



nZEB  HERTEN

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



# Net Zero Energy Office Building Germany, Ruhr region

1st part of Daikin nZEB project



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Public

# 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**

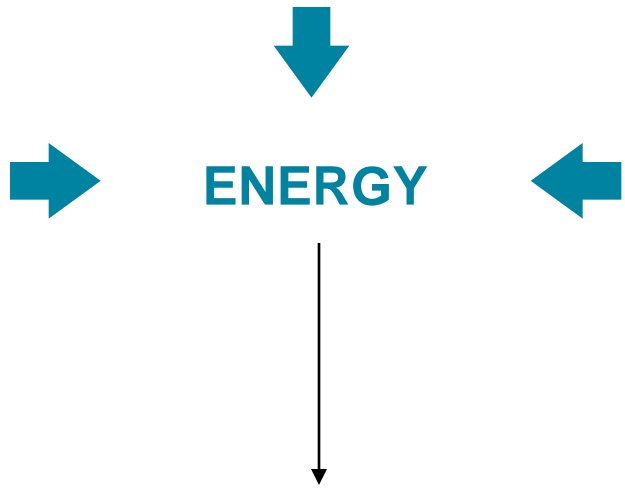
20% less primary energy use compared to 2020 projection

**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  
CO<sub>2</sub> 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

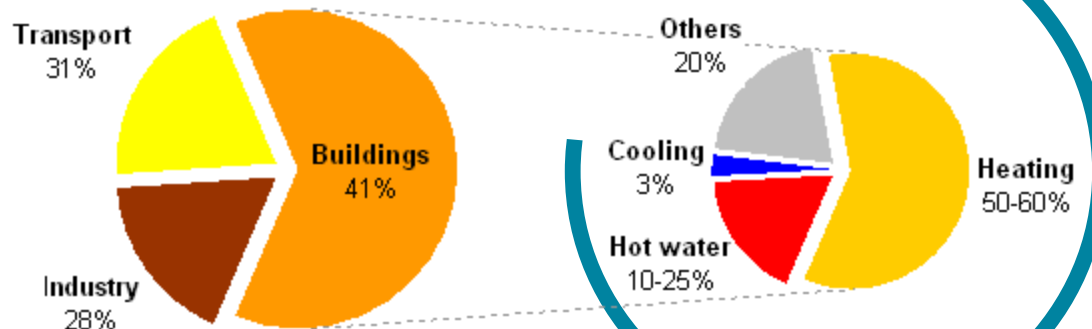
7. Regulation on fluorinated greenhouse gases  
F gas regulation  in force 2011
8. Emission Trading

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

# The way towards...

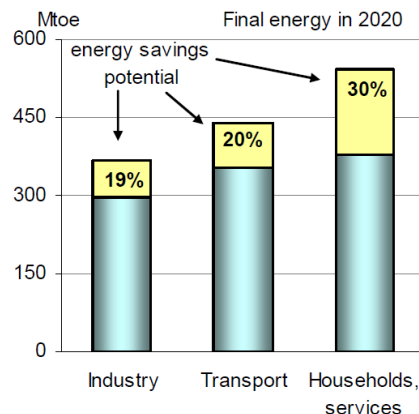
Energy use in building is of high importance + big saving potential

Primary energy consumption with EU



Source: Eurostat

33% of total energy consumption is HVAC related



Estimated energy consumption reduction potential in 2020



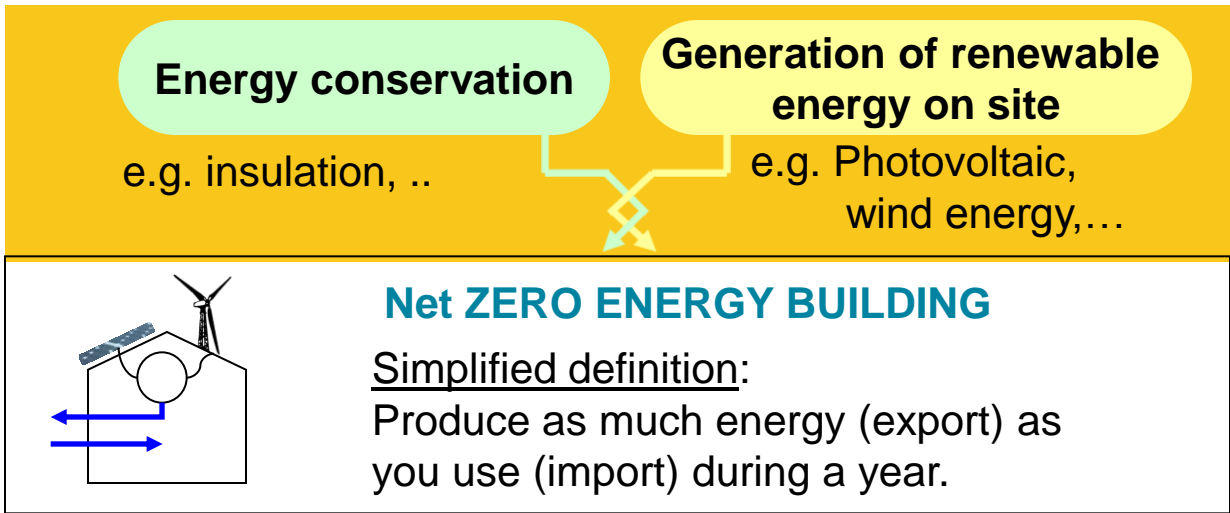
Energy Performance of Buildings Directive

