Hong Kong

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EcoCommercial Building Program

Case Study of an Energy-efficient Metropolitan Commercial Building

With the courtesy of The University of Tokyo Institute of Industrial Science, Kawazoe Lab

Powered by:

BAYER

- ECB Introduction
- General concept
- Metropolitan Features
- QD lighthouse

Sustainable Buildings are the Smallest Building Blocks of a Green City

Materials → Products & Services → Sustainable Buildings

Bayer MaterialScience

A leading polymer company

€11.5 bn turnover*

14,500 employees*

R&D: €242 million*

*2012 figures

ECB EcoCommercial Building 生 态 商 务 建 筑

Global network

of qualified experts for

sustainable construction

Innovative Design

Resource & energy efficiency

Socio economic benefits (health)

The EcoCommercial Building Program in a Nutshell

Vision

Net Zero through integrated building (design) concepts and sustainable technologies.

Mission

To collaborate with our stakeholders and leverage the resultant synergies to provide innovative custom solutions.

Scope

- Manage the collaboration platform of building and construction industry stakeholders
- Build the bridge between building decision makers and solution providers
- Scout and push for tangible sustainable building projects
- Promote verifiable building performance through lighthouse projects
- Support the Chinese government to meet its energy saving targets

Characteristics of Office Building Located in Central Business Districts and Downtown Areas

- Cramped and narrow lots
- High rise buildings
- Limited options for onsite energy generation

- Seldom single-owned or one-tenant-buildings
- Mostly multiple party user and tenant structure
- Difficulty to implement harmonized energy saving measures

- Average area of office space per person (Japan):
- Leased: 6 m²
- Single Owner: 10 m²

Source: office book published by Syokokusha 01/02/2011

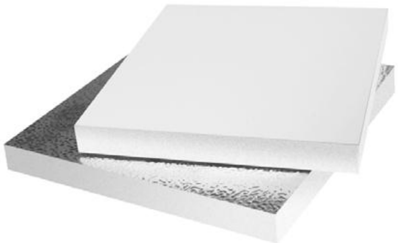
- Selection for case study:
- High-density area in the Aoyama ward, Tokyo

Key Technological Elements Being Considered in the Metropolitan Office Study

ECB

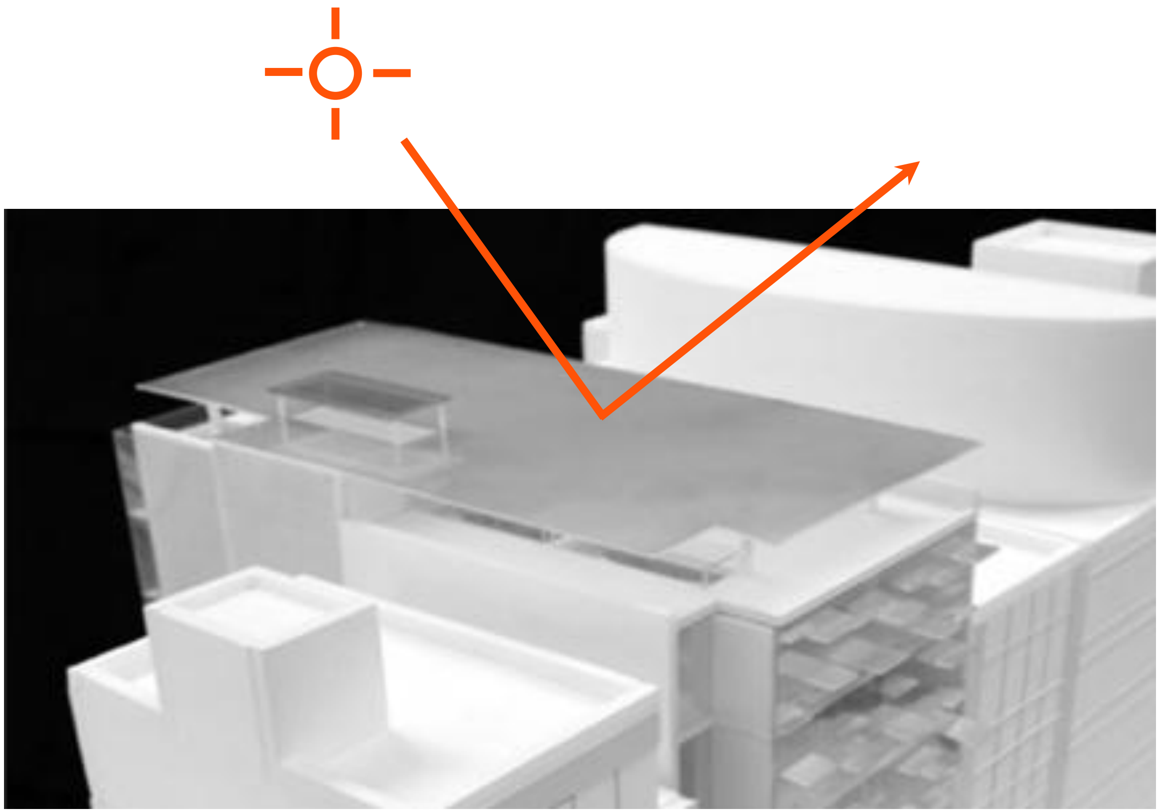
◆ Improve passive (energy) performance of the building	➢ Effective insulation of building envelope ➢ Solar chimney for natural ventilation and day-lighting ➢ Optimization of apertures
◆ Equipment + Structure ◆ Dynamic control of structural temperature	➢ Radiation heating & cooling by hot & cold column ➢ Radiation heating & cooling by personal heat-storage partition
◆ Energy saving and efficiency gains	➢ Optimization of use of lighting, equipment and appliances
◆ Utilization of renewable power sources	➢ Photovoltaic power generation & leaf façade ➢ Ground-source heat pump

