



nZEB  HERTEN

Net-Zero-Energy-Building Test Office | DAIKIN Europe N.V.,
Zeller Kälte- und Klimatechnik GmbH and Athoka GmbH



**Presentation in the REHVA seminar
HVAC for Net Zero Energy Buildings
at ISH Frankfurt March 17, 2011**

**Net Zero Energy Office Building
Germany, Ruhr region**
1st part of Daikin nZEB project



Overview of the presentation

1. Background ... the way towards ...
2. Daikin's net Zero Energy Project
3. Net Zero Energy Office Building
4. Experience since building is occupied

The way towards...

- ENERGY
- LEGISLATION
- BUILDINGS
- ZERO ENERGY
- CHALLENGES
- TASKS
- THE PROJECT

Economic development



20% less primary energy use compared to 2020 projection

Global warming



CO2 emissions: 20% reduction by 2020

Energy independency



20% share of renewable energy sources by 2020



EU 20 – 20 – 20 policy

The way towards...

ENERGY

20 % less
primary energy

LEGISLATION

BUILDINGS

ZERO ENERGY

20 % less
CO₂ emissions

CHALLENGES

TASKS

20 % share
renewable
energy

THE PROJECT

1. Ecodesign Directive (criteria under development)
Water heaters, boilers, air conditioners, heat pumps, ...
2. Energy labels (addition and revision ongoing)
- 3. Energy performance of buildings Directive** (recast)
4. Ecolabel : the EU ecoflower
5. Energy Service Directive
6. Combined Heat & Power (CHP) directive

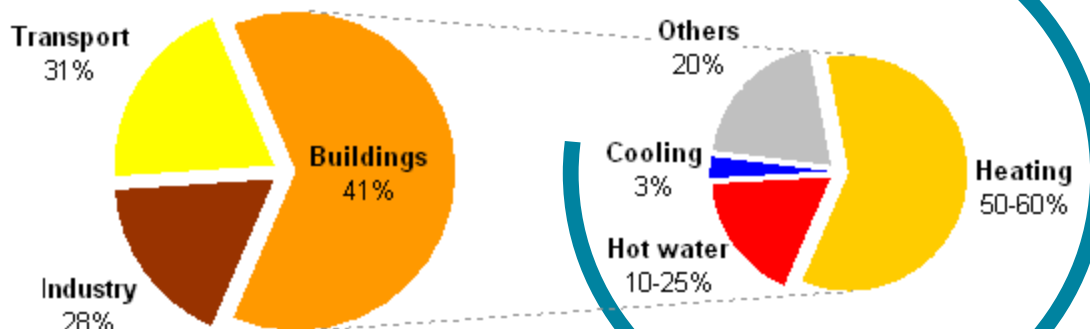
7. Regulation on fluorinated greenhouse gases
F gas regulation → in force 2011
8. Emission Trading

- 9. The Renewable Energy Source directive**
Incl. aerothermal, hydrothermal & geothermal energy

The way towards...

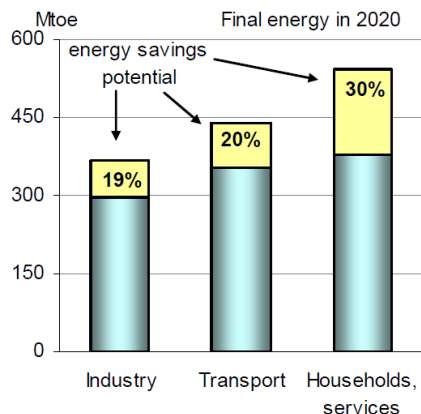
Energy use in building is of high importance + big saving potential

