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SUPPORT THE DISSEMINATION AND ROLL-OUT OF THE SET OF ENERGY PERFORMANCE OF BUILDING STANDARDS DEVELOPED UNDER EC MANDATE M/480

Report on Case Study to EN ISO 52000-1 Overarching standard - Simplified cases

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Final report

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Abbreviations and acronyms in this document:

CEN	**European standards organization**
EN	**European standard**
EPBD	**Energy Performance of Buildings Directive**
EPB standard	**Standard for the calculation of energy performance of buildings, that complies with the requirements given in ISO 52000-1, CEN/TS 16628 and CEN/TS 16629 or later updates**
ISO	**International organization for standardization**
LCA	**Life cycle assessment**
MS	**EU Member State(s)**
NA (/ND)	**National Annex or National Datasheet for EPB standards**
RER	**Renewable energy ratio**
TR	**Technical report (of CEN and/or ISO)**

1 Introduction

This document is intended to present a series of simplified examples dealing with specific topics of EN ISO 52000-1.

This document is focused on the weighted energy and the Renewable Energy Ratio (RER), that is on the indicators that are likely to be used for regulatory purpose.

This document shows the effect of the choices concerning the parameters needed to apply this standard, such as the value of k_{exp}, the value of the weighting factors and the choices on the RER evaluation perimeter (e.g. amounts of energy carriers being used in the building) for a number of typical generation technologies.

The spreadsheet with the simplified cases is available on EPB Center website for download, to reproduce and extend the examples shown in this document.

The webinars on primary energy and exported energy also deal with this topic and may be downloaded from the EPB Center website.

For a detailed presentation of this topic, see the case study on EN ISO 52000-1.

2 Executive summary

The collection of simple cases covers specific impacting features about EN ISO 52000-1. The simplified cases allow to concentrate on single aspects of the standard without the noise and disturbance of the high number of parameters and the time dependence of actual cases.

The following concepts have been investigated:

- delivered energy weighting;
- exported energy weighting;
- renewable energy ratio (RER);
- application to the main generation technologies;
- the matching factor.

3 The context of the case study

When drafting EN ISO 52000-1 a number of conceptual issues about energy weighting where analysed and then incorporated in the calculation methodology. An example is the evaluation of exported energy, which can be done naturally in two different ways. Since countries, in particular the EU Member States (MSs) did different choices, the calculation procedure in EN ISO 52000-1 had to include a number of parameters, such as k_{exp}, that allow to switch the approach within the same calculation scheme.

Additionally, the calculation scheme had to be designed to support time dependent weighting factors. This made the mathematics and the equations more complex. This is not impacting the user because his task is just to decide if the value of a weighting factor is constant or if it is a given time series. However, this impacts the readability of the equations.

Understanding the weighting factors is a critical step in using the set of (CEN and ISO) EPB standards as well as any other alternative energy performance calculation procedure. The weighting procedure is the interface between the building calculation and the external world. Any calculation about the building will end-up with an amount of energy carriers that are imported and exported. These are like apple, pears and oranges that cannot be summed directly. The raw “kWh” information is not enough to characterise neither their energy impact nor their environmental impact (though energy impact can be considered one possible type of environmental impact).

The "weighting", i.e. the association of an amount of a "weight" to each unit of imported or exported energy carrier, allows to evaluate every specific impact. Each 1 kWh of imported energy carrier will have an impact in terms of:

- non-renewable primary energy, that is natural resources depletion;
- CO_2 emission, which should include both local (CO_2 in flue gas after local combustion, for fuels) and external (CO_2 emission when producing and/or transporting the energy carrier), that is GHG emissions;
- polluting emissions, typically from combustion of fuels;
- cost;
- any other measurable impact, such as e.g. water use.

This also provides the connection of energy performance to any LCA calculation. Energy performance is the basis for the operational part of the use of energy for any LCA calculation.

The standard EN ISO 52000-1 does not cover the calculation of weighting factors, which is yet another wide and complex topic. EN ISO 52000-1 assumes that the value of any weighting factors is known and provides a way to apply them to imported and exported energy.