Improve Passive Performance of the Building
Effective Insulation of Building Envelope



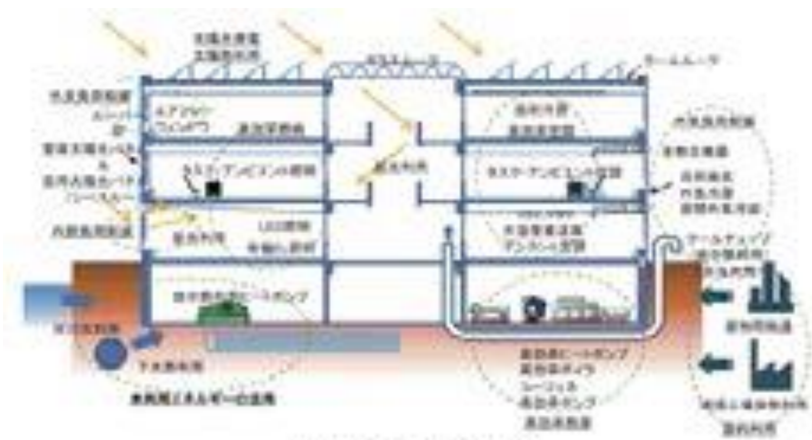
	25 mm PS: Inside of the external wall	30 mm PUR: Outside of the external wall	50 mm PUR: Outside of the external wall
Cost of materials (JPY/piece) W910 * L1820	1000	2000	3300
Cost difference re base model (JPY/piece)	-	1000	2300
Additional cost (external wall area = 1910 m^2)	-	1,153,000	2,651,900
Primary energy requirement for air-conditioning (kWh/m^2/a)	85.8	80.7	78.6
Total reduction in fuel and energy consumption (JPY/a)	-	128,673	179,773
Return of investment (a)	-	9	15

Improve Passive Performance of the Building
Support of Roof Insulation by Shading



