

# Measured energy rating

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***Countries are looking for  
simplification of certification***

in order to save the efforts and money

**Old existing buildings**

– gathering the input data is often very labour-intensive

**One possibility is a measured energy rating**

**The countries are mostly aware of the advantages  
often are not aware of all risks arising from use it**

# Measured energy rating

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## **Advantages:**

- ✓ relatively easier, not so expensive;
- ✓ easy to understand by user;
- ✓ it may draw the attention to a wrong use and operation.

## **Disadvantages:**

- a lot of obscurities; influenced by behavior of occupants;
- ? the separation of measured energy for different uses;
- ? the data quality;
- ? correction for standard conditions;
- ? calculation of energy savings.

Not suitable for all building types



# Slovak certification scheme

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**SK:** For certification of all building types:

- after construction, renovation - **calculated energy rating**
- existing buildings (sold or rented) - **calculated or measured energy rating**

The scale is the same



Normalization  
of measured energy  
to standard conditions

Normalization = also calculation procedures are needed

but not sufficient in CEN standards

Measured energy rating is not used in practice

Detailed method is under preparation



# Measured energy rating

## Slovak Republic - Apartment Blocks

(about 900 227 flats, 93 % connected to district heating)

**Suitable building type  
for measured energy rating because:**

- EPC – only for whole building not for flats
- meters for delivered heat are on the building boundary (separate for space heating and DHW)
- losses inside building are mostly recoverable
- behaviour of one user does not influence the total energy consumption
- Only correction for weather to the standard climate is needed



# EN 15603: Energy performance of buildings — Overall energy use and definition of energy ratings

## 7 Measured energy rating<sup>1</sup>

### 7.1 General requirements

The amounts of all energy carriers delivered to the building and exported by the building shall be measured and reported in a table based on Table 7.

### 7.2 Assessment period

#### 7.2.1 General

The amounts in Table 7 shall be assessed as closely as possible for the same period.

The time period is an integer number of years. It should take the average over several most recent full years, as long as the building and its use pattern has been the same.

If the assessment period is not an integer number of years, the annual energy use shall be obtained by extrapolation according to 7.2.2.

If the time period is shorter than three years, a correction for weather according to 7.4 shall be performed



# EN 15603: Energy performance of buildings — Overall energy use and definition of energy ratings

## 7.3.5 Energy monitoring

Periodic measurement of energy use allows quantifying building-related properties such as effective boiler efficiency, apparent heat loss coefficient or equivalent solar collecting area. Annual energy use for heating can be calculated from these data.

NOTE Annex B provides more information.

## 7.4 Correction for weather

If the measured energy rating is not based on energy use over at least three full years, a correction of the measured energy use for weather is necessary to ensure that the energy consumed during the period of measurement is representative of the average weather for the building's location or region.

To achieve this, the measured energy use for heating and cooling shall be adjusted to the average weather for the building's location i.e. the regional climate.

The general method to perform this correction is to use the calculation model described in clause 6 to calculate and validate a tailored energy rating according to clause 9, and to use the validated calculation model to re-calculate the energy use with average local or regional weather data.

Simpler correction methods, such as the method given in 7.2.2.2 and their limits of application can be defined on a national basis, taking account of the purpose of the assessment, the climate and the building type and usages.



# EN 15603: Energy performance of buildings — Overall energy use and definition of energy ratings

## Annex B (informative)

### Energy monitoring

#### B.1 Energy signature

Heating and cooling energy use is correlated to climatic data over a suitable period. Plotting for several time periods the average heating or cooling power versus average external temperature allows a fast detection of malfunctions and provides useful information on the building energy performance. This monitoring method assumes constant internal temperature, and that external temperature is the most influential parameter. It is useful in buildings with stable internal gains and relatively low passive solar gains.

Energy use for heating and cooling, as well as an average external temperature or accumulated temperature difference is recorded at regular intervals. These intervals can be as small as one hour, but for manual monitoring, a week is often used. The average external temperature can also be obtained from a neighbouring meteorological station. Average power is obtained by dividing the energy use by the duration of the time interval between successive records.

The average power is plotted versus the average external temperature or degree-days. For the heating season, a diagram as shown in Figure B.1 is obtained. Lines are drawn through the dots measured during the heating season (heating on, cooling off), the cooling season (cooling on, heating off) and intermediate season (both off) using a linear regression (see Figure B.1).



