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SPREADSHEET SUPPORTING THE CASE STUDY ON

EN ISO 52000-1

ENERGY PERFORMANCE OF BUILDINGS
"OVERARCHING STANDARD"

SIMPLIFIED DEMONSTRATION
OF DELIVERED AND EXPORTED ENERGY WEIGHTING

This spreadsheet:	
This spreadsheet is part of a series, to support the implementation and use of the set of (CEN, ISO) EPB standards	
(see below)	
Main related standard(s):	**ISO 52000-1, Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures**
Spreadsheet created by:	Laurent Socal (EPB Center expert)
Contact:	https://epb.center/contact/
Date:	2022-02-14
	Replaces file: --
Detailed info:	See sheet "Explanation"

The series of spreadsheets to support the implementation and use of the set of EPB standards:	
EPB spreadsheets:	This spreadsheet is part of a series of spreadsheets to support the implementation and use of the set of (CEN, ISO) EPB standards
	Each of these spreadsheets complies with a specific template and follows specific rules

Main purpose:	The main purpose of these EPB spreadsheets is to support the implementation and use of the standards.
	They aim to demonstrate the validity of the calculation procedures and the required input and provided output data defined in the standard.
	They support the expert user of the standards, in particular those who want to review the content of the standard and those who want to translate the standard into software, to understand the correct interpretation of the formulae and calculation steps in the standard, or e.g. to explore the sensitivity for variations in input values.
	Some spreadsheets have been further developed to include more advanced features or to become more user friendly (see sheet "Explanation")

Limitations:	In general, these spreadsheets do not cover the full range of calculation options that are possible according to the standard to which it applies. This concerns e.g. the number of instances of a variable, the number of time intervals and/or special calculation cases.
	These spreadsheets cover only a single or a cluster of EPB standards and are not meant to perform a full energy performance calculation.
	Note also that these spreadsheets are mainly intended for testing and demonstration and therefore not aiming to be user friendly or to be protected against wrong or improper use.
	The spreadsheets related to the EPB standards are provided to demonstrate specific elements of the calculation procedures in the relevant standard(s). Consequently, they do not replace the EPB standards, but they shall be used along with the EPB standards.

Responsible:	In general, the preparation of the spreadsheet is a collective process in which several experts (including main developers of the standard) are involved
	See "Background" below for information on the first versions of (most of) these spreadsheets

Acknowledgement:	The EPB spreadsheets produced or upgraded after 2018 have been prepared under a contract with the European Union, represented by the European Commission (Service contract ENER/C3/2017-437/SI2-785.185). Start: 21 September 2018 for 3 years. See "Background" for information on previous (2012-2017) versions of many of these spreadsheets

Disclaimer:	Although these spreadsheets have been developed with care, neither the authors or contributors warrant that the calculations and procedures in this spreadsheet are free of errors. The EPB Center expressly disclaims any liability or responsibility arising from use of this spreadsheet, or any consequences thereof. Any responsibility arising from the use of this spreadsheet lies with the user.
	The information and views set out in this document are those of the author(s) and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

Terms of use:	The user is not allowed to redistribute a modified version of this spreadsheet.
	The author(s) would appreciate your feed back on the spreadsheet (see **Contact** above)

More information:	www.epb.center

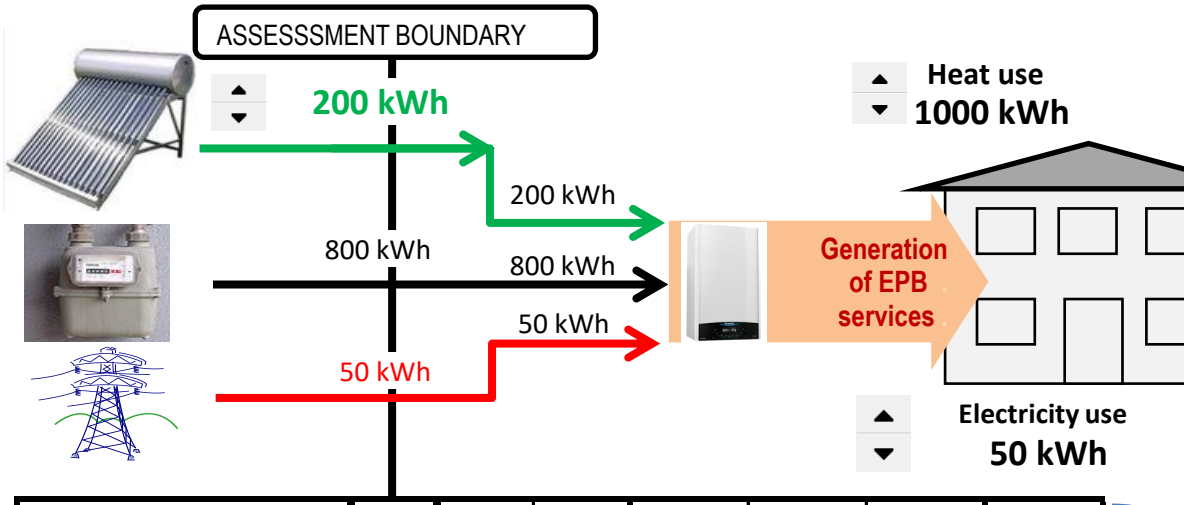
Background:	First published versions of these spreadsheets were developed during 2012-2017, in the framework of the preparation and revision of the set of EN or ISO standards on the energy performance of buildings, to support the European "Energy Performance of Buildings Directive" recast 2010, under Mandate M/480 of the European Commission to CEN.
	These first versions were meant for use by CEN and ISO Technical Committee(s) and the Working Group(s) working on the preparation or revision of the EPB-standard to which this spreadsheet applies.
	These first public versions of the spreadsheets were mainly intended to support checking that all formulae in the standard under development were consistent and could be linked with other relevant (EPB) standards.
	Many of these spreadsheets have been developed parallel to the preparation of the set of EPB standards under the M/480 mandate from the European Commission (2012 - 2017) and do not necessarily reflect the final status of the standard.
	More information: https://epb.center/epb-standards/background/

EPB standard:	(EN) ISO 52000-1:2017	Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures
Responsible in ISO and/or CEN:		CEN/TC 371 in collaboration with ISO/TC 163 and TC 205 Joint Working Group on EPB standards
Use	These spreadsheets allow to experiment the effect of changing values for typical situations Please input the desired values in the yellow cellsa and areas: - either by typing a value in the cells with a yellow background - or by pressing the up/down arrows of the selectors - or by clicking on the tick-boxes Specific instruction is provided on the right of the diagrams, in the grey area, where applicable	10 50 FALSE
Color codes:	GREEN: renewable primary energy RED: non-renewable primary energy	
Main features:	This spreadsheet demonstrates the impacts of exported energy on energy performance - impact of the choice about Kexp = 0,0 or 1,0 - impact and effects of the change of the calculation interval - potential cross compensation between energy carriers - effect of time mismatch between production and use of electric energy See the accompanying short videos for more details (see links below)	
Time intervals and period:	These are demonstrations showing seasonal/yearly values A couple of sheets are specifically dedicated to the effect of the calculation interval	
Sheets	**Gas-Tsolar**	Demonstration of the evaluation of delivered energy
	PV	Demonstration of the evaluation of exported energy
	HP-PV	Demonstration of the case with a heat pump
	Chiller-PV	Demonstration of the case with a chiller
	Gas-PV	Demonstration of the potential influence between energy carriers
	Boil-CGN	Demonstration of the case with a cogenerator
	PV-District	Demonstration of the case of a district heating
	HP-PV-match	Demonstration of the use of a matching factor
	Light-PV-match	Demonstration of the effect of time mismatch between production and use of electricity
	Free-cooling	Demonstration of the case of free heat extraction to the environment
	Free-heating	Demonstration of the case of free heat supply from the environment
	Multi-weight	Demonstration of the several weighting possibilities
Main limitations:	This spreadsheet is intended to demonstrate specific features of EN ISO 52000-1 without the noise of all the details. For a complete demonstration of the calculation procedure of EN ISO 52000-1, please refer to "Spreadsheets" section at https://epb.center/documents/	
Protection:	The sheets are protected without password to prevent unintentional disruption of the calculation chain. If you desire to modify the sheets, please remove the protection.	
More information:	CEN ISO/TR 52000-2, *Energy performance of buildings — Energy performance of buildings — Overarching EPB assessment — Part 2: Explanation and justification of ISO 52000-1* Published June 2017	
Links:	https://epb.center/support/documents/iso-52000-1/ https://epb.center/support/documents/isotr-52000-2/ https://epb.center/support/short-videos/ https://epb.center/support/case-studies/	

History of this spreadsheet

Status: **Published**

Date	Developer	Description
2020-04-25	Laurent Socal	First public version
2021-09-25	Laurent Socal	Revision for case studies
2021-10-31	Laurent Socal	Deliverable for case studies
2022-02-14	Laurent Socal	Free cooling and free heating added

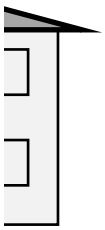


		E	fPnren	fPren	EPnren	EPren	Eptot	RER
		kWh			kWh	kWh	kWh	tot
+ Delivered energy	TS	200	0,00	1,00	0	200	200	
+ Delivered energy	Grid	50	1,95	0,47	98	24	121	
+ Delivered energy	Gas	800	1,05	0,00	840	0	840	
TOTAL STEP A					***938***	***224***	***1.161***	***0,19***

Kexp ☑	**1,0**							
TOTAL STEP A					**938**	**224**	**1.161**	
+ Exported energy								
- Avoided grid gen		**0**	1,95	0,47	0	0	0	
Energy performance					**938**	**224**	**1.161**	**0,19**
Energy available ext.								

