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Energy performance of fenestration systems for residential buildings — Calculation procedure

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National foreword

This British Standard is the UK implementation of ISO 18292:2011, incorporating corrigendum April 2012.

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INTERNATIONAL STANDARD

ISO 18292

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Energy performance of fenestration systems for residential buildings — Calculation procedure

Performance énergétique des systèmes de fenêtrage pour les bâtiments résidentiels — Mode opératoire de calcul

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18292 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*.

Introduction

This International Standard specifies a procedure for the determination of energy rating of window and door products and other products that are installed in building envelope openings, also known as fenestration systems. To enable the fenestration industry and their clients to utilize energy performance instead of thermal transmittance to assess their products, there is a need for a simple, clear, accurate and transparent procedure that enables the energy performance of these products to be assessed using national climate data and nationally selected reference buildings.

This International Standard specifies detailed procedures for calculating the energy performance of fenestration products. In this International Standard, the energy performance is derived from thermal transmittance, solar gain, and air infiltration data obtained using standard procedures. Converting that value into an energy rating for the fenestration system is the responsibility of each country's appropriate national body. It is intended that the details of that rating system be published in a publicly available document. These procedures require the use of reference conditions, which differ between countries and can represent conditions other than actual. Allowing different reference conditions enables each country to determine its own reference values in accordance with local conditions. As long as these conditions are publicly available and the calculation is based on standardized procedures as specified in this International Standard, it is possible to calculate the energy performance of a specific product to the desired national reference conditions.

Energy performance of fenestration systems for residential buildings — Calculation procedure

1 Scope

This International Standard specifies a procedure for calculation of the energy performance of fenestration systems used in residential buildings, for rating of fenestration systems, doors and skylights, including the effects of frame, sash, glazing, and shading components. This International Standard specifies procedures for the calculation of the heating and cooling energy use in residential buildings, internal and external climatic conditions, and relevant building characteristics.

These procedures can accommodate all climatic conditions and installation details. It is the responsibility of the appropriate regulatory authority to identify the clauses of this International Standard to be applied in their area of jurisdiction and the climatic data and reference building specification(s) to be used.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6613, *Windows and door height windows — Air permeability test*

ISO 7345, *Thermal insulation — Physical quantities and definitions*

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

ISO 9288, *Thermal insulation — Heat transfer by radiation — Physical quantities and definitions*

ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

ISO 10077-2, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames*

ISO 12567-1, *Thermal performance of windows and doors — Determination of thermal transmittance by the hot-box method — Part 1: Complete windows and doors*

ISO 12567-2, *Thermal performance of windows and doors — Determination of thermal transmittance by hot box method — Part 2: Roof windows and other projecting windows*

ISO 13790:2008, *Energy performance of buildings — Calculation of energy use for space heating and cooling*

ISO 15099, *Thermal performance of windows, doors and shading devices — Detailed calculations*

ISO 15927-1, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 1: Monthly means of single meteorological elements*

ISO 15927-4, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 4: Hourly data for assessing the annual energy use for heating and cooling*

EN 410, *Glass in building — Determination of luminous and solar characteristics of glazing*

EN 1026, *Windows and doors — Air permeability — Test method*

EN 13363-1, *Solar protection devices combined with glazing — Calculation of solar and light transmittance — Part 1: Simplified method*

EN 13363-2, *Solar protection devices combined with glazing — Calculation of total solar energy transmittance and light transmittance — Part 2: Detailed calculation method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345 and ISO 9288 and the following apply.

3.1
solar heat gain
g
total solar energy transmittance (solar factor)

NOTE 1 The solar heat gain of the whole fenestration system, including glazing, frame and solar shading device, is denoted g_W.

NOTE 2 The total solar energy transmittance is also known as the solar heat gain coefficient with the acronym SHGC.

3.2
daylight potential
DP
τ_{DP}
potential of a fenestration system to supply a building with daylight

NOTE Daylight potential is not incorporated into the energy performance value.

3.3
thermal transmittance
U
heat flow rate in the steady state divided by area and by the temperature difference between the surroundings on each side of a system

[ISO 7345:1987, 2.12]

NOTE The thermal transmittance of the whole fenestration system, including glazing, frame and solar shading device, is denoted U_W.

3.4
energy performance of a fenestration system
EP
P_E
calculated annual energy need divided by area for heating and cooling caused by the fenestration system, in the reference building under the reference climatic conditions

NOTE This International Standard defines a separate energy performance value for heating and cooling conditions.

4 Symbols and units

Symbols and units used are in accordance with ISO 7345 and ISO 9288. The quantities which are specific to this International Standard are also defined in Table 1.

Table 1 — Symbols and units

Symbol	Quantity	Unit
A	area	m^2
C	effective heat capacity of a conditioned space	J/K
c	specific heat capacity	J/(kg·K)
F	factor	—
g	total solar energy transmittance of a building element	—
H	heat transfer coefficient	W/K
h	surface coefficient of heat transfer	$W/(m^2 \cdot K)$
I_{sol}	solar irradiance	W/m^2
L	overall air infiltration rate	m^3/s
P_E	annual energy performance	kWh/m^2
Q	quantity of heat	kWh
q_V	(volume) airflow rate	m^3/s
R	thermal resistance	$m^2 \cdot K/W$
T	thermodynamic temperature	K
t	time, period of time	hours
U	thermal transmittance	$W/(m^2 \cdot K)$
α	absorption coefficient of a surface for solar radiation	—
γ	tilt angle	°
Γ	heat balance ratio	—
ε	emissivity of a surface for long-wave thermal radiation	—
η	efficiency, utilization factor	—
θ	Celsius temperature	°C
κ	heat capacity per area	$J/(m^2 \cdot K)$
ρ	density	kg/m^3
r	albedo	—
σ	Stefan-Boltzmann constant ($\sigma = 5{,}67 \times 10^{-8}$)	$W/(m^2 \cdot K^4)$
τ	time constant	h
τ_{DP}	daylight potential	—
Φ	heat flow rate, thermal power	W
χ	point thermal transmittance	W/K
Ψ	linear thermal transmittance	W/(m·K)
NOTE These symbols are, where possible, the same as those in ISO 13790.		

In this International Standard, the energy performance values are calculated in kilowatt hours per square metre. Users may convert these values to other units as appropriate.

The subscripts indicated in Table 2 are used.

Table 2 — Subscripts

avg	time-average	m	mass-related conductance or capacitance
base	base	nd	need
C	cooling, capacity	ob	obstacles
C,nd	cooling need, or building need for cooling	or	orientation
DP	daylight potential	p	pressure
E	energy	pre-cool	pre-cool
e	external, exterior, envelope	pre-heat	pre-heat
g	ground	ref	reference
gl	glazing, glazed element	s	designated space
gn	gains	seas	seasonal
H	heating, or horizontal	set	setpoint
H,nd	heating need, or building need for heating	sh	shading
hor	horizontal	sol	solar (heat gains)
ht	heat transfer	tr	transmission (heat transfer)
i, j, k, m, n	dummy integers	V	volume
int	internal (heat and temperature)	ve	ventilation (heat transfer)
ls	loss	w	fenestration system
m	monthly, designated month	Δ	difference

NOTE 1 These subscripts are in line with the subscripts used in ISO 13790.

NOTE 2 Variables are also defined when they appear for the first time.

5 Principle

5.1 Introduction

Energy performance of the fenestration system is expressed through energy performance indices, P_E, one representative of the heating season and one representative of the cooling season.

This procedure shall be followed for all fenestration tilt angles, γ.

The $P_{E,\mathrm{H,w}}$, and $P_{E,\mathrm{C,w}}$ values are the energy needs per area of the fenestration system per year, i.e. the contribution of the fenestration system to the energy needs of the reference building for heating and cooling.

$P_{E,\mathrm{H,w}}$ is the fenestration heating energy performance index, expressed in kilowatt hours per square metre, while $P_{E,\mathrm{C,w}}$ is the fenestration cooling energy performance index, expressed in kilowatt hours per square metre.

Different calculation procedures are possible as given in ISO 13790:

— monthly energy balance calculation method;

— seasonal energy balance calculation method;

— hourly energy balance calculation method.

The energy need of the reference building caused by the fenestration system is considered to be independent of the heating, ventilation, and air conditioning system in this International Standard.

5.2 Heating energy performance

Monthly method:

$$P_{E,\,\mathrm{H,w},i} = \sum_{m=1}^{12} \frac{Q_{\mathrm{H,nd,w,m},i}}{A_{\mathrm{w},i}} \tag{1}$$

Seasonal method:

$$P_{E,\,\mathrm{H,w},i} = \frac{Q_{\mathrm{H,nd,w,seas},i}}{A_{\mathrm{w},i}} \tag{2}$$

Hourly method:

$P_{E,\,\mathrm{H,w},i}$ is the annual heating energy associated with the fenestration system, expressed in kilowatt hours per square metre.