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

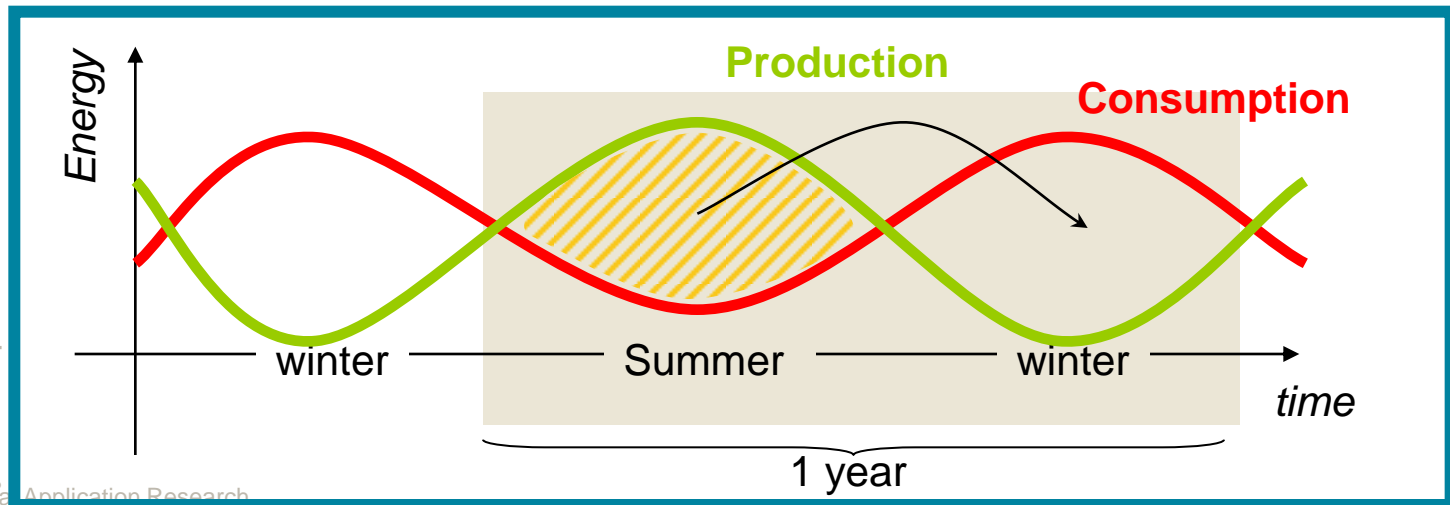
# net Zero Energy Buildings using heatpumps are part of solution for intelligent grids

