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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 Title of contact:
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www.epa-nr.org

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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.



Energy management: The temperature of the heating system is controlled by an outdoor temperature sensor allowing for a lower temperature at high outdoor temperatures.

Energy consumption year 2005:

	The building	National
		average
Fuel	126 kWh/m ²	105 kWh/m ²
Electricity	39 kWh/m²	43 kWh/m²
Water	210 l/m ²	250 l/m ²

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.

Planned refurbishment: No further refurbishment is planned.

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

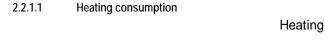
The building has problems regarding air tightness at the two under-roof floors. These problems was introduced in 2003 when 70 mm of the roof insulation was removed to increase the ventilation in the roof construction and in this way eliminate a mould growth problem. The mould problem was introduced some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





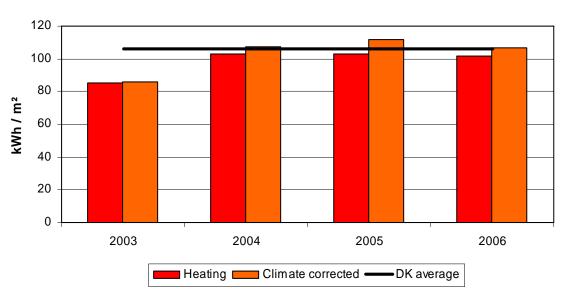


Figure 1. Recorded heating consumption in kWh/m² in 2003 - 2006 (meter reading and climate adjusted respectively) and the Danish average consumption in buildings used for similar purpose and size. The degree-day independent heating consumption constitutes about 20 % of the total heating consumption.

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.

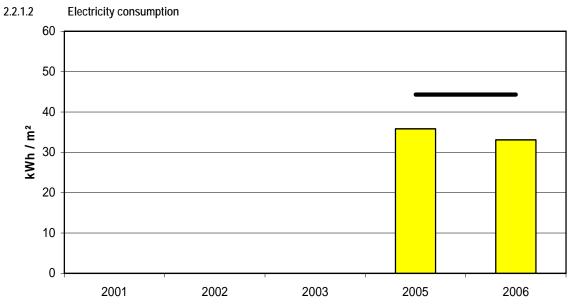


Figure 2. Recorded electricity consumption in kWh/m² in 2005 and 2006 and the Danish average consumption in buildings used for similar purpose and size.



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

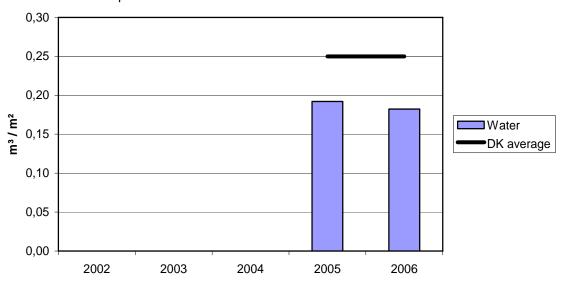


Figure 3. Registered water consumption at Rosenkæret 39 in 2004 and 2005 in m³/m² and the Danish average consumption in buildings used for similar purpose and size. The domestic hot water consumption is estimated to be 30 % of the total water consumption.

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:

- New extension building (430 m²),
 Basement, 1st and 2nd floor of old building (1986 m²),
 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/m²/vear	CO ₂ emission of the building: kg/m²/year
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202.32	29.8

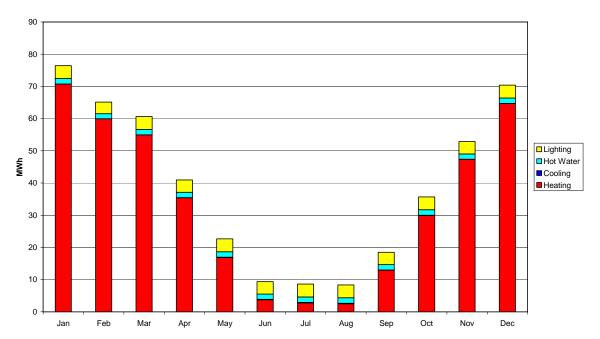
Final energy demand, primary energy demand and CO2 emission by energy carrier

			, , , , , , , , , , , , , , , , , , ,
	Annual final energy con-	Primary energy con-	CO ₂ emission of the
	sumption* of the building	sumption of the building:	building:
	per fuel type:	kWh/m²/year	kg/m²/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