This simplified case study complements the regular case study on EN ISO 52000-1 with a set of focused simplified examples.

4 Coverage of the scope

The following specific aspects of EN 52000-1 are covered by the set of simplified cases:

- delivered (imported) energy weighting;
- exported energy weighting;
- renewable energy ratio (RER);
- application to the main generation technologies;
- matching factor.

The most important variant is indeed the generation technology because this determines which are the energy carriers and therefore the possible interactions if several generation technologies are used in the same building.

5 Cases

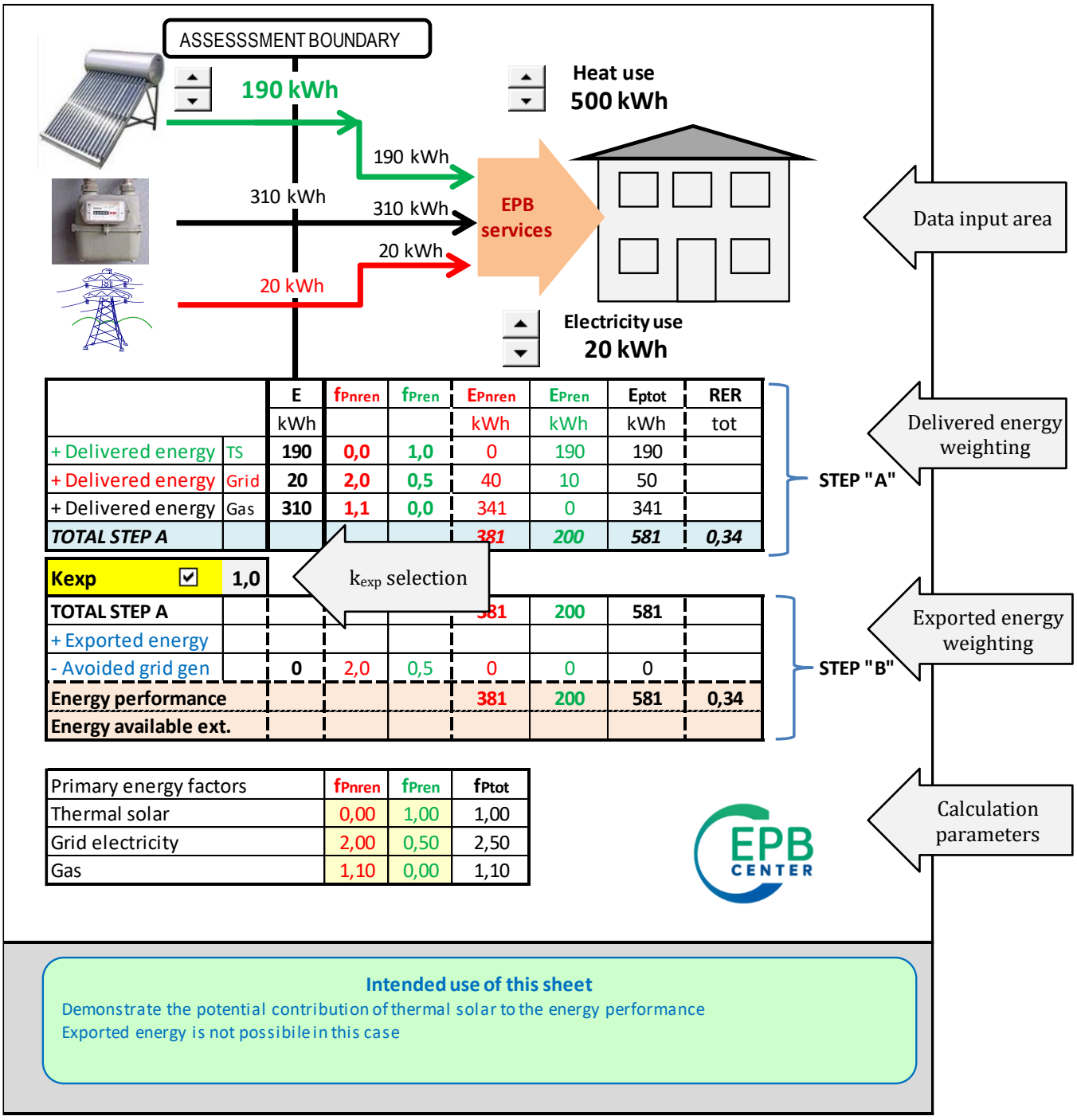
5.1 Overall

The package consists of:

- a presentation, organized in chapters focused on terminology and each one of the specific aspects that are investigated in this case study;
- a spreadsheet that allows to generate simple didactic examples
- a series of examples explained in this report in the following clauses

The spreadsheet allows experimenting specific features and installation configurations with simple calculation examples.

