

Pilot study - Office building

National report - Denmark

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Pilot study – Office building National report – Denmark

Final report, May 2007

Energy Performance Assessment
of Existing Non-Residential Buildings

Report Number:
EC Contract: EIE/04/125/S07.38651
www.epa-nr.org

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Pilot study – Office building

National report – Denmark

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1 Introduction

This is the Pilot study National report performed in the frame of Work package 4 of the EPA-NR project.

The pilot Study consists of three Pilot projects for non residential buildings:

- Pilot project for one education building
- Pilot project for one offices building
- Pilot project for one health care building

Pilot projects are real buildings for which the EPA-NR method was applied.

1.1 Goal of pilot study

The goals of pilot study are:

- The evaluation of EPA-NR method , including the building diagnosis and the EPA-NR software
- The assessment of Energy Performance of the building and creating an useful Energy Performance Advice for the owner of the building

For the first objective, an evaluation procedure was defined and a questionnaire [1] was performed. The questionnaire was filled for each pilot project by the person who applies the EPA-NR method to the building.

The analysis of all the questionnaire answers was the basis of the evaluation of EPA-NR method and the recommendations of modifications.

The evaluation of EPA-NR method including recommendations for modifications are described in a specific (internal) report [2].

The assessment of Energy Performance of the building indicates the actual performance of the building and some proposed energy saving measures to reduce the energy consumption taking into account the indoor environment, investment costs, payback times and technical feasibility.

The assessment of Energy Performance of the pilot projects including a set of energy saving measures is described in this report.

The results of the pilot study will serve as demonstration for dissemination.

1.2 Structure of the report

The report is divided into three chapters:

- Chapter 2 concerns the pilot project for education sector
- Chapter 3 concerns the pilot project for offices sector
- Chapter 4 concerns the pilot project for health care sector

The characteristics of the building surveyed are described in paragraph 1 of the chapter.

The results of building diagnosis including a description of actual situation of the building and energy demand calculation using EPA-NR software are described in paragraph 2 of the chapter.

Paragraph 3 of the chapter presents a number of scenarios to improve the energy performance of the building, for each scenario, the energy saving, the investments and payback time are given and finally the most appropriate scenario as an advice to the owner is described.

2 Office building, Rosenkæret 39

2.1 Project summary



Rosenkæret 39, Office building, Gladsaxe

Owner: private. User: Gladsaxe municipality.

Type of building : Office in old factory building

Location : city area with surrounding buildings in similar height and relatively low density

Owner (optional): Private

Year of construction: 1952/1962

Total gross area (m²): 3622 m².

Total conditioned area (m²): 3300 m².

Building occupancy: from 8 am to 5 pm, 5 days/week all year.

Number of occupants (approximately): 90.

Short description: The building is orientated South-East, surrounded by buildings of the same height and moderate density. The building can be considered being one zone, consisting of offices, reception, and meeting rooms.

Construction: It is a typical Danish hollow core masonry building constructed in 1950'es. An extension building was constructed in the 60'es. There are two ordinary floors plus two floors in the attic and a full basement. At the West end of the building there is an extension with wooden facade covering. The 45 ° sloping roof is covered by traditional red roofing tiles.

Heating / cooling/ ventilation/ lighting systems: All systems in the building can be described as traditional systems for low tech Danish office buildings. Heating is made by a natural gas boiler located in the basement.

<p>Energy management: The temperature of the heating system is controlled by an outdoor temperature sensor allowing for a lower temperature at high outdoor temperatures.</p> <p>Energy consumption year 2005:</p> <table> <tr> <th></th><th>The building</th><th>National average</th></tr> <tr> <td>Fuel</td><td>126 kWh/m²</td><td>105 kWh/m²</td></tr> <tr> <td>Electricity</td><td>39 kWh/m²</td><td>43 kWh/m²</td></tr> <tr> <td>Water</td><td>210 l/m²</td><td>250 l/m²</td></tr> </table>				The building	National average	Fuel	126 kWh/m ²	105 kWh/m ²	Electricity	39 kWh/m ²	43 kWh/m ²	Water	210 l/m ²	250 l/m ²
	The building	National average												
Fuel	126 kWh/m ²	105 kWh/m ²												
Electricity	39 kWh/m ²	43 kWh/m ²												
Water	210 l/m ²	250 l/m ²												
<p>Previous refurbishment: Windows towards North at 3rd and 4th floor replaced with low energy glazing. Other windows replaced over time and are all less than 15 years old. Heating system updated in '93 and '95. Roof insulation at main (old) building decreased with 70 mm and roof construction made ventilated in 2003. Refurbishment of extension building and establishment of mechanical ventilation in 2005.</p> <p>Planned refurbishment: No further refurbishment is planned.</p>														

Rosenkæret is located in an area with light industry in buildings of the same or lower height. The building was constructed in the early fifties and extended in the early sixties. Originally the building was used to light industry, but was later rebuild to meet the requirements of an office building.

The building is owned by a private company and rented to Gladsaxe municipality.

2.2 Audit of the building

2.2.1 Actual situation

The building has problems regarding air tightness at the two under-roof floors. These problems was introduced in 2003 when 70 mm of the roof insulation was removed to increase the ventilation in the roof construction and in this way eliminate a mould growth problem. The mould problem was introduced some years earlier in conjunction with additional insulation of the roof to save energy.

Some of the windows in the old part of the building are with traditional double pane glazing. These windows do also cause problems with cold draft.

The heating system is old and based on eight natural gas boilers operating in cascade. Occasionally it is not possible to produce sufficient heat for space heating, and it is thus not possible to operate the building with night set back of the indoor temperature.

The windows in the roof top are of many different sizes and shapes. This is because the building was used as demonstration site for the former owner. It gives a disorderly visual impression of the roof top. The many different sizes and shapes may also result in increased costs with respect to maintenance and replacement.

