



IEA - ECBCS Annex 48
Heat Pumping and Reversible Air conditioning



International energy Agency
**Energy Conservation in
Buildings and Community
Systems Programme**

Analysis of building heating and cooling demands in the purpose of assessing the reversibility and heat recovery potentials

ANNEXES

Subtasks 1.1 to 1.3 of subtask 1 :
“Analysis of heating and cooling demands and equipment performances”

Annex 48 of the International Energy Agency
Energy conservation in buildings and Community Systems Programme

March 2009

Author:
Pascal STABAT
Mines ParisTech, France

Operating agents :

Jean LEBRUN, Laboratoire de thermodynamique - Campus du Sart-Tilman B49 (P33) B-4000 Liège
(j.lebrun@ulg.ac.be)

Philippe ANDRE, Département des sciences de l'environnement - Avenue de Longwy, 185 B6700 Arlon
(p.andre@ulg.ac.be)

Subtask leaders :

Dominique MARCHIO, Pascal STABAT, Mines ParisTech, France, 60 boulevard Saint Michel, 75272 Paris Cedex
06 (dominique.marchio@ensmp.fr, pascal.stabat@ensmp.fr)

Preface

What is Annex 48?

Environmental concerns and the recent increase of energy costs open the door to innovative techniques to provide heating and cooling in buildings. Among these techniques, heat pumps represent an area of growing interest. Heat pumping is probably today one of the quickest and safest solutions to save energy and to reduce CO₂ emissions. Substituting a heat pump to a boiler may save more than 50% of primary energy, if electricity is produced by a modern gas-steam power plant and even more if a part of that electricity is produced from a renewable source.

The heat pump market was, till now, concentrated on residential buildings. A growing attention is now given to new and existing non-residential buildings where heating and cooling demands co-exist. In many non-residential buildings, an attractive energy saving opportunity consists in using the refrigeration machine for heat production. This can be done by condenser heat recovery whenever there is some simultaneity between heating and cooling demands. When there is no simultaneity, reversibility has to be looked for.

This is the matter considered in the frame of the International Energy Agency project: IEA-ECBCS Annex 48 "Heat pumping and reversible air conditioning".

What are the main aims of Annex 48 ?

The aim of the project is to promote the most efficient combinations of heating and cooling techniques in air-conditioned buildings, thanks to heat recovery and reversible systems. The main goals are:

- To allow a quick identification of heat pumping potentials in existing buildings;
- To help designers in preserving the future possibilities and in considering "heat pumping" solutions;
- To document the technological possibilities and heat pumping solutions;
- To improve commissioning and operation of buildings equipped with heat pump systems;
- To make available a set of reference case studies.

Which tasks are covered by Annex 48 ?

Five tasks are being performed :

Subtask 1 : Analysis of building heating and cooling demands and of equipment performances.

- Classification and characterization of existing building stock;
- Characterization of existing HVAC systems;
- Evaluation of the potential of heat recovery and heat pumping systems, in order to save energy and reduce CO₂ emissions;
- Development and use of simulation models to identify the heating and cooling demands and the best heat pumping potentials.

Subtask 2 : Design

- Development of a design handbook for heat pump systems.
- Development of innovative design tools addressed to architects, consulting engineers and installers, in such a way to reach a global optimisation of the whole HVAC system.

Subtask 3 : Global performances evaluation and commissioning methods

- Development of evaluation methods devoted to heat pump solutions
- Tests with synthetic data and with measured data
- Development of computer-based tool for heat pump system operation

Subtask 4 : Case studies and demonstration

- Documentation of reference case studies
- Use of case studies to test the methods and tools developed in the annex
- Conversion of most successful case studies into demonstration projects.

Subtask 5: dissemination

- website

- paper work (leaflet, handbooks),
- workshops, seminars and conferences.

How can I get information or participate to Annex 48 ?

To obtain information about the project, to attend to workshops and meetings or to propose a participation, please contact Jean Lebrun (j.lebrun@ulg.ac.be) or Philippe André (p.andre@ulg.ac.be) and visit the Annex 48 project website : www.ecbcs-48.org

Participants:

Université de Liège, Belgique



J. Lebrun
Co-operating Agent
S. Bertagnolio
Laboratoire de
Thermodynamique
Campus du Sart-Tilman B49
(P33)
B-4000 Liège
mail : j.lebrun@ulg.ac.be
stephane.bertagnolio@ulg.ac.be
web : www.labohtap.ulg.ac.be

P. André
Co-operating Agent
Département des sciences de
l'environnement
Avenue de Longwy, 185
B-6700 Arlon
mail : p.andre@ulg.ac.be
web :
<http://www.dsge.ulg.ac.be/arlon/>

CEA - INES, France



D. Corgier, F. Claudon
Co - Leader of Subtask 1
CEA - INES RDI
Laboratoire d'Intégration
Solaire
Savoie Technolac - BP 332
50 Avenue du Lac Léman
F - 73377 Le Bourget du Lac
mail : david.corgier@cea.fr
fabrice.claudon@cea.fr
web : www.cea.fr

Mines ParisTech, France



D. Marchio, P. Stabat
Co - Leaders of Subtask 1
Centre Énergétique et Procédés
-
Mines ParisTech
60 Bd St Michel
F - 75272 Paris Cedex 06
mail :
dominique.marchio@ensmp.fr
pascal.stabat@ensmp.fr
web : www.ccp.ensmp.fr

Greth, France



B. Thonon
Leader of Subtask 5
Greth
Savoie Technolac - BP 302
50 Avenue du Lac Léman
F - 73377 Le Bourget du Lac
mail : bernard.thonon@greth.fr
web : www.greth.fr

Georg-Simon-Ohm- Hochschule Nürnberg, Germany



W. Stephan
Co - Leader of Subtask 2
leg Institut für Energie and
Gebäude
Kesslerplatz 12
D - 90489 Nürnberg
mail : wolfram.stephan@t-online.de

HLK Stuttgart GmbH, Germany



J. Schmid
Co - Leader of Subtask 2
HLK Stuttgart GmbH
Pfaffenwaldring 6A
D - 70569 Stuttgart
mail : joerg.schmid@hlk-stuttgart.de
web : www.hlk-stuttgart.de

TEB GmbH, Germany



M. Madjidi, T. Dippel
Co - Leaders of Subtask 2
Transferzentrum
Energieeffizientes
Bauen GmbH
Kehlstr. 27/1
D - 71665 Vaihingen/Enz
mail : info@madjidi.de
dippel@teb-online.de
web : www.teb-online.de

Politecnico di Torino, Italy



M. Masoero
Leader of Subtask 4
Politecnico di Torino
mail : marco.masoero@polito.it
web : www.polito.it

Table of contents

ANNEX 1 :	TPOLOGY OF AIR-CONDITIONED OFFICE BUILDINGS AND HEALTH CARE INSTITUTIONS	
1	Representative office buildings.....	5
2	Representative health care institutions.....	19
ANNEX 2 :	RESULTS OF HEATING AND COOLING DEMANDS IN OFFICE BUILDINGS.....	37
ANNEX 3 :	RESULTS OF HEATING AND COOLING DEMANDS IN HEATH CARE BUILDINGS	56
ANNEX 4:	ANALYSIS OF HEAT TRANSFER IN FOUR-PIPES FAN COIL UNITS	58
ANNEX 5:	ASSUMPTIONS ON PRESSURE DROPS IN AIR HANDLING UNITS	62
ANNEX 6:	GHG EMISSION FACTORS.....	63
ANNEX 7 :	BUILDING ENERGY CONSUMPTION RESULTS (TABLES)	65
ANNEX 8 :	BUILDING ENERGY CONSUMPTION RESULTS (GRAPHS)	69

ANNEX 1 : TYPOLOGY OF AIR-CONDITIONED OFFICE BUILDINGS AND HEALTH CARE INSTITUTIONS

1 Representative office buildings

1.1 Description of representative types

From plans, and typical descriptions, geometrical characteristics are derived: ratio of outside wall surfaces, ratio of glazed surface... Thus, the air-conditioned office buildings have been classified in three categories according to French stock [FIL 2005]. This typology is proposed to be widened to all European countries.

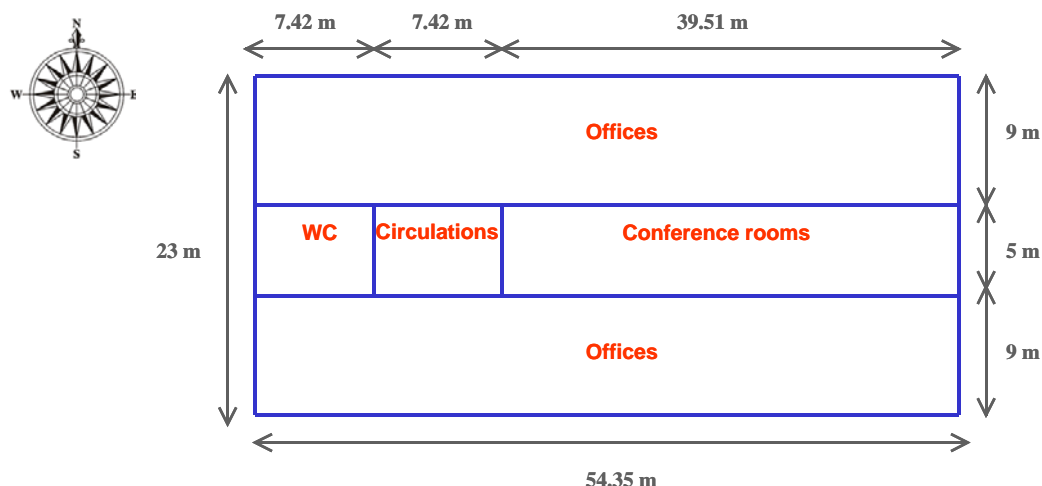
1. The first type corresponds to buildings of huge areas mainly glazed. It is subdivided into three branches listed below with their estimated repartition percentage of total office buildings:
 - Broad open space offices 14%
 - Broad partitioned offices 20%
 - Thin partitioned offices 33%
2. The second type concerns the buildings subjected to renovation. The surface area of this type is medium and this type is less glazed than the first one 8%
3. The third type concerns the small buildings existing in the industrial suburban zones 25%

Table 1 : Typology of air-conditioned office buildings

share per type		Share of surface in %
TYPE 1-a	Broad open space offices, blind meeting room - 15 000 m ²	14%
TYPE 1-b	Same as TYPE 1-a but broad partitioned offices	20%
TYPE 1-c	Idem TYPE 1-b but Thin geometry - glazed meeting room	33%
TYPE 2	Retrofitted buildings, partitioned offices, heavy inertia - 5000 m ²	8%
TYPE 3	Small buildings of industrial suburban zones - 1000 m ²	25%

1.2 Geometrical description

1.2.1 Type 1a



Building Type 1a has 12 identical floors of 3 m height each.

Table 2 : Repartition of UTH by use

UTH ¹	Usage	Surface area of one floor	Surface area of 12 floors	Percentage of total	Volume
1	WC	37.0	444.6	3	1 333.8
2	offices	489.1	5869.8	78.3	17 609.4
3	offices	489.1	5869.8		17 609.4
4	meeting rooms	197.6	2371.2	15.8	7 113.6
5	circulations	37.0	444.6	3	1 333.8
Total		1250	15 000	100	45 000

Table 3 : Outside surface area for one floor

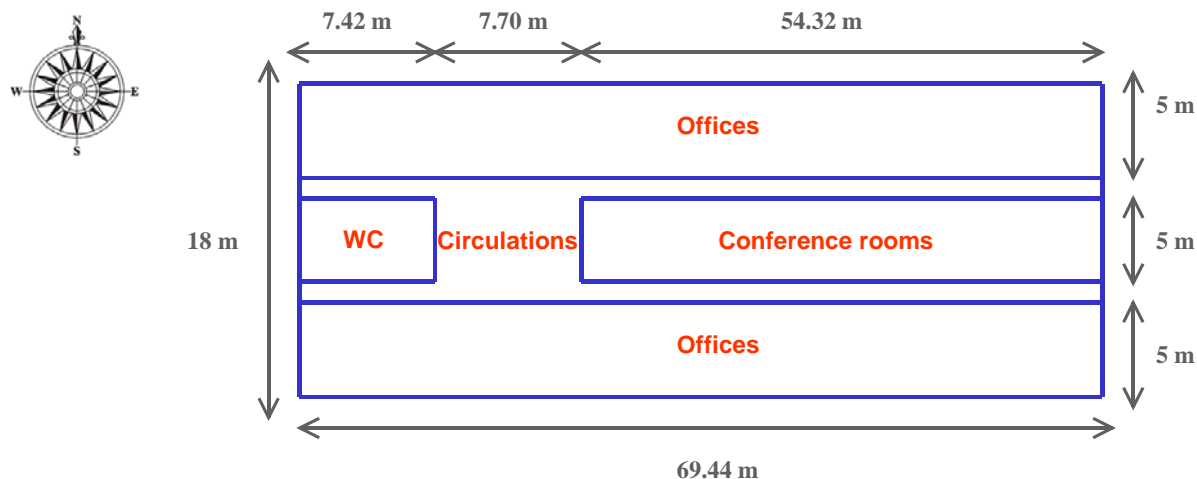
Room height m		Outside surfaces for one floor									
Surface area m ² 15000		Ceiling	Vertical (opaque and glazed)				Glazed surface				
Usage	UTH		N	S	E	W	N	S	E	W	
WC	1	37.1	0	0	0	15	0	0	0	0	
offices	2	489.1	163.0	0	27	27	81.5	0	0	0	
offices	3	489.1	0	163.0	27	27	0	81.5	0	0	
meeting rooms	4	197.6	0	0	15	0	0	0	0	0	
circulations	5	37.1	0	0	0	0	0	0	0	0	

Table 4 : Total outside surface area

Room height m		Outside surfaces for the building								
Surface area m ² 15000		roof	Vertical (opaque and glazed)				Total	Total	Total	
Usage	UTH		N	S	E	W	Vertical		glazed	
WC	1	37.1	0	0	0	180	180	217.1	0	
offices	2	489.2	1956.6	0	324	324	2604.6	3093.8	978.3	
offices	3	489.2	0	1956.6	324	324	2604.6	3093.8	978.3	
meeting rooms	4	197.6	0	0	180	0	180	377.6	0	
circulations	5	37.1	0	0	0	0	0	37.1	0	
total m ²		1250					5569.2	6819.2	1956.6	
Ratio (with respect to useful total surface area)							0.37	0.45	0.13	

¹ UTH : Homogeneous thermal zone

1.2.2 Type 1b



Building Type 1b has 12 identical floors.

Table 5 : Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 12 floors	Percentage of total	Volume
1	WC	37.1	445.2	3.0	1 335.6
2	offices	347.2	4166.4	55.6	12 499.2
3	offices	347.2	4166.4		12 499.2
4	meeting rooms	271.6	3259.2	21.7	9 777.6
5	circulations	246.9	2962.8	19.7	8 885.5
Total		1249.9	14 999	100	44 997.1

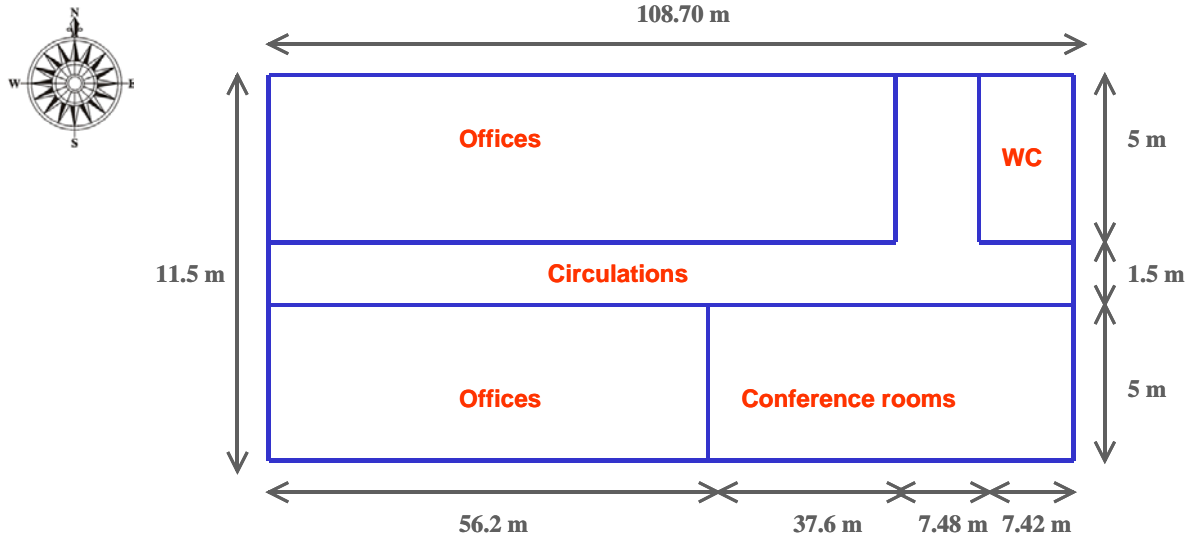
Table 6: Outside surface area for one floor

Room height m		Outside surfaces for one floor								
Surface area m ² 15000		Ceiling	Vertical (opaque and glazed)				Glazed surface			
Usage	UTH		N	S	E	W	N	S	E	W
WC	1	37.1	0	0	0	15	0	0	0	0
offices	2	347.2	208.3	0	15	15	104.2	0	0	0
offices	3	347.2	0	208.3	15	15	0	104.2	0	0
meeting rooms	4	271.6	0	0	15	0	0	0	0	0
circulations	5	246.9	0	0	9	9	0	0	0	0

Table 7 : Total outside surface area

Room height m		Outside surfaces for the building							
Surface area m ² 15000		roof	Vertical (opaque and glazed)				Total	Total	Total
Usage	UTH		N	S	E	W	Vertical		glazed
WC	1	37.1	0	0	0	180	180	217.1	0
offices	2	347.2	2499.6	0	180	180	2859.6	3206.8	1 250
offices	3	347.2	0	2499.6	180	180	2859.6	3206.8	1 250
meeting rooms	4	271.6	0	0	180	0	180	451.6	0
circulations	5	246.9	0	0	108	108	216	462.8	0
total m ²		1 250					6 295.2	7 545.1	2 500
Ratio (with respect to useful total surface area)							0.42	0.50	0.17

1.2.3 Type 1c



Building Type 1c has 12 identical floors.

Table 8 : Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 12 floors	Percentage of total	Volume
1	WC	37.0	444.6	3	1333.8
2	offices	281	3372	60	10 116
3	offices	469	5628		16 884
4	meeting rooms	262.5	3150	21	9450
5	circulations	200.5	2405.4	16	7216.2
Total		1250	15 000	100	45 000

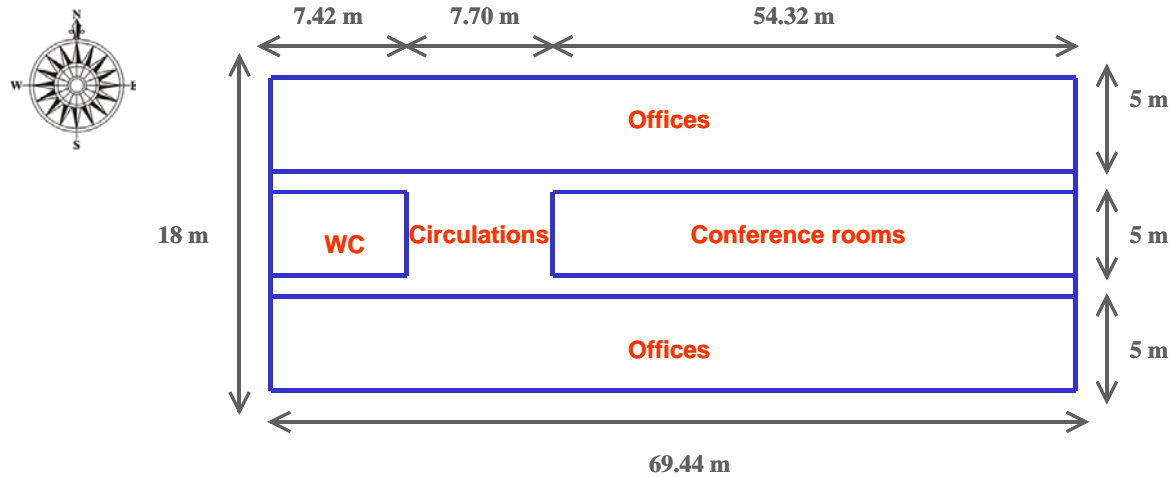
Table 9: Outside surface area for one floor

Room height m		3		Outside surfaces for one floor								
Surface area m ²		15000		Ceiling	Vertical (opaque and glazed)				Glazed surface			
Usage	UTH	N	S		E	W	N	S	E	W		
WC	1	37.1	22.3	0	15	0	11.1	0	0	0		
offices	2	281	0	168.6	0	15	0	84.3	0	0		
offices	3	469	281.4	0	0	15	140.7	0	0	0		
meeting rooms	4	262.5	0	157.5	15	0	0	78.8	0	0		
circulations	5	200.5	22.4	0	4.5	4.5	11.2	0	0	0		

Table 10 : Total outside surface area

Room height m		3		Outside surfaces for the building							
Surface area m ²		15000		roof	Vertical (opaque and glazed)				Total	Total	Total
Usage	UTH	N	S		E	W	Vertical		glazed		
WC	1	37.1	267.1	0.0	180	0	447.1	484.2	133.6		
offices	2	281	0.0	2023.2	0	180	2203.2	2484.2	1011.6		
offices	3	469	3376.8	0.0	0	180	3556.8	4025.8	1688.4		
meeting rooms	4	262.5	0.0	1890.0	180	0	2070.0	2332.5	945		
circulations	5	200.5	269.3	0.0	54	54	377.3	577.7	134.6		
total m ²		1250					8654.4	9904.5	3913.2		
Ratio (with respect to useful total surface area)							0.58	0.66	0.26		

1.2.4 Type 2



Building Type 2 has 4 identical floors.

Table 11 : Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 4 floors	Percentage of total	Volume
1	WC	37.1	148.4	3	445.2
2	offices	347.2	1388.8	56	4166.4
3	offices	347.2	1388.8		4166.4
4	meeting rooms	271.6	1086.4	22	3259.2
5	circulations	246.8	987.3	20	2961.8
Total		1250	5000	100	14997

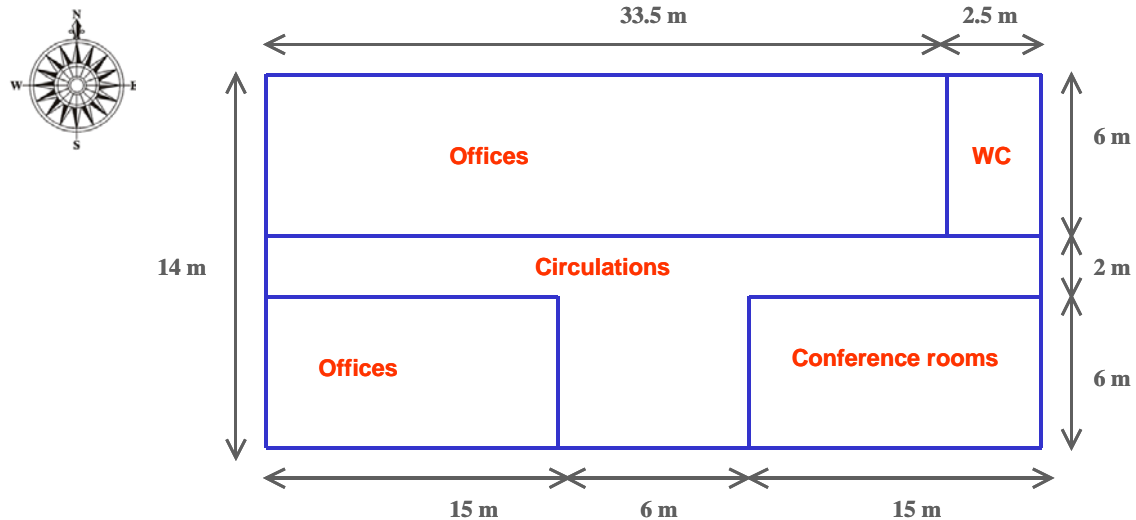
Table 12: Outside surface area for one floor

Room height m		Outside surfaces for one floor									
Surface area m ²		Ceiling	Vertical (opaque and glazed)				Glazed surface				
Usage	UTH		N	S	E	W	N	S	E	W	
WC	1	37.1	0	0	0	15	0	0	0	0	
offices	2	347.2	208.3	0	15	15	57	0	0	0	
offices	3	347.2	0	208.3	15	15	0	57	0	0	
meeting rooms	4	271.6	0	0	15	0	0	0	0	0	
circulations	5	246.8	0.0	0	9	9	0	0	0	0	

Table 13 : Total outside surface area

Room height m		Outside surfaces for the building								
Surface area m ²		roof	Vertical (opaque and glazed)				Total	Total	Total	
Usage	UTH		N	S	E	W	Vertical		glazed	
WC	1	37.1	0	0	0	60	60	97.1	0	
offices	2	347.2	833.3	0	60	60	953.3	1300.5	229.2	
offices	3	347.2	0	833.3	60	60	953.3	1300.5	229.2	
meeting rooms	4	271.6	0	0	60	0	60	331.6	0	
circulations	5	246.8	0	0	36	36	72	318.8	0	
total m ²		1250					2098.6	3348.5	458.3	
Ratio (with respect to useful total surface area)							0.42	0.67	0.09	

1.2.5 Type 3



Building Type 3 has 2 identical floors.

Table 14 : Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 2 floors	Percentage of total	Volume
1	WC	15	30	3	81.0
2	offices	90	180	58	486.0
3	offices	201	402		1085.4
4	meeting rooms	90	180	18	486.0
5	circulations	108	216	21	583.2
Total		504	1008	100	2721,6

Table 15: Outside surface area for one floor

Room height m 2.7		Outside surfaces for one floor									
Surface area m ² 1000		Ceiling	Vertical (opaque and glazed)				Glazed surface				
Usage	UTH		N	S	E	W	N	S	E	W	
WC	1	15	6.8	0	16.2	0	3.8	0	0	0	
offices	2	90	0	40.5	0	16.2	0	22.5	0	0	
offices	3	201	90.5	0	0	16.2	50.3	0	0	0	
meeting rooms	4	90	0	40.5	16.2	0	0	22.5	0	0	
circulations	5	108	0	16.2	5.4	5.4	0	9.0	0	0	

Table 16 : Total outside surface area

Room height m 2.7		Outside surfaces for the building								
Surface area m ² 1000		roof	Vertical (opaque and glazed)				Total	Total	Total	
Usage	UTH		N	S	E	W	Vertical		glazed	
WC	1	15	14	0	32	0	46	60.9	7.5	
offices	2	90	0	81	0	32	113.4	203.4	45.0	
offices	3	201	181	0	0	32	213.3	414.3	100.5	
meeting rooms	4	90	0	81	32	0	113	203.4	45.0	
circulations	5	108	0	32	11	11	54	162.0	18.0	
total m ²		504					540	1044	216	
Ratio (with respect to useful total surface area)							0.54	1.04	0.21	

1.2.6 Summary of the geometrical characteristics

Table 17: General characteristics of the considered types

Building type	1a	1b	1c	2	3
Total surface area	15000 m ²			5000 m ²	1000 m ²
Height under ceiling	3 m			2.7m	
Orientation	North/South or East/West				
Ratio of surface area by type of use (with respect to useful total surface area)					
Offices	0.78	0.55	0.6	0.55	0.58
Meeting rooms	0.16	0.22	0.21	0.22	0.18
WC	0.03	0.03	0.03	0.03	0.03
Circulations	0.03	0.2	0.16	0.20	0.21
Ratio of outside walls surface area (with respect to useful total surface area)					
Total	0.45	0.50	0.66	0.67	1.04
Vertical walls (opaque and glazed)	0.37	0.42	0.58	0.42	0.54
Roof	0.08	0.08	0.08	0.25	0.5
Glazed surfaces (vertical)	0.13	0.17	0.26	0.09	0.21
	50% of vertical surfaces with window (N/S or E/W)			27.5% of vertical surfaces with window (N/S or E/W)	34% of vertical surfaces with window (N/S or E/W)

1.3 Building envelope characteristics

1.3.1 Thermal insulation

Two levels of overall thermal transfer coefficients U are given in order to account for climate zone differences :

Table 18 :Values of U in W/m²K

	Values in W/m ² .K	Description
wall	0.8	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.024m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)
	0.6	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.036m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)
window	3	Double glazing of 4mm width for each glazing and 8mm air space.
	2	Double glazing of 4mm width for each glazing and 12mm air space, with reflective coating (effective emittance of 0.2).
roof	0.4	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.06m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)
	0.3	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.085m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)

For the sake of simplicity, no thermal bridge is considered. These losses are balanced by the choice of a quite high U_{wall}. The heat losses by the ground are neglected.

1.3.2 Thermal inertia

The thermal inertia of type 1 buildings is considered as low and the thermal inertia of type 2 and 3 buildings is considered as medium.

Table 19 :Inertia of buildings

Building type	1a	1b	1c	2	3
Total surface area	15000 m ²			5000 m ²	1000 m ²
Height under ceiling	3 m				2.7m
Thermal inertia	low			medium	medium
Surface of each wall (m²)²					
Outside Wall	3612	3795	4741	1640	324
Windows	1956	2500	3913	458	216
Intermediate floors and ceiling	28750	28750	28750	8750	
Floor and ceiling (heavy)					1512
Roof	1250	1250	1250	1250	504
Inner walls	6000	8000	12000		713
Inner walls (heavy)				4500	
Daily thermal inertia according to Standard EN ISO 13786³					
C _m (kJ/m ² /K)	~130			215	190
A _m (-)	~2.6			2.7	3.2

Table 20 :Wall description

	composition	C _m (kJ/m ² /K)
Outside Wall	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.024m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)	30
Windows	Double glazing of 4mm width for each glazing and 8mm air space.	7

² detailed description of walls is given in Table 20

³ The daily inertia of furniture is taken into account by adding a fixed thermal capacity value of 20 kJ/m²/K

Floor & ceiling	Cement 0.1m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$)	93
Floor & ceiling (heavy)	Cement 0.15m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$)	126
Roof	Outside layer : Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$) insulating material 0.06m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029 \text{ W/(m.K)}$, $c_p= 1220 \text{ J/(kg.K)}$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72 \text{ W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)	25
Inner walls	plaster 0.02m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72 \text{ W/(m.K)}$, $c_p= 840 \text{ J/(kg.K)}$)	16
Inner walls (heavy)	Cement 0.1m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W/(m.K)}$, $c_p= 1000 \text{ J/(kg.K)}$)	93

1.3.3 Solar heat gain

	Solar heat gain coefficient without solar protection	Light transmission ratio without solar protection	Solar heat gain coefficient with solar protection	Light transmission ratio with solar protection
Wall	0.01	-	-	-
Windows	0.6	0.6	0.2	0.2
Roof	0.015	-	-	-

1.3.4 Infiltration

The air permeability of the building under 4 Pa is fixed to $1.7 \times$ (heat loss surface: outside walls and roof) / (surface area)

Building type	1a	1b	1c	2	3
Air permeability ($\text{m}^3/\text{h}/\text{m}^2$)	0.77	0.86	1.12	1.14	1.77

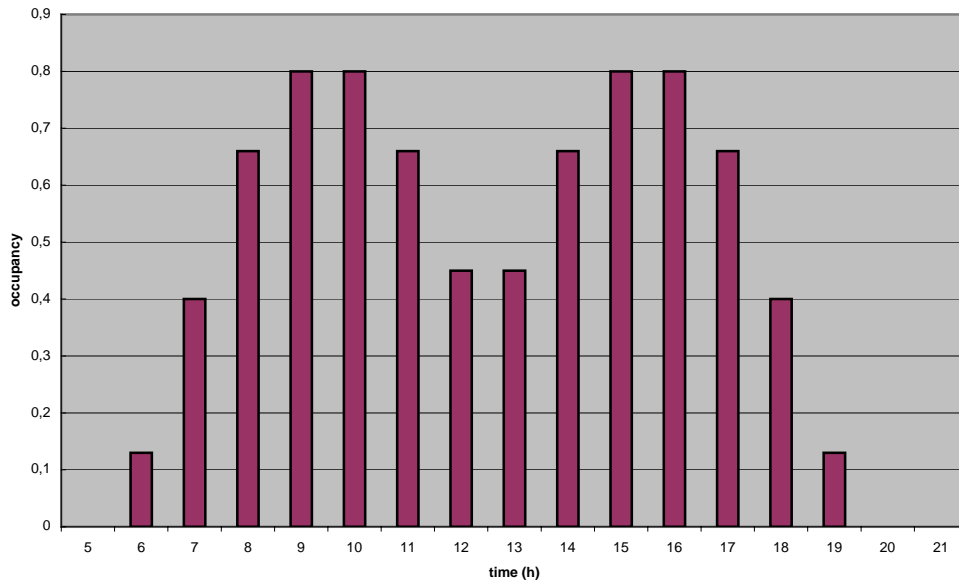
1.4 Internal heat sources

1.4.1 People and electrical devices

The sizing of the offices is defined as one person per 12 m². The sensible heat released by each person is supposed to be 105W and the moisture release is 0.09kg/h. The heat released by the appliances is sized to 15W/m². The appliances are essentially computer equipment. In the use of the building, one assumes that at maximum, the offices are occupied at 80% of the sizing values and the same for the appliance loads.

The occupancy profile is defined as follows :

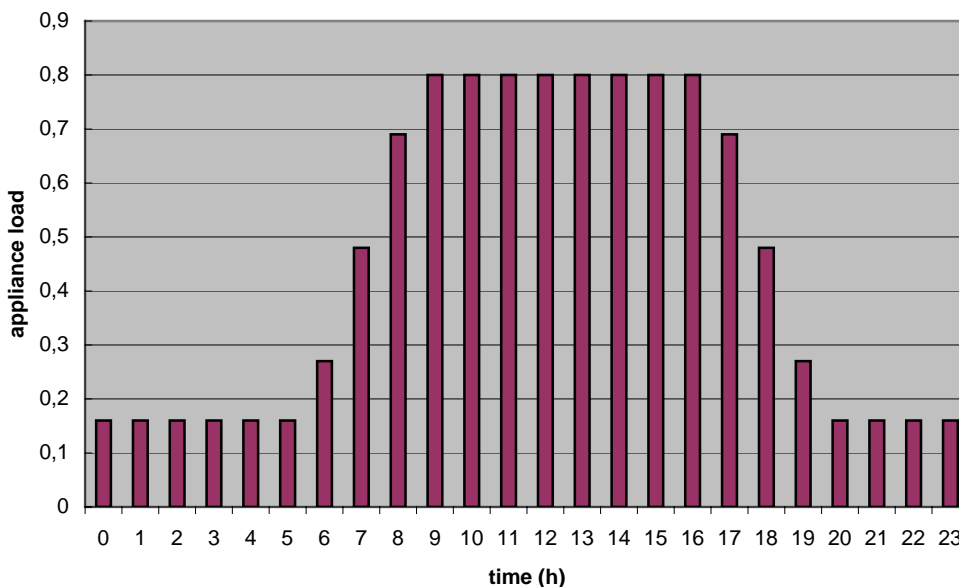
Figure 1 : Occupancy profile in the offices compared to the sizing value



No consideration about holiday and bank holiday is taken into account.

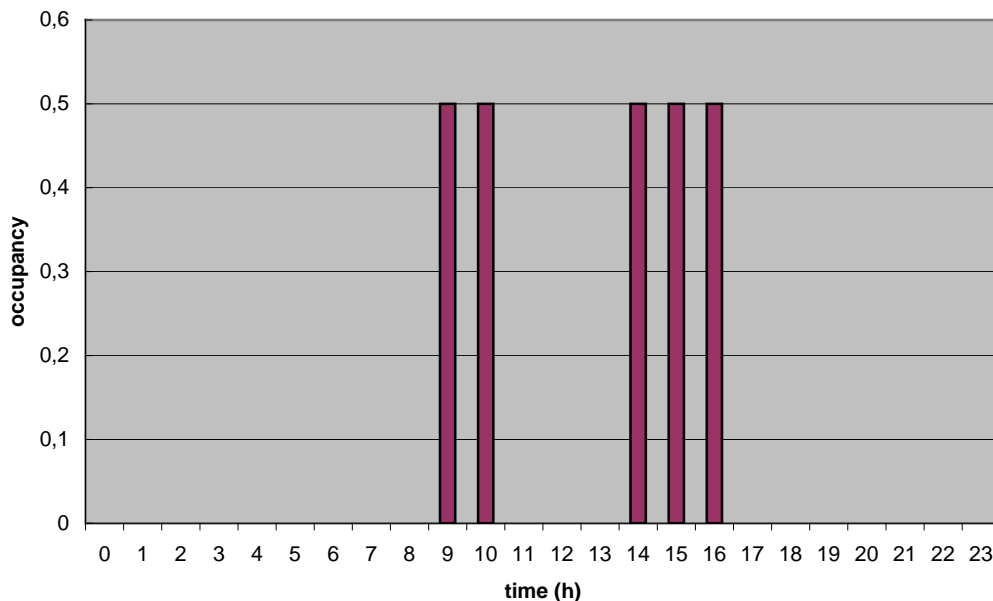
The appliance load profile is defined as follows :

Figure 2 : Appliance profile in the offices compared to the sizing value



The conference rooms are sized for one person per 3.5m². One assumes there is no electrical device in the conference rooms at the exception of lighting. The occupancy profile of conference room are defined as follows :

Figure 3 : Occupancy profile in the conference rooms compared to the sizing value



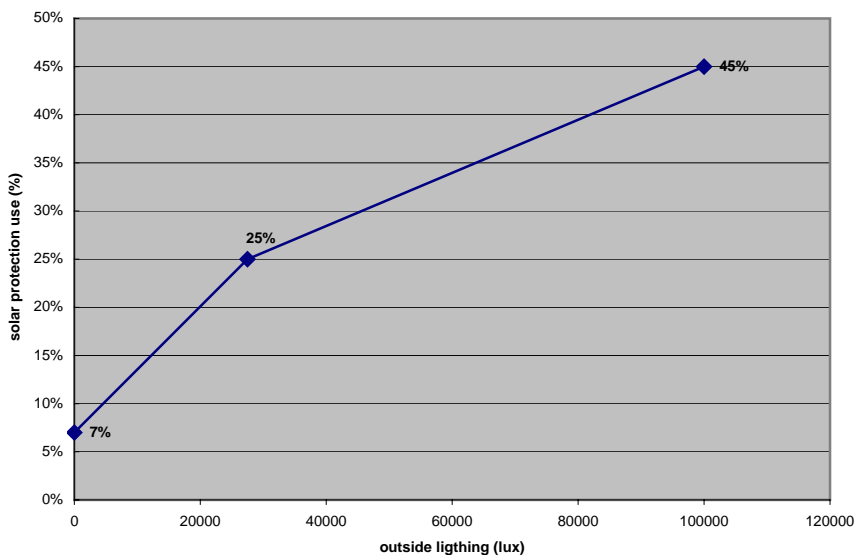
No occupation is considered in toilets and circulations.

1.4.2 Solar protection and lighting

The lighting power is assessed to 18W/m² in offices and conference rooms, 12W/m² in the circulations and 6W/m² in the toilets.