The organization of each sheet is illustrated in figure 1.



		E	fPnren	fPren	EPnren	EPren	Eptot	RER
		kWh			kWh	kWh	kWh	tot
+ Delivered energy	TS	190	0,0	1,0	0	190	190	
+ Delivered energy	Grid	20	2,0	0,5	40	10	50	
+ Delivered energy	Gas	310	1,1	0,0	341	0	341	
TOTAL STEP A					*381*	*200*	*581*	*0,34*

Kexp ☑	**1,0**							
TOTAL STEP A					381	200	581	
+ Exported energy								
- Avoided grid gen		0	2,0	0,5	0	0	0	
Energy performance					381	200	581	0,34
Energy available ext.								

Primary energy factors	fPnren	fPren	fPtot
Thermal solar	0,00	1,00	1,00
Grid electricity	2,00	0,50	2,50
Gas	1,10	0,00	1,10

Figure 1 – Organisation of the examples.

You may change the input data by clicking on the controls. This will increase and decrease energy flows and the result will be shown immediately.

The block “step A” is dedicated to the delivered energy weighting.

The block “step B” is dedicated to the exported energy weighting

By checking the box, you may toggle the value of k_{exp} between 0 and 1.

Optionally you may change manually some calculation parameters, such as the weighting factors. The input cells have a yellow background. Do not type any value in the other cells to avoid disrupting the calculation chain.

Some sheets also include notes with the intended didactic use.

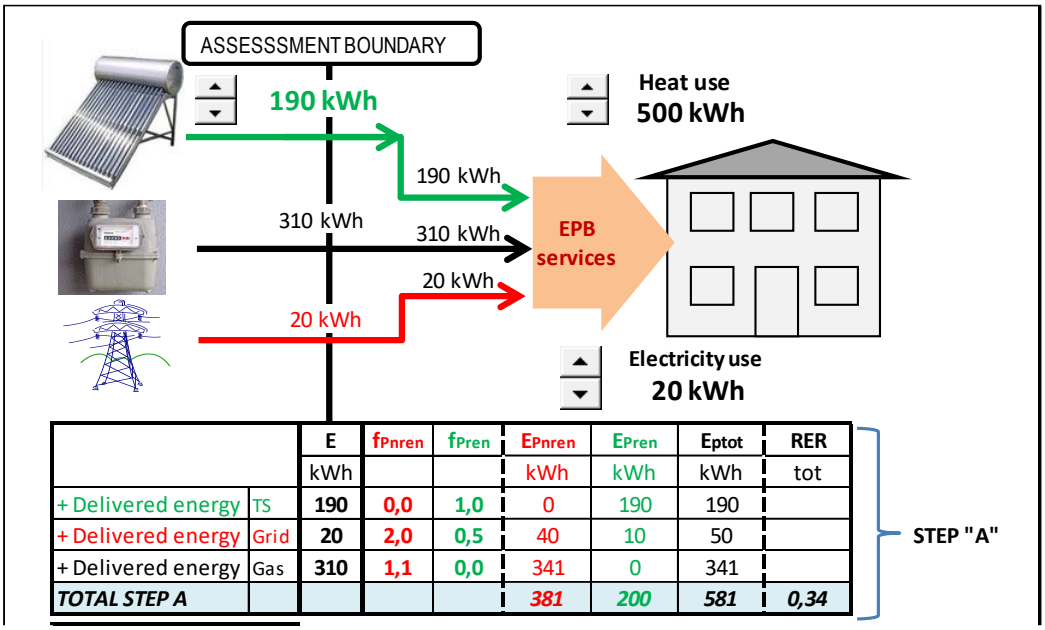
Not shown in figure 1: the actual spreadsheet has additional instruction and information on the right of the working area.