# Correction for standard climate conditions

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## ***Simple average for 3 years***

***(EN 15603, Art. 7)***

= correction for average climate conditions  
for building's location

Suitable for some countries

**Cannot be used in Slovakia**

Global indicator  
for **standard climate conditions**

The same scale for calculated and measured rating



# Correction for standard weather conditions

*Actually used*

**Simple Degree Days  
correction**

$$E_N = E_m \cdot \frac{D_{t,standard}}{D_{t,real}}$$

**not very accurate  
especially  
for new buildings  
of better quality**

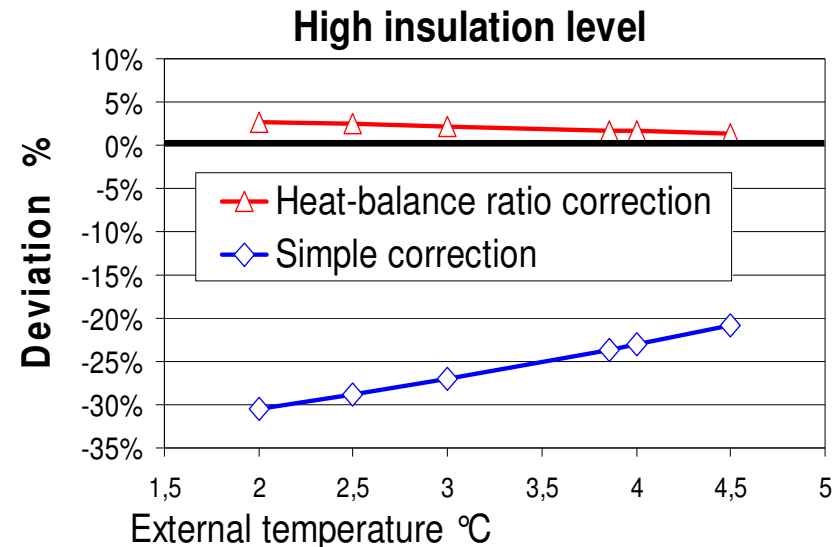
**Inaccuracy 15 – 31 %**

*Developed*

**Heat-Balance ratio  
Degree Days correction**

**More accurate method  
also for buildings of better quality**

**Inaccuracy 0,1 – 3 %**



# Correction for standard climate conditions

## Method for heat-balance ratio Degree Days correction

More exact method - based on typical values for heat-balance ratio

**Example** – buildings in original state built before 1983:

Level of thermal properties	Typical gain/loss ratio $\gamma$	Typical gain utilisation factor $\eta_{H,gn}$	$\eta_{H,gn} \cdot \gamma$
A0a-original state - built-up before 1983	0.236	0.963	<b>0.23</b>

$$\Rightarrow E_n = E_m \cdot \left( \frac{k - 0,23}{1 - 0,23} \right)$$

**Or can be used more exact formulas for different actual climate**

$$E_n = E_m \cdot \frac{\left( k - \frac{779,15}{D_{t,real}} \right)}{\left( 1 - \frac{779,15}{D_{t,real}} \right)}$$

**Method is accurate but data quality must be ensured**

# Correction for standard climate conditions

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## *Method based on energy monitoring*