Energy demand

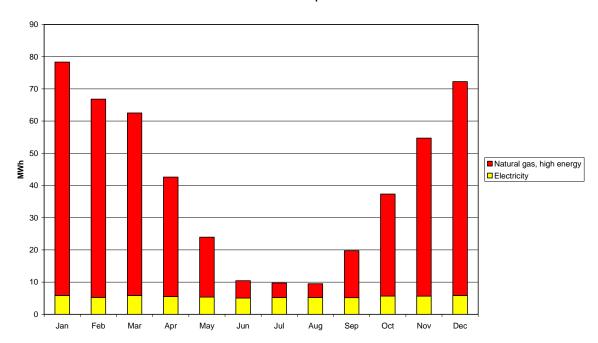


Distribution of heating demand on different sources: Lighting; Domestic hot water; Cooling; and Heating.



Energy demand by energy source

Fuel consumption



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).

	А	nnual losse	s	Annual gains						
Total	Total	Trans- mission	Ventila- tion	Total	Solar	Sun space	Internal heat			
kWh/m² (heating)	136.21	50.09	86.12	54.65	23.64	0	31.01			
kWh/m² (cooling)	329.21	130.42	198.79	58.06	27.05	0	31.01			

Old building	А	nnual losse	s	Annual gains						
Total cooling kWh/m²	Total	Trans- mission	Ventila- tion	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			

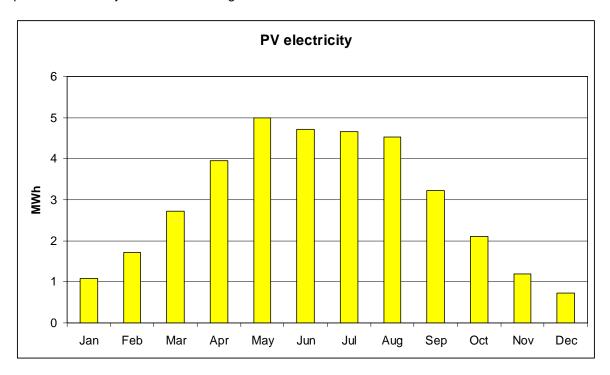


2.3 Calculation of energy savings: scenarios for improvement

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

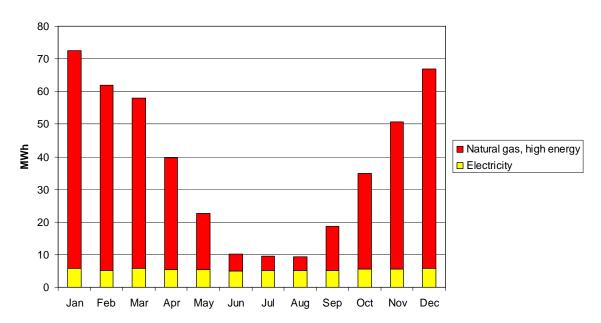
2.3.2.1 Background and proposed solution

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

Fuel consumption



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

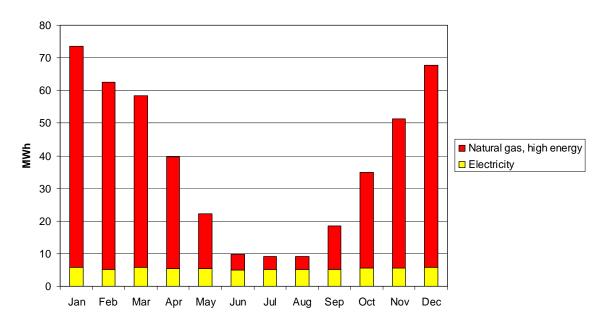
2.3.3.1 Background and proposed solution

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.







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:

ErrModel: Rosenhamet	Rosenbaret Created 9.05.2007 11.38							01,0	0,100	0,000	0,000	0,00
Project: Rosenkæret		First floor,	42,0	180,0	90,0	0,300	0,00	0,10	0,100	0,000	0,000	0,00
Climate Library	D:Programmer/SBi/Enr/Tool/Enr/ClimateDk:xml	ext walls S	44,0	180,0			4,00	9,10	0,100	0,000	0,000	0,00
Constants Library	D/Programmer/SB/EnrTool/EnrConstDkdU0.xml	First floor, ext wall W	80,5	270,0	90,0	0,300	0,00	0,10	0,100	0,000	0,000	0,00
Fuel Library	D/Programmer/SB/EnrToof/EnrFuelDk:xml	Roof	430,0	0,0	0,0	0,200	0,80	0,04	0,000	0,100	0,000	0,00
	***		0,0	0,0	0,0	0,000	0,00	0,00	0,000	0,000	0,000	0,00
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Zone: New building		Basement			\vdash	\vdash	-					
Gross area, m²	430	walls, sub termin	78,0	0,0	90,0	0,250	0,00	0,20	1,000	0,000	0,000	0,00
Specific internal heat capacity, k3/m² K	150	Terrain.			_							
Specific internal ocupling coefficient, W/m² K	9,2	Transparen	construction									- 4
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Int Temp Cooling, *C	40	- "	$\overline{}$		1,500	1,500	0,660 0	66 0,000	0,000	0,400 0,0	00 0,050	0,00
Lighting		North 45, West 15,	-	\rightarrow	1,500	1,500	_	0,000	0,000	-	\rightarrow	0,00
Total installed lighting power, W	4000	South 48,	-	\rightarrow	1,500	1,500	-	0,000	0,000	-	\rightarrow	0,00
Duylight time usage per year for lighting, hours	1870	0,	-		0,000	0,000	-	000,0 00,0	0,000	-	00 0,000	0,00
Non-daylight time usage per year for lighting, hours	470	- 0,	1	eta Sata	0,000	0,000	0,000	40 000	0,000	0,000 0,0		ayara
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Occupance factor for lighting, -	1	Name	Name Area, m ² U, W/m ² K B_g_h, - B_						B_g_c,		Investm ²	
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Emergency lighting charging energy	no											
Lighting controls stand-by energy	no	Mechanical, balanced VAV ventilation									0,27	
Invest	0	Fraction of time, -								9,27		
Heat Production / Fraction of time	3	Temp rise by fans, °C										
Occupants, Wimi	1,03	Invest										
Fraction Persons present, «	0,06	Heating part									12.00	
Appliances, Wimi	1	Active							true 18			
Fraction Appliances are on, -	0,27		Supply temp, "C									
Airflow rate			Mechanical ventilation, m/s							1,33		
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Natural vent, milis	0	Rocine: Sector _e -										
Fraction Nat Vent is present, -	0		Cooling part									false
Domestic hot water	1		Active									Isisc
Average DHW consumption, m/m/year	0	Supply temp	-				+					0
Boiler Temp, °C	65	Mechanical ventilation, m/s Cool rec. eff										
Cold-water Temp., °C	10	Recirc facto					+					0
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New Heating System	Endocisis
New Heating System	Emission Efficiency, Invest Efficiency, Invest Invest
New Heating System	Endocise
New Heating System	Emission Efficiency, Invest Efficiency, Invest Invest
New Heating System	Endocision Efficiency, Invest Efficiency, Invest Inves
New Heating System	Efficiency Efficiency Towest Efficiency Towest
New Heating System	Efficiency
New Heating System	Efficiency Efficiency Invest
New Heating System	Endocise
New Heating System	Efficiency Efficiency Invest
New Heating System	Endocise
Part Confidence	Efficiency Efficiency Invest
Part Control	Efficiency Efficiency Efficiency Invest Zener OM-building, 8, 1.6.2 floor Cross stee, m² 1986 Specific internal coupling ecoefficient, Wint' K 124 Specific internal coupling ecoefficient, Wint' K 9.2 In Temp Pleating, **C 2.25 In Temp Pleating, **C 2.25 In Temp Pleating, **C 3.25 I
New Heating System	Efficiency Efficiency Efficiency Invest Zener OM building, 8, 1 & 2 floor Crison seez, mi* 1966 Specific internal overgroup coefficient, Wind* K 124 Specific internal overgroup coefficient, Wind* K 9-2 Int Temp Heating, C 2-2,5 In Temp Heating, C 2-2,5 In Tagging Heating Heating Heating Heating, Doors 1980 Dolglight three waspe per year for lighting, Doors 1980 Dolglight dependency factor for lighting 0.5 Dolglight dependency factor for lighting lighting 0.5 Dolglight dependency factor for lighting lighting 0.
Part Control	Pairs
New Heating System	Efficiency Efficiency Efficiency Invest Zener OM building, 8, 1 & 2 floor Crison seez, mi* 1966 Specific internal overgroup coefficient, Wind* K 124 Specific internal overgroup coefficient, Wind* K 9-2 Int Temp Heating, C 2-2,5 In Temp Heating, C 2-2,5 In Tagging Heating Heating Heating Heating, Doors 1980 Dolglight three waspe per year for lighting, Doors 1980 Dolglight dependency factor for lighting 0.5 Dolglight dependency factor for lighting lighting 0.5 Dolglight dependency factor for lighting lighting 0.



