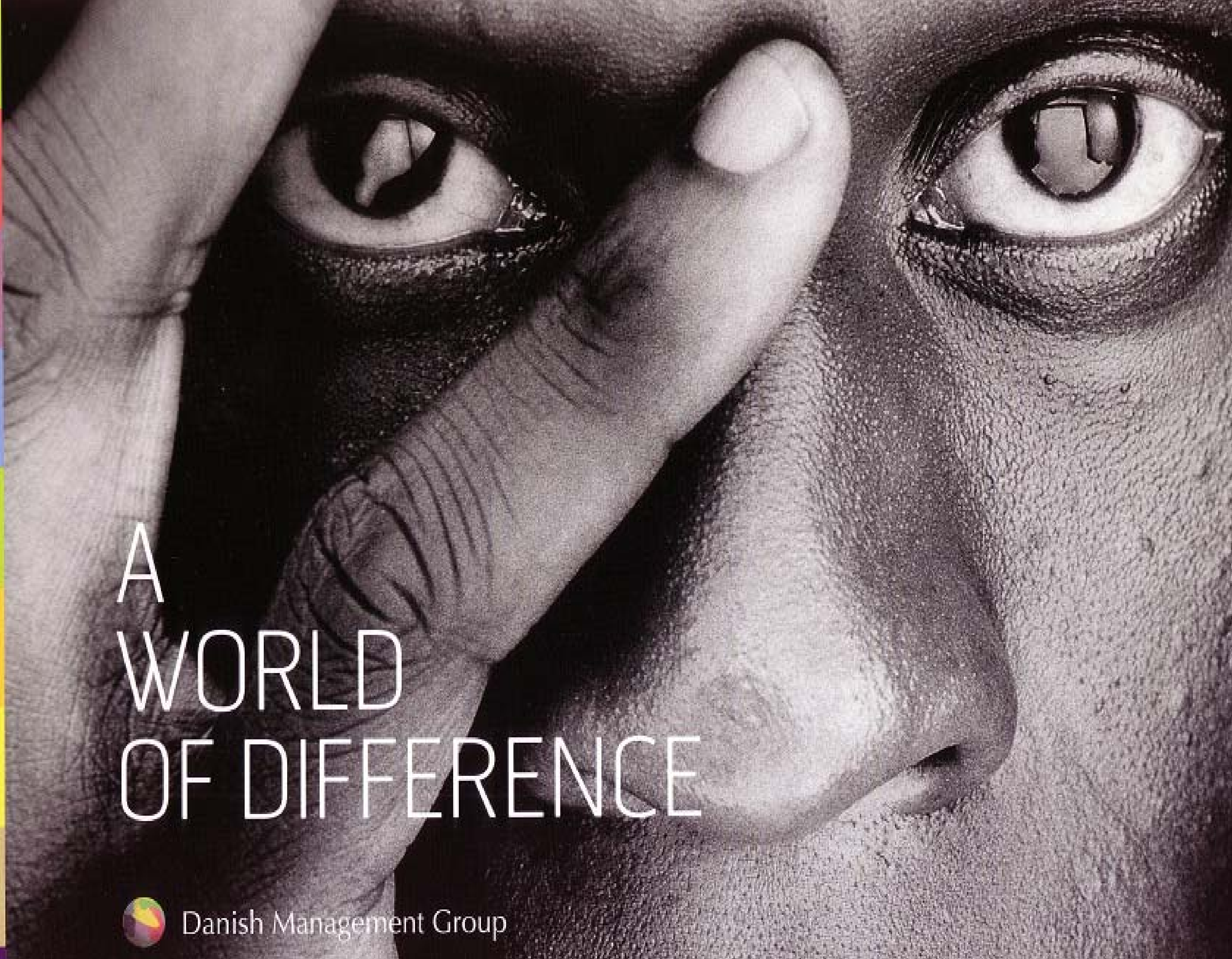
Danish Energy Management

*A part of Danish Management Group*

# New DMG HQ in Denmark

**Fagseminar – Passivhus og lavenergibygg**
**Onsdag d. 18.november 2009**

Kirsten Mariager



# A WORLD OF DIFFERENCE

Danish Management Group

# Who are We?

Danish Management Group (DMG)

**Danish Energy Management (DEM)**
(Energy Management and Consulting)

**Danish Project Management**
(Monitoring and Project Management)

**Danish ICT Management**
(IT and Technology consulting and development)

# Energy Efficiency

2008 – 2012: Energy Efficiency in Industrial, Commercial and Public Sector - Indonesia

Survey of Building Performance

Design of a New Ministry Building in Malaysia

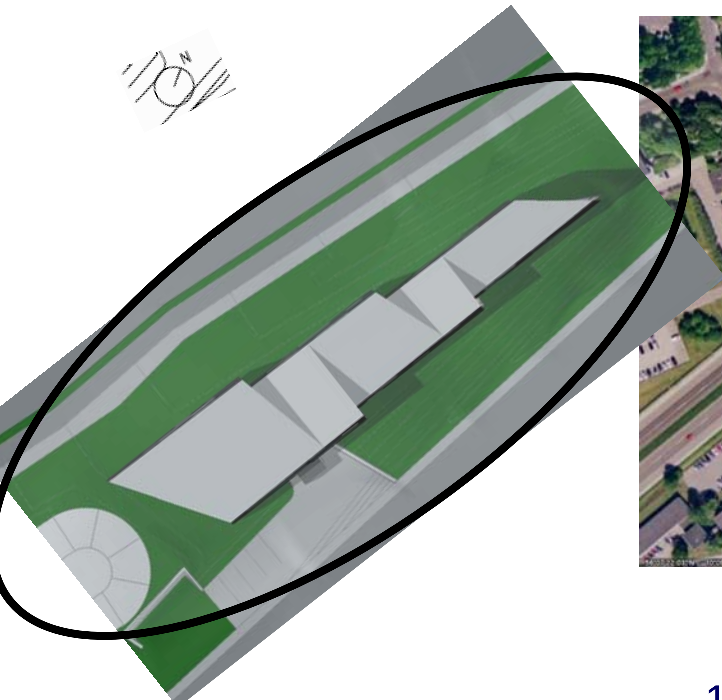
Development of Energy Efficiency in the Building Sector in Botswana ⇩