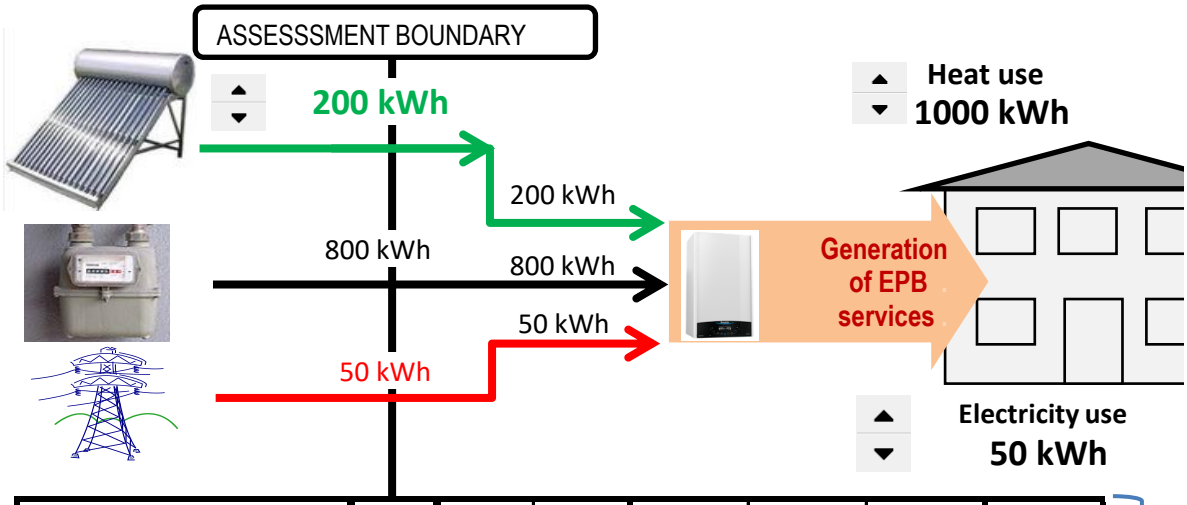
Primary energy factors	fPnren	fPren	fPtot
Thermal solar	0,00	1,00	1,00
Grid electricity	1,95	0,47	2,42
Gas	1,05	0,00	1,05

EPB CENTER



STEP "A"

STEP "B"



		E	fPnren	fPren	EPnren	EPren	Eptot	RER
		kWh			kWh	kWh	kWh	tot
+ Delivered energy	TS	200	0,00	1,00	0	200	200	
+ Delivered energy	Grid	50	1,95	0,47	98	24	121	
+ Delivered energy	Gas	800	1,05	0,00	840	0	840	
TOTAL STEP A					***938***	***224***	***1.161***	***0,19***

Kexp ☑ ☑ Check	**1,0**							
TOTAL STEP A					**938**	**224**	**1.161**	
+ Exported energy								
- Avoided grid gen		**0**	1,95	0,47	0	0	0	
Energy performance					**938**	**224**	**1.161**	**0,19**
Energy available ext.								

Primary energy factors	fPnren	fPren	fPtot
Thermal solar	0,00	1,00	1,00
Grid electricity	1,95	0,47	2,42
Gas	1,05	0,00	1,05

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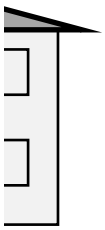
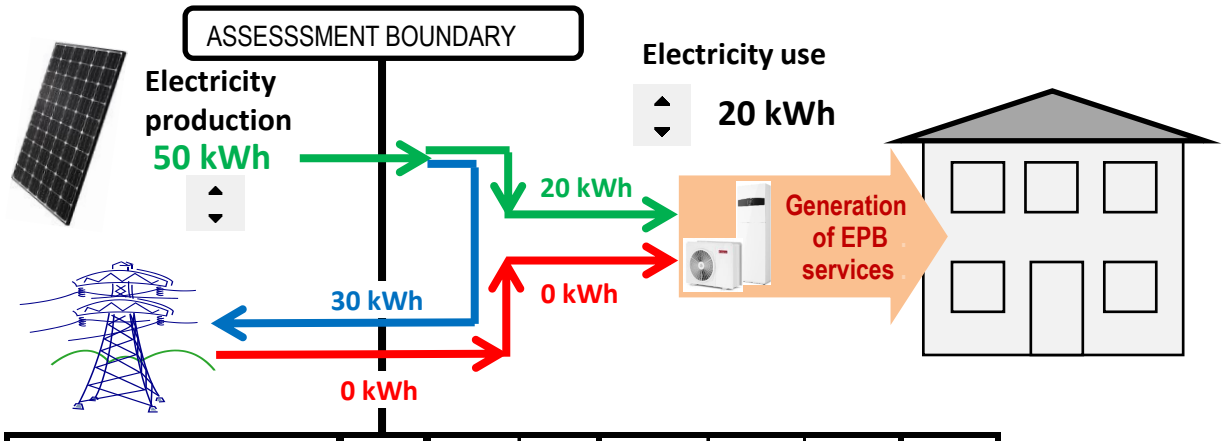


STEP "A"

STEP "B"



		E	fPnren	fPren	EPnren	Epren on-site	EPtot	RER
		kWh			kWh	kWh	kWh	nrb-os
+ Delivered energy	PV	50	0,0	1,0	0	50	50	
- Exported energy	PV	30	0,0	1,0	0	-30	-30	
+ Delivered energy	Grid	0	2,0	0,0	0	0	0	
TOTAL STEP A					***0***	***20***	***20***	***1,00***

STEP "A"

Kexp ☑	**1,0**							
TOTAL STEP A					**0**	**20**	**20**	**1,00**
+ Exported energy	PV	30	0,0	1,0	0	30	30	
- Avoided grid gen	Grid	30	2,0	0,0	-60	0	-60	
Energy performance					**-60**	**50**	**-10**	**-5,00**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

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

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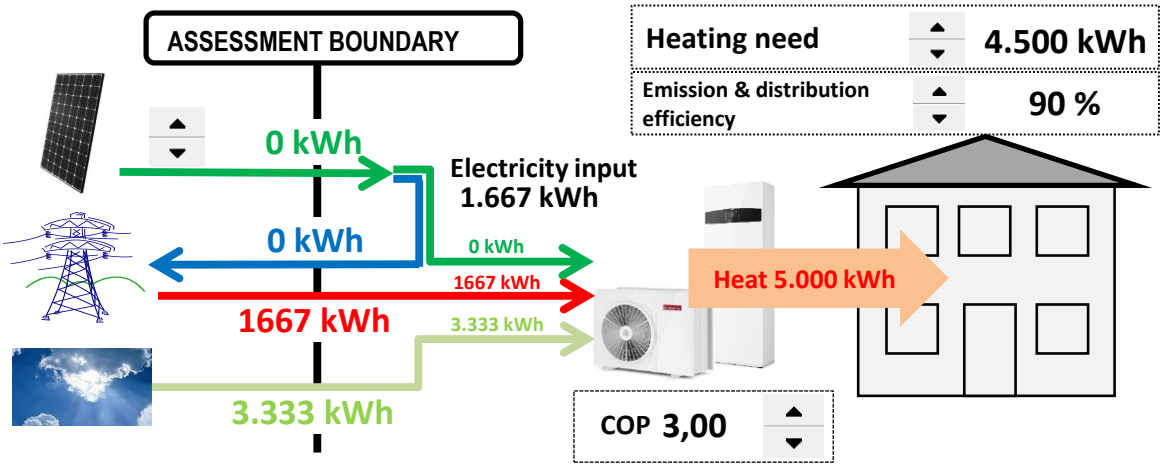

		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	0	0,00	1,00	0	0	0	
- Exported energy	PV	0	0,00	1,00	0	0	0	
+ Environment heat	HP	3.333	0,00	1,00	0	3.333	3.333	
+ Delivered energy	Grid	1.667	1,95	0,47	3.251	783	4.034	
TOTAL STEP A					*3.251*	*4.116*	*7.367*	*0,56*

STEP "A"

Kexp ☑ 1,0								
TOTAL STEP A					3.251	4.116	7.367	
+ Exported energy	PV	0	0,00	1,00	0	0	0	
- Avoided grid gen	Grid	0	1,95	0,47	0	0	0	
Energy performance					**3.251**	**4.116**	**7.367**	**0,56**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	1,00	1,00
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	1,95	0,47	2,42