Name .	Area,	Orientation, dog	Tilt, deg	U. WmK	U.s. Wm/K	G_g_	Ggs.	F_5, -	F_with, -	F.A.	F_0, -	F_C -	Invest/m*	Name Efficiency, - Invest					
Basement	0,0	0,0	0,0	0,000	0,000	0,000	0,00	0,000	0,000	0,000	0,000	0,000	0,00	Emission					
8 North windows	7,8	0,0	90,0	3,000	3,000	0,100	0,10	0,000	0,000	0,300	0,050	0,050	0,00	Name Efficiency, - Invest					
6 South windows	5,9	180,0	90,0	3,000	3,000	0,100	0,10	0,000	0,000	0,200	0,050	0,050	0,00	New Heating System					
windows 2 North doors	11,0	0,0	90,0	3,000	3,000	0,000	0,00	0,000	0,000	0,300	0,050	0,050	0,00	Factor on find consumption, - 0					
- Ist floor	0,0	0,0	0,0	0,000	0,000	0,000	0,00	0,000	0,000	0,000	0,000	0,000	0,00	Use Solar Collector No					
12 North windows	32,4	0,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,300	0,050	0,050	0,00	Aux energy and operation time fraction					
West door	2,4	90,0	90,0	3,000	3,000	0,500	0,50	0,000	0,000	0,250	0,050	0,050	0,00	Name P_nearen, f_contr, - Jan Feb Mar Apr May Jun Jul Aug Sep Oct New Dec					
West window	2,0	90,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,250	0,050	0,050	0,00	Heating Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1					
12 South windows	32,4	180,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,150	0,050	0,050	0,00	Generator eff. and load contribution					
- 2nd floor	0,0	0,0	0,0	0,000	0,000	0,000	0,00	0,000	0,000	0,000	0,000	0,000	0,00	Name Emercincy,- Pure invest van Feo Mar Apr May Am Au Aug Sep Oct Nov Dec					
12 North	32,4	0,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,200	0,050	0,050	0,00	Distribution					
windows West Window	-	_		2.000	1000		-	-			0.000	Н	_	Name Efficiency, - Invest Emirotes					
	5,6	90,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,200	0,050	0,050	0,00	Name Efficiency, - Invest					
12 South windows	32,4	180,0	90,0	3,000	3,000	0,700	0,70	0,000	0,000	0,100	0,050	0,050	0,00						
Ground consti	uction										_			New Heating System					
Name Azes, m ² U, Wim ² K B_g_h, B_g_s, Investin ²										B	g.c	Factor on final consumption, - 0 Use Solar Collector No.							
Basement floor			616,			0,300			0,70		0,70		0.00	Aux energy and operation time fraction					
0, 1 & 2 floor	entilatio	0								_		_		Name p.purrp, f_contr, - Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					
Fraction of tim													0,27	Hesting Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1					
Temp rise by t	ins, °C												0	Generator eff. and load contribution					
Invest													0	Name Efficiency,- COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					
Heating part						_								Distribution					
Active Supply temp.,	c.					\dashv	_						true	Name Efficiency, - Invest					
Mechanical ver		m/s				\neg	_						0,61	Emission					
Heat roc. eff, -		lai vi											0	Name Efficiency, - Invest					
Recirc factor,													0	Canteen Cooling System					
Cooling part						_								Factor on fuel consumption, -					
Active	-					-							false	Aux energy and operation time fraction					
Supply temp., ' Mechanical ver		milia.				\dashv							0	Name P_pump. f_contr, - Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					
