

DIN V 18599-7:2007-02 (E)

Energy efficiency of buildings - Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting - Part 7: Final energy demand of air handling and air conditioning systems for non-residential buildings

	Contents	Page
Foreword	8	
Introduction	10	
1 Scope	11	
2 Normative references	13	
3 Terms and definitions, symbols and units	14	
3.1 Terms and definitions	14	
3.2 Symbols, units and subscripts	16	
4 Calculation methods	18	
4.1 Interfaces to the heating system	19	
5 Energy need for air conditioning	21	
5.1 Default values for HVAC system components	21	
5.1.1 Fans	21	
5.1.2 Heat recovery	21	
5.2 Notes on selecting a room conditioning (HVAC) system	22	
5.3 Energy need for the HVAC heating coils	22	
5.3.1 Loss of control and emission for the HVAC ventilation system (air circulation heat losses)	23	
5.3.2 Loss of distribution for the HVAC ventilation system (air transport heat losses)	23	
5.3.3 Leakage rates	23	
5.3.4 Hot water system temperature for HVAC heating coils	24	
5.3.5 Demand time for HVAC heating coils	24	
5.4 Energy need for the cooling coils	24	
5.4.1 Heat demand for control and emission of air to the room (heat losses of air circulation) ..	25	
5.4.2 Heat demand for air distribution (heat losses during air transport)	25	
5.4.3 Demand time for HVAC cooling coils	25	
5.5 Cooling energy need, room conditioning (cooling)	26	
5.5.1 Room conditioning demand time	26	
5.6 Energy need for humidification	26	
6 Control and emission, distribution and storage	27	
6.1 Heating for ventilation systems	27	
6.2 (Net) refrigeration energy output	27	
6.2.1 Cold for the HVAC system	27	
6.2.2 Cooling energy supply for room conditioning	28	
6.3 Auxiliary energy for room conditioning	30	
6.4 Steam for humidification	30	
6.5 Auxiliary energy for cooling-water and chilled water distribution	31	
6.5.1 Electrical energy expenditure	31	
6.5.1.1 Electrical energy expenditure for distribution	33	
6.5.2 Hydraulic energy requirement for distribution	34	
6.5.2.1 Pressure loss at the design point	35	
6.5.2.2 Approximation values for p	36	

6.5.2.3	Pump operating times	37
6.5.2.4	Mean distribution load	38
6.5.2.5	Correction factor fadj for hydraulic adjustment	39
6.5.3	Expenditure factor for pump operation	40
6.5.3.1	Efficiency factor fe of the pump	40
6.5.3.2	Correction factor fadap for adaptation:	41
6.5.3.3	Pump power control during operation	41
6.5.3.4	Switching of pumps in parallel-pump installations	42
-- Prestandard --	6.6 Other forms of auxiliary energy (ancillary drives)	42
6.6.1	Pump heating coils	42
6.6.2	Pumps and drives for heat recovery	42
6.6.2.1	Pumps in integrated fluid circulation systems	42
6.6.2.2	Rotor drive	42
6.6.2.3	Heat pumps	43
6.6.3	Water humidifier pumps	43
6.6.4	Electrical energy demand for central HVAC unit controls	44
7	Delivered energy for refrigeration and steam generation	44
7.1	Energy use for refrigeration	44
7.1.1	Refrigeration energy output of refrigeration	45
7.1.2	Energy use, compression refrigeration units	47
7.1.2.1	Compressor-type refrigeration units, water-cooled	48
7.1.2.2	Air-cooled compressor-type chillers	50
7.1.2.3	Room air conditioning systems, air-cooled	51
7.1.3	Net generator energy for heating of absorption chillers	53
7.1.4	Gas driven refrigeration units	56
7.1.4.1	Direct evaporation systems (refrigerant distribution) with variable refrigerant mass flow (VRF systems)	56
7.1.4.2	Direct-fired absorption refrigeration systems	56
7.1.6	Energy use for recooling	58
7.1.7	Fractions of energy use for refrigeration and distribution	61
7.2	Delivered energy for steam supply	62
8	Delivered energy	63
8.1	Refrigeration equipment for cooling	63
8.1.1	Electrical energy for compressor-type chillers	63
8.1.2	Steam for heating absorption chillers	63
8.2	Steam generation for humidification	64
8.3	Auxiliary energy for HVAC and air conditioning (electrical)	64
8.3.1	Auxiliary energy for steam supply	64
8.3.2	Other forms of auxiliary energy and recovered energy	64
Annex A (normative)	Characteristics relating to air conditioning	66
A.1	General	66
Annex B (normative)	Methods for determining the part load values of refrigeration	82
B.1	General	82
B.2	Partial load characteristics of air-cooled refrigeration units	83
B.3	Partial load characteristics of water-cooled refrigeration units	84
B.4	Partial load characteristics of recooling systems	88
Annex C (normative)	Heat sources and sinks	91
C.1	General	91
C.2	Heat sources	91
C.3	Heat sinks	91
Annex D (informative)	Guidelines for calculating the electrical energy expenditure for cooling-water and chilled-water distribution systems	92