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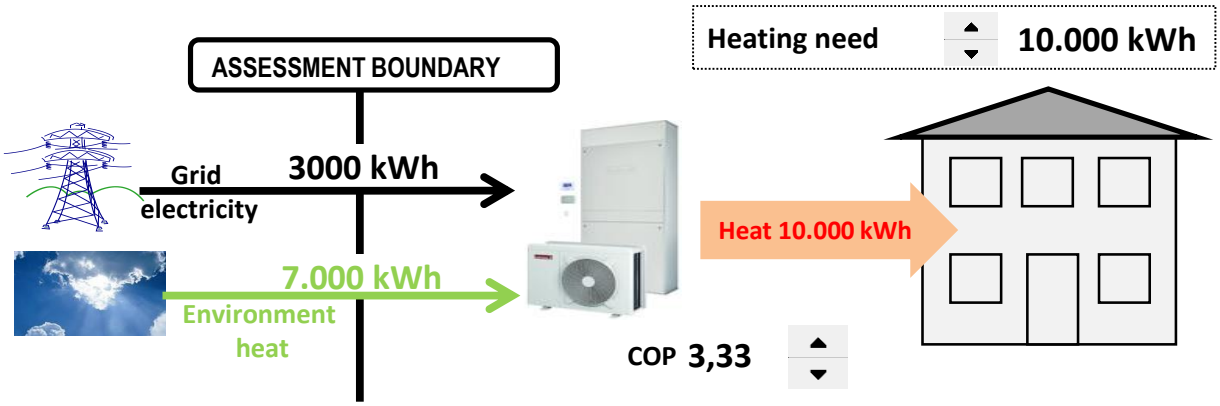

Energy carriers		E_{del}	fPnren	fPren	fPtot	EPnren	EPren	EPtot	RER
		kWh	-	-	-	kWh	kWh	kWh	
+ Environment heat	HP	**7.000**	0,00	1,00	1,00	0	7.000	7.000	
+ Grid electricity	Grid	**3.000**	**1,95**	**0,47**	**2,42**	5.850	1.410	7.260	
					Primary energy	***5.850***	***8.410***	***14.260***	***0,59***

Primary energy factors		fPnren	fPren	fPtot
Environment heat	HP	**0,00**	**1,00**	**1,00**
Grid electricity	Grid	**1,95**	**0,47**	**2,42**

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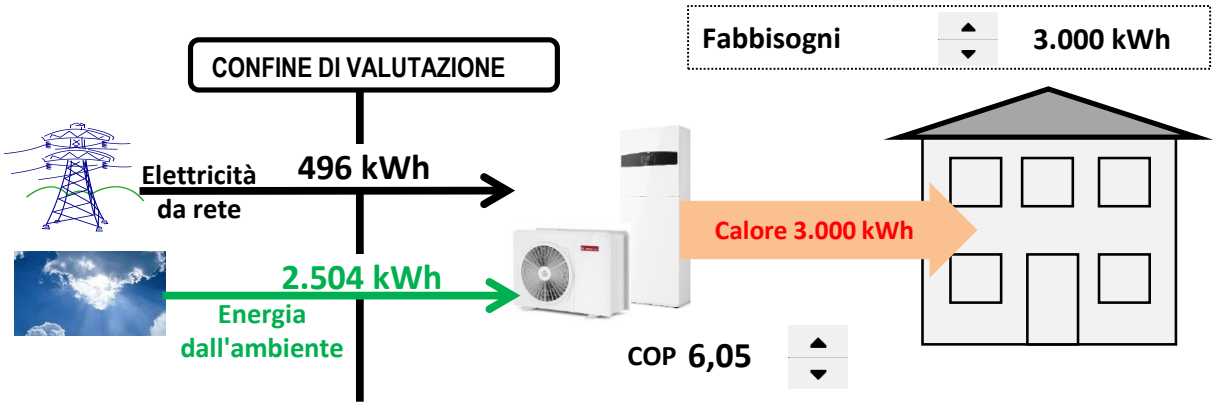
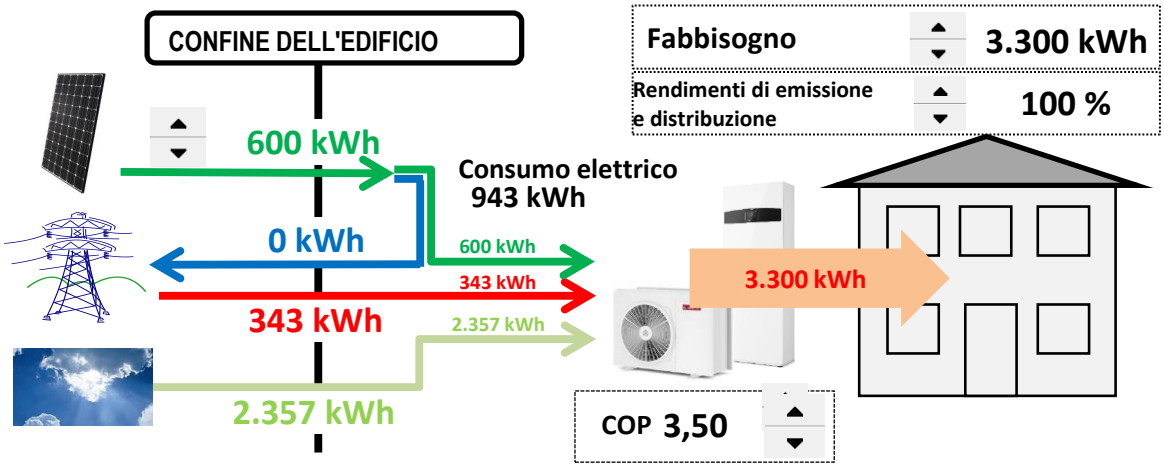


Vettori energetici		E_{del}	fPnren	fPren	fPtot	EPnren	EPren	EPtot	QR
		kWh	-	-	-	kWh	kWh	kWh	
+ Energia ambiente	PdC	**2.504**	0,00	1,00	1,00	0	2.504	2.504	
+ Energia elettrica	Rete	**496**	**1,95**	**0,47**	**2,42**	967	233	1.200	
			Energia primaria			***967***	***2.737***	***3.704***	***0,739***

Fattori di conversione		fPnren	fPren	fPtot
Energia dall'ambiente		**0,00**	**1,00**	**1,00**
Energia elettrica	Rete	**1,95**	**0,47**	**2,42**



		E	fPnren	fPren	EPnren	EPren	EPtot	QR
		kWh			kWh	kWh	kWh	
+ Energia consegnata	PV	600	0,0	1,0	0	600	600	
- Energia esportata	PV	0	0,0	1,0	0	0	0	
+ Calore ambiente	HP	2.357	0,0	1,0	0	2.357	2.357	
+ Energia consegnata	Rete	343	2,0	0,5	669	161	830	
TOTALE PASSO A					*669*	*3.118*	*3.787*	*0,82*

PASSO "A"

Kexp		0,0						
TOTALE PASSO A					669	3.118	3.787	
+ Energia esportata	PV	0	0,0	1,0	0	0	0	
- Evitata da gen rete	Rete	0	2,0	0,5	0	0	0	
Prestazione energetica					669	3.118	3.787	0,82
Energia disponibile		0	0,0	1,0	0	0	0	n.a.

PASSO "B"

Fattori di conversione		fPnren	fPren	fPtot
Fotovoltaico	PV	0,00	1,00	1,00
Calore ambiente	HP	0,00	1,00	1,00
Elettricità da rete	Rete	1,95	0,47	2,42

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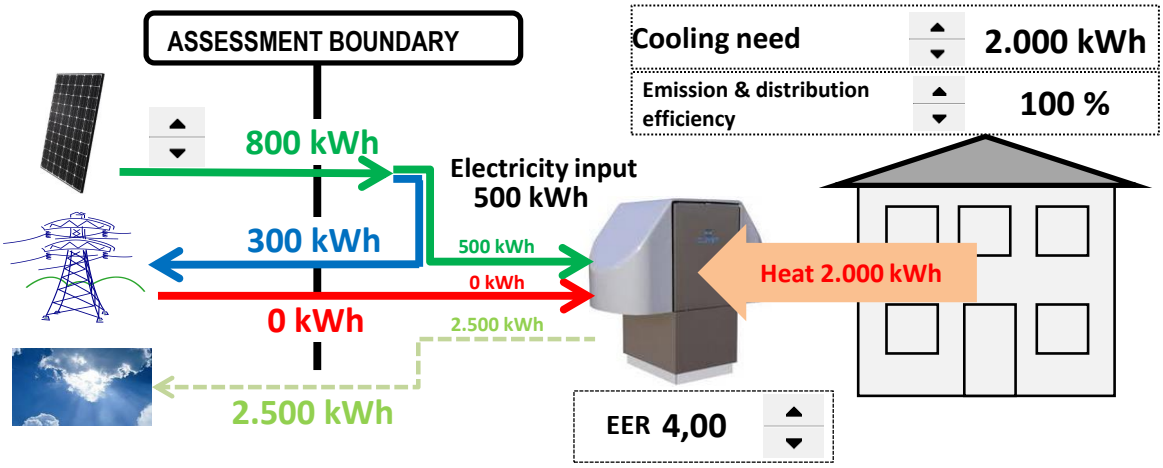