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

ENERGY  
LEGISLATION  
BUILDINGS  
ZERO ENERGY



CHALLENGES  
TASKS  
THE PROJECT



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



ENERGY

LEGISLATION

BUILDINGS

ZERO ENERGY

CHALLENGES

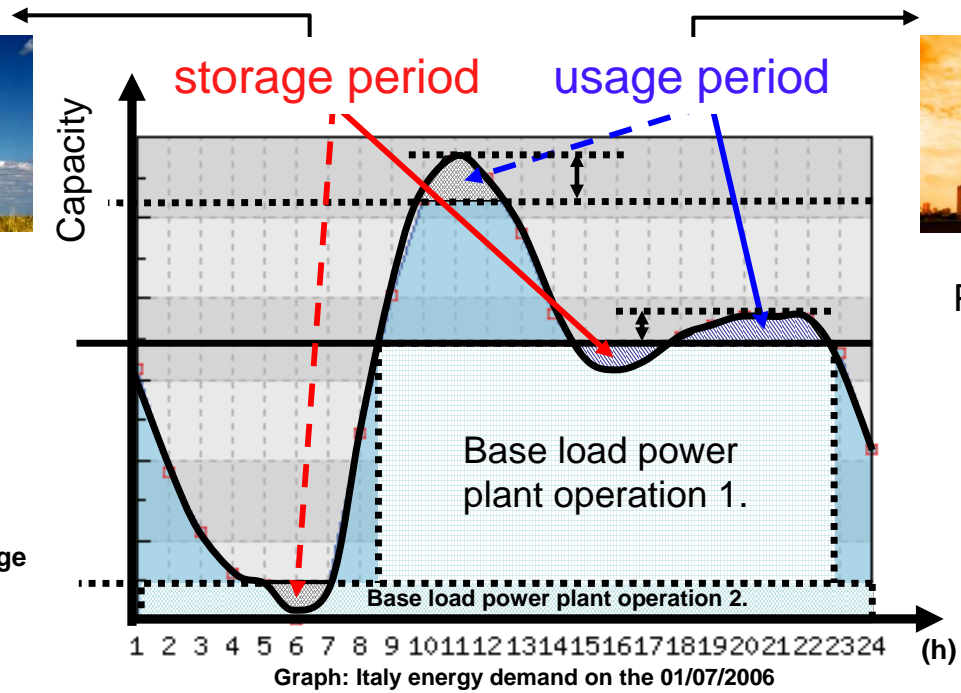
TASKS

THE PROJECT

Overcapacity of renewable energy

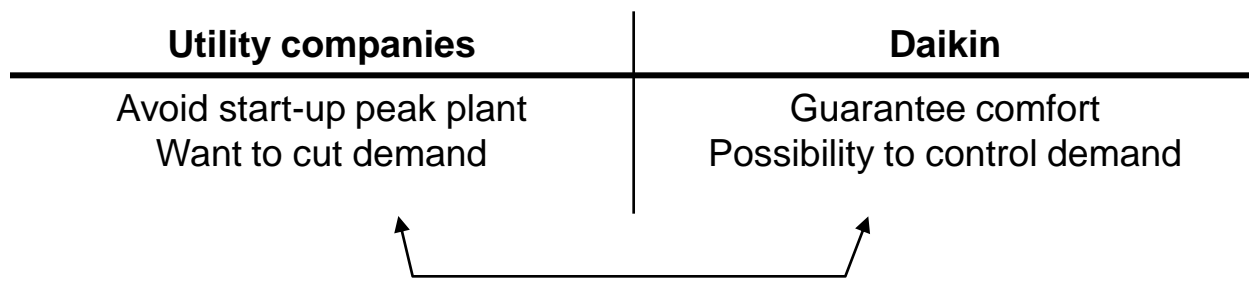
18x negative prices at EEX\*

\*European Energy Exchange (Germany) 2009



Peaks in demand

Peak price up to €1500 / MWh



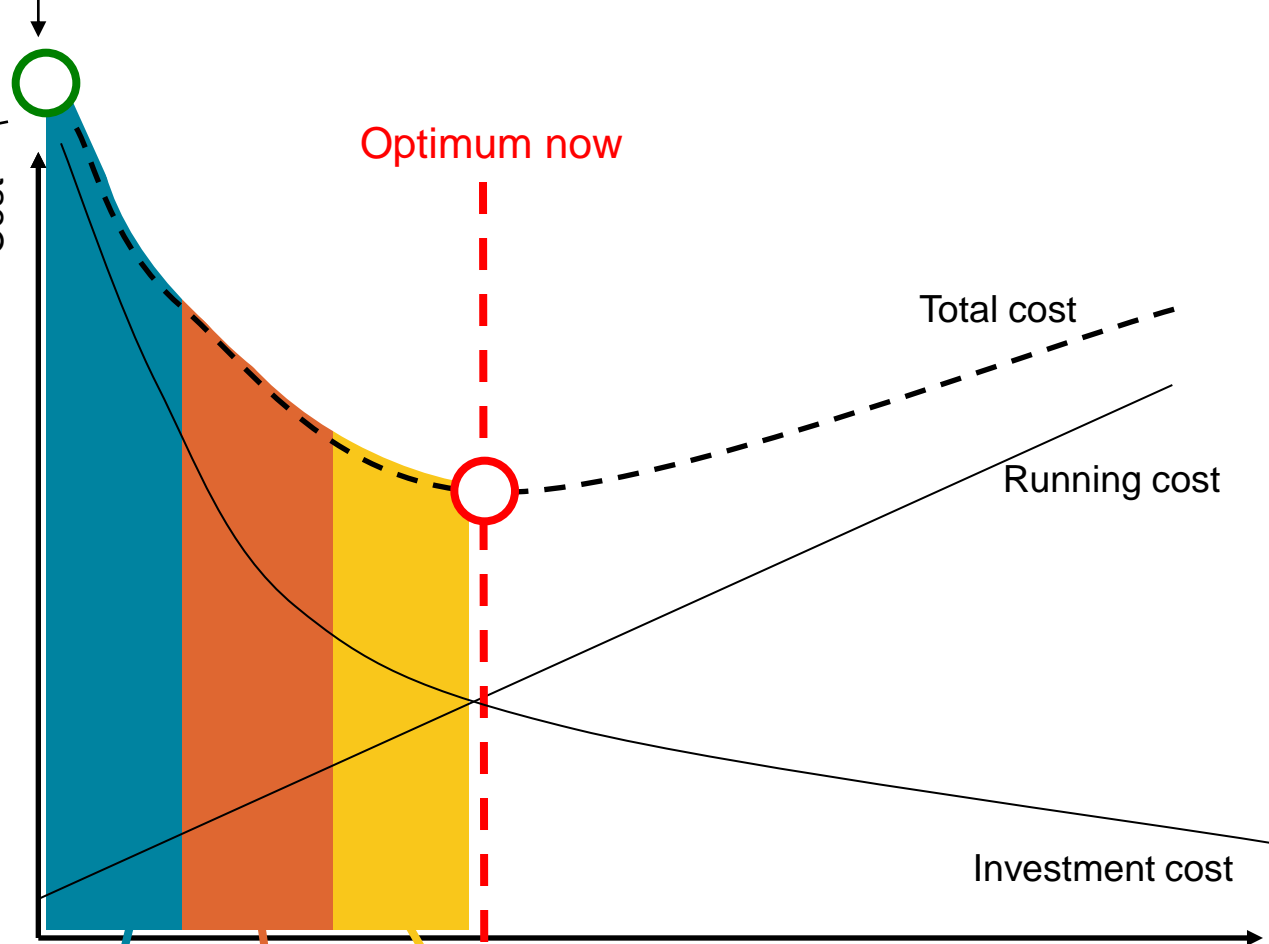
**net Zero Energy Building integrated heatpump solution = access to storage**