Primary energy consumption with EU



Source: Eurostat

33% of total energy consumption is HVAC related



Estimated energy consumption reduction potential in 2020



Energy Performance of Buildings Directive

ENERGY

LEGISLATION

BUILDINGS

ZERO ENERGY

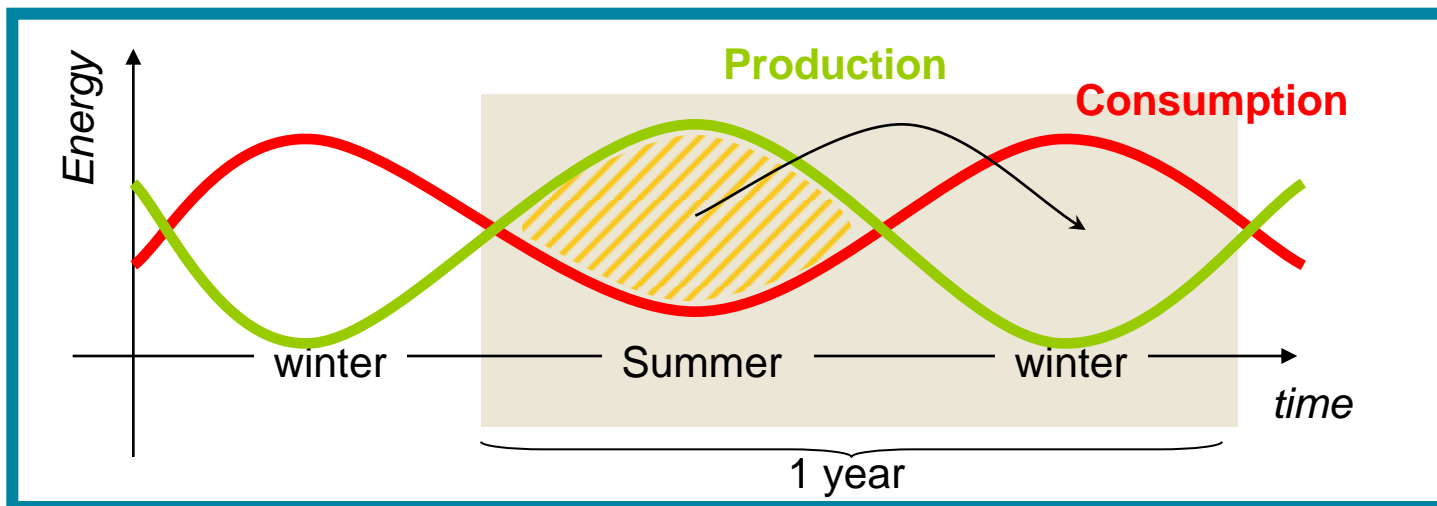
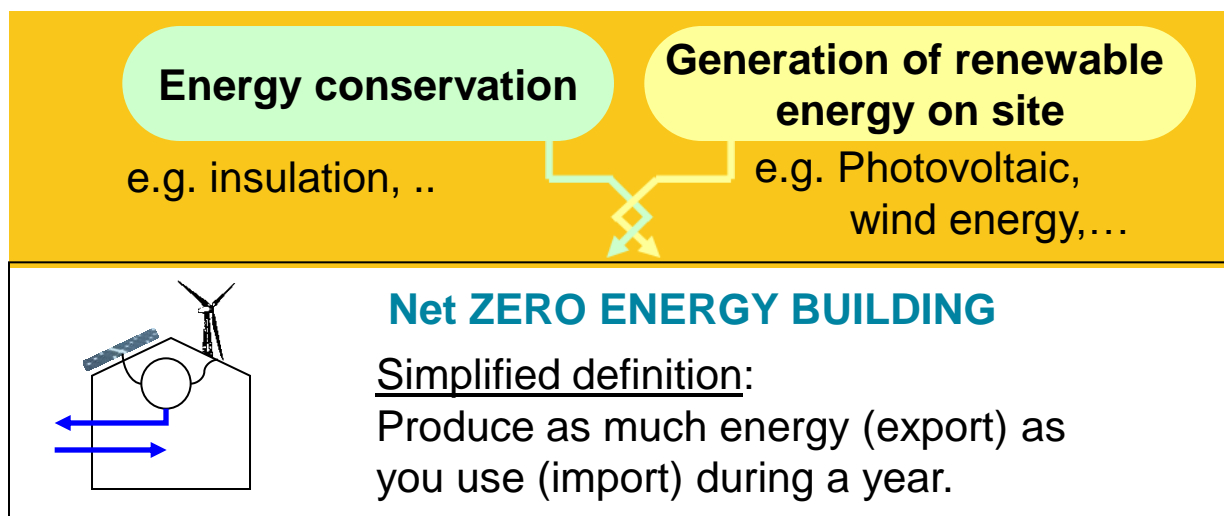
CHALLENGES

TASKS

THE PROJECT

net Zero Energy Buildings using heatpumps are part of solution for intelligent grids

...even if they are contributing to the trouble by definition:



net Zero Energy Buildings using heatpumps are part of solution for intelligent grids



