Energy performance of buildings in the Netherlands

Requirements and test standard

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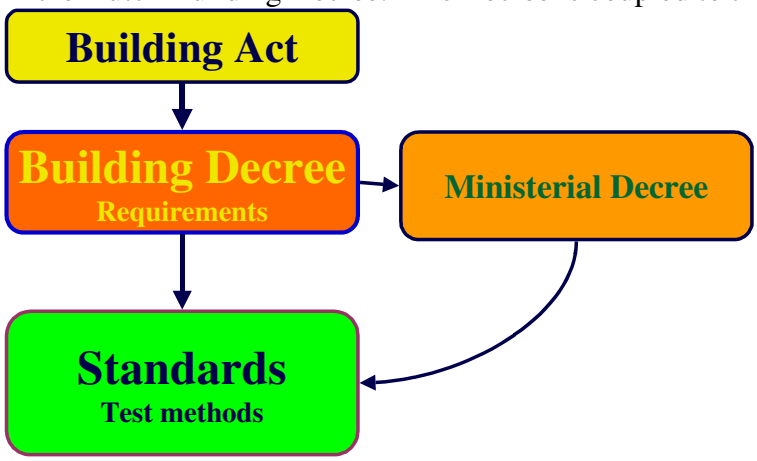
1. Introduction

The Building Regulations with regard to the energy performance of buildings in the Netherlands is an attempt to a performance oriented requirement in conjunction with a test standard. The test standard in fact means a calculation procedure. The requirements are given in the Dutch Building Decree. This Decree is coupled to the building act.



Within the scope of an application for a building permit is has to be proven that the energy use of the building does not reach the maximum allowed energy amount set for that building. The check on the energy performance of a building is thus a so called pre check before the building is being built.
The energy use in reality depends on a number of parameters of which the use of the building is a very important one. In the test these parameters have normalised values derived from actual values in practice. This means that the calculated energy use of a single building will not be in accordance with the actual energy use of that building. But, for the whole building stock we assume that it will be in accordance with the real energy use of the building stock. The energy saving calculated on country level may be expected to be reasonably reliable.
The energy performance is expressed as an **E**nergy **P**erformance **C**haracteristic (EPC)

2. EPC-requirement

The *EPC*-requirement is a factor that is strongly modifying the energy target of a building. The EPC is a calculated energy use for a certain building divided by a reference value.

For dwellings it is calculated as:

$EPC = Q_{perf} / 330A_g + 65\ A_{loss}$

where:

Q_{perf} = the energy performance of the dwelling in MJ
A_g = floor area of the dwelling in m^2
A_{loss} = area of the outside envelope of the dwelling in m^2

In the tabel below the *EPC*-requirements are give for several functions of a building ($EPC_{req;i}$) which are defined in the Dutch Building Degree.

Building type	***EPC***
accommodation building	2,1
assembly (include catering)	2,4
cell and penitentiary building	2,2
dwelling	1,0
educational	0,5
health care, not clinical	1,8
health care, clinical	3,8
office	1,6
residential building	1,0
shop	3,5
sports	2,2

3. Energy consumption of the building

To calculate the energy performance one has to follow a number of steps for as well as heating and cooling.
For the calculation in the test standard the energy consumption of a building takes into account the following items:

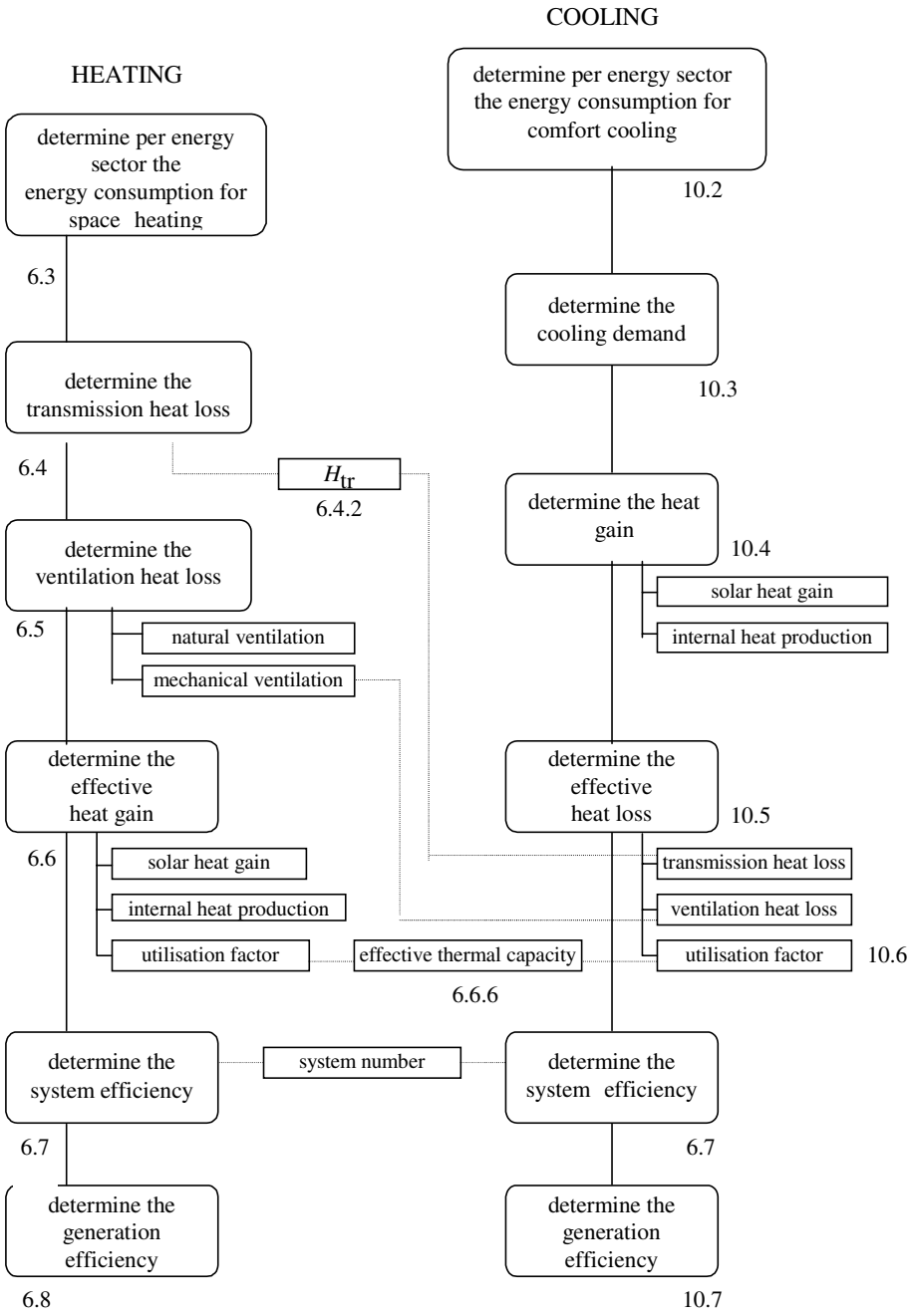
$$Q_{perf} = Q_{heat} + Q_{fan} + Q_{li} + Q_{pump} + Q_{cool} + Q_{hum} + Q_{dhw} - Q_{pv} - Q_{cog}$$

where:
Q_{perf} = the energy consumption for the building
Q_{heat} = the energy consumption for heating
Q_{fan} = the energy consumption for fans
Q_{li} = the energy consumption for lighting
Q_{pump} = the energy consumption for pumps

Q_{cool} = the energy consumption for comfort cooling
Q_{hum} = the energy consumption for humidification
Q_{dhw} = the energy consumption for domestic hot water the decrease of the primary
Q_{pv} = the energy consumption due to photo-voltaic solar energy
Q_{cog} = the decrease of the energy consumption for electricity due to (building bound) co-generation

The calculated energy consumptions are all primary energy expressed in MJ.
The steps to be taken are given in the scheme below.

(from NEN 2916:1998)



3.1 Transmission heat loss

The transmission heat loss (Q_{tr}) have to be determined by :

$Q_{tr} = \sum_{m=1}^{n} H_T \times (\theta_i - \theta_{e;m}) \times t_m$, where:

Q_{tr} = the transmission heat loss of a year
H_T = the transmission heat loss
θ_I = the inside temperature
$\theta_{e;m}$ = the average external temperature during the calculation period m
t_m = the duration of the heating period m

In the Netherlands the following imposed inside temperature θ_i has to be used for the determination of the heat demand.

Building Type	θ_i
accommodation building	19 °C
accommodation not in accommodation building	18 °C
assembly (include catering)	19 °C
cell and penitentiary building	19 °C
dwelling	18 °C
educational	19 °C
health care, not clinical	19 °C
health care, clinical	22 °C
office	19 °C
residential building	18 °C
shop	19 °C
sports	19 °C
sports moderate heated	13 °C

3.2 Ventilation heat

The heat loss due to ventilation can be calculated with:

$Q_{vent} = H_{vent} * 238$

where:
Q_{vent} = the energe consumption for ventilation in MJ
H_{vent} = the specific energe consumption for ventilation in W/K
238 = the time accumulated temperature difference in K. Ms

$H_{vent} = 1.2 * q_v$

where:

q_v = the ventilation flow rate in dm^3/s
1.2 = specific heat kJ/dm^3

$q_v = 0.47\, A_g + 0.13\, q_{v10}$

where:
A_g = floor area of the dwelling in m^2
q_{v10} = air tightness of the dwelling dm^3/s at a pressure difference of 10 Pa

The constants 0.47 and 0.13 are constants to be derived from an extensive multi zone model study for Dutch houses.