2.2.1.1 Heating consumption

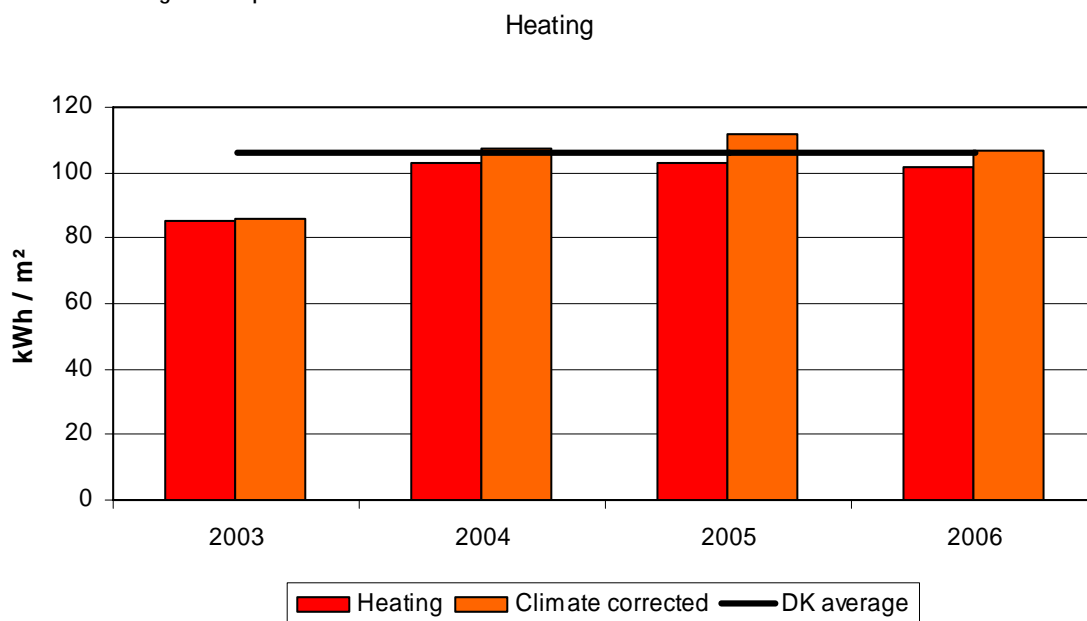


Figure 1. Recorded heating consumption in kWh/m² in 2003 - 2006 (meter reading and climate adjusted respectively) and the Danish average consumption in buildings used for similar purpose and size. The degree-day independent heating consumption constitutes about 20 % of the total heating consumption.

Energy consumption for space heating and domestic hot water has been stable since 2003 and around the Danish average for office buildings. Seventy millimetres of the insulation in the roof construction was removed in 2003 because of mould growth. This action have increased the ventilation over the insulation, eliminated the mould growth and increased the heating consumption.

2.2.1.2 Electricity consumption

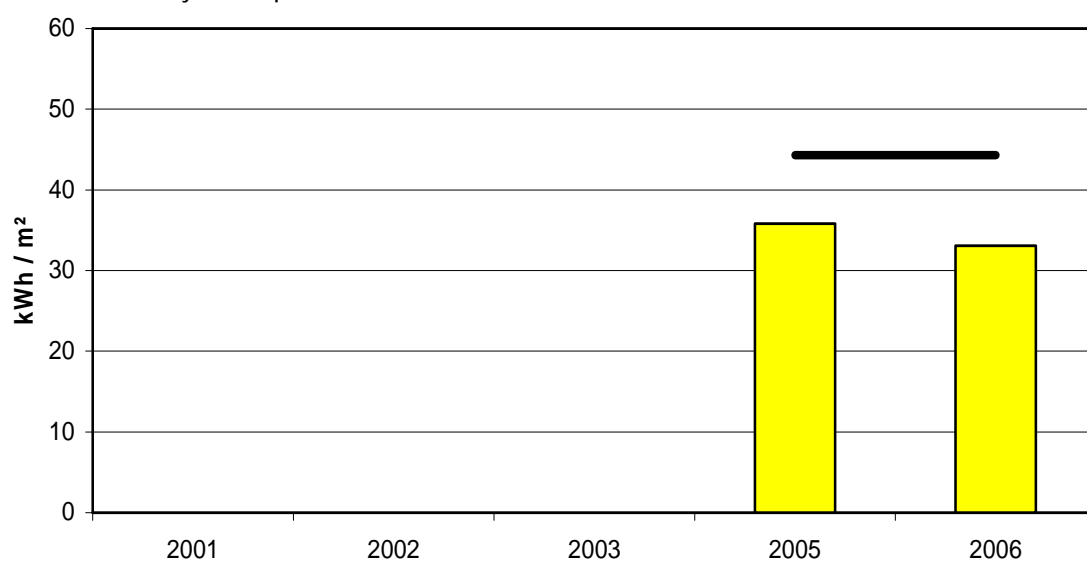


Figure 2. Recorded electricity consumption in kWh/m² in 2005 and 2006 and the Danish average consumption in buildings used for similar purpose and size.

The electricity consumption in Rosenkæret 39 is about 20 per cent lower than the Danish average for office buildings. There are several reasons for this, and among those are: the building is partly natural ventilated, there are almost no mechanical cooling, there is only four floors and the elevators are thus not being used intensive, at the two top floors there are many windows in the 45 ° ceiling contributing considerably with daylight in most of the office hours.

2.2.1.3 Water consumption

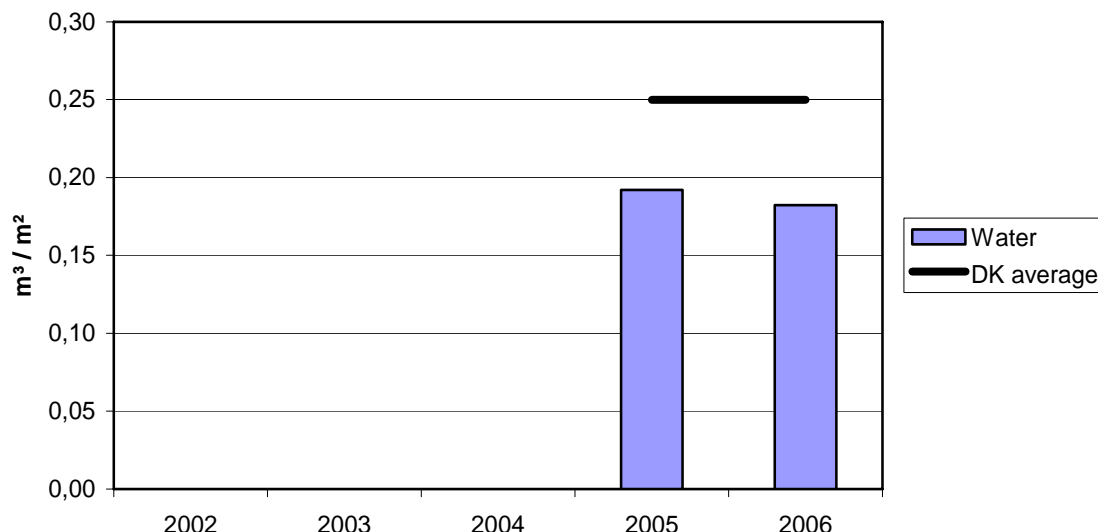


Figure 3. Registered water consumption at Rosenkæret 39 in 2004 and 2005 in m³/m² and the Danish average consumption in buildings used for similar purpose and size. The domestic hot water consumption is estimated to be 30 % of the total water consumption.

2.2.2 Calculating energy 'demand' using EPA-NR software based on actual situation

2.2.2.1 Energy characteristics of the building model

The energy performance was calculated under standard conditions with the EPA-NR software. For the EPA-NR calculations, the building was divided into the following four zones:

1. New extension building (430 m²),
2. Basement, 1st and 2nd floor of old building (1986 m²),
3. Offices under roof on 3rd and 4th floor (823 m²),
4. Canteen on 3rd floor (150 m²).

List of energy uses:

Zone 1: heated, mechanically ventilated with VAV control.

Zone 2: heated, naturally ventilated.

Zone 3: heated and naturally ventilated

Zone 4: heated, cooled and naturally ventilated

All zones have artificial lighting. Zones 2-4 have automatic window openers to control the indoor temperature by natural ventilation.