ENERGY

LEGISLATION

BUILDINGS

ZERO ENERGY

CHALLENGES

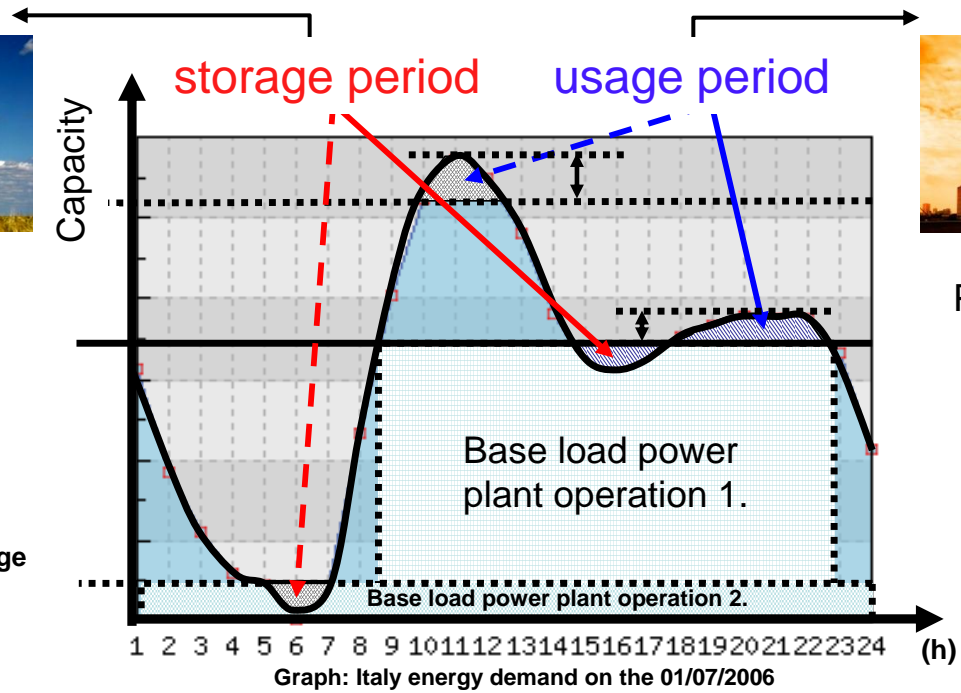
TASKS

THE PROJECT

Overcapacity of renewable energy

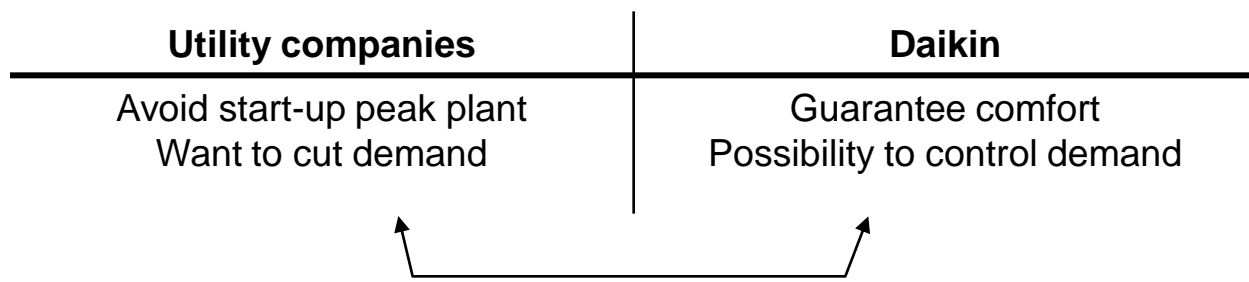
18x negative prices at EEX*

*European Energy Exchange (Germany) 2009



Peaks in demand

Peak price up to €1500 / MWh



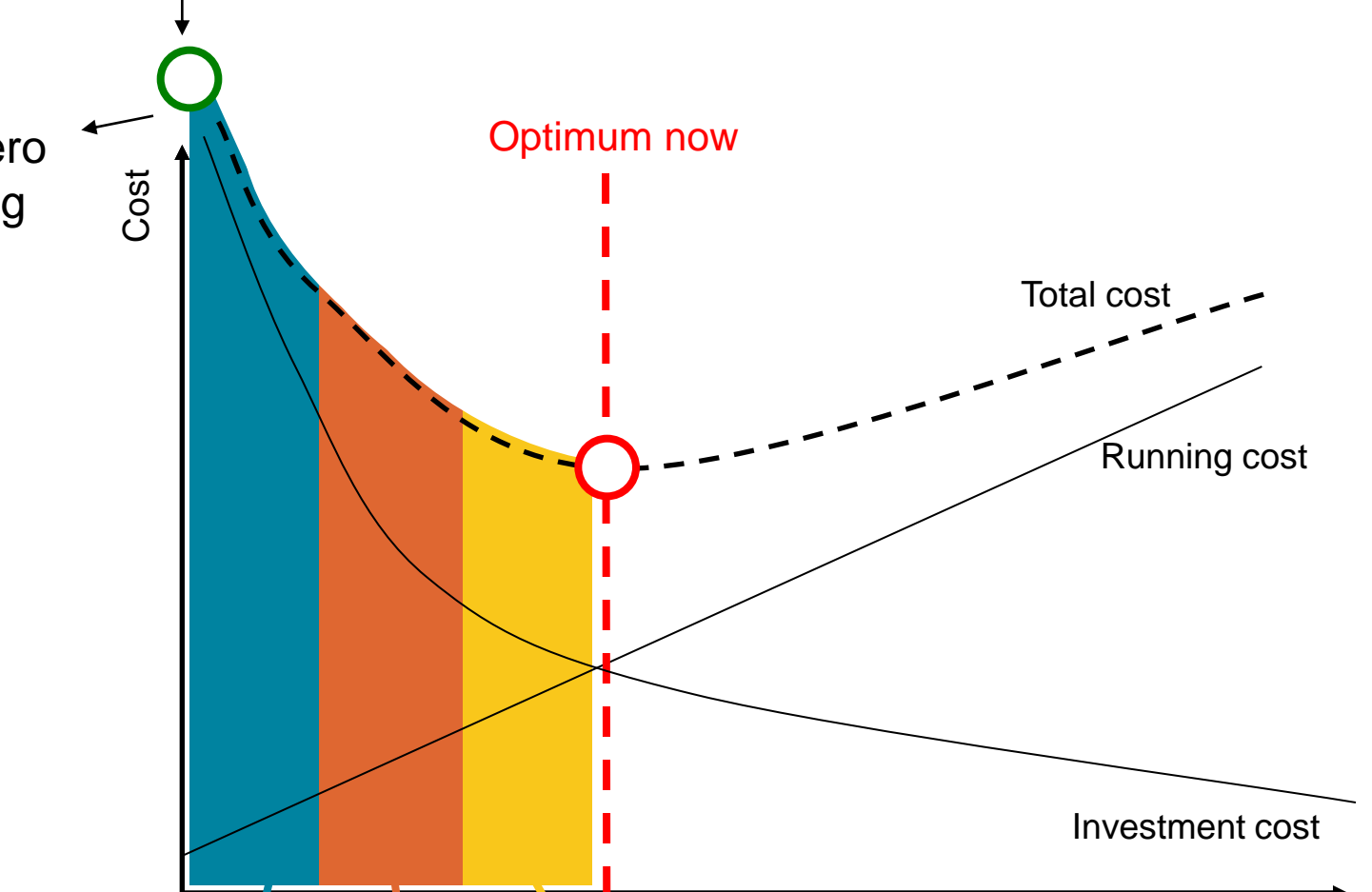
net Zero Energy Building
integrated heatpump solution = access to storage

Target:

Economically feasible net Zero Energy Building

- ENERGY
- LEGISLATION
- BUILDINGS
- ZERO ENERGY
- CHALLENGES
- TASKS
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Legislation recast