The artificial lighting is dependent on the natural lighting and so on the solar protection use. A study [ALE 2006] as shown that the use of solar protection can be described as :

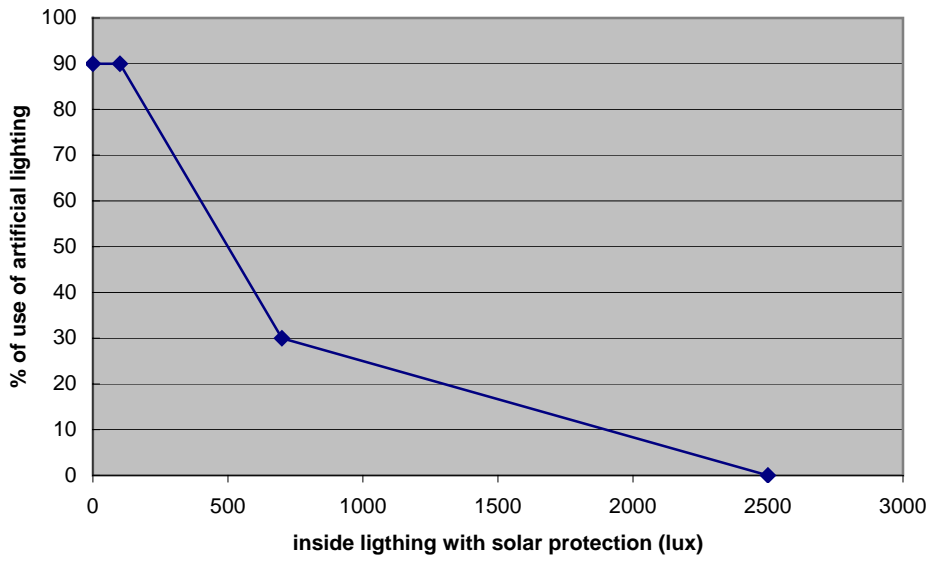
Figure 4 : Average use of solar protection



The position of solar protections during non occupancy is defined as equal to those in the last hour of occupancy.

A study [ALE 2006] as shown that the use of artificial lighting can be described as :

Figure 5 : Average use of artificial lighting



The artificial lighting is supposed switch off during non occupancy.

1.4.3 Ventilation and set point temperatures

Ventilation rate	25 m ³ /h/person in offices 30 m ³ /h/person in conference room 6h-20h during week - Stopped during weekend
Set point temperatures	21°C - 24°C inoccupation heating temperature : 15°C heating from 6h to 20h except Saturday and Sunday Air conditioning stopped during non occupation period

1.4.4 Summary of internal sources and ventilation

UTH	Number of occupants	Outside air supply (m ³ /h)	Exhaust air (m ³ /h)	AHU (m ³ /h)	Lighting (W)	Internal Gains (W)
Office building - Type 1a						
1	0		3000 constant		2670	0
2	489	12 225			105 650	88 000
3	489	12 225			105 650	88 000
4	677	20 310		20 310	42 700	0
5	0		21 450		5340	0
Office building - Type 1b						
1	0		3000 constant		2670	0
2	347	8675			75 000	62 500
3	347	8675			75 000	62 500
4	931	27 930		27 930	58 700	0
5	0		14 350		35 550	0
Office building - Type 1c						
1	0		3000 constant		2670	0
2	281	7025			60 700	50 600
3	469	11 725			101 300	84 400
4	900	27 000		27 000	56 700	0
5	0		15 750		28 850	0
Office building - Type 2						
1	0		1000 constant		890	0
2	116	2900			25 000	20 800
3	116	2900			25 000	20 800
4	310	9 300		9 300	19 550	0
5	0		4800		11 850	0
Office building - Type 3						
1	0		200 constant		180	0
2	15	375			3240	2700
3	33	825			7236	6030
4	51	1530		1530	3240	0
5	0		1000		2592	0

1.5 Building/HVAC System

Reversible heat pump can be associated to fan coils units (FCU) or variable and constant air volume system (VAV and CAV). Some systems are rarely implemented in some types of buildings. The following matrix illustrates how to match system with buildings. It is possible that this table should be inadequate in some countries.

Table 21: HVAC system type matched to building type

	FCU	VAV	CAV	VRF	Reversible multi SPLIT	HP
Office type 1a	✓	✓	✓			
Office type 1b	✓	✓				
Office type 1c	✓	✓				
Office type 2	✓			✓		✓
Office type 3	✓			✓	✓	✓

2 Representative health care institutions

2.1 Description of representative types

In France, there are 4203 health care buildings which represents 465 494 beds (for stay longer than 24h) and 48019 places (for stay shorter than 24h) [FIL 2006]. Thus, the air-conditioned health care buildings have been classified in two categories according to French stock [FIL 2006]. This typology is proposed to be widened to all European countries.

Two characteristic health care buildings have been chosen based on French stock:

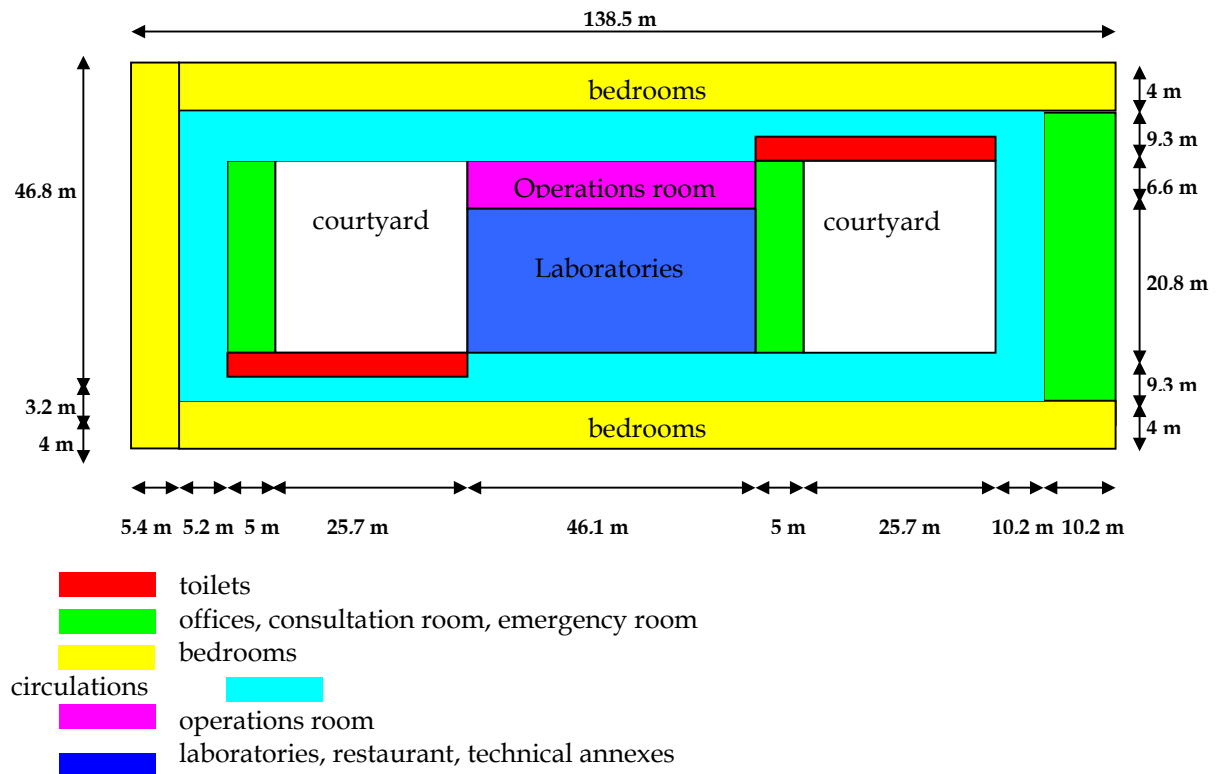
1. The first type corresponds to a large hospital with a surface of 30 353 m². 40%
2. The second type concerns the rest homes (care institutions including retirement homes,) with a surface of 3900 m² 60%

2.2 Geometrical description

2.2.1 TYPE 1 -Large compact hospital

surface = 30 353 m², 300 beds

Figure 6 : health care building type 1 - Hospital



The building has 5 identical floors of 3 m height each. The building of 30 353 m² total surface is split in:

Table 22: Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 5 floors	% of total	Volume
1	offices, consultation rooms, emergency rooms	469,2	2346	12.2	7038
1'		274	1370		4110
2	Laboratories, restaurants, technical annexes	958.9	4794.4	15.8	14382.2
3	Operation room	304.3	1521.3	5.0	4563.9
4	bedrooms	532.4	2662	22.3	7986
5	bedrooms	532.4	2662		7986
6	bedrooms	291.6	1458		4374
7	Circulations	2333.4	11666.8	38.4	35000.4
8	toilets	187.3	936.3	6.2	2809
8'		187.3	936.3		2809
Total		6070,6	30 353	100	91059.6

Table 23: Outside surface area for one floor

Room height m		Outside surfaces for one floor									
Surface area m ²		Ceiling	Architectural projection	Vertical (opaque and glazed)				Glazed surface			
Usage	UTH			N	S	E	W	N	S	E	W
Offices, cons., emerg.	1	469,2	No	0	0	138	0	0	0	38	0
	1'	274	Yes	0	0	164,4	0	0	0	45	0
Labo., rest.,	2	958,9	Yes	0,0	0	0	62,4	0	0	0	17
Operation room	3	304,3	Yes	0	0,0	0	19,8	0	0	0	0
Bedrooms	4	532.4	No	399	0	12	0	110	0	3	0
Bedrooms	5	532.4	No	0	399,3	12	0	0	110	3	0
Bedrooms	6	291.6	No	16	16,2	0	162	4	4	0	45
Circulations	7	2333,4	Yes	77	77,1	0	82,2	21	21	0	23
Toilets	8	187.3	Yes	77	0	0	0	21	0	0	0
	8'	187.3	Yes	0	77,1	0	0	0	21	0	0

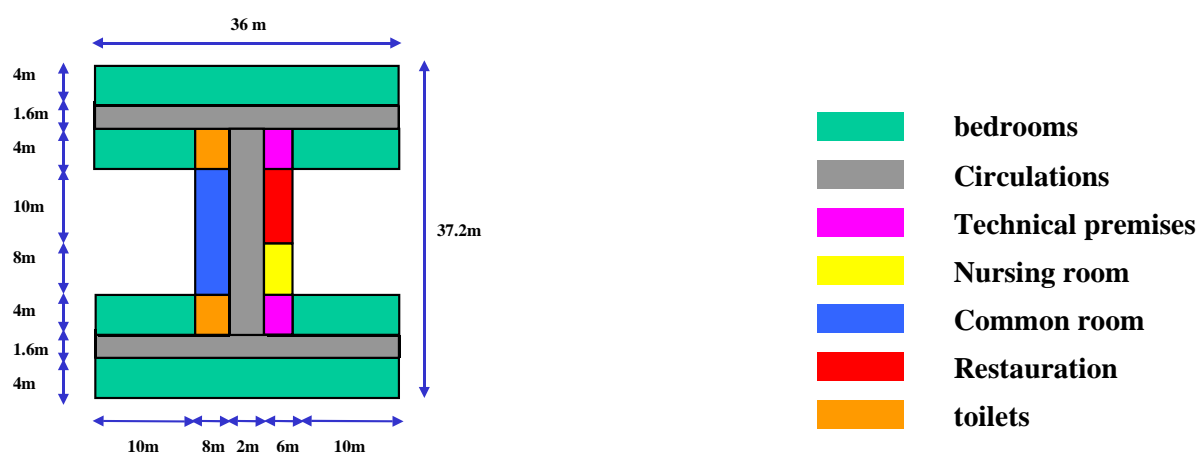
The glazing represents 27.5% of the vertical surfaces for all outside walls except for those of operation rooms where there is no window. The far shading due to architectural projection in the courtyard is taken into account.

Table 24: Total outside surface area

Room height m		3		Outside surfaces for the building							
Surface area m ²		30 353		roof	Vertical (opaque and glazed)				Total	Total	Total
Usage	UTH			N	S	E	W	Vertical		glazed	
Offices, cons., emerg.	1	469.2		0	0	690	0	1512	2255,2	190	
	1'	274		0	0	822	0				
Labo., rest.,	2	958,9		0	0	0	312	312	1270,9	86	
Operation room	3	304,3		0	0	0	99	99	403,3	0	
Bedrooms	4	532.4	1997	0	60	0	0	2057	2610,5	566	
Bedrooms	5	532.4	0	1997	60	0	0	2057	2610,5	566	
Bedrooms	6	291.6	81	81	0	810	0	972	1220,4	267	
Circulations	7	2333,4	386	386	0	411	0	1182	3515,4	325	
Toilets	8	187.3	386	0	0	0	0	771	1145,5	106	
	8'	187.3	0	386	0	0	0				
total m ²		6070,6						8961,0	15031,6	2437.1	
Ratio (with respect to useful total surface area)								0,30	0,50	0,08	

2.2.2 TYPE 2 – Rest homes
surface ≈ 3 900 m², 90 beds

Figure 7 : Health care building type 2 – Rest home



The building has four identical floors. The room height is equal to 3 meters. The number of bed is about 90. The building of 3917 m² total surface is split in:

Table 25: Repartition of UTH by use

UTH	Usage	Surface area of one floor	Surface area of 4 floors	% of total	Volume
1	bedrooms	144	576	22,9	1728
1'		40	160		480
1''		40	160		480
2	bedrooms	144	576	22,9	1728
2'		40	160		480
2''		40	160		480
3	Common room	144	576	14,7	1728
4	restaurant	60	240	6,1	720
5	Nursing room	48	192	4,9	576
6	circulations	167,2	668,8	17,1	2006,4
7	toilets	64	256	6,5	768
8	Technical premises	48	192	4,9	576
Total		979,2	3917	100	11750,4

Table 26: Outside surface area for one floor

Room height m		3		Outside surfaces for one floor									
Surface area m ²		3 917		Ceiling	Architectural projection	Vertical (opaque and glazed)				Glazed surface			
Usage	UTH	N	S			E	W	N	S	E	W		
bedrooms	1	144	No	0	108	12	12	0	32	0	0		
	1'	40	Yes	0	30	0	12	0	9	0	0		
	1''	40	Yes	0	30	12	0	0	9	0	0		
bedrooms	2	144	No	108	0	12	12	32	0	0	0		
	2'	40	Yes	30	0	0	12	9	0	0	0		
	2''	40	Yes	30	0	12	0	9	0	0	0		
Common room	3	144	Yes	0	0	0	54	0	0	0	16		
restaurant	4	60	Yes	0	0	30	0	0	0	9	0		
Nursing room	5	48	Yes	0	0	24	0	0	0	7	0		
circulations	6	167,2	No	0	0	9,6	9,6	0	0	3	3		
Toilets	7	64	No	0	0	0	0	0	0	0	0		
Technical premises	8	48	No	0	0	0	0	0	0	0	0		

The glazing represents 30% of the main vertical surfaces. The far shading due to architectural projections is taken into account.

Table 27: Total outside surface area

Room height m		3		Outside surfaces for the building							
Surface area m ²		3 917		roof	Vertical (opaque and glazed)				Total	Total	Total
Usage	UTH	N	S		E	W	Vertical		glazed		
bedrooms	1	144	0	432	48	48	528	672,0	130		
	1'	40	0	120	0	48	168	208,0	36		
	1''	40	0	120	48	0	168	208,0	36		
bedrooms	2	144	432	0	48	48	528	672,0	130		
	2'	40	120	0	0	48	168	208,0	36		
	2''	40	120	0	48	0	168	208,0	36		
Common room	3	144	0	0	0	216	216	360,0	65		
restaurant	4	60	0	0	120	0	120	180,0	36		
Nursing room	5	48	0	0	96	0	96	144,0	29		
circulations	6	167,2	0	0	38	38	77	244,0	23		
Toilets	7	64	0	0	0	0	0	64,0	0		
Technical premises	8	48	0	0	0	0	0	48,0	0		
total m ²		979,2					2236,8	3216,0	557		
Ratio (with respect to useful total surface area)						0,57	0,82	0,14			

2.3 Building envelope characteristics

2.3.1 Thermal insulation

Two levels of overall thermal transfer coefficients U are given in order to account for differences between climate zones :

Table 28 : Values of U in W/m²K

	Values in W/m ² .K	Description
wall	0.6	Outside layer : insulating material 0.036m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)
	0.4	Outside layer : insulating material 0.06m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)
window	3	Double glazing of 4mm width for each glazing and 8mm air space.
	2	Double glazing of 4mm width for each glazing and 12mm air space, with reflective coating (effective emittance of 0.2).
roof	0.3	Outside layer : insulating material 0.085m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)
	0.2	Outside layer : insulating material 0.13m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)

For the sake of simplicity, no thermal bridge is considered. These losses are balanced by the choice of a quite high U_{wall} .

2.3.2 Thermal inertia

The thermal inertia of type 1 is considered as high and the thermal inertia of type 2 is considered as medium.

Table 29 :Inertia of buildings

Building type	1	2
Total surface area	30 353m ²	3917 m ²
Height under ceiling	3 m	3 m
Thermal inertia	high	medium
Surface of each wall (m²)		
Outside Wall	6524	1609
Windows	2437,1	627,8
Floors & ceilings (heavy)	54635	
Floors ceilings (light)		6854
Roof	6070	979,2
Inner walls (light)		3400
Inner walls (heavy)	14000	
Daily thermal inertia according to Standard EN ISO 13786⁴		
Cm (kJ/m ² /K)	270	240
Am (-)	2.5	2.3

⁴ The daily inertia of furniture is taken into account by adding a fixed thermal capacity value of 20 kJ/m²/K

Table 30 :Wall description

	composition	Cm (kJ/m ² /K)
Outside Wall	Outside layer : insulating material 0.036m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)	137
Windows	Double glazing of 4mm width for each glazing and 12mm air space, with reflective coating (effective emittance of 0.2).	10
Floor (heavy)	Cement 0.20m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$)	140
Floor (light)	Cement 0.10m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$)	93
Roof	Outside layer : insulating material 0.085m ($\rho=56 \text{ kg/m}^3$, $\lambda=0.029\text{W}/(\text{m.K})$, $c_p= 1220 \text{ J}/(\text{kg.K})$) Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$) Inside layer: plaster 0.012m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)	136
Inner walls (light)	plaster 0.04m ($\rho=1860 \text{ kg/m}^3$, $\lambda=0.72\text{W}/(\text{m.K})$, $c_p= 840 \text{ J}/(\text{kg.K})$)	32
Inner walls (heavy)	Cement 0.13m ($\rho=1900 \text{ kg/m}^3$, $\lambda=0.58 \text{ W}/(\text{m.K})$, $c_p= 1000 \text{ J}/(\text{kg.K})$)	115

2.3.3 Solar heat gain

	Solar heat gain coefficient without solar protection	Light transmission ratio without solar protection	Solar heat gain coefficient with solar protection	Light transmission ratio with solar protection
Wall	0.01	-	-	-
Windows	0.6	0.6	0.2	0.2
Roof	0.015	-	-	-

Architectural projections are included.

2.3.4 Infiltration

The air permeability of the building under 4 Pa is fixed to 1.2

Building type	1	2
Air permeability (m ³ /h/m ²)	1.2	1.2

2.4 Internal heat sources

2.4.1 Occupation profiles and internal gains - Type 1

Offices, consultation and emergency rooms

The occupation rate in these rooms is set to 1 person per 26 m² with the following assumptions of 0.47person/bed. The internal gains are set to 7.5 W/m².

One assumes that the offices are occupied to 80% at maximum and the internal gains are at maximum 80% of sizing value.

Figure 8 and Figure 9 show the occupation profiles and internal gains (every day of the week).

Figure 8: Occupation profile in the offices, consultation and emergency rooms compared to maximum

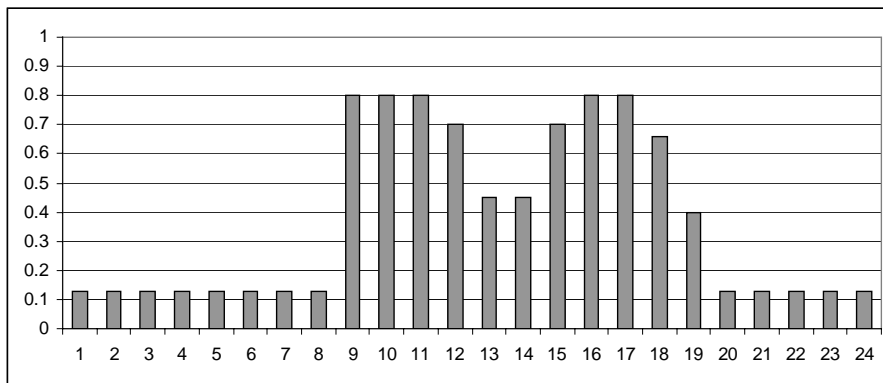
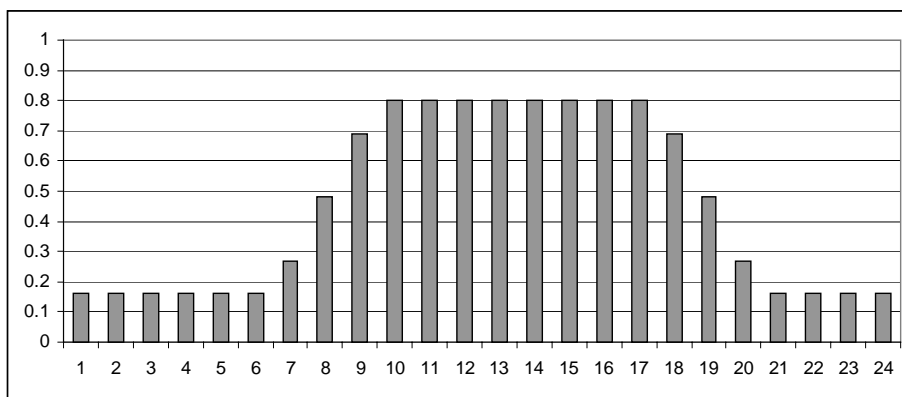


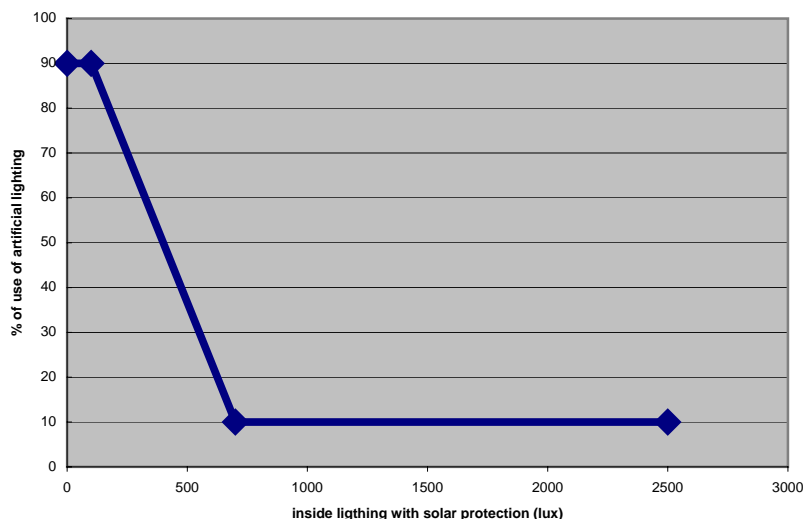
Figure 9: Internal gain profile in the offices, consultation and emergency rooms compared to maximum



The lighting power is sized to 10 W/m².

The solar protection and artificial lighting uses are similar to those of office buildings (2.4.2) with the following use of artificial lighting in function of natural lighting:

Figure 10: Use of artificial lighting (with dimmer and without presence detector)

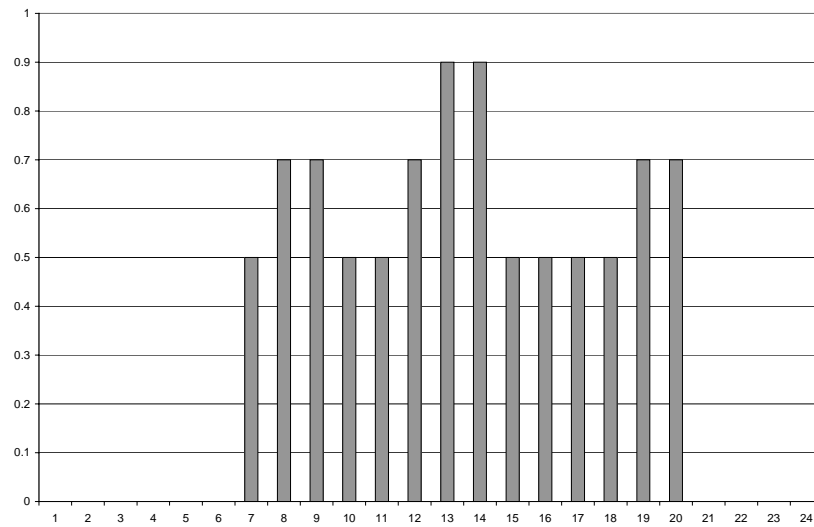


The ventilation flow rate is 25 m³/h per person with 1 person per 26 m².

Laboratories, restaurant, technical annexes

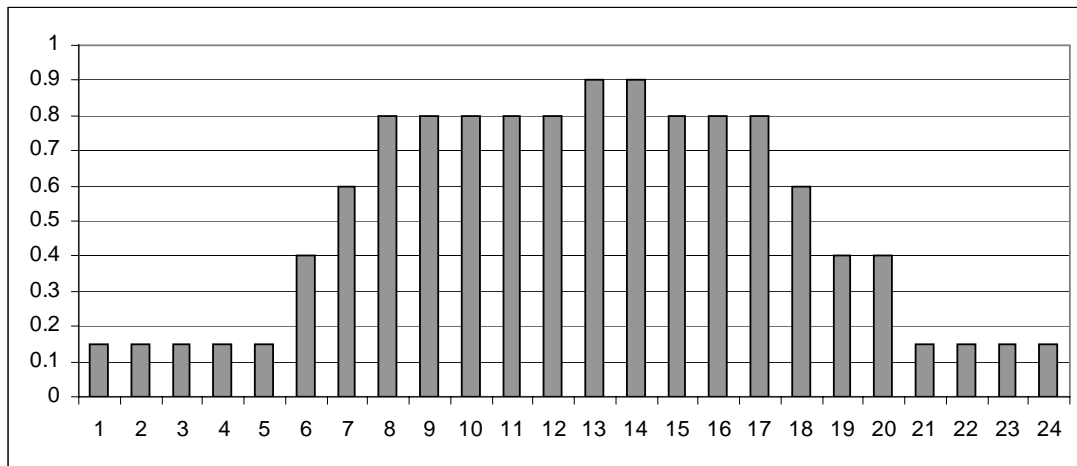
The technical premises are sized for one person per 20m².
Figure 11 shows the occupation profile every day of the week.

Figure 11 : Occupation profile in laboratories, restaurant, technical annexes compared to maximum



The installed lighting power is 10 W/m². (switch on in occupancy only).
 The power of internal is 20 W/m² and the ratio of use is presented on Figure 12.

Figure 12 : Internal gains in laboratories, restaurant, technical annexes compared to maximum

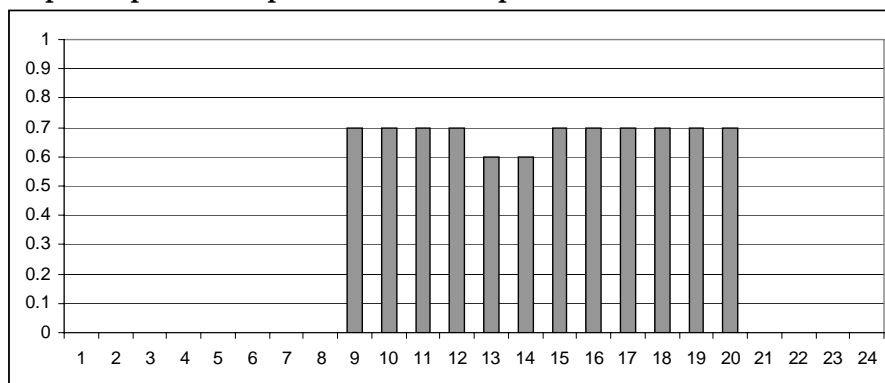


The outdoor air flow rate is 6 vol/h. No solar protection are considered here.
 Nota : no kitchen is taken into account.

Operation room

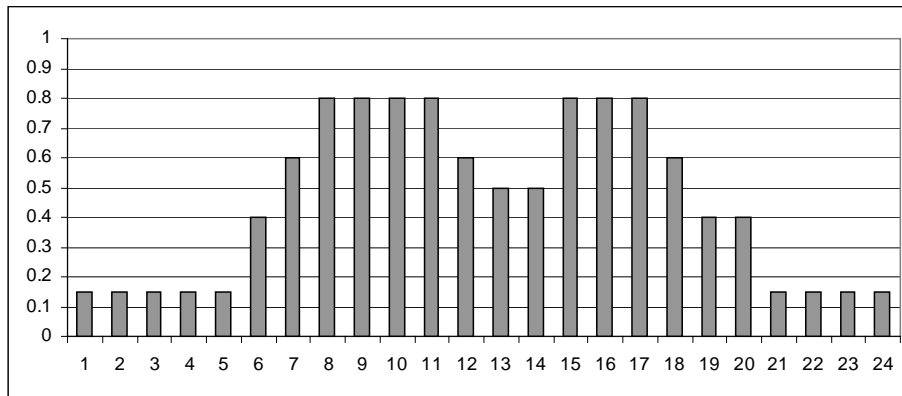
The operation room is sized for 1 person per 10 m². Figure 13 shows the occupation profile every day of the week.

Figure 13 : Occupation profile in operation room compared to maximum



The installed lighting power is 50 W/m² (fully switch on during occupancy only). Figure 14 shows the internal gain profile compared to maximum installed power which is 30 W/m² (every day of the week).

Figure 14 : Internal gain profile in operation room compared to maximum installed power



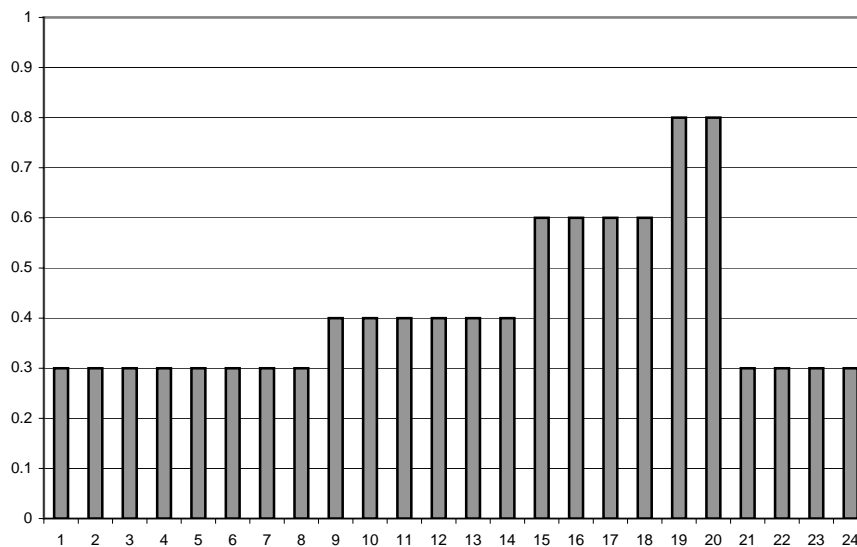
The outside air flow rate is 15 vol/h.

Bedrooms

One considers 101 beds per building surface (including circulations) based on typical ratios found in hospitals. As a consequence, one gets 22 m²/bed. If one assumes up to 2 visitors by bed during the day the bedrooms can welcome up to about 1 person per 8 m² including visitors.

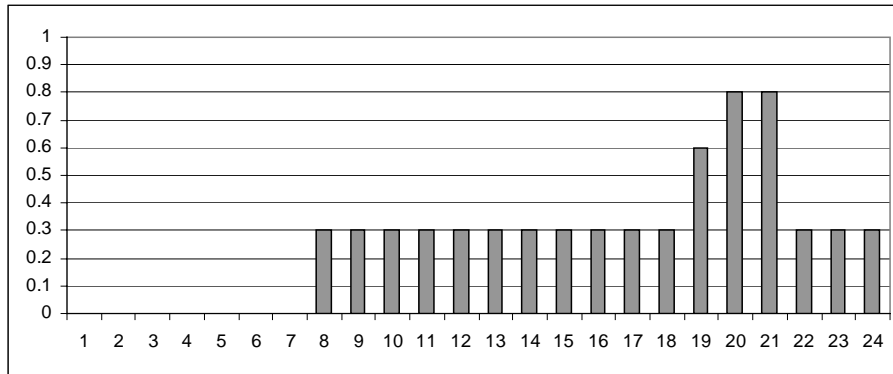
Figure 15 shows the occupation profile for every day of the week.

Figure 15 : Occupation profile in bedroom compared to maximum



The installed lighting power is 10 W/m². The internal gain profile including electrical appliances (TV set...) with a maximum power of 7 W/m² is the same.

Figure 16 : Internal gain profile in bedrooms compared to maximum



The solar protection are assumed to be fully used during summer (Weeks 20 to 37) and partially used (50%) in mid season (weeks 16 to 19 and 38 to 41) and not used all the other weeks. The artificial lighting profile is similar to Figure 16.

The outdoor air flow rate is 25 m³/h per person and 1 person per 8 m².

Circulations

No occupation is considered in circulations. The installed lighting power is 12 W/m². No solar protection is used. As regards the artificial lighting, one assumes that it is similar to Figure 16 during the day and 10% of the lighting is used during night from 23h to 7h.

Toilets

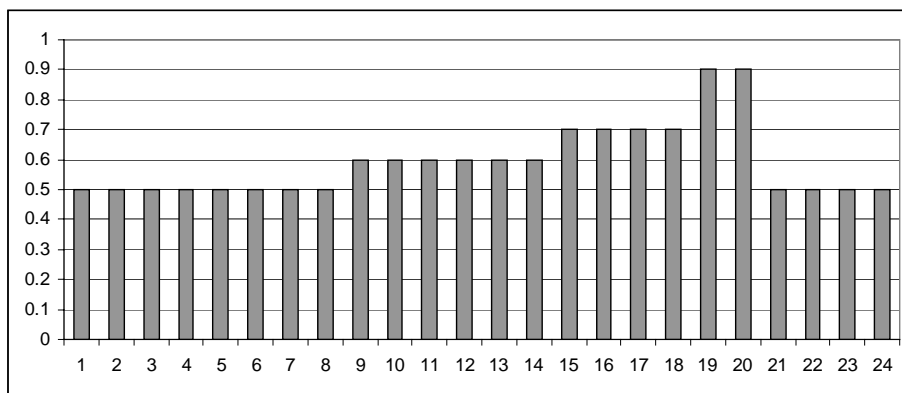
No occupation is considered in toilets. The installed lighting power is 6 W/m². No solar protection is used. The artificial lighting is assumed to be used at 10% all the day long.

2.4.2 Occupation profiles and internal gains - TYPE 2

Bedrooms

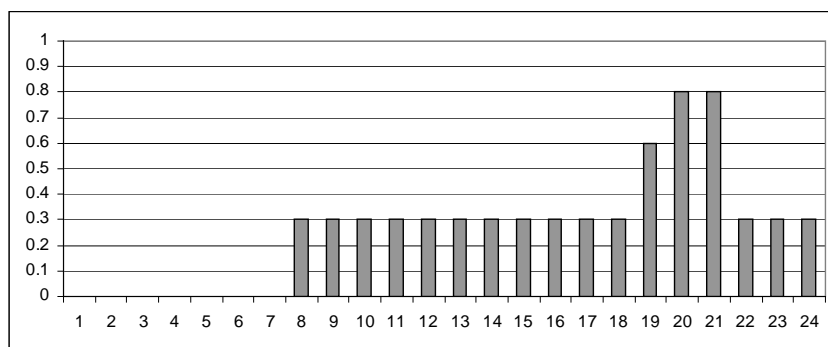
The bedrooms are sized for one person per 20 m². Figure 17 shows the occupation profile for every day of the week.

Figure 17 : Occupation profile in bedrooms compared to maximum



The installed lighting power is 10 W/m². Figure 18 shows the lighting profile. The internal gain profile including electrical appliances (TV set...) with a maximum power of 2.8 W/m² is the same. The solar protection uses are identical those of bedrooms in larges hospitals. The lighting use is similar to bedrooms of Type 1.

Figure 18 : Internal gain profile in bedrooms compared to maximum

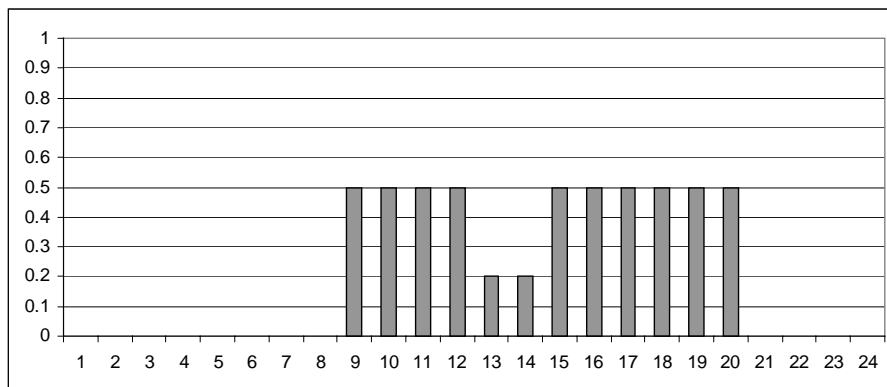


The outdoor air flow rate is 18 m³/h per person and one person per 20 m².

Nursing room

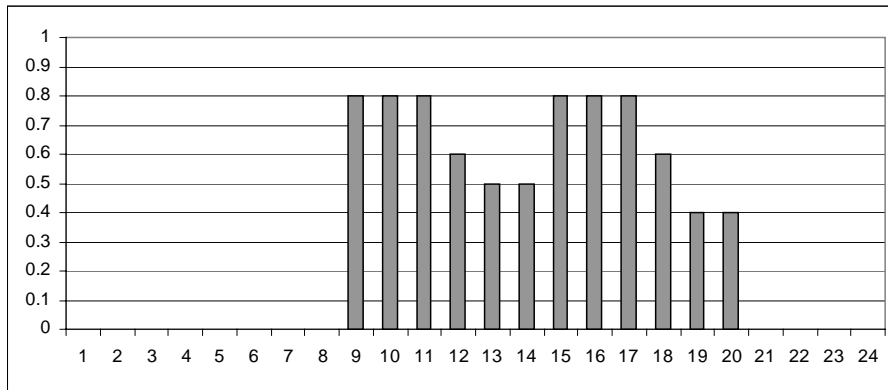
The nursing room is sized for one person per 30 m². Figure 19 shows the occupation profile for every day of the week.

Figure 19 : Occupation profile in nursing room compared to maximum



The installed lighting power is 10 W/m². It is fully used during occupancy only. Figure 20 shows the internal gain profile compared to maximum installed power which is 20 W/m² (every day of the week). Solar protections are used as in bedrooms.

Figure 20 : Internal gain profile in nursing room compared to maximum

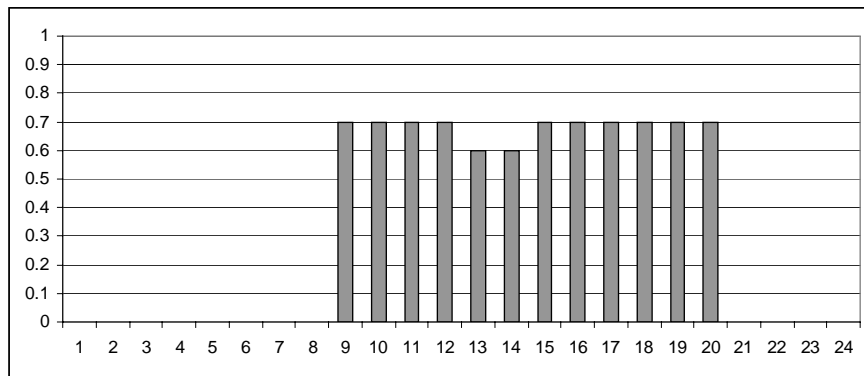


The outdoor air floor rate is 4 vol/h.