# 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

renewable energy e.g. photovoltaic

heatpump e.g. Daikin Altherma

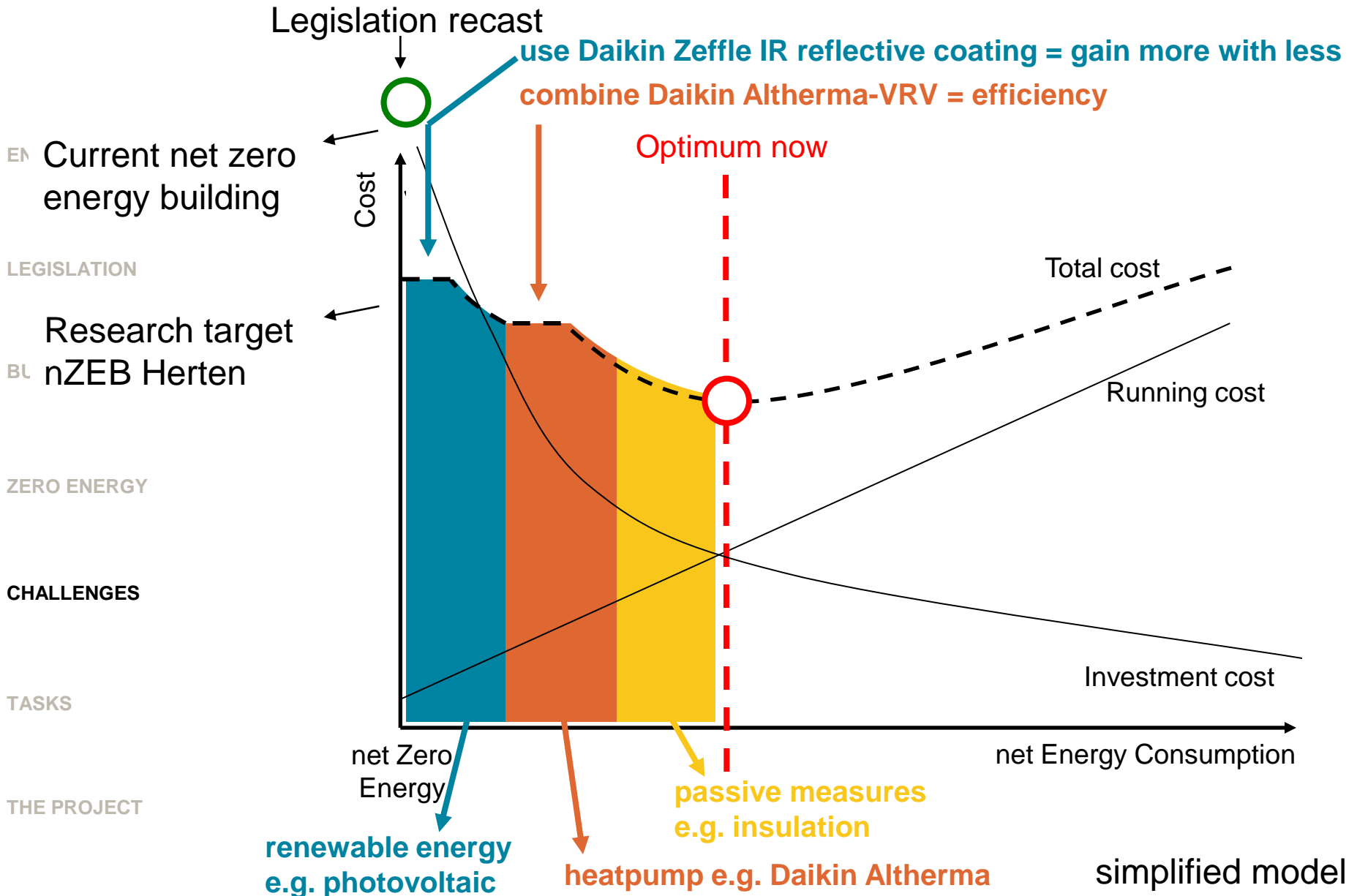
passive measures e.g. insulation

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

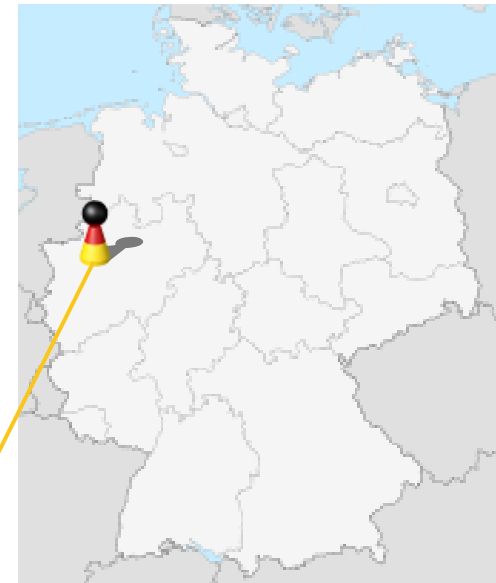
CHALLENGES

TASKS

THE PROJECT