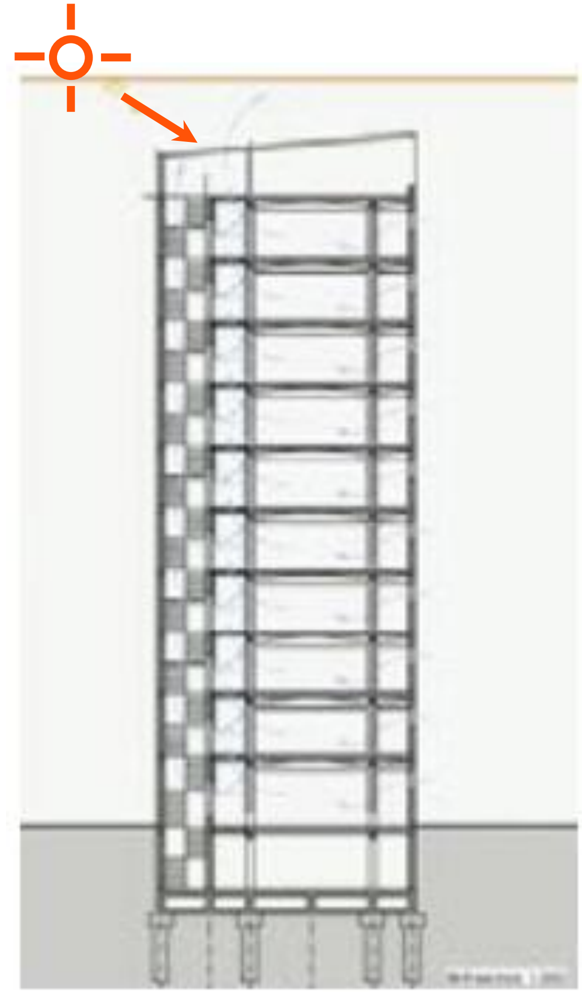
Using double layers of PV panels as a sun-shade for the roof will reduce air-conditioning energy load levels by 4%.

Improve Passive Performance of the Building
Driving Natural Ventilation with a Solar Chimney

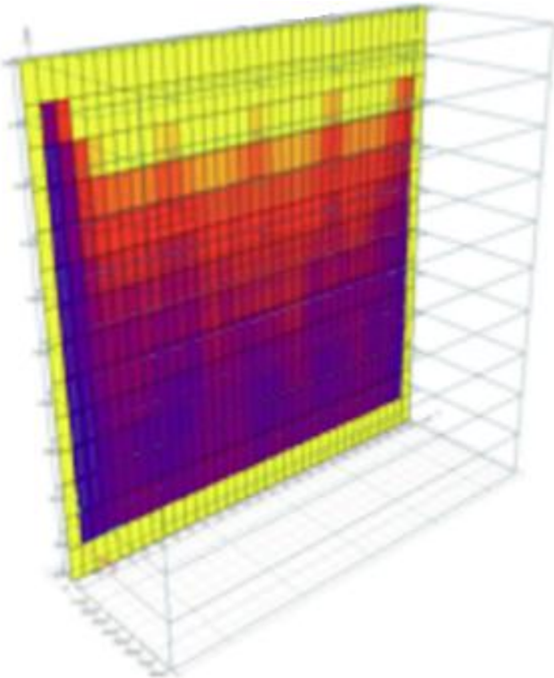
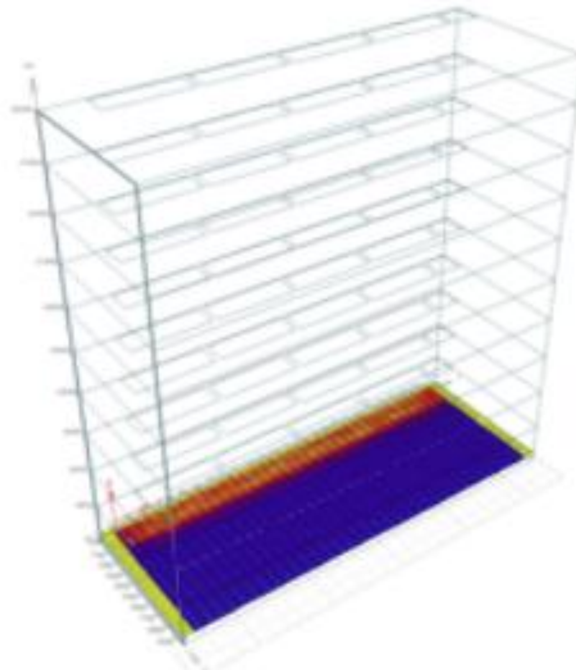


METI: "Towards the realization and expansion of Zero Energy Buildings (ZEB)

As for realization of a low energy building, an atrium is recommended to have a pathway of sun-light & wind for natural ventilation during moderate weather periods. Instead of the atrium, corridors are used because of narrow space.