		E	fPnren	fPren	EPnren	EPren	EPtot	RER	
		kWh			kWh	kWh	kWh		
+ Delivered energy	PV	800	0,0	1,0	0	800	800		
- Exported energy	PV	300	0,0	1,0	0	-300	-300		
- Rejected heat		2.500							
+ Delivered energy	Grid	0	2,3	0,2	0	0	0		
TOTAL STEP A					***0***	***500***	***500***	***1,00***	STEP "A"

Kexp ☑	**1,0**								
TOTAL STEP A					**0**	**500**	**500**		
+ Exported energy	PV	**300**	0,0	1,0	0	300	300		
- Avoided grid gen	Grid	**300**	2,3	0,2	-690	-60	-750		STEP "B"
Energy performance					**-690**	**740**	**50**	**14,80**	
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**	

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	1,00	1,00
Rejected heat				
Grid electricity	Grid	2,30	0,20	2,50

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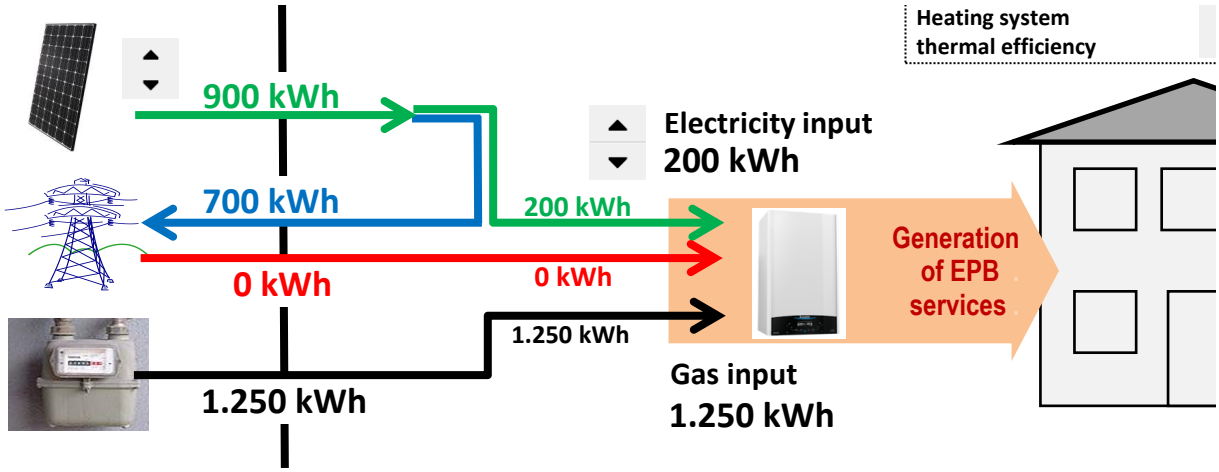
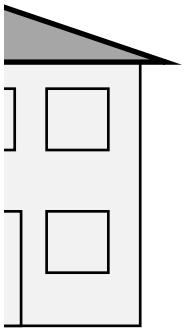


		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	**900**	**0,00**	**1,00**	0	900	900	*1,00*
- Exported energy	PV	**700**	0,00	1,00	0	-700	-700	*1,00*
+ Delivered energy	Grid	**0**	**1,95**	**0,47**	0	0	0	*n.a.*
+ Delivered energy	Gas	**1.250**	**1,05**	**0,00**	1.313	0	1.313	*0,00*
TOTAL STEP A					***1.313***	***200***	***1.513***	***0,13***

Kexp ☑ **1,0**								
TOTAL STEP A					**1.313**	**200**	**1.513**	
+ Exported energy	PV	**700**	0,00	1,00	0	700	700	
- Avoided grid gen	Grid	**700**	1,95	0,47	-1.365	-329	-1.694	
Energy performance					**-53**	**571**	**519**	**1,10**
Energy available ext.		0	0,00	1,00	**0**	**0**	**0**	

Primary energy factors	fPnren	fPren	fPtot
Photovoltaic	0,00	1,00	1,00
Grid electricity	1,95	0,47	2,42
Gas *(or any other fuel)*	1,05	0,00	1,05

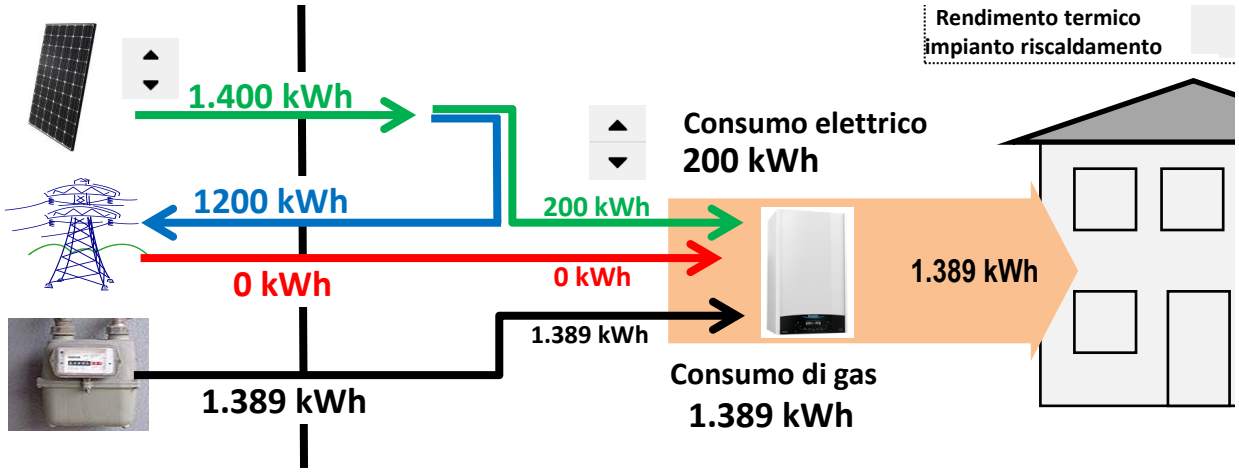
80 %



Step "A"

Step "B"

4

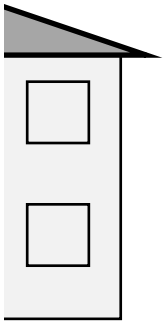


		E	fPnren	fPren	EPnren	EPren	EPtot	QR
		kWh			kWh	kWh	kWh	
+ Energia consegnata	PV	**1.400**	**0,0**	**1,0**	0	1.400	1.400	*1,00*
- Energia esportata	PV	**1.200**	0,0	1,0	0	-1.200	-1.200	*1,00*
+ Calore ambiente	Rete	**0**	**2,0**	**0,5**	0	0	0	*n.a.*
+ Energia consegnata	Gas	**1.389**	**1,1**	**0,0**	1.458	0	1.458	*0,00*
TOTAL STEP A					***1.458***	***200***	***1.658***	***0,12***

Kexp ☑ ☑ Check **1,0**								
TOTAL STEP A					**1.458**	**200**	**1.658**	
+ Energia esportata	PV	**1.200**	0,0	1,0	0	1.200	1.200	
- Evitata da gen rete	Rete	**1.200**	2,0	0,5	-2.340	-564	-2.904	
Prestazione enrgetica					**-882**	**836**	**-46**	**-18,31**
Energia disponibile		0	0,0	1,0	**0**	**0**	**0**	

Fattori di conversione	fPnren	fPren	fPtot
Fotovoltaico	0,00	1,00	1,00
Eletricità da rete	1,95	0,47	2,42
Gas *(o altro combustibile)*	1,05	0,00	1,05

80 %



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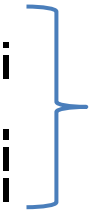
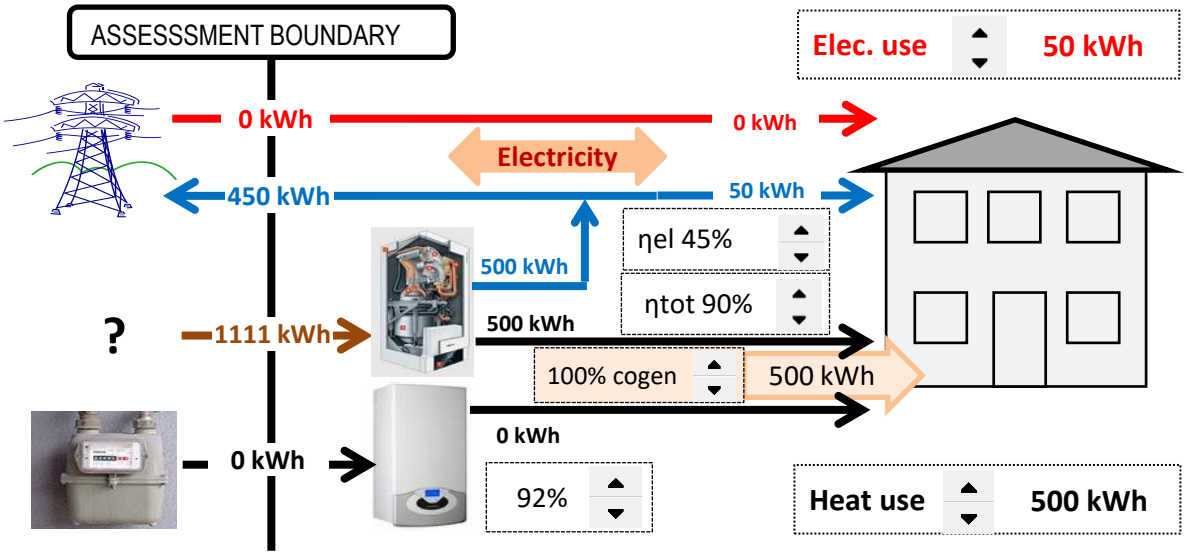