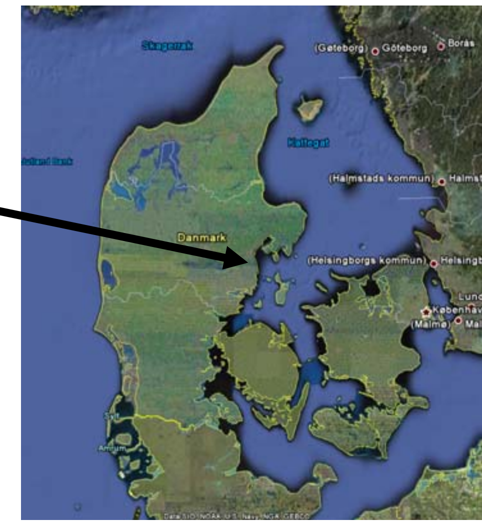
Retrofit of ADB Headquarters ⇨

# Danish Management Group:
# - *A "Green" Group*

- Wind Energy covers all electricity demand of the Group – worldwide
- New headquarter – energy-exporting!

# New DMG HQ in Viby, Denmark

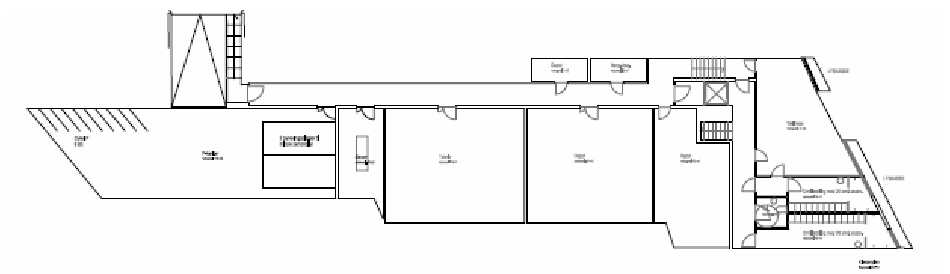


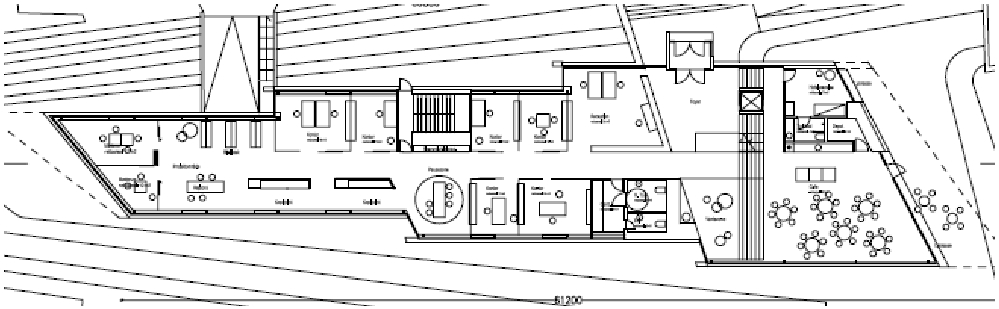

1500 m$^2$ new office building

Being one of Europe's first 100 %
self-sufficient low-energy office building

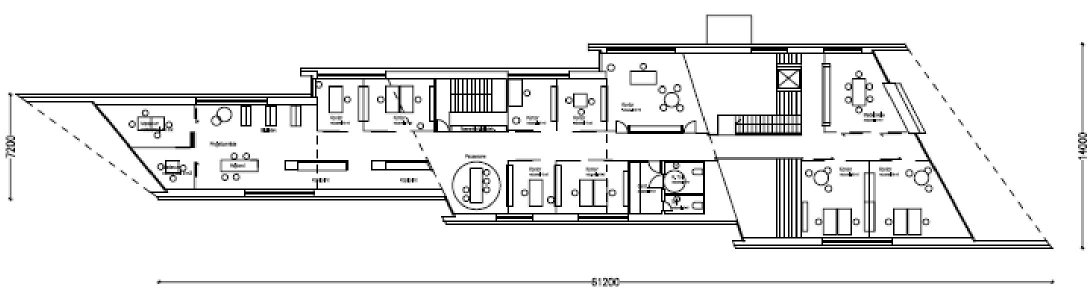
The new Landmark in Aarhus…

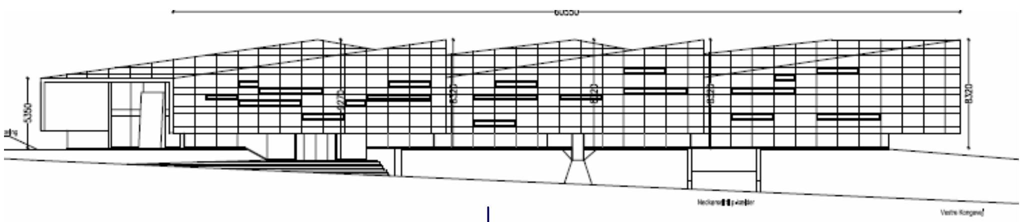
**Basement**



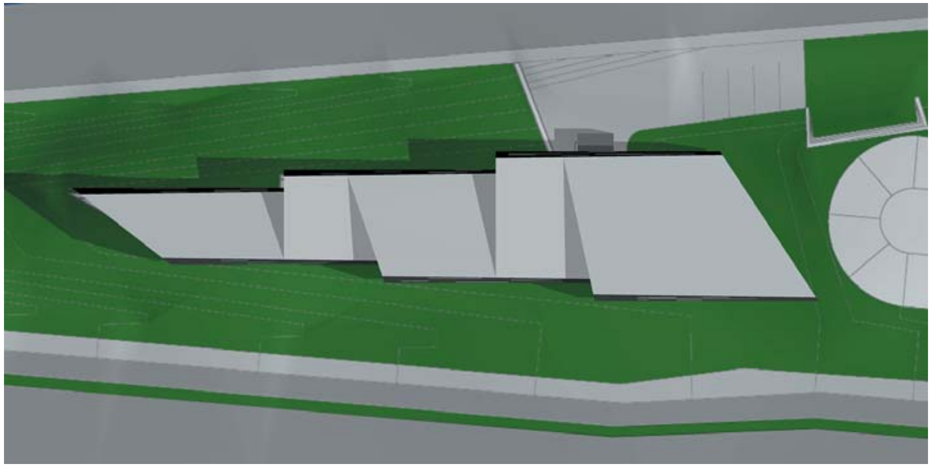

**Ground floor**

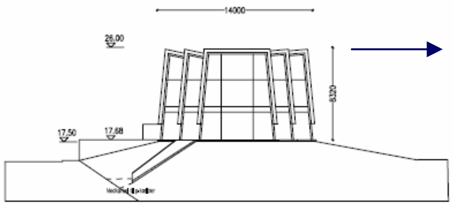



**1st Floor**

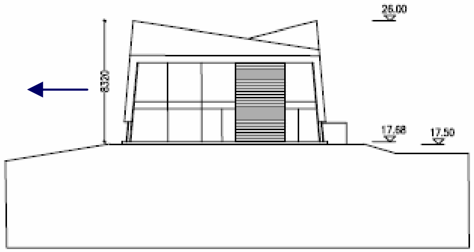



**Facade SE**



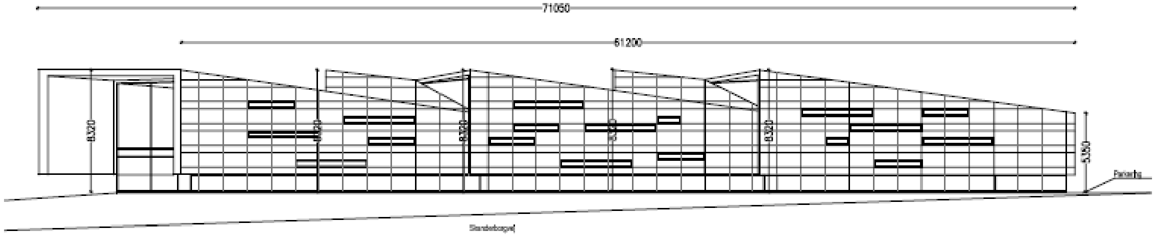



**Facade N**




**Facade S**

**Facade NW**



# The new HQ is one of the first Passive House Office Buildings in Denmark

***Passiv House Definition:***

A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems (Adamson 1987 and Feist 1988). The house heats and cools itself, hence "passive".

Max. 15 kWh/m² heating demand
Max. 120 kWh/m² total primary energy (heating, hot water, electricity)

Following are the basic features that distinguish passive house construction:

| | |
|---|---|
| Compact form and good insulation: | All components of the exterior shell of the house are insulated to achieve a U-factor that does not exceed 0.15 W/(m²K) (0.026 Btu/h/ft²/°F). |