Operational parameters used for the calculation:

	Zone 1	Zone 2	Zone 3	Zone 4
Heating temperature set point	20 °C	20 °C	20 °C	20 °C
Cooling temperature set point	-	-	-	23 °C
Operation time for heating/year	5110 h/a	5110 h/a	5110 h/a	5110 h/a
Operation time for cooling/year	-	-	-	8760 h/a
Operation time for ventilation/year	2365 h/a	-	-	-
Operation time for lighting/year	2340 h/a	2340 h/a	2340 h/a	500 h/a

Input data used for the calculation is found in Appendix 2 as documentation produced by the EPA-NR tool.

2.2.2.2 Results

Primary energy demand and CO₂ emission of the building

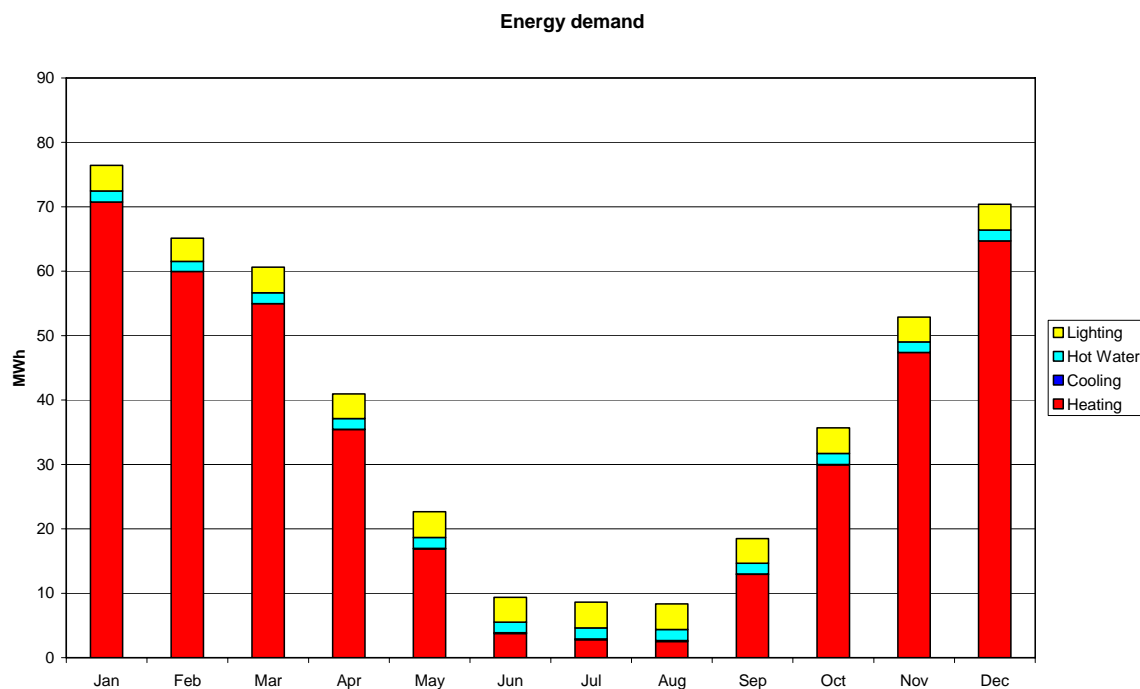
Primary energy consumption of the building: kWh/m ² /year	CO ₂ emission of the building: kg/m ² /year
202.32	29.8

Final energy demand, primary energy demand and CO₂ emission by energy carrier

	Annual final energy consumption* of the building per fuel type:	Primary energy consumption of the building: kWh/m ² /year	CO ₂ emission of the building: kg/m ² /year
Natural gas	507.95 MWh/year	149.88	14.2
Electricity	75.15 MWh/year	55.43	15.5

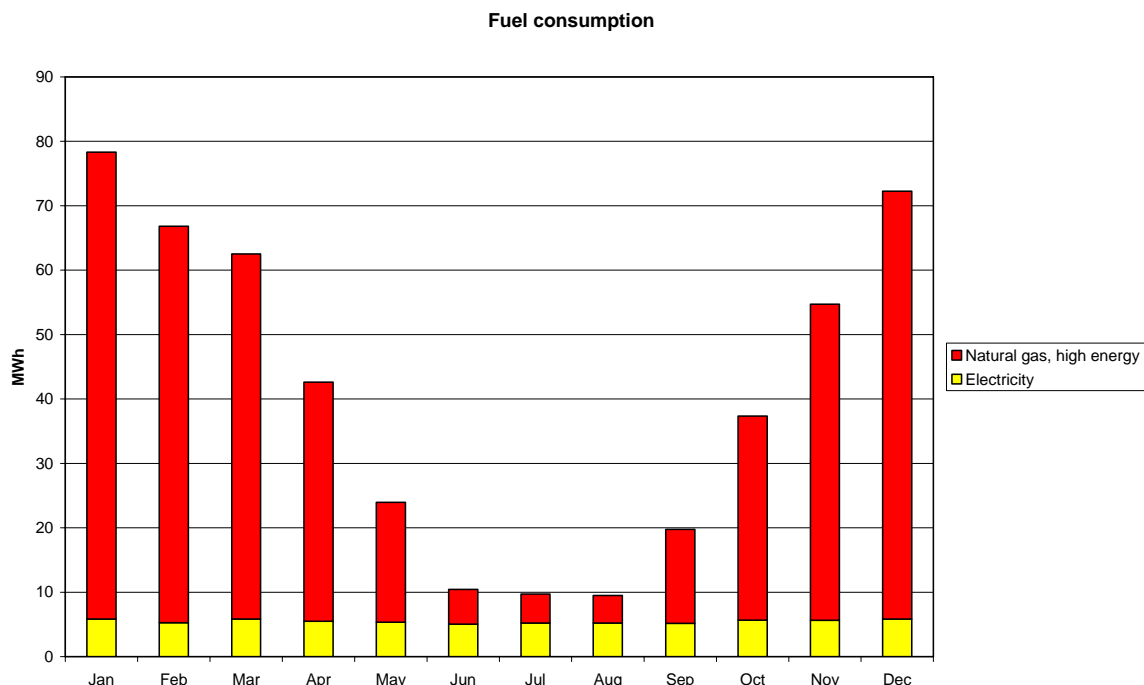
* Calculated under standard user pattern and outdoor conditions.

Energy demands by month



Distribution of heating demand on different sources: Lighting; Domestic hot water; Cooling; and Heating.

Energy demand by energy source



Energy consumption at Rosenkæret 39 is, as in most Danish office buildings dominated by the energy consumption for space heating (above).

The cooling energy consumption is reduced due to optimal possibilities for utilization of natural ventilation and manually controlled solar shading in the old part of the building, which is the part that has the highest potential solar loads during summer time (see table below).