Step "B"



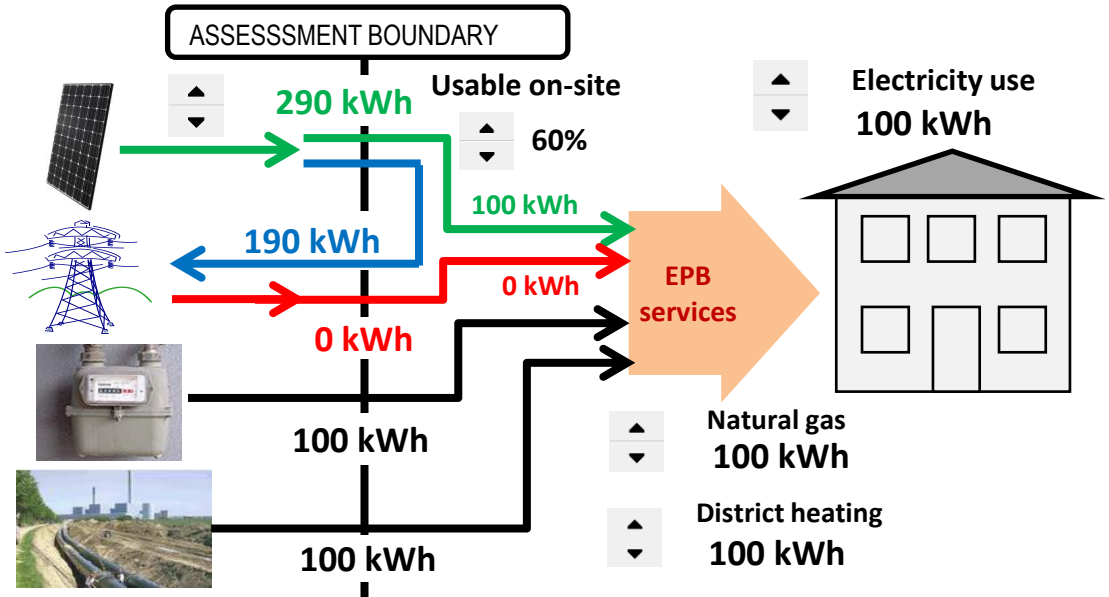
Allocation factors according to power bonus method				
Grid efficiency	%	44	aw	aq
Cogen electric efficiency	%	45	1,02	-0,02
Cogen thermal efficiency	%	45		

Cogenerator conversion factors	fPnren	fPren	fPtot
Fuel conversion factor	0,20	**1,00**	1,20
Cogen heat weighting	-0,01	-0,05	-0,06
Cogen electricity weighting	0,45	2,27	2,73

		E	fPnren	fPren	EPnren	EPren1	EPren2	EPtot	RER	RER
		kWh			kWh	kWh	kWh	kWh	tot	nrb-os
+ Delivered energy	Blr	**0**	1,1	0,0	0		0	0		
+ Delivered energy	Cgn	**1.111**	0,2	1,0	222		1.111	1.333		
- Exported energy	Cgn	**450**	0,5	2,3	-205		-1.023	-1.227		
+ Delivered energy	Grid	**0**	2,0	0,5	0	0		0		
TOTAL STEP A					***18***	***0***	***88***	***106***	***0,83***	***0,83***

Kexp ☑ **1,0**										
TOTAL STEP A					**18**	**0**	**88**	**106**		
+ Exported energy	Cgn	**450**	0,5	2,3	205		1.023	1.227		
- Avoided grid gen	Grid	**450**	2,0	0,5	-900	-225		-1.125		
Energy performance					**-678**	**-225**	**1.111**	**208**	**4,25**	**5,33**
Energy available ext.		0	0,5	2,3	**0**		**0**	**0**	**n.a.**	**n.a.**

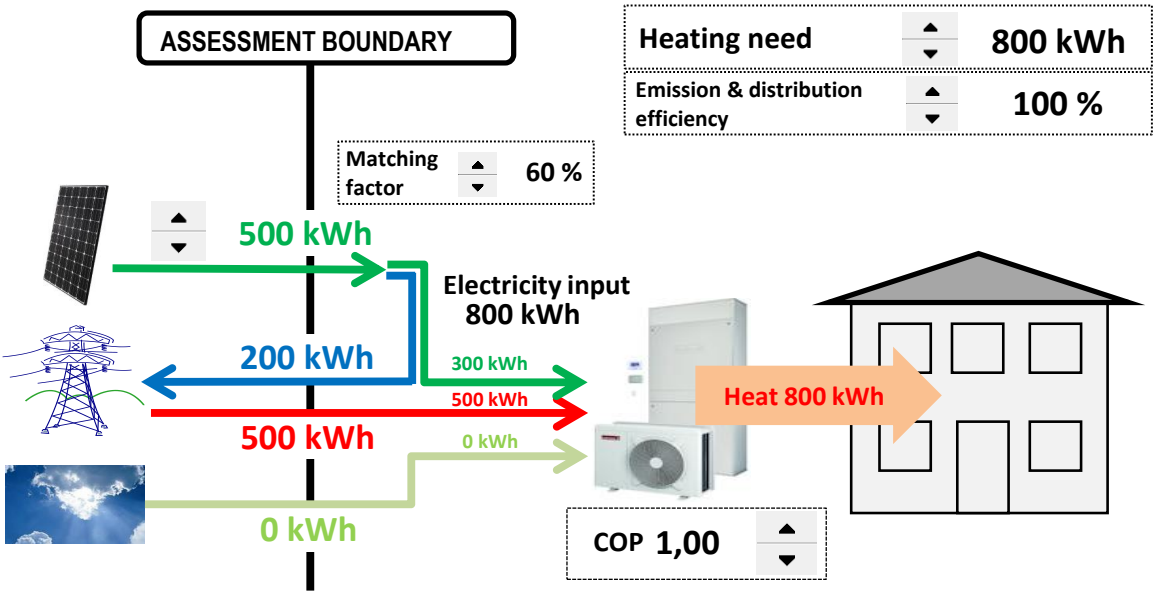
Primary energy factors	fPnren	fPren	fPtot
Cogen input	0,20	1,00	1,20
Boiler input	1,10	0,00	1,10
Grid electricity	2,00	0,50	2,50



		E	fPnren	fPren	EPnren	EPren	Eptot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	290	0,0	1,0	0,0	290,0	290,0	
- Exported energy	PV	190	0,0	1,0	0,0	-190,0	-190,0	
+ Delivered energy	Grid	0	2,0	0,5	0,0	0,0	0,0	
+ Delivered energy	Gas	100	1,1	0,0	110,0	0,0	110,0	
+ Delivered energy	DH	100	0,3	0,7	28,0	72,0	100,0	
TOTAL STEP A					***138,0***	***172,0***	***310,0***	***0,55***

Kexp ☑	**1,0**							
TOTAL STEP A					**138**	**172**	**310**	
+ Exported energy	PV	**190**	0,0	1,0	0	190	190	
- Avoided grid gen	Grid	**190**	2,0	0,5	-380	-95	-475	
Energy performance					**-242,0**	**267,0**	**25,0**	**10,7**
Energy available ext.		0	0,0	1,0	**0,0**	**0,0**	**0,0**	

Primary energy factors	fPnren	fPren	fPtot
Photovoltaic	0,00	1,00	1,00
Grid electricity	2,00	0,50	2,50
Gas	1,10	0,00	1,10
District heating	0,28	0,72	1,00



		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	500	0,0	2,5	0	1.250	1.250	
- Exported energy	PV	200	0,0	2,5	0	-500	-500	
+ Environment heat	HP	0	0,0	1,0	0	0	0	
+ Delivered energy	Grid	500	2,0	0,5	1.000	250	1.250	
TOTAL STEP A					*1.000*	*1.000*	*2.000*	*0,50*