NOTE For the hourly method, separating cooling and heating components is a complex task, which can involve multiple steps; see ISO 13790:2008, 15.3.1.2.

where

$P_{E,\,\mathrm{H,w},i}$ is the energy performance value of the fenestration system facing orientation i for the heating season, expressed in kilowatt hours per square metre;

i is the orientation of the fenestration system, in degrees;

$A_{\mathrm{w},i}$ is the area of the (projected) fenestration system area, in square metres;

$Q_{\mathrm{H,nd,w,m}}$ is the net heat loss through the fenestration system, for the heating mode, per month, m, determined in accordance with 6.2, expressed in kilowatt hours;

$Q_{\mathrm{H,nd,w,seas}}$ is the net heat loss through the fenestration system, for the heating mode, per season, seas, determined in accordance with 6.2, expressed in kilowatt hours.

For situations where fenestration systems are placed in more than one position:

$$P_{E,\,\mathrm{H,w}} = \frac{\sum_i A_{\mathrm{or},i} P_{E,\,\mathrm{H,w,or},i}}{\sum_i A_{\mathrm{or},i}} \tag{3}$$

where $A_{\mathrm{or},i}$ is the area of the fenestration, in square metres, and at orientation i, in degrees.

5.3 Cooling energy performance

Monthly method:

$$P_{E,\mathrm{C,w},i} = \sum_{m=1}^{12} \frac{Q_{\mathrm{C,nd,w,m},i}}{A_{\mathrm{w},i}} \tag{4}$$

Seasonal method:

$$P_{E,\mathrm{C,w},i} = \frac{Q_{\mathrm{C,nd,w,seas},i}}{A_{\mathrm{w},i}} \tag{5}$$

Hourly method:

$P_{E,\,\mathrm{C,w},i}$ is the annual cooling energy associated with the fenestration systems, expressed in kilowatt hours per square metre.

NOTE For the dynamic method, separating cooling and heating components is a complex task which can involve multiple steps; see ISO 13790:2008, 15.3.1.2.

where

$P_{E,\,\mathrm{C,w},i}$ is the energy performance value of the fenestration system facing orientation i for the cooling season, expressed in kilowatt hours per square metre;

i is the orientation of the fenestration system, in degrees;

$A_{\mathrm{w},i}$ is the area of the (projected) fenestration system area, in square metres;

$Q_{\mathrm{C,nd,w,m}}$ is the net heat gain through the fenestration system, for the cooling mode, per month, m, determined in accordance with 6.3, expressed in kilowatt hours;

$Q_{\mathrm{C,nd,w,seas},i}$ is the net heat gain through the fenestration system, for the cooling mode, per season, seas, determined in accordance with 6.3, expressed in kilowatt hours.

For situations where fenestration systems are placed in more than one position:

$$P_{E,\,\mathrm{C,w}} = \frac{\sum_i A_{\mathrm{or},i} P_{E,\,\mathrm{C,w,or},i}}{\sum_i A_{\mathrm{or},i}} \tag{6}$$

where $A_{\mathrm{or},i}$ is the area of the fenestration system, in square metres, at orientation i, in degrees.

When calculating P_E using hourly methods, it is recommended that changes in U-values due to the exposure to actual environmental conditions and angle dependency of g-value (SHGC) be considered. It is not therefore recommended that fixed values that are used to compare products for U-value and g-value (SHGC) be used to calculate energy performance. It is necessary to use the same building assumptions and boundary conditions for both simplified and hourly calculation methods to ensure compatibility. Hourly calculation programmes need to comply with validation and verification tests as specified in the Bibliography.

6 Methodology and basic equations

6.1 General

6.1.1 Introduction

For the evaluation of the energy performance for fenestration systems, all data used shall be for the same tilt angle of either a typical situation for that fenestration system or the one given in national regulations.

The procedure presented in this International Standard includes two different parts, 6.1.2 and 6.1.3, that shall be distinguished.

6.1.2 Part 1: Preparation of the national or regional fenestration system energy rating procedures

The following actions shall be performed once only by the responsible bodies as part of the overall preparation of the national or regional fenestration system energy rating procedures:

— determination of what is to be included having regard to the climate and other factors for the country or region for which the rating scheme is being set up (e.g. whether to include heating, cooling or both, whether to define a rating for daylighting);

— the calculation of the energy use of a reference building in order to obtain the building-dependent parameters needed for the rating of the fenestration system;

— the choice of representative climate and other relevant data needed as parameters in the calculation of the energy performance of the fenestration system, including all conversions that are independent of the specifications of the fenestration system to be rated;

— establishing procedures and templates for the conversion from calculated energy performance for heating or cooling into a classification (rating);

— if appropriate, establishing procedures and templates for the conversion from the day-lighting performance of the fenestration system (characterized by a daylight potential) into a classification (rating).

6.1.3 Part 2: Calculation of the energy performance of a specific fenestration system

The user applying this International Standard shall calculate the energy performance of a specific fenestration system in accordance with the steps outlined here. The energy rating can be carried out either in a specific orientation or as a weighted average of a number of orientations.

The calculation procedure consists of four steps. Each step involves the gathering of a specific set of input data, followed by specific “pre-processing” calculations.

Figure 1 gives a detailed schematic overview of the calculation steps and the data that are needed as input; the main sources of the data are also given. The detailed procedures are given in 6.2 to 6.5. Only the general principles are provided here.

Step 1: Climate. ***Input data:*** Select appropriate nationally or regionally representative climate data, such as external temperature and the intensity of solar radiation incident on the fenestration system with given orientation and tilt.

Step 2: Building. ***Input data:*** Select appropriate data on one (or a set of) nationally specified reference building(s) and reference occupancy, including reference services (heating, cooling and ventilation) and their control.

Step 3: Fenestration system. ***Input data:*** Obtain the fenestration system properties: thermal transmittance, solar transmittance, heat transfer due to air leakage, and daylight potential.

Step 4: Calculation procedure. From the building-related data (step 2), together with the fenestration system data (step 3) and the climate data (step 1), the gain and loss utilization factors for heating and cooling respectively are calculated for monthly and seasonal methods. For the hourly method, the energy balance of the reference building is calculated each time a fenestration product is being evaluated.

Finally, with all input data available and all “pre-processing” calculations done, the energy performance of the fenestration system can be calculated for the heating mode, $P_{E,\mathrm{H,w}}$, and for the cooling mode, $P_{E,\mathrm{C,w}}$, separately. This procedure is given in Clause 5.

It may be decided at a national level to present one annual energy performance value, combining the value for heating with the value for cooling.

NOTE The energy performance value can be used as a basis for classification, using a continuous or discrete scale and benchmarks, e.g. in a way similar to EN 15217 for the energy performance classification for buildings.