Total	Annual losses			Annual gains			
	Total	Transmission	Ventilation	Total	Solar	Sun space	Internal heat
kWh/m ² (heating)	136.21	50.09	86.12	54.65	23.64	0	31.01
kWh/m ² (cooling)	329.21	130.42	198.79	58.06	27.05	0	31.01

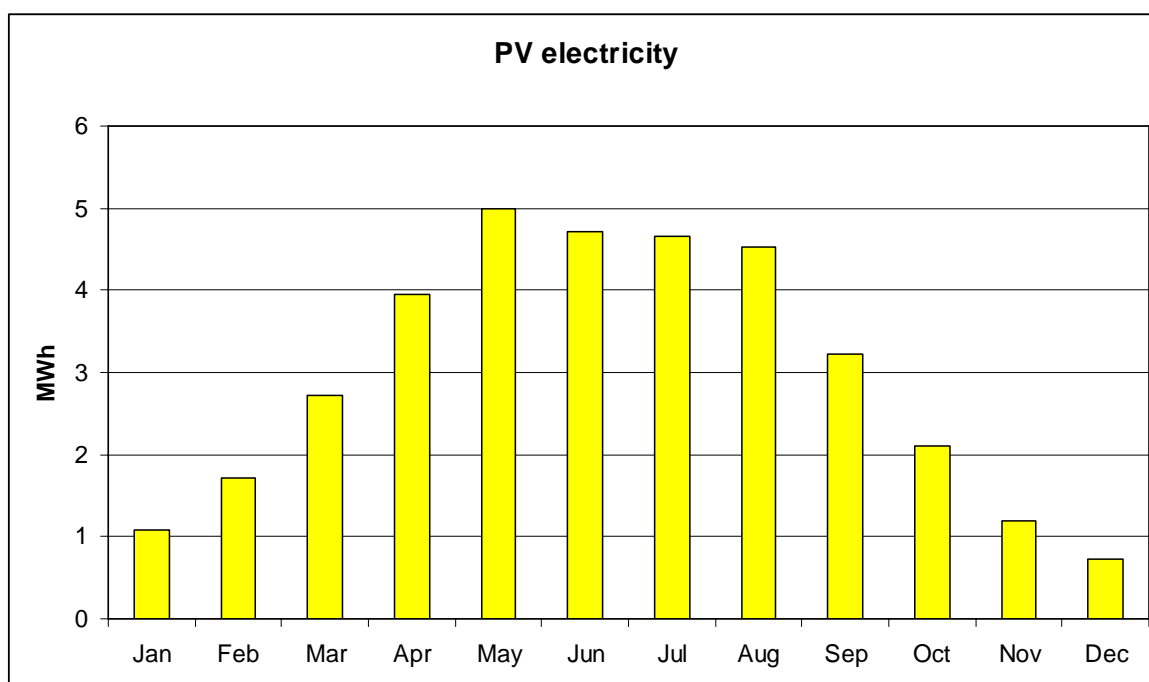
Old building	Annual losses			Annual gains			
	Total	Transmission	Ventilation	Total	Solar	Sun space	Internal heat
0, 1 & 2 floor	281.85	111.08	170.77	53.39	19.0	0	34.39
3 and 4 floor	477.87	120.97	356.9	59.99	27.76	0	32.23
Canteen	58.39	36.9	21.49	46.68	24.02	0	22.66

2.3 Calculation of energy savings: scenarios for improvement

2.3.1 Scenario 1- PV system on South facing roof face

2.3.1.1 Background and proposed solution

Integration of a photo voltaic solar system in the South facing roof face with a 45 ° inclination was the initial idea to reduce energy consumption from the building. This action was suggested to create a more uniform appearance of the roof and minimise the visual impact of the many windows in the roof. It was thus suggested to apply PV solar cells to the entire opaque surface of the South facing roof (325 m²). With an overall efficiency factor of the PV system of 9 %, such a system will produce electricity as shown in the figure below.



The annual electrical output from the PV system is calculated to be 35.63 MWh giving a payback time of about 40 years when the cost for installing the system is 8000 DKK (1070 €) per m².

2.3.1.2 Conclusion

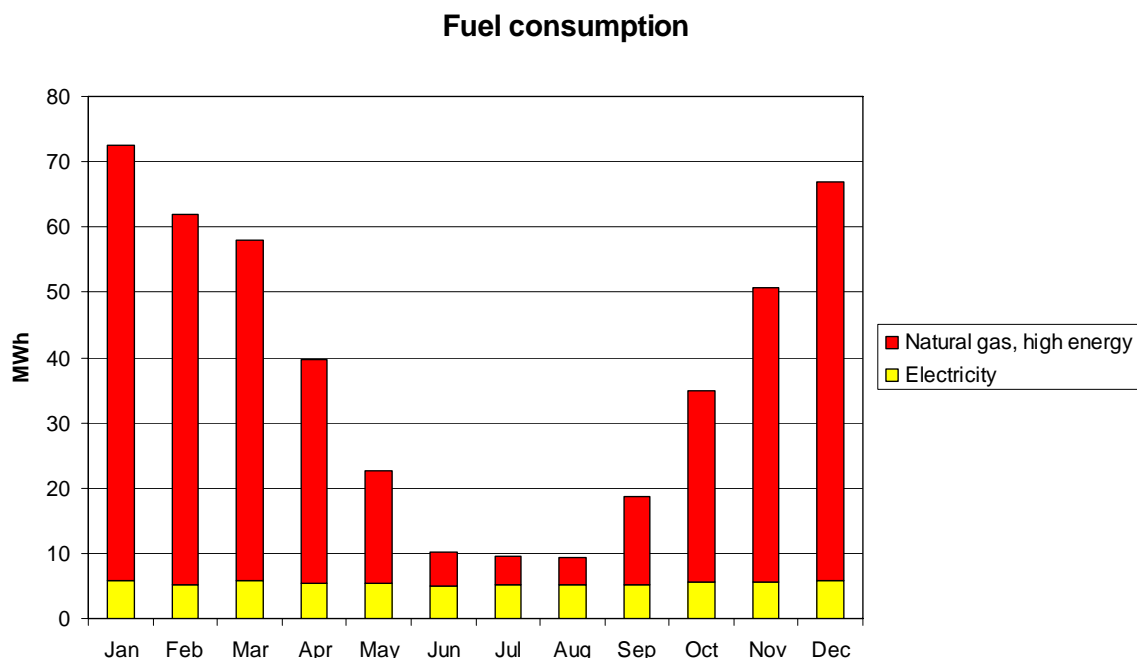
Installation of a PV system on the entire South facing roof face is not, as an energy saving measure, cost effective, but from an architectural point of view it could improve the visual impression of the building, creating a more uniform view of the roof-top. In addition to this, the South facing roof face is the one facing the main entrance of the building and the access road.

2.3.2 Scenario 2 – Replacement of boilers to natural gas condensing boilers

2.3.2.1 Background and proposed solution

The existing boilers (eight natural gas boilers in cascade) are old, inefficient and do not provide the necessary amount of heating at any given time. A new rack of boilers is suggested by the user of the building. The cost for installing new boilers in the building falls in the user, and cost analyses have not been performed yet.

2.3.2.2 Calculation results



The annual consumption of natural gas decreases from 422 MWh to 389 MWh, equal to a reduction of 8 per cent. With an investment of 40 000 DKK (5300 €) per gas boiler in the cascade of eight gas boilers, gives a simple pay-back time of 11.6 years.

2.3.2.3 Conclusion

A pay-back time of about 12 years would normally be considered a good investment if the owner and the user of the building is the same entity. In this case however, the user and the owner is not the same. In addition to this is the cost of the boilers to the user of the building. To justify such an investment a long term rental contract or a buy-back obligation should be possible.