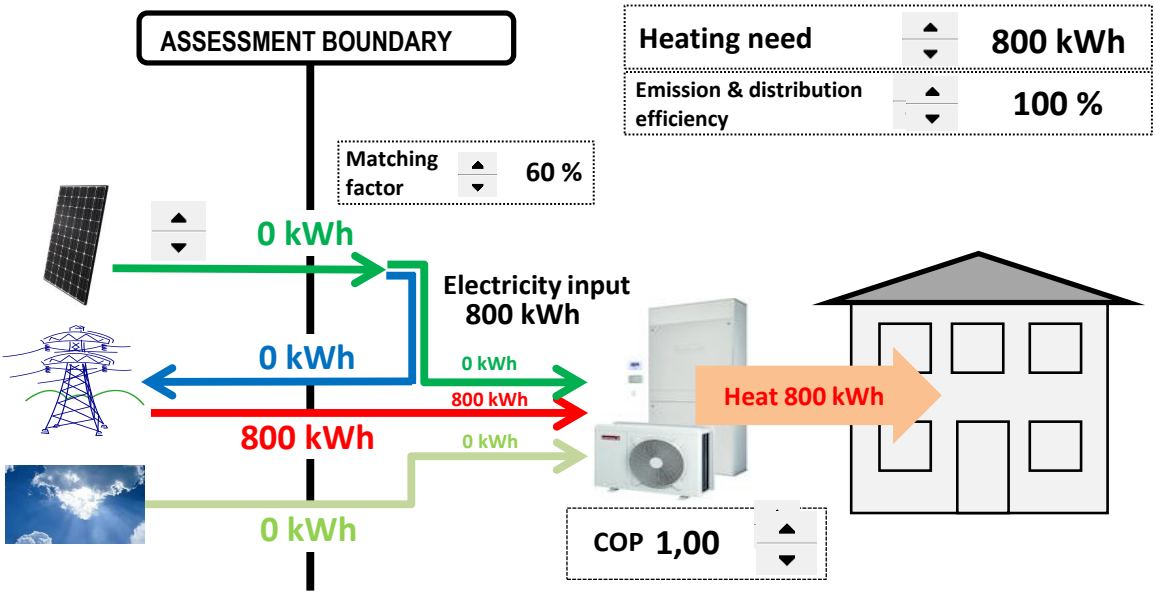
STEP "A"

Kexp ☑ 1,0								
TOTAL STEP A					1.000	1.000	2.000	
+ Exported energy	PV	200	0,0	2,5	0	500	500	
- Avoided grid gen	Grid	200	2,0	0,5	-400	-100	-500	
Energy performance					600	1.400	2.000	0,70
Energy available ext.		0	0,0	2,5	0	0	0	n.a.

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	2,50	2,50
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	2,00	0,50	2,50

EPB CENTER



		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	0	0,0	2,5	0	0	0	
- Exported energy	PV	0	0,0	2,5	0	0	0	
+ Environment heat	HP	0	0,0	1,0	0	0	0	
+ Delivered energy	Grid	800	2,0	0,5	1.600	400	2.000	
TOTAL STEP A					*1.600*	*400*	*2.000*	*0,20*

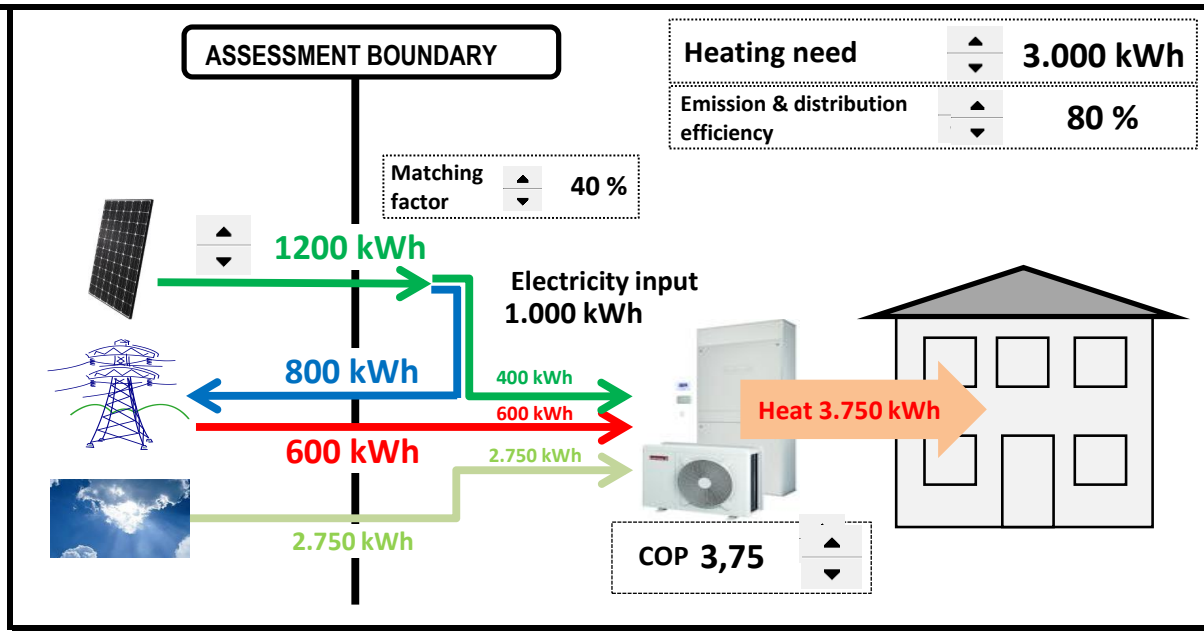
STEP "A"

Kexp		1,0						
TOTAL STEP A					1.600	400	2.000	
+ Exported energy	PV	0	0,0	2,5	0	0	0	
- Avoided grid gen	Grid	0	2,0	0,5	0	0	0	
Energy performance					1.600	400	2.000	0,20
Energy available ext.		0	0,0	2,5	0	0	0	n.a.

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	2,50	2,50
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	2,00	0,50	2,50

EPB CENTER



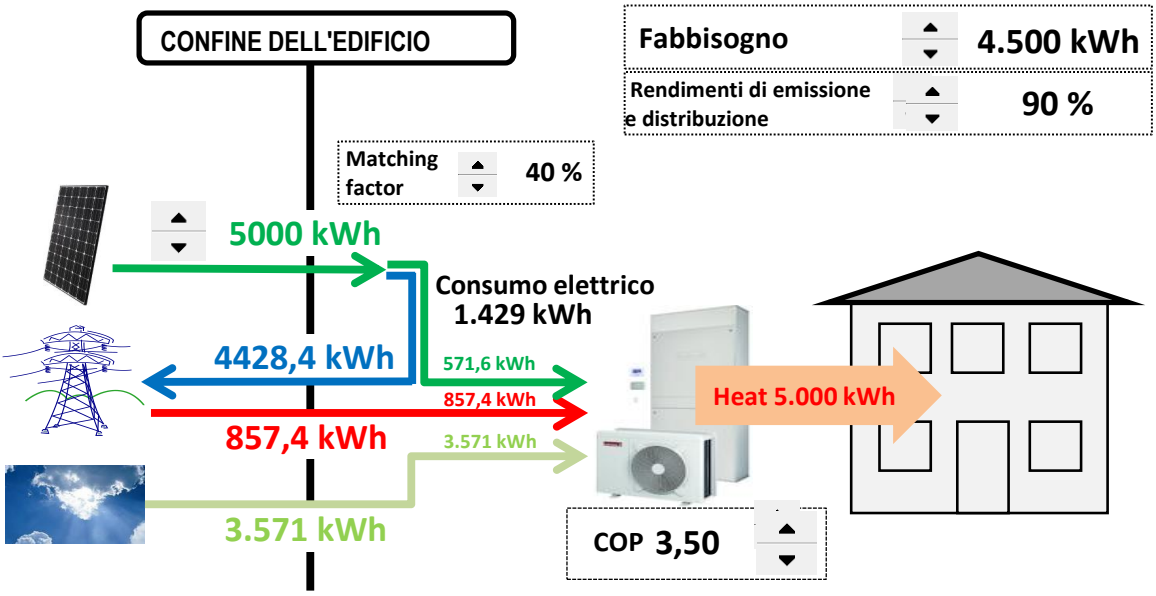
		E	fPnren	fPren	EPnren	EPren	EPtot	RER	
		kWh			kWh	kWh	kWh		
+ Delivered energy	PV	1.200	0,0	1,0	0	1.200	1.200		STEP "A"
- Exported energy	PV	800	0,0	1,0	0	-800	-800		
+ Environment heat	HP	2.750	0,0	1,0	0	2.750	2.750		
+ Delivered energy	Grid	600	2,0	0,5	1.200	300	1.500		
TOTAL STEP A					*1.200*	*3.450*	*4.650*	*0,74*	

Kexp ☑ ☑ Check	1,0							
TOTAL STEP A					1.200	3.450	4.650	
+ Exported energy	PV	800	0,0	1,0	0	800	800	
- Avoided grid gen	Grid	800	2,0	0,5	-1.600	-400	-2.000	
Energy performance					**-400**	**3.850**	**3.450**	**1,12**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	1,00	1,00
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	2,00	0,50	2,50