There are several sheets dedicated to various installation configurations or demonstration objectives. They are briefly described in the following.

5.2 Delivered energy weighting

The sheet "***Gas-Tsolar***" is suitable to experiment with delivered energy weighting:

- there are no exported energy carriers
- the three carriers are one mainly renewable, one mainly non-renewable and one mixed.



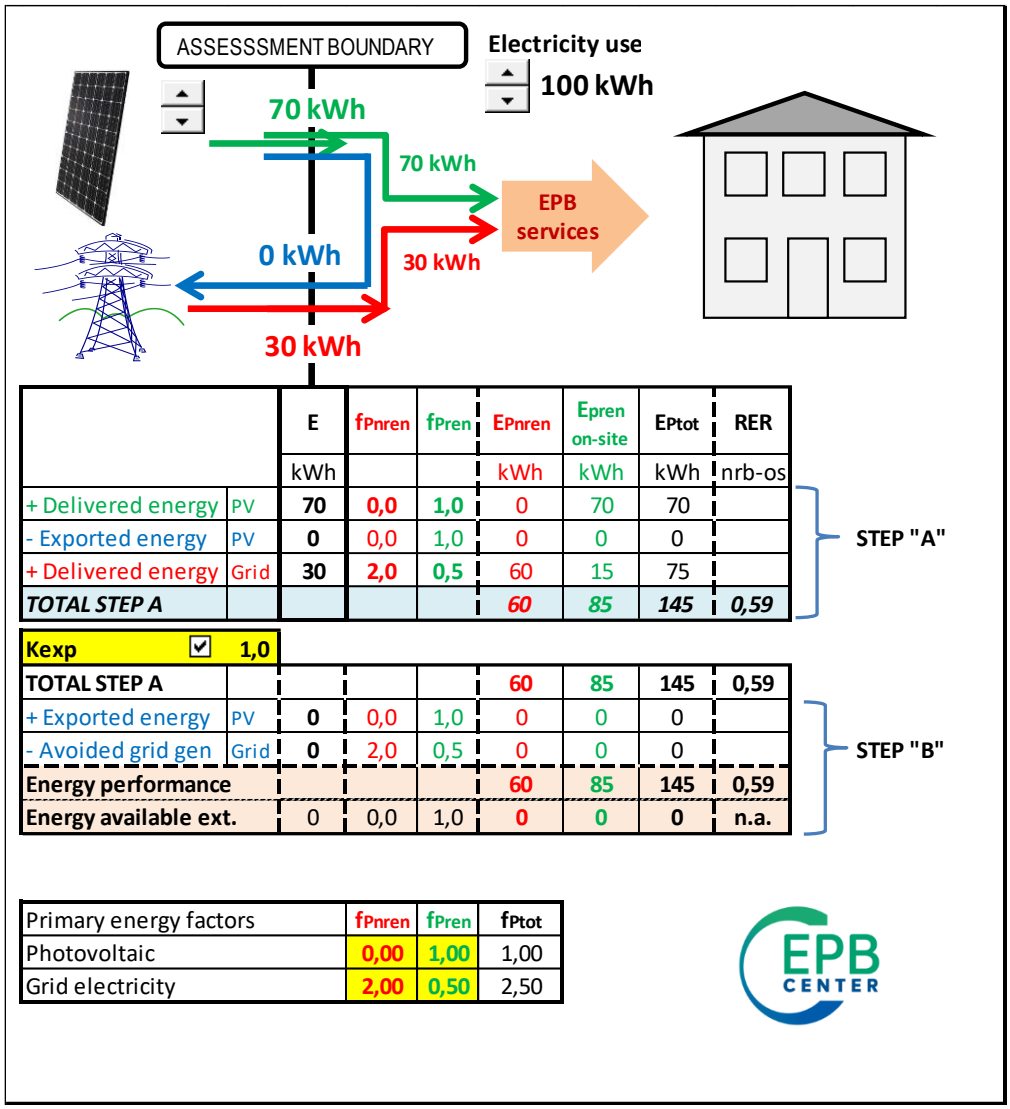
		E	fPnren	fPren	EPnren	EPren	Eptot	RER	
		kWh			kWh	kWh	kWh	tot	
+ Delivered energy	TS	190	0,0	1,0	0	190	190		
+ Delivered energy	Grid	20	2,0	0,5	40	10	50		
+ Delivered energy	Gas	310	1,1	0,0	341	0	341		
TOTAL STEP A					***381***	***200***	***581***	***0,34***	STEP "A"