Improve Passive Performance of the Building
Maximizing Day-lighting with a Solar Chimney

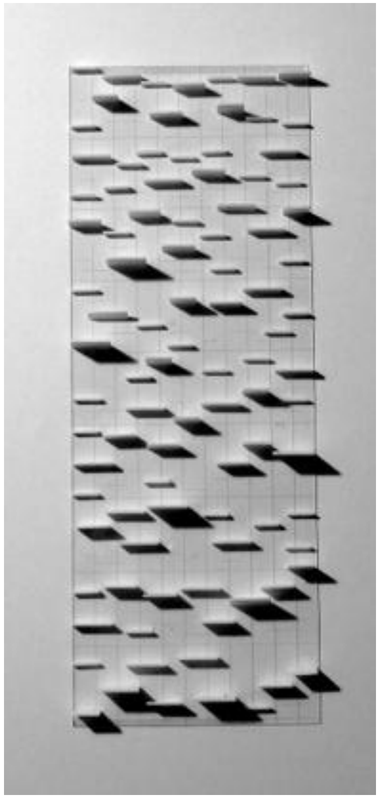
During the noon hours, incident light from the skylight properly illuminates the corridors.
Lighting energy demand could be reduced by 6 %, pay-back time of the investment would be 11 years.

Improve Passive Performance of the Building
Shading by Leaf Façade and Optimization of Apertures

The PV panels in the front façade are arranged in the leaf-like order which aims to cast shadows.
These shadows, although they may seem to cast irregular patterns, have been carefully positioned so as to not overlap with each other.

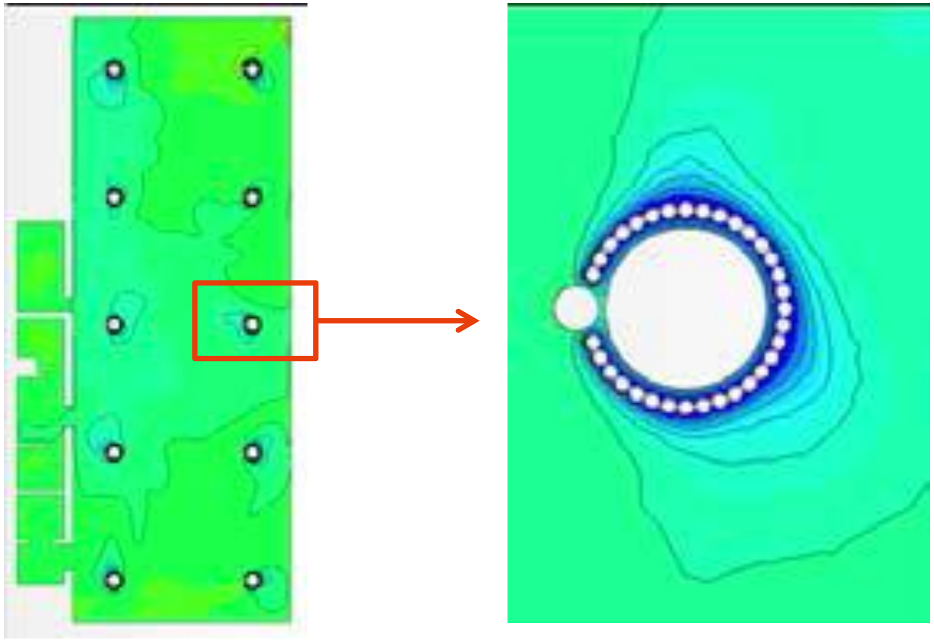
The optimization of apertures and leaf façade can reduce energy consumption by 2.2 % and promises a return of investment within 23 years.