**EN 15603 Annex B :**  
The average power is plotted  
versus the average external temperature or degree-days

**SK:** uses Degree Days  
(internal temperature can be measured or estimated)

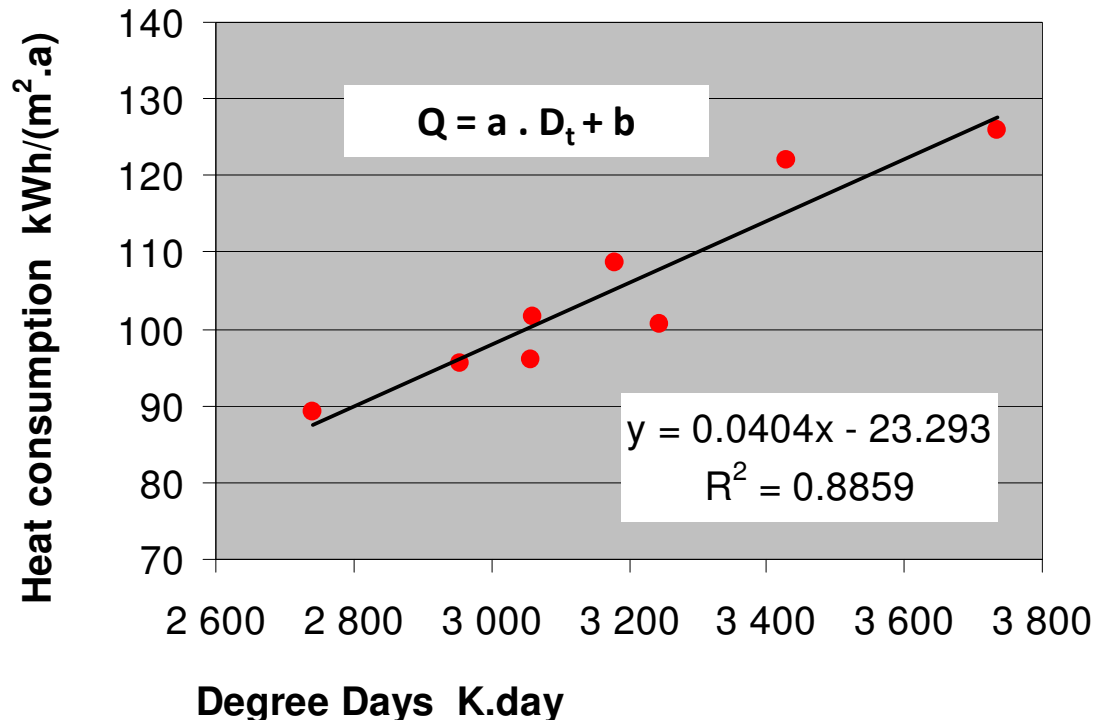
**SK:** Experience with old national standard  
STN 73 0550:1996 - Method for space heating  
based on measurements from short time period (min. 30 days)

**Problem of short time measurements:**  
thermal inertia of the buildings of better quality

# Measured energy rating

## EN 15603:

The average power plotted versus the degree-days



## Linear regression:

Slope “a” = sensitivity of the building to changes in temperature difference.

From “a”

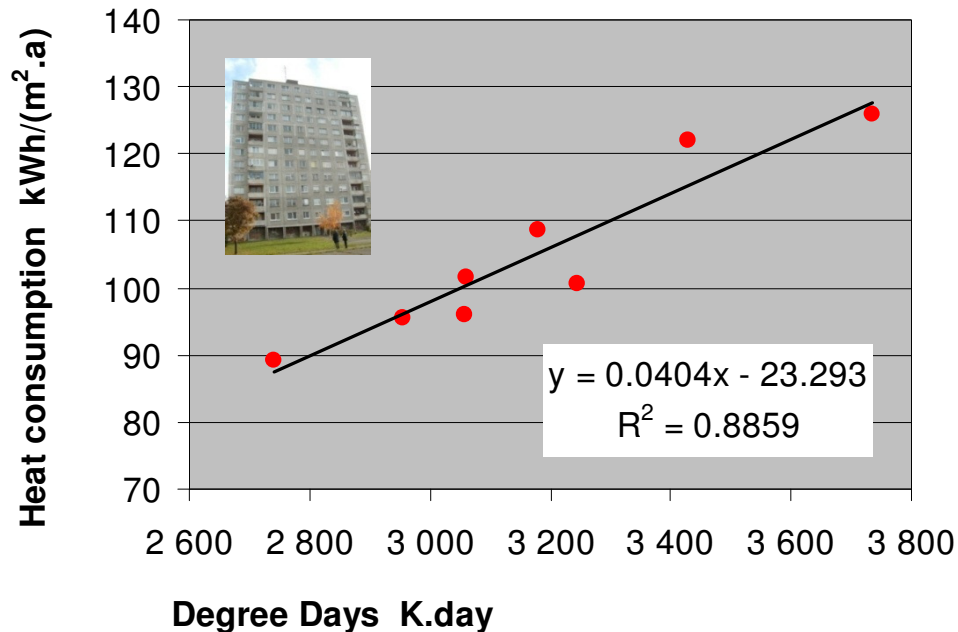
heat transfer coefficient  $H$  W/(K.m<sup>2</sup>) is calculated

Constant „b“ = heat gains, heating system losses, malfunctions

(not depending on weather)

Normalization by extrapolation to the standard climate (3422 K.day)

# Measured energy rating - example



*Data quality can be checked  
3 requirements*

1. *min. 3 years measurements*
2. *correlation coefficient (min. 0.7)*
3. *heat transfer coefficient  $H$  W/(K.m<sup>2</sup>) calculated from the slope of the regression line – compared with the **typical values***

Calculated rating = 115,5 kWh/(m<sup>2</sup>.a)