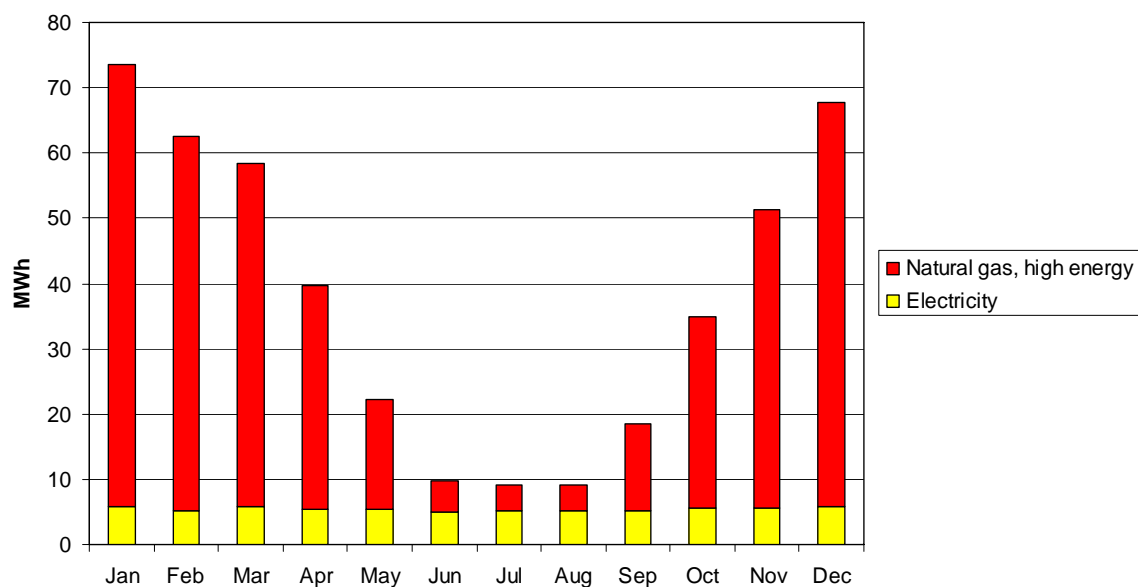
2.3.3 Scenario 2 – Replacement of windows in parts of the building

2.3.3.1 Background and proposed solution

The windows in the basement, first and second floor of the old building are traditional double pane windows with a U-value of 3 W/m²K. Replacement of these windows to today's standard with an overall U-value of 1.5 W/m²K would reduce the energy consumption for space heating and decrease the registered problems with draft near the windows.

2.3.3.2 Calculation results

Fuel consumption



The annual consumption of natural gas decreases from 422 MWh to 391 MWh, equal to a reduction of 7 per cent. With an investment of 1200 DKK (160 €) per m² windows, the calculated energy savings gives a simple pay-back time of less than 7 years.

2.3.3.3 Conclusion

Replacement of the glazing in the windows from traditional double pane thermo coupled glazing to a more energy efficient window of today's standard is an economical sound investment, especially if it is done in conjunction with a scheduled maintenance of the building.

Appendix 1: additional information

The office building at Rosenkæret 39 was established in 1993 in an old factory building originally constructed for light industry. The building is privately owned but the municipality of Gladsaxe rents the premises. Even though the size of the building has a size that made it mandatory to be in the ELO energy certification scheme (since 1997), it has never been labelled.



Landscaped office at Roenkæret at ground, 1st and 2nd floor.

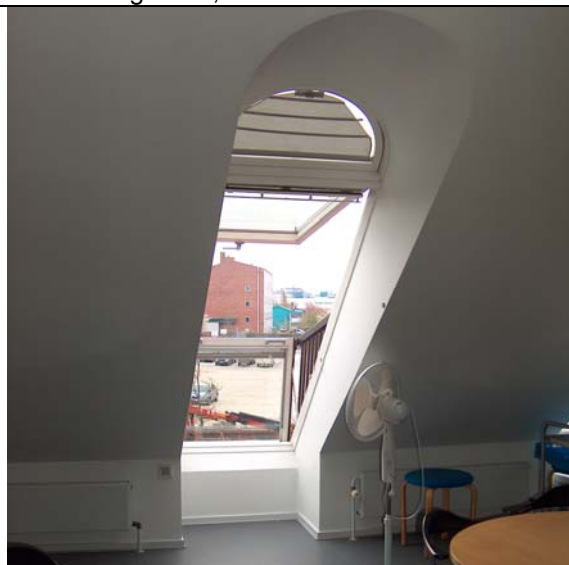


Natural ventilation and internal solar shading in offices on ground, 1st and 2nd floor.



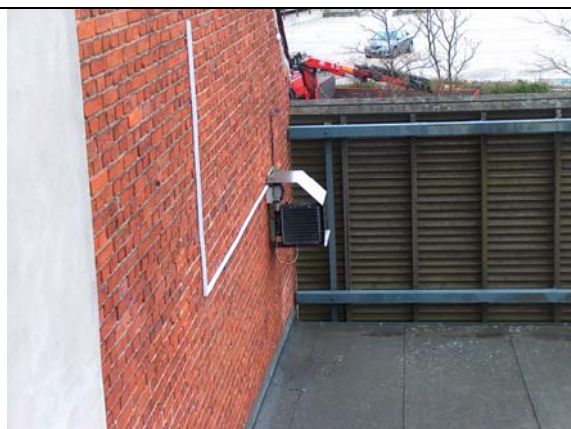
Canteen and kitchen at 3rd floor.

Windows with integrated balcony and solar shading in canteen area.





Landscape offices at 3rd floor.



Wall mounted condenser for cooling engine for canteen.



Landscape offices at 4th floor



Internal meeting rooms with replacement air from surrounding office landscape.



Natural gas boilers operating in cascade.

Domestic hot water storage.





Windows with integrated solar shading.



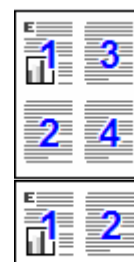
Insulated heating distribution system in basement.

Appendix 2: Input data for calculations

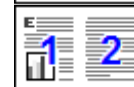
The following summary of inputs is taken directly from the EPA-NR calculation tool, exported into one pdf-file per pilot project.