| Southern orientation and shade considerations: | Passive use of solar energy is a significant factor in passive house design. |
| Energy-efficient window glazing and frames: | Windows (glazing and frames, combined) should have U-factors not exceeding 0.80 W/(m²K) (0.14 Btu/h/ft²/°F), with solar heat-gain coefficients around 50%. |
| Building envelope air-tightness: | Air leakage through unsealed joints must be less than 0.6 times the house volume per hour. |
| Passive preheating of fresh air: | Fresh air may be brought into the house through underground ducts that exchange heat with the soil. This preheats fresh air to a temperature above 5°C (41°F), even on cold winter days. |
| Highly efficient heat recovery from exhaust air using an air-to-air heat exchanger: | Most of the perceptible heat in the exhaust air is transferred to the incoming fresh air (heat recovery rate over 80%). |
| Hot water supply using regenerative energy sources: | Solar collectors or heat pumps provide energy for hot water. |
| Energy-saving household appliances: | Low energy refrigerators, stoves, freezers, lamps, washers, dryers, etc. are indispensable in a passive house. |

uelles Zertifizierung Publikationen Presse Passivhaus Institut Dienste

http://www.passivehouse.com

# Bygningsdirektivet – en hjælp
## Nye energirammer april 06 / BR08

- opvarmning
- varmt brugsvand
- ventilation
- køling
- elforbrug (boliger kun basisdrift) x 2,5