Common rooms

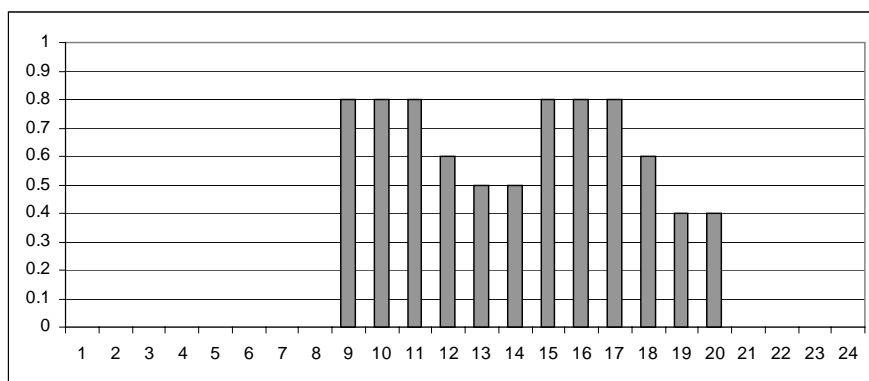
The common rooms are sized for 1 person per 6 m². Figure 21 shows the occupation profile for every day of the week.

Figure 21 : Occupation profile in common rooms compared to maximum



The installed lighting power is 12 W/m² and its use profile is as Figure 21. Figure 22 shows the internal gain profile compared to maximum installed power which is 2 W/m² (every day of the week).

Figure 22 : Internal gain profile in common rooms compared to maximum

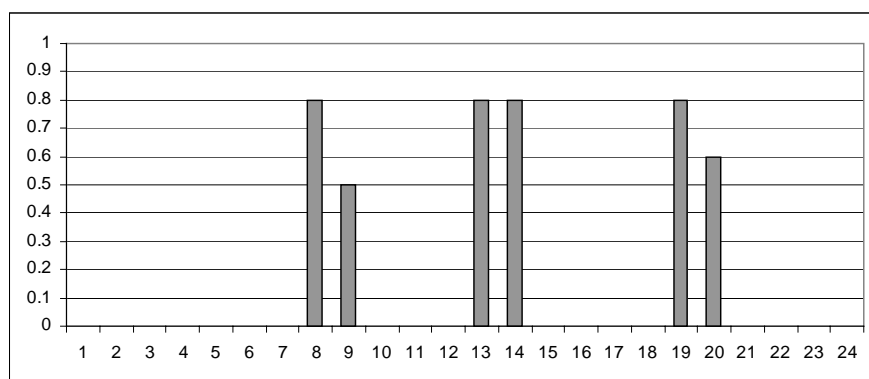


The outdoor air flow rate is 18 m³/person and 1 person per 6 m². The solar protections are managed as in the bedrooms.

Restaurants

The sized occupation rate is one person per 5 m². Figure 23 shows the occupation and internal gain profiles for every day of the week

Figure 23 : Occupation and internal gain profiles in restaurants



The installed lighting power is 12 W/m² (switch on during occupancy only as in Figure 23). The internal gain profile is presented above with a maximum power of electrical appliances of 2 W/m². The outdoor air flow rate is 18 m³/person and 1 person per 5 m². The solar protections are managed as in the bedrooms.

Nota : no kitchen is taken into account.

Circulations

One assumes no occupation in circulations. The installed lighting power is 12 W/m². No solar protection is used. As regards the artificial lighting, one assumes a similar use to bedrooms.

Toilets

No occupation is considered in toilets. The installed lighting power is 6 W/m², one assumes 10% of use all the day.

Technical premises

The technical premises are not heated, cooled and are not considered in the simulations.

2.4.3 Ventilation and set point temperatures

The ventilation is carried by air handling units for all rooms except for bedrooms, circulations and toilets. For these zones, the air is supplied in bedrooms and is exhausted in toilets and circulations through extraction system. The ventilation is stopped only in the operation rooms during non occupation period.

Set point temperatures are defined in homogeneous thermal zones.

Table 31 : Summary of the set points in the different zones of the two building types

	Cooling set point (° C)	Summer Relative Humidity set point (%)	Heating set point (° C)	Winter Relative Humidity set point (%)
Offices, consultations, emergency rooms Restaurants, common rooms	24	-	21	-
Laboratories, technical annexes, Nursing rooms	26	55 % maximum	20	HR uncontrolled
Operation rooms	26	55 ± 10	24	55 ± 10
Bedrooms	24	-	21	-

The inoccupation heating temperature is 15°C and air conditioning is stopped during inoccupation period.

2.4.4 Summary of internal sources and ventilation

Large Hospital - type 1							
UTH	Nb occ	Outside air supply (m ³ /h)	Exhaust air (m ³ /h)	AHU (m ³ /h)	Lighting (W)	Solar protections	Internal gains (W)
1	143	3 575			37 160	As in office buildings	27 870
2	240	86 299		86 299	47 944	No solar protection	95 888
3	152	68 459		68 459	76 065	No solar protection	45 639
4	333	8 319			26 620	Fully used during summer, 50% during mid season, not used during winter	18 634
5	333	8 319			26 620		18 634
6	182	4 556			14 580		10 206
7	0		16 100		140 002	No solar protection	0
8	0		8 669		11 235	No solar protection	0

Rest home - type 2						
UTH	Number of occupants	Outside air supply (m ³ /h)	Exhaust air (m ³ /h)	AHU (m ³ /h)	Lighting (W)	Internal Gains (W)
1	45	1 620			8960	2508.8
2	45				8960	2508.8
3	96	1 728			6912	1152
4	48	864		864	2880	480
5	7	2 304		2 304	1920	3840
6	0		2 009		8026	0
7	0		1 339		1536	0

2.5 Hot water consumption scenario

2.5.1 hospital – Type 1

Based on [AIC 1991], the hot water consumption is simulated by using the following equation :

$$V_h = \frac{V_{pj}}{24}, (V_h)_i = \alpha_i \cdot V_h$$

V_{pj} : Daily volume consumption (in L)

V_h : Average hourly volume consumption (in L)

V_{hi} : Hourly volume consumption (in L)

with α_i a dimensionless coefficient defined hour by hour in Table 32

Table 32: Hourly values of Hot Water consumption in hospitals

period	0 to 1h	1 to 2h	2 to 3h	3 to 4h	4 to 5h	5 to 6h	6 to 7h	7 to 8h	8 to 9h	9 to 10h	10 to 11h	11 to 12h	12 to 13h	13 to 14h	14 to 15h	15 to 16h	16 to 17h	17 to 18h	18 to 19h	19 to 20h	20 to 21h	21 to 22h	22 to 23h	23 to 24h	$\Sigma \alpha_i$
Monday to Thursday	0	0	0	0	0	0,55	0,41	2,59	2,73	3,36	1,27	3,82	1,05	0,82	0,59	1,5	1	2	1,91	0,05	0,27	0,09	0	0	24
Friday to Saturday	0	0	0	0	0	0,18	0,76	2,05	2,85	2,85	1,69	4,07	0,58	1,08	0,43	1,05	1,3	1,05	3,46	0,18	0,43	0	0	0	24
Sunday	0	0	0	0	0	0,74	0,87	3,05	4,79	1,57	0,91	3,48	0,52	0,35	0,44	0,91	0,83	2,4	2,26	0,35	0,22	0,26	0,04	0	24

The hourly share of hot water consumption based on Table 32 is represented on Figure 24.

Figure 24 : Hourly share of hot water consumption in hospitals

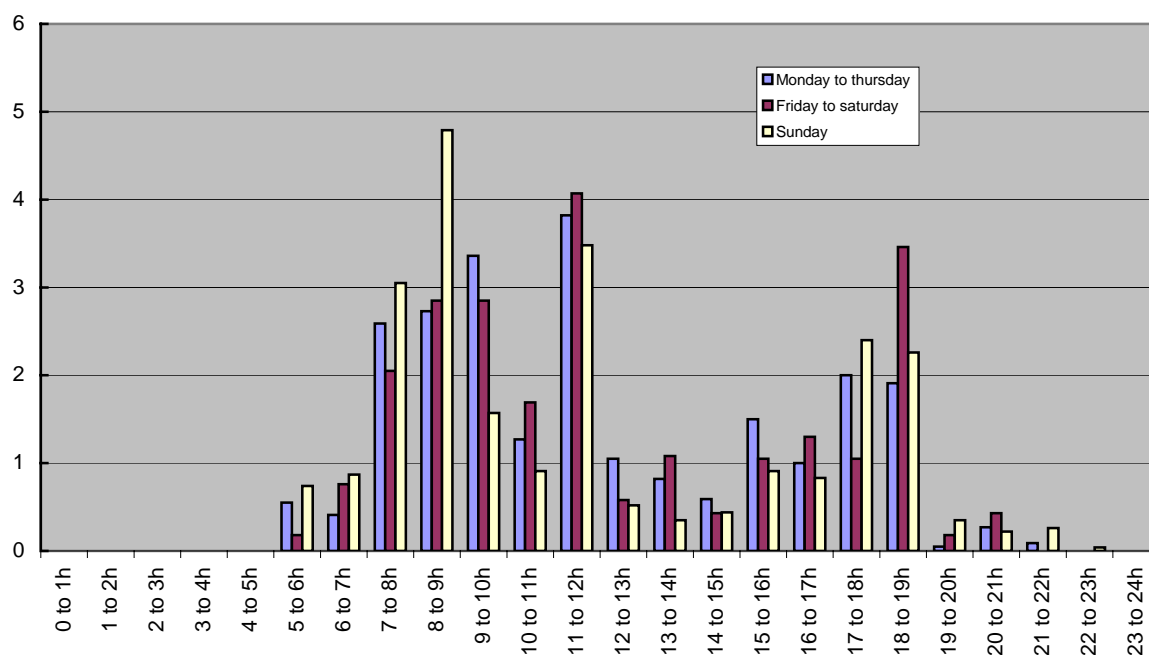


Table 33: Hot water consumption in hospital type 1

Needs of hot water in liters at 60 °C	Ratio [AIC 1991]	L/day
bedrooms	60 L/bed/day	18 000
Restaurant	10 L/meal	9 000

2.5.2 Rest home – type 2

The hot water consumption is simulated as for Hospital- type 1 with the following hourly share :

Table 34: Hourly values of Hot Water consumption in rest homes

period	0 to 1h	1 to 2h	2 to 3h	3 to 4h	4 to 5h	5 to 6h	6 to 7h	7 to 8h	8 to 9h	9 to 10h	10 to 11h	11 to 12h	12 to 13h	13 to 14h	14 to 15h	15 to 16h	16 to 17h	17 to 18h	18 to 19h	19 to 20h	20 to 21h	21 to 22h	22 to 23h	23 to 24h	$\Sigma \alpha_i$
Monday to Tuesday	0	0	0	0,2	0,4	0,6	2,81	2,61	2,41	2,41	1	0,6	0,4	0,2	0,4	0,4	0,4	0,4	4,82	2,01	0,4	0,8	0,7	0	24
Thursday to Friday	0	0	0	0,17	0,35	0,7	4,01	2,27	1,05	0,52	0,35	0,7	1,05	0,17	0,44	0,26	0,52	0,61	6,98	0,7	0,52	0,7	1,92	0	24
Wednesday, Saturday, Sunday	0	0	0	0	0,09	0,45	7,49	2,85	0,27	0,36	0,18	0,36	0,89	0,18	0,36	0,18	0,18	0,36	4,46	3,39	0,36	0,54	1,07	0	24

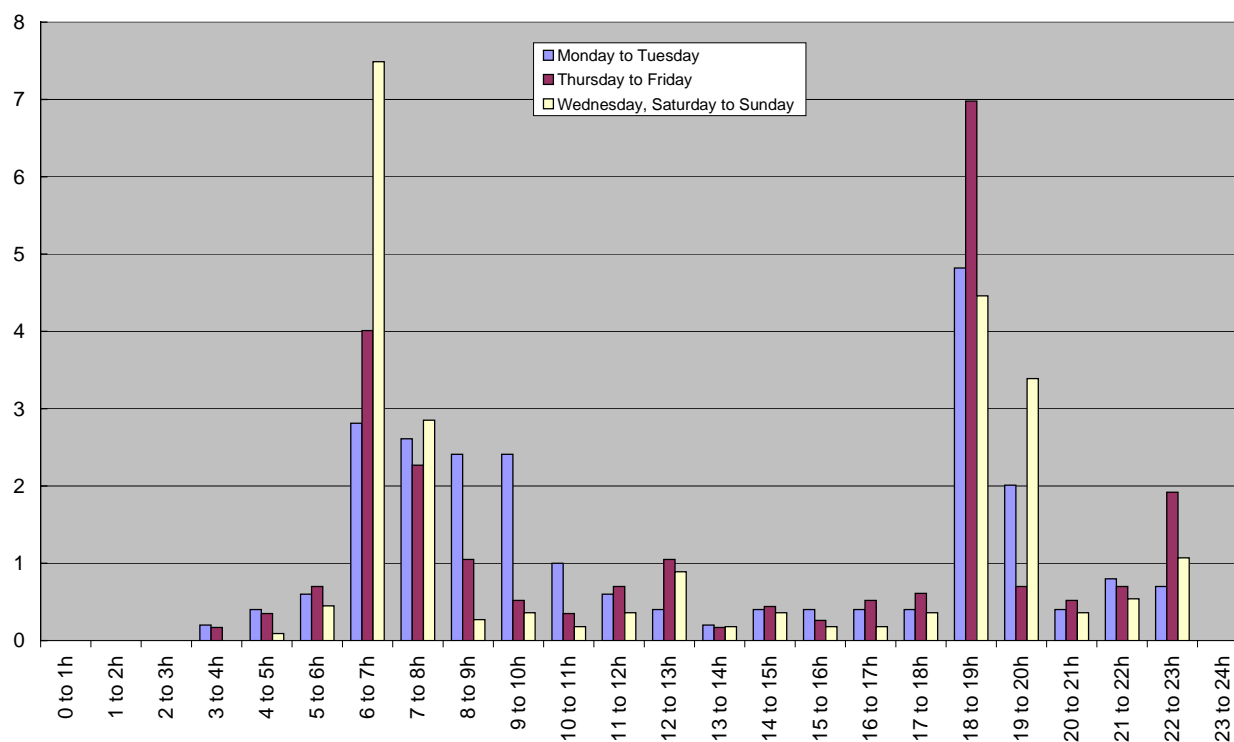


Figure 25 : Hourly share of hot water consumption in rest homes

Table 35: Hot water consumption in rest homes type 2

Needs of hot water in liters at 60 °C	Ratio [AIC 1991]	L/day
bedrooms	40 L/ bed/day	3 600
Restaurant	5 L /meal	1 350

2.6 Building/HVAC System

Reversible heat pump can be associated to fan coils units (FCU) or constant air volume system (CAV). Some systems are rarely implemented in some types of buildings. The following matrix illustrates how to match system with buildings. It is possible that this table should be inadequate in some countries.

Table 36: HVAC system type matched to building type

	FCU	VAV	CAV	VRF	Reversible multi SPLIT	HP
hospital type 1	✓		✓			
Rest home type 2	✓			✓	✓	✓

References:

- [ADE 2005] Chiffres clés du bâtiment 2005. ADEME
- [AIC 1991] Guide n°3 de l'AICVF : l'eau chaude sanitaire dans les bâtiments résidentiels et tertiaires, conception et calcul des installations. Recommandation 02-2004 ECS, AICVF.
- [ALE 2006] Impact de la gestion de l'éclairage et des protections solaires sur la consommation d'énergie de bâtiments de bureaux climatisés. ALESSANDRINI J.M., FLEURY, E, FILFLI S., MARCHIO D., Climamed, Lyon, France, 2006
- [EEC 2005] Energy Efficiency and Certification of Central Air Conditioners study (EECCAC) for the D.G. Transportation- energy (DGTREN) of the Commission of the E.U.. Co-ordinator: ADNOT J. janvier 2005
- [FIL 2005] Quelles solutions pour les bâtiments tertiaires climatisés à moins de 100 kwh/m² ? FILFLI S., ALESSANDRINI J.M., FLEURY E., MARCHIO D., TOURNIE P., DAMOLIS P., GOURMEZ D., rapport ADEME, 2006
- [FIL 2006] Quelles solutions pour les établissements de santé à consommation d'énergie annuelle inférieure to 100 kwh/m². FILFLI S., ALESSANDRINI J.M., FLEURY E., MARCHIO D., TOURNIE P., DAMOLIS P., GOURMEZ D., rapport ADEME, 2006

ANNEX 2 : RESULTS OF HEATING AND COOLING DEMANDS IN OFFICE BUILDINGS

Table 37: Results for high loads buildings with set point temperatures of 21/24°C

Building case				energy demand (kWh/m ² /year) - 5 zones -				Ratio max heating on cooling power	Number of hours with simultaneous cooling and heating demand	Energy demand when simultaneity H/C demand		Number of days with non simultaneous cooling and heating demand	Energy demand when daily H/C demand but non simultaneous	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating	Annual cooling	Winter heating	Summer cooling			heating	cooling		heating	cooling
HIGH LOADS 21/24°C SETPOINT TEMPERATURES														
1a NS	PARIS	LOW	LOW	22.2	36.0	21.3	24.7	0.96	824	2.2	6.9	131	10.7	9.6
1a NS	PARIS	HIGH	LOW	21.3	39.2	20.4	26.7	0.74	883	2.5	8.3	122	10.1	9.0
1a NS	PARIS	LOW	HIGH	32.4	29.6	31.0	22.5	1.03	684	1.9	5.5	116	11.1	8.3
1a NS	PARIS	HIGH	HIGH	31.3	32.6	29.9	24.4	0.85	759	2.3	6.8	110	10.5	8.4
1a NS	TORINO	LOW	LOW	20.5	50.2	20.3	33.1	0.83	712	2.1	6.4	125	12.1	11.0
1a NS	TORINO	HIGH	LOW	19.2	54.5	19.1	35.4	0.63	769	2.4	7.7	120	11.9	10.9
1a NS	TORINO	LOW	HIGH	29.9	44.4	29.5	32.0	1.00	654	2.0	5.5	118	14.7	9.2
1a NS	TORINO	HIGH	HIGH	28.5	48.5	28.2	34.3	0.76	723	2.4	6.8	115	14.1	9.7
1a NS	ATHENES	LOW	LOW	6.7	78.5	6.7	45.8	0.42	702	1.8	6.2	101	5.6	10.3
1a NS	ATHENES	HIGH	LOW	6.1	83.6	6.1	48.2	0.25	749	2.0	7.3	100	5.2	11.0
1a NS	ATHENES	LOW	HIGH	9.9	74.2	9.9	46.9	0.42	627	1.7	5.2	109	7.8	9.2
1a NS	ATHENES	HIGH	HIGH	9.2	79.1	9.2	49.3	0.33	690	2.1	6.3	111	7.8	9.9
1a NS	MUNICH	LOW	LOW	27.9	37.1	26.6	24.4	1.10	1056	4.0	11.3	126	12.5	10.8
1a NS	MUNICH	HIGH	LOW	26.7	41.2	25.4	26.8	0.73	1137	4.6	13.6	121	12.1	11.4
1a NS	MUNICH	LOW	HIGH	42.1	29.3	40.0	21.4	1.45	859	3.4	8.8	112	11.0	10.3
1a NS	MUNICH	HIGH	HIGH	40.7	33.0	38.6	23.8	1.02	940	4.1	11.0	108	11.1	10.7
1a NS	LISBOA	LOW	LOW	5.6	63.2	5.5	32.5	0.44	918	2.4	8.7	84	4.2	9.3
1a NS	LISBOA	HIGH	LOW	5.4	66.3	5.3	33.8	0.37	972	2.6	9.5	84	4.0	10.1
1a NS	LISBOA	LOW	HIGH	8.0	56.1	7.9	31.6	0.44	903	2.6	7.9	114	6.7	10.6
1a NS	LISBOA	HIGH	HIGH	7.8	59.0	7.7	33.0	0.38	966	2.9	8.8	106	6.3	10.2
1a EW	PARIS	LOW	LOW	22.2	37.4	21.4	26.1	0.90	767	1.9	6.9	120	9.8	8.4
1a EW	PARIS	HIGH	LOW	21.3	41.3	20.5	28.7	0.69	837	2.3	8.5	113	9.4	8.0
1a EW	PARIS	LOW	HIGH	32.4	31.0	31.0	23.9	1.02	650	1.8	5.5	95	8.5	6.2
1a EW	PARIS	HIGH	HIGH	31.4	34.8	30.0	26.4	0.79	710	2.2	7.2	94	9.3	6.5
1a EW	TORINO	LOW	LOW	20.6	51.6	20.4	35.0	0.75	619	1.6	5.7	111	10.8	8.8
1a EW	TORINO	HIGH	LOW	19.5	56.5	19.3	38.0	0.55	667	1.8	6.8	109	10.7	8.7
1a EW	TORINO	LOW	HIGH	30.2	46.1	29.8	33.9	0.90	555	1.4	4.9	111	13.3	8.0
1a EW	TORINO	HIGH	HIGH	28.9	50.8	28.6	36.9	0.66	621	1.8	6.2	103	12.4	7.7
1a EW	ATHENES	LOW	LOW	6.7	81.8	6.7	49.0	0.42	643	1.5	5.6	98	5.4	9.2
1a EW	ATHENES	HIGH	LOW	6.1	88.0	6.1	52.4	0.26	677	1.7	6.6	96	5.0	9.5
1a EW	ATHENES	LOW	HIGH	9.9	77.5	9.9	50.1	0.43	561	1.4	4.6	102	7.3	7.6
1a EW	ATHENES	HIGH	HIGH	9.2	83.6	9.2	53.6	0.30	607	1.6	5.7	101	6.9	7.9
1a EW	MUNICH	LOW	LOW	28.1	38.7	26.8	26.1	0.92	985	3.6	11.3	110	11.0	8.5
1a EW	MUNICH	HIGH	LOW	27.1	43.6	25.8	29.2	0.59	1054	4.1	13.8	108	10.9	9.4
1a EW	MUNICH	LOW	HIGH	42.5	31.0	40.4	23.1	1.29	803	3.1	9.1	96	9.2	8.4
1a EW	MUNICH	HIGH	HIGH	41.2	35.5	39.1	26.2	0.54	892	3.8	11.7	91	9.3	8.6
1a EW	LISBOA	LOW	LOW	5.5	67.8	5.4	35.9	0.37	906	2.4	8.4	74	3.8	7.5
1a EW	LISBOA	HIGH	LOW	5.3	72.8	5.2	38.6	0.28	976	2.7	9.5	66	3.4	7.0
1a EW	LISBOA	LOW	HIGH	7.9	60.6	7.8	35.1	0.37	898	2.6	7.6	84	5.4	6.3
1a EW	LISBOA	HIGH	HIGH	7.7	65.6	7.6	37.8	0.28	966	3.0	8.9	81	5.3	6.3
1b NS	PARIS	LOW	LOW	33.0	26.6	32.2	19.7	1.06	549	1.7	3.3	131	12.3	10.2
1b NS	PARIS	HIGH	LOW	31.3	29.8	30.7	21.8	1.00	636	2.2	4.5	125	11.9	10.3
1b NS	PARIS	LOW	HIGH	46.0	22.4	44.7	17.7	1.24	505	1.8	3.2	133	15.5	10.1
1b NS	PARIS	HIGH	HIGH	44.2	25.3	43.0	19.7	1.18	597	2.4	4.4	125	14.7	10.2
1b NS	TORINO	LOW	LOW	29.8	41.7	29.8	29.1	1.04	585	2.3	4.1	128	15.9	11.0
1b NS	TORINO	HIGH	LOW	28.0	46.2	27.9	31.6	0.93	653	2.7	5.4	125	16.2	11.5
1b NS	TORINO	LOW	HIGH	41.5	37.3	41.3	27.9	1.20	612	2.7	4.1	127	18.6	10.7
1b NS	TORINO	HIGH	HIGH	39.5	41.6	39.3	30.4	1.14	687	3.4	5.5	123	18.0	11.6
1b NS	ATHENES	LOW	LOW	9.3	67.3	9.3	42.8	0.53	470	1.4	3.1	123	9.2	10.7
1b NS	ATHENES	HIGH	LOW	8.4	72.7	8.4	45.4	0.43	529	1.7	4.1	117	8.5	11.0
1b NS	ATHENES	LOW	HIGH	14.0	64.5	14.0	43.9	0.67	491	1.7	3.2	127	12.1	10.4
1b NS	ATHENES	HIGH	HIGH	12.9	69.7	12.9	46.5	0.54	554	2.1	4.2	123	11.7	10.7
1b NS	MUNICH	LOW	LOW	39.0	28.4	38.0	19.7	1.42	873	4.3	7.4	134	15.6	12.4
1b NS	MUNICH	HIGH	LOW	37.1	32.7	36.1	22.3	1.09	974	5.2	9.7	127	15.3	12.8
1b NS	MUNICH	LOW	HIGH	56.1	22.5	54.2	16.9	1.73	806	4.6	6.6	128	16.3	12.0
1b NS	MUNICH	HIGH	HIGH	53.8	26.5	52.0	19.4	1.42	912	5.8	9.0	126	16.5	13.1

Table 38: Results for high load buildings with set point temperatures of 20/25°C

Building case				energy demand (kWh/m ² /year) - 5 zones -				Ratio max heating on cooling power	Number of hours with simultaneous cooling and heating demand	Energy demand when simultaneity H/C demand		Number of days with non simultaneous cooling and heating demand	Energy demand when daily H/C demand but non simultaneous	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating	Annual cooling	Winter heating	Summer cooling			heating	cooling		heating	cooling
HIGH LOADS 20/25°C SETPOINT TEMPERATURES														
1a NS	PARIS	LOW	LOW	18.8	-30.9	18.3	-22.4	0.87	489	1.0	-3.2	121	6.7	-8.7
1a NS	PARIS	HIGH	LOW	18.0	-34.1	17.5	-24.4	0.70	567	1.3	-4.1	112	6.4	-8.1
1a NS	PARIS	LOW	HIGH	27.7	-24.9	26.7	-19.8	1.02	364	0.7	-2.2	109	5.5	-9.1
1a NS	PARIS	HIGH	HIGH	26.8	-27.8	25.8	-21.8	0.87	445	1.0	-3.1	103	6.1	-8.5
1a NS	TORINO	LOW	LOW	17.3	-44.6	17.2	-30.7	0.79	459	1.0	-3.2	118	8.5	-9.3
1a NS	TORINO	HIGH	LOW	16.2	-48.8	16.1	-33.0	0.59	518	1.3	-4.1	114	8.1	-9.7
1a NS	TORINO	LOW	HIGH	25.6	-38.6	25.4	-29.1	0.99	385	0.8	-2.4	109	9.2	-7.6
1a NS	TORINO	HIGH	HIGH	24.4	-42.6	24.2	-31.5	0.77	471	1.2	-3.2	105	9.8	-7.3
1a NS	ATHENES	LOW	LOW	5.1	-71.5	5.1	-43.2	0.35	463	0.9	-3.1	106	4.2	-9.2
1a NS	ATHENES	HIGH	LOW	4.7	-76.6	4.7	-45.6	0.23	521	1.1	-3.9	101	4.0	-9.0
1a NS	ATHENES	LOW	HIGH	7.6	-66.7	7.6	-43.8	0.40	357	0.7	-2.2	108	5.0	-8.6
1a NS	ATHENES	HIGH	HIGH	7.2	-71.6	7.2	-46.2	0.31	424	1.0	-3.0	109	5.3	-8.8
1a NS	MUNICH	LOW	LOW	24.6	-32.8	23.6	-22.5	1.12	794	2.4	-7.3	119	7.6	-11.1
1a NS	MUNICH	HIGH	LOW	23.5	-36.8	22.5	-24.9	0.74	890	3.0	-9.2	114	7.7	-11.6
1a NS	MUNICH	LOW	HIGH	37.4	-25.2	35.8	-19.2	1.49	598	1.8	-5.1	107	7.4	-10.1
1a NS	MUNICH	HIGH	HIGH	36.1	-28.8	34.5	-21.5	1.05	703	2.4	-6.8	109	8.0	-10.8
1a NS	LISBOA	LOW	LOW	4.1	-56.4	4.1	-30.0	0.34	646	1.4	-4.8	99	3.4	-9.7
1a NS	LISBOA	HIGH	LOW	4.0	-59.4	4.0	-31.4	0.28	700	1.6	-5.5	92	3.3	-9.3
1a NS	LISBOA	LOW	HIGH	6.0	-48.7	6.0	-28.7	0.40	578	1.3	-3.7	117	4.8	-9.8
1a NS	LISBOA	HIGH	HIGH	5.9	-51.7	5.9	-30.1	0.30	640	1.5	-4.4	114	4.8	-9.8
1a EW	PARIS	LOW	LOW	18.8	-32.4	18.3	-23.8	0.86	463	0.9	-3.3	105	5.4	-6.9
1a EW	PARIS	HIGH	LOW	18.1	-36.3	17.6	-26.3	0.65	542	1.2	-4.4	102	5.5	-6.9
1a EW	PARIS	LOW	HIGH	27.8	-26.4	26.9	-21.2	1.02	373	0.9	-2.4	88	4.8	-6.4
1a EW	PARIS	HIGH	HIGH	26.9	-30.0	26.0	-23.7	0.80	455	1.2	-3.5	81	5.2	-5.3
1a EW	TORINO	LOW	LOW	17.4	-46.2	17.4	-32.6	0.71	362	0.7	-2.6	107	7.2	-8.1
1a EW	TORINO	HIGH	LOW	16.5	-51.0	16.4	-35.6	0.50	428	1.0	-3.4	99	6.8	-7.4
1a EW	TORINO	LOW	HIGH	26.0	-40.5	25.8	-31.0	0.93	304	0.6	-2.0	86	6.1	-5.8
1a EW	TORINO	HIGH	HIGH	24.9	-45.1	24.7	-34.1	0.66	373	0.9	-2.8	85	6.2	-6.2
1a EW	ATHENES	LOW	LOW	5.1	-74.8	5.1	-46.3	0.37	395	0.7	-2.6	100	4.0	-7.7
1a EW	ATHENES	HIGH	LOW	4.7	-81.0	4.7	-49.8	0.21	442	0.9	-3.2	95	3.7	-7.6
1a EW	ATHENES	LOW	HIGH	7.7	-70.1	7.7	-46.9	0.39	302	0.6	-1.8	101	4.6	-7.5
1a EW	ATHENES	HIGH	HIGH	7.1	-76.1	7.1	-50.4	0.29	347	0.7	-2.5	100	4.7	-7.4
1a EW	MUNICH	LOW	LOW	24.9	-34.5	23.9	-24.2	0.95	731	2.2	-7.4	100	6.0	-8.8
1a EW	MUNICH	HIGH	LOW	23.9	-39.3	23.0	-27.2	0.59	823	2.7	-9.5	94	5.8	-8.9
1a EW	MUNICH	LOW	HIGH	37.9	-27.0	36.2	-20.8	1.36	579	1.8	-5.4	88	6.1	-7.9
1a EW	MUNICH	HIGH	HIGH	36.7	-31.5	35.1	-23.9	0.82	672	2.4	-7.5	87	6.4	-8.5
1a EW	LISBOA	LOW	LOW	4.0	-60.9	4.0	-33.5	0.29	638	1.4	-4.5	81	3.0	-6.5
1a EW	LISBOA	HIGH	LOW	3.9	-66.0	3.9	-36.1	0.21	705	1.6	-5.4	76	2.8	-6.6
1a EW	LISBOA	LOW	HIGH	5.9	-53.2	5.9	-32.2	0.34	591	1.4	-3.5	93	4.2	-6.5
1a EW	LISBOA	HIGH	HIGH	5.8	-58.2	5.8	-34.9	0.22	666	1.7	-4.4	84	3.8	-6.2
1b NS	PARIS	LOW	LOW	29.8	-24.4	29.1	-18.4	1.03	245	0.6	-1.2	128	8.6	-9.4
1b NS	PARIS	HIGH	LOW	28.5	-27.7	27.8	-20.5	0.96	327	0.9	-1.9	126	8.9	-9.9
1b NS	PARIS	LOW	HIGH	40.5	-20.9	39.2	-16.6	1.23	232	0.6	-1.1	119	9.3	-9.1
1b NS	PARIS	HIGH	HIGH	39.0	-23.9	37.7	-18.7	1.16	318	1.0	-1.8	110	9.1	-8.9
1b NS	TORINO	LOW	LOW	27.2	-38.5	27.1	-27.0	1.00	343	1.1	-2.0	128	12.5	-9.6
1b NS	TORINO	HIGH	LOW	25.5	-43.1	25.4	-29.5	0.94	412	1.5	-2.9	128	12.8	-10.8
1b NS	TORINO	LOW	HIGH	36.8	-34.7	36.5	-25.9	1.17	336	1.2	-1.8	129	14.0	-10.1
1b NS	TORINO	HIGH	HIGH	35.0	-39.1	34.7	-28.4	1.10	418	1.7	-2.8	121	13.4	-10.5
1b NS	ATHENES	LOW	LOW	8.3	-62.5	8.3	-39.8	0.50	259	0.7	-1.4	125	6.6	-9.5
1b NS	ATHENES	HIGH	LOW	7.6	-67.9	7.6	-42.4	0.39	312	0.9	-2.0	121	6.2	-10.0
1b NS	ATHENES	LOW	HIGH	12.0	-59.7	12.0	-40.4	0.65	242	0.6	-1.3	115	8.0	-7.8
1b NS	ATHENES	HIGH	HIGH	11.2	-64.9	11.2	-43.0	0.51	313	0.9	-1.9	119	8.4	-8.9
1b NS	MUNICH	LOW	LOW	37.1	-27.7	35.8	-19.2	1.43	617	2.4	-4.5	131	11.1	-12.0
1b NS	MUNICH	HIGH	LOW	35.4	-32.1	34.1	-21.8	1.11	728	3.2	-6.4	122	11.4	-11.9
1b NS	MUNICH	LOW	HIGH	51.5	-22.7	49.3	-16.8	1.79	539	2.3	-3.7	124	11.9	-10.8
1b NS	MUNICH	HIGH	HIGH	49.6	-26.8	47.4	-19.4	1.46	654	3.3	-5.5	120	12.0	-11.7