The reproduction of the input summary should be read as indicated in the figures to the right, depending on the number of pages shown on one page of this report.

three or four pages:



one or two pages:



EPA-Model: Rosenkærret		Created: 9-05-2007 11:38									
Project: Rosenkærret											
Climate Library	D:\Programmer\SBi\EneTool\EneClimateDK.xml										
Constants Library	D:\Programmer\SBi\EneTool\EneConstDKBLS.xml										
Fuel Library	D:\Programmer\SBi\EneTool\EneFuelDK.xml										
Building: Rosenkærret Aale											
Zone: New building											
Zone area, m ²	430										
Specific internal heat capacity, kJ/m ³ K	150										
Specific internal coupling coefficient, W/m ² K	9.2										
Int Temp Heating, °C	20.5										
Int Temp Cooling, °C	16										
Lighting											
Total installed lighting power, W	4000										
Daylight time usage per year for lighting, hours	1870										
Non-daylight time usage per year for lighting, hours	470										
Daylight dependency factor for lighting, -	1										
Occupancy factor for lighting, -	1										
Fraction not removed by exhaust ventilation, -	1										
Emergency lighting charging energy	no										
Lighting controls stand-by energy	no										
Invest	0										
Heat Production / Fraction of time											
Occupants, W/m ²	1.03										
Fraction Persons present, -	0.06										
Appliances, W/m ²	1										
Fraction Appliances are on, -	0.27										
Airflow rate											
Infiltration, m ³ /s	0.11										
Natural vent, m ³ /s	0										
Fraction Nat Vent is present, -	0										
Domestic hot water											
Average DHW consumption, m ³ /m ² /year	0										
Boiler Temp, °C	65										
Cold-water Temp, °C	10										
Opaque Construction											
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	Alpha, °	R, m ² °C/W	F _{g,s} , -	F _{g,n} , -	F _{g,e} , -	Invest/m ²	
First floor, east wall N	45.0			0.0	90.0	0.300	0.00	0.10	0.100	0.000	0.00
First floor, east wall S	42.0	180.0	90.0	0.300	0.00	0.10	0.100	0.000	0.000	0.00	
First floor, east wall W	80.5	270.0	90.0	0.300	0.00	0.10	0.100	0.000	0.000	0.00	
Roof	430.0			0.0	0.0	0.200	0.00	0.04	0.000	0.100	0.000
-	0.0			0.0	0.0	0.000	0.00	0.00	0.000	0.000	0.00
Basement walls	62.0			0.0	90.0	0.300	0.00	0.10	0.200	0.000	0.00
Basement walls, sub-terrain	78.0			0.0	90.0	0.250	0.00	0.20	1.000	0.000	0.00
Transparent construction											
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	U _s , W/m ² K	G _{g,s} , -	G _{g,n} , -	F _{g,s} , -	F _{g,n} , -	F _{g,e} , -	Invest/m ²
North	45.0	0.0	90.0	1.300	1.300	0.660	0.660	0.000	0.000	0.000	0.00
West	15.5	270.0	90.0	1.300	1.300	0.660	0.660	0.000	0.150	0.000	0.00
South	48.0	180.0	90.0	1.300	1.300	0.660	0.660	0.000	0.150	0.000	0.00
-	0.0	0.0	90.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
Ground construction											
Name	Area, m ²	U, W/m ² K	B _{g,s} , -	B _{g,n} , -	Invest/m ²						
Basement floor	430.0	0.250	0.70	0.70	0.00						
Mechanical, balanced VAV ventilation											
Fraction of time, -											0.27
Temp rise by fans, °C											0
Invest											0
Heating part											
Active											true
Supply temp., °C											18
Mechanical ventilation, m ³ /s											1.33
Heat rec. eff., -											0.8
Recirc. factor, -											0
Cooling part											
Active											false
Supply temp., °C											0
Mechanical ventilation, m ³ /s											0
Cool rec. eff., -											0
Recirc. factor, -											0
Humidification part											
Active											false

Heat supply air, g/kg														0		
Eff. heat recovery, -														0		
Auxiliary fan energy																
Spec. electricity cons. for fan, W/m²														2800		
Systems																
Heating														Shared Heating System		
Shared Heating System																
Factor on fuel consumption, -														1		
Use Solar Collector														No		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux.	0.3	1	1	1	1	1	0.75	0.25	0	0	0	0.25	0.75	1	1	
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Condensate gas boiler	0.80	1	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1
Distribution																
Name	Efficiency, -												Invest			
Heating distribution system, standard value													0.95			
Enduse																
Name	Efficiency, -												Invest			
Corrections													0.95			
Old building, 0, 1 & 2 floor													0.95			
Old building, 3 & 4 floor													0.95			
Karsten													0.95			
New Heating System																
Factor on fuel consumption, -														0		
Use Solar Collector														No		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux.	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution																
Name	Efficiency, -												Invest			
Enduse																
Name	Efficiency, -												Invest			
New Heating System																
Factor on fuel consumption, -														0		
Use Solar Collector														No		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux.	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution																
Name	Efficiency, -												Invest			
Enduse																
Name	Efficiency, -												Invest			
New Heating System																
Factor on fuel consumption, -														0		
Use Solar Collector														No		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux.	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution																
Name	Efficiency, -												Invest			
Enduse																
Name	Efficiency, -												Invest			
New Heating System																
Factor on fuel consumption, -														0		
Use Solar Collector														No		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux.	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution																
Name	Efficiency, -												Invest			
Enduse																
Name	Efficiency, -												Invest			
Central Cooling System																
Factor on fuel consumption, -														1		
Axis energy and operation time fraction																
Name	P _{fan} , W/m²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Cooling Aux.	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1		
Generator off, and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling generation off	1	3.5	Electricity	0	1	1	1	1	1	1	1	1	1	1	1	

Distribution															
Name	Efficiency, -												Invest		
Cooling distribution efficiency													0.9		
Enduse															
Name	Efficiency, -												Invest		
Karsten													1		
Shared Dhw System															
Factor on fuel consumption, -														1	
Use Solar Collector														No	
Generator off, and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DHW generated in heating system	0.80	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1
Distribution															
Name	Efficiency, -												Invest		
DHW distribution													0.7		
Enduse															
Name	Efficiency, -												Invest		
Karsten													1		
Old building, 3 & 4 floor													1		
Old building, 0, 1 & 2 floor													1		
New Dhw System															
Factor on fuel consumption, -														0	
Use Solar Collector														No	
Generator off, and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution															
Name	Efficiency, -												Invest		
Enduse															
Name	Efficiency, -												Invest		
New Dhw System															
Factor on fuel consumption, -														0	
Use Solar Collector														No	
Generator off, and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution															
Name	Efficiency, -												Invest		
Enduse															
Name	Efficiency, -												Invest		
Zone: Old building, 0, 1 & 2 floor															
Gross area, m²														1986	
Specific internal heat capacity, kJ/m² K														124	
Specific internal coupling coefficient, W/m² K														9.2	
Int Temp Heating, °C														20.5	
Int Temp Cooling, °C														16.5	
Lighting															
Total installed lighting power, W														19860	
Daylight time usage per year for lighting, hours														1870	
Non-daylight time usage per year for lighting, hours														470	
Daylight dependency factor for lighting, -														0.5	
Occupancy factor for lighting, -														1	
Fraction not removed by exhaust ventilation, -														1	
Emergency lighting charging energy														no	
Lighting controls stand-by energy														no	
Invest														0	
Heat Production / Fraction of time															
Occupants, W/m²														2.85	
Fraction Persons present, -														0.27	
Appliances, W/m²														4.45	
Fraction Appliances are on, -														0.35	
Airflow rate															
Infiltration, m/s														0.993	
Natural vent, m/s														0	
Fraction Nat Vent is present, -														0	
Domestic hot water															
Average DHW consumption, m³/year														0.87	
Boiler Temp, °C														65	
Cold-water Temp, °C														10	
Opaque Construction															
Name	Area, m²	Orientation, deg	Tilt, deg	U, W/m²K	Alpha, -	R _{se} , m²K/W	F _{g,s} , -	F _{g,n} , -	F _{g,e} , -	Invest, m					
0 walls	120.0	90.0	90.0	0.300	0.60	0.04	0.100	0.000	0.000	0.00					
1 walls	188.0	90.0	90.0	0.300	0.60	0.04	0.100	0.000	0.000	0.00					
2 walls	225.0	90.0	90.0	0.300	0.60	0.04	0.100	0.000	0.000	0.00					
Transparent construction															