EPB CENTER



		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	5.000	0,0	1,0	0	5.000	5.000	
- Exported energy	PV	4.428	0,0	1,0	0	-4.428	-4.428	
+ Environment heat	HP	3.571	0,0	1,0	0	3.571	3.571	
+ Delivered energy	Grid	857	2,0	0,5	1.672	403	2.075	
TOTAL STEP A					*1.672*	*4.546*	*6.218*	*0,73*

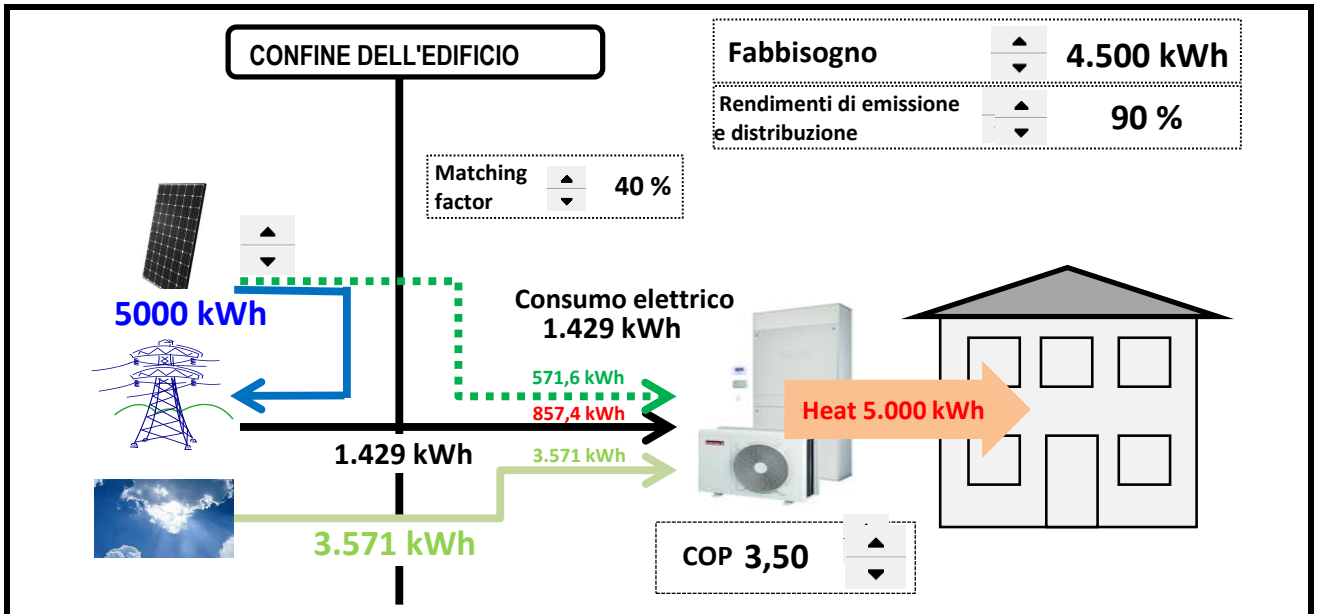
STEP "A"

Kexp ☑ ☑ Check	1,0							
TOTAL STEP A					1.672	4.546	6.218	
+ Exported energy	PV	4.428	0,0	1,0	0	4.428	4.428	
- Avoided grid gen	Grid	4.428	2,0	0,5	-8.635	-2.081	-10.717	
Energy performance					-6.963	6.893	-71	-97,33
Energy available ext.		0	0,0	1,0	0	0	0	n.a.

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	1,00	1,00
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	1,95	0,47	2,42

EPB CENTER



		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	5.000	0,0	1,0	0	5.000	5.000	
- Exported energy	PV	4.428	0,0	1,0	0	-4.428	-4.428	
+ Environment heat	HP	3.571	0,0	1,0	0	3.571	3.571	
+ Delivered energy	Grid	857	2,0	0,5	1.715	429	2.144	
TOTAL STEP A					*1.715*	*4.571*	*6.286*	*0,73*

STEP "A"

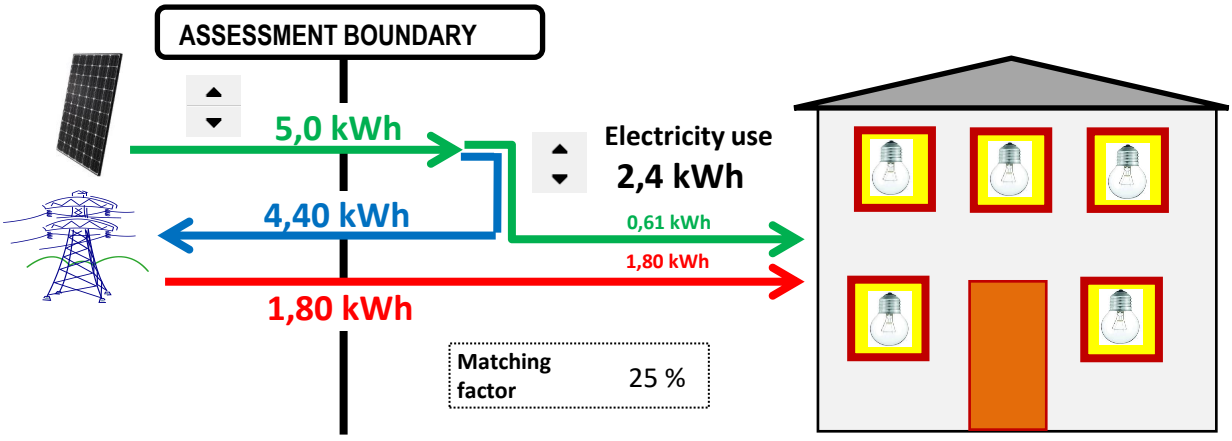
Kexp ☑ ☑ Ch	1,0

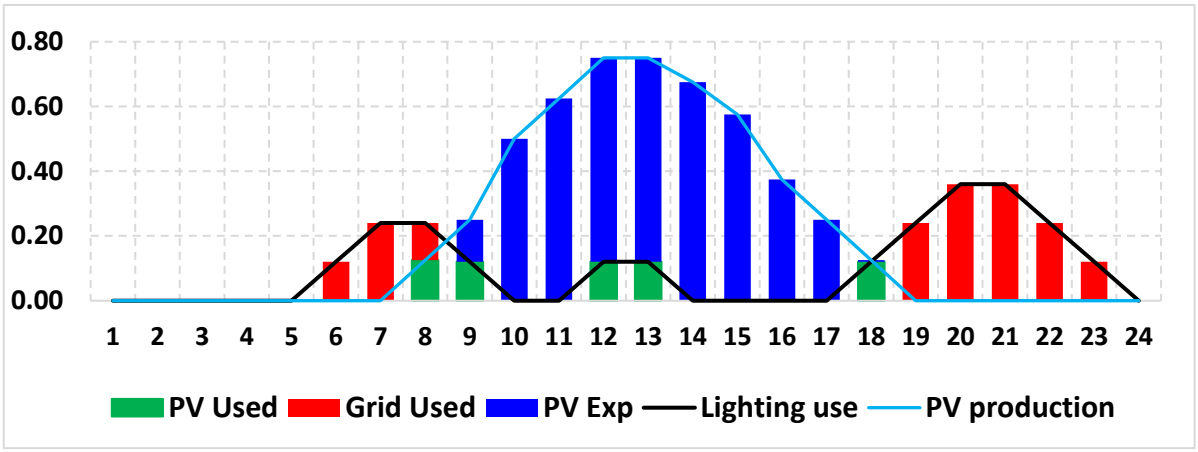
TOTAL STEP A					**1.715**	**4.571**	**6.286**	
+ Exported energy	PV	**4.428**	0,0	1,0	0	4.428	4.428	
- Avoided grid gen	Grid	**4.428**	2,0	0,5	-8.857	-2.214	-11.071	
Energy performance					**-7.142**	**6.786**	**-356**	**-19,03**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	0,00	1,00	1,00
Environment heat	HP	0,00	1,00	1,00
Grid electricity	Grid	2,00	0,50	2,50

EPB CENTER





		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	**5**	**0,0**	**1,0**	0	5	5	
- Exported energy	PV	**4**	0,0	1,0	0	-4	-4	
+ Delivered energy	Grid	**2**	**2,0**	**0,5**	4	1	4	
TOTAL STEP A					***4***	***2***	***5***	***0,30***

STEP "A"

Kexp ☑	**1,0**							
TOTAL STEP A					**4**	**2**	**5**	
+ Exported energy	PV	**4**	0,0	1,0	0	4	4	
- Avoided grid gen	Grid	**4**	2,0	0,5	-9	-2	-11	
Energy performance					**-5**	**4**	**-2**	**-2,47**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