$H$ W/(K.m <sup>2</sup> ) In interval $H \pm 3 \sigma$	Correlation coefficient (min. 0.7)	Number of measurements (min. 3)	Extrapolation to 3422 K.day $E_{n, 3422}$ kW/h(m <sup>2</sup> .a)
<u>1,68</u>	<u>0,9412</u>	<u>8</u>	<u>114,9</u>

*Only if data are correct →  
can be used for  
measured energy rating*

**SK:**

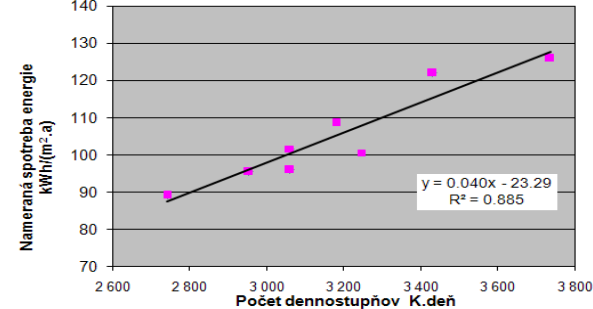
## Data for measured energy rating for certification:

- must be **separately metered** for each energy use
- **Apartment blocks** → the annual heat consumption from previous years **from the energy bills** can be used (calibrated meters on the building boundary)
- **Also the data from special metering can be used**  
(but should not make the method more expensive than calculated rating)
- **Combination measured + calculated rating is allowed (DHW)**

# Measured energy rating – software tool

## Prevádzkové hodnotenie energetickej hospodárnosti bytového domu podľa Zák. 555/2005 Z.z.

Adresa:	Repašského č.5, Bratislava	Ref. budova č.	5
Stavebná sústava:	ZTB		
Celková podlahová plocha:	5 230.5 m <sup>2</sup>	Normalizovaná vonkajšia teplota v °C	3.86
Počet podlaží:	12	Normalizovaná vnútorná teplota v °C	20
Typ domu:	radový	Vonkajšia výpočtová teplota v °C	-11
Rýchlosť vetra podľa NA STN EN 13790:2004 pre okres:	Bratislava pôvodne 4.08 m/s		
Okná:			
Korekčný faktor pre vietor:	1.00		
Stav bytového domu a konštrukcií:	A0a - pôvodný do roku 1983		
Typ konštrukcie:	ťažká		



### Porovnávacie hodnoty pre daný typ bytového domu :

	Hodnota	$\sigma$	Tolerancia $\pm 3.\sigma$	
Merné tepelné zisky na 1 m <sup>2</sup> celkovej podl. plochy:	kWh/(m <sup>2</sup> .a)	35.45	2.00	6.00
Faktor využitia tepelných ziskov podľa tab. ....:		0.963		
Koeficient pre pomer tepelných ziskov a strát		809.15		
<b>H - porovnávacia hodnota</b>	W/(K.m <sup>2</sup> )	<b>1.869</b>	<b>0.226</b>	<b>0.678</b>

Rok	Jednotky	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Počet meraní
Skutočné namerané meteorologické denostupne	K.deň		3 180	3 735	3 429	2 954	3 059	2 741		3 060	3 245	
Skutočná nameraná spotreba energie	GJ		2652	2658	2591	2034	2042	1907		2160	2132	
	kWh/(m <sup>2</sup> .a)		140.8	141.2	137.1	108.0	108.4	101.3		114.7	113.2	
Skutočná priemerná vnútorná teplota	°C		21.5	21.5	21.5	21.5	21.5	21.5		21.5	21.5	
Počet dní vykurovacej sezóny	dni		212	212	212	212	212	212		212	212	
Ekvivalentná vonkajšia teplota pre 212 dní	°C		5.00	2.38	3.83	6.07	5.57	7.07		5.57	4.69	
Vyregulovaná vykurovacia sústava + termostatické ventily:			nie	áno	áno	áno	áno	áno		áno	áno	8
Koeficient pre vykurovaciu sústavu (vyregul., nevyregul.):			1.15	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Pomer tepelných ziskov a strát			0.2544	0.2166	0.2360	0.2739	0.2645	0.2952		0.2644	0.2494	
Koeficient vnútornej teploty			0.915	0.915	0.915	0.915	0.915	0.915		0.915	0.915	
Korekčný faktor pre vietor			1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
<b>Upravená spotreba na 20°C</b>	kWh/(m <sup>2</sup> .a)		<b>108.7</b>	<b>126.0</b>	<b>122.0</b>	<b>95.5</b>	<b>96.1</b>	<b>89.2</b>		<b>101.6</b>	<b>100.6</b>	
<b>Upravená spotreba na 3422 K.deň po rokoch</b>	kWh/(m <sup>2</sup> .a)		<b>118.9</b>	<b>113.4</b>	<b>121.7</b>	<b>114.7</b>	<b>110.4</b>	<b>118.1</b>		<b>116.7</b>	<b>107.3</b>	<b>115.2</b>
Smerodajná odchýlka spotreby pre 3422 K.deň :	4.41		chyba strednej hodnoty:	1.56		Interval spoľahlivosti priemeru podľa Príl. F v STN EN 15603 pre $\alpha=0.05$ :						3.1
										asset rating:	114.8	