# Danish Energy Regulation

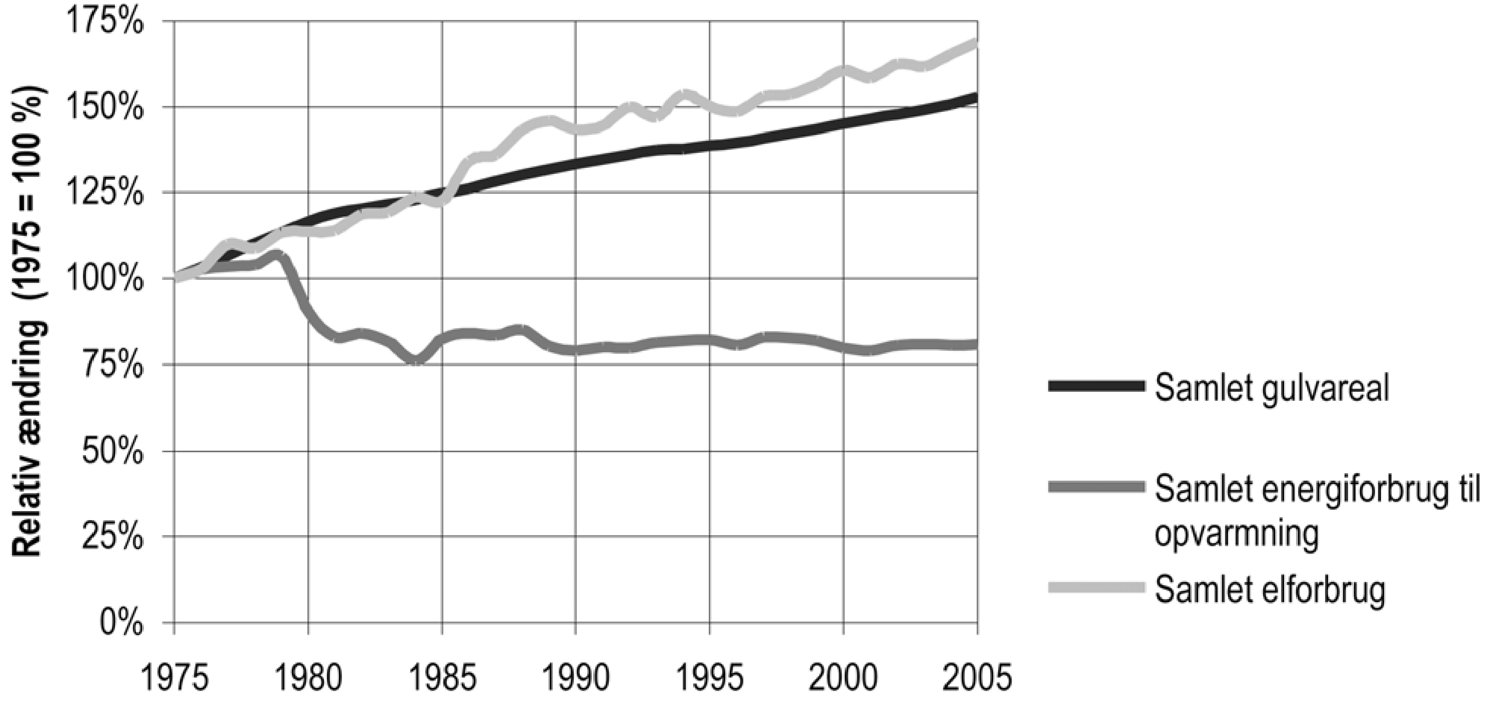
$$(95+\frac{2200}{A})\ kWh/m^2\ pr.\ år,$$

*hvor A er det opvarmede etageareal.*

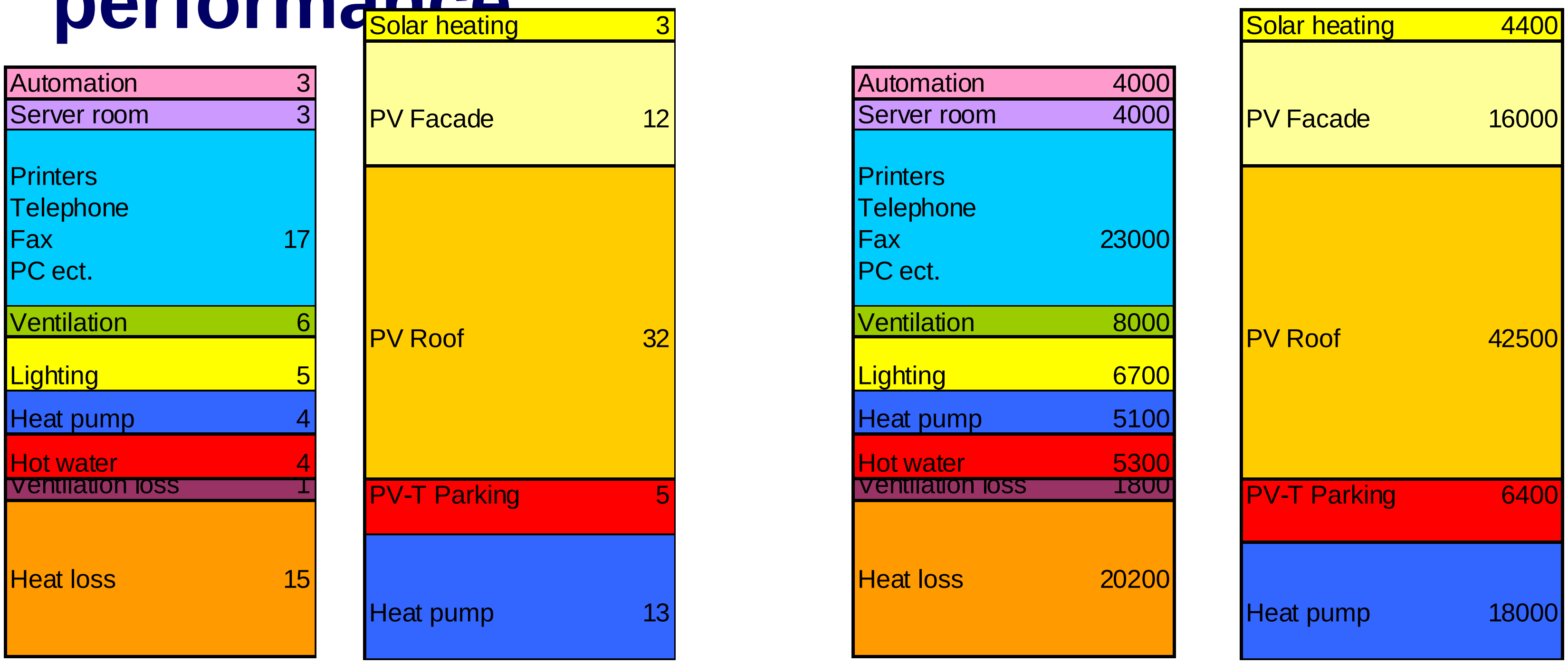
Nybyggeri (ex 150m²)

| | |
|---|---|
| Standard boliger | 70 + 2200 : A = 85 kWh/m²/år |
| LE 2 | 50 + 1600 : A = 61 kWh/m²/år |
| LE 1 | 35 + 1100 : A = 42 kWh/m²/år |
| *Dansk passivstandard (på vej)* | *17,5 +550 : A = 21 kWh/m²/år* |
| | |
| Standard andet | 95 + 2200 : A = 110 kWh/m²/år |
| LE 2 | 70 + 1600 : A = 81 kWh/m²/år |
| LE1 | 50 + 1100 : A = 57 kWh/m²/år |
| *Dansk Passivstandard (på vej)* | *23,7 +550 : A = 27 kWh/m²/år* |