Shading of the façade at 11:00 am



Equipment and Structure

Radiant Heating and Cooling with “Hot Columns”

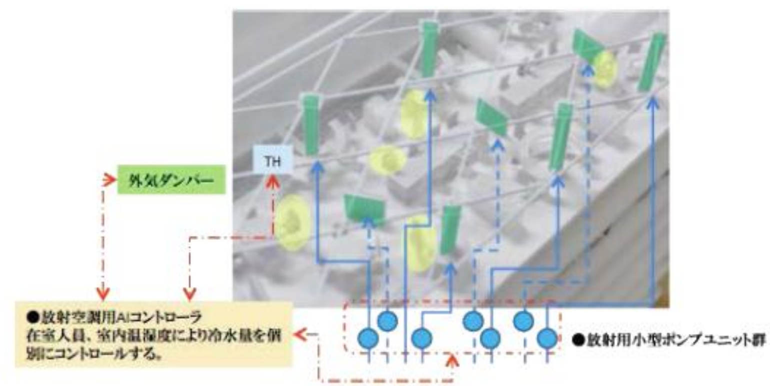


The radiation heating (cooling) system saves 20 % of thermal energy (heat) and 50 % of energy to convey the thermal energy, affording a comfortable air-conditioning system.

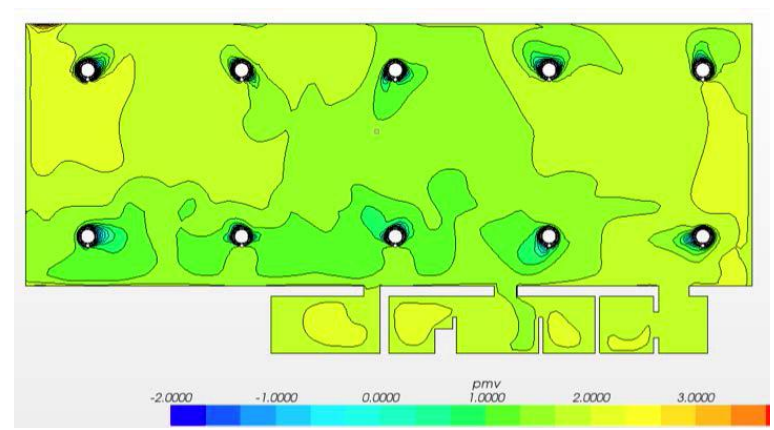
The use of columns to transport thermal energy enables the optimization of buildings’ heat-storage capacity.

Equipment and Structure
Optimization of the HVAC Performance with AI

Dynamic control of structural temperature



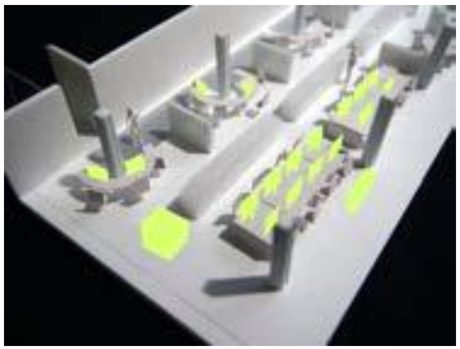
AIを活用したZEB制御システム

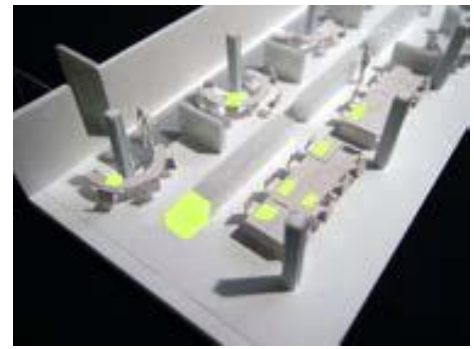


The practical uses of artificial intelligence (AI) for control and optimization of low energy (or zero-energy) building systems:
Air-conditioning: 15-20 % reduction of energy consumption, return of investment within 2 years.