Figure 2 – "Gas-Tsolar" sheet interface

The k_{exp} selector has no effect in this sheet because there is no exported energy carrier. Just change the energy amounts and see how the primary energy amounts and the RER evolve.

5.3 Exported energy weighting

The sheet "***PV***" is fine to start with exported energy because there is only one energy carrier, electricity.



		E	fPnren	fPren	EPnren	Epren on-site	EPtot	RER	
		kWh			kWh	kWh	kWh	nrb-os	
+ Delivered energy	PV	70	0,0	1,0	0	70	70		STEP "A"
- Exported energy	PV	0	0,0	1,0	0	0	0		
+ Delivered energy	Grid	30	2,0	0,5	60	15	75		
TOTAL STEP A					*60*	*85*	*145*	*0,59*	
Kexp ☑ **1,0**									
TOTAL STEP A					60	85	145	0,59	STEP "B"
+ Exported energy	PV	0	0,0	1,0	0	0	0		
- Avoided grid gen	Grid	0	2,0	0,5	0	0	0		
Energy performance					60	85	145	0,59	
Energy available ext.		0	0,0	1,0	0	0	0	n.a.	

Primary energy factors	fPnren	fPren	fPtot
Photovoltaic	0,00	1,00	1,00
Grid electricity	2,00	0,50	2,50

Figure 3 – "PV" sheet with no export

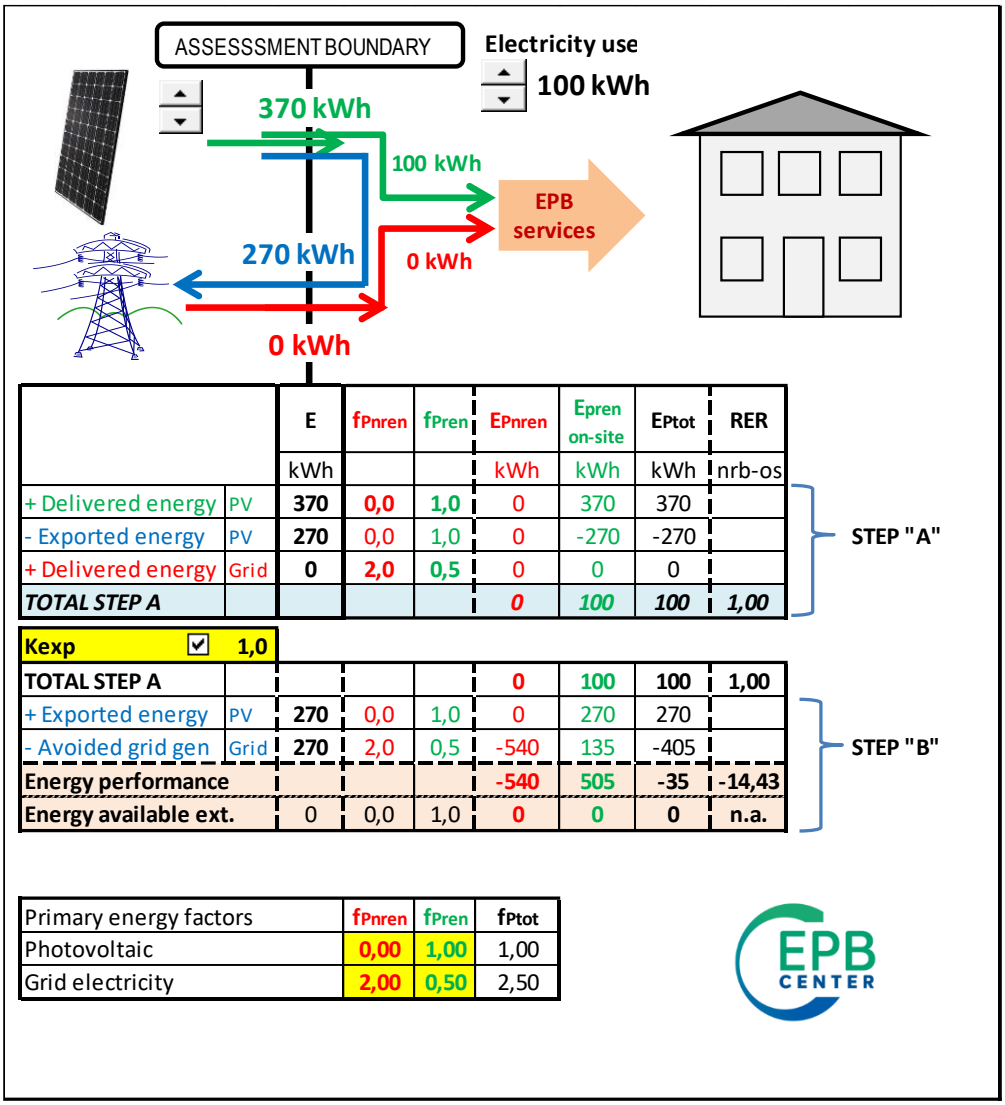
You may start with no exported energy (PV production less than electricity use) as shown in figure 3.