HIGH LOADS 20/25°C SETPOINT TEMPERATURES

1b NS	LISBOA	LOW	LOW	6.4	-41.4	6.3	-23.8	0.62	338	0.9	-1.7	129	5.3	-8.7
1b NS	LISBOA	HIGH	LOW	6.1	-44.5	6.1	-25.2	0.51	388	1.0	-2.3	123	5.2	-9.1
1b NS	LISBOA	LOW	HIGH	9.3	-36.6	9.3	-22.8	0.67	331	1.0	-1.6	127	6.7	-7.5
1b NS	LISBOA	HIGH	HIGH	9.1	-39.7	9.0	-24.2	0.59	392	1.2	-2.2	124	6.6	-8.1
1b EW	PARIS	LOW	LOW	29.9	-26.1	29.2	-20.1	1.03	244	0.6	-1.2	104	7.5	-6.5
1b EW	PARIS	HIGH	LOW	28.7	-30.1	27.9	-22.7	0.97	332	0.9	-2.0	98	7.4	-6.7
1b EW	PARIS	LOW	HIGH	40.6	-22.5	39.3	-18.3	1.23	219	0.5	-1.1	109	8.3	-7.9
1b EW	PARIS	HIGH	HIGH	39.2	-26.3	37.9	-20.9	1.16	320	1.0	-2.0	97	8.1	-7.0
1b EW	TORINO	LOW	LOW	27.5	-40.2	27.4	-29.3	0.93	220	0.5	-1.0	109	10.6	-7.2
1b EW	TORINO	HIGH	LOW	25.9	-45.4	25.8	-32.5	0.79	287	0.8	-1.6	109	11.1	-7.4
1b EW	TORINO	LOW	HIGH	37.2	-36.6	37.0	-28.2	1.09	224	0.5	-1.0	110	10.8	-7.9
1b EW	TORINO	HIGH	HIGH	35.5	-41.6	35.2	-31.4	0.99	293	0.8	-1.6	105	11.9	-7.6
1b EW	ATHENES	LOW	LOW	8.3	-66.4	8.3	-43.8	0.45	159	0.3	-0.7	116	6.0	-7.9
1b EW	ATHENES	HIGH	LOW	7.5	-73.0	7.5	-47.4	0.33	215	0.5	-1.2	109	5.7	-7.0
1b EW	ATHENES	LOW	HIGH	12.0	-63.8	12.0	-44.3	0.59	161	0.3	-0.7	108	7.7	-6.6
1b EW	ATHENES	HIGH	HIGH	11.2	-70.2	11.2	-48.0	0.44	208	0.5	-1.3	105	7.4	-6.5
1b EW	MUNICH	LOW	LOW	37.5	-29.6	36.2	-21.2	1.34	545	1.8	-4.3	107	8.8	-9.2
1b EW	MUNICH	HIGH	LOW	35.9	-34.9	34.6	-24.6	0.84	652	2.6	-6.3	100	9.2	-8.9
1b EW	MUNICH	LOW	HIGH	52.1	-24.8	49.8	-18.9	1.68	501	1.9	-3.7	102	9.9	-8.6
1b EW	MUNICH	HIGH	HIGH	50.3	-29.8	48.1	-22.3	1.10	605	2.7	-5.8	96	9.6	-9.0
1b EW	LISBOA	LOW	LOW	6.2	-46.5	6.2	-27.9	0.51	346	0.8	-1.2	96	4.4	-5.5
1b EW	LISBOA	HIGH	LOW	6.0	-51.9	5.9	-30.7	0.37	420	1.1	-1.9	90	4.1	-5.7
1b EW	LISBOA	LOW	HIGH	9.2	-41.8	9.1	-26.9	0.59	332	0.9	-1.1	102	6.2	-5.4
1b EW	LISBOA	HIGH	HIGH	8.9	-47.1	8.8	-29.8	0.44	419	1.3	-1.8	96	5.9	-5.4
1c NS	PARIS	LOW	LOW	44.3	-24.5	43.0	-19.2	1.02	198	0.5	-0.7	128	11.1	-9.7
1c NS	PARIS	HIGH	LOW	40.4	-28.7	39.6	-22.1	0.93	164	0.3	-0.4	126	10.7	-9.7
1c NS	PARIS	LOW	HIGH	55.2	-21.2	53.4	-17.4	1.18	153	0.4	-0.5	119	11.5	-9.3
1c NS	PARIS	HIGH	HIGH	51.0	-25.0	49.7	-20.1	1.08	132	0.3	-0.3	113	10.7	-8.7
1c NS	TORINO	LOW	LOW	38.1	-40.1	37.9	-29.6	1.00	236	0.6	-0.8	130	15.7	-9.6
1c NS	TORINO	HIGH	LOW	33.6	-46.4	33.5	-33.5	0.92	172	0.4	-0.4	128	14.5	-10.7
1c NS	TORINO	LOW	HIGH	47.9	-36.4	47.5	-28.3	1.15	217	0.5	-0.6	132	16.9	-10.3
1c NS	TORINO	HIGH	HIGH	43.0	-42.3	42.8	-32.2	1.06	162	0.4	-0.4	128	15.3	-11.0
1c NS	ATHENES	LOW	LOW	12.3	-67.5	12.3	-45.1	0.60	190	0.4	-0.5	125	9.1	-9.6
1c NS	ATHENES	HIGH	LOW	9.9	-75.7	9.9	-49.6	0.51	117	0.2	-0.2	121	7.5	-9.7
1c NS	ATHENES	LOW	HIGH	15.9	-64.9	15.9	-45.5	0.69	142	0.3	-0.4	117	9.8	-8.0
1c NS	ATHENES	HIGH	HIGH	13.3	-72.7	13.3	-50.0	0.62	94	0.2	-0.2	119	9.4	-8.7
1c NS	MUNICH	LOW	LOW	49.9	-27.5	48.5	-20.0	1.30	407	1.4	-1.9	133	12.8	-11.7
1c NS	MUNICH	HIGH	LOW	44.7	-32.9	43.8	-23.6	1.15	350	1.0	-1.3	121	11.6	-11.1
1c NS	MUNICH	LOW	HIGH	64.5	-22.7	62.4	-17.4	1.58	358	1.2	-1.5	124	12.7	-10.7
1c NS	MUNICH	HIGH	HIGH	58.9	-27.5	57.4	-20.8	1.40	298	1.0	-1.1	114	10.7	-10.7
1c NS	LISBOA	LOW	LOW	9.9	-40.4	9.8	-25.0	0.58	362	0.9	-1.4	132	7.5	-8.3
1c NS	LISBOA	HIGH	LOW	8.4	-44.7	8.4	-27.2	0.53	278	0.6	-0.9	126	6.5	-8.6
1c NS	LISBOA	LOW	HIGH	12.9	-36.1	12.7	-23.9	0.72	301	0.8	-1.0	129	8.5	-6.9
1c NS	LISBOA	HIGH	HIGH	11.2	-40.1	11.1	-26.1	0.66	255	0.5	-0.7	125	7.4	-7.4
1c EW	PARIS	LOW	LOW	44.7	-26.9	43.5	-21.4	1.03	235	0.6	-1.2	107	10.6	-7.0
1c EW	PARIS	HIGH	LOW	41.0	-31.7	40.3	-24.8	0.93	187	0.4	-0.8	99	9.5	-6.4
1c EW	PARIS	LOW	HIGH	55.6	-23.5	53.9	-19.5	1.19	170	0.4	-0.9	108	10.5	-8.0
1c EW	PARIS	HIGH	HIGH	51.5	-27.9	50.4	-22.7	1.09	170	0.4	-0.7	101	10.1	-7.1
1c EW	TORINO	LOW	LOW	39.6	-43.4	39.4	-32.6	0.91	205	0.5	-1.1	110	13.8	-7.6
1c EW	TORINO	HIGH	LOW	35.5	-50.2	35.5	-37.4	0.83	169	0.4	-0.8	112	14.1	-7.8
1c EW	TORINO	LOW	HIGH	49.4	-39.7	49.1	-31.3	1.05	169	0.4	-0.8	114	14.2	-8.7
1c EW	TORINO	HIGH	HIGH	45.1	-46.2	45.0	-35.9	0.96	141	0.4	-0.6	109	14.4	-8.1
1c EW	ATHENES	LOW	LOW	12.9	-73.4	12.9	-50.1	0.55	158	0.3	-0.8	116	8.8	-8.5
1c EW	ATHENES	HIGH	LOW	10.6	-82.8	10.6	-56.0	0.43	109	0.2	-0.4	111	7.9	-7.2
1c EW	ATHENES	LOW	HIGH	16.6	-70.8	16.6	-50.6	0.65	127	0.3	-0.6	110	10.2	-6.9
1c EW	ATHENES	HIGH	HIGH	14.1	-79.9	14.1	-56.3	0.53	86	0.1	-0.3	106	8.9	-6.9
1c EW	MUNICH	LOW	LOW	51.3	-31.1	49.9	-23.0	1.20	394	1.4	-3.0	108	10.5	-9.9
1c EW	MUNICH	HIGH	LOW	46.6	-37.4	45.8	-27.3	1.01	348	1.2	-2.3	97	9.9	-8.0
1c EW	MUNICH	LOW	HIGH	66.0	-26.2	63.8	-20.3	1.45	352	1.3	-2.5	103	11.0	-9.1
1c EW	MUNICH	HIGH	HIGH	60.9	-32.0	59.5	-24.5	1.28	309	1.1	-2.1	92	9.8	-7.9
1c EW	LISBOA	LOW	LOW	9.7	-46.0	9.7	-29.5	0.57	352	0.9	-1.2	102	6.7	-5.6
1c EW	LISBOA	HIGH	LOW	8.1	-52.3	8.1	-33.3	0.44	293	0.7	-0.9	95	5.7	-5.6
1c EW	LISBOA	LOW	HIGH	12.6	-41.5	12.6	-28.3	0.70	280	0.8	-0.9	104	8.0	-5.0
1c EW	LISBOA	HIGH	HIGH	10.9	-47.4	10.9	-32.0	0.56	244	0.6	-0.7	99	7.1	-5.1
"2" NS	PARIS	LOW	LOW	28.3	-18.8	27.6	-15.6	1.31	238	0.5	-0.8	80	3.7	-3.6
"2" NS	PARIS	HIGH	LOW	27.6	-20.8	26.9	-17.0	1.27	299	0.7	-1.1	81	4.2	-3.4
"2" NS	PARIS	LOW	HIGH	39.0	-15.8	37.7	-13.8	1.54	177	0.4	-0.5	79	3.9	-4.1
"2" NS	PARIS	HIGH	HIGH	38.1	-17.6	36.9	-15.1	1.49	240	0.6	-0.8	77	4.5	-3.6
"2" NS	TORINO	LOW	LOW	23.5	-31.5	23.4	-24.2	1.12	295	0.8	-1.0	88	6.0	-3.7
"2" NS	TORINO	HIGH	LOW	22.6	-34.3	22.5	-25.9	1.05	364	1.1	-1.4	86	6.3	-3.9
"2" NS	TORINO	LOW	HIGH	33.0	-28.1	32.8	-23.1	1.31	248	0.6	-0.8	75	4.8	-3.5
"2" NS	TORINO	HIGH	HIGH	31.9	-30.7	31.7	-24.7	1.23	314	0.9	-1.1	77	6.1	-3.5

HIGH LOADS 20/25°C SETPOINT TEMPERATURES

"2" NS	ATHENES	LOW	LOW	8.0	-53.4	8.0	-36.7	0.59	241	0.5	-0.8	87	3.7	-3.8
"2" NS	ATHENES	HIGH	LOW	7.6	-56.8	7.6	-38.4	0.48	297	0.7	-1.1	91	4.3	-4.0
"2" NS	ATHENES	LOW	HIGH	11.7	-51.2	11.7	-37.2	0.69	198	0.4	-0.6	78	3.4	-3.8
"2" NS	ATHENES	HIGH	HIGH	11.2	-54.4	11.2	-38.9	0.62	241	0.6	-0.9	78	3.8	-3.8
"2" NS	MUNICH	LOW	LOW	35.3	-20.1	34.0	-15.6	1.73	518	1.8	-2.6	91	6.5	-4.8
"2" NS	MUNICH	HIGH	LOW	34.4	-22.7	33.1	-17.2	1.59	615	2.4	-3.6	86	6.5	-5.0
"2" NS	MUNICH	LOW	HIGH	50.1	-15.9	47.9	-13.2	2.19	420	1.4	-1.9	86	5.8	-5.1
"2" NS	MUNICH	HIGH	HIGH	49.0	-18.2	46.8	-14.8	2.00	521	2.1	-2.8	86	6.8	-5.2
"2" NS	LISBOA	LOW	LOW	6.0	-37.5	6.0	-23.1	0.56	469	1.3	-1.6	105	4.4	-4.9
"2" NS	LISBOA	HIGH	LOW	5.9	-39.5	5.9	-24.1	0.46	523	1.5	-2.0	100	4.4	-4.8
"2" NS	LISBOA	LOW	HIGH	8.9	-32.8	8.8	-22.1	0.70	359	1.0	-1.1	108	5.4	-4.2
"2" NS	LISBOA	HIGH	HIGH	8.7	-34.8	8.7	-23.0	0.62	416	1.2	-1.4	105	5.5	-4.4
"2" EW	PARIS	LOW	LOW	28.4	-20.1	27.7	-16.7	1.31	242	0.6	-0.9	69	3.2	-2.7
"2" EW	PARIS	HIGH	LOW	27.8	-22.6	27.1	-18.5	1.21	309	0.9	-1.4	70	3.7	-2.7
"2" EW	PARIS	LOW	HIGH	39.1	-17.0	37.9	-14.9	1.53	212	0.6	-0.7	70	3.6	-3.4
"2" EW	PARIS	HIGH	HIGH	38.3	-19.3	37.1	-16.6	1.48	280	0.9	-1.2	61	3.6	-2.5
"2" EW	TORINO	LOW	LOW	23.9	-33.1	23.8	-25.7	1.06	219	0.5	-0.9	69	3.7	-3.2
"2" EW	TORINO	HIGH	LOW	23.1	-36.4	23.0	-27.9	0.97	271	0.8	-1.2	69	4.1	-3.3
"2" EW	TORINO	LOW	HIGH	33.5	-29.8	33.3	-24.5	1.23	208	0.5	-0.7	62	4.0	-2.4
"2" EW	TORINO	HIGH	HIGH	32.6	-32.9	32.4	-26.7	1.15	245	0.6	-1.1	63	4.5	-2.7
"2" EW	ATHENES	LOW	LOW	8.0	-56.1	8.0	-39.2	0.55	193	0.4	-0.6	73	2.5	-3.1
"2" EW	ATHENES	HIGH	LOW	7.6	-60.2	7.6	-41.6	0.45	223	0.5	-0.9	76	3.3	-2.8
"2" EW	ATHENES	LOW	HIGH	11.8	-53.9	11.8	-39.7	0.67	150	0.3	-0.5	70	2.7	-3.3
"2" EW	ATHENES	HIGH	HIGH	11.3	-58.0	11.3	-42.1	0.56	193	0.5	-0.8	70	2.8	-3.4
"2" EW	MUNICH	LOW	LOW	35.7	-21.6	34.4	-16.8	1.62	478	1.7	-2.9	69	4.4	-3.9
"2" EW	MUNICH	HIGH	LOW	34.9	-24.7	33.6	-19.0	1.32	565	2.2	-3.9	65	4.4	-3.9
"2" EW	MUNICH	LOW	HIGH	50.6	-17.4	48.4	-14.5	2.04	414	1.5	-2.2	71	4.9	-3.8
"2" EW	MUNICH	HIGH	HIGH	49.6	-20.3	47.4	-16.6	1.76	501	2.2	-3.2	70	5.5	-4.2
"2" EW	LISBOA	LOW	LOW	5.9	-41.0	5.9	-25.8	0.51	468	1.3	-1.6	78	3.5	-2.7
"2" EW	LISBOA	HIGH	LOW	5.8	-44.5	5.8	-27.7	0.36	521	1.5	-2.0	71	3.6	-2.3
"2" EW	LISBOA	LOW	HIGH	8.8	-36.4	8.7	-24.8	0.65	387	1.2	-1.1	88	4.8	-2.9
"2" EW	LISBOA	HIGH	HIGH	8.6	-39.8	8.6	-26.7	0.50	453	1.5	-1.6	79	4.4	-2.7
"3" NS	PARIS	LOW	LOW	53.7	-19.0	52.5	-16.5	1.37	124	0.2	-0.3	91	6.2	-4.7
"3" NS	PARIS	HIGH	LOW	50.1	-22.2	49.2	-18.9	1.26	93	0.1	-0.2	88	6.1	-4.4
"3" NS	PARIS	LOW	HIGH	64.3	-16.7	62.5	-14.9	1.53	87	0.1	-0.2	88	6.0	-5.1
"3" NS	PARIS	HIGH	HIGH	60.4	-19.6	59.1	-17.2	1.42	66	0.1	-0.1	87	6.1	-5.0
"3" NS	TORINO	LOW	LOW	36.9	-36.2	36.8	-28.9	1.02	182	0.3	-0.5	103	10.2	-4.6
"3" NS	TORINO	HIGH	LOW	32.8	-41.4	32.8	-32.5	0.92	134	0.2	-0.2	108	10.4	-5.3
"3" NS	TORINO	LOW	HIGH	46.1	-33.2	45.9	-27.7	1.16	151	0.2	-0.3	97	8.8	-4.8
"3" NS	TORINO	HIGH	HIGH	41.7	-38.0	41.6	-31.2	1.06	111	0.1	-0.2	103	10.1	-5.3
"3" NS	ATHENES	LOW	LOW	15.4	-62.0	15.4	-45.5	0.74	98	0.1	-0.2	95	5.8	-4.6
"3" NS	ATHENES	HIGH	LOW	13.0	-68.6	13.0	-49.5	0.64	53	0.1	-0.1	96	5.7	-4.9
"3" NS	ATHENES	LOW	HIGH	19.1	-60.4	19.1	-46.0	0.82	71	0.1	-0.1	85	4.4	-4.7
"3" NS	ATHENES	HIGH	HIGH	16.5	-66.7	16.5	-49.9	0.74	39	0.0	-0.1	87	5.8	-4.5
"3" NS	MUNICH	LOW	LOW	54.8	-21.5	53.6	-17.2	1.60	322	0.8	-1.2	103	7.7	-6.3
"3" NS	MUNICH	HIGH	LOW	50.2	-25.7	49.3	-20.3	1.40	257	0.5	-0.8	96	6.8	-6.0
"3" NS	MUNICH	LOW	HIGH	69.0	-17.8	67.0	-14.9	1.89	254	0.6	-0.9	98	7.2	-6.2
"3" NS	MUNICH	HIGH	HIGH	63.9	-21.6	62.5	-17.8	1.65	236	0.6	-0.6	96	7.7	-6.0
"3" NS	LISBOA	LOW	LOW	10.9	-35.5	10.9	-24.7	0.72	262	0.6	-0.7	118	6.0	-4.7
"3" NS	LISBOA	HIGH	LOW	9.4	-38.9	9.4	-26.7	0.65	239	0.4	-0.6	115	5.3	-4.9
"3" NS	LISBOA	LOW	HIGH	13.8	-32.1	13.7	-23.7	0.84	207	0.4	-0.5	116	6.5	-3.8
"3" NS	LISBOA	HIGH	HIGH	12.2	-35.3	12.1	-25.7	0.79	201	0.3	-0.4	115	6.3	-4.1
"3" EW	PARIS	LOW	LOW	54.1	-21.1	52.9	-18.2	1.36	155	0.3	-0.6	77	4.6	-4.2
"3" EW	PARIS	HIGH	LOW	50.6	-25.0	49.9	-21.3	1.17	125	0.2	-0.4	70	4.6	-3.4
"3" EW	PARIS	LOW	HIGH	64.6	-18.7	62.9	-16.6	1.52	109	0.2	-0.4	80	5.0	-5.3
"3" EW	PARIS	HIGH	HIGH	60.8	-22.3	59.7	-19.5	1.34	94	0.2	-0.3	73	4.5	-4.5
"3" EW	TORINO	LOW	LOW	38.2	-39.4	38.1	-31.5	0.94	168	0.4	-0.7	80	5.9	-4.5
"3" EW	TORINO	HIGH	LOW	34.8	-45.6	34.7	-36.0	0.84	132	0.3	-0.5	80	6.1	-4.2
"3" EW	TORINO	LOW	HIGH	47.4	-36.3	47.2	-30.3	1.07	145	0.3	-0.5	80	5.8	-4.8
"3" EW	TORINO	HIGH	HIGH	43.7	-42.1	43.6	-34.7	0.97	103	0.2	-0.4	79	6.1	-4.5
"3" EW	ATHENES	LOW	LOW	15.9	-67.1	15.9	-49.7	0.68	88	0.1	-0.3	85	4.3	-4.7
"3" EW	ATHENES	HIGH	LOW	13.7	-75.2	13.7	-55.0	0.57	50	0.1	-0.1	85	5.3	-4.2
"3" EW	ATHENES	LOW	HIGH	19.6	-65.6	19.6	-50.1	0.76	76	0.1	-0.3	78	4.2	-4.1
"3" EW	ATHENES	HIGH	HIGH	17.3	-73.3	17.3	-55.3	0.67	51	0.1	-0.1	78	4.3	-3.9
"3" EW	MUNICH	LOW	LOW	56.0	-24.6	54.7	-19.6	1.45	307	0.9	-2.0	86	6.3	-6.0
"3" EW	MUNICH	HIGH	LOW	51.9	-30.0	51.1	-23.6	1.25	266	0.7	-1.5	73	5.2	-4.9
"3" EW	MUNICH	LOW	HIGH	70.0	-20.8	68.1	-17.3	1.71	288	0.9	-1.6	81	5.8	-5.8
"3" EW	MUNICH	HIGH	HIGH	65.5	-25.7	64.2	-21.0	1.48	253	0.7	-1.3	78	6.1	-5.2
"3" EW	LISBOA	LOW	LOW	10.6	-40.3	10.6	-28.6	0.64	267	0.6	-0.7	96	5.4	-3.5
"3" EW	LISBOA	HIGH	LOW	9.1	-45.9	9.1	-32.2	0.55	241	0.5	-0.5	87	4.8	-3.1
"3" EW	LISBOA	LOW	HIGH	13.4	-36.7	13.4	-27.5	0.75	176	0.4	-0.4	101	6.2	-3.0
"3" EW	LISBOA	HIGH	HIGH	11.8	-42.0	11.8	-31.0	0.68	185	0.4	-0.3	95	5.9	-2.8

Table 39: Results for low load buildings with set point temperatures of 21/24°C

Building case				energy demand (kWh/m ² /year) - 5 zones -				Ratio max heating on cooling power	Number of hours with simultaneous cooling and heating demand	Energy demand when simultaneity H/C demand		Number of days with non simultaneous cooling and heating demand	Energy demand when daily H/C demand but non simultaneous	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating	Annual cooling	Winter heating	Summer cooling			heating	cooling		heating	cooling
LOW LOADS – 21/24 °C SETPOINT TEMPERATURES														
1a NS	PARIS	LOW	LOW	34.0	-19.4	32.9	-15.5	1.19	405	0.7	-2.2	117	8.1	-8.1
1a NS	PARIS	HIGH	LOW	32.6	-22.3	31.5	-17.5	0.92	501	0.9	-3.3	112	8.0	-7.9
1a NS	PARIS	LOW	HIGH	47.4	-16.3	45.6	-13.7	1.39	310	0.5	-1.5	109	8.4	-7.3
1a NS	PARIS	HIGH	HIGH	45.7	-18.9	44.0	-15.6	1.18	402	0.8	-2.4	104	8.3	-7.3
1a NS	TORINO	LOW	LOW	30.3	-31.7	30.0	-23.7	1.11	494	1.0	-2.6	119	11.6	-7.9
1a NS	TORINO	HIGH	LOW	28.6	-35.8	28.3	-26.1	0.80	580	1.4	-3.8	121	11.8	-8.9
1a NS	TORINO	LOW	HIGH	42.1	-28.3	41.7	-22.7	1.32	395	0.9	-2.0	112	11.0	-8.2
1a NS	TORINO	HIGH	HIGH	40.3	-32.1	39.8	-25.1	1.01	496	1.4	-3.1	114	11.5	-9.2
1a NS	ATHENES	LOW	LOW	10.2	-54.1	10.2	-36.4	0.54	388	0.6	-2.1	117	6.9	-7.6
1a NS	ATHENES	HIGH	LOW	9.3	-59.1	9.3	-38.9	0.34	467	0.9	-3.1	119	7.2	-8.1
1a NS	ATHENES	LOW	HIGH	15.1	-52.3	15.1	-37.5	0.57	325	0.6	-1.6	105	7.4	-6.7
1a NS	ATHENES	HIGH	HIGH	14.1	-57.1	14.1	-40.0	0.46	404	0.9	-2.5	109	7.8	-7.1
1a NS	MUNICH	LOW	LOW	40.5	-20.3	38.8	-15.1	1.59	667	1.7	-4.9	120	8.9	-9.6
1a NS	MUNICH	HIGH	LOW	38.7	-24.0	37.1	-17.5	1.04	783	2.4	-6.9	118	9.2	-10.3
1a NS	MUNICH	LOW	HIGH	58.0	-15.7	55.5	-12.6	1.97	544	1.5	-3.5	117	9.7	-9.1
1a NS	MUNICH	HIGH	HIGH	55.9	-19.0	53.5	-14.9	1.41	648	2.2	-5.4	116	9.6	-10.6
1a NS	LISBOA	LOW	LOW	8.4	-33.0	8.3	-20.8	0.77	520	0.9	-2.6	121	5.6	-6.8
1a NS	LISBOA	HIGH	LOW	8.0	-35.9	7.9	-22.2	0.62	592	1.1	-3.3	116	5.6	-7.1
1a NS	LISBOA	LOW	HIGH	12.7	-29.0	12.5	-20.0	0.77	484	0.9	-2.1	119	7.2	-5.6
1a NS	LISBOA	HIGH	HIGH	12.2	-31.8	12.0	-21.3	0.63	561	1.2	-2.9	115	7.1	-5.9
1a EW	PARIS	LOW	LOW	34.1	-20.9	33.0	-16.9	1.18	416	0.8	-2.4	100	7.0	-6.0
1a EW	PARIS	HIGH	LOW	32.7	-24.5	31.6	-19.5	0.86	505	1.1	-3.7	92	6.7	-5.6
1a EW	PARIS	LOW	HIGH	47.5	-17.7	45.7	-15.0	1.39	309	0.6	-1.6	98	7.6	-6.4
1a EW	PARIS	HIGH	HIGH	45.8	-21.0	44.1	-17.5	1.08	413	1.0	-2.8	95	7.9	-6.4
1a EW	TORINO	LOW	LOW	30.6	-33.4	30.4	-25.7	0.98	369	0.6	-2.1	101	9.5	-5.9
1a EW	TORINO	HIGH	LOW	29.0	-38.1	28.8	-28.8	0.68	454	0.9	-3.0	100	9.5	-6.6
1a EW	TORINO	LOW	HIGH	42.7	-30.3	42.2	-24.7	1.24	299	0.5	-1.7	101	9.7	-6.9
1a EW	TORINO	HIGH	HIGH	40.8	-34.7	40.4	-27.8	0.86	377	0.8	-2.6	98	9.7	-7.2
1a EW	ATHENES	LOW	LOW	10.3	-57.6	10.3	-39.7	0.52	296	0.4	-1.6	108	6.6	-6.2
1a EW	ATHENES	HIGH	LOW	9.4	-63.7	9.4	-43.2	0.36	346	0.6	-2.4	109	6.6	-6.5
1a EW	ATHENES	LOW	HIGH	15.2	-55.9	15.2	-40.8	0.53	238	0.4	-1.2	94	6.8	-5.4
1a EW	ATHENES	HIGH	HIGH	14.1	-61.9	14.1	-44.4	0.41	302	0.6	-2.1	95	7.1	-5.6
1a EW	MUNICH	LOW	LOW	40.9	-22.1	39.3	-16.9	1.39	638	1.6	-5.1	99	7.3	-7.5
1a EW	MUNICH	HIGH	LOW	39.2	-26.6	37.6	-20.0	0.80	738	2.2	-7.4	95	7.0	-8.1
1a EW	MUNICH	LOW	HIGH	58.5	-17.5	56.0	-14.2	1.85	532	1.4	-3.8	96	7.8	-7.8
1a EW	MUNICH	HIGH	HIGH	56.6	-21.6	54.2	-17.2	1.07	637	2.0	-6.0	96	8.4	-7.9
1a EW	LISBOA	LOW	LOW	8.2	-37.6	8.1	-24.5	0.60	521	1.0	-2.2	97	5.2	-4.7
1a EW	LISBOA	HIGH	LOW	7.8	-42.6	7.7	-27.3	0.43	607	1.3	-3.1	90	4.8	-4.9
1a EW	LISBOA	LOW	HIGH	12.4	-33.7	12.3	-23.6	0.61	475	0.9	-1.9	104	6.9	-4.4
1a EW	LISBOA	HIGH	HIGH	11.9	-38.5	11.8	-26.4	0.44	587	1.3	-2.9	97	6.6	-4.4
1b NS	PARIS	LOW	LOW	45.5	-20.3	43.8	-15.2	1.32	376	1.0	-2.0	129	11.6	-9.4
1b NS	PARIS	HIGH	LOW	43.6	-23.4	42.0	-17.2	1.24	484	1.5	-3.0	120	11.5	-9.2
1b NS	PARIS	LOW	HIGH	58.6	-17.6	55.8	-13.9	1.51	337	1.2	-1.6	123	12.8	-8.9
1b NS	PARIS	HIGH	HIGH	56.4	-20.5	53.9	-15.9	1.42	417	1.6	-2.6	120	12.7	-9.4
1b NS	TORINO	LOW	LOW	40.1	-33.5	39.8	-23.5	1.27	511	1.9	-3.0	126	12.7	-10.8
1b NS	TORINO	HIGH	LOW	38.0	-38.0	37.7	-26.0	1.15	594	2.5	-4.3	126	13.3	-11.8
1b NS	TORINO	LOW	HIGH	51.7	-30.6	51.0	-22.8	1.42	475	2.2	-2.7	124	15.1	-10.3
1b NS	TORINO	HIGH	HIGH	49.4	-35.0	48.8	-25.3	1.34	576	2.9	-4.0	119	14.7	-10.9
1b NS	ATHENES	LOW	LOW	15.0	-55.2	15.0	-36.4	0.69	375	1.0	-2.0	125	10.6	-8.4
1b NS	ATHENES	HIGH	LOW	13.9	-60.5	13.9	-39.1	0.54	455	1.3	-2.9	124	10.3	-9.1
1b NS	ATHENES	LOW	HIGH	20.3	-53.7	20.3	-37.4	0.84	355	1.1	-1.9	128	13.3	-8.7
1b NS	ATHENES	HIGH	HIGH	19.1	-59.0	19.1	-40.1	0.66	443	1.6	-2.8	125	13.0	-9.3
1b NS	MUNICH	LOW	LOW	52.3	-22.5	49.9	-15.4	1.78	705	3.2	-4.9	135	13.5	-11.7
1b NS	MUNICH	HIGH	LOW	50.0	-26.7	47.8	-18.0	1.37	842	4.3	-7.1	131	13.7	-12.6
1b NS	MUNICH	LOW	HIGH	69.3	-18.6	65.6	-13.6	2.13	628	3.1	-4.2	128	13.6	-11.1
1b NS	MUNICH	HIGH	HIGH	66.7	-22.5	63.2	-16.1	1.76	746	4.4	-6.3	127	13.2	-13.1
1b NS	LISBOA	LOW	LOW	13.0	-30.1	12.9	-18.5	0.83	391	1.0	-2.0	128	7.6	-6.5
1b NS	LISBOA	HIGH	LOW	12.4	-33.2	12.3	-19.9	0.67	468	1.3	-2.7	122	7.6	-6.9

LOW LOADS – 21/24 °C SETPOINT TEMPERATURES														
1b NS	LISBOA	LOW	HIGH	18.2	-27.2	18.0	-17.9	0.99	406	1.3	-2.1	125	8.8	-6.5
1b NS	LISBOA	HIGH	HIGH	17.6	-30.1	17.4	-19.3	0.82	516	1.7	-2.9	111	8.4	-6.4
1b EW	PARIS	LOW	LOW	45.5	-21.9	43.8	-16.8	1.33	340	0.7	-1.8	119	11.3	-8.2
1b EW	PARIS	HIGH	LOW	43.6	-25.6	42.1	-19.4	1.25	460	1.3	-3.0	112	11.4	-7.6
1b EW	PARIS	LOW	HIGH	58.6	-19.1	56.0	-15.5	1.51	323	0.9	-1.4	114	12.7	-7.7
1b EW	PARIS	HIGH	HIGH	56.5	-22.7	54.1	-18.0	1.42	415	1.4	-2.6	110	13.1	-8.0
1b EW	TORINO	LOW	LOW	40.4	-35.2	40.1	-25.8	1.17	371	0.9	-1.8	118	13.2	-9.0
1b EW	TORINO	HIGH	LOW	38.4	-40.3	38.0	-29.1	0.96	453	1.2	-2.7	112	13.1	-9.1
1b EW	TORINO	LOW	HIGH	52.2	-32.5	51.5	-25.1	1.32	374	1.0	-1.7	113	14.9	-8.4
1b EW	TORINO	HIGH	HIGH	49.9	-37.4	49.3	-28.4	1.17	449	1.4	-2.7	108	14.4	-9.0
1b EW	ATHENES	LOW	LOW	14.9	-59.1	14.9	-40.4	0.62	258	0.5	-1.1	119	10.2	-6.8
1b EW	ATHENES	HIGH	LOW	13.8	-65.7	13.8	-44.1	0.46	313	0.7	-1.9	117	10.2	-7.1
1b EW	ATHENES	LOW	HIGH	20.3	-57.8	20.3	-41.3	0.76	256	0.6	-1.1	113	12.3	-6.4
1b EW	ATHENES	HIGH	HIGH	19.1	-64.3	19.1	-45.1	0.57	326	0.9	-1.9	110	12.2	-6.4
1b EW	MUNICH	LOW	LOW	52.6	-24.3	50.4	-17.5	1.65	653	2.4	-4.7	113	11.8	-9.2
1b EW	MUNICH	HIGH	LOW	50.5	-29.3	48.3	-20.8	1.01	768	3.2	-7.1	106	11.5	-9.5
1b EW	MUNICH	LOW	HIGH	69.7	-20.5	66.1	-15.6	1.99	601	2.5	-4.1	114	13.2	-9.4
1b EW	MUNICH	HIGH	HIGH	67.3	-25.2	63.8	-18.9	1.29	711	3.4	-6.5	110	13.2	-10.3
1b EW	LISBOA	LOW	LOW	12.6	-35.3	12.5	-22.8	0.66	355	0.7	-1.2	106	7.1	-5.1
1b EW	LISBOA	HIGH	LOW	12.0	-40.5	11.9	-25.8	0.48	472	1.2	-2.0	97	6.7	-5.4
1b EW	LISBOA	LOW	HIGH	17.8	-32.4	17.6	-22.2	0.81	389	0.8	-1.4	104	8.6	-5.0
1b EW	LISBOA	HIGH	HIGH	17.1	-37.5	16.9	-25.2	0.59	503	1.4	-2.4	97	8.2	-5.2
1c NS	PARIS	LOW	LOW	61.6	-20.5	59.3	-16.2	1.25	222	0.6	-0.7	131	14.7	-9.8
1c NS	PARIS	HIGH	LOW	56.9	-24.7	55.3	-19.2	1.14	217	0.5	-0.5	121	13.3	-9.6
1c NS	PARIS	LOW	HIGH	74.9	-18.2	71.7	-14.9	1.40	189	0.6	-0.5	124	15.0	-9.3
1c NS	PARIS	HIGH	HIGH	69.9	-22.0	67.5	-17.7	1.28	178	0.5	-0.4	120	13.8	-9.6
1c NS	TORINO	LOW	LOW	52.3	-35.6	51.9	-26.5	1.22	343	1.2	-1.2	127	15.8	-10.9
1c NS	TORINO	HIGH	LOW	47.2	-42.0	46.9	-30.6	1.12	275	0.9	-1.0	129	15.7	-12.1
1c NS	TORINO	LOW	HIGH	64.1	-32.9	63.5	-25.6	1.35	304	1.2	-1.0	128	18.0	-10.7
1c NS	TORINO	HIGH	HIGH	58.6	-38.9	58.1	-29.6	1.25	279	1.1	-1.0	119	15.9	-11.1
1c NS	ATHENES	LOW	LOW	19.8	-61.0	19.8	-42.2	0.79	204	0.5	-0.5	128	13.3	-8.9
1c NS	ATHENES	HIGH	LOW	16.8	-69.3	16.8	-46.9	0.67	156	0.3	-0.3	126	12.4	-9.4
1c NS	ATHENES	LOW	HIGH	25.1	-59.8	25.1	-43.1	0.87	183	0.5	-0.5	126	15.0	-8.8
1c NS	ATHENES	HIGH	HIGH	21.9	-67.7	21.9	-47.7	0.78	148	0.4	-0.3	126	14.0	-9.7
1c NS	MUNICH	LOW	LOW	66.3	-22.4	64.0	-16.4	1.58	429	1.7	-1.6	143	15.7	-12.7
1c NS	MUNICH	HIGH	LOW	60.3	-27.8	58.8	-20.1	1.38	395	1.6	-1.3	129	13.8	-11.9
1c NS	MUNICH	LOW	HIGH	83.6	-18.8	80.1	-14.4	1.86	379	1.5	-1.3	129	14.1	-11.2
1c NS	MUNICH	HIGH	HIGH	77.0	-23.6	74.5	-17.8	1.64	350	1.6	-1.2	126	12.5	-12.7
1c NS	LISBOA	LOW	LOW	17.9	-29.2	17.7	-19.7	0.88	330	0.8	-1.0	131	10.2	-6.2
1c NS	LISBOA	HIGH	LOW	15.9	-33.6	15.7	-22.0	0.80	291	0.6	-0.8	124	9.1	-6.7
1c NS	LISBOA	LOW	HIGH	23.2	-26.8	22.8	-19.0	1.01	308	0.8	-0.9	127	11.0	-6.2
1c NS	LISBOA	HIGH	HIGH	20.9	-30.8	20.7	-21.3	0.91	319	0.7	-1.0	116	9.9	-6.4
1c EW	PARIS	LOW	LOW	61.8	-22.8	59.7	-18.3	1.25	227	0.5	-1.1	120	14.7	-8.6
1c EW	PARIS	HIGH	LOW	57.2	-27.5	55.9	-21.8	1.14	206	0.5	-0.8	112	13.9	-7.9
1c EW	PARIS	LOW	HIGH	75.1	-20.4	72.1	-16.9	1.40	206	0.6	-0.9	114	14.7	-8.1
1c EW	PARIS	HIGH	HIGH	70.1	-24.7	68.1	-20.2	1.28	177	0.5	-0.7	109	13.7	-8.5
1c EW	TORINO	LOW	LOW	53.7	-38.7	53.3	-29.5	1.10	239	0.7	-1.1	119	17.1	-9.1
1c EW	TORINO	HIGH	LOW	48.9	-45.6	48.7	-34.4	1.00	214	0.6	-0.8	113	15.8	-9.2
1c EW	TORINO	LOW	HIGH	65.6	-36.1	64.9	-28.6	1.23	231	0.7	-0.9	117	18.4	-9.0
1c EW	TORINO	HIGH	HIGH	60.5	-42.6	60.1	-33.4	1.12	195	0.6	-0.8	110	16.5	-9.1
1c EW	ATHENES	LOW	LOW	20.3	-66.9	20.3	-47.3	0.73	171	0.3	-0.7	119	13.1	-7.1
1c EW	ATHENES	HIGH	LOW	17.4	-76.4	17.4	-53.3	0.57	107	0.2	-0.4	115	12.4	-7.0
1c EW	ATHENES	LOW	HIGH	25.6	-65.7	25.6	-48.2	0.81	143	0.3	-0.5	114	14.8	-6.9
1c EW	ATHENES	HIGH	HIGH	22.6	-74.9	22.6	-54.1	0.68	126	0.2	-0.5	107	13.4	-6.1
1c EW	MUNICH	LOW	LOW	67.4	-25.8	65.2	-19.3	1.44	426	1.5	-2.6	112	13.1	-9.6
1c EW	MUNICH	HIGH	LOW	61.9	-32.1	60.6	-23.8	1.22	374	1.2	-2.2	103	12.2	-8.7
1c EW	MUNICH	LOW	HIGH	84.7	-22.1	81.4	-17.2	1.70	390	1.5	-2.3	115	14.4	-10.1
1c EW	MUNICH	HIGH	HIGH	78.7	-27.8	76.4	-21.4	1.48	366	1.3	-2.1	104	12.4	-9.1
1c EW	LISBOA	LOW	LOW	17.3	-34.9	17.2	-24.4	0.85	266	0.6	-0.7	107	9.3	-4.5
1c EW	LISBOA	HIGH	LOW	15.1	-41.2	15.1	-28.5	0.64	230	0.5	-0.6	97	8.0	-4.8
1c EW	LISBOA	LOW	HIGH	22.5	-32.3	22.3	-23.6	0.96	258	0.5	-0.8	107	10.7	-4.4
1c EW	LISBOA	HIGH	HIGH	20.1	-38.1	20.0	-27.5	0.74	244	0.5	-0.8	97	9.2	-4.5
"2" NS	PARIS	LOW	LOW	44.6	-13.4	43.1	-11.6	1.72	230	0.4	-0.7	85	5.3	-3.6
"2" NS	PARIS	HIGH	LOW	43.4	-15.2	41.9	-12.9	1.65	310	0.7	-1.1	85	6.0	-3.5
"2" NS	PARIS	LOW	HIGH	58.1	-11.5	55.6	-10.4	1.93	196	0.4	-0.5	82	5.9	-3.6
"2" NS	PARIS	HIGH	HIGH	56.7	-13.1	54.3	-11.6	1.85	266	0.6	-0.9	81	6.3	-3.8
"2" NS	TORINO	LOW	LOW	36.3	-24.5	36.0	-19.9	1.42	325	0.8	-0.9	89	7.3	-3.3
"2" NS	TORINO	HIGH	LOW	34.9	-27.2	34.6	-21.6	1.32	417	1.2	-1.5	89	7.8	-3.8
"2" NS	TORINO	LOW	HIGH	48.2	-22.4	47.7	-19.1	1.60	251	0.5	-0.7	86	6.9	-4.2
"2" NS	TORINO	HIGH	HIGH	46.7	-24.9	46.1	-20.8	1.49	346	1.0	-1.3	85	7.9	-4.2
"2" NS	ATHENES	LOW	LOW	14.8	-44.4	14.8	-32.7	0.80	230	0.4	-0.7	80	4.5	-3.1
"2" NS	ATHENES	HIGH	LOW	14.0	-47.7	14.0	-34.4	0.67	306	0.7	-1.1	84	6.0	-3.2
"2" NS	ATHENES	LOW	HIGH	20.4	-43.8	20.4	-33.6	0.92	190	0.4	-0.5	72	4.6	-3.1