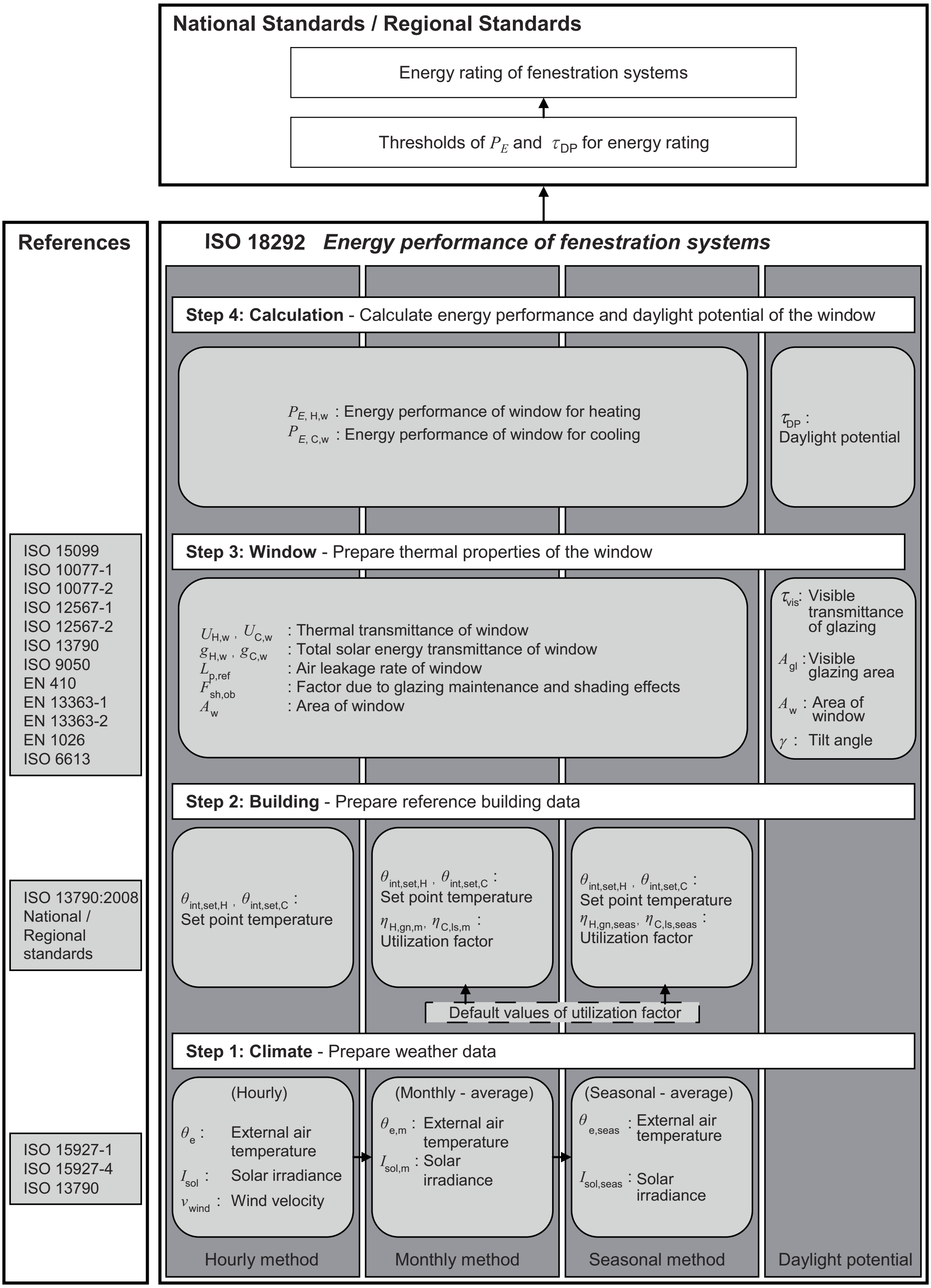


Figure 1 — Calculation procedure for energy performance values

6.2 The fenestration energy performance for heating

The fenestration energy performance for heating is the annual sum of the monthly contributions or the seasonal weighted average for the seasonal utilization factor method, from the fenestration product to the energy need for space heating. For the hourly method, the fenestration product energy performance for heating is the annual sum of the hourly contribution from the fenestration product to the energy need for space heating.

The contributions from the fenestration to the energy needs for space heating are calculated on a monthly basis using Equation (7):

$$Q_{\text{H,nd,w,m}} = f_{\text{H,m}} \left(Q_{\text{H,ht,w,m}} - \eta_{\text{H,gn,m}} Q_{\text{H,gn,w,m}} \right) \tag{7}$$

and on a seasonal basis using Equation (8):

$$Q_{\text{H,nd,w,seas}} = f_{\text{H,seas}} \left(Q_{\text{H,ht,w,seas}} - \eta_{\text{H,gn,seas}} Q_{\text{H,gn,w,seas}} \right) \tag{8}$$

where

$Q_{\text{H,nd,w}}$ is the net heat loss through the fenestration system, for the heating period, expressed in kilowatt hours;

$Q_{\text{H,ht,w}}$ is the overall heat transfer by transmission and infiltration through the fenestration system, for the heating mode, expressed in kilowatt hours, determined in accordance with 6.4;

$Q_{\text{H,gn,w}}$ is the overall solar heat gain through the fenestration system, for the heating mode, expressed in kilowatt hours, determined in accordance with 6.4;

$f_{\text{H,m}}$ is the fraction of the month that is part of the heating season;

$f_{\text{H,seas}}$ is the fraction of the year that is the heating season;

$\eta_{\text{H,gn}}$ is the dimensionless gain utilization factor for heating, determined in accordance with the procedure outlined in Annex A.

For hourly calculations, see 5.2.

The fraction of the month that is part of the heating season shall be calculated for each month m as:

$$f_{\text{H,m}} = \frac{Q_{\text{H,nd,m}}}{\left(Q_{\text{H,nd,m}} + Q_{\text{C,nd,m}} \right)} \tag{9}$$

NOTE 1 Since there are no internal heat gains coming in via the fenestration system, $Q_{\text{H,gn,w}} = Q_{\text{H,sol,w}}$.

NOTE 2 The fraction $f_{\text{H,m}}$ is already part of the calculation of the energy balance of the reference building in accordance with ISO 13790.

6.3 The fenestration energy performance for cooling

The fenestration energy performance for cooling is the annual sum of the monthly contributions or the seasonal weighted average for the seasonal utilization factor method, from the fenestration product to the energy need for space cooling. For the hourly method, the fenestration product energy performance for cooling is the annual sum of the hourly contribution from the fenestration product to the energy need for space cooling.

The monthly contributions from the fenestration system to the energy need for space cooling shall be calculated on a monthly basis using Equation (10):

$$Q_{\text{C,nd,w,m}} = f_{\text{C,m}} \left(Q_{\text{C,gn,w,m}} - \eta_{\text{C,ls}} Q_{\text{C,ht,w,m}} \right) \quad (10)$$

and on a seasonal basis using Equation (11):

$$Q_{\text{C,nd,w,seas}} = f_{\text{C,seas}} \left(Q_{\text{C,gn,w,seas}} - \eta_{\text{C,ls}} Q_{\text{C,ht,w,seas}} \right) \quad (11)$$

For hourly calculations, see 5.3.

where

$Q_{\text{C,nd,w}}$ is the net heat gain through the fenestration system, for the cooling mode, expressed in kilowatt hours;

$Q_{\text{C,ht,w}}$ is the overall heat transfer by transmission and infiltration through the fenestration system, for the cooling mode, expressed in kilowatt hours, determined in accordance with 6.4;

$Q_{\text{C,gn,w}}$ is the overall solar heat gain through the fenestration system, for the cooling mode, expressed in kilowatt hours, determined in accordance with 6.4;

$f_{\text{C,m}}$ is the fraction of the month that is part of the cooling season;

$f_{\text{C,seas}}$ is the fraction of the year that is the cooling season;

$\eta_{\text{C,ls}}$ is the dimensionless loss utilization factor for cooling, determined in accordance with the procedure outlined in Annex A.

The fraction of the month that is part of the cooling season shall be calculated for each month m as detailed in ISO 13790:

$$f_{\text{C,m}} = \frac{Q_{\text{C,nd,m}}}{\left(Q_{\text{H,nd,m}} + Q_{\text{C,nd,m}} \right)} \quad (12)$$

NOTE Since there are no internal heat gains coming in via the fenestration system, $Q_{\text{C,gn,w}} = Q_{\text{C,sol,w}}$.

6.4 The heat balance elements

6.4.1 Heat transfer

The overall heat transfer by transmission and air leakage shall be calculated as follows.

For the heating mode:

$$Q_{\text{H,ht,w}} = \left(U_{\text{H,w}} A_{\text{w}} + H_{\text{H,ve,w}} \right) \left(\theta_{\text{int,set,H}} - \theta_{\text{e,avg}} \right) \frac{t}{1\,000} \quad (13)$$

where

$U_{\text{H,w}}$ is the thermal transmittance (U-value) of the fenestration product for the heating mode, expressed in watts per square metre kelvin, determined in accordance with 8.2;

$H_{\text{H,ve,w}}$ is the heat transfer coefficient due to air leakage of the fenestration system, expressed in watts per kelvin, determined in accordance with 8.5;

A_w is the area of the (projected) fenestration system area, expressed in square metres;

$\theta_{int,set,H}$ is equal to the set point temperature for heating, in degrees Celsius, to be determined in accordance with Clause 9;

$\theta_{e,avg}$ is equal to the time-averaged external air temperature, in degrees Celsius, to be determined in accordance with Clause 7;

t is the total length of the considered time period, in hours.

NOTE 1 Normally there is no difference between heating and cooling mode with respect to the value of the heat transfer coefficient due to air leakage.

NOTE 2 For more details of this approach, see Annex A.

For the cooling mode:

$$Q_{C,ht,w} = \left(U_{C,w} A_w + H_{C,ve,w}\right)\left(\theta_{int,set,C} - \theta_{e,avg}\right)\frac{t}{1\,000} \tag{14}$$

where

$U_{C,w}$ is the thermal transmittance (U-value) of the fenestration system for the cooling mode, expressed in watts per square metre kelvin, determined in accordance with 8.2;

$H_{C,ve,w}$ is the heat transfer coefficient due to air leakage of the fenestration system, expressed in watts per kelvin, determined in accordance with 8.5;

A_w is the area of the (projected) fenestration system area, in square metres;

$\theta_{int,set,C}$ is equal to the set point temperature for cooling, in degrees Celsius, to be determined in accordance with Clause 9;

$\theta_{e,avg}$ is equal to the time-average external air temperature, in degrees Celsius, to be determined in accordance with Clause 7;

t is the total length of the considered time period, in hours.

NOTE 3 There can be a difference in U-value between heating and cooling mode if the fenestration system is adaptive to the time period over which the calculation is made (e.g. season, day) and day and night (e.g. movable solar blind, curtains, seasonal add-ons).

NOTE 4 Normally there is no difference between heating and cooling mode with respect to the value of the heat transfer coefficient due to air leakage.

NOTE 5 For more details of this approach, see Annex A.

6.4.2 Solar gain

The overall solar heat gain through the fenestration system shall be calculated as follows.