Then increase the PV production and observe what happens when PV electricity exceeds electricity use.

When PV electricity exceeds electricity use, then try selecting k_{exp} = 1 or 0 by checking or unchecking the control box. Observe:

- energy performance;
- energy available externally;
- RER in the various configurations.

Figure 4 shows an example with high electricity export.



		E	fPnren	fPren	EPnren	Epren on-site	EPtot	RER	
		kWh			kWh	kWh	kWh	nrb-os	
+ Delivered energy	PV	370	0,0	1,0	0	370	370		STEP "A"
- Exported energy	PV	270	0,0	1,0	0	-270	-270		
+ Delivered energy	Grid	0	2,0	0,5	0	0	0		
TOTAL STEP A					*0*	*100*	*100*	*1,00*	
Kexp ☑ 1,0									
TOTAL STEP A					0	100	100	1,00	STEP "B"
+ Exported energy	PV	270	0,0	1,0	0	270	270		
- Avoided grid gen	Grid	270	2,0	0,5	-540	135	-405		
Energy performance					-540	505	-35	-14,43	
Energy available ext.		0	0,0	1,0	0	0	0	n.a.	

Primary energy factors	fPnren	fPren	fPtot
Photovoltaic	0,00	1,00	1,00
Grid electricity	2,00	0,50	2,50