# Danish Energy Demand – overwiev



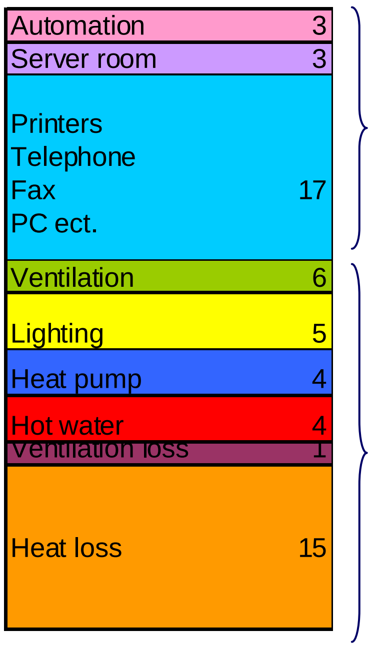
# Energy balances – Annually energy demand and annually energy performance




| Energy demand | Energy performance | Energy demand | Energy performance |
|---|---|---|---|
| 58 kWh/m2 office building | 65 kWh/m2 office building | 78100 kWh/year | 87300 kWh/year |

**+ 10% energy surplus**

# *Energy demand*




40% ~ 23 kWh/m2

60% ~ 35 kWh/m2

Total 58 kWh/m2

Primary Energy – building operation

15*1+(1+4+4+5+6)*2,5 = 65 kWh/m2

Primary Energy – all installations

15*1+43*2,5 = 123 kWh/m2

# Energy strategies – passive strategies

- Minimization of passive solar heating in the summer – glazing, orientation
- 500 mm insulation of building envelope U = 0,1 $W/m^2{}^oC$ – Light weight construction
- No thermal bridges
- Low energy windows U = 0,8 $W/m^2{}^oC$
- Light transmission through glazing areas
- No central heating
- Natural ventilation in summer
- Mechanical ventilation in winter

**Some priorities:**

**- Low energy demand**

**- Manual operation**

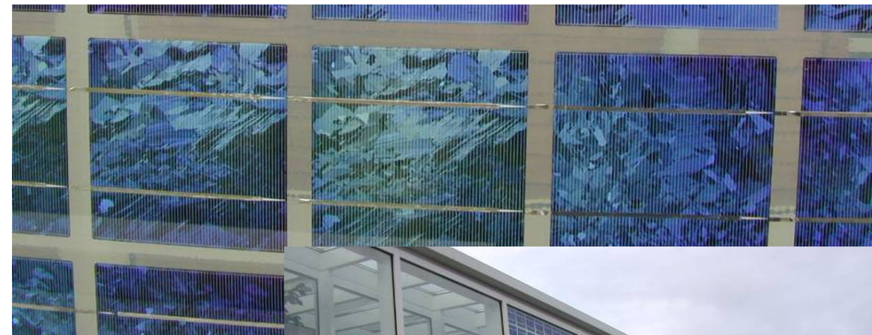
**- Visible and honest – it is what you see**

**- No noisy ventilation systems**

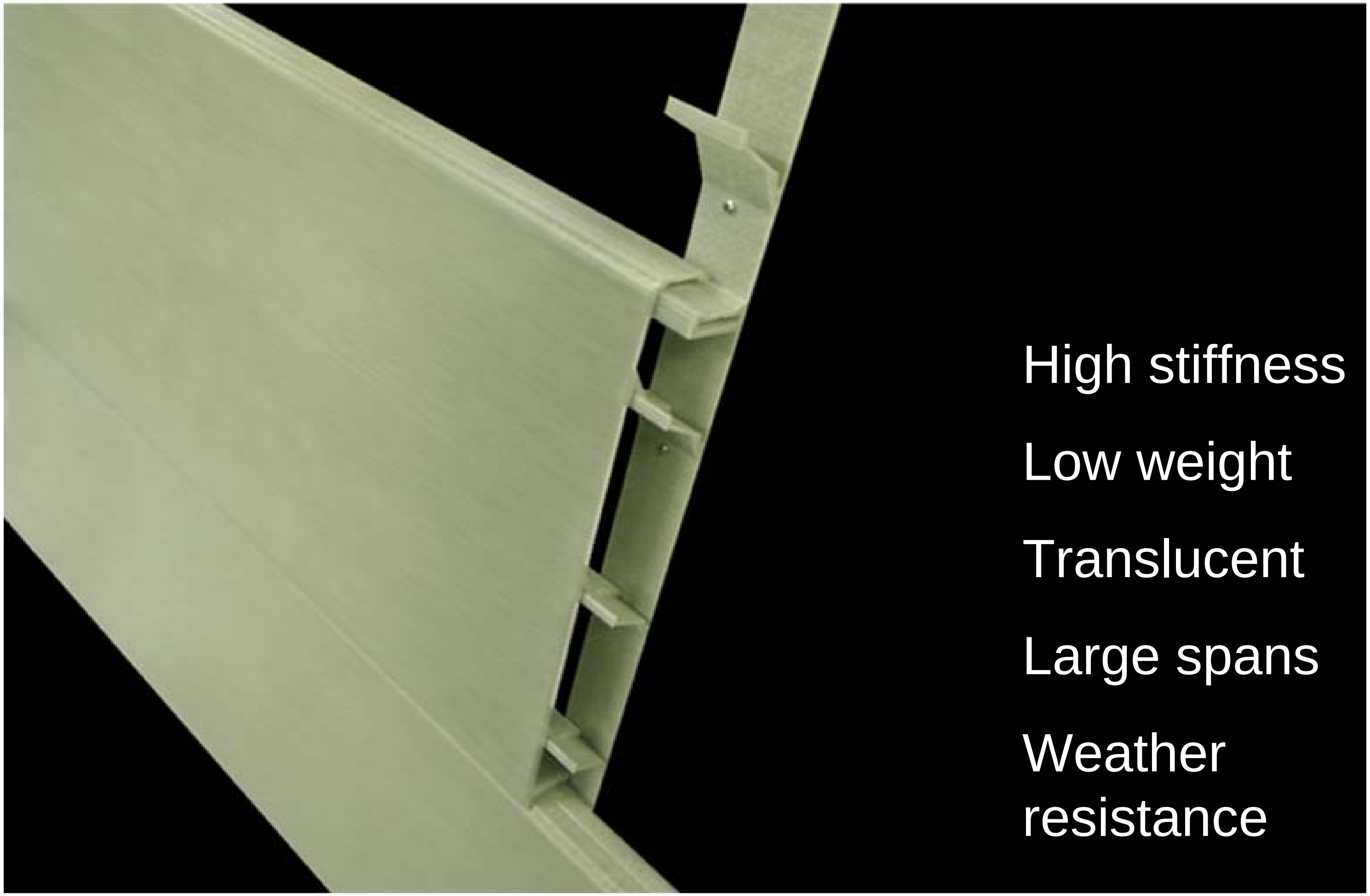
**- Indoor climate – thermal/atmospheric**