Distribution																
Name	Efficiency, -	Invest														
End-use																
Name	Efficiency, -	Invest														
Zone: Old building, 3 & 4 floor																
Gross area, m ²		823														
Specific internal heat capacity, kJ/m ³ K		124														
Specific internal coupling coefficient, W/m ² K		9.2														
Int Temp Heating, °C		20.5														
Int Temp Cooling, °C		40														
Lighting																
Total installed lighting power, W		8235														
Daylight time usage per year for lighting, hours		906														
Non-daylight time usage per year for lighting, hours		1404														
Daylight dependency factor for lighting, -		1														
Occupancy factor for lighting, -		1														
Fraction not removed by exhaust ventilation, -		1														
Emergency lighting charging energy		no														
Lighting controls stand-by energy		no														
Intest		0														
Heat Production / Fraction of time																
Occupants, W/m ²		1.17														
Fraction Persons present, -		0.24														
Appliances, W/m ²		4.43														
Fraction Appliances are on, -		0.35														
Airflow rate																
Infiltration, m/s		0.11														
Natural vent, m/s		2.3														
Fraction Nat Vent is present, -		0.3														
Domestic hot water																
Average DHW consumption, m ³ /m ² /year		0.07														
Boiler Temp, °C		65														
Cold-water Temp, °C		10														
Opaque Construction																
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	Alpha, -	R, m ² W/K	F _g , -	F _{sh} , -	F _{sc} , -	Invest/m ²						
West Wall	71.0	270.0	90.0	0.300	0.70	0.04	0.050	0.000	0.000	0.00						
East Wall	101.0	90.0	90.0	0.300	0.70	0.05	0.050	0.000	0.000	0.00						
North Roof	41.6	0.0	45.0	0.200	0.80	0.04	0.000	0.000	0.000	0.00						
South Roof	325.0	180.0	45.0	0.200	0.80	0.04	0.000	0.000	0.000	0.00						
Transparent construction																
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	U _g , W/m ² K	G _g , -	G _{sh} , -	F _g , -	F _{sh} , -	F _{sc} , -	Invest/m ²					
West windows	7.0	270.0	90.0	3.000	3.000	0.700	0.70	0.000	0.000	0.000	0.00					
East Windows	7.0	90.0	90.0	3.000	3.000	0.700	0.70	0.000	0.000	0.000	0.00					
North roof windows, 3	18.4	0.0	45.0	2.000	2.000	0.630	0.63	0.000	0.300	0.020	0.010					
North roof windows, 4	17.8	0.0	45.0	2.000	2.000	0.630	0.63	0.000	0.300	0.020	0.010					
South roof windows, 3	4.2	180.0	45.0	2.000	2.000	0.630	0.63	0.000	0.500	0.020	0.010					
South roof windows, 4	15.6	180.0	45.0	2.000	2.000	0.630	0.63	0.000	0.500	0.020	0.010					
Ground construction																
Name	Area, m ²	U, W/m ² K	R _g , h, -	R _g , s, -	Invest/m ²											
Shared Heating System																
Factor on fuel consumption, -		1														
Use Solar Collector		No														
Aux energy and operation time fraction																
Name	P _{pump} , W/m ²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux	0.3	1	1	1	1	1	1	1	1	1	1	1	1	1		
Generator eff. and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cascade gas boiler	0.89	1	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	
Distribution																
Name	Efficiency, -	Invest														
Heating distribution system, standard value	0.93	0														
End-use																
Name	Efficiency, -	Invest														
Connection	0.95	0														
Old building, 0, 1 & 2 floor	0.95	0														
Old building, 3 & 4 floor	0.95	0														
Karsten	0.95	0														
New Heating System																
Factor on fuel consumption, -		0														
Use Solar Collector		No														
Aux energy and operation time fraction																
Name	P _{pump} , W/m ²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator eff. and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DHW generated in heating system	0.89	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1	
Distribution																
Name	Efficiency, -	Invest														
DHW distribution	0.7	0														
End-use																
Name	Efficiency, -	Invest														
Karsten	1	0														
Old building, 3 & 4 floor	1	0														
Old building, 0, 1 & 2 floor	1	0														
New DHW System																
Factor on fuel consumption, -		0														
Use Solar Collector		No														
Aux energy and operation time fraction																
Name	P _{pump} , W/m ²	f _{cont} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heating Aux	0	0	1	1	1	1	1	1	1	1	1	1	1	1		
Generator eff. and load contribution																
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DHW generated in heating system	0.89	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1	
Distribution																
Name	Efficiency, -	Invest														
DHW distribution	0.7	0														
End-use																
Name	Efficiency, -	Invest														
Karsten	1	0														
Old building, 3 & 4 floor	1	0														
Old building, 0, 1 & 2 floor	1	0														