# Net Zero Energy Office Building

# Building concept



Location: Herten, Ruhr region, Germany

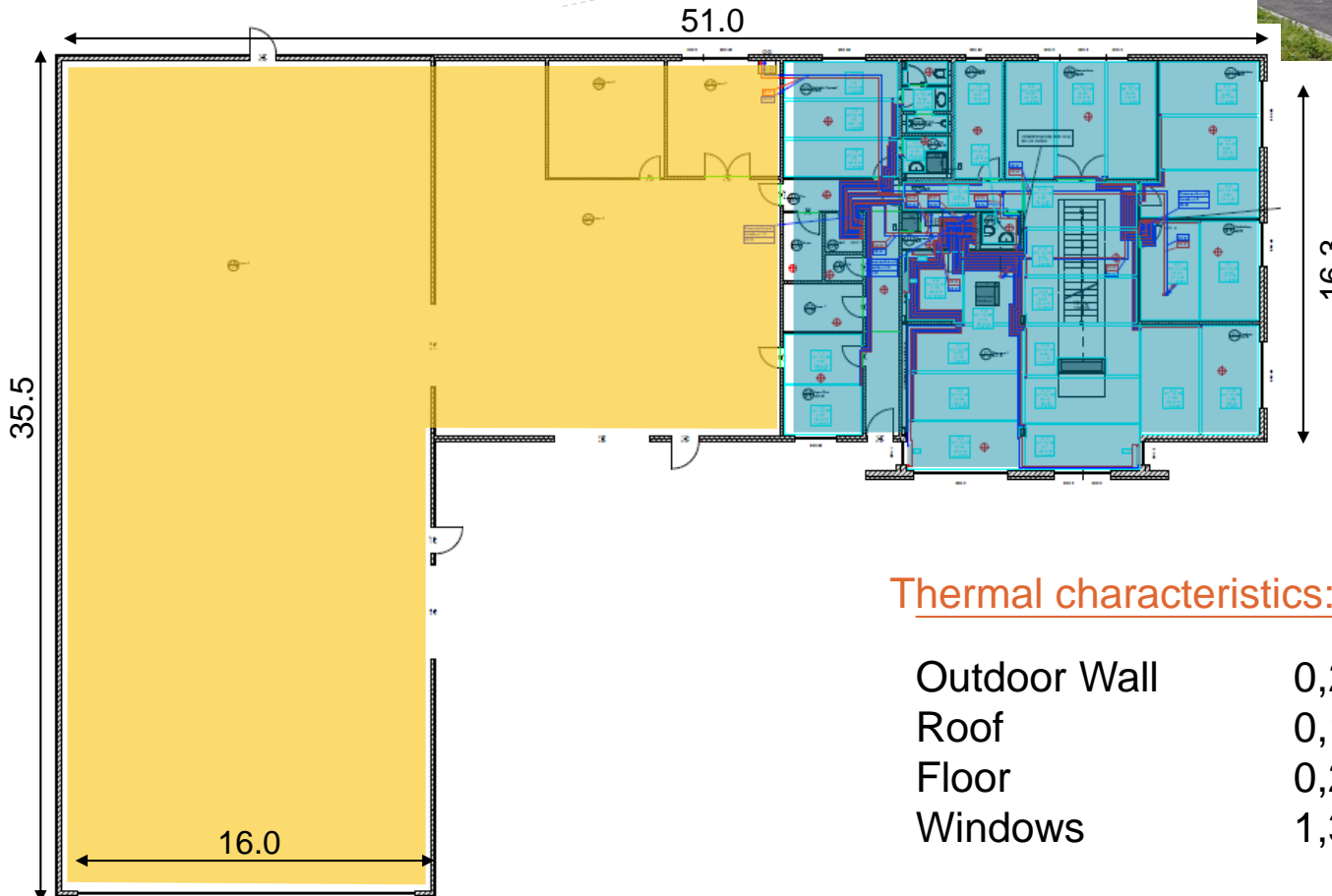
Warehouse (1 floor)

Office (2 floors)



# Boundary condition: Plans / Blueprints

- Warehouse 800 m<sup>2</sup>
- Office 535m<sup>2</sup> (305m<sup>2</sup> + 230m<sup>2</sup>)