Current net zero energy building

Optimum now

Cost

Total cost

Running cost

Investment cost

net Zero Energy

net Energy Consumption

passive measures
e.g. insulation

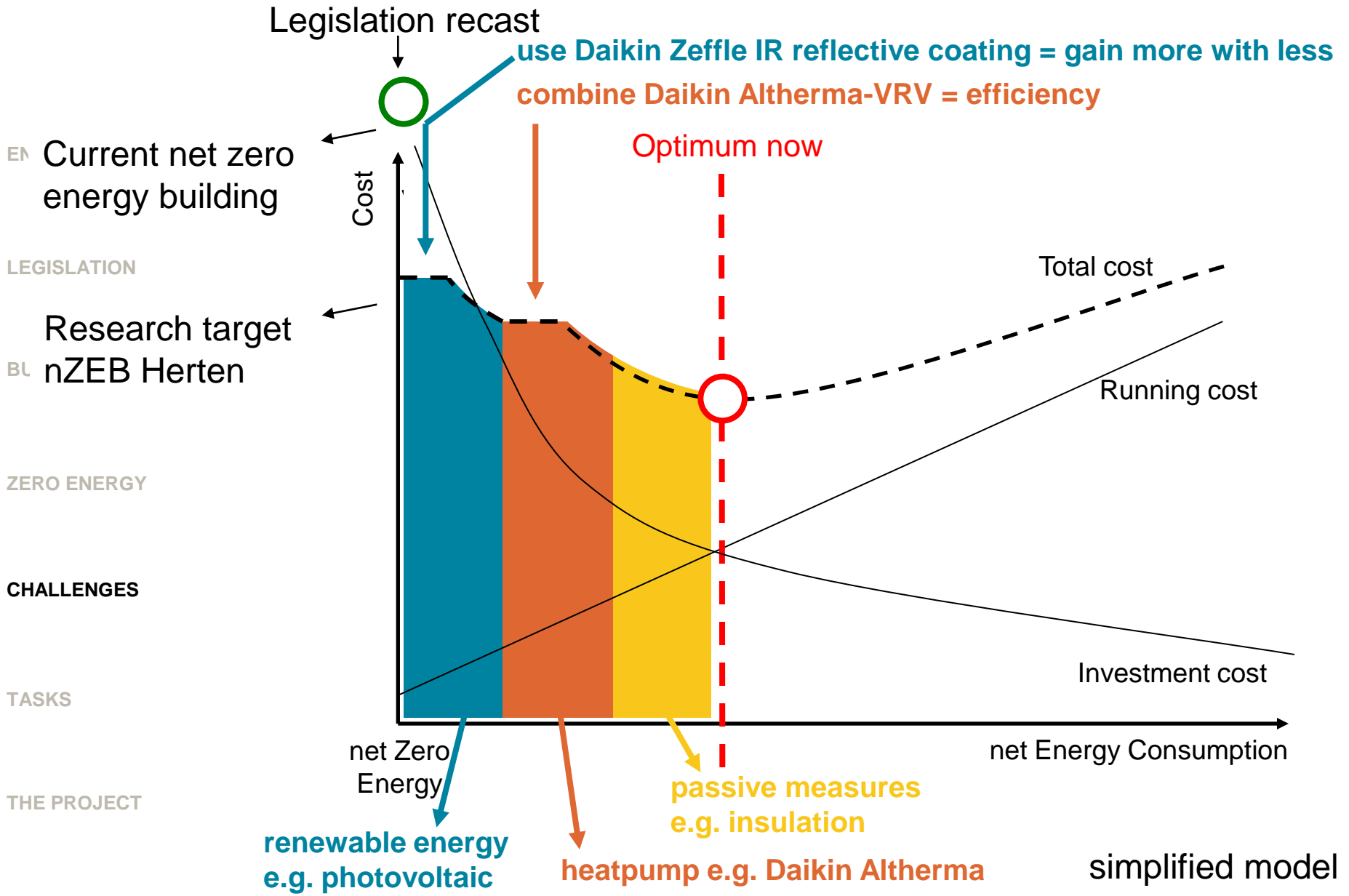
renewable energy
e.g. photovoltaic

heatpump e.g. Daikin Altherma

simplified model

Target:

Economically feasible net Zero Energy Building



The way towards...

ENERGY

PHASE 1

LEGISLATION

Current product evaluation / level-up solutions
Gain knowledge on calculation methodology in MS
Inform decision makers in the MS & EU commission
Promote our present solution for nZEB

BUILDINGS

ZERO ENERGY

PHASE 2

CHALLENGES

New technology / product evaluation
Prepare economically feasible solution
Get advantage for next calculation methodology in MS
Inform decision makers in the MS & EU commission