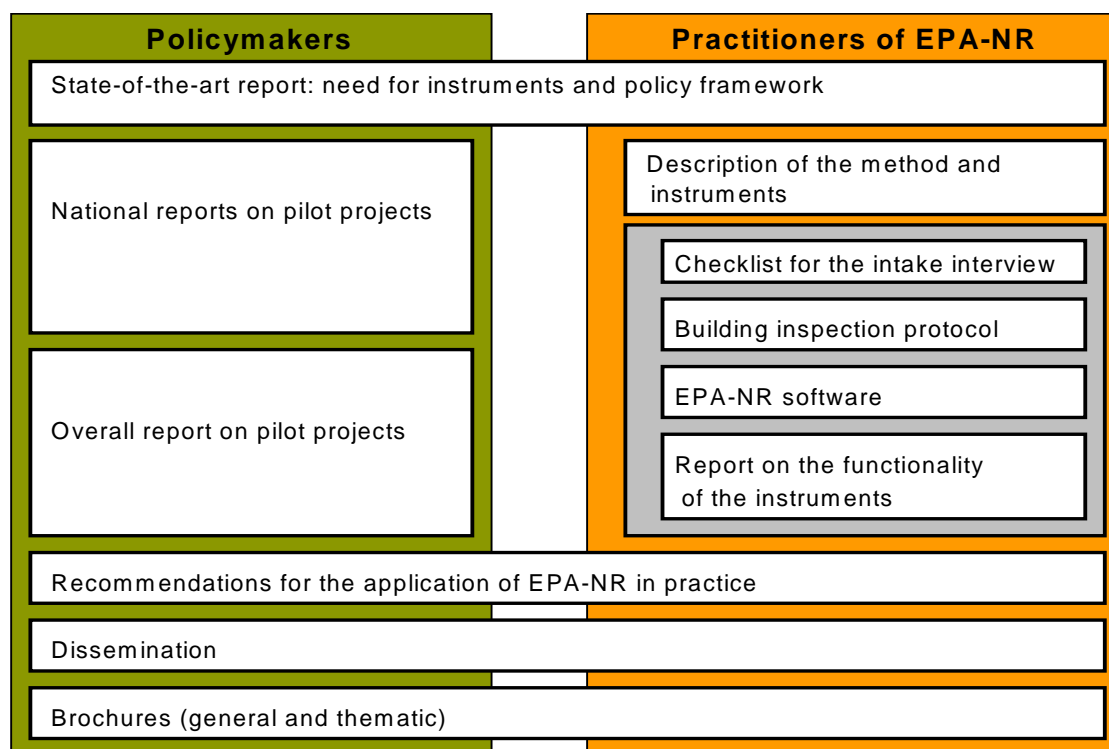
Envision																			Dive												Shared Dive System											
Name		Efficiency, -																	Invest																							
New Dive System																																										
Factor on fuel consumption, -																			0												1											
Use Solar Collector																			No												No											
Generator off, and load contribution																																										
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																											
Distribution																																										
Name		Efficiency, -																	Invest																							
Envision																																										
Name		Efficiency, -																	Invest																							
Zone: Kanten																																										
Gross area, m ²																			150																							
Specific internal heat capacity, kJ/m ³ K																			124																							
Specific internal coupling coefficient, W/m ² K																			0.2																							
In Temp Heating, °C																			20.5																							
In Temp Cooling, °C																			23																							
Lighting																																										
Total installed lighting power, W																			1125																							
Daylight time usage per year for lighting, hours																			58																							
Non-daylight time usage per year for lighting, hours																			202																							
Daylight dependency factor for lighting, -																			1																							
Occupancy factor for lighting, -																			1																							
Fraction not removed by exhaust ventilation, -																			1																							
Emergency lighting charging energy																			no																							
Lighting controls stand-by energy																			no																							
Invest																			0																							
Heat Production / Fraction of time																																										
Occupants, W/m ²																			35																							
Fraction Persons present, -																			0.03																							
Appliances, W/m ²																			5																							
Fraction Appliances are on, -																			0.27																							
Airflow rate																																										
Infiltration, m/s																			0.02																							
Natural vent, m/s																			0																							
Fraction Nat Vent is present, -																			0																							
Domestic hot water																																										
Average DHW consumption, m ³ /m ² /year																			0.07																							
Boiler Temp, °C																			66.5																							
Cold-water Temp, °C																			10																							
Opaque Construction																																										
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	Alpha, -	R _{se} , m ² K/W	F _{g,h} , -	F _{g,v} , -	F _{g,e} , -	Invest/m ²																																
West gable	20.0	270.0	90.0	0.300	0.70	0.04	0.050	0.000	0.000	0.00																																
South roof	96.9	180.0	90.0	0.200	0.80	0.04	0.000	0.000	0.000	0.00																																
Transparent construction																																										
Name	Area, m ²	Orientation, deg	Tilt, deg	U, W/m ² K	U _A , W/m ² K	G _{g,v} , -	G _{g,h} , -	F _{g,v} , -	F _{g,h} , -	F _{g,e} , -	Invest/m ²																															
South roof windows	8.1	180.0	45.0	2.000	2.000	0.630	0.40	0.000	0.500	0.000	0.00																															
Ground construction																																										
Name	Area, m ²	U, W/m ² K	θ _{g,h} , -	θ _{g,v} , -	Invest/m ²																																					
Cantenn Abu																																										
Fraction of time, -																			0.03																							
Temp rise by fans, °C																			0																							
Invest																			0																							
Heating part																																										
Active																			false																							
Supply temp, °C																			18																							
Mechanical ventilation, m/s																			0.50																							
Heat rec. eff., -																			0																							
Recirc. factor, -																			0																							
Cooling part																																										
Active																			false																							
Supply temp, °C																			0																							
Mechanical ventilation, m/s																			0																							
Cool rec. eff., -																			0																							
Recirc. factor, -																			0																							
Humidification part																																										
Active																			false																							
Hum. supply air, g/kg																			0																							
Eff. hum. recovery, -																			0																							
Auxiliary fan energy																																										
Spec. electricity cons. for fans, W/m ²																			2300																							
Systems																																										
Heating																			Shared Heating System																							
Cooling																			Custom Cooling System																							
Shared Heating System																																										
Factor on fuel consumption, -																			1																							
Use Solar Collector																			No																							
Aux energy and operation time fraction																																										
Name	F _{g,pump} , W/m ²	f _{g,cont.} , -	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																												
Heating Aux	0.3	1	1	1	1	0.75	0.25	0	0	0	0.25	0.75	1	1																												
Generator off, and load contribution																																										
Name	Efficiency, -	COP, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																										
Cascade gas boilers	0.89	1	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1																										
Distribution																																										
Name		Efficiency, -																	Invest																							
Heating distribution system, standard value																			0.93																							
Envision																																										

Shared Dhw System															
Factor on fuel consumption, -												1			
Use Solar Collector												No			
Generator off- and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DHW generated in heating system	0,85	Natural gas, high energy	0	1	1	1	1	1	1	1	1	1	1	1	1
Distribution															
Name	Efficiency, -										Invest				
DHW distribution	0,7										0				
Endvision															
Name	Efficiency, -										Invest				
Kortum	1										0				
Old building, 3 & 4 floor	1										0				
Old building, 0, 1 & 2 floor	1										0				
New Dhw System															
Factor on fuel consumption, -												0			
Use Solar Collector												No			
Generator off- and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution															
Name	Efficiency, -										Invest				
Endvision															
Name	Efficiency, -										Invest				
New Dhw System															
Factor on fuel consumption, -												0			
Use Solar Collector												No			
Generator off- and load contribution															
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distribution															
Name	Efficiency, -										Invest				
Endvision															
Name	Efficiency, -										Invest				

Project Description

EPA-NR is a project in the framework of the 'Intelligent Energy – Europe' Programme (IEE) of the European Commission. EPA-NR provides an assessment method for the Energy Performance Certificate according to the Energy Performance of Buildings Directive (EPBD) and offers additional advice for existing non residential buildings. The project, in which seven EU Member States are participating, is co-ordinated by EBM-consult, The Netherlands. It started in January 2005 and will last for two years.

The EPA-NR method consists of an energy calculation model and process supporting tools like inspection protocols, checklists and building component libraries. The EPA-NR method produces an Energy Performance Certificate for non-residential buildings with the possibility for additional advice. The two major target groups are policy makers and practitioners who are each addressed with a tailored set of deliverables.



The EPA-NR method:

- is in line with the EPBD and CEN-standards
- takes into account the local framework with respect to legislation, technical aspects, design- and building maintenance processes and acceptance by actors in the market
- is modular and flexible and therefor easily adjustable to the national context, the diversity in the market and new or modified CEN-standards
- is tested through pilot projects in seven EU Member States
- can be further developed and maintained at low cost due to the joint efforts
- offers additionally policy recommendations addressing all levels of authorities in Europe
- guarantees simple transfer to all EU Member States

Project Partners



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