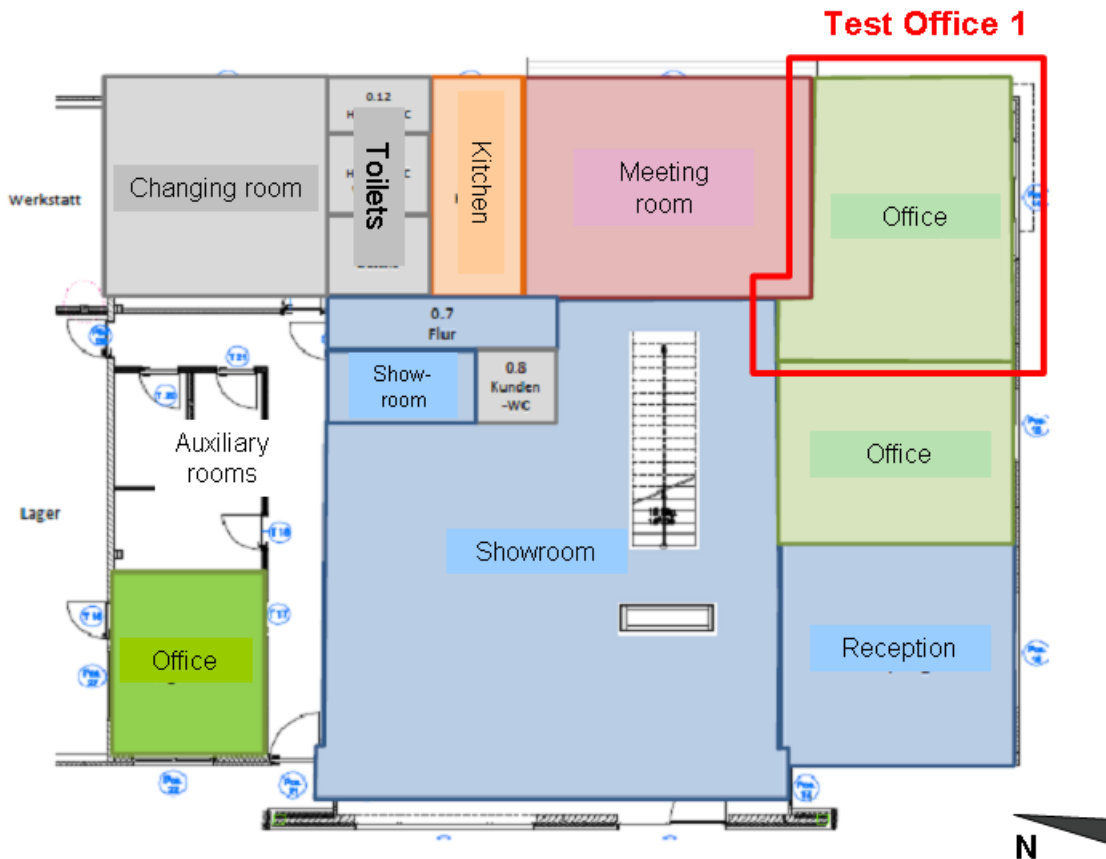


## Thermal characteristics:

|              |                          |
|--------------|--------------------------|
| Outdoor Wall | 0,23 W/m <sup>2</sup> K. |
| Roof         | 0,16 W/m <sup>2</sup> K  |
| Floor        | 0,24 W/m <sup>2</sup> K  |
| Windows      | 1,30 W/m <sup>2</sup> K  |

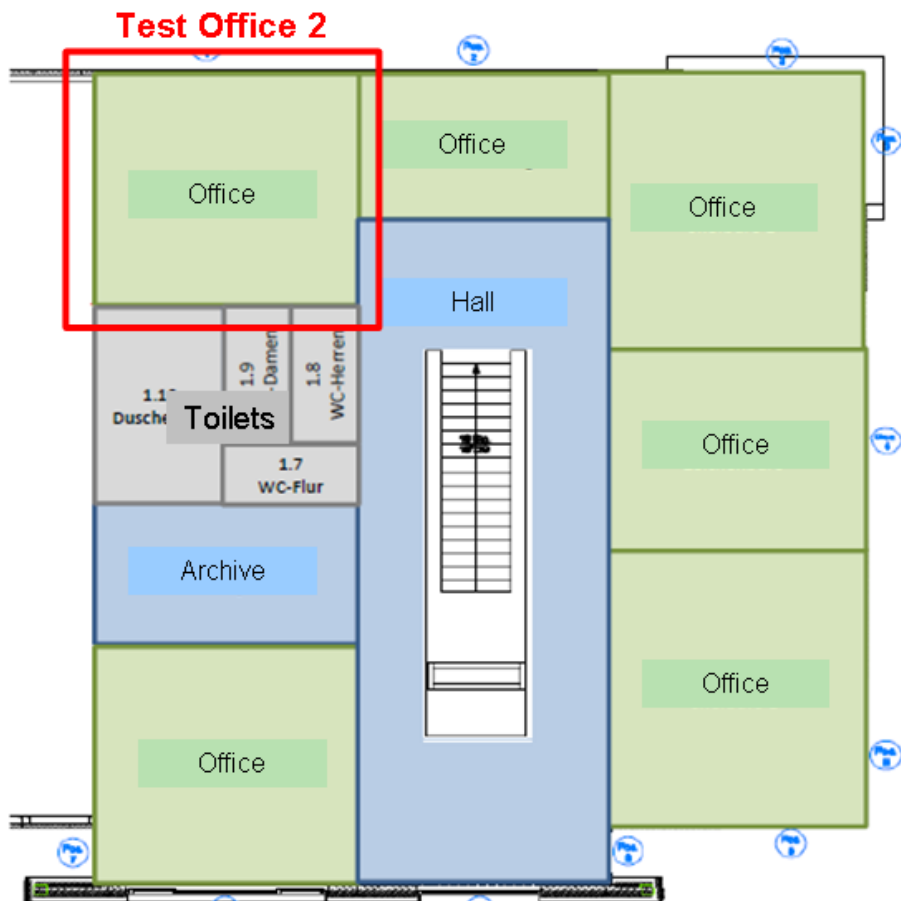
# Building Zones

## 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

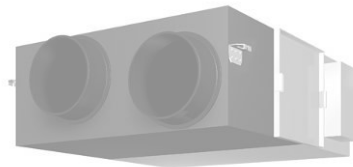
Use of **LED-technology** for night-lighting and spot-lighting