TASKS

THE PROJECT

ENERGY

LEGISLATION

BUILDINGS

ZERO ENERGY

CHALLENGES

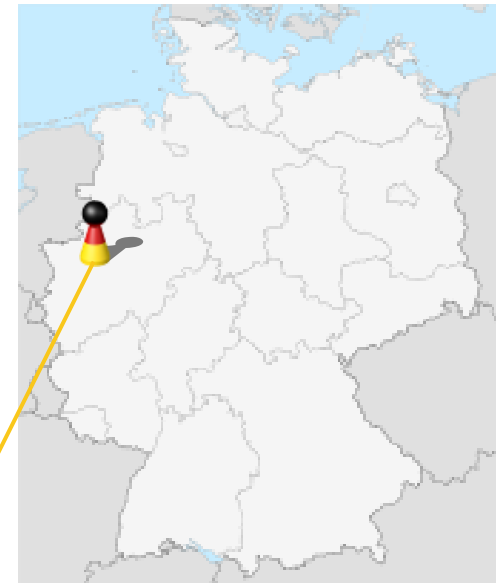
TASKS

THE PROJECT

Net Zero Energy Office Building

Building concept

Location: Herten, Ruhr region, Germany



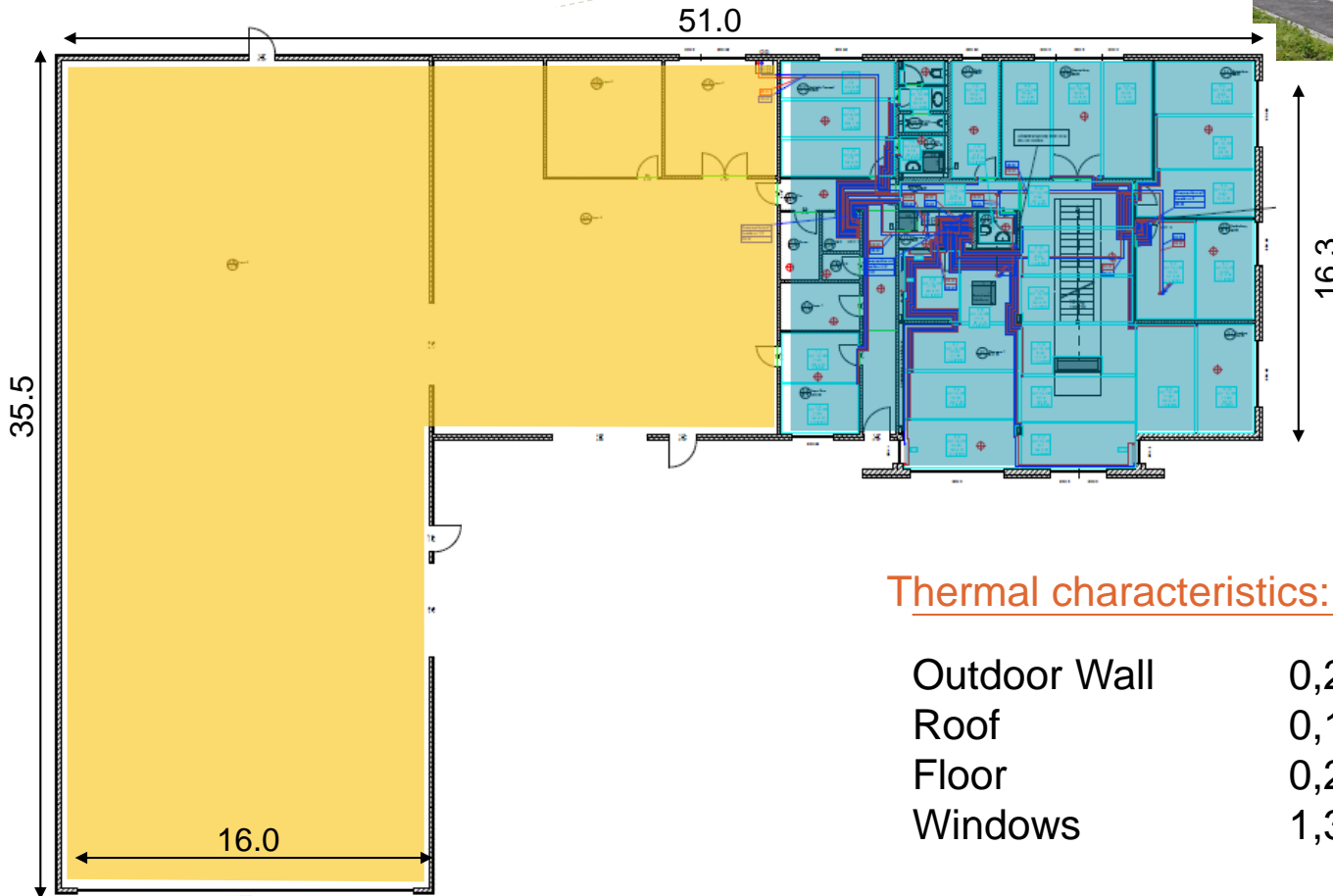
Warehouse (1 floor)

Office (2 floors)



Boundary condition: Plans / Blueprints

- Warehouse 800 m²
- Office 535m² (305m² + 230m²)

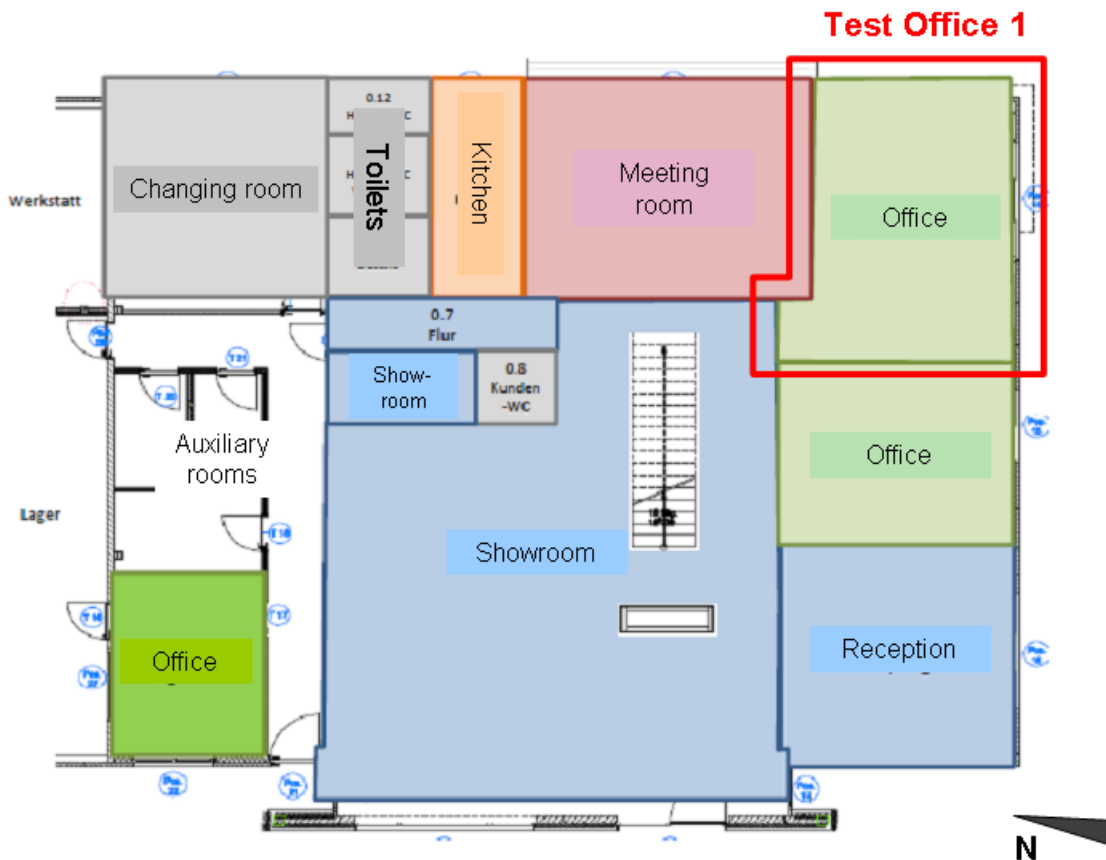


Thermal characteristics:

Outdoor Wall	0,23 W/m ² K.
Roof	0,16 W/m ² K
Floor	0,24 W/m ² K
Windows	1,30 W/m ² K

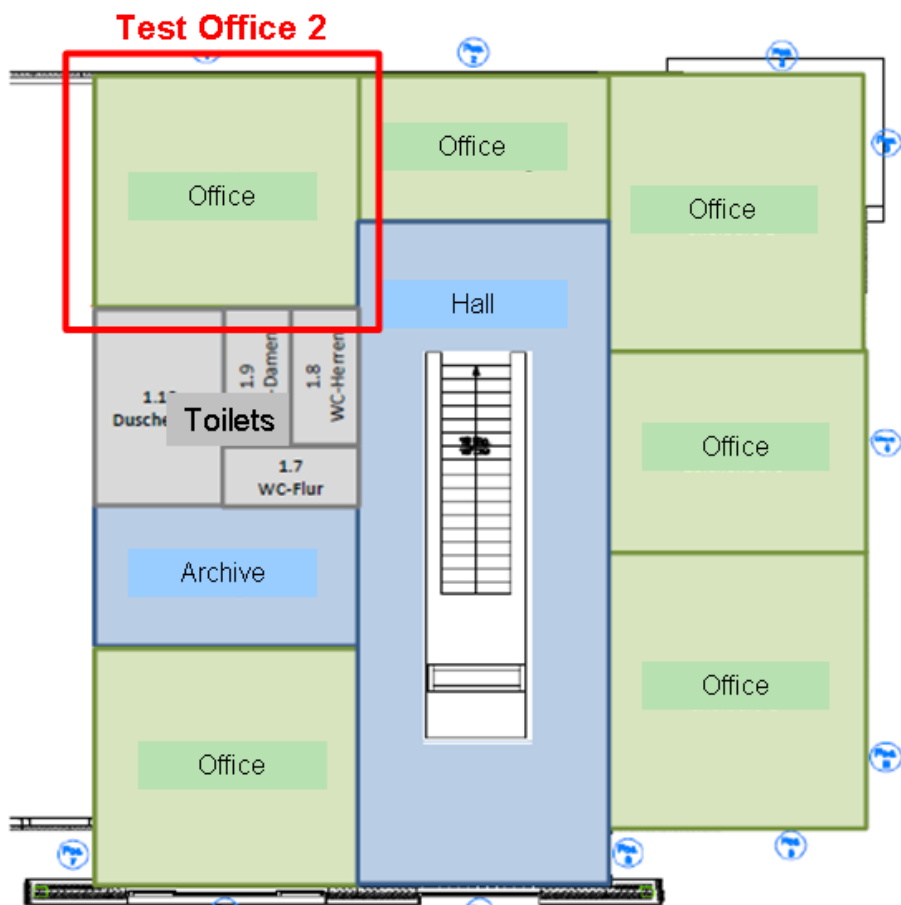
Building Zones

Ground Level



Building Zones

Level 1



Technical Concept

Heating

Daikin Altherma – Air to Water heat pump
with floor heating

VRV – Air to Air heat pump
used for heating

Cooling

VRV – Air to Air heat pump
Cooling + dehumidification in summer

Daikin Altherma

Ventilation

VAM – heat recovery ventilation

Sensible and latent heat recovery

Lighting

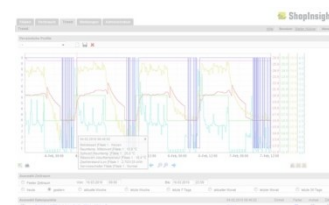
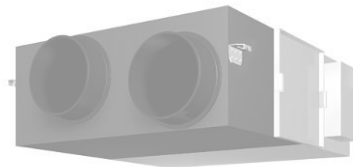
Use of **LED-technology** for night-lighting and spot-lighting

Power generation

Thin film Photovoltaic with 27,3 kWp

Energy-monitoring

Building management system



Daikin Altherma

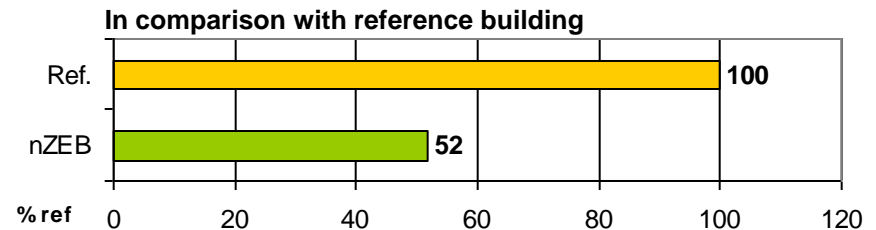
Heat load of the building: 13,3 kW

Ground floor: 7,4 kW for 305m² + 300l DHW → ERLQ008BAV3
 Level 1: 5,8 kW for 240 m² → ERLQ007BAV3