For the heating mode:

$$Q_{H,gn,w} = F_{sh,ob}\, g_{H,w}\, I_{sol}\, A_w \frac{t}{1\,000} \tag{15}$$

where

$F_{sh,ob}$ is the factor due to glazing maintenance and shading effects during the heating season, determined in accordance with 8.3;

$g_{H,w}$ is the dimensionless total solar energy transmittance of the fenestration system, for the heating mode, determined in accordance with 8.3;

I_{sol} is the average solar irradiance for the considered time period on the fenestration system plane, expressed in watts per square metre, determined in accordance with 7.3;

A_w is the area of the (projected) fenestration system area, in square metres;

t is the total length of the considered time period, in hours.

For the cooling mode:

$$Q_{C,gn,w} = F_{sh,ob}\, g_{C,w}\, I_{sol}\, A_w \frac{t}{1\,000} \quad (16)$$

where $g_{C,w}$ is the dimensionless total solar energy transmittance of the fenestration system, for the cooling mode, determined in accordance with 8.3.

NOTE There can be a difference in U-value or g-value between heating and cooling mode if the fenestration product is adaptive to the time period over which the calculation is made (e.g. season, day) and day and night (e.g. movable solar blind, curtains, seasonal add-ons).

6.5 Assessment of the solar control potential of the rated fenestration system

6.5.1 Principle

The rated fenestration system can:

a) have solar control provisions incorporated (e.g. solar control glazing, incorporated blinds);

b) be an assembly of glazing, frame, and solar control device (e.g. an add-on solar control provision film, blind);

c) have no solar control provision.

The energy performance for cooling, $P_{E,\,C,w}$, reflects these differences.

A procedure is specified in 6.5.2 to assess the solar control potential of a rated fenestration system, without the need to compare a series of different fenestration systems.

This is done by comparing the rating of the fenestration system against the rating of the same fenestration system provided with a fictitious reference high-performance solar control provision.

If the difference in rating is small, the energy performance of the fenestration product for cooling is apparently efficient, for the given conditions; adding a high-performance solar control provision does not lead to significant improvement of the energy performance of the fenestration product for cooling.

If the difference in rating is large, the energy performance of the fenestration system for cooling is apparently inefficient for the given conditions and hence subject to significant improvement by adding a solar control provision.

6.5.2 Procedure

The following procedure can be used to assess the solar control potential of the rated fenestration system as described in more detail in Annex B:

- a fictitious reference high-performance solar control provision is defined;
- a formula is given to calculate the new properties of the fenestration system with this added fictitious reference solar control provision;
- the energy performance is calculated for the fenestration system without and with this added fictitious reference solar control provision;
- a recommendation is given to national or regional fenestration system energy rating schemes to rate the “solar control potential” of the fenestration system in the given conditions on the basis of the difference between the energy performance as calculated for the fenestration system without and with this added fictitious reference solar control provision.

The g-value for the combination of a fenestration system with additional external solar shading device is derived using the simplified method given in EN 13363-1, EN 13363-2 and ISO 15099. EN 13363-1 gives conservative values for the summer situation (assuming no ventilation between shading and fenestration system).

NOTE See Annex B for background information and an example.

7 Climate data

7.1 Introduction

This clause specifies the procedure shown as step 1 in Figure 1.

The climate-related data, definitions, and procedures given in ISO 13790:2008, Annex F shall be used.

Typical data shall be defined on a regional or national basis.

7.2 External air temperature

The value for the external air temperature, θ_e, shall be the appropriate time-period mean external air temperature, in degrees Celsius.

NOTE Temperature should be averaged over the appropriate time period; see A.2 for the difference with the degree-day method.

7.3 Solar radiation

Follow the procedures specified in ISO 13790:2008, Annex F.

Validated theoretical models of solar radiation on vertical and tilted surfaces, at different orientations and geographic places and times can also be used.

7.4 Wind speed

Wind speed (air velocity) is only needed when hourly calculation methods are used. It is a parameter to calculate the external surface heat transfer coefficient as specified in ISO 15099. National standard values can also be used.

8 Basic thermal and solar-optical fenestration properties

8.1 Introduction

Fundamental thermal and solar-optical fenestration properties are thermal transmittance, U, total solar energy transmittance or solar factor, g, light transmittance, τ_{vis}, and air leakage, $L_{\Delta p}$, where Δp is the pressure difference at which the air leakage is measured, in pascals.

8.2 Thermal transmittance, U-value

The thermal transmittance, U-value, is determined for the whole fenestration product. Calculate the U-value as specified in ISO 15099, ISO 10077-1, and ISO 10077-2. The U-value can also be determined by laboratory measurement in accordance with the procedures specified in ISO 12567-1 and ISO 12567-2.

8.3 Total solar energy transmittance or solar factor, g-value

Total solar energy transmittance or solar factor, g, shall be calculated as follows:

a) whole fenestration system (frame + glazing) with or without shading devices: ISO 15099 or ISO 13790;

b) glazing: ISO 9050 and EN 410;

c) glazing with shading devices: EN 13363-1 and EN 13363-2.

The effect of the following shall be defined at a national level:

- influence of incident angle on solar gain;
- influence of the frame component;
- in the case where no agreed national guidance for defining the influence of incident angle on solar gain values is available, use the value defined in ISO 13790.

The tilt angle of the fenestration system may slightly affect its g-value. When no specific data for tilted fenestration systems is available, the g-values obtained in the vertical position can be used.

8.4 Daylight potential

The daylight potential of a fenestration system indicates its potential to supply a building with daylight and depends on the visible transmittance, the glazing to fenestration system area ratio and on the view factor from the glazing to the sky and the ground. The latter parameter is used to determine the effect of different fenestration system slope angles.

The visible transmittance, τ_{vis}, shall be calculated for the glazing as specified in ISO 15099, ISO 9050 or EN 410. For shading devices it can also be calculated using the procedures in EN 13363-1 and EN 13363-2.

Quantify daylight potential of the fenestration system and quote this figure with the energy rating. Daylight potential is an important parameter for fenestration system selection but is not used in the energy rating procedure.

In this International Standard, the daylight potential of the fenestration system as a building component is treated as independent of parameters such as the fenestration system height over floor, building overhangs and of the interior of the building. These all affect the daylight performance in practical situations.

The daylight potential, τ_{DP}, is given by Equation (17):

$$\tau_{DP} = \tau_{vis} \left(F_{g-s} + r F_{g-g} \right) \frac{A_{gl}}{A_w} \tag{17}$$

where

τ_{vis} is the visible transmittance of the glazing;

F_{g-s} is the view factor from the glazing to the sky;

F_{g-g} is the view factor from the glazing to the ground;

r is the albedo of the ground (for temperate climates a value of 0,2 is normally used, for polar and tropical climates other values may be more appropriate);

A_{gl} is the visible glazing area of the fenestration system, in square metres;

A_w is the area of the fenestration system, in square metres.

The view factor from the glazing to the sky depends on the type of the rated fenestration system: façade fenestration system (vertical), roof fenestration system and skylight (sloped) or roof light (horizontal). Self-shading effects from frame and sash may be neglected if frame and sash rebate is small compared to the dimensions of the fenestration system ($<$1/20).

The relationships between the view factors and fenestration product angle are given below:

$$F_{g-s} = \frac{(1 + \cos\gamma)}{2} \tag{18}$$

$$F_{g-g} = \frac{(1 - \cos\gamma)}{2} \tag{19}$$

where

γ is the angle between the glazing plane and the horizontal, where $\gamma = 0°$.

If the given fenestration system comprises a movable shading device that shades direct solar radiation (e.g. venetian blind), give values for the complete dynamic range (fully open and fully closed).

8.5 Air infiltration (air permeability) and ventilation

8.5.1 Air infiltration

The overall air infiltration (air permeability) rate, L, is measured for the whole fenestration product at the reference pressure difference and is denoted $L_{\Delta p,\text{ref}}$. Measure $L_{\Delta p,\text{ref}}$ as specified in EN 1026 or ISO 6613.

NOTE The procedure to recalculate L to another pressure difference, $L_{\Delta p}$, is specified in EN 12207, and is incorporated into Equation (17).

The heat transfer coefficient due to air infiltration of the fenestration system is given by:

$$H_{\text{ve,w}} = \frac{1}{3,6} \times \left(\frac{\Delta p}{\Delta p_{\text{ref}}} \right)^{2/3} \rho C_p L_{\Delta p_{\text{ref}}} \quad (20)$$

where

$H_{\text{ve,w}}$ is the heat transfer coefficient due to air infiltration of the fenestration system, expressed in watts per kelvin;

Δp is the average pressure difference in the building, in pascals (if no national value is defined, use $\Delta p = 6$ Pa);

Δp_{ref} is the reference pressure difference that was used for the measurement of the air leakage rate of the fenestration system, in pascals;

ρC_p is the thermal capacitance of air, $\rho C_p = 1{,}24$ kJ/(m³·K);

$L_{\Delta p_{\text{ref}}}$ is the air leakage rate of the fenestration system at a pressure difference Δp_{ref}, expressed in cubic metres per hour.