## Power generation

**Thin film Photovoltaic** with 27,3 kWp

## Energy-monitoring

Building management system





# Daikin Altherma

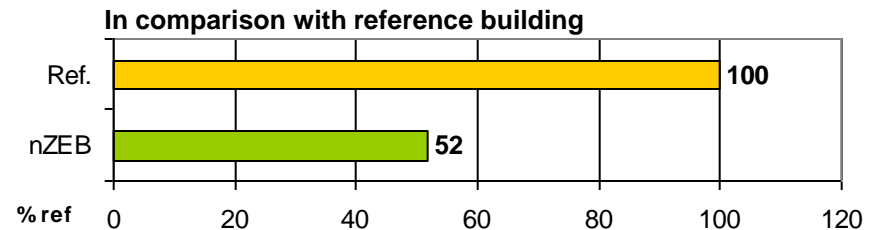
Heat load of the building: 13,3 kW

Ground floor: 7,4 kW for 305m<sup>2</sup> + 300l DHW → ERLQ008BAV3  
 Level 1: 5,8 kW for 240 m<sup>2</sup> → ERLQ007BAV3

2 circuits – 2 outdoor units



| HEATING (prim E)              |                |
|-------------------------------|----------------|
| Specific kWh/m <sup>2</sup> 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:

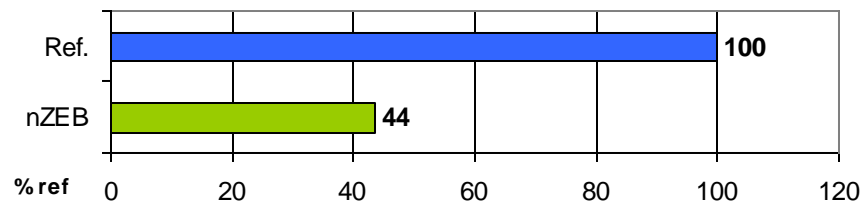
| Geschoß | Raum-Nr. | Plan-Nr. | Bezeichnung   | Fläche [m <sup>2</sup> ] | qo [W/m <sup>2</sup> ] | Qo [kW]     |
|---------|----------|----------|---------------|--------------------------|------------------------|-------------|
| EG      | 1        | 0.2      | Empfang       | 23,7                     | 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     |          | <b>Summe</b>  | <b>213,2</b>             |                        | <b>13,0</b> |

| Geschoß | Raum-Nr. | Plan-Nr. | Bezeichnung  | Fläche [m <sup>2</sup> ] | qo [W/m <sup>2</sup> ] | 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     |          | <b>Summe</b> | <b>141,7</b>             |                        | <b>9,8</b> |

| COOLING (prim E)              |                |
|-------------------------------|----------------|
| Specific kWh/m <sup>2</sup> a | Absolute kWh/a |
| 14,07                         | 7.519,51       |