LOW LOADS – 21/24 °C SETPOINT TEMPERATURES														
"2" NS	ATHENES	HIGH	HIGH	19.5	-46.9	19.5	-35.4	0.83	258	0.7	-0.9	73	4.9	-3.4
"2" NS	MUNICH	LOW	LOW	51.5	-13.5	49.2	-10.9	2.24	486	1.5	-2.0	98	7.5	-4.4
"2" NS	MUNICH	HIGH	LOW	50.0	-15.8	47.8	-12.6	2.03	614	2.3	-3.0	97	7.7	-5.1
"2" NS	MUNICH	LOW	HIGH	69.1	-10.6	65.6	-9.2	2.67	386	1.2	-1.4	91	7.1	-4.0
"2" NS	MUNICH	HIGH	HIGH	67.4	-12.7	64.0	-10.7	2.42	487	1.8	-2.3	92	7.4	-4.8
"2" NS	LISBOA	LOW	LOW	12.1	-24.6	12.0	-17.3	0.90	378	0.8	-0.9	106	5.7	-3.0
"2" NS	LISBOA	HIGH	LOW	11.7	-26.5	11.6	-18.3	0.80	452	1.1	-1.3	100	5.7	-3.1
"2" NS	LISBOA	LOW	HIGH	17.3	-22.0	17.1	-16.7	1.04	306	0.6	-0.7	104	6.8	-2.7
"2" NS	LISBOA	HIGH	HIGH	16.8	-23.8	16.6	-17.6	0.99	397	0.9	-1.1	94	6.7	-2.4
"2" EW	PARIS	LOW	LOW	44.8	-14.6	43.3	-12.6	1.71	247	0.5	-0.8	73	4.7	-2.8
"2" EW	PARIS	HIGH	LOW	43.5	-16.9	42.1	-14.4	1.53	331	0.9	-1.5	70	4.8	-2.7
"2" EW	PARIS	LOW	HIGH	58.3	-12.7	55.8	-11.4	1.91	213	0.5	-0.6	78	6.0	-3.4
"2" EW	PARIS	HIGH	HIGH	56.9	-14.8	54.5	-13.1	1.83	282	0.8	-1.2	74	5.9	-3.5
"2" EW	TORINO	LOW	LOW	36.8	-26.1	36.5	-21.4	1.33	240	0.5	-0.8	74	5.6	-2.5
"2" EW	TORINO	HIGH	LOW	35.5	-29.3	35.2	-23.7	1.19	309	0.7	-1.3	75	6.2	-2.8
"2" EW	TORINO	LOW	HIGH	48.9	-24.0	48.3	-20.7	1.50	207	0.4	-0.7	79	6.8	-3.5
"2" EW	TORINO	HIGH	HIGH	47.4	-27.1	46.9	-22.9	1.39	269	0.6	-1.2	75	7.0	-3.3
"2" EW	ATHENES	LOW	LOW	14.9	-47.3	14.9	-35.2	0.74	162	0.3	-0.5	77	4.5	-2.5
"2" EW	ATHENES	HIGH	LOW	14.1	-51.4	14.1	-37.7	0.60	213	0.5	-0.9	78	5.5	-2.5
"2" EW	ATHENES	LOW	HIGH	20.6	-46.7	20.6	-36.1	0.88	151	0.3	-0.4	61	3.5	-2.4
"2" EW	ATHENES	HIGH	HIGH	19.7	-50.7	19.7	-38.6	0.73	207	0.6	-0.8	64	4.2	-2.5
"2" EW	MUNICH	LOW	LOW	51.9	-15.0	49.7	-12.2	2.07	472	1.5	-2.3	78	5.9	-3.2
"2" EW	MUNICH	HIGH	LOW	50.5	-17.9	48.3	-14.4	1.68	568	2.1	-3.5	78	6.5	-3.8
"2" EW	MUNICH	LOW	HIGH	69.6	-12.0	66.2	-10.4	2.47	384	1.2	-1.7	84	7.5	-3.8
"2" EW	MUNICH	HIGH	HIGH	68.0	-14.7	64.6	-12.4	2.19	489	2.0	-2.9	76	7.5	-3.5
"2" EW	LISBOA	LOW	LOW	11.9	-28.2	11.8	-20.2	0.75	380	0.8	-0.8	92	5.9	-2.1
"2" EW	LISBOA	HIGH	LOW	11.5	-31.6	11.4	-22.1	0.59	495	1.3	-1.4	83	5.6	-2.2
"2" EW	LISBOA	LOW	HIGH	17.1	-25.7	16.9	-19.5	0.94	318	0.7	-0.8	82	6.0	-2.0
"2" EW	LISBOA	HIGH	HIGH	16.6	-28.9	16.4	-21.5	0.73	435	1.2	-1.4	81	6.5	-2.0
"3" NS	PARIS	LOW	LOW	73.1	-15.8	70.6	-13.9	1.67	116	0.2	-0.2	104	10.2	-5.4
"3" NS	PARIS	HIGH	LOW	68.7	-19.0	66.9	-16.4	1.54	106	0.2	-0.2	99	9.0	-5.4
"3" NS	PARIS	LOW	HIGH	85.8	-14.3	82.4	-12.8	1.81	97	0.2	-0.2	95	9.2	-5.5
"3" NS	PARIS	HIGH	HIGH	81.2	-17.2	78.6	-15.2	1.68	99	0.2	-0.2	95	9.7	-5.4
"3" NS	TORINO	LOW	LOW	51.3	-31.7	51.0	-25.9	1.24	233	0.5	-0.4	105	11.1	-5.7
"3" NS	TORINO	HIGH	LOW	46.5	-37.0	46.4	-29.7	1.13	211	0.5	-0.4	108	11.2	-6.0
"3" NS	TORINO	LOW	HIGH	62.5	-29.6	62.0	-25.1	1.38	174	0.4	-0.3	104	11.2	-6.1
"3" NS	TORINO	HIGH	HIGH	57.4	-34.6	57.1	-28.7	1.26	184	0.5	-0.3	101	10.9	-6.2
"3" NS	ATHENES	LOW	LOW	24.5	-57.0	24.5	-43.1	0.93	113	0.2	-0.2	101	9.5	-4.7
"3" NS	ATHENES	HIGH	LOW	21.5	-63.6	21.5	-47.1	0.81	77	0.1	-0.1	103	9.2	-5.1
"3" NS	ATHENES	LOW	HIGH	29.8	-56.5	29.8	-43.9	0.99	83	0.1	-0.1	91	8.5	-5.1
"3" NS	ATHENES	HIGH	HIGH	26.6	-62.9	26.6	-47.9	0.91	69	0.1	-0.1	92	8.6	-5.2
"3" NS	MUNICH	LOW	LOW	72.5	-16.8	70.3	-13.8	1.92	322	0.7	-0.9	109	9.2	-6.2
"3" NS	MUNICH	HIGH	LOW	67.0	-21.0	65.5	-16.9	1.67	288	0.7	-0.7	104	8.4	-6.5
"3" NS	MUNICH	LOW	HIGH	88.9	-14.1	85.6	-12.0	2.20	240	0.6	-0.6	105	9.1	-6.2
"3" NS	MUNICH	HIGH	HIGH	83.0	-17.9	80.7	-14.9	1.92	272	0.8	-0.5	101	8.1	-6.6
"3" NS	LISBOA	LOW	LOW	20.1	-26.1	19.9	-19.9	1.05	226	0.4	-0.4	115	8.4	-3.1
"3" NS	LISBOA	HIGH	LOW	18.1	-29.6	18.0	-21.9	0.89	223	0.4	-0.4	107	7.5	-3.0
"3" NS	LISBOA	LOW	HIGH	25.2	-24.3	24.9	-19.2	1.15	190	0.4	-0.3	110	8.6	-3.2
"3" NS	LISBOA	HIGH	HIGH	23.1	-27.5	22.8	-21.2	1.03	204	0.4	-0.4	105	8.0	-3.1
"3" EW	PARIS	LOW	LOW	73.2	-17.8	71.0	-15.6	1.65	134	0.2	-0.5	90	8.0	-5.2
"3" EW	PARIS	HIGH	LOW	68.9	-21.7	67.4	-18.7	1.42	111	0.2	-0.4	89	8.3	-4.9
"3" EW	PARIS	LOW	HIGH	85.8	-16.1	82.7	-14.4	1.80	122	0.3	-0.5	91	8.8	-5.2
"3" EW	PARIS	HIGH	HIGH	81.3	-19.7	79.0	-17.4	1.59	93	0.2	-0.3	83	7.6	-5.1
"3" EW	TORINO	LOW	LOW	52.4	-34.7	52.2	-28.6	1.14	166	0.3	-0.6	97	10.2	-5.4
"3" EW	TORINO	HIGH	LOW	48.2	-40.9	48.1	-33.2	1.02	143	0.2	-0.4	95	10.2	-4.8
"3" EW	TORINO	LOW	HIGH	63.6	-32.7	63.1	-27.7	1.27	141	0.3	-0.5	93	11.0	-5.1
"3" EW	TORINO	HIGH	HIGH	59.2	-38.5	58.9	-32.2	1.14	120	0.2	-0.4	89	9.7	-5.5
"3" EW	ATHENES	LOW	LOW	24.9	-62.1	24.9	-47.4	0.85	85	0.1	-0.3	94	8.9	-4.3
"3" EW	ATHENES	HIGH	LOW	22.1	-70.2	22.1	-52.8	0.73	58	0.1	-0.2	90	9.2	-3.7
"3" EW	ATHENES	LOW	HIGH	30.2	-61.7	30.2	-48.2	0.91	71	0.1	-0.2	86	8.6	-4.4
"3" EW	ATHENES	HIGH	HIGH	27.3	-69.6	27.3	-53.5	0.82	70	0.1	-0.2	81	8.6	-3.7
"3" EW	MUNICH	LOW	LOW	73.3	-19.8	71.3	-16.1	1.73	315	0.8	-1.5	96	9.0	-5.8
"3" EW	MUNICH	HIGH	LOW	68.3	-25.1	67.0	-20.1	1.49	272	0.7	-1.3	87	8.2	-5.1
"3" EW	MUNICH	LOW	HIGH	89.6	-16.9	86.5	-14.3	1.99	277	0.8	-1.3	92	8.5	-6.1
"3" EW	MUNICH	HIGH	HIGH	84.2	-21.7	82.1	-18.0	1.71	268	0.7	-1.2	88	8.3	-5.8
"3" EW	LISBOA	LOW	LOW	19.5	-31.1	19.4	-24.0	0.92	161	0.2	-0.3	99	8.1	-2.3
"3" EW	LISBOA	HIGH	LOW	17.4	-36.8	17.4	-27.8	0.78	149	0.3	-0.2	95	7.5	-2.3
"3" EW	LISBOA	LOW	HIGH	24.5	-29.1	24.4	-23.3	1.01	150	0.2	-0.3	94	8.3	-2.1
"3" EW	LISBOA	HIGH	HIGH	22.2	-34.4	22.2	-26.9	0.89	145	0.3	-0.2	90	7.9	-2.3

Table 40: Results for low load buildings with set point temperatures of 20/25°C

Building case				energy demand (kWh/m ² /year) - 5 zones -				Ratio max heating on cooling power	Number of hours with simultaneous cooling and heating demand	Energy demand when simultaneity H/C demand		Number of days with non simultaneous cooling and heating demand	Energy demand when daily H/C demand but non simultaneous	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating	Annual cooling	Winter heating	Summer cooling			heating	cooling		heating	cooling
LOW LOADS 20/25°C SETPOINT TEMPERATURES														
1a NS	PARIS	LOW	LOW	29.4	-16.0	28.7	-13.4	1.18	148	0.2	-0.6	100	3.9	-6.7
1a NS	PARIS	HIGH	LOW	28.1	-18.7	27.4	-15.3	0.97	226	0.3	-1.1	102	4.4	-7.0
1a NS	PARIS	LOW	HIGH	41.3	-12.9	40.1	-11.4	1.41	105	0.1	-0.3	92	4.0	-6.0
1a NS	PARIS	HIGH	HIGH	39.8	-15.3	38.6	-13.2	1.26	182	0.3	-0.7	95	4.7	-6.2
1a NS	TORINO	LOW	LOW	26.1	-27.2	26.0	-21.4	1.12	204	0.3	-0.8	115	7.6	-7.5
1a NS	TORINO	HIGH	LOW	24.5	-31.1	24.4	-23.8	0.82	290	0.5	-1.5	115	8.2	-7.9
1a NS	TORINO	LOW	HIGH	36.8	-23.8	36.6	-20.0	1.31	135	0.2	-0.5	99	5.7	-7.1
1a NS	TORINO	HIGH	HIGH	35.0	-27.4	34.8	-22.4	1.06	212	0.4	-1.1	104	7.4	-7.5
1a NS	ATHENES	LOW	LOW	7.9	-48.3	7.9	-33.7	0.50	167	0.2	-0.7	100	3.9	-5.7
1a NS	ATHENES	HIGH	LOW	7.1	-53.2	7.1	-36.3	0.32	226	0.3	-1.2	103	4.0	-6.6
1a NS	ATHENES	LOW	HIGH	11.9	-46.2	11.9	-34.3	0.56	116	0.1	-0.5	85	3.2	-5.7
1a NS	ATHENES	HIGH	HIGH	11.0	-50.8	11.0	-36.9	0.44	172	0.3	-0.9	95	4.5	-6.3
1a NS	MUNICH	LOW	LOW	36.1	-17.2	34.9	-13.3	1.65	418	0.8	-2.4	114	5.8	-8.8
1a NS	MUNICH	HIGH	LOW	34.5	-20.7	33.3	-15.7	1.08	535	1.3	-3.9	113	6.3	-9.6
1a NS	MUNICH	LOW	HIGH	52.3	-12.6	50.4	-10.6	2.08	277	0.5	-1.4	108	5.6	-7.9
1a NS	MUNICH	HIGH	HIGH	50.4	-15.7	48.5	-12.8	1.49	385	0.9	-2.6	110	6.3	-8.9
1a NS	LISBOA	LOW	LOW	6.2	-27.8	6.2	-18.4	0.72	245	0.4	-0.9	120	3.9	-5.4
1a NS	LISBOA	HIGH	LOW	6.0	-30.6	5.9	-19.8	0.58	309	0.5	-1.4	117	3.8	-6.1
1a NS	LISBOA	LOW	HIGH	9.4	-23.7	9.4	-17.2	0.75	157	0.2	-0.5	116	4.6	-4.7
1a NS	LISBOA	HIGH	HIGH	9.1	-26.3	9.0	-18.5	0.60	232	0.4	-0.9	109	4.8	-4.6
1a EW	PARIS	LOW	LOW	29.5	-17.5	28.8	-14.7	1.18	166	0.2	-0.7	89	3.1	-5.7
1a EW	PARIS	HIGH	LOW	28.3	-20.9	27.6	-17.3	0.89	275	0.5	-1.5	81	3.4	-5.1
1a EW	PARIS	LOW	HIGH	41.4	-14.3	40.2	-12.7	1.40	141	0.2	-0.5	81	3.4	-5.4
1a EW	PARIS	HIGH	HIGH	39.9	-17.4	38.8	-15.0	1.13	206	0.4	-1.1	77	3.5	-5.3
1a EW	TORINO	LOW	LOW	26.6	-29.2	26.5	-23.4	1.04	146	0.2	-0.6	87	3.8	-5.6
1a EW	TORINO	HIGH	LOW	25.2	-33.7	25.1	-26.5	0.69	202	0.3	-1.0	85	4.6	-5.4
1a EW	TORINO	LOW	HIGH	37.4	-25.9	37.2	-22.0	1.23	119	0.1	-0.4	86	4.3	-5.9
1a EW	TORINO	HIGH	HIGH	35.8	-30.1	35.5	-25.1	0.88	165	0.2	-0.9	83	4.6	-5.7
1a EW	ATHENES	LOW	LOW	7.9	-51.9	7.9	-37.0	0.47	111	0.1	-0.4	92	3.5	-4.8
1a EW	ATHENES	HIGH	LOW	7.2	-57.9	7.2	-40.6	0.32	155	0.2	-0.9	90	3.4	-5.1
1a EW	ATHENES	LOW	HIGH	12.0	-49.9	12.0	-37.7	0.52	86	0.1	-0.3	73	2.4	-4.3
1a EW	ATHENES	HIGH	HIGH	11.1	-55.7	11.1	-41.2	0.39	137	0.2	-0.7	76	3.1	-4.3
1a EW	MUNICH	LOW	LOW	36.6	-19.0	35.4	-15.0	1.49	405	0.8	-2.7	91	4.3	-6.9
1a EW	MUNICH	HIGH	LOW	35.2	-23.4	34.0	-18.1	0.81	511	1.2	-4.4	90	5.0	-7.1
1a EW	MUNICH	LOW	HIGH	52.9	-14.4	51.0	-12.1	1.93	298	0.6	-1.7	94	5.0	-7.0
1a EW	MUNICH	HIGH	HIGH	51.1	-18.3	49.2	-15.1	1.10	417	1.1	-3.2	89	5.2	-7.1
1a EW	LISBOA	LOW	LOW	6.0	-32.4	6.0	-22.1	0.55	262	0.4	-0.7	95	3.5	-3.9
1a EW	LISBOA	HIGH	LOW	5.8	-37.3	5.8	-24.8	0.38	343	0.6	-1.3	88	3.4	-3.9
1a EW	LISBOA	LOW	HIGH	9.2	-28.3	9.2	-20.8	0.58	159	0.2	-0.4	101	4.6	-3.7
1a EW	LISBOA	HIGH	HIGH	8.9	-32.9	8.8	-23.6	0.39	268	0.5	-0.9	97	4.6	-3.7
1b NS	PARIS	LOW	LOW	40.0	-16.3	38.9	-13.1	1.31	155	0.3	-0.6	112	7.2	-6.9
1b NS	PARIS	HIGH	LOW	38.2	-19.3	37.2	-15.0	1.22	223	0.6	-1.1	114	7.8	-7.7
1b NS	PARIS	LOW	HIGH	51.8	-13.9	50.0	-11.6	1.52	140	0.3	-0.6	105	7.8	-6.8
1b NS	PARIS	HIGH	HIGH	49.8	-16.6	48.2	-13.5	1.42	208	0.6	-1.1	110	8.7	-7.5
1b NS	TORINO	LOW	LOW	35.2	-28.4	35.0	-21.2	1.23	264	0.8	-1.3	125	11.5	-8.3
1b NS	TORINO	HIGH	LOW	33.2	-32.8	33.0	-23.7	1.15	344	1.2	-2.1	125	11.4	-9.7
1b NS	TORINO	LOW	HIGH	45.8	-25.6	45.4	-20.2	1.40	246	0.9	-1.1	116	11.0	-8.1
1b NS	TORINO	HIGH	HIGH	43.6	-29.7	43.3	-22.7	1.32	343	1.4	-1.9	115	11.6	-9.1
1b NS	ATHENES	LOW	LOW	11.8	-48.8	11.8	-33.7	0.68	165	0.3	-0.8	108	6.4	-6.2
1b NS	ATHENES	HIGH	LOW	10.8	-54.1	10.8	-36.4	0.52	225	0.5	-1.3	118	7.4	-7.3
1b NS	ATHENES	LOW	HIGH	16.3	-47.2	16.3	-34.3	0.83	155	0.4	-0.7	102	7.5	-6.3
1b NS	ATHENES	HIGH	HIGH	15.2	-52.3	15.2	-36.9	0.65	216	0.6	-1.2	108	7.9	-7.2
1b NS	MUNICH	LOW	LOW	47.2	-18.7	45.5	-13.6	1.86	425	1.5	-2.6	132	9.9	-10.7
1b NS	MUNICH	HIGH	LOW	45.1	-22.8	43.4	-16.2	1.41	563	2.4	-4.2	125	9.9	-11.6
1b NS	MUNICH	LOW	HIGH	63.0	-15.0	60.3	-11.6	2.27	356	1.4	-2.0	120	10.2	-9.0
1b NS	MUNICH	HIGH	HIGH	60.6	-18.7	58.0	-14.1	1.85	475	2.2	-3.5	122	10.8	-10.8
1b NS	LISBOA	LOW	LOW	9.8	-24.9	9.8	-16.2	0.84	181	0.4	-0.9	111	5.4	-4.8
1b NS	LISBOA	HIGH	LOW	9.4	-27.8	9.3	-17.6	0.67	235	0.6	-1.3	108	5.3	-5.3
1b NS	LISBOA	LOW	HIGH	14.0	-21.9	13.9	-15.3	0.96	169	0.4	-0.8	113	6.6	-4.5

LOW LOADS 20/25°C SETPOINT TEMPERATURES														
1b NS	LISBOA	HIGH	HIGH	13.5	-24.7	13.4	-16.7	0.83	223	0.7	-1.2	118	6.9	-5.5
1b EW	PARIS	LOW	LOW	40.0	-17.9	39.0	-14.6	1.31	132	0.2	-0.5	101	6.9	-6.4
1b EW	PARIS	HIGH	LOW	38.3	-21.6	37.3	-17.2	1.20	216	0.5	-1.2	103	7.4	-6.5
1b EW	PARIS	LOW	HIGH	51.9	-15.5	50.1	-13.1	1.52	129	0.3	-0.5	99	7.6	-6.3
1b EW	PARIS	HIGH	HIGH	50.0	-18.9	48.3	-15.6	1.41	214	0.6	-1.1	98	7.9	-6.7
1b EW	TORINO	LOW	LOW	35.6	-30.3	35.5	-23.5	1.13	134	0.2	-0.5	106	8.6	-6.9
1b EW	TORINO	HIGH	LOW	33.7	-35.3	33.5	-26.8	0.97	201	0.4	-0.9	106	9.4	-7.3
1b EW	TORINO	LOW	HIGH	46.4	-27.7	46.0	-22.5	1.30	123	0.2	-0.4	105	9.5	-7.3
1b EW	TORINO	HIGH	HIGH	44.2	-32.4	43.9	-25.8	1.19	197	0.4	-0.9	106	10.5	-7.6
1b EW	ATHENES	LOW	LOW	11.8	-53.0	11.8	-37.7	0.60	79	0.1	-0.3	103	6.6	-5.1
1b EW	ATHENES	HIGH	LOW	10.7	-59.4	10.7	-41.5	0.44	144	0.3	-0.7	100	6.5	-5.0
1b EW	ATHENES	LOW	HIGH	16.3	-51.5	16.3	-38.2	0.75	79	0.1	-0.3	95	7.1	-5.2
1b EW	ATHENES	HIGH	HIGH	15.2	-57.7	15.2	-42.0	0.55	140	0.3	-0.7	94	7.4	-5.1
1b EW	MUNICH	LOW	LOW	47.7	-20.7	46.0	-15.7	1.66	398	1.1	-2.5	109	8.5	-8.5
1b EW	MUNICH	HIGH	LOW	45.7	-25.6	44.0	-19.0	1.02	515	1.7	-4.2	99	8.3	-8.0
1b EW	MUNICH	LOW	HIGH	63.5	-17.1	60.9	-13.6	2.03	344	1.1	-2.0	104	9.5	-8.5
1b EW	MUNICH	HIGH	HIGH	61.3	-21.6	58.7	-16.8	1.32	466	1.8	-3.7	104	10.0	-9.0
1b EW	LISBOA	LOW	LOW	9.5	-30.0	9.5	-20.4	0.66	130	0.2	-0.3	106	5.5	-4.5
1b EW	LISBOA	HIGH	LOW	9.1	-35.2	9.1	-23.4	0.47	232	0.5	-0.8	100	5.3	-4.7
1b EW	LISBOA	LOW	HIGH	13.7	-27.1	13.6	-19.6	0.82	123	0.2	-0.3	110	7.2	-4.3
1b EW	LISBOA	HIGH	HIGH	13.2	-32.1	13.1	-22.5	0.58	232	0.6	-0.8	105	7.1	-4.8
1c NS	PARIS	LOW	LOW	54.8	-16.4	53.3	-13.6	1.22	55	0.1	-0.1	114	9.8	-7.0
1c NS	PARIS	HIGH	LOW	50.4	-20.2	49.4	-16.4	1.10	33	0.1	-0.1	112	9.1	-7.4
1c NS	PARIS	LOW	HIGH	66.9	-14.2	64.7	-12.2	1.38	40	0.1	-0.1	106	9.5	-6.6
1c NS	PARIS	HIGH	HIGH	62.1	-17.6	60.6	-14.8	1.25	30	0.1	-0.1	107	9.4	-7.2
1c NS	TORINO	LOW	LOW	46.4	-30.0	46.2	-23.6	1.18	118	0.3	-0.3	133	14.9	-8.7
1c NS	TORINO	HIGH	LOW	41.5	-36.0	41.4	-27.6	1.08	99	0.2	-0.3	125	13.7	-8.7
1c NS	TORINO	LOW	HIGH	57.2	-27.3	56.8	-22.4	1.33	109	0.3	-0.2	116	12.9	-7.9
1c NS	TORINO	HIGH	HIGH	51.9	-32.9	51.7	-26.3	1.22	97	0.3	-0.3	117	12.8	-9.0
1c NS	ATHENES	LOW	LOW	15.8	-53.9	15.8	-38.9	0.74	48	0.1	-0.1	111	8.2	-6.3
1c NS	ATHENES	HIGH	LOW	13.1	-61.9	13.1	-43.6	0.64	15	0.0	0.0	115	8.2	-6.7
1c NS	ATHENES	LOW	HIGH	20.3	-52.5	20.3	-39.4	0.83	39	0.1	-0.1	104	8.8	-6.0
1c NS	ATHENES	HIGH	HIGH	17.4	-60.0	17.4	-44.0	0.76	19	0.0	0.0	104	8.5	-6.3
1c NS	MUNICH	LOW	LOW	60.3	-18.4	58.7	-14.1	1.55	167	0.5	-0.5	134	10.9	-10.4
1c NS	MUNICH	HIGH	LOW	54.5	-23.4	53.6	-17.6	1.36	151	0.5	-0.4	125	10.0	-10.5
1c NS	MUNICH	LOW	HIGH	76.2	-14.8	73.8	-11.9	1.86	148	0.4	-0.4	122	11.0	-8.7
1c NS	MUNICH	HIGH	HIGH	70.0	-19.3	68.4	-15.2	1.63	126	0.4	-0.3	120	10.1	-9.7
1c NS	LISBOA	LOW	LOW	13.7	-23.9	13.5	-16.8	0.84	101	0.2	-0.2	124	7.3	-4.8
1c NS	LISBOA	HIGH	LOW	11.9	-27.8	11.8	-19.1	0.75	80	0.1	-0.2	112	6.2	-4.8
1c NS	LISBOA	LOW	HIGH	17.9	-21.4	17.8	-15.9	0.97	79	0.1	-0.2	120	8.1	-4.3
1c NS	LISBOA	HIGH	HIGH	16.0	-25.1	15.9	-18.0	0.87	68	0.1	-0.2	118	7.8	-4.4
1c EW	PARIS	LOW	LOW	55.1	-18.7	53.8	-15.7	1.22	75	0.1	-0.4	99	8.5	-6.4
1c EW	PARIS	HIGH	LOW	50.9	-23.1	50.1	-19.0	1.10	53	0.1	-0.2	100	8.8	-6.0
1c EW	PARIS	LOW	HIGH	67.1	-16.3	65.2	-14.1	1.39	63	0.1	-0.3	98	8.7	-6.4
1c EW	PARIS	HIGH	HIGH	62.6	-20.3	61.3	-17.2	1.26	51	0.1	-0.2	94	8.3	-6.3
1c EW	TORINO	LOW	LOW	47.8	-33.2	47.6	-26.6	1.06	81	0.2	-0.3	111	12.0	-7.4
1c EW	TORINO	HIGH	LOW	43.4	-39.8	43.3	-31.4	0.96	68	0.1	-0.2	102	11.0	-6.3
1c EW	TORINO	LOW	HIGH	58.7	-30.5	58.4	-25.4	1.20	56	0.1	-0.2	103	10.7	-7.3
1c EW	TORINO	HIGH	HIGH	54.0	-36.7	53.8	-30.0	1.09	50	0.1	-0.2	104	12.1	-6.9
1c EW	ATHENES	LOW	LOW	16.3	-59.9	16.3	-44.1	0.69	44	0.0	-0.2	104	8.6	-5.2
1c EW	ATHENES	HIGH	LOW	13.7	-69.2	13.7	-50.0	0.55	18	0.0	0.0	96	7.8	-4.7
1c EW	ATHENES	LOW	HIGH	20.9	-58.5	20.9	-44.5	0.78	32	0.1	-0.1	93	8.5	-5.0
1c EW	ATHENES	HIGH	HIGH	18.1	-67.3	18.1	-50.3	0.66	24	0.0	-0.1	89	8.3	-4.6
1c EW	MUNICH	LOW	LOW	61.5	-21.9	60.0	-17.0	1.41	198	0.6	-1.1	107	9.3	-8.6
1c EW	MUNICH	HIGH	LOW	56.4	-27.8	55.5	-21.4	1.22	146	0.4	-0.9	99	8.6	-7.5
1c EW	MUNICH	LOW	HIGH	77.5	-18.1	75.2	-14.7	1.69	181	0.5	-1.0	104	9.2	-8.8
1c EW	MUNICH	HIGH	HIGH	71.9	-23.5	70.4	-18.7	1.47	160	0.4	-0.8	99	9.3	-8.0
1c EW	LISBOA	LOW	LOW	13.3	-29.3	13.3	-21.5	0.82	64	0.1	-0.1	107	6.8	-3.8
1c EW	LISBOA	HIGH	LOW	11.5	-35.3	11.5	-25.4	0.62	64	0.1	-0.1	100	6.1	-3.8
1c EW	LISBOA	LOW	HIGH	17.5	-26.7	17.4	-20.4	0.92	48	0.1	-0.1	109	8.6	-3.5
1c EW	LISBOA	HIGH	HIGH	15.5	-32.2	15.5	-24.1	0.73	58	0.1	-0.2	103	7.6	-3.9
"2" NS	PARIS	LOW	LOW	39.1	-10.6	38.2	-9.6	1.77	54	0.1	-0.1	67	2.2	-2.6
"2" NS	PARIS	HIGH	LOW	38.0	-12.2	37.1	-10.9	1.68	105	0.1	-0.2	68	2.8	-2.7
"2" NS	PARIS	LOW	HIGH	51.3	-8.8	49.7	-8.2	2.03	29	0.0	-0.1	61	2.1	-2.7
"2" NS	PARIS	HIGH	HIGH	50.0	-10.3	48.5	-9.5	1.94	69	0.1	-0.1	67	2.8	-2.9
"2" NS	TORINO	LOW	LOW	31.9	-20.8	31.8	-17.6	1.41	98	0.2	-0.2	75	3.2	-3.2
"2" NS	TORINO	HIGH	LOW	30.6	-23.3	30.5	-19.3	1.30	167	0.3	-0.4	73	3.5	-3.3
"2" NS	TORINO	LOW	HIGH	42.8	-18.6	42.5	-16.6	1.60	59	0.1	-0.1	76	3.8	-3.2
"2" NS	TORINO	HIGH	HIGH	41.3	-21.0	41.0	-18.3	1.49	125	0.2	-0.3	73	3.8	-3.5
"2" NS	ATHENES	LOW	LOW	11.8	-39.2	11.8	-29.9	0.78	67	0.1	-0.1	64	1.7	-2.3
"2" NS	ATHENES	HIGH	LOW	11.1	-42.4	11.1	-31.7	0.66	109	0.2	-0.3	68	2.2	-2.7
"2" NS	ATHENES	LOW	HIGH	16.5	-38.3	16.5	-30.4	0.90	43	0.1	-0.1	60	1.8	-2.5
"2" NS	ATHENES	HIGH	HIGH	15.6	-41.3	15.6	-32.2	0.82	82	0.1	-0.2	60	2.1	-2.7

LOW LOADS 20/25°C SETPOINT TEMPERATURES														
"2" NS	MUNICH	LOW	LOW	46.6	-10.9	45.0	-9.3	2.48	259	0.6	-0.8	86	3.8	-3.6
"2" NS	MUNICH	HIGH	LOW	45.2	-13.1	43.5	-10.9	2.20	346	0.9	-1.4	90	4.5	-4.6
"2" NS	MUNICH	LOW	HIGH	63.0	-8.2	60.4	-7.4	3.04	170	0.3	-0.4	85	4.3	-3.6
"2" NS	MUNICH	HIGH	HIGH	61.4	-10.2	58.8	-8.9	2.70	254	0.6	-0.9	87	4.9	-4.2
"2" NS	LISBOA	LOW	LOW	9.2	-19.9	9.1	-14.9	0.88	106	0.2	-0.2	94	3.5	-1.9
"2" NS	LISBOA	HIGH	LOW	8.9	-21.7	8.9	-15.8	0.80	166	0.3	-0.4	99	3.9	-2.3
"2" NS	LISBOA	LOW	HIGH	13.2	-17.4	13.1	-14.0	1.03	61	0.1	-0.1	83	3.4	-1.6
"2" NS	LISBOA	HIGH	HIGH	12.8	-19.0	12.8	-14.9	1.01	102	0.2	-0.2	87	3.9	-1.9
"2" EW	PARIS	LOW	LOW	39.3	-11.8	38.4	-10.6	1.75	74	0.1	-0.2	59	1.8	-2.3
"2" EW	PARIS	HIGH	LOW	38.2	-13.9	37.3	-12.3	1.59	136	0.3	-0.5	60	2.6	-2.4
"2" EW	PARIS	LOW	HIGH	51.5	-9.9	49.9	-9.2	2.01	69	0.1	-0.1	57	2.2	-2.2
"2" EW	PARIS	HIGH	HIGH	50.2	-11.9	48.7	-10.8	1.92	121	0.3	-0.4	61	2.8	-2.5
"2" EW	TORINO	LOW	LOW	32.5	-22.4	32.4	-19.1	1.31	85	0.1	-0.2	63	2.5	-2.4
"2" EW	TORINO	HIGH	LOW	31.4	-25.5	31.2	-21.4	1.20	126	0.2	-0.4	64	3.0	-2.3
"2" EW	TORINO	LOW	HIGH	43.4	-20.3	43.1	-18.1	1.50	64	0.1	-0.1	63	2.9	-2.6
"2" EW	TORINO	HIGH	HIGH	42.1	-23.2	41.8	-20.3	1.38	100	0.2	-0.3	66	3.5	-2.9
"2" EW	ATHENES	LOW	LOW	11.9	-42.1	11.9	-32.4	0.73	46	0.1	-0.1	51	1.1	-1.8
"2" EW	ATHENES	HIGH	LOW	11.2	-46.1	11.2	-34.9	0.59	86	0.2	-0.2	58	1.7	-2.0
"2" EW	ATHENES	LOW	HIGH	16.6	-41.2	16.6	-32.9	0.86	31	0.0	0.0	52	1.3	-2.1
"2" EW	ATHENES	HIGH	HIGH	15.8	-45.1	15.8	-35.5	0.72	72	0.1	-0.2	48	1.5	-1.8
"2" EW	MUNICH	LOW	LOW	47.1	-12.4	45.5	-10.5	2.26	268	0.7	-1.0	69	3.1	-3.0
"2" EW	MUNICH	HIGH	LOW	45.8	-15.2	44.2	-12.7	1.75	357	1.0	-1.8	71	4.1	-3.2
"2" EW	MUNICH	LOW	HIGH	63.5	-9.5	60.9	-8.6	2.77	201	0.5	-0.6	73	3.8	-3.2
"2" EW	MUNICH	HIGH	HIGH	62.0	-12.1	59.5	-10.6	2.32	295	0.9	-1.3	70	4.1	-3.4
"2" EW	LISBOA	LOW	LOW	9.0	-23.6	9.0	-17.7	0.76	113	0.2	-0.2	78	3.2	-1.7
"2" EW	LISBOA	HIGH	LOW	8.7	-26.8	8.7	-19.7	0.58	215	0.5	-0.4	76	3.4	-1.6
"2" EW	LISBOA	LOW	HIGH	13.1	-21.0	13.0	-16.8	0.94	80	0.1	-0.1	74	3.1	-1.5
"2" EW	LISBOA	HIGH	HIGH	12.7	-24.1	12.6	-18.8	0.73	164	0.4	-0.3	70	3.5	-1.6
"3" NS	PARIS	LOW	LOW	65.4	-12.4	63.8	-11.2	1.66	15	0.0	0.0	78	4.5	-3.6
"3" NS	PARIS	HIGH	LOW	61.3	-15.2	60.2	-13.6	1.51	6	0.0	0.0	76	4.5	-3.4
"3" NS	PARIS	LOW	HIGH	76.9	-10.9	74.7	-10.1	1.84	9	0.0	0.0	73	4.4	-3.5
"3" NS	PARIS	HIGH	HIGH	72.6	-13.4	71.0	-12.2	1.68	2	0.0	0.0	71	5.2	-3.4
"3" NS	TORINO	LOW	LOW	45.5	-26.7	45.4	-22.9	1.22	34	0.0	0.0	95	6.7	-4.3
"3" NS	TORINO	HIGH	LOW	41.0	-31.6	41.0	-26.5	1.10	38	0.0	0.0	88	6.5	-3.6
"3" NS	TORINO	LOW	HIGH	55.8	-24.7	55.5	-21.8	1.37	20	0.0	0.0	86	5.9	-4.4
"3" NS	TORINO	HIGH	HIGH	51.0	-29.2	50.9	-25.3	1.24	21	0.0	0.0	87	7.2	-4.0
"3" NS	ATHENES	LOW	LOW	19.9	-50.1	19.9	-39.4	0.90	14	0.0	0.0	72	3.8	-2.7
"3" NS	ATHENES	HIGH	LOW	17.1	-56.5	17.1	-43.4	0.79	1	0.0	0.0	71	3.5	-2.9
"3" NS	ATHENES	LOW	HIGH	24.4	-49.4	24.4	-39.8	0.97	9	0.0	0.0	66	3.4	-2.8
"3" NS	ATHENES	HIGH	HIGH	21.5	-55.5	21.5	-43.8	0.89	0	0.0	0.0	65	3.9	-2.7
"3" NS	MUNICH	LOW	LOW	66.2	-13.4	64.7	-11.5	1.93	87	0.1	-0.2	101	5.4	-5.2
"3" NS	MUNICH	HIGH	LOW	61.0	-17.3	60.1	-14.4	1.66	68	0.1	-0.1	100	6.3	-5.2
"3" NS	MUNICH	LOW	HIGH	81.4	-10.8	79.2	-9.6	2.26	63	0.1	-0.1	95	5.3	-4.8
"3" NS	MUNICH	HIGH	HIGH	75.9	-14.2	74.3	-12.3	1.94	46	0.1	-0.1	93	5.6	-5.2
"3" NS	LISBOA	LOW	LOW	15.4	-20.9	15.3	-16.7	1.03	38	0.0	0.0	96	5.1	-1.8
"3" NS	LISBOA	HIGH	LOW	13.7	-24.0	13.6	-18.7	0.91	38	0.0	0.0	95	4.7	-2.0
"3" NS	LISBOA	LOW	HIGH	19.6	-19.0	19.4	-15.8	1.14	23	0.0	0.0	93	5.6	-1.8
"3" NS	LISBOA	HIGH	HIGH	17.7	-21.8	17.6	-17.7	1.06	34	0.0	0.0	90	5.3	-1.8
"3" EW	PARIS	LOW	LOW	65.6	-14.3	64.2	-12.9	1.64	35	0.0	-0.1	69	3.9	-3.3
"3" EW	PARIS	HIGH	LOW	61.6	-17.8	60.8	-15.8	1.39	22	0.0	-0.1	69	3.7	-3.4
"3" EW	PARIS	LOW	HIGH	77.0	-12.7	75.0	-11.6	1.82	30	0.0	-0.1	73	4.5	-3.7
"3" EW	PARIS	HIGH	HIGH	72.8	-15.9	71.5	-14.4	1.57	20	0.0	-0.1	64	4.2	-3.1
"3" EW	TORINO	LOW	LOW	46.8	-29.8	46.7	-25.5	1.12	38	0.1	-0.1	77	4.4	-3.5
"3" EW	TORINO	HIGH	LOW	42.9	-35.7	42.8	-30.0	0.99	32	0.0	-0.1	73	4.7	-2.9
"3" EW	TORINO	LOW	HIGH	57.0	-27.7	56.7	-24.3	1.26	25	0.0	-0.1	84	5.7	-4.4
"3" EW	TORINO	HIGH	HIGH	52.8	-33.2	52.7	-28.7	1.13	17	0.0	-0.1	74	5.2	-3.2
"3" EW	ATHENES	LOW	LOW	20.3	-55.4	20.3	-43.7	0.82	18	0.0	0.0	58	2.2	-2.4
"3" EW	ATHENES	HIGH	LOW	17.8	-63.2	17.8	-49.0	0.70	6	0.0	0.0	57	2.6	-2.1
"3" EW	ATHENES	LOW	HIGH	24.9	-54.6	24.9	-44.1	0.89	11	0.0	0.0	59	2.6	-2.5
"3" EW	ATHENES	HIGH	HIGH	22.2	-62.2	22.2	-49.3	0.80	6	0.0	0.0	55	2.7	-2.3
"3" EW	MUNICH	LOW	LOW	67.2	-16.4	65.8	-13.8	1.73	146	0.3	-0.6	82	4.7	-4.5
"3" EW	MUNICH	HIGH	LOW	62.5	-21.3	61.6	-17.7	1.47	103	0.2	-0.5	74	4.5	-4.1
"3" EW	MUNICH	LOW	HIGH	82.3	-13.5	80.2	-11.8	2.02	104	0.2	-0.4	80	4.8	-4.9
"3" EW	MUNICH	HIGH	HIGH	77.3	-18.0	75.8	-15.4	1.72	103	0.2	-0.4	74	4.7	-4.4
"3" EW	LISBOA	LOW	LOW	15.0	-25.7	15.0	-20.7	0.89	20	0.0	0.0	81	4.2	-1.5
"3" EW	LISBOA	HIGH	LOW	13.2	-30.9	13.2	-24.4	0.77	19	0.0	0.0	83	4.6	-1.6
"3" EW	LISBOA	LOW	HIGH	19.1	-23.6	19.1	-19.7	0.99	11	0.0	0.0	80	4.8	-1.4
"3" EW	LISBOA	HIGH	HIGH	17.1	-28.5	17.1	-23.2	0.89	19	0.0	0.0	74	4.2	-1.5