D.1	General	92
D.2	Specific volume flow in the distribution circuit	92
D.3	Pressure losses pZ at the design point	93
D.4	Annual pump operating times Id,t	93
D.5	Specific electrical power for water distribution	93
D.6	Electrical energy expenditure for distribution	94
-- Prestandard -- Annex E (informative) Interfaces		95
Annex F (normative) Default values for refrigeration equipment in existing systems		97
F.1	Existing systems from 1990 onwards	97
F.2	Existing systems before 1995	97
Annex G (normative) Estimation of heat recovery		98
G.1	Estimation of heat recovery for existing systems	98
G.2	Estimation of temperature ratios in fixed plate heat exchangers	98
G.3	Estimation of the temperature ratio for rotary heat exchangers	99
G.4	Rotary heat exchangers with sorption material	100
G.5	Estimation of the temperature ratio in integrated fluid circulation coil heat exchangers ..	101
Annex H (normative) External air volume flow and specific power demand of fans in existing systems		102
H.1	Evaluation of energy demand	102
H.2	Use of values	102
Bibliography		103
-- Prestandard -- Figures Figure 2 -- System principle of heating, ventilation and air conditioning (HVAC) systems of non-residential buildings		12
Figure 4 -- Heating for the HVAC system		18
Figure 5 -- Cooling for the HVAC system		18
Figure 6 -- Cooling energy for room conditioning		19
Figure 7 -- Steam generation for humidification		19
Figure 8 -- Procedure for calculating the pump energy demand for cooling-water and chilled water ..		33
Figure D.1 -- Example of a multi-circuit chilled-water distribution system		92
Figure G.1 -- Dimensions of heat exchanger (notation)		99
Figure G.2 -- Rotary heat exchangers without sorption material		99
Figure G.3 -- Rotary heat exchangers with sorption material		100
Figure G.4 -- Estimation of the temperature ratio for integrated fluid circulation coil heat exchangers		101
Tables Table 1 -- Symbols, units and subscripts		16
Table 3 -- Default values for fans		21
Table 5 -- Default values for the supply air temperature difference per type of room conditioning system (only to be used for proof of energy performance, not for design purposes)		22

