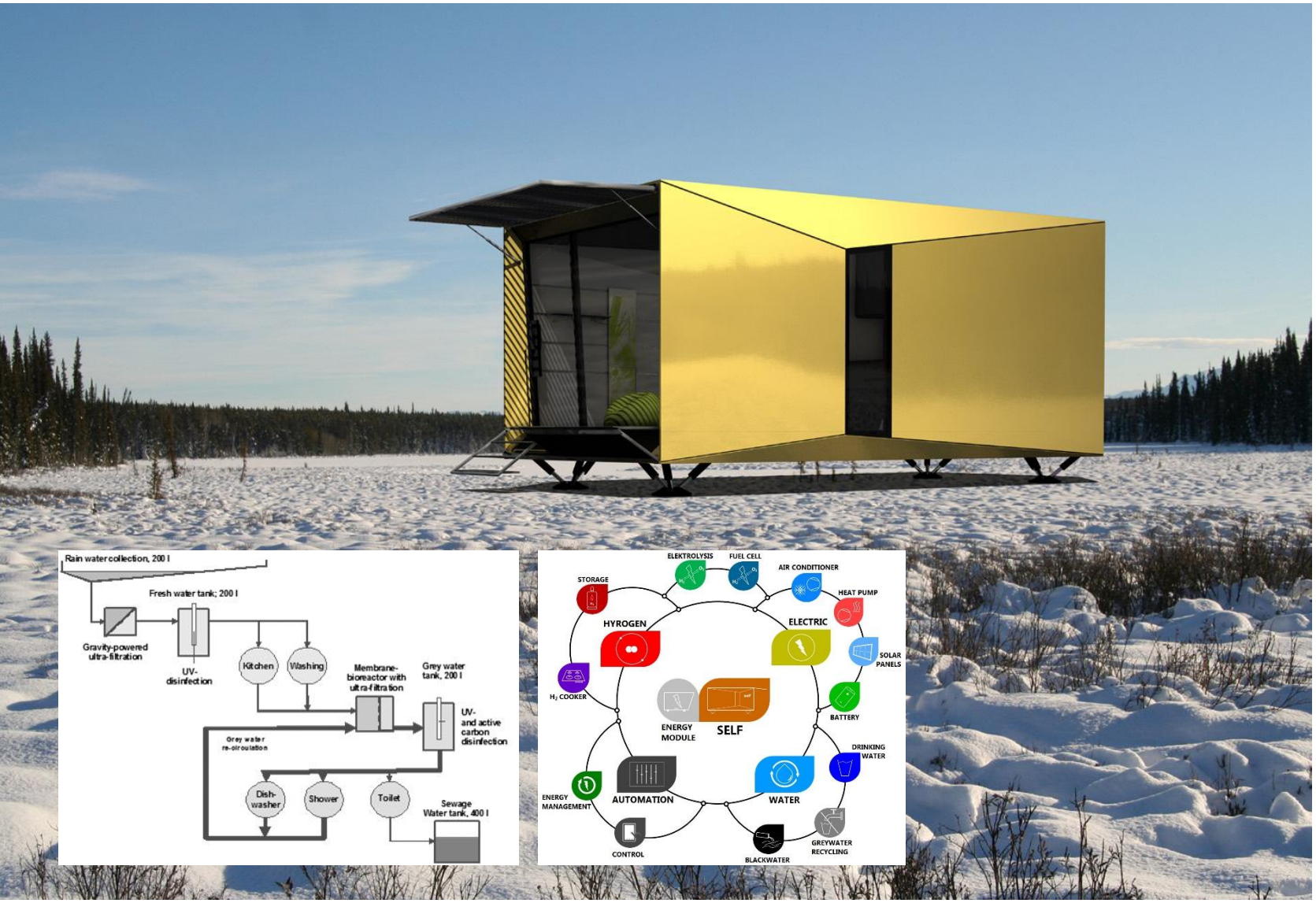
SELF is designed for two people to live and work in.

It is easy to transport and ready for use at any time.

High insulation technology and energy-efficienttechnologies guarantee a comfortable indoor climate all year round in central and southern climate all year round without external energy supply.

**EXAMPLE – SELF Empa**

案例：xxxx




## Technology

Spaceloft aerogel and vacuum high insulation technology (overall U-Value = 0.1 W/m2,K)

3.75 kWp roof PV (23% efficiency)

Heat pump (source exhaust air)

LED Lighting (daylight controlled)

Lithium-Polymer-Battery (56 kWhe)

Seasonal Storage Hydrogen Tanks (120 kWh)

Rainwater use and wastewater treatment for reuse

**EXAMPLE – SELF Empa**

# 案例：xxxx

**World Tour with self sufficient mobile tiny house**

House with kitchen, toilet, shower, running water, A/C and up to 6 beds

Powered by Solar Energy

Eye-catching design turns into a butterfly at the push of a button

Large wingspan to collect the sun's energy

Fully self-powered, produces enough energy to drive up to 220 km/day

Designed and built by Swiss universities and engineers

**EXAMPLE – Solar Butterfly HSLU**

# 案例：xxxx

## Technology

2 x 40 $m^2$ integrated and additional PV (24% efficiency)

Light weight PV Panels (4.3 kg instead 16 kg)

120 kWhe/day capacity (battery)

Shower waste water heat reuse by 60%  (joulia heat exchanger)

Rain water collector and electric AC/heating

Made out of 800 kg PET plastic bottles from the Ocean mainly for the walls, the solar panels and the furniture of the SolarButterfly

**EXAMPLE – GEE Live Lab HSLU**

# 案例：xxxx


EXAMPLE – GEE Live Lab HSLU

# 案例： xxxx

## 方法紧随挑战——综合规划助力零碳建筑及可持续解决方案

THE METHOD FOLLOWS THE CHALLENGE – INTEGRATED PLANNING FOR ZEB AND SUSTAINABLE SOLUTIONS

## “电灯并不是来自于对蜡烛的不断改进”
## 奥伦·哈拉里（1949-2010）

"The electric light did not come from the continuous improvement of candles“

Oren Harari (1949-2010)

# 创新&可持续–零碳建筑需要新的方法

INNOVATION & SUSTAINABILITY – NEW METHODS NEEDED FOR ZEB

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

南京大学建筑与城市规划学院
School of Architecture & Urban Planning, NJU

中华人民共和国
住房和城乡建设部

IBE环能科技
中国建筑节能协会

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

intep
skat Swiss Resource Centre and Consultancies for Development

# 感谢您的关注！ 提问环节

THANK YOU! YOUR QUESTIONS?

*Project site at the Old Floating Bridge Area of Shuidong Town, Ganzhou*