8.5.2 Natural ventilation through deliberate opening of the fenestration system

Use the procedures given in ISO 13790 for calculating free cooling and night time ventilation during cooling mode.

9 Reference building

9.1 Introduction

This clause describes step 2 of Figure 1.

It describes the set of data needed on one (or a set of) nationally specified reference building(s) and reference occupancy, including reference services (heating, cooling and ventilation) and their control.

ISO 13790 shall be used as the basis for specifying the reference building.

The energy performance of the fenestration system shall be determined using one of the following options of mounting the fenestration system being evaluated into the reference building:

a) one fenestration system type in one specific orientation;

b) area weighted average results from one fenestration system type placed in each of the four cardinal orientations;

c) defined by national regulations.

NOTE Ensure that the ratio of fenestration system area to reference building floor area is as specified by national regulations or use a “typical” ratio.

9.2 Overview of data

A reference building shall be specified. This could be on a national or regional level and should represent a building typical for the region relevant for the rating. Parameters for calculating the energy performance of fenestration systems are specified in ISO 13790. The reference building shall define:

- the geometry of the building including the distribution of fenestration systems at different orientations and slopes and effects of shading and surroundings;
- the thermal properties of the building envelope (U-value, thermal conductivity, specific heat, mass);
- internal gains (e.g. define the standard number of people and usage or use data given in national regulations);
- a reference fenestration system to be able to calculate the utilization factors;
- building operating parameters such as set-point temperature and operating schedule;
- all other input data required for the seasonal, monthly or hourly method;

The same reference building that is used to evaluate vertical fenestration systems can be used to evaluate sloped fenestration systems installed at their correct orientation.

10 Assessment report

The report giving an assessment of the energy performance of the fenestration product in accordance with this International Standard shall include at least the following information:

a) a technical description of the product;

b) name of the person responsible for the calculation;

c) all input data, especially those associated with the reference building, which shall be listed and justified, e.g. by reference to International Standards or national standards, or by reference to the appropriate annexes to this International Standard or to other documents — specifically the data reported shall be sufficient to enable the calculation to be replicated;

d) a note indicating which method (detailed simulation, simple hourly, monthly or seasonal) was used and, if seasonal, the assumed fixed length of the heating and cooling season;

e) a reference to this International Standard (ISO 18292:2011);

f) energy performance values for the heating or cooling season;

g) if applicable, daylight potential.

Annex A
(informative)

Explanation of gain/loss utilization factor method used in ISO 13790 for the fenestration system energy balance equation

A.1 Building energy balance

The following gives a summary of the main equations from ISO 13790:2008 for the monthly method and the seasonal method.

The monthly energy need for space heating is calculated using Equation (A.1):

$$Q_{\mathrm{H,nd}} = Q_{\mathrm{H,ht}} - \eta_{\mathrm{H,gn}} Q_{\mathrm{H,gn}} \tag{A.1}$$

The monthly energy need for space cooling is calculated using Equation (A.2):

$$Q_{\mathrm{C,nd}} = Q_{\mathrm{C,gn}} - \eta_{\mathrm{C,ls}} Q_{\mathrm{C,ht}} \tag{A.2}$$

where

$Q_{\mathrm{H,ht}}$ is the total heat transfer by transmission and ventilation of the building for the heating mode, expressed in kilowatt hours;

$Q_{\mathrm{C,ht}}$ is the total heat transfer by transmission and ventilation of the building for the cooling mode, expressed in kilowatt hours;

$Q_{\mathrm{H,gn}}$ is the total solar and internal heat gains of the building for the heating mode, expressed in kilowatt hours;

$Q_{\mathrm{C,gn}}$ are the total solar and internal heat gains of the building for the cooling mode, expressed in kilowatt hours;

$\eta_{\mathrm{H,gn}}$ is the dimensionless gain utilization factor for heating;

$\eta_{\mathrm{C,ls}}$ is the dimensionless loss utilization factor for cooling.

Leaving out the index H for heating and C for cooling, the total monthly heat transfer of the building by transmission and ventilation, Q_{ht}, is given by:

$$Q_{\mathrm{ht}} = Q_{\mathrm{tr}} + Q_{\mathrm{ve}} \tag{A.3}$$

where

Q_{tr} is the total heat transfer of the building by transmission, in kilowatt hours;

Q_{ve} is the total heat transfer of the building by ventilation, in kilowatt hours.

The total monthly heat gains, Q_{gn}, of the building by internal and solar gains are:

$$Q_{gn} = Q_{int} + Q_{sol} \quad (A.4)$$

where

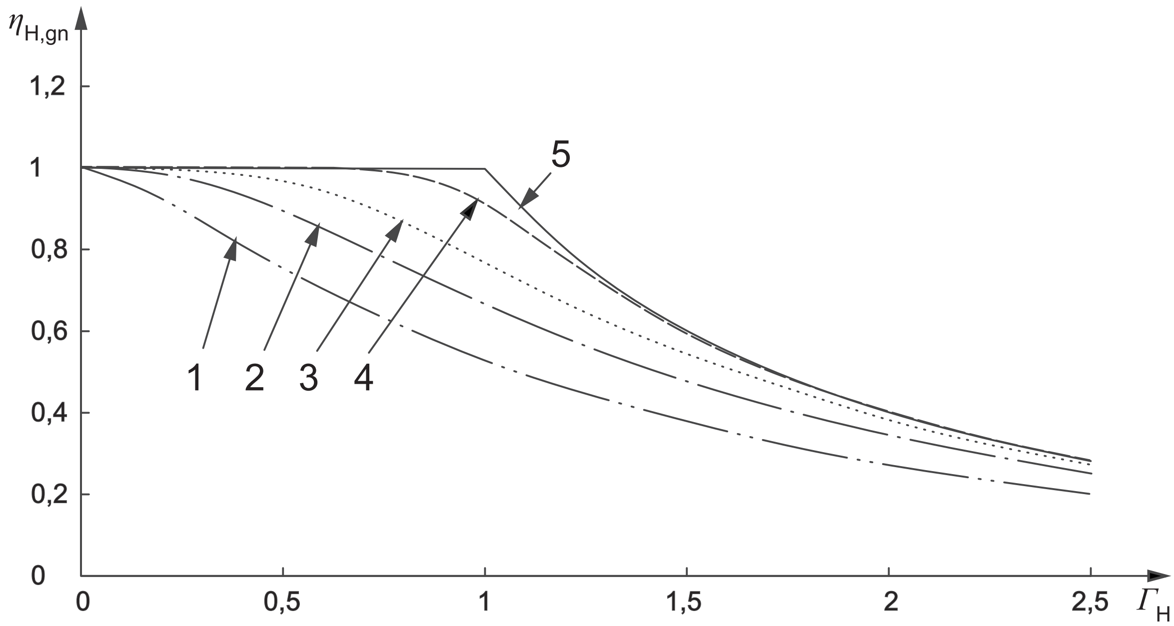
Q_{int} is the sum of internal heat gains of the building, expressed in kilowatt hours;

Q_{sol} is the sum of solar heat gains of the building, expressed in kilowatt hours.

Values for the gain utilization factor for heating, $\eta_{H,gn}$, are obtained by curves depending on the heat balance ratio for heating, Γ_H, and the time constant of the building, as shown in Figure A.1.

The heat balance ratio for the heating mode, Γ_H, is given by:

$$\Gamma_H = \frac{Q_{H,gn}}{Q_{H,ht}} \quad (A.5)$$



Key

Time constant, τ

1 8 h (low inertia)
2 1 d
3 2 d
4 7 d
5 ∞ (high inertia)