Energy saving

Optimization of Artificial Lighting and Equipment





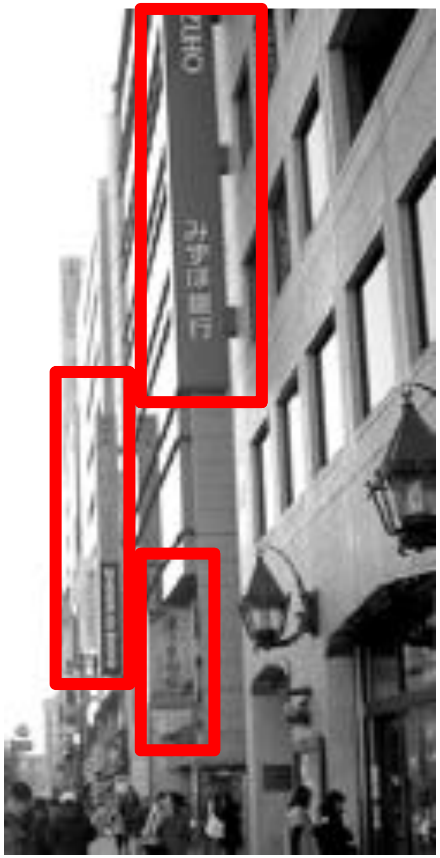
Desk lighting	14 W
Desktop PC	300 W
Personal humidifying device	80 W
Electric heater	300 W
Others	

LED desk lighting	7 W
Notebook PC	50 W

Energy reduction of lighting and equipment: 44%

In most offices, the energy consumption of lighting equipment and appliances usually stands for 42 % of total energy demand.
Thus methods for reducing consumption should be strictly imposed.
The use of LED lighting can reduce energy consumption by 50 % and promises a return of investment within 9 years.

Utilization of Renewable Power Sources
Photovoltaic Power Generation by Leaf Façade



- Installation and fixation like advertisement boards
- Easy replacement of the PV panels (potential new PV panel generation)
- Optimization of angle, size and position of PV panels at the front façade (front is most important because of adjacent buildings):
  Vertical position to sun-light
  Most efficient light in the morning
  Front side as open as possible (day-light)
- Different designs of upper and lower floor window ribbons considered

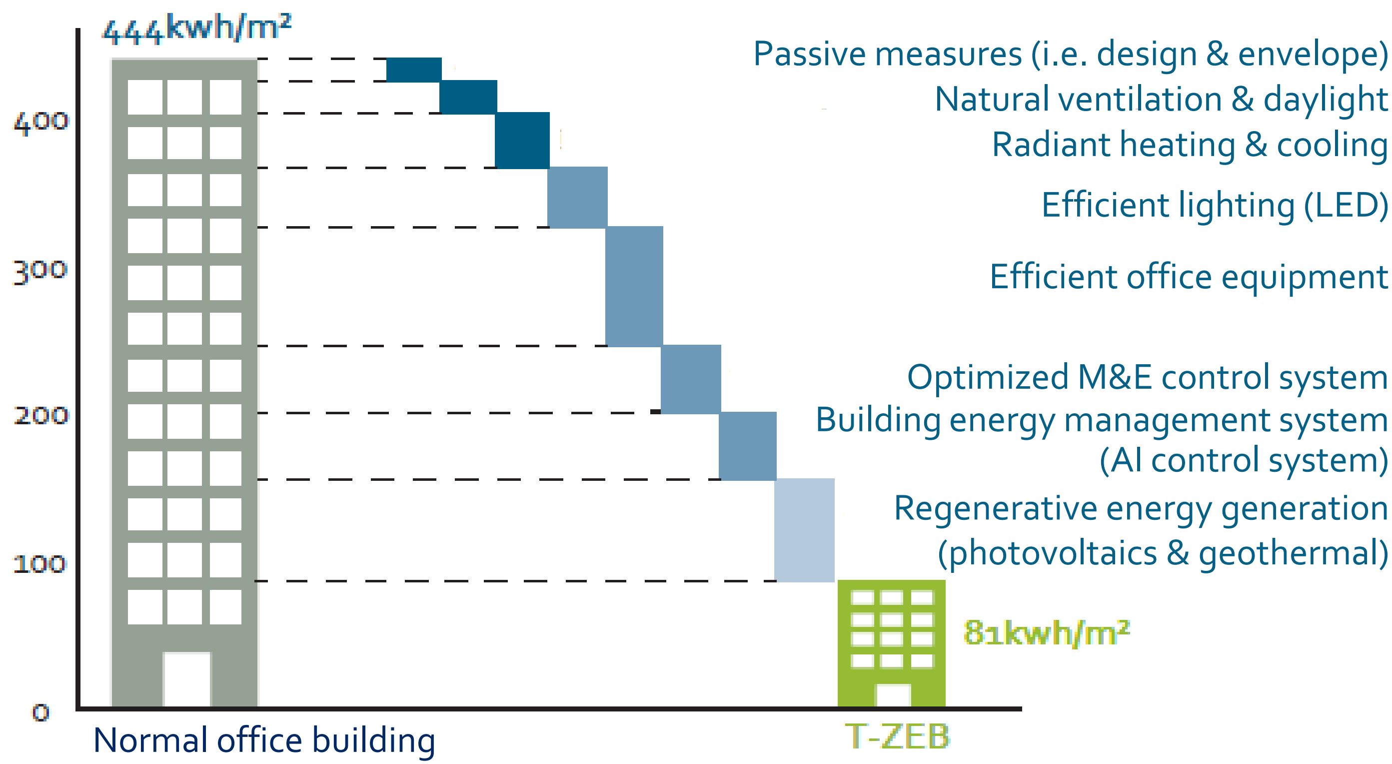
Utilization of Renewable Power Sources
Photovoltaic Power Generation by Leaf Façade