# Energy strategy – technologies

- Solar Heating (domestic hot water) 15 $m^2$
- Mechanical ventilation in winter with heat recovery (85%)
- BIPV in roof and SE-façade - 450 $m^2$ + 220 $m^2$
- PVT on roof area over parking area (electricity + hot air)
- Heat pump for central preheating of ventilation air



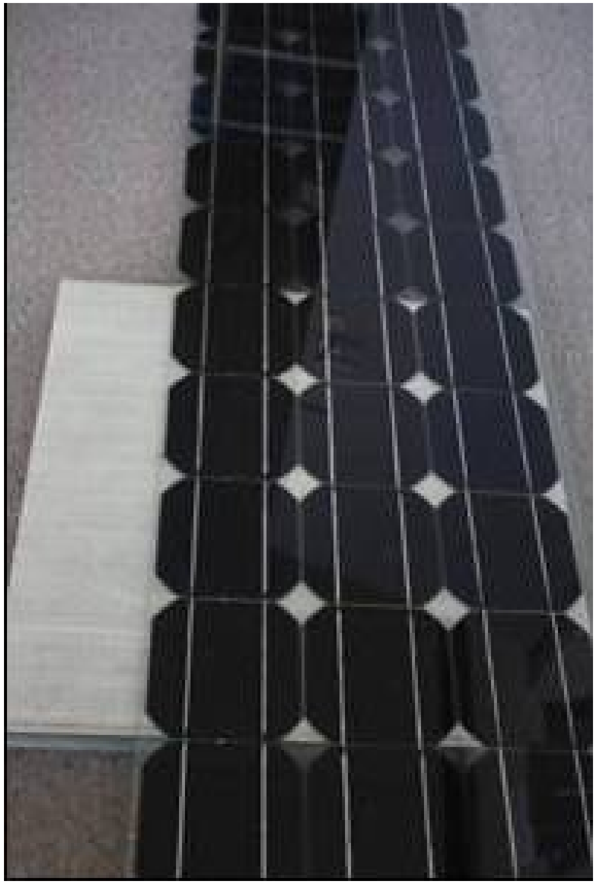
# PV – Composite Facade



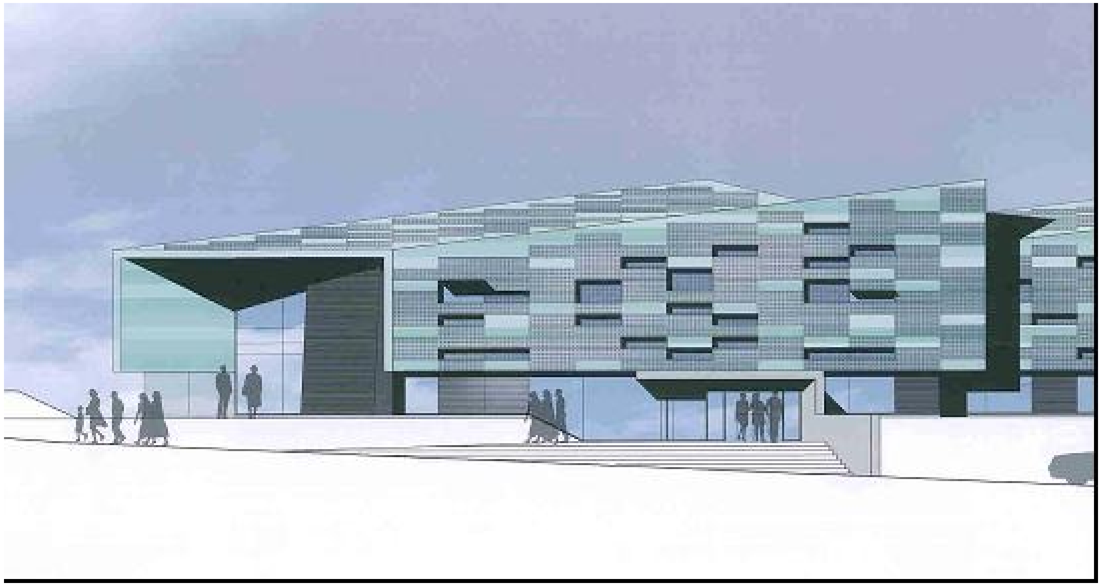
# PV – Composite Facade

- Black Siemens mono crystalline solar cells (156 x 156 mm)
- Profiles 500 x 1620 mm horizontally
- Lamination directly on profiles
- Alternatively glued with clear TESA tape
- Junction box on the back
- On roof single layered glass is used as front covering
- 50 mm ventilated cavity – openings in top and bottom (preheating/cooling)

# The Pattern



# The Pattern – flexibility

# PV – Costs and Performance (incl. VAT 25%)

- PV Cost ~ 4,6 mill dkr/614.000 Euro
- PV Cost pr. $m^2$ ~ 6.800 dkr/906 Euro/$m^2$

Performance:

Roof – 92 kWh/$m^2$ (Amorpheus 44 kWh/$m^2$ / 4.400 dkr/$m^2$)