4. Example

4.1 Reference energy consumption

Usable floor area of the heated zone

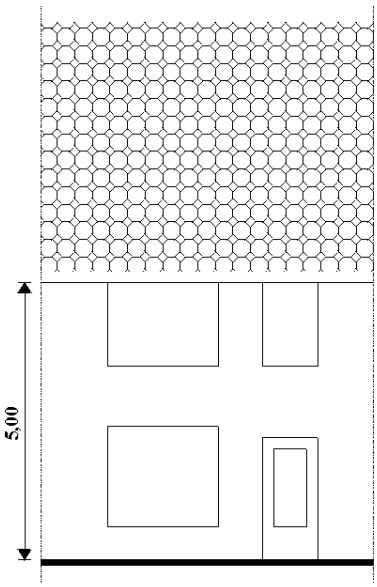
Ground floor	45,00 m²
First floor	45,00 m²
Attic	30,00 m²
$A_{g;heatz}$ =	**120,00 m²**

Area of the envelop

	d		A		$d \cdot A$
Ground floor	0,70	x	45,00 m²	=	31,50 m²
outer wall South	1,00	x	25,00 m²	=	25,00 m²
outer wall North	1,00	x	25,00 m²	=	25,00 m²
inner wall East	0,00	x	87,30 m²	=	0,00 m²
inner wall West	0,00	x	87,30 m²	=	0,00 m²
Roof	1,00	x	64,00 m²	=	64,00 m²
			A_{loss}	=	**145,50 m²**

$A_{g;cool} = 0$

Reference energy consumption,
Q_{ref} = 330 x 120,00 + 65 x 145,50 =
39600 + 9457 = **49058 MJ**



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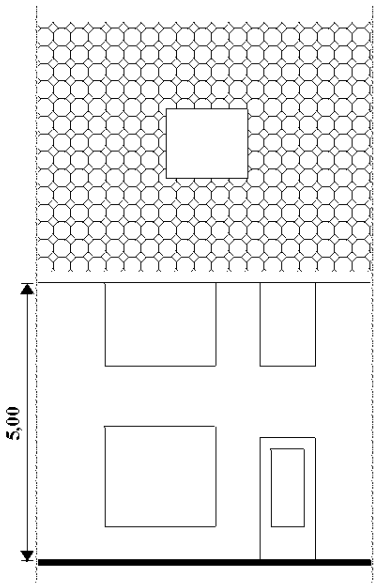

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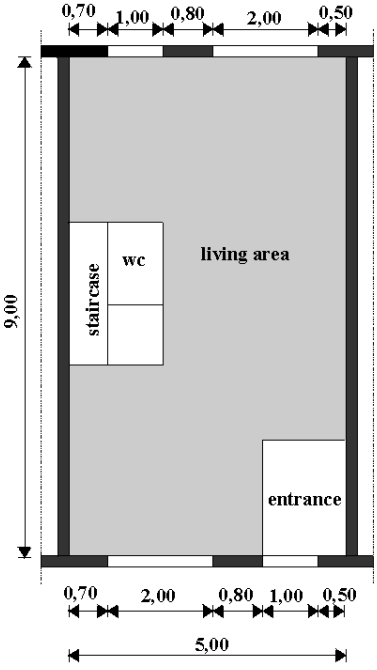
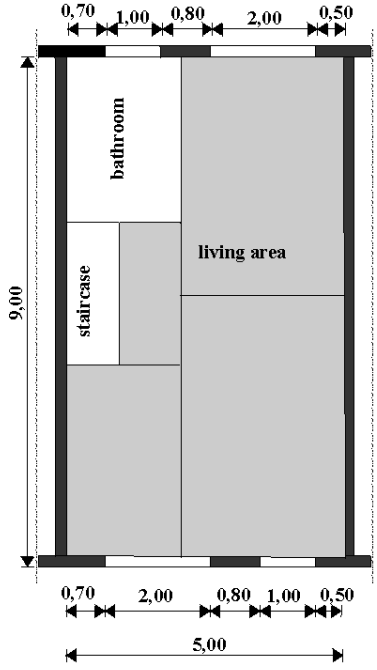
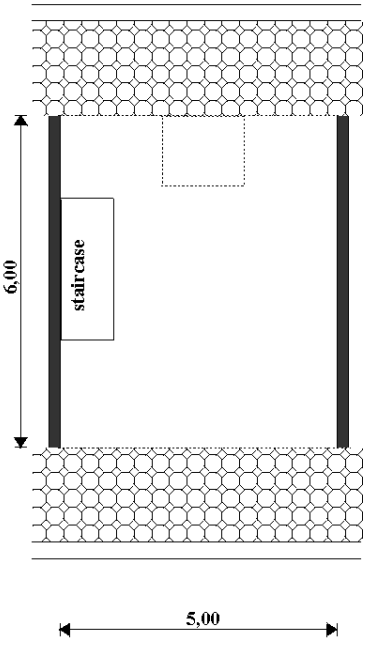