Cool rec. eff,-						\neg							0	Cooling Aux 0,5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					
Reciec factor,													0	Generator eff. and load contribution					
Humidificatio	part					_								Name Efficiency, COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					
Autor						-							61						
Active Hum supply at	cele					\dashv	_						false 0	Cooling generation 1 3.5 Electricity 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					
Eff. hum. recov						\neg	_						0	Distribution					
Auxiliary fan	mergy													Name Efficiency, · Invest					
Spec. electricit	cons. fo	r fans, Ws/m²											2300	Cooling distribution efficiency 0,9 0					
Systems														Emission					
Heating Dhw						-							Heating System ed Dhw System	Name Efficiency, - Invest					
Daw						_						Shan	od LAW System	Kinten 1					
Sluced Heatin						_								Shared Dhrv System					
Factor on fael o		ion, -				\dashv							1 No	Factor on final consumption, -					
Use Solar Colli Aux energy as		lon diese for ette					_						- No	Use Solar Collector No Generator eff, and load contribution					
Name	_		-		Feb	Mar	I-I	v.	la la	,_1	,_1	٦.	No.	Name Efficiency, - Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Now Dec					
1000	<u> </u>	with	contr, -	7811	reb	atat	vbt	atay'	All ME	Aug	sep	Off	Nov Dec	DHW					
Heating Aux Generator eff.		0,3	- 1	- 1		1	0,75	V,25	0 0	0	0,25	0,75	1 1	generated in 0,000 Natural gas, 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					
			·			P. 1	ye.	, I	(m)	uI.		1	No.	gystern Distribution					
Name	Efficien	" .		od Inve	N Am	Feb	Mar	Vbx y	say Am	ns At	g Set	Oet	Nov Dec	Name Efficiency, - Invest.					
Cascade gas boilers		0,89 1	Natural g high ener	gas, ggy	0 1	- 1	ı.t	1	1 1	1	1	-1	1 1	DHW distribution 0,7 0					
Distribution				_										Emission					
Name				-					ncy, -				Invest	Name Efficiency, - Invest					
Heating distrib	ation syst	em, standard val	lac .	_					0,93				0	Karteen 1 0					
Emission Name				Т				Efficie	I				Invest	Old bailding, 3 & 4 floor 1 0 Old bailding, 0, 1 & 2 floor 1 0					
Convectors				+					0.95				anves.	the second secon					
Old building, 0	1825	oor		\vdash					0,95				0	New Dirw System					
Old building, 3	& 4 floo	rii							0,95				0	Factor on find consumption, - 0 Use Solar Collector No					
Karfeen.									0,95				0	Generator eff, and load contribution					
New Heating 5	ystem													Name Efficiency,- Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					
Factor on fact of	onsungt	ion, +											0	Distribution					
Use Solar Colli													No	Name Efficiency, - Invest					
Aux energy as	$\overline{}$		$\overline{}$	_	_	_	_	_					-	Emission					
Name	P,	W/m² C	contr	Jan	Feb :	Mar	Apr	May	Jun Isl	Aug	Sep	Oct	Nov Dec	Name Efficiency, - Invest					
Heating Aux	-	0	0	- 1	- 1	- 1	1	1	1 1	1	-1	1	1 1	New Dhw System					
Generator eff.			_	_	_		_	_		_	_		$\overline{}$	Factor on fuel consumption, - 0					
Name Uffic	iency, -	COP, Fud	Invest	Jan	Feb	Mar	Apr	May	Ain Ail	Aug	Sep	Oct	Nov Dec	Use Solar Collector No					
Distribution														Generator eff, and load contribution					
														Name Efficiency, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec					