Table 41: Results of cooling and heating demand in kWh/m²/year* (only 3 zones, circulations and toilets are excluded here)

Building case				STPT 21/24°C High Loads		STPT 20/25°C High Loads		STPT 21/24°C Low Loads		STPT 20/25°C Low Loads	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating (kWh/m ² /year)	Annual cooling (kWh/m ² /year)	Annual heating (kWh/m ² /year)	Annual cooling (kWh/m ² /year)	Annual heating (kWh/m ² /year)	Annual cooling (kWh/m ² /year)	Annual heating (kWh/m ² /year)	Annual cooling (kWh/m ² /year)
1a NS	PARIS	LOW	LOW	21.8	-35.2	18.5	-30.3	33.7	-18.9	29.1	-15.5
1a NS	PARIS	HIGH	LOW	20.9	-38.4	17.7	-33.5	32.2	-21.8	27.8	-18.3
1a NS	PARIS	LOW	HIGH	32.0	-28.9	27.4	-24.4	47.0	-15.8	41.0	-12.5
1a NS	PARIS	HIGH	HIGH	30.9	-31.9	26.5	-27.2	45.3	-18.4	39.4	-14.9
1a NS	TORINO	LOW	LOW	20.2	-49.2	17.0	-43.7	30.0	-30.8	25.9	-26.4
1a NS	TORINO	HIGH	LOW	18.9	-53.4	15.9	-47.9	28.3	-34.9	24.3	-30.3
1a NS	TORINO	LOW	HIGH	29.6	-43.4	25.4	-37.8	41.8	-27.5	36.6	-23.1
1a NS	TORINO	HIGH	HIGH	28.2	-47.4	24.1	-41.7	39.9	-31.2	34.8	-26.6
1a NS	ATHENES	LOW	LOW	6.6	-76.9	5.1	-70.1	10.1	-52.7	7.8	-47.0
1a NS	ATHENES	HIGH	LOW	6.0	-81.9	4.7	-75.1	9.2	-57.6	7.1	-51.9
1a NS	ATHENES	LOW	HIGH	9.8	-72.5	7.6	-65.2	15.0	-50.9	11.8	-44.9
1a NS	ATHENES	HIGH	HIGH	9.1	-77.3	7.1	-70.0	13.9	-55.5	10.9	-49.4
1a NS	MUNICH	LOW	LOW	27.5	-36.4	24.3	-32.2	40.1	-19.8	35.8	-16.7
1a NS	MUNICH	HIGH	LOW	26.3	-40.4	23.2	-36.1	38.3	-23.4	34.2	-20.3
1a NS	MUNICH	LOW	HIGH	41.7	-28.6	37.1	-24.7	57.6	-15.3	52.0	-12.3
1a NS	MUNICH	HIGH	HIGH	40.3	-32.3	35.8	-28.2	55.5	-18.5	50.0	-15.3
1a NS	LISBOA	LOW	LOW	5.5	-61.9	4.1	-55.2	8.3	-31.9	6.2	-26.9
1a NS	LISBOA	HIGH	LOW	5.3	-64.8	3.9	-58.2	8.0	-34.8	5.9	-29.7
1a NS	LISBOA	LOW	HIGH	8.0	-54.7	6.0	-47.6	12.6	-28.1	9.4	-22.9
1a NS	LISBOA	HIGH	HIGH	7.8	-57.6	5.9	-50.5	12.1	-30.7	9.1	-25.4
1a NS	PARIS	LOW	LOW	21.8	-36.6	18.6	-31.8	33.7	-20.4	29.1	-17.0
1a EW	PARIS	HIGH	LOW	21.0	-40.6	17.8	-35.7	32.3	-23.9	27.9	-20.4
1a EW	PARIS	LOW	HIGH	32.0	-30.4	27.5	-25.9	47.0	-17.2	41.0	-14.0
1a EW	PARIS	HIGH	HIGH	31.0	-34.0	26.6	-29.4	45.3	-20.4	39.6	-17.0
1a EW	TORINO	LOW	LOW	20.3	-50.7	17.2	-45.3	30.3	-32.6	26.3	-28.4
1a EW	TORINO	HIGH	LOW	19.2	-55.5	16.2	-50.1	28.7	-37.2	24.9	-32.9
1a EW	TORINO	LOW	HIGH	29.9	-45.1	25.7	-39.7	42.3	-29.5	37.1	-25.2
1a EW	TORINO	HIGH	HIGH	28.6	-49.7	24.6	-44.2	40.5	-33.8	35.4	-29.3
1a EW	ATHENES	LOW	LOW	6.6	-80.2	5.1	-73.4	10.1	-56.2	7.8	-50.7
1a EW	ATHENES	HIGH	LOW	6.0	-86.3	4.6	-79.5	9.2	-62.3	7.1	-56.6
1a EW	ATHENES	LOW	HIGH	9.8	-75.8	7.6	-68.6	15.0	-54.5	11.9	-48.7
1a EW	ATHENES	HIGH	HIGH	9.1	-81.8	7.1	-74.5	14.0	-60.3	11.0	-54.3
1a EW	MUNICH	LOW	LOW	27.7	-38.0	24.5	-33.9	40.4	-21.6	36.3	-18.6
1a EW	MUNICH	HIGH	LOW	26.7	-42.8	23.6	-38.6	38.8	-26.0	34.8	-22.9
1a EW	MUNICH	LOW	HIGH	42.1	-30.4	37.5	-26.5	58.1	-17.1	52.5	-14.1
1a EW	MUNICH	HIGH	HIGH	40.8	-34.8	36.4	-30.8	56.1	-21.0	50.7	-17.9
1a EW	LISBOA	LOW	LOW	5.4	-66.5	4.0	-59.8	8.1	-36.7	6.0	-31.6
1a EW	LISBOA	HIGH	LOW	5.2	-71.5	3.8	-64.8	7.7	-41.6	5.7	-36.4
1a EW	LISBOA	LOW	HIGH	7.8	-59.3	5.9	-52.1	12.3	-32.7	9.2	-27.4
1a EW	LISBOA	HIGH	HIGH	7.6	-64.2	5.8	-57.0	11.8	-37.4	8.8	-32.0
1b NS	PARIS	LOW	LOW	34.3	-25.2	29.6	-21.3	45.1	-16.9	39.7	-13.7
1b NS	PARIS	HIGH	LOW	32.8	-28.5	28.3	-24.5	43.2	-19.9	37.9	-16.6
1b NS	PARIS	LOW	HIGH	46.1	-22.1	40.2	-18.3	58.1	-15.0	51.4	-11.9
1b NS	PARIS	HIGH	HIGH	44.5	-25.2	38.7	-21.2	56.0	-17.7	49.5	-14.4
1b NS	TORINO	LOW	LOW	31.2	-39.2	27.0	-34.4	39.8	-29.0	35.0	-24.7
1b NS	TORINO	HIGH	LOW	29.4	-43.8	25.3	-38.8	37.7	-33.4	33.0	-28.9
1b NS	TORINO	LOW	HIGH	41.8	-36.0	36.5	-31.0	51.3	-26.8	45.5	-22.4
1b NS	TORINO	HIGH	HIGH	39.9	-40.4	34.7	-35.3	49.1	-31.0	43.4	-26.4
1b NS	ATHENES	LOW	LOW	10.7	-62.4	8.3	-56.3	14.9	-48.7	11.7	-43.2
1b NS	ATHENES	HIGH	LOW	9.8	-67.8	7.5	-61.6	13.8	-53.9	10.7	-48.3
1b NS	ATHENES	LOW	HIGH	15.1	-60.5	11.9	-54.0	20.2	-47.8	16.3	-42.1
1b NS	ATHENES	HIGH	HIGH	14.2	-65.7	11.1	-59.1	19.0	-52.9	15.2	-47.0
1b NS	MUNICH	LOW	LOW	41.2	-28.1	36.8	-24.5	51.9	-19.0	46.9	-16.0
1b NS	MUNICH	HIGH	LOW	39.4	-32.4	35.2	-28.8	49.6	-23.1	44.8	-19.9
1b NS	MUNICH	LOW	HIGH	56.8	-23.6	51.2	-20.1	68.8	-15.9	62.6	-12.9
1b NS	MUNICH	HIGH	HIGH	54.7	-27.7	49.3	-24.1	66.3	-19.6	60.2	-16.5
1b NS	LISBOA	LOW	LOW	8.4	-41.3	6.3	-35.8	12.9	-24.6	9.8	-20.4
1b NS	LISBOA	HIGH	LOW	8.1	-44.4	6.1	-38.9	12.4	-27.6	9.4	-23.3

1b NS	LISBOA	LOW	HIGH	12.2	-37.5	9.3	-31.9	18.2	-22.6	14.0	-18.3
1b NS	LISBOA	HIGH	HIGH	11.8	-40.6	9.0	-34.8	17.5	-25.4	13.5	-21.0
1b EW	PARIS	LOW	LOW	34.3	-26.8	29.7	-22.9	45.1	-18.4	39.8	-15.3
1b EW	PARIS	HIGH	LOW	32.8	-30.7	28.4	-26.8	43.2	-22.1	38.0	-18.8
1b EW	PARIS	LOW	HIGH	46.1	-23.7	40.3	-19.9	58.1	-16.5	51.5	-13.4
1b EW	PARIS	HIGH	HIGH	44.5	-27.4	38.8	-23.5	56.0	-19.9	49.6	-16.6
1b EW	TORINO	LOW	LOW	31.4	-40.8	27.3	-36.1	40.1	-30.7	35.4	-26.6
1b EW	TORINO	HIGH	LOW	29.7	-45.9	25.7	-41.1	38.0	-35.6	33.5	-31.4
1b EW	TORINO	LOW	HIGH	42.1	-37.8	36.9	-32.9	51.8	-28.7	46.1	-24.5
1b EW	TORINO	HIGH	HIGH	40.2	-42.7	35.2	-37.8	49.6	-33.4	43.9	-29.0
1b EW	ATHENES	LOW	LOW	10.6	-66.4	8.2	-60.3	14.8	-52.8	11.7	-47.5
1b EW	ATHENES	HIGH	LOW	9.7	-72.9	7.5	-66.8	13.7	-59.2	10.7	-53.7
1b EW	ATHENES	LOW	HIGH	15.0	-64.5	11.9	-58.1	20.2	-52.0	16.3	-46.4
1b EW	ATHENES	HIGH	HIGH	14.1	-70.9	11.1	-64.4	18.9	-58.3	15.1	-52.5
1b EW	MUNICH	LOW	LOW	41.5	-29.9	37.2	-26.4	52.2	-20.8	47.4	-17.9
1b EW	MUNICH	HIGH	LOW	39.8	-35.0	35.6	-31.5	50.1	-25.7	45.4	-22.6
1b EW	MUNICH	LOW	HIGH	57.1	-25.5	51.6	-22.1	69.2	-17.8	63.1	-14.8
1b EW	MUNICH	HIGH	HIGH	55.2	-30.4	49.9	-26.8	66.8	-22.2	60.8	-19.1
1b EW	LISBOA	LOW	LOW	8.2	-46.6	6.2	-41.0	12.5	-29.9	9.5	-25.6
1b EW	LISBOA	HIGH	LOW	7.8	-51.9	5.9	-46.3	12.0	-35.0	9.1	-30.6
1b EW	LISBOA	LOW	HIGH	11.9	-42.7	9.1	-37.0	17.7	-27.8	13.6	-23.4
1b EW	LISBOA	HIGH	HIGH	11.6	-47.9	8.8	-42.1	17.0	-32.7	13.1	-28.1
1c NS	PARIS	LOW	LOW	47.5	-26.5	41.7	-22.1	58.6	-18.0	52.2	-14.4
1c NS	PARIS	HIGH	LOW	43.4	-30.7	38.0	-26.0	54.0	-21.8	47.9	-17.9
1c NS	PARIS	LOW	HIGH	59.5	-23.3	52.6	-19.1	71.8	-15.9	64.1	-12.4
1c NS	PARIS	HIGH	HIGH	55.1	-27.1	48.5	-22.5	66.9	-19.4	59.6	-15.5
1c NS	TORINO	LOW	LOW	40.9	-42.0	35.9	-36.4	49.8	-31.6	44.1	-26.6
1c NS	TORINO	HIGH	LOW	36.2	-48.2	31.5	-42.3	44.7	-37.6	39.3	-32.2
1c NS	TORINO	LOW	HIGH	51.7	-38.6	45.6	-32.9	61.5	-29.2	54.9	-24.2
1c NS	TORINO	HIGH	HIGH	46.7	-44.4	40.9	-38.3	56.1	-34.7	49.7	-29.3
1c NS	ATHENES	LOW	LOW	14.6	-68.5	11.6	-61.4	18.8	-54.5	15.1	-48.2
1c NS	ATHENES	HIGH	LOW	12.1	-76.5	9.4	-69.1	16.0	-62.3	12.5	-55.7
1c NS	ATHENES	LOW	HIGH	18.9	-66.3	15.2	-58.9	24.1	-53.5	19.6	-46.9
1c NS	ATHENES	HIGH	HIGH	16.1	-73.9	12.7	-66.2	21.0	-60.9	16.7	-54.0
1c NS	MUNICH	LOW	LOW	52.5	-29.0	47.3	-24.9	63.4	-19.7	57.6	-16.2
1c NS	MUNICH	HIGH	LOW	47.2	-34.3	42.3	-29.9	57.5	-24.7	52.1	-20.8
1c NS	MUNICH	LOW	HIGH	68.2	-24.3	61.9	-20.4	80.6	-16.4	73.5	-13.0
1c NS	MUNICH	HIGH	HIGH	62.4	-29.1	56.4	-24.8	74.2	-20.8	67.5	-17.0
1c NS	LISBOA	LOW	LOW	12.2	-43.3	9.3	-37.0	17.0	-25.8	13.0	-21.0
1c NS	LISBOA	HIGH	LOW	10.5	-47.6	7.9	-41.0	15.0	-29.8	11.3	-24.7
1c NS	LISBOA	LOW	HIGH	15.8	-39.3	12.2	-32.9	22.2	-23.6	17.2	-18.9
1c NS	LISBOA	HIGH	HIGH	13.9	-43.2	10.6	-36.6	20.0	-27.4	15.3	-22.2
1c EW	PARIS	LOW	LOW	47.8	-28.5	42.2	-24.2	58.9	-19.8	52.6	-16.2
1c EW	PARIS	HIGH	LOW	43.9	-33.1	38.6	-28.6	54.5	-24.1	48.5	-20.2
1c EW	PARIS	LOW	HIGH	59.8	-25.2	53.0	-21.0	72.1	-17.7	64.5	-14.2
1c EW	PARIS	HIGH	HIGH	55.6	-29.4	49.1	-25.0	67.3	-21.6	60.1	-17.8
1c EW	TORINO	LOW	LOW	42.4	-44.4	37.5	-39.1	51.3	-34.0	45.7	-29.2
1c EW	TORINO	HIGH	LOW	38.3	-51.0	33.7	-45.4	46.7	-40.4	41.4	-35.3
1c EW	TORINO	LOW	HIGH	53.3	-41.1	47.3	-35.6	63.1	-31.7	56.6	-26.8
1c EW	TORINO	HIGH	HIGH	48.9	-47.3	43.2	-41.6	58.2	-37.7	52.0	-32.4
1c EW	ATHENES	LOW	LOW	15.3	-73.5	12.3	-66.5	19.4	-59.5	15.7	-53.3
1c EW	ATHENES	HIGH	LOW	12.9	-82.4	10.1	-75.2	16.7	-68.4	13.2	-61.9
1c EW	ATHENES	LOW	HIGH	19.6	-71.3	15.9	-64.0	24.8	-58.5	20.2	-52.1
1c EW	ATHENES	HIGH	HIGH	17.0	-79.9	13.6	-72.3	21.8	-67.0	17.5	-60.2
1c EW	MUNICH	LOW	LOW	53.9	-31.8	48.8	-27.9	64.7	-22.4	59.1	-18.9
1c EW	MUNICH	HIGH	LOW	49.1	-37.8	44.4	-33.6	59.3	-28.0	54.1	-24.3
1c EW	MUNICH	LOW	HIGH	69.7	-27.1	63.5	-23.3	81.8	-19.0	75.0	-15.6
1c EW	MUNICH	HIGH	HIGH	64.5	-32.6	58.6	-28.5	76.0	-24.1	69.5	-20.3
1c EW	LISBOA	LOW	LOW	11.8	-48.6	9.2	-42.2	16.4	-30.9	12.7	-26.1
1c EW	LISBOA	HIGH	LOW	10.0	-54.9	7.7	-48.2	14.3	-37.0	10.9	-31.7
1c EW	LISBOA	LOW	HIGH	15.5	-44.3	12.0	-37.9	21.6	-28.6	16.8	-23.7
1c EW	LISBOA	HIGH	HIGH	13.5	-50.2	10.3	-43.5	19.2	-34.2	14.8	-28.9
"2" NS	PARIS	LOW	LOW	31.9	-19.4	27.6	-16.2	43.7	-10.7	38.4	-8.4
"2" NS	PARIS	HIGH	LOW	31.1	-21.4	26.9	-18.1	42.4	-12.4	37.2	-9.9
"2" NS	PARIS	LOW	HIGH	43.9	-16.7	38.2	-13.5	57.1	-9.2	50.4	-7.0
"2" NS	PARIS	HIGH	HIGH	42.9	-18.5	37.3	-15.2	55.7	-10.8	49.2	-8.3
"2" NS	TORINO	LOW	LOW	26.7	-31.6	23.1	-27.5	35.7	-20.3	31.5	-17.1
"2" NS	TORINO	HIGH	LOW	25.7	-34.4	22.2	-30.2	34.4	-22.9	30.2	-19.6
"2" NS	TORINO	LOW	HIGH	37.1	-28.5	32.5	-24.4	47.6	-18.6	42.3	-15.3
"2" NS	TORINO	HIGH	HIGH	36.0	-31.1	31.5	-26.9	46.1	-21.0	40.8	-17.6

"2" NS	ATHENES	LOW	LOW	10.1	-53.1	7.9	-47.4	14.6	-38.2	11.7	-33.7
"2" NS	ATHENES	HIGH	LOW	9.6	-56.4	7.5	-50.7	13.8	-41.4	10.9	-36.8
"2" NS	ATHENES	LOW	HIGH	14.5	-51.3	11.6	-45.4	20.1	-37.9	16.3	-33.0
"2" NS	ATHENES	HIGH	HIGH	13.9	-54.5	11.0	-48.5	19.2	-41.0	15.5	-36.0
"2" NS	MUNICH	LOW	LOW	38.7	-20.3	34.7	-17.4	50.6	-10.7	45.9	-8.7
"2" NS	MUNICH	HIGH	LOW	37.7	-22.8	33.7	-19.9	49.1	-13.0	44.4	-10.8
"2" NS	MUNICH	LOW	HIGH	54.7	-16.3	49.3	-13.6	68.2	-8.4	62.2	-6.5
"2" NS	MUNICH	HIGH	HIGH	53.4	-18.7	48.2	-15.8	66.4	-10.3	60.6	-8.3
"2" NS	LISBOA	LOW	LOW	8.0	-38.0	6.0	-32.6	12.1	-19.8	9.1	-15.9
"2" NS	LISBOA	HIGH	LOW	7.8	-40.0	5.9	-34.6	11.7	-21.6	8.9	-17.6
"2" NS	LISBOA	LOW	HIGH	11.6	-34.0	8.9	-28.4	17.2	-17.8	13.1	-13.9
"2" NS	LISBOA	HIGH	HIGH	11.4	-35.9	8.7	-30.3	16.7	-19.5	12.8	-15.5
"2" EW	PARIS	LOW	LOW	32.0	-20.6	27.7	-17.4	43.8	-11.9	38.5	-9.6
"2" EW	PARIS	HIGH	LOW	31.2	-23.2	27.0	-19.9	42.5	-14.1	37.4	-11.6
"2" EW	PARIS	LOW	HIGH	44.0	-17.9	38.3	-14.7	57.2	-10.4	50.6	-8.1
"2" EW	PARIS	HIGH	HIGH	43.0	-20.2	37.5	-16.9	55.8	-12.4	49.3	-9.9
"2" EW	TORINO	LOW	LOW	27.0	-33.0	23.5	-29.1	36.2	-22.0	32.1	-18.8
"2" EW	TORINO	HIGH	LOW	26.1	-36.3	22.7	-32.3	35.0	-25.1	30.9	-21.8
"2" EW	TORINO	LOW	HIGH	37.6	-30.1	33.0	-26.1	48.2	-20.3	42.9	-17.0
"2" EW	TORINO	HIGH	HIGH	36.6	-33.2	32.1	-29.1	46.7	-23.2	41.6	-19.8
"2" EW	ATHENES	LOW	LOW	10.2	-55.7	7.9	-50.1	14.7	-41.2	11.8	-36.6
"2" EW	ATHENES	HIGH	LOW	9.6	-59.9	7.5	-54.2	13.9	-45.2	11.1	-40.6
"2" EW	ATHENES	LOW	HIGH	14.6	-54.1	11.6	-48.2	20.3	-40.9	16.4	-36.0
"2" EW	ATHENES	HIGH	HIGH	14.0	-58.1	11.1	-52.2	19.4	-44.8	15.7	-39.8
"2" EW	MUNICH	LOW	LOW	39.0	-21.7	35.0	-18.9	51.0	-12.2	46.3	-10.1
"2" EW	MUNICH	HIGH	LOW	38.1	-24.8	34.2	-21.9	49.6	-15.0	45.1	-12.8
"2" EW	MUNICH	LOW	HIGH	55.1	-17.8	49.8	-15.0	68.6	-9.7	62.6	-7.7
"2" EW	MUNICH	HIGH	HIGH	54.0	-20.7	48.8	-17.8	67.0	-12.3	61.2	-10.1
"2" EW	LISBOA	LOW	LOW	7.9	-41.7	5.9	-36.2	11.8	-23.5	8.9	-19.6
"2" EW	LISBOA	HIGH	LOW	7.7	-45.1	5.7	-39.7	11.4	-26.8	8.7	-22.8
"2" EW	LISBOA	LOW	HIGH	11.4	-37.6	8.7	-32.0	16.9	-21.5	13.0	-17.6
"2" EW	LISBOA	HIGH	HIGH	11.2	-41.0	8.6	-35.3	16.4	-24.6	12.6	-20.5
"3" NS	PARIS	LOW	LOW	51.5	-20.1	45.5	-16.4	63.7	-12.8	57.0	-10.0
"3" NS	PARIS	HIGH	LOW	48.0	-23.2	42.3	-19.2	59.8	-15.5	53.4	-12.4
"3" NS	PARIS	LOW	HIGH	63.2	-17.8	56.0	-14.2	76.3	-11.4	68.5	-8.6
"3" NS	PARIS	HIGH	HIGH	59.4	-20.6	52.6	-16.7	72.2	-13.9	64.6	-10.8
"3" NS	TORINO	LOW	LOW	36.7	-35.5	32.3	-30.7	45.9	-25.6	40.8	-21.5
"3" NS	TORINO	HIGH	LOW	32.9	-40.4	28.7	-35.2	41.7	-30.1	36.8	-25.7
"3" NS	TORINO	LOW	HIGH	46.9	-32.7	41.4	-27.9	57.1	-23.7	51.0	-19.7
"3" NS	TORINO	HIGH	HIGH	42.8	-37.2	37.5	-32.0	52.5	-28.0	46.7	-23.5
"3" NS	ATHENES	LOW	LOW	16.4	-59.3	13.1	-52.7	21.5	-46.7	17.5	-41.0
"3" NS	ATHENES	HIGH	LOW	14.0	-65.2	11.0	-58.4	18.8	-52.5	15.0	-46.5
"3" NS	ATHENES	LOW	HIGH	20.8	-57.9	16.8	-51.1	26.7	-46.3	22.0	-40.4
"3" NS	ATHENES	HIGH	HIGH	18.2	-63.6	14.5	-56.5	23.9	-51.8	19.4	-45.6
"3" NS	MUNICH	LOW	LOW	52.8	-21.8	47.8	-18.5	64.6	-13.4	59.0	-10.7
"3" NS	MUNICH	HIGH	LOW	48.3	-25.7	43.6	-22.1	59.6	-17.0	54.3	-13.9
"3" NS	MUNICH	LOW	HIGH	68.0	-18.2	61.8	-15.0	80.9	-11.0	74.2	-8.4
"3" NS	MUNICH	HIGH	HIGH	63.2	-21.7	57.3	-18.2	75.6	-14.1	69.1	-11.2
"3" NS	LISBOA	LOW	LOW	12.3	-36.5	9.4	-30.7	17.8	-20.7	13.8	-16.5
"3" NS	LISBOA	HIGH	LOW	10.8	-39.7	8.1	-33.6	16.1	-23.6	12.2	-19.1
"3" NS	LISBOA	LOW	HIGH	15.9	-33.3	12.2	-27.4	22.9	-19.2	17.8	-14.9
"3" NS	LISBOA	HIGH	HIGH	14.3	-36.2	10.8	-30.1	21.0	-21.8	16.2	-17.3
"3" EW	PARIS	LOW	LOW	51.7	-21.9	45.8	-18.2	63.8	-14.5	57.2	-11.6
"3" EW	PARIS	HIGH	LOW	48.3	-25.4	42.8	-21.5	60.0	-17.7	53.7	-14.5
"3" EW	PARIS	LOW	HIGH	63.3	-19.5	56.3	-15.9	76.4	-12.9	68.6	-10.1
"3" EW	PARIS	HIGH	HIGH	59.7	-22.7	53.0	-18.9	72.3	-15.9	64.8	-12.7
"3" EW	TORINO	LOW	LOW	37.9	-38.1	33.6	-33.5	47.0	-28.1	42.0	-24.1
"3" EW	TORINO	HIGH	LOW	34.5	-43.6	30.4	-38.7	43.2	-33.4	38.5	-29.1
"3" EW	TORINO	LOW	HIGH	48.1	-35.3	42.7	-30.5	58.1	-26.3	52.2	-22.2
"3" EW	TORINO	HIGH	HIGH	44.5	-40.5	39.3	-35.4	54.1	-31.1	48.3	-26.7
"3" EW	ATHENES	LOW	LOW	16.9	-63.6	13.6	-57.1	21.9	-51.1	17.9	-45.5
"3" EW	ATHENES	HIGH	LOW	14.7	-70.7	11.7	-64.0	19.4	-58.0	15.6	-52.2
"3" EW	ATHENES	LOW	HIGH	21.3	-62.3	17.3	-55.5	27.2	-50.7	22.4	-44.8
"3" EW	ATHENES	HIGH	HIGH	18.9	-69.1	15.2	-62.1	24.5	-57.4	20.0	-51.2
"3" EW	MUNICH	LOW	LOW	53.7	-24.7	48.8	-21.3	65.3	-16.1	59.9	-13.3
"3" EW	MUNICH	HIGH	LOW	49.6	-29.4	45.1	-25.9	60.7	-20.5	55.6	-17.4
"3" EW	MUNICH	LOW	HIGH	68.8	-20.9	62.8	-17.6	81.5	-13.4	74.9	-10.6
"3" EW	MUNICH	HIGH	HIGH	64.5	-25.3	58.7	-21.7	76.6	-17.3	70.3	-14.3
"3" EW	LISBOA	LOW	LOW	12.1	-40.2	9.3	-34.2	17.5	-24.3	13.5	-20.0
"3" EW	LISBOA	HIGH	LOW	10.4	-44.9	7.9	-38.6	15.6	-28.7	11.9	-24.1

"3" EW	LISBOA	LOW	HIGH	15.6	-36.8	12.0	-30.8	22.4	-22.6	17.6	-18.3
"3" EW	LISBOA	HIGH	HIGH	13.8	-41.2	10.5	-34.8	20.4	-26.7	15.8	-21.9

* m² refers to the total surface area of the building

Table 42: Maximum heating and cooling powers

Building case				STPT 21/24°C High Loads		STPT 20/25°C High Loads		STPT 21/24°C Low Loads		STPT 20/25°C Low Loads	
Type/ Orientation	Climate	Solar factor	ventilation	Max heating power (W/m ²)	Max cooling power (W/m ²)	Max heating power (W/m ²)	Max cooling power (W/m ²)	Max heating power (W/m ²)	Max cooling power (W/m ²)	Max heating power (W/m ²)	Max cooling power (W/m ²)
1a NS	PARIS	LOW	LOW	48.5	50.5	41.9	48.2	50.3	42.3	47.0	39.9
1a NS	PARIS	HIGH	LOW	48.5	65.5	41.8	59.7	49.9	54.1	46.6	48.3
1a NS	PARIS	LOW	HIGH	55.2	53.4	51.4	50.5	63.1	45.3	59.5	42.3
1a NS	PARIS	HIGH	HIGH	55.0	64.7	51.1	58.5	63.0	53.2	59.3	47.1
1a NS	TORINO	LOW	LOW	48.6	58.8	42.0	53.1	52.3	47.1	49.1	43.8
1a NS	TORINO	HIGH	LOW	48.4	77.1	41.8	71.4	52.2	65.4	49.0	59.8
1a NS	TORINO	LOW	HIGH	57.9	58.0	54.1	54.9	65.7	49.8	62.0	47.2
1a NS	TORINO	HIGH	HIGH	57.8	76.3	54.0	70.3	65.6	64.6	62.0	58.6
1a NS	ATHENES	LOW	LOW	37.1	89.3	29.7	83.8	42.1	77.5	35.8	72.0
1a NS	ATHENES	HIGH	LOW	27.4	107.5	23.1	102.0	33.0	95.8	29.1	90.3
1a NS	ATHENES	LOW	HIGH	37.8	90.4	34.1	84.5	45.0	78.6	40.9	72.7
1a NS	ATHENES	HIGH	HIGH	35.9	108.6	32.3	102.7	44.6	96.9	40.4	91.0
1a NS	MUNICH	LOW	LOW	51.6	46.7	48.4	43.2	59.5	37.4	56.5	34.2
1a NS	MUNICH	HIGH	LOW	51.4	70.1	48.2	65.2	59.4	57.1	56.5	52.2
1a NS	MUNICH	LOW	HIGH	68.6	47.3	65.1	43.8	76.4	38.8	73.0	35.1
1a NS	MUNICH	HIGH	HIGH	68.5	67.3	65.1	62.0	76.4	54.3	72.9	49.0
1a NS	LISBOA	LOW	LOW	27.9	63.2	19.6	57.7	39.1	51.1	33.0	45.6
1a NS	LISBOA	HIGH	LOW	27.4	73.3	19.1	67.6	38.3	61.6	32.1	55.8
1a NS	LISBOA	LOW	HIGH	28.2	63.4	23.0	57.6	39.7	51.3	34.3	45.5
1a NS	LISBOA	HIGH	HIGH	27.7	73.2	19.9	67.4	38.8	61.4	33.5	55.4
1a EW	PARIS	LOW	LOW	48.5	54.2	41.9	48.6	50.0	42.4	46.9	39.8
1a EW	PARIS	HIGH	LOW	48.5	69.8	41.8	64.2	49.8	58.1	46.6	52.5
1a EW	PARIS	LOW	HIGH	55.0	54.0	51.3	50.4	62.7	45.2	59.0	42.1
1a EW	PARIS	HIGH	HIGH	54.9	69.7	51.2	63.7	62.6	57.9	58.9	52.0
1a EW	TORINO	LOW	LOW	48.6	65.0	42.0	59.3	52.6	53.4	49.4	47.7
1a EW	TORINO	HIGH	LOW	48.4	88.8	41.8	83.1	52.5	77.2	49.3	71.5
1a EW	TORINO	LOW	HIGH	58.1	64.2	54.4	58.2	65.9	53.0	62.2	50.4
1a EW	TORINO	HIGH	HIGH	58.1	88.0	54.4	82.0	65.8	76.4	62.2	70.4
1a EW	ATHENES	LOW	LOW	40.4	96.7	33.5	91.2	43.8	84.9	37.2	79.4
1a EW	ATHENES	HIGH	LOW	31.6	121.3	24.7	115.7	39.8	109.6	33.8	104.0
1a EW	ATHENES	LOW	HIGH	41.6	97.7	35.4	91.9	45.3	86.0	41.3	80.1
1a EW	ATHENES	HIGH	HIGH	36.9	122.3	33.4	116.4	45.0	110.6	40.9	104.7
1a EW	MUNICH	LOW	LOW	51.6	55.9	48.6	51.0	59.5	42.9	56.5	38.0
1a EW	MUNICH	HIGH	LOW	51.5	87.4	48.5	82.4	59.4	74.5	56.5	69.5
1a EW	MUNICH	LOW	HIGH	68.6	53.1	65.1	47.8	76.4	41.3	73.0	37.8
1a EW	MUNICH	HIGH	HIGH	49.2	91.6	65.1	79.3	76.4	71.6	72.9	66.3
1a EW	LISBOA	LOW	LOW	28.0	74.6	19.6	68.6	37.6	62.7	31.5	57.0
1a EW	LISBOA	HIGH	LOW	27.7	97.4	19.3	91.4	37.1	85.5	30.5	79.8
1a EW	LISBOA	LOW	HIGH	27.9	74.6	22.9	68.2	38.2	62.6	32.8	56.5
1a EW	LISBOA	HIGH	HIGH	27.7	97.4	19.9	90.9	37.8	85.4	31.3	79.3
1b NS	PARIS	LOW	LOW	52.2	49.3	48.0	46.8	57.5	43.4	53.2	40.7
1b NS	PARIS	HIGH	LOW	51.9	51.9	47.6	49.4	57.2	46.1	53.0	43.4
1b NS	PARIS	LOW	HIGH	64.3	51.9	59.6	48.7	69.3	46.0	64.5	42.5
1b NS	PARIS	HIGH	HIGH	64.1	54.5	59.4	51.3	69.1	48.7	64.4	45.2
1b NS	TORINO	LOW	LOW	54.4	52.4	50.2	50.3	59.5	46.9	55.1	44.8
1b NS	TORINO	HIGH	LOW	54.2	58.2	50.0	53.3	59.4	51.5	55.0	47.8
1b NS	TORINO	LOW	HIGH	66.9	55.9	62.2	53.3	71.7	50.4	67.0	47.8
1b NS	TORINO	HIGH	HIGH	66.8	58.8	62.1	56.2	71.7	53.4	66.9	50.8
1b NS	ATHENES	LOW	LOW	36.1	67.9	31.5	63.2	42.2	61.1	38.1	56.4
1b NS	ATHENES	HIGH	LOW	35.9	84.3	31.3	79.6	42.0	77.5	37.6	72.9
1b NS	ATHENES	LOW	HIGH	46.1	68.6	41.3	63.7	52.1	61.8	47.8	57.6
1b NS	ATHENES	HIGH	HIGH	45.9	85.0	40.9	80.1	51.8	78.3	47.4	73.4
1b NS	MUNICH	LOW	LOW	61.9	43.7	57.7	40.3	66.7	37.5	62.5	33.7
1b NS	MUNICH	HIGH	LOW	61.8	56.5	57.6	52.1	66.7	48.8	62.5	44.5
1b NS	MUNICH	LOW	HIGH	77.5	44.8	73.1	40.8	82.4	38.7	78.0	34.4
1b NS	MUNICH	HIGH	HIGH	77.5	54.5	73.0	49.9	82.4	46.8	77.9	42.2
1b NS	LISBOA	LOW	LOW	31.5	47.1	26.6	43.2	33.3	40.2	30.2	36.2
1b NS	LISBOA	HIGH	LOW	31.4	56.6	26.5	51.9	33.3	49.7	30.2	45.0
1b NS	LISBOA	LOW	HIGH	34.9	48.2	30.8	45.9	40.8	41.3	37.3	38.9
1b NS	LISBOA	HIGH	HIGH	34.9	56.7	30.7	51.8	40.8	49.9	37.3	45.0
1b EW	PARIS	LOW	LOW	53.2	49.1	48.1	46.5	57.3	43.1	53.1	40.4
1b EW	PARIS	HIGH	LOW	53.2	51.7	47.8	49.2	57.1	45.9	52.9	44.2
1b EW	PARIS	LOW	HIGH	64.8	51.6	59.5	48.4	69.0	45.7	64.3	42.3
1b EW	PARIS	HIGH	HIGH	64.8	54.2	59.4	51.0	68.9	48.5	64.2	45.6
1b EW	TORINO	LOW	LOW	54.9	56.3	50.5	54.1	59.6	50.8	55.3	48.7