ground floor



first floor



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4.2 Energy consumption

4.2.1 Energy consumption for heating

Transmission heat loss

	A		U [W/m²· K]		A [m²]		$a\cdot U\cdot A$ [W/K]
Ground floor	0,73	x	0,30	x	45,00	=	9,52
Solid parts outer walls	1,00	x	0,30	x	30,00	=	9,00
Roofs	1,00	x	0,30	x	62,20	=	18,66
Windows	1,00	x	1,6	x	19,60	=	31,36
Solid part doors	1,00	x	3,0	x	2,20	=	6,60
					$\boldsymbol{H_{tr}}$	=	**75,14**

Q_{tr} = 75,14 x (18-5) x (212 x 24 x 3600 x 10^{-6}) = 86,20 x 238 = 17884 MJ

Ventilation heat

q_{v10} = 60 dm^3/s

q_v = (0,47 x 120,00 + 0,13 x 60) = 64,2 dm^3/s,

H_v = 1,2 x 64,2 = 77,04 W/K

Q_{vent} = 77,04 x 238 = 18336 MJ

Utilised gain

The solar gain is:

	A		ZTA		*bearing*		*shade*				
windows South	8,90	x	0,6	x	0,90	x	0,75	x	1140	=	4565 MJ
windows North	8,90	x	0,6	x	0,33	x	0,75	x	1140	=	1674 MJ
windows North, roof	1,80	x	0,6	x	0,46	x	0,75	x	1140	=	424 MJ
									Q_{sun}	=	6663 MJ

(*ZTA* = solar energy transmission factor)

The internal gain, Q_{int} = 110 x 120,00 = 13200 MJ

Q_{gain} = 6663 + 13200 = 19863 MJ

Auxiliary energy consumption

Q_{aux} = 0

For the heating is used a HR-100 boiler.

$\eta_{sys;heat}$ = 0,925

$\eta_{gen;heat}$ = 0,9

$$\boldsymbol{Q_{heat}} = \frac{17884 + 18336 - 19863}{0{,}925 \times 0{,}9} + 0 = \mathbf{19648\ MJ}$$

4.2.2 Energy consumption for mechanical ventilation

$P_{eff} = 0{,}03$ kW

$\boldsymbol{Q_{fan}}$ = 3,6 x 8760 x 0,03 x 0,5/0,39 = **1213 MJ**

4.2.3 Energy consumption for lighting

$$\boldsymbol{Q_{li}} = \frac{3{,}6}{0{,}39} \times 7 \times 120{,}00 \times 1 = \mathbf{7754\ MJ}$$

4.2.4 Energy consumption for pumps

$f_{cntrl;heat} = 0{,}5$

$\boldsymbol{Q_{pump}}$ = 8 x 0,5 x 120,00 / 0,39 = **1231 MJ**

4.2.5 Energy consumption for domestic hot water

$\eta_{sys;dhw} = 0{,}90$
$\eta_{gen;dhw} = 0{,}90$

$$\boldsymbol{Q_{dhw}} = \frac{68 \times 120{,}00}{0{,}9 \times 0{,}9} = \mathbf{10047\ MJ}$$

4.2.6 Energy performance

Q_{heat}	=	19648 MJ
Q_{fan}	=	1213 MJ
Q_{li}	=	7754 MJ
Q_{pump}	=	1231 MJ
Q_{cool}	=	0 MJ
Q_{hum}	=	0 MJ
Q_{dhw}	=	10047 MJ
Q_{pv}	=	- 0 MJ
Q_{cog}	=	- 0 MJ
Q_{perf}	=	39893 MJ

The EPC is: $\frac{Q_{\text{perf}}}{Q_{\text{ref}}} = \frac{39893}{49058} = 0{,}81 \ < 1$

The energy performance of the example terrace house complies with the requirement.

5. References

[1] Dutch Building Decree
Staatsblad 680, 1999
Den Haag

[2] NEN 5128
Energy Performance of dwellings and residential buildings
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[2] NEN 2916
Energy Performance of non residential buildings
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