Table 6 -- Minimum utilization factor for demand-oriented space cooling	26
Table 7 -- Factors for cooling, HVAC system (mean annual value)	28
Table 8 -- Factors (mean annual values) for room conditioning	29
Table 9 -- Default values for the specific energy demand of fans for room conditioning	30
Table 10 -- Essential parameters for electrical energy expenditure for cooling and chilled water networks	32
Table 11 -- Specific pressure loss R in kPa/m and additional share of individual flow resistances z in pipework	36
Table 12 -- Assumed values for pressure losses across components in distribution circuits	37
Table 13 -- Operating modes	38
Table 14 -- Values of CP1 and CP2 in relation to the pump operating mode	41
Table 15 -- Electrical power for rotor drives	43
Table 16 -- Default values for water humidifiers (mean annual values)	44
Table 17 -- Overview of refrigeration systems modelled using the characteristic value method	45
Table 18 -- Examples of zoning for cooling supply	46
-- Prestandard -- Table 19 -- Types of partial load control of water-cooled compressor-type refrigeration units evaluated by the characteristic value method	48
Table 20 -- Default values for the rated energy efficiency ratio of cooling EER for water-cooled chillers	49
Table 21 -- Types of partial load control of air-cooled compressor-type chillers evaluated by the characteristic value method	50
Table 22 -- Default values for the rated energy efficiency ratio of cooling EER for air-cooled compressor chillers	51
Table 23 -- Types of partial load control of air-cooled room air conditioning systems evaluated by the characteristic value method	52
Table 24 -- Rated energy efficiency ratios of cooling EER for air-cooled room air conditioning systems with < 12 kW	52
Table 25 -- Rated energy efficiency ratios of cooling EER for air-cooled room air conditioning systems with > 12 kW	52
Table 26 -- Types of partial load control of absorption chillers evaluated by the characteristic value method	54
Table 27 -- Rated heat ratio for single-stage absorption chillers	55
Table 28 -- Rated heat ratio for direct-fired refrigeration units	57
Table 29 -- Specific electrical energy demand qR,electr of recooling systems	59
Table 30 -- Energy fractions for evaluating the energy characteristics of indirect cooling systems (chillers)	61

Table 31 -- Energy fractions for evaluating the energy characteristics of direct cooling systems (direct evaporation units)	62
Table 32 -- Delivered energy factors for steam generation	63
Table A.1 -- Relationship between the type of usage and tables of characteristics	67
Table A.2 -- Partial load characteristics (types of usage: 1, 2, 3, 4, 5, 16, 17, 18, 20)	68
Table A.3 -- Partial load characteristics (types of usage: 6, 7, 28, 29, 30)	69
Table A.4 -- Partial load characteristics (type of usage: 8)	70
Table A.5 -- Partial load characteristics (types of usage: 9, 26)	71
Table A.6 -- Partial load characteristics (type of usage: 10)	72
Table A.7 -- Partial load characteristics (type of usage: 11)	73
Table A.8 -- Partial load characteristics (type of usage: 12)	74
Table A.9 -- Partial load characteristics (types of usage: 13, 14, 15)	75
Table A.10 -- Partial load characteristics (type of usage: 21)	76
Table A.11 -- Partial load characteristics (type of usage: 22)	77
Table A.12 -- Partial load characteristics (types of usage: 23, 24)	78
Table A.13 -- Partial load characteristics (type of usage: 25)	79
Table A.14 -- Partial load characteristics (type of usage: 27)	80
Table A.15 -- Partial load characteristics (type of usage: 31)	81
Table B.1 -- Distribution rules for partial load demand values per partial load stage kn	83
Table B.2 -- Correlation between partial load stages kn and external air temperatures for air-cooled refrigeration units	83
-- Prestandard -- Table B.3 -- Part load value PLV_n for air-cooled refrigeration units	84
Table B.4 -- Partial load factor f_{1,n} for water-cooled refrigeration units per partial load stage kn	85
Table D.1 -- Specific volume flows	92
Table D.2 -- Pressure losses at the design point	93
Table D.3 -- Annual pump operating times	93
Table D.4 -- Electrical energy expenditure for distribution	94
Table E.1 -- Input parameters	95
Table E.2 -- Output parameters	96
Table F.1 -- Factor taking into account the age of existing refrigeration equipment	97
Table G.1 -- Estimation of the temperature ratio t for fixed plate heat exchangers	98