2 circuits – 2 outdoor units



HEATING (prim E)	
Specific kWh/m ² a	Absolute kWh/a
44	23.614,48



Daikin VRV heat pump



Outdoor unit

RXYQ8P8

Nominal cooling capacity: 22,4 kW

Indoor unit

11 indoor units



Different types

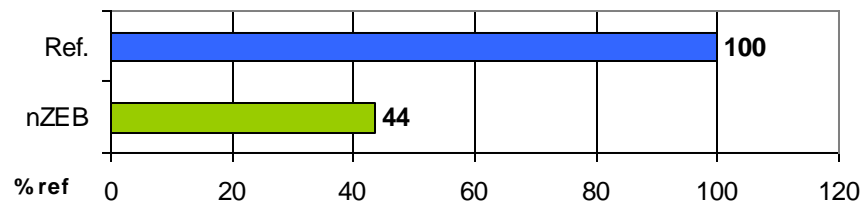
Design cool loads:

Geschoß	Raum-Nr.	Plan-Nr.	Bezeichnung	Fläche [m ²]	qo [W/m ²]	Qo [kW]
EG	1	0.2	Empfang	23,7	60	1,4
EG	14	0.3	Meisterbüro 1	21,7	70	1,5
EG	17	0.4	Meisterbüro 2	29,5	70	2,1
EG	18	0.5	Besprechung	32,0	85	2,7
EG	21	0.1	Showroom 1	106,3	50	5,3
EG	alle		Summe	213,2		13,0

Geschoß	Raum-Nr.	Plan-Nr.	Bezeichnung	Fläche [m ²]	qo [W/m ²]	Qo [kW]
OG	2	1.6	Marketing	24,2	60	1,5
OG	3	1.2	Chef Büro 1	28,9	70	2,0
OG	4	1.4	Chef Büro 2	28,3	70	2,0
OG	9	1.12	Vertrieb	26,4	70	1,8
OG	12	1.5	Buchhaltung	13,0	60	0,8
OG	13	1.3	Zeichen-Büro	20,9	80	1,7
EG	alle		Summe	141,7		9,8

COOLING (prim E)	
Specific kWh/m ² a	Absolute kWh/a
14,07	7.519,51

In comparison with reference building

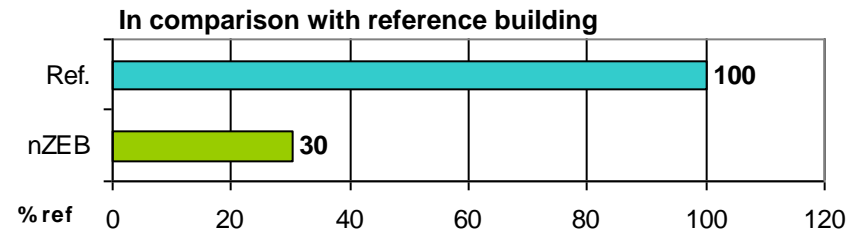


Daikin VAM heat recovery ventilation

VAM units

- Ground floor → Supply air: 863 m³/h
VAM1000FAVE
- Level 1 → Supply air: 400 m³/h
VAM650FAVE