In comparison with reference building



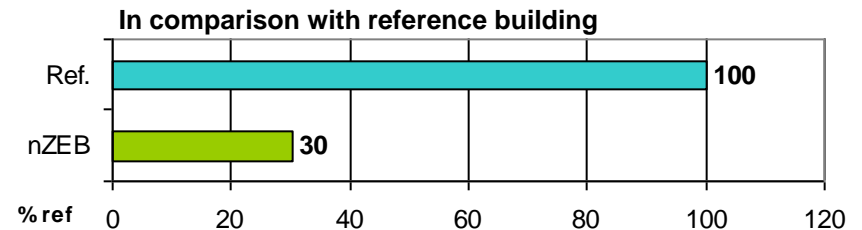
# Daikin VAM heat recovery ventilation

## VAM units

Ground floor → Supply air: 863 m<sup>3</sup>/h  
VAM1000FAVE

Level 1 → Supply air: 400 m<sup>3</sup>/h  
VAM650FAVE

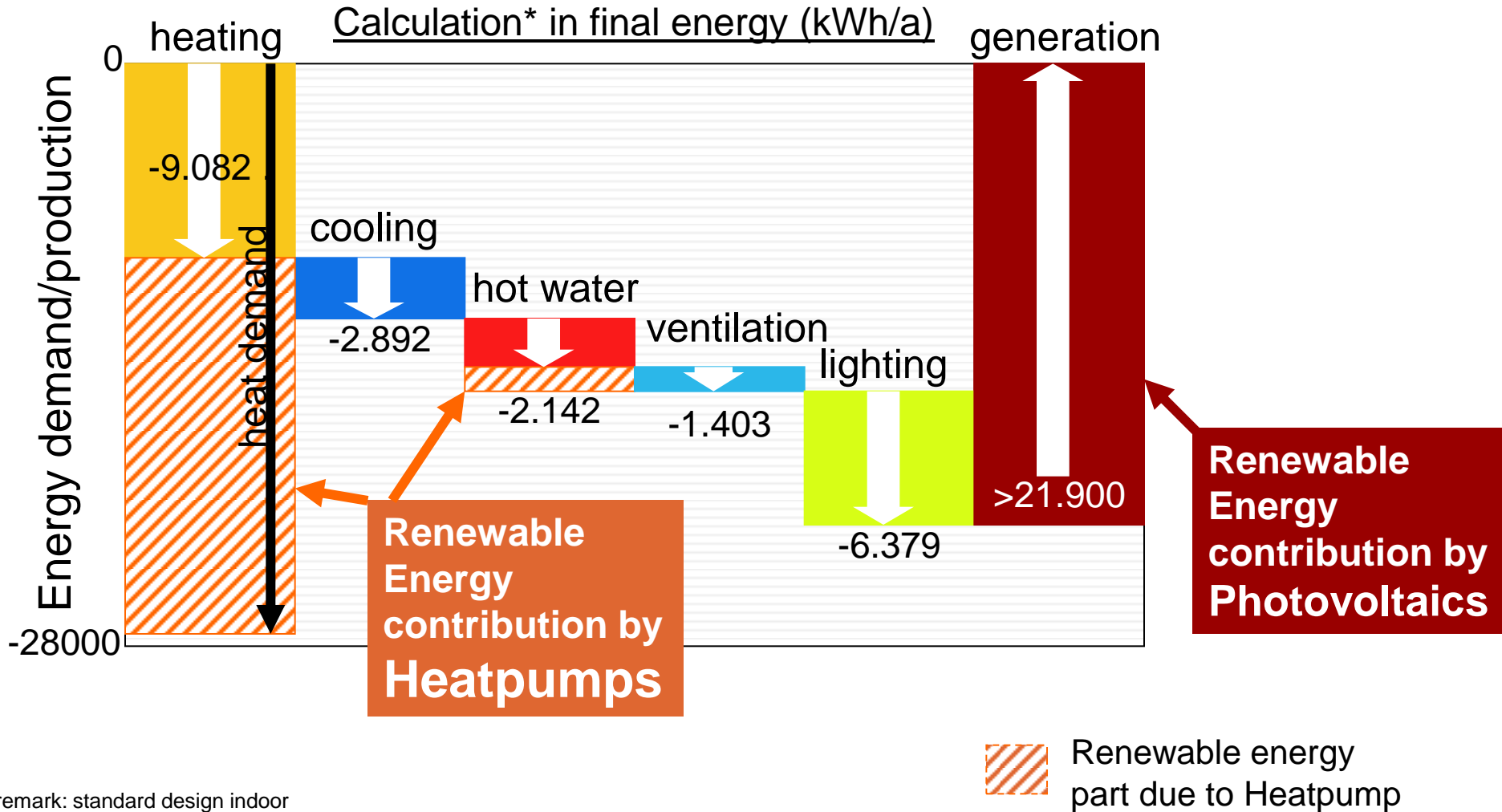
Efficiency heat recovery: 71,8%



| VENTILATION (prim E)             |                   |
|----------------------------------|-------------------|
| Specific<br>kWh/m <sup>2</sup> a | Absolute<br>kWh/a |
| 6,83                             | 3.650,21          |

# Heat pumps are inevitable

- contributing as much as photovoltaic to net Zero Energy Buildings



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

\*methodology: non-residential building □ DIN V 18599 20

# 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*



*CO<sub>2</sub> sensor*



*Power meter*

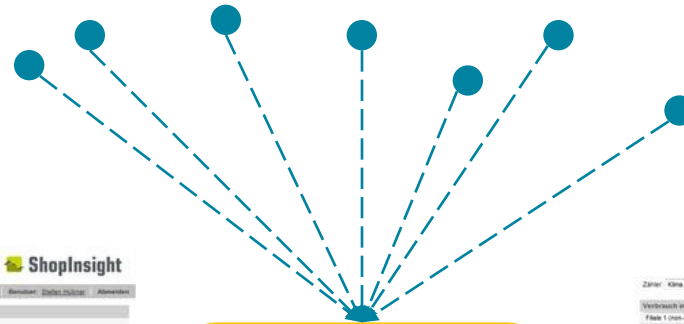


*Weather station*

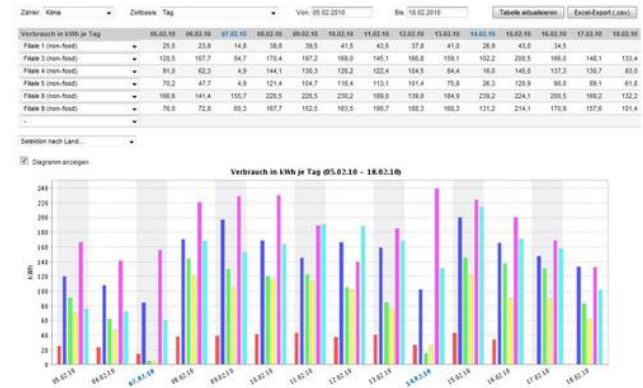
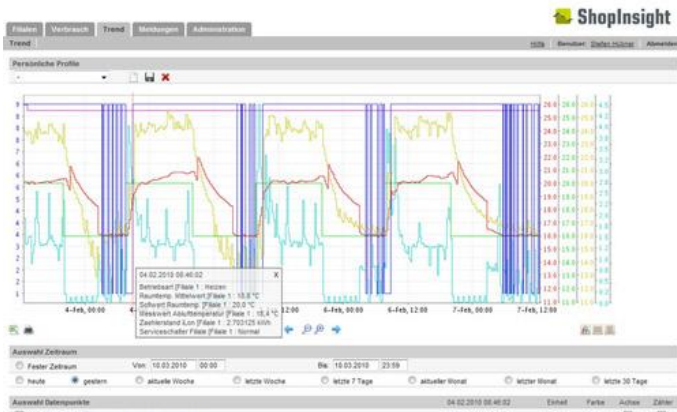


# Measuring & monitoring

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 1<sup>st</sup> 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, Energy Performance of Buildings Directive, 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.