$\eta_{H,gn}$ gain utilization factor for heating

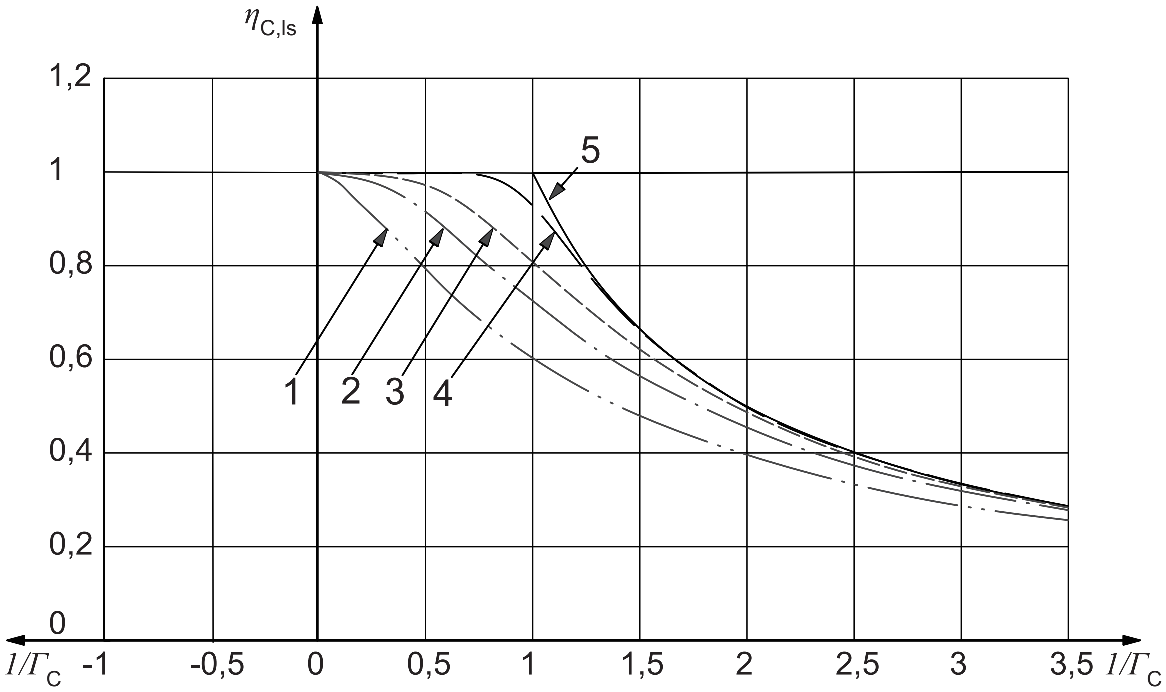
Γ_H heat balance ratio for heating

Figure A.1 — Illustration of gain utilization factor for heating mode, for the time constants listed in the key, valid for monthly calculation method

Values for the loss utilization factor for cooling, $\eta_{C,ls}$, are obtained by curves depending on the heat balance ratio for cooling, Γ_C, and the time constant of the building, as shown in Figure A.2.

The heat balance ratio for the cooling mode, Γ_C, is given by:

$$\Gamma_C = \frac{Q_{C,ls}}{Q_{C,ht}} \quad \text{(A.6)}$$



Key

Time constant, τ

1 8 h (low inertia)

2 1 d

3 2 d

4 7 d

5 ∞ (high inertia)

$\eta_{C,ls}$ loss utilization factor for cooling

Γ_C heat balance ratio for cooling

Figure A.2 — Illustration of loss utilization factor for cooling mode, for the time constants listed in the key, valid for monthly calculation method

A.2 Accumulated temperature difference versus degree-day method

The monthly or seasonal weighted average for the seasonal utilization factor method in ISO 13790 is a utilization factor approach. In the utilization factor approach, the energy needs for heating are calculated as the difference between the heat transfer by transmission and ventilation, and the sum of gains from internal and solar sources, multiplied by a gain utilization factor. This factor is calculated on a monthly basis, or as a seasonal weighted average in case of the seasonal utilization factor method. This is given in Equation (A.7).

$$Q_{\mathrm{H,nd}} = \left(H_{\mathrm{tr}} + H_{\mathrm{ve}}\right) \sum_{j=1}^{k} \left(\theta_{\mathrm{int,set,H}} - \theta_{\mathrm{e},j}\right) \frac{t}{1\,000} - \eta_{\mathrm{H,gn}} Q_{\mathrm{H,gn}} \quad \text{subject to} \quad Q_{\mathrm{H,nd}} \geqslant 0 \tag{A.7}$$

where

$\theta_{\mathrm{int,set,H}}$ is the set point temperature for heating, in degrees Celsius;

θ_{e} is the external air temperature, in degrees Celsius;

j is the counter for the number of hours in a given month;

k is the number of hours.

If, during the given month or seasonal weighted average for the seasonal utilization factor method, there are intervals with zero energy needs for heating, these are implicitly taken into account by (a lower value of) the utilization factor, as explained in more detail in ISO 13790:2008, Annex I.

This approach should not be confused with the degree-day method, such as that specified in ISO 15927-6, which also uses an accumulated temperature difference.

In the degree-day method, the energy needs for heating are calculated without explicitly taking into account the effect of internal and solar gains. This defect is compensated by taking only a subset of the number of days (degree-day method) or hours (degree-hour method) when calculating the heat transfer by transmission and ventilation.

For the degree-hour and degree-day method:

$$Q_{\mathrm{H,nd}} = \frac{\left(H_{\mathrm{tr}} + H_{\mathrm{ve}}\right)}{1\,000} \sum_{m=1}^{n} \max\left[0;\left(\theta_{\mathrm{int,base}} - \theta_{\mathrm{e,m}}\right)\right] \tag{A.8}$$

where

$\theta_{\mathrm{int,base}}$ is a predefined temperature, lower than the indoor set point temperature, in degrees Celsius;

$n = 8\,760$ for the degree-hour method;

$n = 365$ for the degree-day method.

This reduction in temperature difference and the reduction in the number of days are needed because the (utilized) internal and solar gains are disregarded in the equations.

Other calculation details:

— in the utilization factor method all hours of the considered month, or seasonal weighted average for the seasonal utilization factor method, shall be included in the calculation of the accumulated temperature difference;

— no distinction shall be made between days or hours with external temperature higher or lower than a certain base temperature as in a degree-day method;

— the indoor temperature shall be defined by the set point temperature and not by a base temperature as used in the degree-day method.

For the cooling mode, a similar reasoning applies.

A.3 Monthly method: Correction factor for season length

Because the fenestration system energy balance is extracted from the overall energy balance of the building or building zone, the utilization factor is not enough to separate the months which are part of the heating or cooling season from the months that are outside these seasons. The solution for this is to use the parameter given in ISO 13790:2008, 7.4.1:

$$L_{H} = \sum_{m=1}^{m=12} f_{H,m}$$

where

$f_{H,m}$ is the fraction of the month that is part of the heating season;

$(1 - f_{H,m})$ is the fraction of the month that is part of the cooling season.

The fraction of the month that is part of the heating season is calculated for each month m as:

$$f_{H,m} = \frac{Q_{H,nd,m}}{\left(Q_{H,nd,m} + Q_{C,nd,m}\right)} \tag{A.9}$$

Following the monthly calculation method specified in ISO 13790, $f_{H,m}$ is automatically calculated.

NOTE Normally, $f_{H,m}$ is used to determine the number of hours of operation of certain season-length dependent provisions (e.g. pumps, fans, central pre-heating). For the fenestration system energy performance calculation, this factor is appropriate to weight whether a month is fully, partly or zero part of the heating season (or cooling season).

For central pre-heating or pre-cooling in the reference building, the full equation reads:

$$f_{H,m} = \frac{Q_{H,nd,m,d}}{\left(Q_{H,nd,m} + Q_{C,nd,m} + Q_{V,pre\text{-}heat,m} + Q_{V,pre\text{-}cool,m}\right)} \tag{A.10}$$

Annex B
(informative)

Assessment of the solar control potential of the rated fenestration system

B.1 Introduction

B.1.1 Principle

As stated in 6.5, the rated fenestration system may:

a) have solar control provisions incorporated (e.g. solar control glazing, incorporated blinds);

b) be an assembly of glazing, frame and solar control device (e.g. an add-on solar control provision film, blind);

c) have no solar control provision.

This annex provides a procedure to assess the solar control potential of a rated fenestration system, without the need to compare series of different fenestration systems.

This is done by comparing the rating of the fenestration system against the rating of the same fenestration system provided with a fictitious reference high-performance solar control provision.

If the difference in rating is small, the energy performance of the fenestration product for cooling is apparently efficient, for the given conditions: adding a high-performance solar control provision does not lead to significant improvement of the energy performance of the fenestration product for cooling.

If the difference in rating is large, the energy performance of the fenestration system for cooling is apparently inefficient for the given conditions and hence subject to significant improvement by adding a solar control provision.

B.1.2 Procedure

As stated in 6.5, the following procedure can be used to assess the solar control potential of the rated fenestration system:

- a fictitious reference high-performance solar control provision is defined;
- a formula is given to calculate the new properties of the fenestration system with this added fictitious reference solar control provision;
- the energy performance is calculated for the fenestration system without and with this added fictitious reference solar control provision;
- a recommendation is given to national or regional fenestration system energy rating schemes to rate the “solar control potential” of the fenestration system in the given conditions on the basis of the difference between the energy performance as calculated for the fenestration system without and with this added fictitious reference solar control provision.

These procedures are presented in more detail in B.2 to B.5.

B.2 Reference solar control system

The properties of the reference solar control system are based on an external shading device.

NOTE The properties are used for the summer (cooling mode) situation:

— solar transmittance: $\tau_e = 0{,}2$;

— solar absorptance: $\alpha_e = 0{,}4$.

B.3 Fenestration system properties with the fictitious reference solar control provision

The g-value for the combination of fenestration system with additional fictitious solar control provision is derived using the simplified method given in EN 13363-1, which gives conservative values for the summer situation (assuming no ventilation between shading and fenestration system).

The change in U-value is ignored.