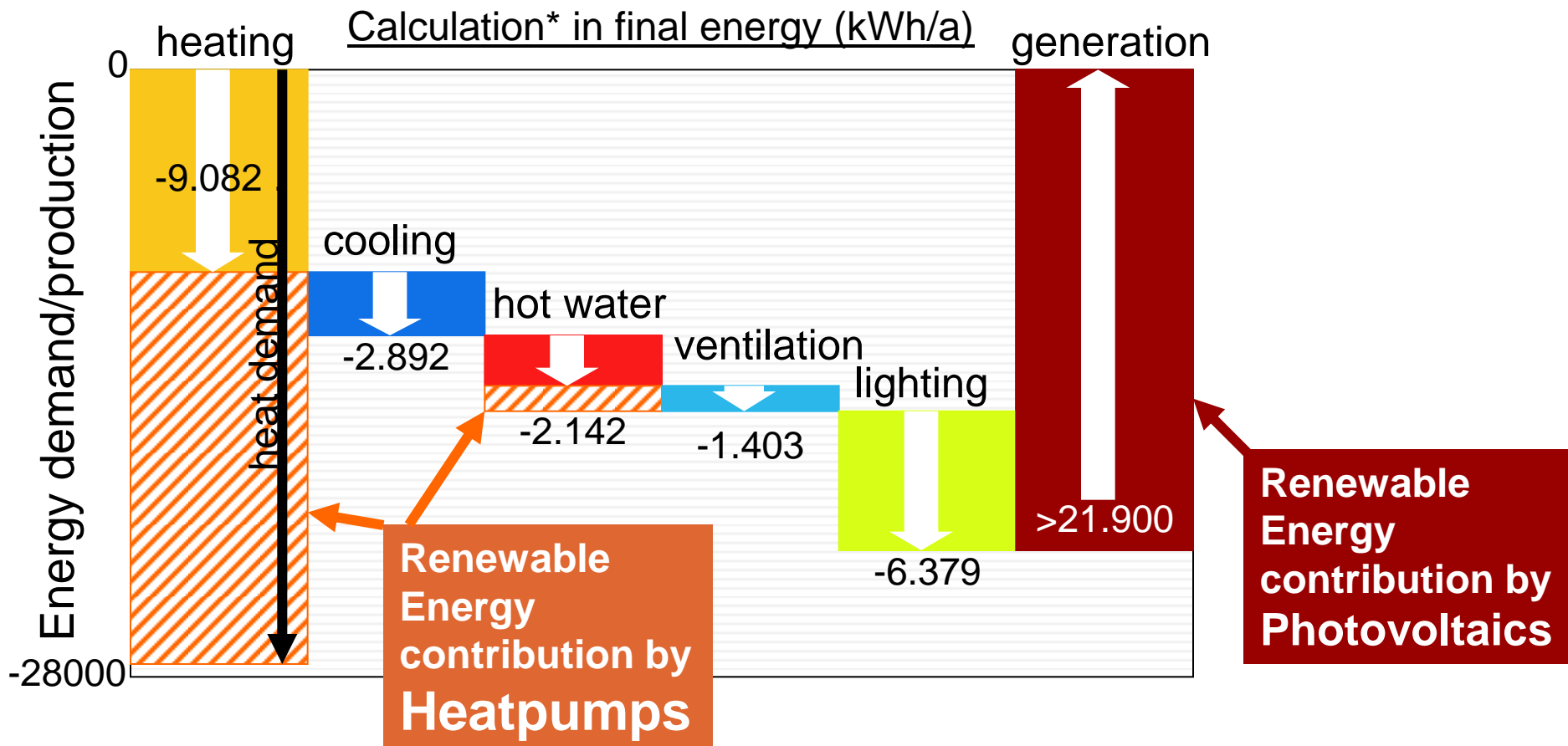
Efficiency heat recovery: 71,8%




VENTILATION (prim E)	
Specific kWh/m ² a	Absolute kWh/a
6,83	3.650,21

Heat pumps are inevitable

- contributing as much as photovoltaic to net Zero Energy Buildings



 Renewable energy part due to Heatpump

remark: standard design indoor temperature in Germany:
heating: 20°C
cooling: 26°C

*methodology: non-residential building → DIN V 18599

Measuring & monitoring

Temperature sensors

- Room temperature
- Ventilation air temperature
- Floor contact temperature
- PV tube temperature
- Outdoor temperature
- Roof temperature

Humidity sensors

- Outdoor humidity
- Room humidity

Power meters

- Electricity

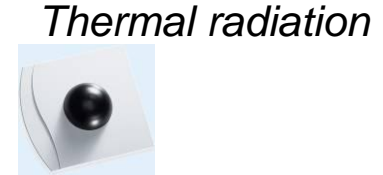
Other sensors

- CO2 concentrations
- Solar radiation
- Presence detection
- Window/door contacts
- Weather station
- Daikin equipment operation

Total more than 500 sensors installed



Duct temp. & humidity sensor



Thermal radiation

Strap on temp. sensor



CO₂ sensor



Power meter

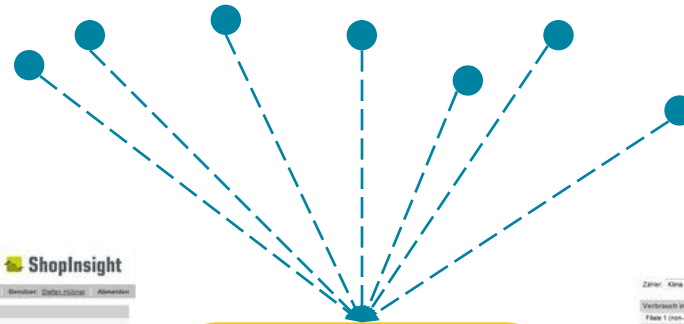


Weather station

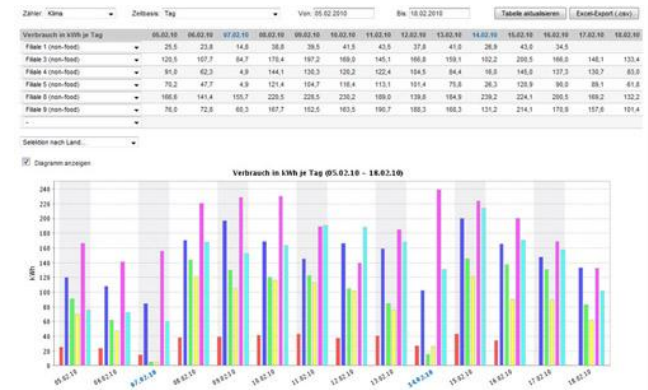
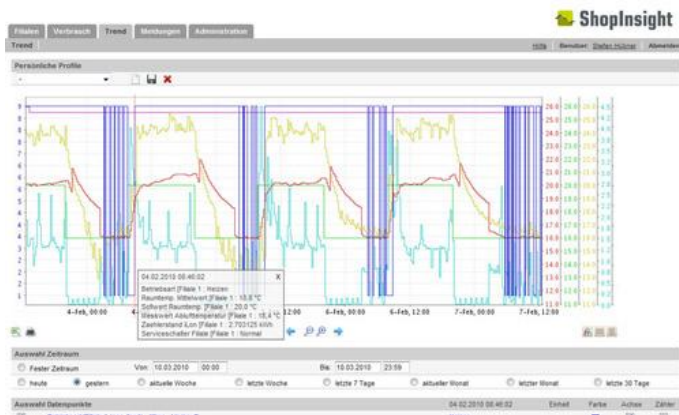


Measuring & monitoring

Sensors:



Measurement & Visualisation System



- electronic data recording every 15 min
- Web-based data management

DAIKIN + Research Partners

Project partners



RESEARCH TOPICS:

**Indoor Air Quality / Comfort / Ventilation / Energy saving
Alternative solutions**



**Potential of Daikin concept & environmental impact
Influence of different climates**



**Monitoring of Daikin Altherma-VRV combination
Alternative solutions**



**Net Zero Energy Building (nZEB) concept
Design alternative concept, modelling in TRNSYS**



**Relation of Building Energy Management of
Daikin test nZEB and intelligent grid**

First experience

Building is occupied since 1st of November 2010

Construction phase: supervision of execution is highly important

Ventilation: installation and commissioning is decisive to reach target efficiency

Calculation of Net Zero Energy Building (nZEB) level accordingly to EPBD, EnEV in this case, shows difference to reality

Net Zero Energy Building (nZEB) concept requires good calculation methodology in order to reach net zero energy level in reality

=> We are on track but not yet economically feasible.

Our target is to learn in phase 1 about how to come to economically feasible solutions for net Zero Energy Buildings

which reach to zero in reality, only real nZEB will contribute to achieve EU 20-20-20 targets.