Distribution	Aux energy and operation time fraction
Name Efficiency, - Invest	Name P. Purump, f. contr Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Doc
Emission	
Name Efficiency, - Invest	Heating Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1
	Generator eff. and load contribution
Zone: Old building, 3 & 4 floor	Name Efficiency,- COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Gross area, m² 823	Distribution
Specific internal heat capacity, kUm' K. 124	Name Efficiency, - Invest
Specific internal coupling coefficient, W/m ² K 9,2	
Int Temp Heating, °C 20,5	Emission
Int Temp Ceeding, °C 40	Name Efficiency, - Invest
Lighting	New Heating System
Total installed lighting power, W 8235	Factor on fael consumption, - 0
Daylight time usage per year for lighting, hours 936	Use Solar Collector No
Non-daylight time usage per year for lighting, hours 1404	
Daylight dependency factor for lighting 1	Aux energy and operation time fraction
HILLIAN CONTRACTOR CON	Name P. Prantp. C. confr Jun Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
Occupance factor for lighting, -	Hosting Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Fraction not removed by exhaust vertilation, -	Generator eff. and load contribution
Emergency lighting charging energy no	
Lighting controls stand-by energy no	Name Efficiency,- COP: Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Irrest 0	Distribution
Heat Production / Fraction of time	Name Efficiency, - Invest
Occupants, W/m² 1,17	
Fraction Persons present, - 0,26	Emirdon
Appliances, Wim ² 4,45	Name Efficiency, - Invest
Fraction Appliances are on, - 0,35	New Heating System
Airflow rate	Factor on fael consumption, - 0
Infiltration, m/s 0,11	Use Solar Collector No
Natural vent, m/s 2,5 Fraction Nat Vent is present. 0,3	Aux energy and operation time fraction
AND	Name P_parep. f_contr,- Jan Feb Mar Apr May Jun Jul Ang Sep Oct Nov Dec
Donnestic but water	Hesting Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1
Average DHW consumption, m/m²/year 0,07	Generator eff. and load contribution
Boller Temp, °C 65	
Cold-water Temp., *C 10	Name Efficiency,- COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
	Distribution
Opaque Construction	Name Efficiency, - Invest
$Name \qquad Area, m^2 \qquad Orientation, deg \qquad \begin{array}{llll} Tilt, & U, Winr'K & Alpha, \cdot & R, se, \\ & deg & U, Winr'K & Alpha, \cdot & R, se, \\ & m'K'W & F_h, \cdot & F_o, \cdot & F_f, \cdot & Investinr' \end{array}$	Familyden
West Wall 71,0 270,0 90,0 0,300 0,70 0,04 0,050 0,000 0,000 0,00	Name Efficiency, - Invest
East Wall 101,0 90,0 90,0 0,300 0,70 0,05 0,050 0,000 0,000 0,00	
North Roof 414,0 0,0 45,0 0,200 0,80 0,04 0,000 0,000 0,000 0,00	Canteen Cooling System
South Roof 325,0 180,0 45,0 0,200 0,90 0,04 0,000 0,000 0,000 0,000	Factor on fael consumption, - 1
Transparent construction	Aux energy and operation time fraction
	Name P. Purrp. C. contr Jun Feb Mar Apr May Jun Jul Aug Sep Oct Nov Die
	Cooling Aux 0,5 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	Generator eff. and load contribution
West 7,0 270,0 90,0 3,000 0,700 0,700 0,000 0,000 0,050 0,050 0,000 0,00	
windows	
Note that the state of the stat	Name Efficiency,- COP. Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
mindows T 90,0 90,0 3,000 0,700 0,70 0,000 0	Name Efficiency, COP. Fuel Invest Jun Feb Mart Apr May Jun Jul Aug Sep Oct Nov Dec Cocling
### ##################################	Name Efficiency, COP. Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
mindows T 90,0 90,0 3,000 0,700 0,70 0,000 0	Name Efficiency, COP. Fuel Invest Jun Feb Mart Apr May Jun Jul Aug Sep Oct Nov Dec Cocling
Initiations 1.0 90,0 90,0 3,000 3,000 0,70 0,70 0,000 0,050 0,650 0,000 0,00	Name Efficiency, COP, Fud Invest Jun Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
### ##################################	Name
Initiations 1.0 90,0 90,0 3,000 3,000 0,70 0,70 0,000 0,050 0,650 0,000 0,00	Name Efficiency, - CCPs
windows 1.0 90.0 90.0 3.000 3.000 0.70 0.70 0.000 0.050 0.050 0.000 0.00	Name Efficiency COP Ful Invest Jun Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
	Name Efficiency, - COPs, and a line of the color of the
mixtures 3 300 3,000 3,000 3,000 0,700 0,700 0,000 0,	Name Efficiency COP Ful Invest Jun Feb Mar Apr May Jun Jul Aug Sep Oct New Dec
	Name
	Name Efficiency, - COP, - Full lines Jun Feb. Mar Apr. May Jun Jul Aug Sep Oct Nov Dec. Coding generation 1 3,5 Exceptionly 0 1
Section Columbia	Name
Section Comparison Compar	Name
Section Company Comp	Name
Section Property	Name Efficiency, COP, Fuel Invose Jan Fob Mar Apr Mary Jan Jul Aug Sep Oct Nov Dec
State	Name
Section Page	Name
Section Part	Name
Section Page	Name
Section Part	Name
Section Commitments Comm	Name
Section Part	Name
Section Commitment Commit	Name
Section Part	Name
Section Company Comp	Name
Section Company Comp	Name
Section Continue	Name
Section Comparison Compar	Name
Section Company Control Cont	Name
Section Continue	Name
Section Commitment Commit	Name
Section Commitments Comm	Name
Section Continues Contin	Name
Section Continue	Name