B.4 Recommended approach

It is recommended that fenestration product energy rating schemes rate the “solar control potential” of the fenestration system on the basis of the difference between the energy performance calculated for the fenestration system with and without a reference solar control system.

B.5 Examples of assessment of solar control potential

For the example below (country and orientation), the ratings in Table B.1 were obtained.

Table B.1 — Example fenestration system A

Fenestration system	Rating
Energy performance for heating of fenestration system A:	$P_{E,\,\mathrm{H,w}}$ = 9,8 kWh/m^2
Energy performance for cooling of fenestration system A:	$P_{E,\,\mathrm{C,w}}$ = 1,2 kWh/m^2
Energy performance for cooling of fenestration system A, with the addition of the reference solar shading device:	$P_{E,\,\mathrm{C,w+ref.sh}}$ = 1,0 kWh/m^2

So, for fenestration system A the difference between $P_{E,\,\mathrm{C,w}}$ and $P_{E,\,\mathrm{C,w+ref.sh}}$ is only 20 %.

This leads to the conclusion that, for the given conditions (reference building, climate and given orientation), the addition of a high-performance solar control provision to fenestration system A does not lead to a significant improvement of the energy performance of the fenestration system for cooling.

The energy performance of the fenestration system for cooling is apparently efficient, for the given conditions. This is either due to intrinsic properties of the fenestration system A itself, or due to the given conditions.

For fenestration system B (see Table B.2), the difference between $P_{E,\mathrm{C,w}}$ and $P_{E,\mathrm{C,w+ref.sh}}$ is very large.

Table B.2 — Example fenestration system B

Fenestration system	Rating
Energy performance for heating of fenestration system B:	$P_{E,\ \mathrm{H,w}}$ = 7,3 kWh/m^2
Energy performance for cooling of fenestration system B:	$P_{E,\ \mathrm{C,w}}$ = 3,6 kWh/m^2
Energy performance for cooling of fenestration system B, with addition of the reference solar shading device:	$P_{E,\ \mathrm{C,w+ref.sh}}$ = 1,0 kWh/m^2

This leads to the conclusion that, for the given conditions (reference building, climate and given orientation), fenestration system B is apparently inefficient for cooling. The addition of a high-performance solar control provision to fenestration system B leads to highly improved energy performance of the fenestration system for cooling.

Consequently, it is worth considering adding a solar control provision in this case.

Annex C
(informative)

Example of the calculation of $P_{E,\text{ H,w}}$ and $P_{E,\text{ C,w}}$ using a monthly method

C.1 Introduction

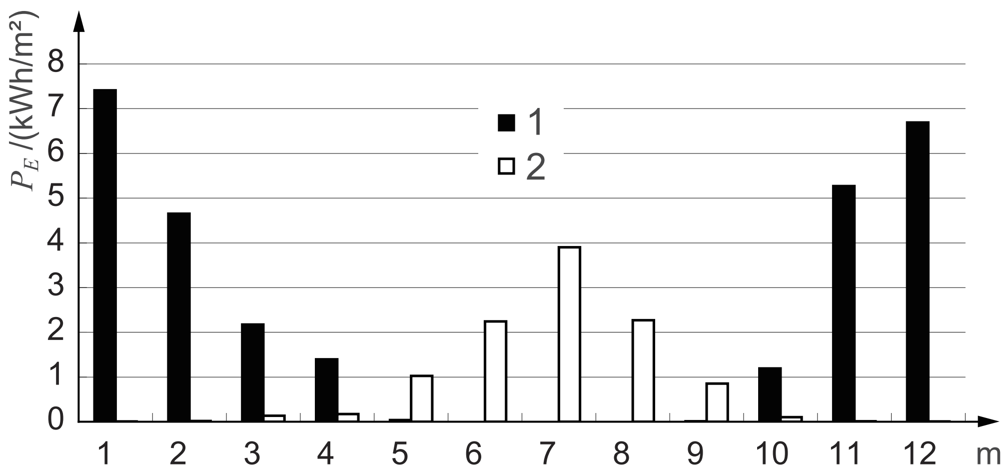
An example of this calculation procedure has been produced following the monthly method specified in ISO 13790. This example uses the data from the worked example in ISO 13790:2008, Annex J.

In this example, the reference building (monthly method in accordance with ISO 13790), including climate and operating conditions, and the energy performance of a specific fenestration system as a function of fenestration system properties and orientation(s), is specified. Also, the calculation of the energy perfomance of the fenestration system with reference solar shading is included.

C.2 Reference building and climate

See ISO 13790:2008, Annex J. Chosen climate: Paris.

Figure C.1 shows the calculated monthly energy needs for heating and cooling.



Key

P_E energy need

m month

1 heating needs per square metre of floor (whole building)

2 cooling needs per square metre of floor (whole building)

Figure C.1 — Calculated monthly energy needs for heating and cooling

For the fraction of the month that is part of the heating season or cooling season, see 6.2, 6.3, and Table C.1.

Table C.1 — Fraction of the month

Month	**Fraction of the month in heating season** $f_{H,m}$	**Fraction of the month in cooling season** $1 - f_{H,m}$
01	1,00	0,00
02	1,00	0,00
03	0,94	0,06
04	0,89	0,11
05	0,03	0,97
06	0,00	1,00
07	0,00	1,00
08	0,00	1,00
09	0,01	0,99
10	0,92	0,08
11	1,00	0,00
12	1,00	0,00

Single zone; otherwise one of the zones requires definition for the fenestration system energy rating.

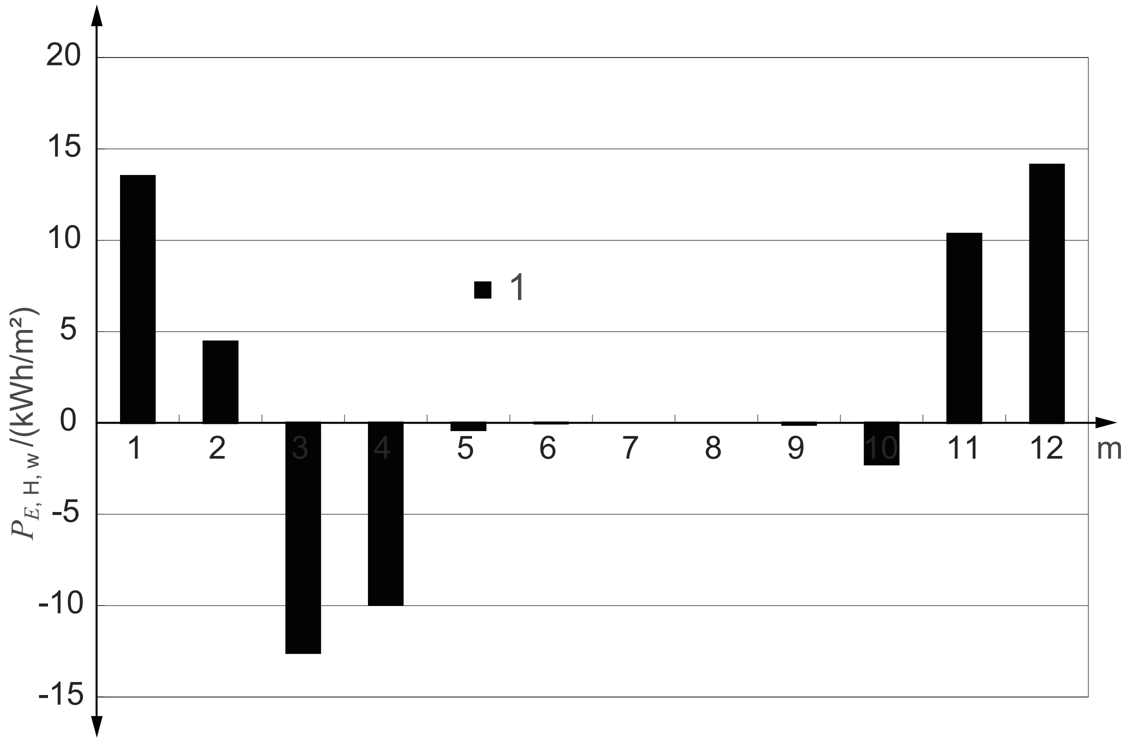
Fenestration system input data are given in Table C.2.