1b EW	TORINO	HIGH	LOW	54.9	68.4	50.5	63.5	59.6	61.7	55.2	56.9
1b EW	TORINO	LOW	HIGH	67.2	59.8	62.3	57.2	71.8	54.3	67.0	51.7
1b EW	TORINO	HIGH	HIGH	67.2	67.8	62.3	62.8	71.8	61.2	67.0	56.1
1b EW	ATHENES	LOW	LOW	36.1	74.9	31.3	70.3	42.1	68.1	38.3	63.5
1b EW	ATHENES	HIGH	LOW	35.9	97.3	30.8	92.6	41.7	90.5	37.8	85.8
1b EW	ATHENES	LOW	HIGH	46.8	75.7	41.5	70.8	52.3	68.9	48.1	64.0
1b EW	ATHENES	HIGH	HIGH	46.5	98.0	41.0	93.1	51.9	91.3	47.7	86.3
1b EW	MUNICH	LOW	LOW	62.1	46.5	57.7	43.2	66.7	40.4	62.6	37.7
1b EW	MUNICH	HIGH	LOW	62.1	73.3	57.7	68.9	66.7	65.7	62.6	61.3
1b EW	MUNICH	LOW	HIGH	77.8	47.6	73.1	43.6	82.5	41.5	78.0	38.4
1b EW	MUNICH	HIGH	HIGH	77.8	71.3	73.1	66.7	82.5	63.7	78.0	59.1
1b EW	LISBOA	LOW	LOW	31.6	57.1	26.7	52.5	33.3	50.3	30.3	45.6
1b EW	LISBOA	HIGH	LOW	31.6	76.5	26.6	71.6	33.3	69.9	30.3	65.0
1b EW	LISBOA	LOW	HIGH	35.3	57.3	31.1	52.4	40.8	50.5	37.3	45.6
1b EW	LISBOA	HIGH	HIGH	35.3	76.4	31.0	71.2	40.8	69.8	37.3	64.6
1c NS	PARIS	LOW	LOW	63.6	60.1	58.5	57.4	68.9	55.1	63.8	52.4
1c NS	PARIS	HIGH	LOW	63.3	65.1	58.1	62.6	68.7	60.3	63.6	57.7
1c NS	PARIS	LOW	HIGH	75.8	62.9	70.3	59.7	80.9	57.9	75.4	54.5
1c NS	PARIS	HIGH	HIGH	75.6	67.9	70.1	64.9	80.8	63.0	75.2	60.0
1c NS	TORINO	LOW	LOW	65.3	62.6	60.2	60.1	70.5	57.8	65.3	55.3
1c NS	TORINO	HIGH	LOW	65.1	67.8	60.1	65.3	70.4	63.1	65.2	60.6
1c NS	TORINO	LOW	HIGH	78.1	66.2	72.6	63.2	83.2	61.4	77.6	58.5
1c NS	TORINO	HIGH	HIGH	78.0	71.4	72.5	68.4	83.1	66.7	77.5	63.8
1c NS	ATHENES	LOW	LOW	48.2	73.9	42.5	71.2	54.6	69.0	49.4	66.4
1c NS	ATHENES	HIGH	LOW	47.7	88.3	42.1	83.3	54.2	81.0	48.8	76.0
1c NS	ATHENES	LOW	HIGH	58.0	78.5	52.2	75.4	64.2	73.7	58.8	70.6
1c NS	ATHENES	HIGH	HIGH	57.6	89.1	51.7	83.8	63.7	81.8	58.2	76.5
1c NS	MUNICH	LOW	LOW	73.2	54.8	68.4	52.4	78.3	49.6	73.4	47.3
1c NS	MUNICH	HIGH	LOW	73.1	61.6	68.3	59.1	78.2	56.6	73.3	54.1
1c NS	MUNICH	LOW	HIGH	89.2	56.1	84.1	53.2	94.6	51.0	89.3	48.0
1c NS	MUNICH	HIGH	HIGH	89.1	62.7	84.0	59.9	94.5	57.7	89.2	54.8
1c NS	LISBOA	LOW	LOW	35.7	54.6	30.4	52.1	42.5	48.1	38.3	45.5
1c NS	LISBOA	HIGH	LOW	35.6	59.5	30.4	57.2	42.5	53.1	38.3	50.7
1c NS	LISBOA	LOW	HIGH	43.6	56.0	38.3	53.1	49.6	49.4	44.9	46.2
1c NS	LISBOA	HIGH	HIGH	43.5	60.9	38.3	58.0	49.6	54.5	44.9	51.4
1c EW	PARIS	LOW	LOW	55.2	59.9	58.5	57.1	68.7	54.9	63.7	52.0
1c EW	PARIS	HIGH	LOW	54.7	64.9	58.2	62.5	68.5	60.0	63.4	57.6
1c EW	PARIS	LOW	HIGH	65.9	62.6	70.2	59.2	80.7	57.6	75.2	54.1
1c EW	PARIS	HIGH	HIGH	65.6	67.5	70.0	64.4	80.5	62.7	75.0	59.5
1c EW	TORINO	LOW	LOW	57.7	68.8	60.5	66.3	70.6	64.1	65.5	61.6
1c EW	TORINO	HIGH	LOW	57.7	75.3	60.5	72.8	70.6	70.8	65.4	68.3
1c EW	TORINO	LOW	HIGH	68.7	72.4	72.7	69.4	83.3	67.7	77.6	64.8
1c EW	TORINO	HIGH	HIGH	68.6	78.9	72.7	75.9	83.2	74.3	77.6	71.4
1c EW	ATHENES	LOW	LOW	42.0	79.3	42.0	76.4	54.4	74.7	49.4	71.8
1c EW	ATHENES	HIGH	LOW	41.5	100.6	41.2	95.5	53.6	93.3	48.6	88.3
1c EW	ATHENES	LOW	HIGH	50.5	83.7	52.1	80.4	64.3	79.1	58.9	75.8
1c EW	ATHENES	HIGH	HIGH	49.9	101.4	51.3	96.0	63.6	94.1	58.3	88.8
1c EW	MUNICH	LOW	LOW	64.7	59.5	68.4	57.2	78.3	54.5	73.5	52.1
1c EW	MUNICH	HIGH	LOW	64.6	72.6	68.3	67.8	78.3	64.4	73.5	60.2
1c EW	MUNICH	LOW	HIGH	78.6	60.9	84.2	58.0	94.6	55.8	89.3	53.0
1c EW	MUNICH	HIGH	HIGH	78.6	70.5	84.1	65.8	94.6	63.8	89.3	60.9
1c EW	LISBOA	LOW	LOW	32.3	57.7	30.5	53.3	42.6	50.3	38.3	46.9
1c EW	LISBOA	HIGH	LOW	32.3	73.9	30.4	68.9	42.5	66.6	38.3	61.5
1c EW	LISBOA	LOW	HIGH	39.3	58.4	38.6	55.2	49.6	51.9	44.9	48.8
1c EW	LISBOA	HIGH	HIGH	39.3	74.1	38.5	68.8	49.6	66.7	44.9	61.4
"2" NS	PARIS	LOW	LOW	52.3	39.1	47.8	36.4	55.6	32.4	52.0	29.5
"2" NS	PARIS	HIGH	LOW	52.2	40.3	47.8	37.6	55.6	33.7	51.9	30.8
"2" NS	PARIS	LOW	HIGH	63.6	41.5	58.6	38.1	67.2	34.9	63.2	31.2
"2" NS	PARIS	HIGH	HIGH	63.5	42.7	58.6	39.4	67.1	36.2	63.1	32.6
"2" NS	TORINO	LOW	LOW	52.3	45.5	48.2	43.0	55.8	39.2	51.6	36.7
"2" NS	TORINO	HIGH	LOW	51.9	48.1	47.8	45.6	55.5	41.9	51.3	39.4
"2" NS	TORINO	LOW	HIGH	64.7	49.0	60.0	45.9	68.1	42.7	63.4	39.6
"2" NS	TORINO	HIGH	HIGH	64.3	51.6	59.6	48.6	67.8	45.4	63.1	42.3
"2" NS	ATHENES	LOW	LOW	36.0	59.3	32.5	55.5	41.8	52.3	38.2	48.7
"2" NS	ATHENES	HIGH	LOW	34.3	68.4	30.7	64.6	41.4	61.5	37.8	57.6
"2" NS	ATHENES	LOW	HIGH	45.0	62.2	41.0	59.2	51.7	56.0	47.7	53.0
"2" NS	ATHENES	HIGH	HIGH	44.7	69.2	40.2	65.1	51.4	62.2	47.4	58.1
"2" NS	MUNICH	LOW	LOW	60.0	36.4	56.9	32.8	65.7	29.3	62.3	25.1
"2" NS	MUNICH	HIGH	LOW	60.0	39.4	56.8	35.8	65.6	32.4	62.2	28.3
"2" NS	MUNICH	LOW	HIGH	75.4	37.4	71.8	32.8	81.0	30.4	77.2	25.4
"2" NS	MUNICH	HIGH	HIGH	75.4	40.4	71.7	35.8	80.9	33.5	77.1	28.5
"2" NS	LISBOA	LOW	LOW	25.6	42.3	22.0	39.5	30.7	34.2	27.7	31.4
"2" NS	LISBOA	HIGH	LOW	23.4	45.5	19.3	41.7	30.5	38.3	27.6	34.4
"2" NS	LISBOA	LOW	HIGH	33.0	44.6	29.0	41.5	38.1	36.5	34.7	33.7
"2" NS	LISBOA	HIGH	HIGH	30.9	45.9	26.3	42.6	38.0	38.4	34.7	34.5
"2" EW	PARIS	LOW	LOW	52.5	39.2	47.8	36.5	55.6	32.5	51.8	29.6

"2" EW	PARIS	HIGH	LOW	52.5	43.4	47.8	39.5	55.6	36.4	51.7	32.5
"2" EW	PARIS	LOW	HIGH	63.8	41.6	58.6	38.2	67.0	35.0	63.1	31.3
"2" EW	PARIS	HIGH	HIGH	63.8	43.3	58.6	39.6	66.9	36.5	62.9	32.8
"2" EW	TORINO	LOW	LOW	52.5	48.2	48.2	45.7	55.7	42.0	51.6	39.4
"2" EW	TORINO	HIGH	LOW	52.4	53.5	48.1	49.4	55.6	46.5	51.5	42.9
"2" EW	TORINO	LOW	HIGH	64.8	51.7	60.0	48.6	68.0	45.4	63.4	42.4
"2" EW	TORINO	HIGH	HIGH	64.7	55.1	59.9	52.1	67.9	49.0	63.3	45.9
"2" EW	ATHENES	LOW	LOW	37.3	64.0	33.4	60.2	42.2	57.0	38.7	53.2
"2" EW	ATHENES	HIGH	LOW	36.9	76.3	32.3	72.4	41.9	69.3	38.4	65.5
"2" EW	ATHENES	LOW	HIGH	46.6	65.1	41.6	61.8	51.7	59.0	47.9	55.7
"2" EW	ATHENES	HIGH	HIGH	46.5	77.1	40.9	73.0	51.5	70.1	47.8	66.0
"2" EW	MUNICH	LOW	LOW	61.0	38.8	56.9	35.2	65.8	31.7	62.3	27.6
"2" EW	MUNICH	HIGH	LOW	61.0	46.6	56.9	43.1	65.7	39.1	62.3	35.6
"2" EW	MUNICH	LOW	HIGH	76.3	39.8	71.9	35.3	81.1	32.8	77.2	27.9
"2" EW	MUNICH	HIGH	HIGH	76.3	44.7	71.8	40.9	81.0	37.0	77.2	33.3
"2" EW	LISBOA	LOW	LOW	30.5	47.6	22.1	43.4	30.6	40.7	27.8	36.4
"2" EW	LISBOA	HIGH	LOW	29.9	58.9	19.6	54.6	30.6	52.0	27.8	47.7
"2" EW	LISBOA	LOW	HIGH	36.3	48.1	29.2	44.8	38.1	40.6	34.7	36.9
"2" EW	LISBOA	HIGH	HIGH	36.1	58.8	27.1	54.3	38.1	51.9	34.7	47.4
"3" NS	PARIS	LOW	LOW	68.9	49.3	63.7	46.6	73.9	44.2	68.6	41.4
"3" NS	PARIS	HIGH	LOW	68.7	52.9	63.5	50.3	73.8	47.9	68.5	45.3
"3" NS	PARIS	LOW	HIGH	79.9	51.9	74.2	48.6	84.8	46.8	79.1	43.1
"3" NS	PARIS	HIGH	HIGH	79.7	55.4	74.1	52.4	84.7	50.5	79.0	47.1
"3" NS	TORINO	LOW	LOW	58.9	56.8	54.8	54.0	64.4	51.8	60.0	49.0
"3" NS	TORINO	HIGH	LOW	58.7	61.9	54.7	59.1	64.3	57.0	59.9	54.3
"3" NS	TORINO	LOW	HIGH	70.6	60.1	66.1	56.9	76.0	55.1	71.2	51.9
"3" NS	TORINO	HIGH	HIGH	70.4	65.2	66.0	62.0	75.9	60.3	71.1	57.1
"3" NS	ATHENES	LOW	LOW	56.4	72.3	51.1	68.8	62.4	67.4	57.3	63.9
"3" NS	ATHENES	HIGH	LOW	55.8	83.8	50.5	79.0	61.9	76.9	56.8	72.1
"3" NS	ATHENES	LOW	HIGH	65.4	76.4	59.7	72.5	70.9	71.6	65.4	67.6
"3" NS	ATHENES	HIGH	HIGH	64.9	84.6	59.2	79.5	70.5	77.7	65.0	72.6
"3" NS	MUNICH	LOW	LOW	77.0	47.9	72.0	45.1	81.9	42.6	76.8	39.8
"3" NS	MUNICH	HIGH	LOW	76.9	54.2	71.9	51.3	81.8	48.9	76.7	46.1
"3" NS	MUNICH	LOW	HIGH	91.5	49.1	86.1	45.7	96.4	43.8	90.9	40.3
"3" NS	MUNICH	HIGH	HIGH	91.4	55.3	86.0	52.0	96.3	50.1	90.8	46.8
"3" NS	LISBOA	LOW	LOW	39.0	49.2	33.2	45.8	44.0	41.9	39.8	38.5
"3" NS	LISBOA	HIGH	LOW	38.7	56.1	32.8	50.6	43.9	49.3	39.8	43.8
"3" NS	LISBOA	LOW	HIGH	44.8	51.4	39.9	47.5	50.6	44.1	46.0	40.3
"3" NS	LISBOA	HIGH	HIGH	44.7	56.0	39.8	50.4	50.5	49.2	45.9	43.5
"3" EW	PARIS	LOW	LOW	55.3	49.9	63.9	46.9	74.0	44.7	68.7	41.8
"3" EW	PARIS	HIGH	LOW	55.2	57.0	63.8	54.4	73.9	52.0	68.6	49.4
"3" EW	PARIS	LOW	HIGH	63.9	52.3	74.3	48.9	84.9	47.2	79.1	43.6
"3" EW	PARIS	HIGH	HIGH	63.8	58.5	74.3	55.5	84.8	53.5	79.1	50.4
"3" EW	TORINO	LOW	LOW	48.5	61.6	55.1	58.9	64.6	56.8	60.2	54.0
"3" EW	TORINO	HIGH	LOW	48.4	68.0	55.0	65.3	64.5	63.3	60.1	60.5
"3" EW	TORINO	LOW	HIGH	57.6	65.0	66.3	61.8	76.2	60.1	71.4	56.9
"3" EW	TORINO	HIGH	HIGH	57.6	71.3	66.3	68.1	76.2	66.5	71.4	63.3
"3" EW	ATHENES	LOW	LOW	45.6	78.2	50.9	74.7	62.5	73.4	57.3	69.9
"3" EW	ATHENES	HIGH	LOW	45.0	92.4	50.3	87.6	62.0	85.5	56.8	80.6
"3" EW	ATHENES	LOW	HIGH	52.6	82.3	59.7	78.4	70.8	77.5	65.3	73.6
"3" EW	ATHENES	HIGH	HIGH	52.1	93.1	59.3	88.1	70.4	86.2	65.0	81.2
"3" EW	MUNICH	LOW	LOW	62.2	52.5	72.0	49.6	81.9	47.2	76.8	44.4
"3" EW	MUNICH	HIGH	LOW	62.1	60.6	72.0	57.4	81.8	55.1	76.7	52.3
"3" EW	MUNICH	LOW	HIGH	73.6	53.6	86.2	50.3	96.5	48.4	90.9	45.0
"3" EW	MUNICH	HIGH	HIGH	73.5	61.3	86.1	58.0	96.4	56.2	90.8	52.9
"3" EW	LISBOA	LOW	LOW	31.9	54.8	32.7	51.3	44.0	48.1	39.9	44.6
"3" EW	LISBOA	HIGH	LOW	31.8	63.6	32.3	58.8	44.0	56.5	39.9	51.7
"3" EW	LISBOA	LOW	HIGH	37.5	56.9	40.0	53.1	50.6	50.2	46.0	46.4
"3" EW	LISBOA	HIGH	HIGH	37.5	63.8	40.0	58.8	50.6	56.7	46.0	51.7

ANNEX 3 : RESULTS OF HEATING AND COOLING DEMANDS IN HEALTH CARE BUILDINGS

Table 43: Main results

Building type				Energy demand (kWh/m ² /year)				Ratio max heating on cooling power	Number of hours with simultaneous cooling and heating demand	Energy demand when simultaneity H/C demand		Number of days with non simultaneous cooling and heating demand	Energy demand when daily H/C demand but non simultaneous	
Type/ Orientation	Climate	Solar factor	ventilation	Annual heating	Annual cooling	Winter heating	Summer cooling			heating	cooling		heating	cooling
1	PARIS	LOW	LOW	56.0	-19.0	50.3	34.3	1.47	1812	9.2	-2.8	59	6.1	-2.4
1	PARIS	HIGH	LOW	58.3	-20.0	51.7	37.2	1.39	1484	6.9	-2.3	62	6.0	-2.6
1	PARIS	LOW	HIGH	71.6	-16.9	56.6	35.4	1.60	1499	6.4	-2.9	92	7.6	-4.3
1	PARIS	HIGH	HIGH	71.0	-18.2	56.6	37.9	1.49	1325	6.0	-2.4	93	7.3	-4.5
1	TORINO	LOW	LOW	49.1	-29.9	49.2	44.1	1.11	1551	7.8	-2.3	50	5.7	-2.1
1	TORINO	HIGH	LOW	51.5	-32.2	50.5	47.1	1.07	1310	6.2	-2.0	55	6.0	-2.3
1	TORINO	LOW	HIGH	63.1	-27.5	55.6	45.8	1.21	1116	4.2	-2.0	73	7.5	-3.1
1	TORINO	HIGH	HIGH	63.0	-29.8	55.6	48.1	1.15	1073	4.2	-1.9	74	7.5	-3.2
1	ATHENES	LOW	LOW	16.3	-59.5	32.4	50.7	0.64	1797	7.3	-2.7	54	3.8	-2.4
1	ATHENES	HIGH	LOW	17.2	-62.7	33.8	53.8	0.63	1600	6.3	-2.4	58	4.0	-2.5
1	ATHENES	LOW	HIGH	22.5	-57.7	37.8	53.5	0.71	1285	4.9	-2.4	85	5.5	-4.0
1	ATHENES	HIGH	HIGH	22.5	-60.9	37.8	55.7	0.68	1297	5.0	-2.4	84	5.5	-4.0
1	MUNICH	LOW	LOW	77.7	-15.3	68.1	28.2	2.42	2183	13.7	-3.2	42	6.1	-1.4
1	MUNICH	HIGH	LOW	79.6	-16.5	69.3	31.3	2.21	1925	11.4	-2.9	48	6.6	-1.6
1	MUNICH	LOW	HIGH	97.4	-13.0	76.2	27.9	2.73	1627	7.0	-2.9	80	8.0	-3.8
1	MUNICH	HIGH	HIGH	96.5	-14.0	76.2	31.1	2.45	1429	6.5	-2.4	79	7.5	-3.8
1	LISBOA	LOW	LOW	12.6	-36.9	21.4	46.5	0.46	2971	9.7	-5.4	23	1.6	-1.0
1	LISBOA	HIGH	LOW	13.6	-37.3	22.4	48.6	0.46	2708	8.6	-4.9	38	2.4	-1.8
1	LISBOA	LOW	HIGH	18.3	-33.5	24.9	48.5	0.51	2458	7.3	-5.6	68	4.5	-3.1
1	LISBOA	HIGH	HIGH	18.3	-34.9	24.9	50.1	0.50	2427	7.2	-5.5	68	4.4	-3.1
2	PARIS	LOW	LOW	51.9	-6.1	40.7	21.1	1.93	29	0.0	0.0	96	2.3	-1.9
2	PARIS	HIGH	LOW	51.7	-11.3	41.3	28.3	1.46	42	0.0	-0.1	93	2.1	-3.1
2	PARIS	LOW	HIGH	80.8	-4.0	53.8	23.7	2.27	26	0.0	-0.1	61	3.2	-0.8
2	PARIS	HIGH	HIGH	79.5	-7.5	53.8	30.4	1.77	26	0.0	-0.1	66	3.1	-1.7
2	TORINO	LOW	LOW	35.2	-16.9	33.9	23.8	1.42	81	0.1	-0.1	91	2.0	-4.0
2	TORINO	HIGH	LOW	38.5	-24.2	36.1	31.0	1.16	68	0.1	-0.1	89	2.2	-4.2
2	TORINO	LOW	HIGH	63.9	-11.9	49.0	27.8	1.76	50	0.0	-0.1	73	3.4	-2.0
2	TORINO	HIGH	HIGH	63.7	-18.3	49.0	33.9	1.45	50	0.0	-0.1	70	3.4	-2.1
2	ATHENES	LOW	LOW	13.2	-39.0	29.8	30.9	0.96	52	0.0	-0.1	76	1.3	-2.7
2	ATHENES	HIGH	LOW	14.7	-48.2	31.3	38.0	0.82	47	0.0	-0.1	69	1.2	-2.6
2	ATHENES	LOW	HIGH	26.6	-36.3	41.3	36.8	1.12	34	0.0	0.0	50	1.5	-1.3
2	ATHENES	HIGH	HIGH	26.6	-44.8	41.3	42.5	0.97	34	0.0	0.0	50	1.5	-1.4
2	MUNICH	LOW	LOW	47.9	-6.5	41.9	17.3	2.42	190	0.2	-0.5	110	1.7	-3.2
2	MUNICH	HIGH	LOW	50.4	-11.7	43.5	24.2	1.80	180	0.2	-0.4	103	1.5	-4.3
2	MUNICH	LOW	HIGH	88.2	-2.5	59.8	18.0	3.32	80	0.1	-0.2	62	1.5	-1.1
2	MUNICH	HIGH	HIGH	86.3	-5.7	59.8	24.7	2.42	84	0.1	-0.2	64	1.8	-1.7
2	LISBOA	LOW	LOW	13.5	-15.6	21.4	24.8	0.86	346	0.3	-0.8	99	2.6	-2.5
2	LISBOA	HIGH	LOW	15.2	-18.5	22.7	29.6	0.77	284	0.3	-0.7	90	2.5	-2.1
2	LISBOA	LOW	HIGH	26.3	-10.8	30.1	29.9	1.01	102	0.1	-0.2	78	2.4	-1.1
2	LISBOA	HIGH	HIGH	26.1	-13.9	30.1	33.7	0.89	102	0.1	-0.2	82	2.5	-1.2

Table 44: Maximum heating and cooling powers

Type/ Orientation	Climate	Solar factor	ventilation	Max heating power (W/m ²)	Max cooling power (W/m ²)	Max cooling power in partially air conditioned rest homes (W/m ²)
1	PARIS	LOW	LOW	50.3	34.3	
1	PARIS	HIGH	LOW	51.7	37.2	
1	PARIS	LOW	HIGH	56.6	35.4	
1	PARIS	HIGH	HIGH	56.6	37.9	
1	TORINO	LOW	LOW	49.2	44.1	
1	TORINO	HIGH	LOW	50.5	47.1	
1	TORINO	LOW	HIGH	55.6	45.8	
1	TORINO	HIGH	HIGH	55.6	48.1	
1	ATHENES	LOW	LOW	32.4	50.7	
1	ATHENES	HIGH	LOW	33.8	53.8	
1	ATHENES	LOW	HIGH	37.8	53.5	
1	ATHENES	HIGH	HIGH	37.8	55.7	
1	MUNICH	LOW	LOW	68.1	28.2	
1	MUNICH	HIGH	LOW	69.3	31.3	
1	MUNICH	LOW	HIGH	76.2	27.9	
1	MUNICH	HIGH	HIGH	76.2	31.1	
1	LISBOA	LOW	LOW	21.4	46.5	
1	LISBOA	HIGH	LOW	22.4	48.6	
1	LISBOA	LOW	HIGH	24.9	48.5	
1	LISBOA	HIGH	HIGH	24.9	50.1	
2	PARIS	LOW	LOW	40.7	21.1	8.0
2	PARIS	HIGH	LOW	41.3	28.3	10.6
2	PARIS	LOW	HIGH	53.8	23.7	9.8
2	PARIS	HIGH	HIGH	53.8	30.4	12.1
2	TORINO	LOW	LOW	33.9	23.8	8.4
2	TORINO	HIGH	LOW	36.1	31.0	11.0
2	TORINO	LOW	HIGH	49.0	27.8	10.8
2	TORINO	HIGH	HIGH	49.0	33.9	12.9
2	ATHENES	LOW	LOW	29.8	30.9	10.6
2	ATHENES	HIGH	LOW	31.3	38.0	13.2
2	ATHENES	LOW	HIGH	41.3	36.8	14.0
2	ATHENES	HIGH	HIGH	41.3	42.5	15.9
2	MUNICH	LOW	LOW	41.9	17.3	6.8
2	MUNICH	HIGH	LOW	43.5	24.2	9.1
2	MUNICH	LOW	HIGH	59.8	18.0	7.4
2	MUNICH	HIGH	HIGH	59.8	24.7	9.8
2	LISBOA	LOW	LOW	21.4	24.8	9.5
2	LISBOA	HIGH	LOW	22.7	29.6	11.5
2	LISBOA	LOW	HIGH	30.1	29.9	12.1
2	LISBOA	HIGH	HIGH	30.1	33.7	14.1

ANNEX 4: ANALYSIS OF HEAT TRANSFER IN FOUR-PIPES FAN COIL UNITS

The FCU water temperature in heating mode varies from one unit to another from 40°C to 90°C maximum temperature. However, the use of chillers in heating mode can generally not allow to reach water temperatures higher than 50°C in the worst cases and 65°C in the best cases [BER, 2007].

Many Fan coil units exist, the most common are :

- 1 coil, 4 pipes
- 2 coils, 4 pipes
- 1 coil, 2 pipes + electric heat

The study is focused on a 2coils – 4 pipes FCU (CIAT Major 2, 435). All calculations have been carried out with using the cooling and heating models from Consoclim [CON, 2000], [MOR, 2002].

Description of the model:

The cooling coil model used in ConsoClim is based on a heat and mass transfer representation according to the Threlkeld Method [THR, 1970] (Figure 26).

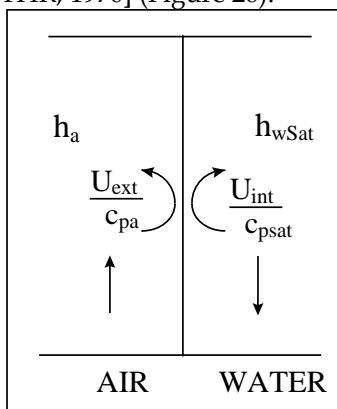


Figure 26: heat and mass transfer in Cooling Coil: representation using THRELKELD method

Then, the air-side and water-side heat transfer coefficients are expressed based on convection heat transfer correlations of Dittus Boelter and Colburn factor respectively.

The water side heat transfer coefficient is defined as follows:

$$\frac{UA_{int\,Rat}}{m_{wRat}^{0.8}} = 0.023 A_{int} \frac{\lambda_w}{d_{int}} \left(\frac{1}{\pi d_{int} \mu_w} \right)^{0.8} \left(\frac{\mu_w c_{pw}}{\lambda_w} \right)^{0.4} \quad (1)$$

In the range of typical temperatures for air-conditioning (typically [5- 12°C]), water properties as cinematic viscosity μ , thermal conductivity λ are assumed to be constant. Thus, for one coil (i.e. d_{int} and A_{int} are constant), inside heat transfer coefficient variation only depends on water mass flow rate for turbulent flows. Non-rating value can be calculated from rating value by identifying all the constant (or assumed to be constant) values using the known rating value as follows :

which leads to:

$$UA_{int} = \frac{UA_{int\,Rat}}{m_{wRat}^{0.8}} m_w^{0.8} \quad (2)$$

Second, concerning the air-side heat transfer coefficient determination for non-nominal conditions, the heat transfer coefficient is written using convection and fin resistance.

$$UA_{ext} = \frac{1}{R_{ext}} + \frac{1}{R_{ail}} \quad R_{ext} = \frac{1}{h_{ext} A_{ext}} \quad R_{ail} = \frac{1}{h_{ext} A_s \eta_{ail}} \quad (3)$$

Using a similar approach to internal heat transfer coefficient, the air-side heat transfer coefficient is expressed as follows:

$$UA_{ext} = \frac{UA_{extRat}}{V_{aRat}^{0.77}} V_a^{0.77} \quad (4)$$

UA_{ext} and UA_{int} are determined based on performance data from the manufacturer's catalog.

The cooling coil is now supposed to be used in heating mode. The UA_{int} is recalculated considering that the water properties are modified. Indeed the water temperature passes from 7-12°C to 40-45°C for instance what implies about 40% of heat exchange increase. Equation (4) is changed to account for dry conditions, UA_{ext} becomes :

$$UA_{ext} = \frac{UA_{extRat}}{V_{aRat}^{0.67}} V_a^{0.67} \quad (5)$$

The performance of the cooling coil operating in heating mode is assessed by using the NTU-effectiveness method.

Case study:

The FCU, CIAT Major 2, 435, delivers a heating power of 7690 W at 90/70°C water temperature and 19°C air conditions. The total and sensible cooling power at 7/12°C water temperatures and 27°C and 50% RH air conditions are of 8240 W and 5790 W respectively. The nominal water flow rates are 0.092 kg/s in the heating coil and 0.394 kg/s in the cooling coil.

The calculation of UA_{ext} and UA_{int} in cooling mode gives 882 W/K and 2760 W/K respectively.

In the following, one considers a 45°C water inlet temperature, which can be generally easily reached by heat pumps.

The water-side heat transfer coefficient is increased of 42.5% in order to account for the changes of water properties due to the temperature changes from 7-12°C to 45-40°C.

The heat transfer calculations in the cooling coil in heating mode (Table 45) show that:

- if the water flow rate in heating mode is equal to water flow rate in cooling mode, the cooling coil in heating mode at 45/40°C can deliver about 11% more power than the heating coil at 90/70°C;
- if the inlet water temperature in the cooling coil is lower to 40°C, the cooling coil in heating mode delivers about 12% less power than the heating coil at 90/70°C;
- If the inlet water flow rate is equal to those of the heating coil, the cooling coil in heating mode at 45/40°C delivers 25% less power than the heating coil at 90/70°C.

Table 45: Comparison of the use of cooling coil in heating mode with the heating coil

Heating power in W according to:			
Use of the heating coil	Use of the cooling coil	Use of the cooling coil	Use of the cooling coil
Water temperatures : 90/70°C	Water temperatures : 45/39.8°C	Water temperatures : 45/29.7°C	Water temperatures : 40/35.8°C
$\dot{m}_w=0.092\text{kg/s}$	$\dot{m}_w=0.394\text{kg/s}$	$\dot{m}_w=0.092\text{kg/s}$	$\dot{m}_w=0.394\text{kg/s}$
7 690 W	8 600 W	5 800 W	6 900 W

Since the FCU are often used at medium fan speed, it is interesting to know the inlet water temperature which can transfer at maximum fan speed as heat as the same FCU operating at medium fan speed and 90°C inlet water temperature. The results (Figure 27) shows that the same heat power can be transferred at 77°C if the FCU operates at maximum fan speed. This temperature is in general much higher than the maximum temperature which can provide Heat pumps. Since maximum heating power is often required during the heating up of the building before occupancy, an anticipated heating up of the building can be considered in order to compensate the decrease of the heating power due to the lower water temperatures provided by the heat pump. This will imply an increase of the fan energy consumption. Furthermore, the use of the cooling coil for heating is possible on condition that the thermo static valve can be fitted for heating operation.

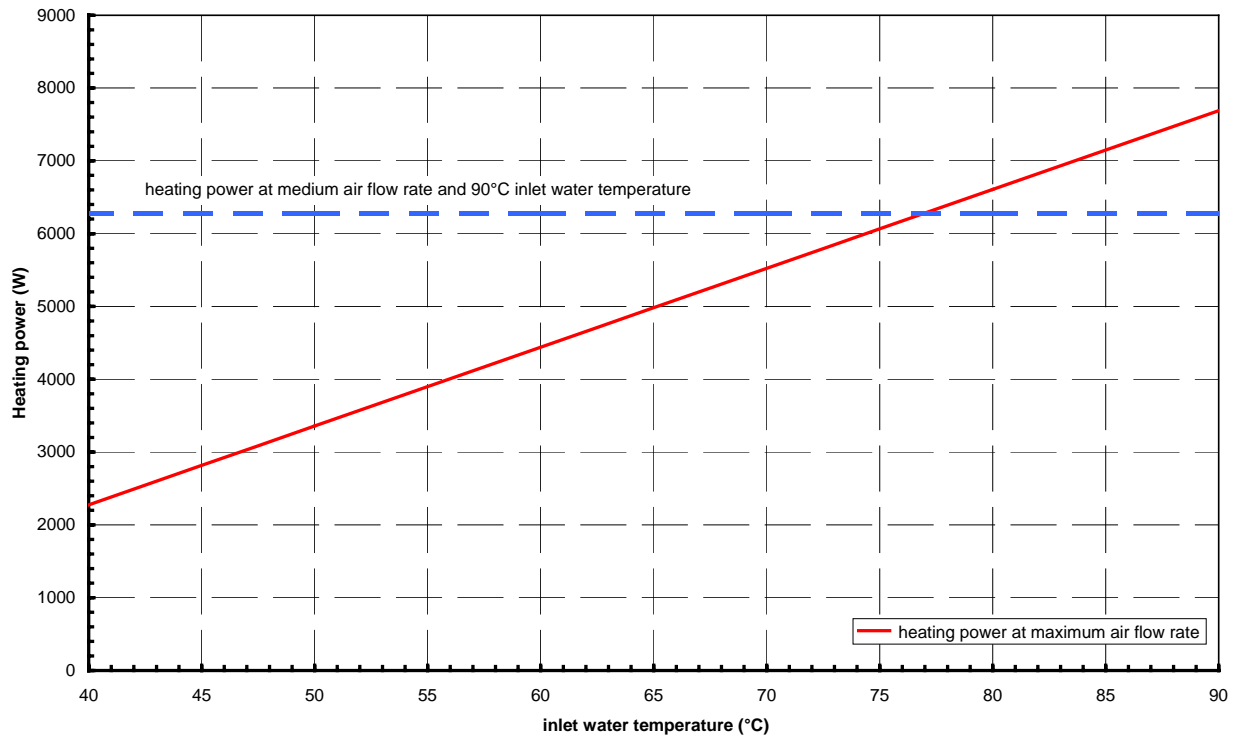


Figure 27: Impact of the inlet water temperature decrease in the heating coil of a FCU at maximum air flow rate and water flow rate.

Conclusion:

Even if a heat pump can not provide hot water temperature higher than 50°C, one can consider in the case of 2 coils FCU, the boiler can be replaced by a heat pump provided that the cooling coil is used for heating, which has a better heat transfer than the heating coil and the water flow rate in the cooling coil is at the same level in heating mode as in the cooling mode.

In the case of 1 coil FCU, the hot water temperatures are generally lower, equal to or below 50°C.

Nomenclature:

A_{ext}, A_{int}, A_s	m^2	air-side exchange area, water-side exchange area, fin area
c_{pa}, c_{psat}, c_{pw}	J/kgK	specific heat of air, of saturated air, of water
d_{int}	m	inside pipe diameter
h_a, h_{wsat}	J/kg	air enthalpy, saturated enthalpy of air at liquid temperature
\dot{m}_w	kg/s	water flow rate
R_{ail}, R_{ext}	K/W	fin thermal resistance, air-side convection resistance
NTU		number of transfer unit
UA_h	kg/s	overall enthalpy heat transfer coefficient
UA_{ext}, UA_{int}	W/K	air-side and liquid-side heat transfer coefficient
V_a	m^3/s	specific dry air volumic flow rate
λ_a, λ_w	W/mK	thermal air conductivity, thermal water conductivity
μ_a, μ_w	Pa/s	dynamic air and water viscosity
ν_a	m^2/s	cinematic air viscosity
ρ_a, ρ_w	kg/m^3	air and water density

indices :

i	inlet
o	outlet
a	air
w	water
cond	condensation film

References:

[BER, 2007] Pompe à chaleur haute température!... Mais à quelle température ?, BERNIER J., CFP, n°700, avril 2007

[CON, 2000] Méthode de calcul des consommations d'énergie des bâtiments climatisés, BOHLER A., CASARI R., COLLIGNAN B., FLEURY E., MARCHIO D., MILLET J.-R. et MORISOT O., *CONSOCLIM*, rapport CSTB ENEA/CVA-99.176R, janvier 2000.

[MOR 2002] Simplified Model for the Operation of chiller water cooling Coils under nonnominal conditions, MORISOT O. MARCHIO D., STABAT P., HVAC&R RESEARCH, vol 8 n°2, April 2002

[THR, 1970] Thermal environmental engineering, THRELKELD J.L., 2nd ed., Englewood Cliffs, New Jersey: Prentice-Hall, 1970

ANNEX 5: ASSUMPTIONS ON PRESSURE DROPS IN AIR HANDLING UNITS

The pressure drop of AHU components are chosen according to mean values⁵ from [EN 13779] :

Ductwork on supply air :	300 Pa
ductwork on extract air:	200 Pa
heating coil :	80 Pa
cooling coil :	200 Pa
Heat recovery unit :	150 Pa
Humidifier :	50 Pa
Air filters:	150 Pa
Silencer:	50 Pa
Terminal device :	50 Pa
Air inlet and outlet:	50 Pa

Pressure Drop in the AHU in Pa :

	supply	return
CAV	930	250
VAV	1080	400
DF	700	400
SF		150
DF without Heat recovery	500	250

Fan efficiency (fan and motor) :

$$P_{el} = \frac{\dot{V} \cdot \Delta P_t}{\eta_v \cdot \eta_m} \text{ in W}$$

η_v ranges between 57% and 95% for centrifuge fans and 85% and 95% for helicoid fans [REI,1996]

η_m ranges between 75% and 95%.

As for fans, more the motor power is high, better is its efficiency.

η_v η_m can be taken between 50% and 80%;

References :

[EN 13779, 2007] “ventilation for non-residential buildings – performance requirements for ventilation and room-conditioning systems”, NF EN 13779, July 2007

⁵ Except for the cooling coil where the high value is taken into account since the mean value seems low

ANNEX 6: GHG EMISSION FACTORS

The CO₂ emissions due to electricity production can be very variable such as in France where different production means are used according to the peak loads (Figure here below). The main reasons are :

- The climatic variations;
- The availability of production means (in particular water power and nuclear power);
- The management of energy demand.

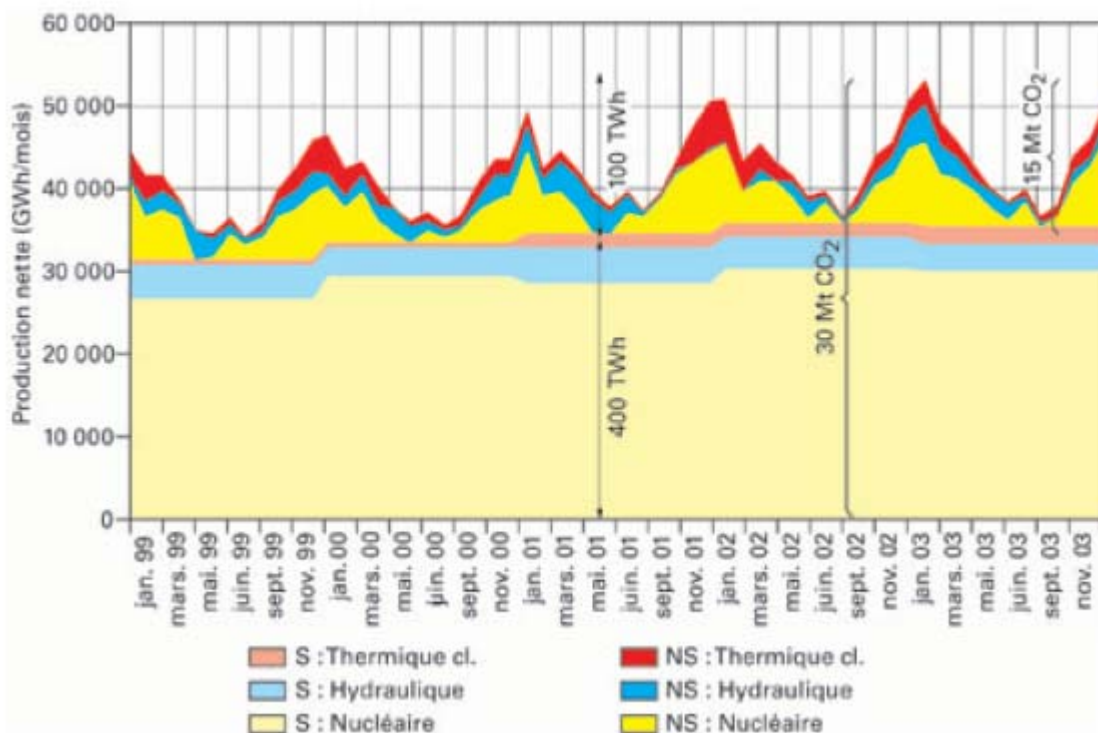


Figure 28: Seasonal electricity demand in France between 1999 and 2003 [DES, 2006]

The Figure below shows the monthly variation of CO₂ content of electricity in France.