Facade – 73 kWh/$m^2$

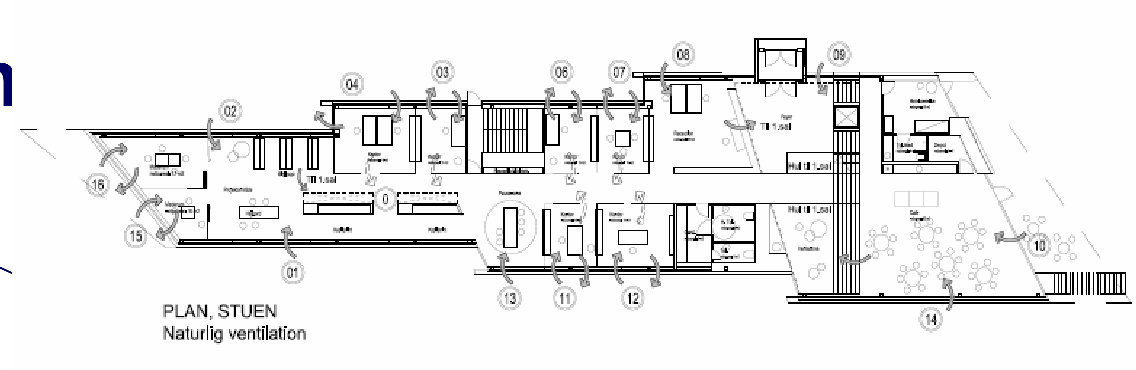
| Solarzellentyp | Labor | Prototyp-/ Pilotfertigung | Produktion |
|---|---|---|---|
| monokristallines Silicium c-Si | 24 % | 21 % | 14 - 18 % |
| multikristallines Silicium mc-Si | 20 % | 18 % | 12 - 14 % |
| Galliumarsenid GaAs | 30 % | 26 % | 22 % |
| amorphes Silicium a-Si | 13 % | 10 % | 5 - 8 % |

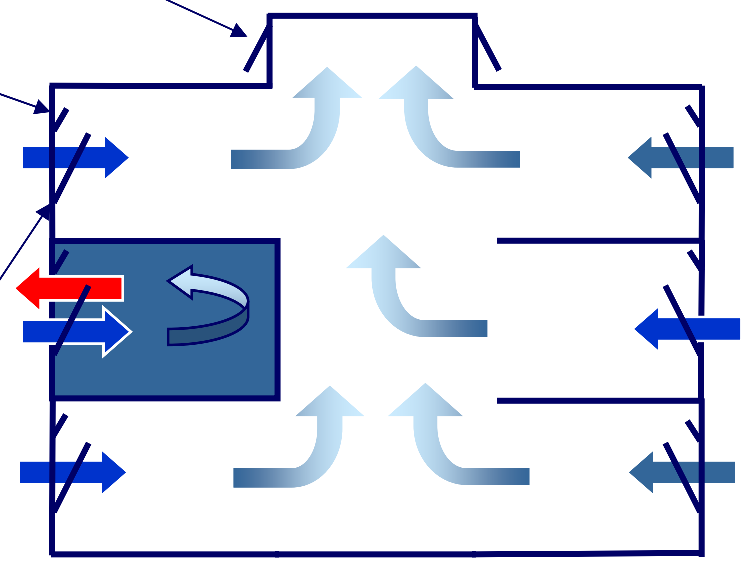
# Natural ventilation

Openings in the skylights and ...

…ventilation openings located in narrow window bands above the ordinary windows in the offices are equipped with electronic actuators. The openings can be left open during night-time.

The ordinary windows in the offices are manually controlled. The windows must be closed during night-time due to security reasons.



# DMG HQ and Economy (Incl. VAT 25%)

1500 $m^2$

**Total cost without grant:**

32 mill dkr ( 4,3 mill. Euro) / 21.000 kr/$m^2$ (2.850 Euro/$m^2$)

Applied for app. 4 mill dkr

**Total cost with grant:**

28 mill dkr (3,7 mill. Euro / 18.700 kr/m2 (2.500 Euro/$m^2$)

**Proposals for grant:**

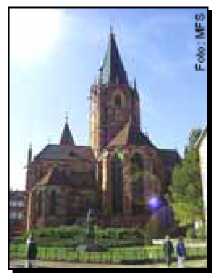
”Development and Demonstration of New PV-Composite Profiles”

”Building Integrated Photo Voltaic – Direct Current”

# Other technologies taken into consideration

- PCM (Phase Changing Material)

**Modern lightweight architecture** — **Heavy old building**


**PCM is the ONLY technology, which is able to STOP temperature increase at indoor application, without causing energy expenses**

**Ready-to-use**
**Micronal® PCM SmartBoard™ 23/26**

BASF

| | |
|---|---|
| Length | 2,00 m |
| Width | 1,25 m |
| Thickness | 15 mm |
| Weight | 11,5 kg/m² |
| PCM content | ca. 3 kg dry/m² |
| Heat capacity (latent) | ca. 330 kJ/m² |



19.08.2004 Dipl. Ing. (FH) Marco Schmidt, EDK/BB-H201, BASF AG, Ludwigshafen, Germany 18

PCM is very small capsules with a core of wax with a melting point at 23ºC or 26ºC

## The theory:

When a material changes from one form to another the temperature is constant during this phase.

Think of a drink:

As long as you have ice in the drink the temperature is 0 ºC. When the ice is melted the temperature rises.

The melting energy is taken from the water.

# Phase Changing Materials – cooling and heating

**The cooling process:**

The sun is shining

The PCM material is warmed up

At 23 °C the PCM is melting

The heat to makes PCM melting is taken from the indoor air

The temperature in the construction (wall/floor/ceiling) is constant during the melting process.

When all the PCM has melted the temperature will rise again

During night the PCM-construction could be cooled by natural ventilation.