	a	b	Dl=x	E=y	$\sigma$
Lineárna regresia a extrapolácia na 3422 K.deň	0.04039	-23.2931	3422	114.9	12.20

chyba strednej hodnoty lineárnej regresie

4.76

### Overenie modelu a vstupných dát

Interval spoľahlivosti pre  $\alpha=0.05$ :

8.5

Kritériá	H W/(K.m <sup>2</sup> )	Korelačný koeficient (min. 0.7)	Počet meraní (min. 3)	E <sub>n, 3422</sub> kWh/(m <sup>2</sup> .a)
Z nameraných hodnôt	1.683	0.9412	8	114.9
Porovnávacia hodnota	1.869	0.700	3	115.2
Rozdiel	0.186			0.23
Tolerancia rozdielu	0.712			10%
Vyhodnotenie overenia výpočtového modelu	vyhovuje	vyhovuje	vyhovuje	vyhovuje

straty pri emisii prídavná energia:  $Q_{em} = 17.3$   
 $E_{inv} = 0.5$

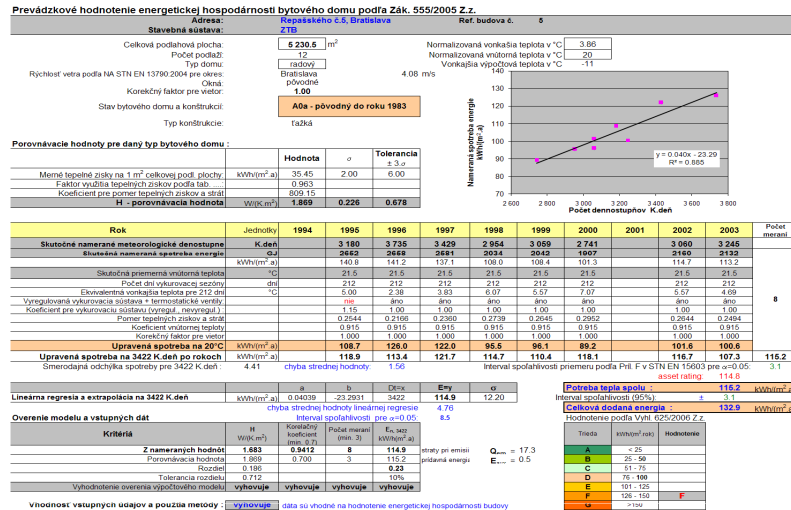
Potreba tepla spolu :	115.2 kWh/(m <sup>2</sup> .a)
Interval spoľahlivosti (95%):	$\pm 3.1$
Celková dodaná energia :	132.9 kWh/(m <sup>2</sup> .a)

Hodnotenie podľa Vyhl. 625/2006 Z.z.

Trieda	kWh/(m <sup>2</sup> .rok)	Hodnotenie
A	< 25	
B	25 - 50	
C	51 - 75	
D	76 - 100	
E	101 - 125	
F	126 - 150	F
G	>150	

Vhodnosť vstupných údajov a použitia metódy : **vyhovuje** dáta sú vhodné na hodnotenie energetickej hospodárnosti budovy

# Measured energy rating



Used for field study of 40 buildings.

## Simple software tool:

- measured input data are checked and judged
- if data are correct - measured energy is normalized using 2 methods
- calculation of confidence intervals – result with lower confidence interval

The result of the study  
**30% of buildings**  
the annual data is not appropriate  
**Calculated energy rating is needed**  
=  
important information for owner  
about the possible  
wrong use, operation, metering

Measured energy rating – less expensive



motivation for  
standard use, correct behaviour,  
correct operation, control and metering  
**= energy savings**



# Thank you for your attention

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