Emission	Dlw Shared Dlw System
Name Efficiency, - Invest	
New Dhw System	Shared Heating System Factor on find consumption, - 1
Factor on find consumption, -	Use Solar Collector No
Use Solar Collector No	Aux energy and operation time fraction
Generator eff. and load contribution	Name P. Dourne, f. contr Jun Feb Mar Apr May Jun Jul Ang Sep Oct Nov Dec
Name Efficiency, - Fuel lawest Jan Feb Mar Apr May Jun Jul Aug Sep Oct New Dec	
Distribution	
Name Efficiency, - Invest	Generator eff. and load contribution
Emission	Name Emissioney, Fust invest Jan Feb Star Apr Stay Jan Jia Aug Sep Oct Nov Dec
Name Efficiency, - Invest	Cascade gan 0,89 1 Natural gas, 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Zone: Kanteen	Distribution
Gross area, m ²	Name Efficiency, - Invest
Specific internal heat capacity, kN tof K 124	Heating distribution system, standard value 0,93 0
Specific internal coupling coefficient, W/m ² K. 9,2	Emission
Int Temp Heating, ¹ C 20,1	Name Efficiency, - Invest
Int Temp Cooling, *C 23	Convectors 0,95 0
Lighting	Old building, 0, 1 & 2 floor 0,95 0
Total installed lighting power, W 112	Old balding, 3 & 4 floor 0,95 0
Daylight time usage per year for lighting, hours 51	Karteen 0,95 0
Non-daylight time usage pet your for lighting, hours 200	New Heating System
Daylight dependency factor for lighting, -	Factor on find consumption, - 0
Occupance factor for lighting, -	Use Solar Collector No
Fraction not removed by exhaust ventilation, -	Aux energy and operation time fraction
Emergency lighting charging energy no	
Lighting cortrols stand-by energy no	war
Invest (Hesting Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1
Heat Production / Fraction of time Occupants, Wins' 33	Generator eff. and load contribution
Oxcepants, Wini ² 3: Fraction Persons present, - 0,03	Name Efficiency, - COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Appliances, Winf	Distribution
Fraction Appliances are on, - 0,21	Name Efficiency, - Invest
Airflow rate	Emission
Infiltration, m ¹ /s 0.01	Name Efficiency, - Invest
Natural vent, mila	No manage and
Fraction Nat Vent is present, -	New Heating System Factor on find consumption, - 0
Domestic hof water	Use Solar Collector No
Average DHW consumption, m/mr/year 0,01	Aux energy and operation time fraction
Boiler Temp, °C 0,65	
Cold-water Temp, °C 10	Name P_pump, f_contr, - Ian Feb Mar Apr May Jun Jul Aug Sep Oct Nov Doc
and the state of t	Heating Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1
Opaque Construction	Generator eff. and load contribution
Name Area, m ² Orientation, deg Tilb, deg U, W/m ² K Alpha, - R, se, m ² K/W F, h, - F, o, - F, f, - Investim	Name Efficiency,- COP, Fuel Invest Jan Feb Mar Apr May Jun Aul Aug Sep Oct Nov Dec
West gable 20,0 270,0 90,0 0,300 0,70 0,04 0,050 0,000 0,000 0,00	Distribution
South roof 96,9 180,0 90,0 0,200 0,80 0,04 0,000 0,000 0,000 0,000	Name Efficiency, - Invest
	Emission
Transparent construction	Name Efficiency, - Invest
Name Area, Orientation, Tilt, U, WinrK U_h, G_E, G_E, F_h, F_h, F_with, F_h, F_o, F_f, Investigation	the second secon
South-roof 8.1 180,0 45,0 2,000 2,000 0,630 0,40 0,000 0,500 0,000 0,050 0,050 0,050	New Heating System
	Factor on flud consumption, - 0
Ground construction	Use Solar Collector No
Name Area, m^{c} U, $W/m^{c}K$ B_g_h, - B_g_c, - Investing	Aux energy and operation time fraction
Cantren Ahu	Name P_namp, f_contr, - Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Fraction of time, - 0.03	Heating Aux 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Temp. rise by fans, °C	Generator eff. and load contribution
Invest	Name Efficiency, - COP, Fuel Invest Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Doc
Heating part	Distribution
Active	Name Efficiency, • Invest
Supply temp, °C 18	
Mechanical vertilation, m/s 0,50	Name Efficiency, - Invest
Heat rec. eff, -	
Recise factor, -	Canteen Cooling System
Cooling part	Factor on find consumption, -
Active false	Aux energy and operation time fraction
Supply temp, "C	Name P_mamp, C_contr, - Jun Feb Mar Apr May Jun Jul Ang Sep Oct Nov Dec
Mechanical ventilation, m/s	Cooling Aux 0,5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Cool rec eff	Generator eff. and load contribution
Recirc. factor, -	Name Efficiency, COP, Fod Invest Jan Fob Mar Apr May Jan Jid Aug Sep Oct Nov Doc
Humidflication part Active false	Cooling
Active sales Hum. supply sir, g kg	generation 1 3,5 Electricity 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Eff. hum recovery, -	Distribution
Auditory for energy	Name Efficiency, - Invest
Spec. electricity cons. for fans, Wa'm ² 2300	Cooling distribution efficiency 0.9 0
Systems 2.00	Emission
Heating Shared Heating System	Name Efficiency, - Invest
Cooling Canteen Cooling System	