**Result:**

Cooling energy and ventilation is reduced

**The heating process:**

In the night the temperature will fall

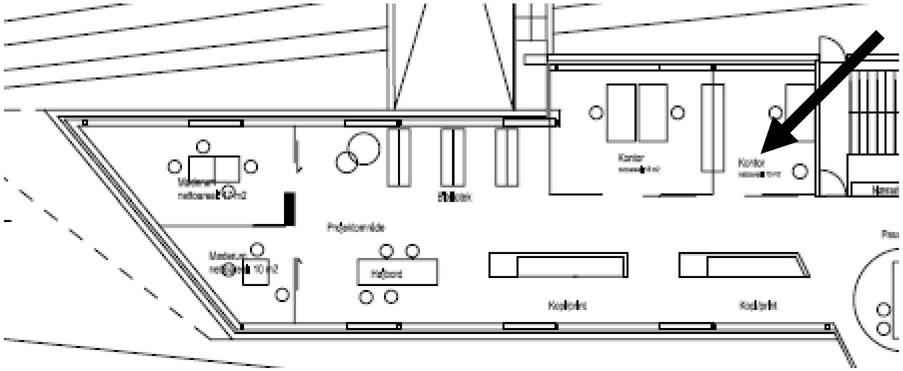
The PCM material is hardening

The temperature in the construction is constant during the hardening period

When all the PCM has hardened the temperature will fall again

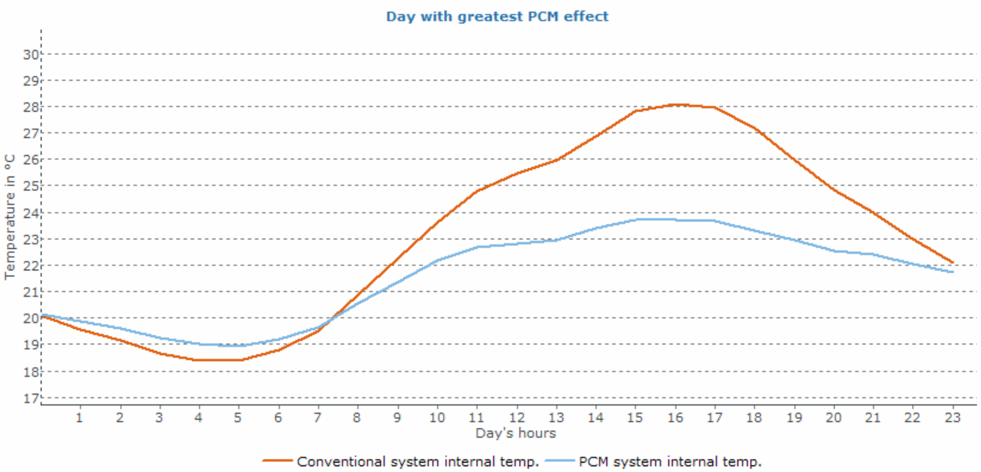
**Result:**

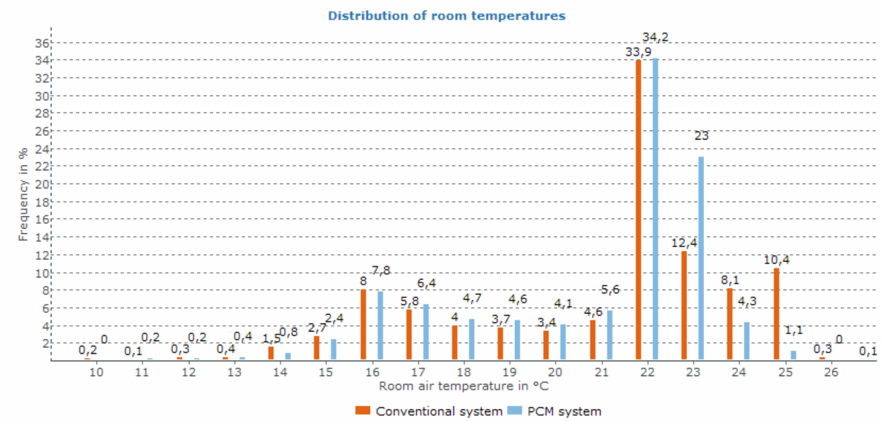
Heating energy can be reduced



**40 m² PCM plaster boards in ceiling and internal walls**

**Office for one person facing SE**




PCM plaster boards compared with traditional plaster boards.

In average the indoor temperature will decrease with 2 ºC using PCM

5% of the time t > 24 ºC with PCM

19% of the time t>24 ºC without PCM

# PCM – Phase Changing Material


**Plaster Boad**

30 dkr/m2 (4 Euro/m2)

**PCM Smart Board**

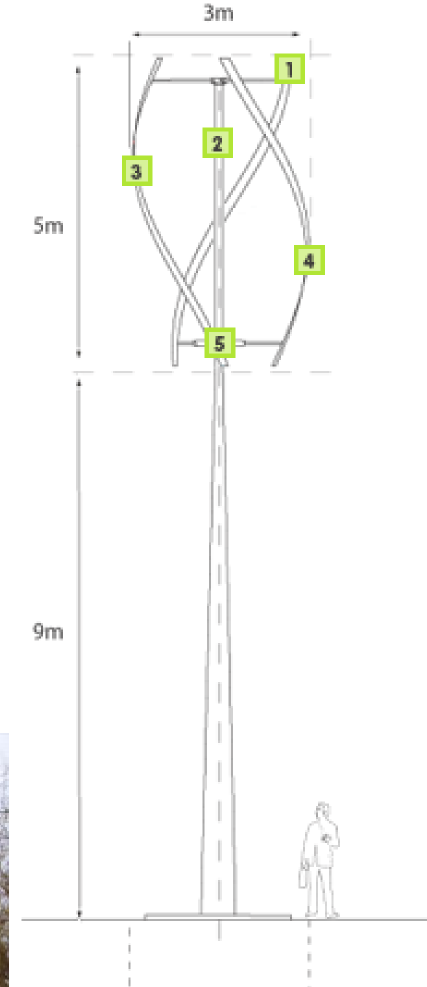
375 dkr/m2 (50 Euro/m2)

http://www.micronal.de/portal/basf/ien/dt.jsp?setCursor=1_290798

# Wind Energy

## Quite Revolution

- *30 db(A) in side buildings and 45 db(A) out side buildings (distance 33 m)*
- *Performance - 6.000 – 10.000 kWh/year*
- *Price -* 360.000 dkr (48.000 Euro)

# BI WE

## Bahrain Wold Trade Centre

# Thank you for your attention!