Roof:	55.5	kW
Left:	36	kW
Back:	45	kW
Front:	13.5	kW
Total:	150	kW

Summing up All Individual Contributions
Technical and Economic Feasibility

1st case (maximum energy saving): Performance

80% less energy ⇨ amortisation 11 years



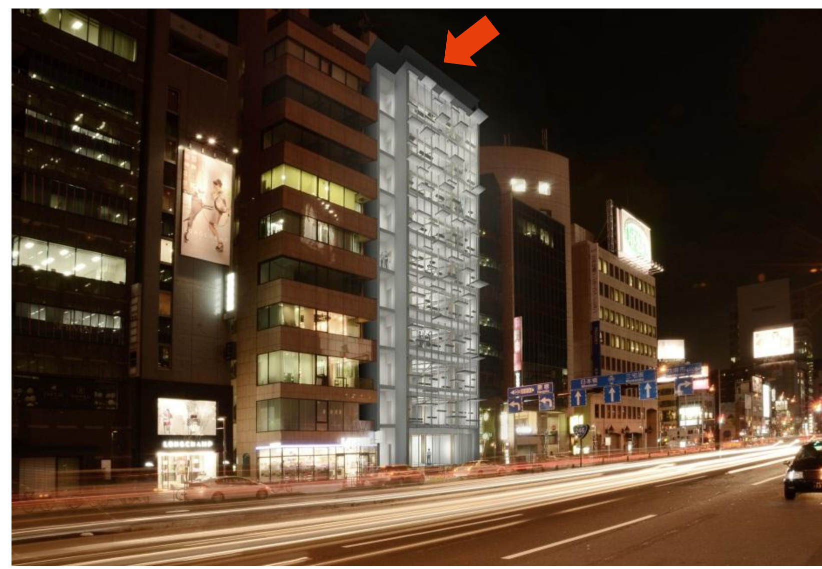
* Primary energy

Summary

Results

Case 1
- approx. 80 % energy saving
- 81 kWh/m^2/a vs. 444 kWh/m^2/a
- amortisation after 11 years

Case 2
- approx. 65 % energy saving
- 165 kWh/m^2/a vs. 444 kWh/m^2/a
- amortisation after 6 years



Conclusion

The ECB concept for sustainable & cost-efficient buildings is also valid under demanding high-density conditions !
i.e. slim & tall buildings in highly condensed lots …

ECB Competence Network in China

ECB Competence Network in Japan

Thank you for your attention