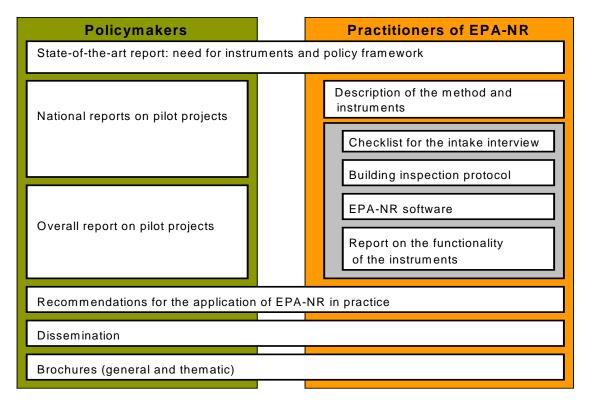
Shared Dhw Sys	desa														
Factor on fluil cor	nsamption, -														- 1
Use Solar Collect	tor														Ne
Generator eff. a	nd load contribu	ition	25 8	5 10	9 10				,	3. 2	gu z				
Name	Efficiency, -	Fuel	Invest	Jan	Feb	Mar	Apr	May	Jun	Jul	Ang	Sep	Oct	Nov	Dec
DHW generated in heating system	0,89	Natural gas, high energy	0	1	1	1	1	1	ï	1	1	1	1	1	1
Distribution															
Name				Efficiency, -							Invest				
DHW distribution				9,7											
Emission															
Name				Efficiency,						Inves					
Karfeen				- 1											
Old building, 3 &		- 1													
Old building, 0, 1		1									0				
New Dhw System Factor on fael cor						_									_
Use Solar Collect	_					⊢									No
Generator eff. a					_	_									150
Name Efficie		liwest	Jan	Feb	Mar	Apr	Me	Ju	m .	lul /	Aug	Sep	Oct	Nov	Dec
Distribution													~ / ~ /		
Name			Efficiency, - Irw											Invest	
Emission															
Name			Efficiency, - Investigation												Inves
New Dhw System Factor on fael cor						_									-
Use Solar Collect						\vdash									N
Generator eff. a		ette e				_									
Name Efficie		Invest	Jan	Feb	Mar	Apr	Me	/ Ju	1	мГ	Aug I	Sep	Oct	Nov	Dec
rante ration	ney, - Falls	mest	ALL	100	mult	Age	Mil	,,,		-	- S	жр	5,61	NOT	Let
			_					or	_						Invest
Distribution Name Emission			_					fficiency						_	anres



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, designand 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
- quarantees simple transfer to all EU Member States



Project Partners



Project Co-ordinators: EBM-Consult (The Netherlands) bpoel@ebm-consult.nl



Ein Unternehmen der Austrian Research Centers.

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Österreichisches Ökologie Institut



SBi (Denmark)

Danish Building Research Institute Aalborg University



CSTB (France)

Centre Scientifique et Technique du Bâtiment



Fraunhofer Institut

Institut Bauphysik

Fraunhofer-IBP (Germany)

Fraunhofer-Institut für Bauphysik



NOA (Greece)

GRoup Energy Conservation (GR.E.C.) Institute for Environmental Research & Sustainable Development (IERSD) National Observatory of Athens



ENEA (Italy)

National Agency for New Technology, Energy and the Environment



TNO (The Netherlands)

Netherlands Organisation for Applied Scientific Research