Table C.2 — Fenestration system input data

Fenestration system properties Description	Quantity	Value	Unit	Remarks
Fenestration system area, per orientation	$A_{w,hor}$	0,00	m^2	For weighting the EP fenestration system over horizontal, East, South, West, North
	$A_{w,East}$	1,00	m^2	
	$A_{w,South}$	1,00	m^2	
	$A_{w,West}$	1,00	m^2	
	$A_{w,North}$	1,00	m^2	
Heating mode (all values including fenestration system frame):				To be most general: properties distinguished for heating versus cooling
U-value	$U_{H,w}$	1,50	$W/(m^2 \cdot K)$	
Infiltration and ventilation coefficient	$H_{H,ve,w}/A_w$	0,30	$W/(m^2 \cdot K)$	Per square metre of fenestration system
g-value (total solar energy transmittance)	$g_{H,w}$	0,50	—	For given orientation/slope or weighted mean over orientation(s)
Light transmittance	$\tau_{H,w,vis}$	0,60	—	For given orientation/slope or weighted mean over orientation(s)
Factor due to glazing maintenance and shading effects	$F_{sh,ob,H}$	1,00	—	For given orientation/slope or weighted mean over orientation(s)
Cooling mode (all values including fenestration system frame)				
U-value	$U_{C,w}$	1,50	$W/(m^2 \cdot K)$	
Infiltration and ventilation coefficient	$H_{C,ve\_w}/A_w$	0,30	$W/(m^2 \cdot K)$	Per square metre of fenestration system
Solar transmittance	$g_{C,w}$	0,50	—	For given orientation/slope or weighted mean over orientation(s)
Light transmittance	$\tau_{C,vis}$	0,60	—	For given orientation/slope or weighted mean over orientation(s)
Factor due to glazing maintenance and shading effects	$F_{sh,ob,C}$	1,00	—	For given orientation/slope or weighted mean over orientation(s)

C.3 Fenestration system energy rating results for heating

The monthly data are plotted in Figure C.2.



Key

$P_{E,\text{H,w}}$	heating energy need
m	month
1	monthly values

Figure C.2 — Energy performance of fenestration system for heating, monthly values

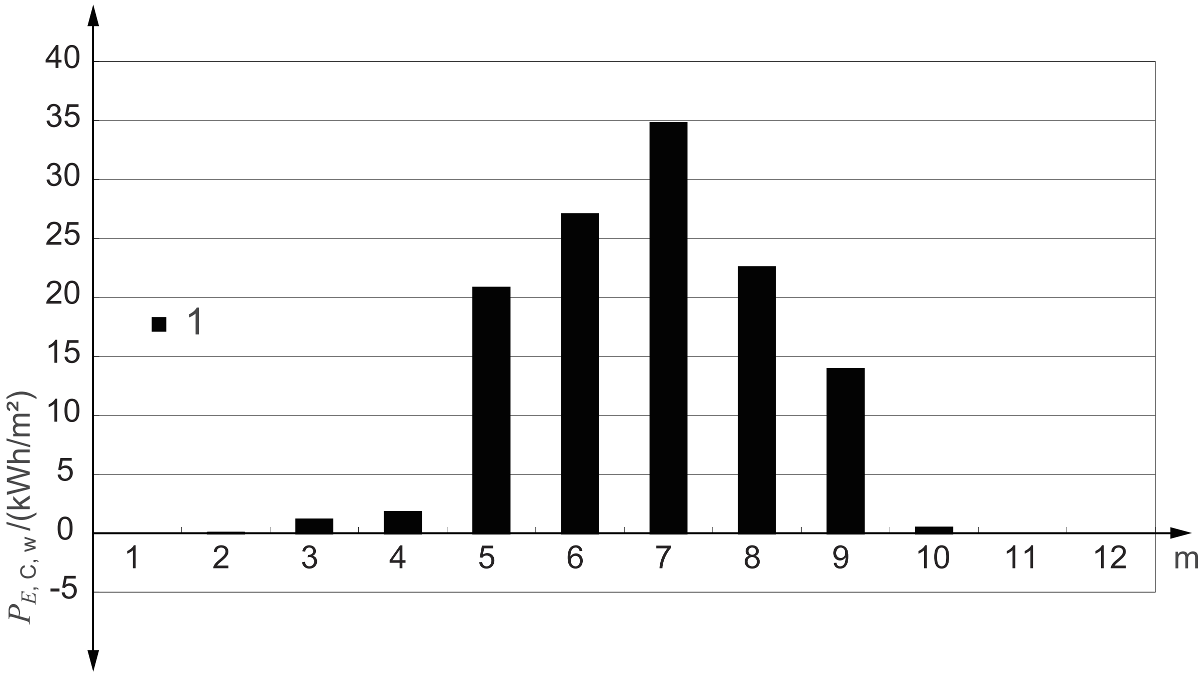
The annual value is the sum of these monthly values (see Table C.3).

Table C.3 — Annual values for heating

Symbol	Value	Unit
$\tau_{\text{H,w,vis}}$	0,60	—
$P_{E,\text{H,w}}$	17	kWh/m^2
NOTE The result depends on fenestration system in combination with orientation(s), climate and reference building.		

C.4 Fenestration system energy rating results for cooling

The monthly data are plotted in Figure C.3.



Key

$P_{E,\mathrm{C,w}}$ heating energy need

m month

1 monthly values

Figure C.3 — Energy performance of fenestration system for cooling, monthly values

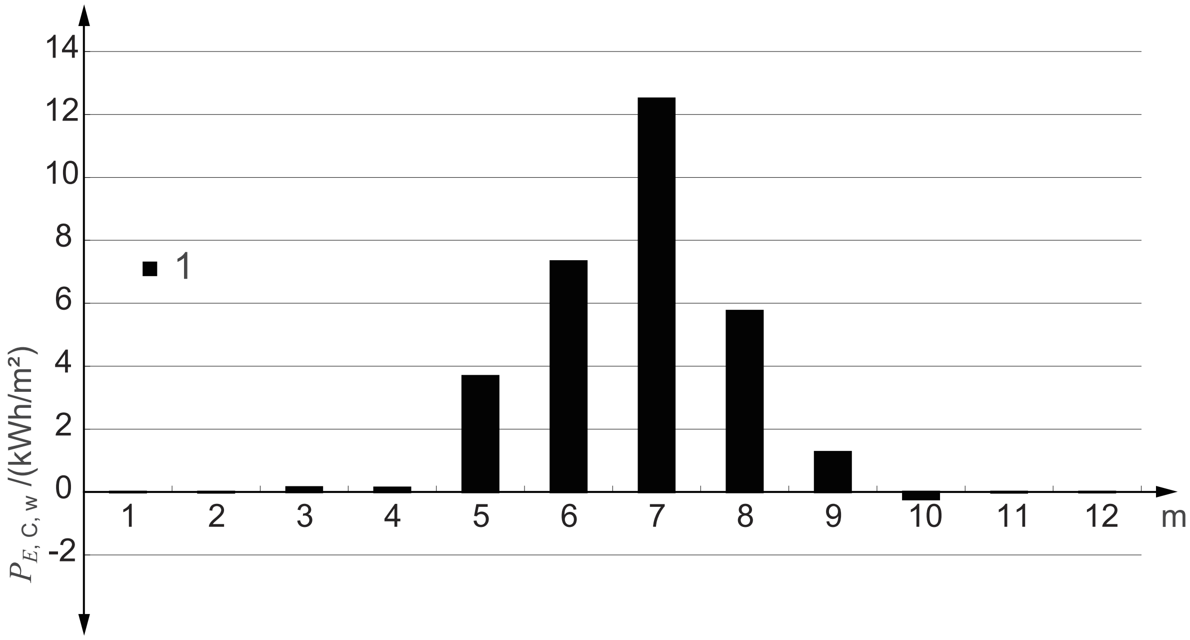
The annual value is the sum of these monthly values (see Table C.4).

Table C.4 — Annual values for cooling

Symbol	Value	Unit
$\tau_{\mathrm{C,w,vis}}$	0,60	—
$P_{E,\mathrm{C,w}}$	122	kWh/m^2
NOTE The result depends on fenestration system in combination with orientation(s), climate and reference building.		

C.5 Results for fenestration system with reference shading

The monthly data are plotted in Figure C.4.



Key

$P_{E,C,w}$ heating energy need

m month

1 monthly values

Figure C.4 — Energy performance of fenestration system for cooling, including reference shading system, monthly values

The annual value is the sum of these monthly values (see Table C.5).

Table C.5 — Annual values

Symbol	Value	Unit
$\tau_{C,w,vis}$	0,60	—
$P_{E,C,w}$	122	kWh/m^2
$P_{E,C,w,ref.sh}$	31	kWh/m^2

NOTE 1 The result depends on fenestration system in combination with orientation(s), climate and reference building.

NOTE 2 If $P_{E,C}$ with the reference shading device is significantly smaller than $P_{E,C}$ without the reference shading device:

— then, for given fenestration system, in given climate and orientation(s), there is room for improvement by adding a solar shading protection;

— else, for given fenestration system, in given climate and orientation(s), there is no need for adding a solar shading protection.

C.6 Conclusion

The comparison between the example fenestration system and the same fenestration system with the reference solar shading shows that for the example fenestration system, in the example climate and orientation(s), the performance could be improved by adding a solar shading protection.

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NOTE The "temperature of the surroundings" is taken as the "environmental temperature" which in turn is defined in ISO 8990:1994 Annex A.

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NOTE Uses a photometer employing a defined light source and a photocell matched to the response of the human eye.

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NOTE Glass, construction materials, glazing, transparency, opacity, airborne sound insulation, acoustic properties and phenomena, performance

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