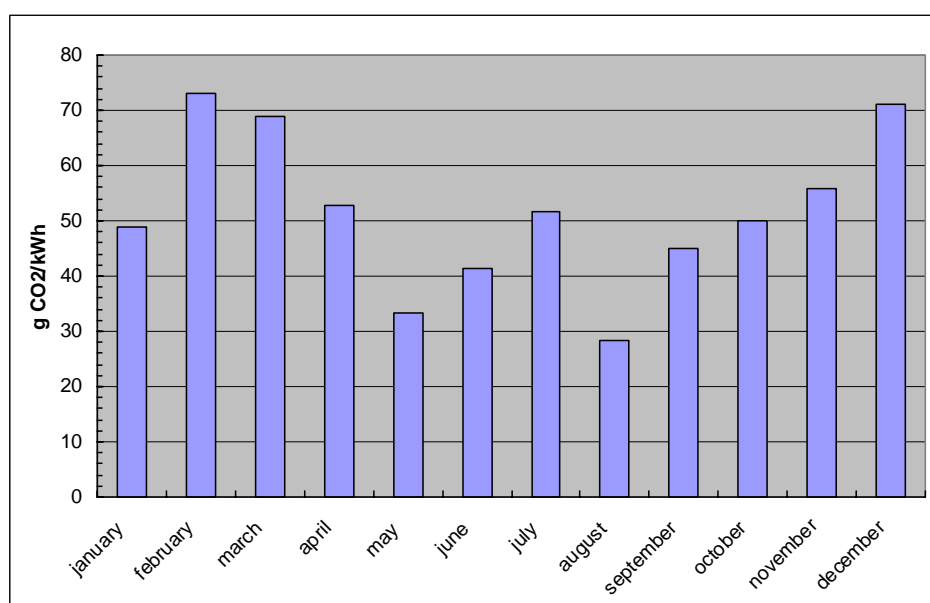


Figure 29: Monthly variation of CO₂ content of electricity based on EDF data in 2005

The CO₂ emissions by electricity utilisation is not easy to determine. ADEME and EDF [DES, 2006] have developed a methodology and provide emission factors by electricity use (Table below).

Table 46: Emission factors by electricity use in France

Use	CO2 emissions
Space heating (electric or auxiliaries of boilers)	180 g/kWh
Lighting	100 g/kWh
Appliances	60 g/kWh
Cooling, HDW...	40 g/kWh

However, in order to use comparable data between European countries, standard data are used [ADE, 2007] presented in the Table below. Here, the network losses are not taken into account.

Table 47: Emission factors of electricity production by country (based on IEA figures of 2004)

Country	kg CO ₂ /kWh
France	0.084
Germany	0.517
Austria	0.205
Belgium	0.268
Denmark	0.334
Spain	0.429
Finland	0.253
Greece	0.814
Ireland	0.645
Italy	0.510
Luxemburg	0.304
The Netherlands	0.440
Portugal	0.502
United kingdom	0.455
Sweden	0.044
EU 15	0.352
USA	0.579
Japan	0.422

The emission factors for fossil fuels including upstream (extraction, transport, refinery) are given in the following table.

	kg CO ₂ /kWh
Fuel oil	0.301
Natural Gas	0.231

References:

[ADE 2007] Guide des facteurs d'émissions - calcul des facteurs d'émissions et sources bibliographiques utilisées, Bilan Carbone version 5.0, ADEME Janvier 2007

[DES, 2006] "Critères et démarches de choix énergétique dans le bâtiment», DESPRETZ H., Techniques de l'ingénieur, BE 9030, 2006

ANNEX 7 : BUILDING ENERGY CONSUMPTION RESULTS (TABLES)

Table 48: simulation results for office buildings (set points 21/24°C, building orientation : North/south)

HVAC	type	climate	Internal loads	solar factor	ventilation	Seasonal boiler efficiency	Seasonal COP	Reference case	Heat pump use	
								Annual boiler consumption (KWh/m ²)	electric heat pump consumption (kWh/m ²)	fuel consumption reduction (kWh/m ²)
DF + FCU	1a	PARIS	LOW	LOW	LOW	0.50	2.70	24.1	4.9	-23.3
DF + FCU	1a	PARIS	LOW	LOW	HIGH	0.50	2.71	30.9	6.8	-29.9
DF + FCU	1a	TORINO	LOW	LOW	LOW	0.42	2.58	21.5	4.4	-21.1
DF + FCU	1a	TORINO	LOW	LOW	HIGH	0.44	2.59	27.9	6.2	-27.4
DF + FCU	1a	ATHENES	LOW	LOW	LOW	0.49	2.98	5.5	0.2	-4.6
DF + FCU	1a	ATHENES	LOW	LOW	HIGH	0.50	2.97	7.6	0.6	-6.4
DF + FCU	1a	MUNICH	LOW	LOW	LOW	0.59	2.07	28.0	6.8	-27.0
DF + FCU	1a	MUNICH	LOW	LOW	HIGH	0.62	2.14	37.3	9.8	-35.3
DF + FCU	1a	LISBOA	LOW	LOW	LOW	0.53	3.12	4.9	0.0	-2.8
DF + FCU	1a	LISBOA	LOW	LOW	HIGH	0.54	3.11	6.6	0.2	-4.0
DF + FCU	1a	PARIS	HIGH	LOW	LOW	0.45	2.72	14.9	1.6	-14.5
DF + FCU	1a	PARIS	HIGH	LOW	HIGH	0.45	2.71	19.3	3.5	-18.7
DF + FCU	1a	TORINO	HIGH	LOW	LOW	0.30	2.60	13.3	1.4	-13.1
DF + FCU	1a	TORINO	HIGH	LOW	HIGH	0.36	2.59	17.7	3.2	-17.4
DF + FCU	1a	ATHENES	HIGH	LOW	LOW	0.40	3.00	3.6	0.0	-3.1
DF + FCU	1a	ATHENES	HIGH	LOW	HIGH	0.42	2.99	4.8	0.0	-4.0
DF + FCU	1a	MUNICH	HIGH	LOW	LOW	0.39	2.04	18.1	2.5	-17.9
DF + FCU	1a	MUNICH	HIGH	LOW	HIGH	0.50	2.05	24.9	5.7	-24.3
DF + FCU	1a	LISBOA	HIGH	LOW	LOW	0.45	3.13	3.1	0.0	-1.9
DF + FCU	1a	LISBOA	HIGH	LOW	HIGH	0.46	3.13	4.1	0.0	-2.5
DF + FCU	1c	PARIS	LOW	LOW	LOW	0.62	2.73	52.3	12.3	-50.3
DF + FCU	1c	PARIS	LOW	LOW	HIGH	0.62	2.74	59.8	14.3	-57.4
DF + FCU	1c	TORINO	LOW	LOW	LOW	0.59	2.60	44.1	10.7	-43.1
DF + FCU	1c	TORINO	LOW	LOW	HIGH	0.60	2.61	51.0	12.7	-49.7
DF + FCU	1c	ATHENES	LOW	LOW	LOW	0.63	2.97	14.0	2.2	-11.9
DF + FCU	1c	ATHENES	LOW	LOW	HIGH	0.63	2.98	16.6	2.6	-14.1
DF + FCU	1c	MUNICH	LOW	LOW	LOW	0.67	2.16	53.9	15.2	-51.6
DF + FCU	1c	MUNICH	LOW	LOW	HIGH	0.68	2.20	63.8	18.1	-60.2
DF + FCU	1c	LISBOA	LOW	LOW	LOW	0.63	3.11	12.5	1.0	-7.5
DF + FCU	1c	LISBOA	LOW	LOW	HIGH	0.64	3.11	15.1	1.5	-9.2
DF + FCU	1c	PARIS	HIGH	LOW	LOW	0.60	2.72	40.8	9.1	-39.3
DF + FCU	1c	PARIS	HIGH	LOW	HIGH	0.60	2.73	47.1	10.9	-45.3
DF + FCU	1c	TORINO	HIGH	LOW	LOW	0.57	2.59	34.5	7.9	-33.7
DF + FCU	1c	TORINO	HIGH	LOW	HIGH	0.58	2.59	40.5	9.7	-39.6
DF + FCU	1c	ATHENES	HIGH	LOW	LOW	0.62	2.98	10.7	1.2	-9.0
DF + FCU	1c	ATHENES	HIGH	LOW	HIGH	0.62	2.98	12.6	1.8	-10.6
DF + FCU	1c	MUNICH	HIGH	LOW	LOW	0.64	2.10	42.9	11.7	-41.8
DF + FCU	1c	MUNICH	HIGH	LOW	HIGH	0.65	2.13	51.4	14.6	-49.5
DF + FCU	1c	LISBOA	HIGH	LOW	LOW	0.63	3.12	9.1	0.5	-5.3
DF + FCU	1c	LISBOA	HIGH	LOW	HIGH	0.63	3.12	10.7	0.8	-6.3
DF + FCU	2	PARIS	LOW	LOW	LOW	0.51	2.73	35.2	7.6	-33.8
DF + FCU	2	PARIS	LOW	LOW	HIGH	0.53	2.75	42.7	9.5	-40.7
DF + FCU	2	TORINO	LOW	LOW	LOW	0.41	2.60	28.1	6.1	-27.5
DF + FCU	2	TORINO	LOW	LOW	HIGH	0.46	2.62	34.9	8.0	-33.9
DF + FCU	2	ATHENES	LOW	LOW	LOW	0.48	2.97	9.4	1.3	-7.9
DF + FCU	2	ATHENES	LOW	LOW	HIGH	0.49	2.98	12.3	1.6	-10.3
DF + FCU	2	MUNICH	LOW	LOW	LOW	0.64	2.21	38.8	9.4	-35.8
DF + FCU	2	MUNICH	LOW	LOW	HIGH	0.65	2.28	48.7	11.9	-43.6
DF + FCU	2	LISBOA	LOW	LOW	LOW	0.52	3.11	7.8	0.4	-4.7
DF + FCU	2	LISBOA	LOW	LOW	HIGH	0.52	3.12	10.4	0.8	-6.3
DF + FCU	2	PARIS	HIGH	LOW	LOW	0.44	2.71	23.9	4.7	-23.1
DF + FCU	2	PARIS	HIGH	LOW	HIGH	0.45	2.72	30.1	6.4	-29.1
DF + FCU	2	TORINO	HIGH	LOW	LOW	0.30	2.59	19.0	3.7	-18.6
DF + FCU	2	TORINO	HIGH	LOW	HIGH	0.36	2.59	24.7	5.3	-24.1
DF + FCU	2	ATHENES	HIGH	LOW	LOW	0.42	2.98	6.1	0.4	-5.1
DF + FCU	2	ATHENES	HIGH	LOW	HIGH	0.44	2.98	8.1	1.0	-6.7
DF + FCU	2	MUNICH	HIGH	LOW	LOW	0.58	2.11	27.5	6.3	-26.5
DF + FCU	2	MUNICH	HIGH	LOW	HIGH	0.54	2.12	36.1	9.6	-35.0
DF + FCU	2	LISBOA	HIGH	LOW	LOW	0.46	3.12	4.7	0.0	-2.8
DF + FCU	2	LISBOA	HIGH	LOW	HIGH	0.47	3.12	6.4	0.3	-3.9
DF + FCU	3	PARIS	LOW	LOW	LOW	0.47	2.76	66.6	14.2	-62.4
DF + FCU	3	PARIS	LOW	LOW	HIGH	0.49	2.76	73.8	16.0	-68.8
DF + FCU	3	TORINO	LOW	LOW	LOW	0.35	2.61	46.0	10.2	-44.5
DF + FCU	3	TORINO	LOW	LOW	HIGH	0.37	2.62	52.5	11.9	-50.6

DF + FCU	3	ATHENES	LOW	LOW	LOW	0.45	2.98	20.2	3.2	-16.3
DF + FCU	3	ATHENES	LOW	LOW	HIGH	0.46	2.99	23.1	3.5	-18.6
DF + FCU	3	MUNICH	LOW	LOW	LOW	0.60	2.23	63.6	15.8	-59.4
DF + FCU	3	MUNICH	LOW	LOW	HIGH	0.61	2.27	73.4	18.3	-67.5
DF + FCU	3	LISBOA	LOW	LOW	LOW	0.47	3.12	18.0	1.4	-9.7
DF + FCU	3	LISBOA	LOW	LOW	HIGH	0.48	3.12	20.8	1.9	-11.3
DF + FCU	3	PARIS	HIGH	LOW	LOW	0.41	2.74	53.8	10.9	-50.8
DF + FCU	3	PARIS	HIGH	LOW	HIGH	0.42	2.74	60.3	12.6	-56.8
DF + FCU	3	TORINO	HIGH	LOW	LOW	0.30	2.59	36.0	7.4	-34.8
DF + FCU	3	TORINO	HIGH	LOW	HIGH	0.30	2.60	41.8	9.0	-40.4
DF + FCU	3	ATHENES	HIGH	LOW	LOW	0.42	2.98	15.8	2.1	-12.6
DF + FCU	3	ATHENES	HIGH	LOW	HIGH	0.43	2.98	18.0	2.6	-14.3
DF + FCU	3	MUNICH	HIGH	LOW	LOW	0.53	2.16	51.8	12.5	-49.5
DF + FCU	3	MUNICH	HIGH	LOW	HIGH	0.57	2.19	60.3	15.1	-57.0
DF + FCU	3	LISBOA	HIGH	LOW	LOW	0.45	3.12	13.2	0.8	-7.0
DF + FCU	3	LISBOA	HIGH	LOW	HIGH	0.45	3.12	15.0	1.1	-8.1
SF + FCU	2	PARIS	LOW	LOW	LOW	0.58	2.77	61.2	12.2	-56.7
SF + FCU	2	PARIS	LOW	LOW	HIGH	0.63	2.80	77.6	15.7	-69.1
SF + FCU	2	TORINO	LOW	LOW	LOW	0.55	2.64	51.0	10.5	-48.2
SF + FCU	2	TORINO	LOW	LOW	HIGH	0.61	2.68	65.5	13.7	-59.3
SF + FCU	2	ATHENES	LOW	LOW	LOW	0.54	2.99	22.1	2.8	-18.5
SF + FCU	2	ATHENES	LOW	LOW	HIGH	0.57	3.00	28.4	4.1	-23.4
SF + FCU	2	MUNICH	LOW	LOW	LOW	0.66	2.36	71.7	14.7	-61.4
SF + FCU	2	MUNICH	LOW	LOW	HIGH	0.68	2.43	93.0	18.3	-73.3
SF + FCU	2	LISBOA	LOW	LOW	LOW	0.57	3.12	19.6	1.6	-13.3
SF + FCU	2	LISBOA	LOW	LOW	HIGH	0.59	3.12	25.5	2.5	-16.5
SF + FCU	2	PARIS	HIGH	LOW	LOW	0.65	2.74	40.0	8.7	-37.9
SF + FCU	2	PARIS	HIGH	LOW	HIGH	0.67	2.76	54.6	12.3	-50.4
SF + FCU	2	TORINO	HIGH	LOW	LOW	0.64	2.62	33.2	7.5	-31.8
SF + FCU	2	TORINO	HIGH	LOW	HIGH	0.67	2.64	46.1	10.9	-43.2
SF + FCU	2	ATHENES	HIGH	LOW	LOW	0.61	3.00	12.5	1.7	-9.9
SF + FCU	2	ATHENES	HIGH	LOW	HIGH	0.64	3.00	17.5	2.8	-13.6
SF + FCU	2	MUNICH	HIGH	LOW	LOW	0.65	2.25	48.5	11.8	-43.8
SF + FCU	2	MUNICH	HIGH	LOW	HIGH	0.67	2.34	67.8	16.3	-57.3
SF + FCU	2	LISBOA	HIGH	LOW	LOW	0.59	3.13	10.6	0.7	-6.2
SF + FCU	2	LISBOA	HIGH	LOW	HIGH	0.63	3.12	14.8	1.5	-8.5
SF + FCU	3	PARIS	LOW	LOW	LOW	0.65	2.78	83.7	18.2	-76.5
SF + FCU	3	PARIS	LOW	LOW	HIGH	0.67	2.79	99.5	21.6	-88.9
SF + FCU	3	TORINO	LOW	LOW	LOW	0.64	2.63	60.6	13.9	-57.3
SF + FCU	3	TORINO	LOW	LOW	HIGH	0.66	2.66	74.4	17.2	-68.6
SF + FCU	3	ATHENES	LOW	LOW	LOW	0.62	2.99	27.3	4.7	-21.5
SF + FCU	3	ATHENES	LOW	LOW	HIGH	0.64	3.00	33.8	5.9	-26.5
SF + FCU	3	MUNICH	LOW	LOW	LOW	0.64	2.32	84.6	20.6	-74.8
SF + FCU	3	MUNICH	LOW	LOW	HIGH	0.66	2.38	105.0	24.7	-88.7
SF + FCU	3	LISBOA	LOW	LOW	LOW	0.58	3.12	24.8	2.4	-13.3
SF + FCU	3	LISBOA	LOW	LOW	HIGH	0.61	3.12	31.1	3.4	-16.8
SF + FCU	3	PARIS	HIGH	LOW	LOW	0.62	2.75	69.3	14.8	-64.5
SF + FCU	3	PARIS	HIGH	LOW	HIGH	0.65	2.76	83.7	18.3	-76.8
SF + FCU	3	TORINO	HIGH	LOW	LOW	0.61	2.61	49.2	10.9	-46.8
SF + FCU	3	TORINO	HIGH	LOW	HIGH	0.64	2.62	61.6	14.2	-57.8
SF + FCU	3	ATHENES	HIGH	LOW	LOW	0.58	2.99	21.8	3.2	-16.9
SF + FCU	3	ATHENES	HIGH	LOW	HIGH	0.61	2.99	27.0	4.4	-20.9
SF + FCU	3	MUNICH	HIGH	LOW	LOW	0.62	2.24	70.8	17.4	-64.8
SF + FCU	3	MUNICH	HIGH	LOW	HIGH	0.64	2.31	89.3	21.7	-78.5
SF + FCU	3	LISBOA	HIGH	LOW	LOW	0.54	3.12	18.6	1.5	-9.7
SF + FCU	3	LISBOA	HIGH	LOW	HIGH	0.57	3.12	22.8	2.2	-12.1
CAV	1a	PARIS	LOW	LOW	LOW	0.68	2.71	15.8	3.3	-14.2
CAV	1a	PARIS	LOW	LOW	HIGH	0.66	2.68	21.9	5.0	-20.1
CAV	1a	TORINO	LOW	LOW	LOW	0.69	2.64	16.4	3.4	-14.3
CAV	1a	TORINO	LOW	LOW	HIGH	0.68	2.56	19.7	4.6	-17.8
CAV	1a	ATHENES	LOW	LOW	LOW					
CAV	1a	ATHENES	LOW	LOW	HIGH					
CAV	1a	MUNICH	LOW	LOW	LOW	0.71	2.15	22.5	5.6	-19.6
CAV	1a	MUNICH	LOW	LOW	HIGH	0.71	2.12	30.7	8.1	-26.2
CAV	1a	LISBOA	LOW	LOW	LOW	0.62	3.16	5.1	0.3	-3.0
CAV	1a	LISBOA	LOW	LOW	HIGH	0.56	3.12	3.9	0.3	-2.6
CAV	1a	PARIS	HIGH	LOW	LOW	0.67	2.89	23.8	4.8	-22.4
CAV	1a	PARIS	HIGH	LOW	HIGH	0.67	2.83	19.6	4.0	-18.2
CAV	1a	TORINO	HIGH	LOW	LOW	0.67	2.84	30.0	6.3	-27.7
CAV	1a	TORINO	HIGH	LOW	HIGH	0.67	2.79	23.7	4.9	-21.4
CAV	1a	ATHENES	HIGH	LOW	LOW					
CAV	1a	ATHENES	HIGH	LOW	HIGH					
CAV	1a	MUNICH	HIGH	LOW	LOW	0.72	2.50	35.4	8.4	-33.8
CAV	1a	MUNICH	HIGH	LOW	HIGH	0.72	2.31	27.5	6.8	-25.6
CAV	1a	LISBOA	HIGH	LOW	LOW	0.68	3.15	14.3	1.8	-10.0
CAV	1a	LISBOA	HIGH	LOW	HIGH	0.67	3.17	12.1	1.4	-8.2

VAV	1a	PARIS	LOW	LOW	LOW	0.68	2.63	14.8	3.6	-14.5
VAV	1a	PARIS	LOW	LOW	HIGH	0.50	2.65	19.7	4.8	-19.1
VAV	1a	TORINO	LOW	LOW	LOW	0.68	2.48	13.1	3.4	-12.9
VAV	1a	TORINO	LOW	LOW	HIGH	0.47	2.50	17.4	4.4	-17.0
VAV	1a	ATHENES	LOW	LOW	LOW	0.60	2.90	2.6	0.3	-2.5
VAV	1a	ATHENES	LOW	LOW	HIGH	0.32	2.89	4.0	0.5	-3.4
VAV	1a	MUNICH	LOW	LOW	LOW	0.70	1.92	15.5	4.4	-13.4
VAV	1a	MUNICH	LOW	LOW	HIGH	0.68	1.99	21.8	6.2	-19.2
VAV	1a	LISBOA	LOW	LOW	LOW	0.65	3.09	1.8	0.1	-1.3
VAV	1a	LISBOA	LOW	LOW	HIGH	0.35	3.08	3.3	0.2	-1.9
VAV	1a	PARIS	HIGH	LOW	LOW	0.70	2.61	5.6	1.3	-5.5
VAV	1a	PARIS	HIGH	LOW	HIGH	0.68	2.59	7.7	1.8	-7.6
VAV	1a	TORINO	HIGH	LOW	LOW	0.70	2.43	5.1	1.2	-5.1
VAV	1a	TORINO	HIGH	LOW	HIGH	0.70	2.42	7.2	1.7	-7.1
VAV	1a	ATHENES	HIGH	LOW	LOW	0.56	2.90	0.8	0.0	-0.8
VAV	1a	ATHENES	HIGH	LOW	HIGH	0.51	2.89	1.0	0.0	-1.0
VAV	1a	MUNICH	HIGH	LOW	LOW	0.70	1.79	7.5	2.1	-6.9
VAV	1a	MUNICH	HIGH	LOW	HIGH	0.70	1.79	10.4	3.1	-9.7
VAV	1a	LISBOA	HIGH	LOW	LOW	0.63	3.13	0.4	0.0	-0.4
VAV	1a	LISBOA	HIGH	LOW	HIGH	0.63	3.12	0.5	0.0	-0.4
VAV	1c	PARIS	LOW	LOW	LOW	0.65	2.72	42.8	10.9	-41.1
VAV	1c	PARIS	LOW	LOW	HIGH	0.65	2.73	46.8	11.9	-44.9
VAV	1c	TORINO	LOW	LOW	LOW	0.67	2.56	34.3	9.3	-33.3
VAV	1c	TORINO	LOW	LOW	HIGH	0.66	2.58	37.7	10.2	-36.6
VAV	1c	ATHENES	LOW	LOW	LOW	0.66	2.94	12.2	2.5	-10.9
VAV	1c	ATHENES	LOW	LOW	HIGH	0.66	2.95	13.9	2.8	-12.2
VAV	1c	MUNICH	LOW	LOW	LOW	0.70	2.14	40.9	11.9	-35.7
VAV	1c	MUNICH	LOW	LOW	HIGH	0.70	2.17	46.1	13.3	-40.6
VAV	1c	LISBOA	LOW	LOW	LOW	0.65	3.10	10.6	1.4	-7.1
VAV	1c	LISBOA	LOW	LOW	HIGH	0.65	3.10	12.6	1.7	-8.2
VAV	1c	PARIS	HIGH	LOW	LOW	0.63	2.69	30.4	7.7	-29.4
VAV	1c	PARIS	HIGH	LOW	HIGH	0.62	2.69	33.9	8.6	-32.8
VAV	1c	TORINO	HIGH	LOW	LOW	0.65	2.53	24.7	6.7	-24.1
VAV	1c	TORINO	HIGH	LOW	HIGH	0.63	2.54	27.7	7.5	-27.1
VAV	1c	ATHENES	HIGH	LOW	LOW	0.64	2.93	8.1	1.5	-7.3
VAV	1c	ATHENES	HIGH	LOW	HIGH	0.63	2.94	9.3	1.8	-8.3
VAV	1c	MUNICH	HIGH	LOW	LOW	0.70	2.05	29.7	9.0	-26.7
VAV	1c	MUNICH	HIGH	LOW	HIGH	0.70	2.07	34.0	10.3	-30.7
VAV	1c	LISBOA	HIGH	LOW	LOW	0.63	3.10	6.2	0.7	-4.2
VAV	1c	LISBOA	HIGH	LOW	HIGH	0.63	3.10	7.2	0.9	-4.8

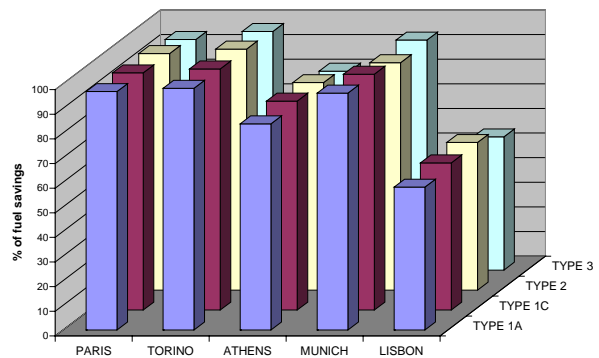
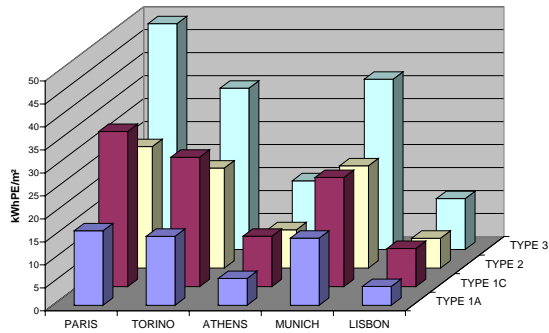
Table 49: Simulation results of health care institutions (Type 1 refers to Large hospitals and Type 2 refers to rest homes)

HVAC	type	climate	Internal loads	solar factor	ventilation	Seasonal boiler efficiency	Seasonal COP	Reference case	Heat pump use	
								Annual boiler consumption (kWh/m ²)	electric heat pump consumption (kWh/m ²)	fuel consumption reduction (kWh/m ²)
SF + FCU	2	PARIS	LOW	LOW	LOW	0.68	2.77	76.9	17.6	-70.0
SF + FCU	2	PARIS	LOW	LOW	HIGH	0.69	2.81	95.5	21.3	-86.4
SF + FCU	2	TORINO	LOW	LOW	LOW	0.66	2.47	56.5	14.8	-53.7
SF + FCU	2	TORINO	LOW	LOW	HIGH	0.69	2.53	76.8	19.9	-73.1
SF + FCU	2	ATHENES	LOW	LOW	LOW	0.57	3.27	22.6	3.0	-15.6
SF + FCU	2	ATHENES	LOW	LOW	HIGH	0.62	3.30	31.4	4.3	-21.1
SF + FCU	2	MUNICH	LOW	LOW	LOW	0.65	2.05	76.0	23.1	-74.4
SF + FCU	2	MUNICH	LOW	LOW	HIGH	0.68	2.16	103.4	28.6	-100.4
SF + FCU	2	LISBOA	LOW	LOW	LOW	0.58	3.53	22.8	1.2	-5.3
SF + FCU	2	LISBOA	LOW	LOW	HIGH	0.63	3.53	31.5	1.9	-7.7
DF + FCU	1	PARIS	LOW	LOW	LOW	0.55	2.24	65.7	19.0	-63.4
DF + FCU	1	PARIS	LOW	LOW	HIGH	0.57	2.25	75.7	22.4	-72.6
DF + FCU	1	TORINO	LOW	LOW	LOW	0.53	2.09	58.6	18.2	-57.0
DF + FCU	1	TORINO	LOW	LOW	HIGH	0.54	2.10	67.5	21.5	-65.5
DF + FCU	1	ATHENES	LOW	LOW	LOW	0.53	2.67	19.1	3.1	-16.5
DF + FCU	1	ATHENES	LOW	LOW	HIGH	0.55	2.67	22.4	4.0	-19.0
DF + FCU	1	MUNICH	LOW	LOW	LOW	0.67	1.84	89.9	30.4	-82.4
DF + FCU	1	MUNICH	LOW	LOW	HIGH	0.67	1.86	101.3	34.5	-91.6
DF + FCU	1	LISBOA	LOW	LOW	LOW	0.56	2.91	15.5	1.3	-10.1
DF + FCU	1	LISBOA	LOW	LOW	HIGH	0.58	2.91	18.6	1.9	-11.4
DF + FCU	2	PARIS	LOW	LOW	LOW	0.67	2.75	68.3	14.0	-51.4
DF + FCU	2	PARIS	LOW	LOW	HIGH	0.68	2.76	81.0	16.7	-62.3
DF + FCU	2	TORINO	LOW	LOW	LOW	0.65	2.46	50.6	11.2	-36.7
DF + FCU	2	TORINO	LOW	LOW	HIGH	0.67	2.48	65.1	15.0	-50.3
DF + FCU	2	ATHENES	LOW	LOW	LOW	0.58	3.30	21.8	2.2	-10.7

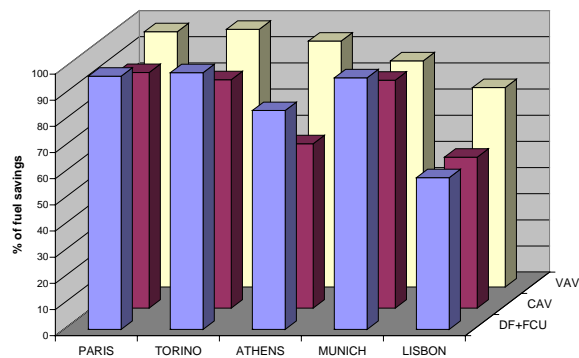
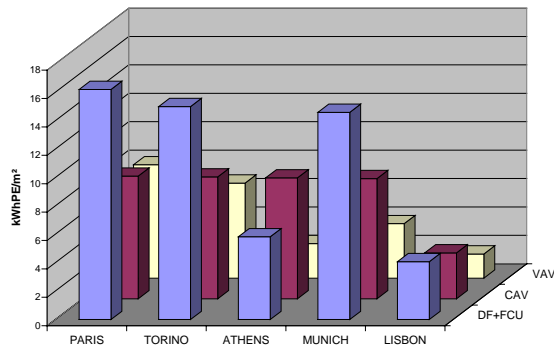
DF + FCU	2	ATHENES	LOW	LOW	HIGH	0.61	3.29	27.4	3.0	-14.3
DF + FCU	2	MUNICH	LOW	LOW	LOW	0.64	2.02	68.6	17.8	-50.2
DF + FCU	2	MUNICH	LOW	LOW	HIGH	0.66	2.10	87.5	22.1	-69.0
DF + FCU	2	LISBOA	LOW	LOW	LOW	0.58	3.54	20.5	0.9	-3.7
DF + FCU	2	LISBOA	LOW	LOW	HIGH	0.61	3.54	26.0	1.4	-5.0
CAV	1	PARIS	LOW	LOW	LOW	0.65	2.23	71.5	20.9	-66.5
CAV	1	PARIS	LOW	LOW	HIGH	0.66	2.26	87.9	25.9	-81.5
CAV	1	TORINO	LOW	LOW	LOW	0.67	2.07	65.0	20.1	-59.1
CAV	1	TORINO	LOW	LOW	HIGH	0.67	2.09	80.2	25.1	-72.9
CAV	1	ATHENES	LOW	LOW	LOW	0.62	2.63	21.1	4.0	-17.6
CAV	1	ATHENES	LOW	LOW	HIGH	0.62	2.63	23.7	4.7	-19.9
CAV	1	MUNICH	LOW	LOW	LOW	0.69	1.84	88.6	28.2	-75.0
CAV	1	MUNICH	LOW	LOW	HIGH	0.69	1.88	109.7	34.1	-89.8
CAV	1	LISBOA	LOW	LOW	LOW	0.64	2.88	18.4	2.3	-12.2
CAV	1	LISBOA	LOW	LOW	HIGH	0.63	2.88	20.7	2.8	-13.4

ANNEX 8 : BUILDING ENERGY CONSUMPTION RESULTS (GRAPHS)

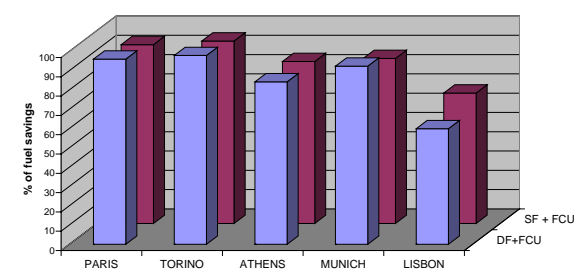
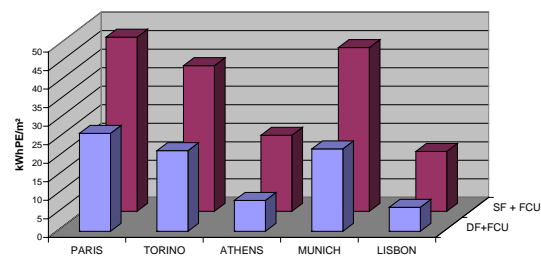
Office buildings



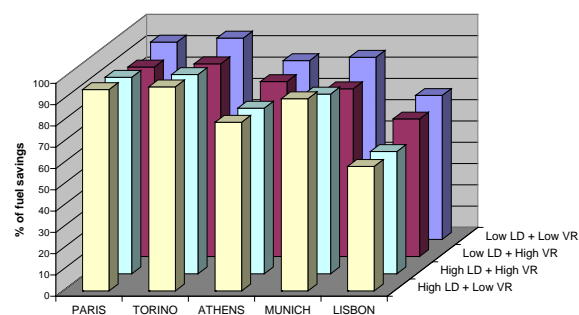
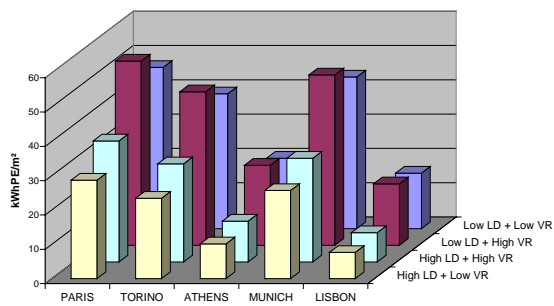
Impact of building type in different climates in kWh PE/m² and in % for Low loads, Low ventilation Rate, DF + FCU case



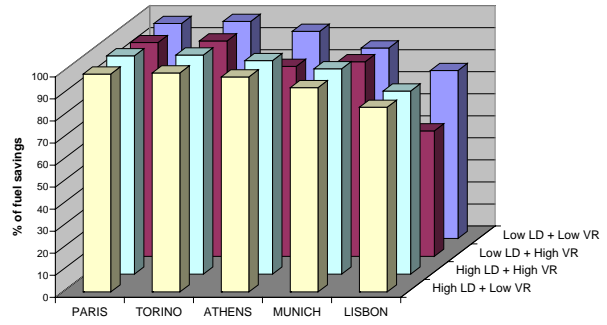
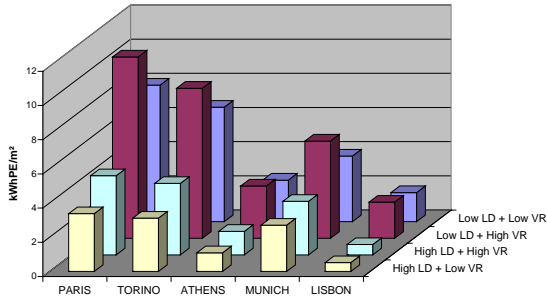
Impact of HVAC system in different climates in kWh PE/m² and in % for Building of type 1A, Low loads, Low ventilation Rate case



Impact of HVAC system in different climates in kWh PE/m² and in % for Building of type 2, Low loads, Low ventilation Rate case

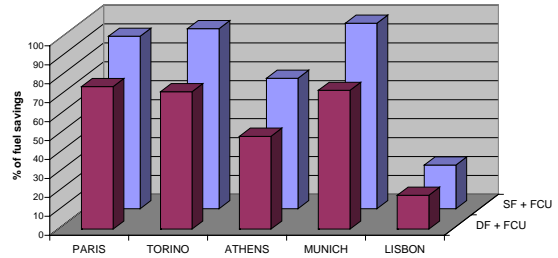
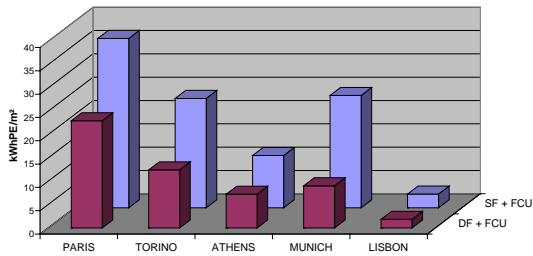


Impact of ventilation rate and internal loads in different climates in kWh PE/m² and in % for Building of type 2, SF + FCU case

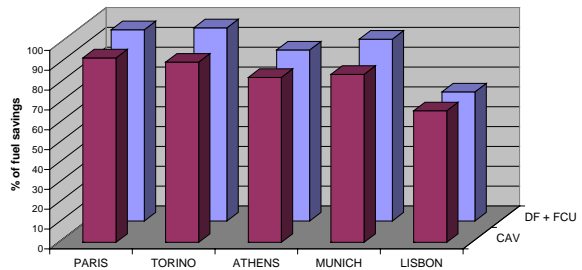
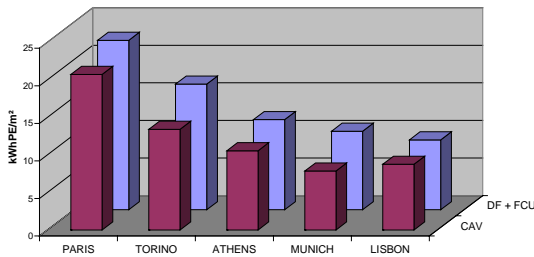


Impact of ventilation rate and internal loads in different climates in kWh PE/m² and in % for Building of type 1A, VAV case

Health care institutions



Impact of HVAC system in different climates in kWh PE/m² and in % for Rest Home, Low ventilation rate



Impact of HVAC system in different climates in kWh PE/m² and in % for large Hospital, Low ventilation rate