Figure 4 – "PV" sheet with high electricity export

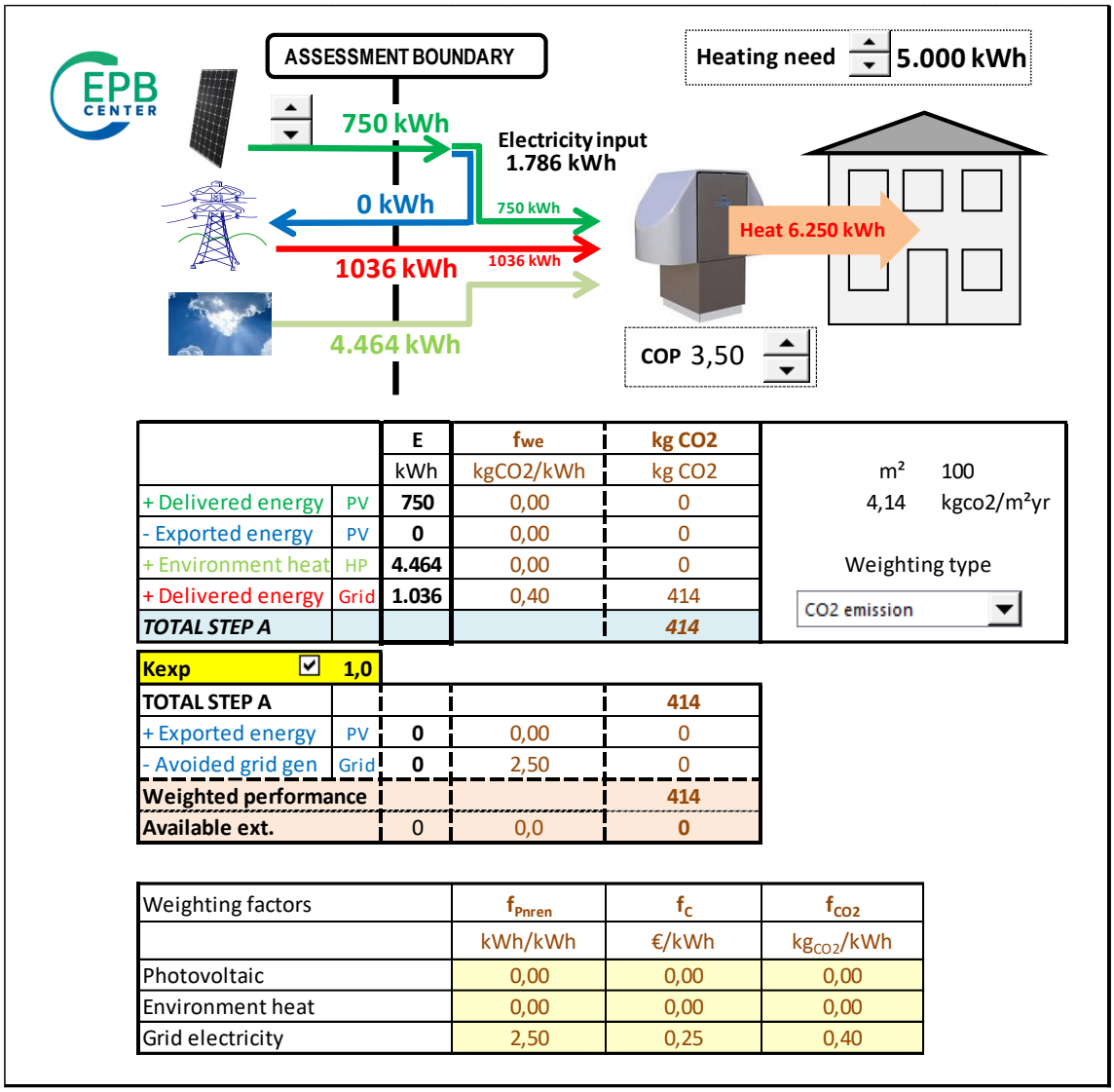
The RER becomes negative when the total primary energy is negative.

5.4 Changing the weighting criterion

The "***Multi-weight***" sheet allows to change the weighting criterion.

Non-renewable primary energy, CO_2 emission and economic cost are available.

Figure 5 shows the sheet "***Multi-weight***" with CO_2 emission selected.



		E	fwe	kg CO2
		kWh	kgCO2/kWh	kg CO2
+ Delivered energy	PV	750	0,00	0
- Exported energy	PV	0	0,00	0
+ Environment heat	HP	4.464	0,00	0
+ Delivered energy	Grid	1.036	0,40	414
TOTAL STEP A				*414*

m² 100
4,14 kgco2/m²yr
Weighting type
CO2 emission

Kexp ☑ 1,0				
TOTAL STEP A				414
+ Exported energy	PV	0	0,00	0
- Avoided grid gen	Grid	0	2,50	0
Weighted performance				414
Available ext.		0	0,0	0

Weighting factors	f_{Pnren}	f_c	f_{CO2}
	kWh/kWh	€/kWh	kg_{CO2}/kWh
Photovoltaic	0,00	0,00	0,00
Environment heat	0,00	0,00	0,00
Grid electricity	2,50	0,25	0,40

Figure 5 – "Multi-weight" sheet with CO_2 emission selected

5.5 Renewable energy ratio (RER)

All sheets also indicate the RER.

No distinction according to the perimeter is done in these sheets.

5.6 Application to the main generation technologies

There are several sheets that allow testing different generation technologies, so that one can compare the achievable results. The following technologies are covered:

- combustion boiler;
- heat pump;
- thermal solar;
- photovoltaic;
- cogeneration;
- district heating;

alone or in combination with others.

5.7 Matching factor.

The sheet "***HP-PV-match***" allows to introduce a matching factor, as it may happen in a monthly calculation method.

The sheet "***Light-PV-match***" allows to define a simple pattern of production and use on 24 hours and calculates the resulting matching factor. You may then increase or decrease proportionally the profiles and see the effect.

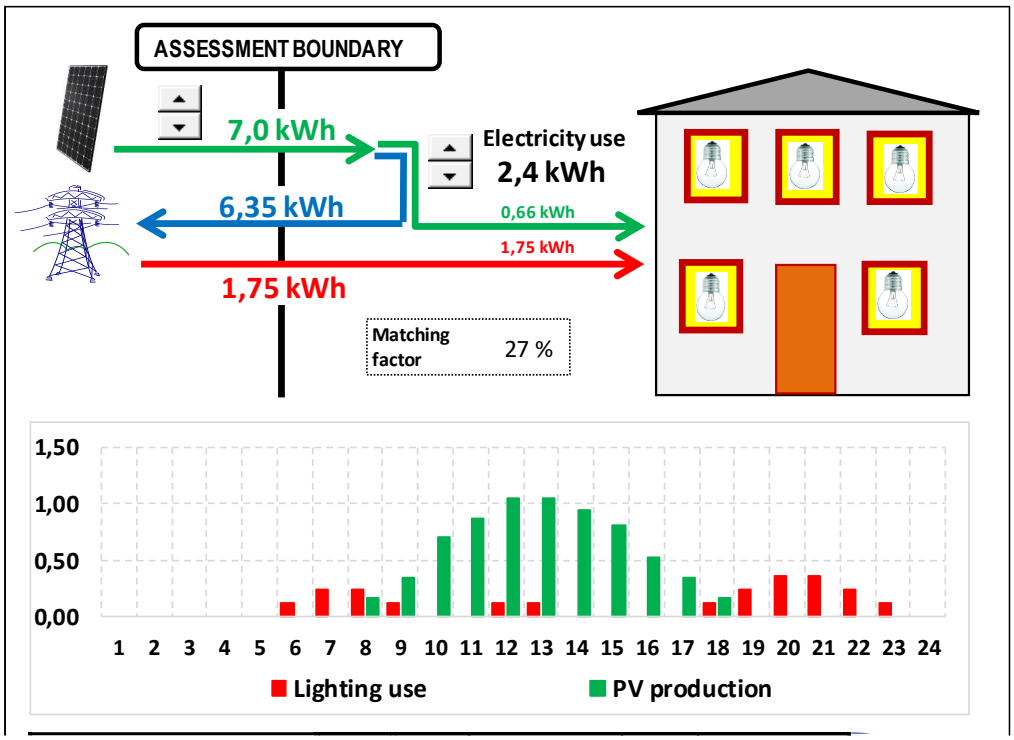


Figure 6 – "Light-PV-match" sheet with sample use and production profiles

6 Conclusions and recommendations

These simplified sheets have a didactic purpose.

EN ISO 52000-1 does exactly the same procedure depicted in the examples, with exactly the two steps A and B shown in the simplified sheets.

Basically, it's as simple as that. Unfortunately, having to do that on an hourly basis, with changing weighting coefficients and taking care of a number of possible options and priorities, makes the equation of EN ISO 52000-1 hard to read without such simplified presentation.

For more information, see the accompanying presentation and the dedicated pages about on EPB Center website https://epb.center.

Bibliography

[1] (EN) ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

[2] (CEN) ISO/TR 52000-2:2017, *Energy performance of buildings — Overarching EPB assessment — Part 2: Explanation and justification of ISO 52000-1*

[3] ENERC32017-437-SI2-785.185, Case study on EN ISO 52000-1, Overarching standard October 31, 2021

Please check the EPB Center website for the overview and most recent versions of the other case study reports.

Link: EPB Center support documents

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