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

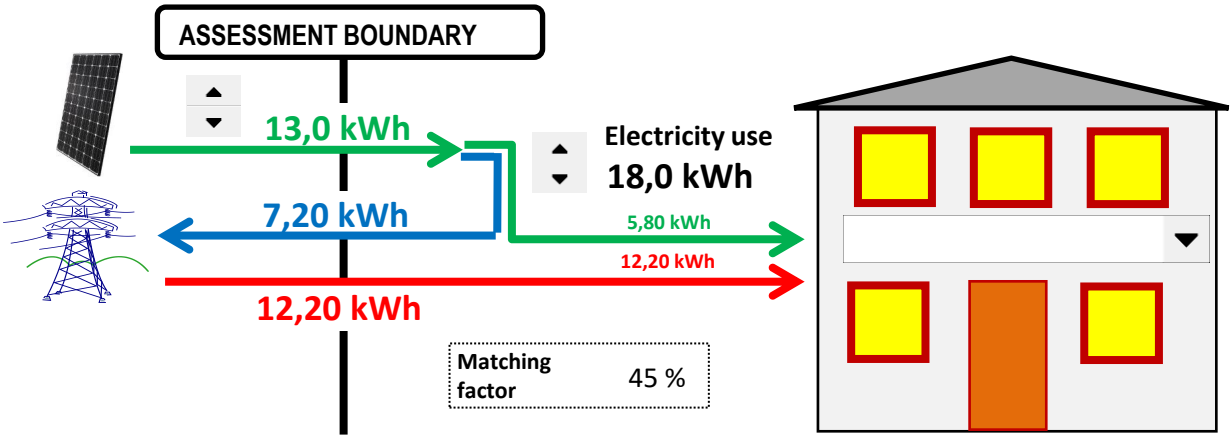
Daily PV generation and electricity use profile

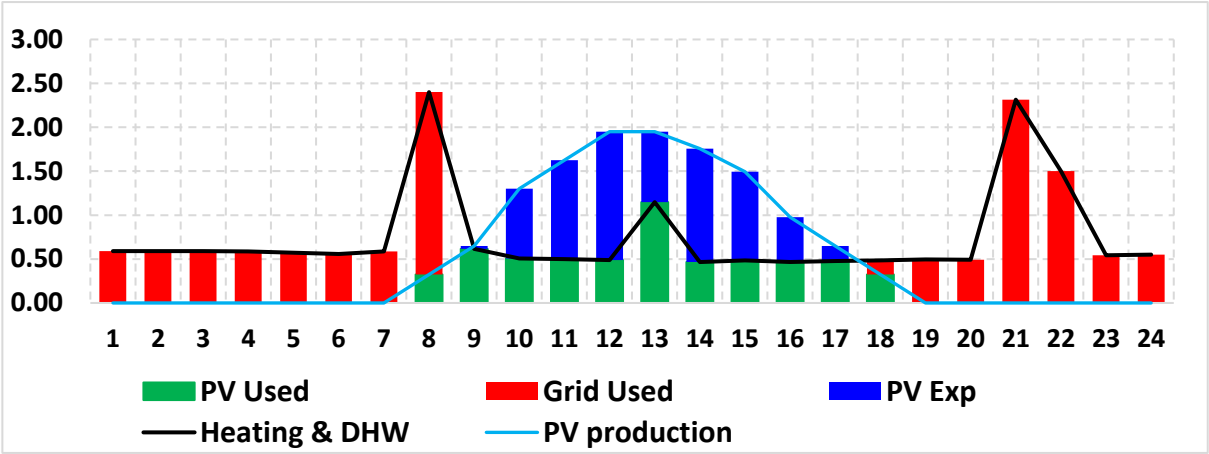
Time of day	PV production		Lighting use		PV Exp	PV Used	Grid Used
	%	kWh	%	kWh	kWh	kWh	kWh
1	0,0	0,00	0,0	0,00	0,00	0,00	0,00
2	0,0	0,00	0,0	0,00	0,00	0,00	0,00
3	0,0	0,00	0,0	0,00	0,00	0,00	0,00
4	0,0	0,00	0,0	0,00	0,00	0,00	0,00
5	0,0	0,00	0,0	0,00	0,00	0,00	0,00
6	0,0	0,00	5,0	0,12	0,00	0,00	0,12
7	0,0	0,00	10,0	0,24	0,00	0,00	0,24
8	2,5	0,13	10,0	0,24	0,00	0,13	0,12
9	5,0	0,25	5,0	0,12	0,13	0,12	0,00
10	10,0	0,50	0,0	0,00	0,50	0,00	0,00
11	12,5	0,63	0,0	0,00	0,63	0,00	0,00
12	15,0	0,75	5,0	0,12	0,63	0,12	0,00
13	15,0	0,75	5,0	0,12	0,63	0,12	0,00
14	13,5	0,68	0,0	0,00	0,68	0,00	0,00
15	11,5	0,58	0,0	0,00	0,58	0,00	0,00
16	7,5	0,38	0,0	0,00	0,38	0,00	0,00
17	5,0	0,25	0,0	0,00	0,25	0,00	0,00
18	2,5	0,13	5,0	0,12	0,01	0,12	0,00
19	0,0	0,00	10,0	0,24	0,00	0,00	0,24
20	0,0	0,00	15,0	0,36	0,00	0,00	0,36
21	0,0	0,00	15,0	0,36	0,00	0,00	0,36
22	0,0	0,00	10,0	0,24	0,00	0,00	0,24
23	0,0	0,00	5,0	0,12	0,00	0,00	0,12
24	0,0	0,00	0,0	0,00	0,00	0,00	0,00
TOTAL	100,0	5,00	100,0	2,40	4,40	0,61	1,80

Could be used, based on daily total	D	2,40
Is used, based on sum of hourly balance	H	0,61
Matching factor, from daily to hourly	H/D	0,25

Intended use of this sheet

Demonstrate the concept of time mismatch between (electric) energy production and use
Demonstrate the concept of matching factor
Demonstrate the effect of the choices such as Kexp and primary energy conversion factors on the consequence of time mismatch between energy production and use.





		E	fPnren	fPren	EPnren	EPren	EPtot	RER	
		kWh			kWh	kWh	kWh		
+ Delivered energy	PV	**13**	**0,0**	**1,0**	0	13	13		STEP "A"
- Exported energy	PV	**7**	0,0	1,0	0	-7	-7		
+ Delivered energy	Grid	**12**	**2,0**	**0,5**	24	6	31		
TOTAL STEP A					***24***	***12***	***36***	***0,33***	

Kexp ☐	**0,0**								
TOTAL STEP A					**24**	**12**	**36**		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					**24**	**12**	**36**	**0,33**	
Energy available ext.		7	0,0	1,0	**0**	**7**	**7**	**1,00**	

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

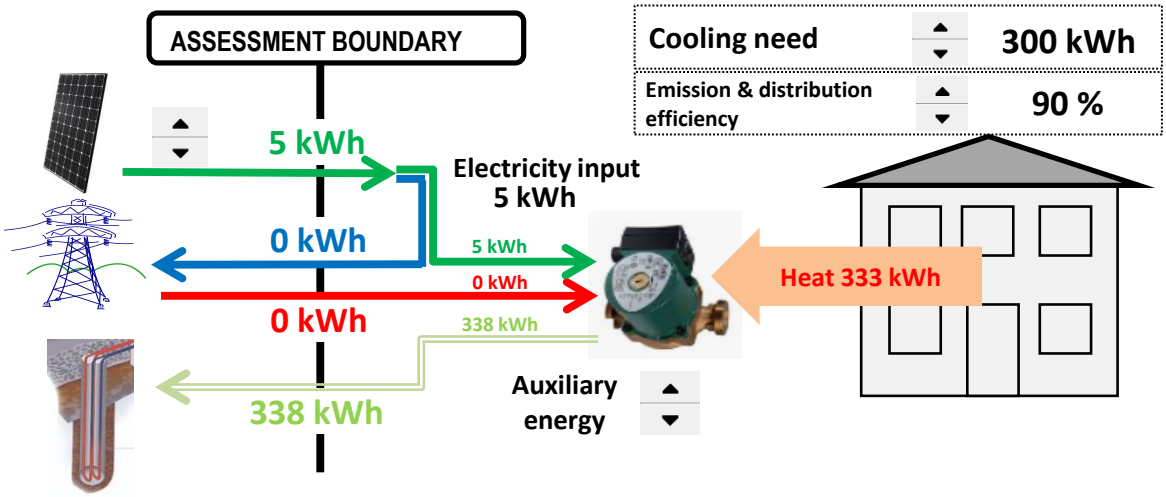
Daily PV generation and electricity use profile

Time of day	PV production		Heating & DHW		PV Exp	PV Used	Grid Used
	%	kWh	%	kWh	kWh	kWh	kWh
1	0,0	0,00	3,4	0,59	0,00	0,00	0,59
2	0,0	0,00	3,4	0,59	0,00	0,00	0,59
3	0,0	0,00	3,4	0,59	0,00	0,00	0,59
4	0,0	0,00	3,4	0,59	0,00	0,00	0,59
5	0,0	0,00	3,3	0,57	0,00	0,00	0,57
6	0,0	0,00	3,2	0,56	0,00	0,00	0,56
7	0,0	0,00	3,4	0,59	0,00	0,00	0,59
8	2,5	0,33	13,9	2,40	0,00	0,33	2,08
9	5,0	0,65	3,6	0,62	0,03	0,62	0,00
10	10,0	1,30	2,9	0,51	0,79	0,51	0,00
11	12,5	1,63	2,9	0,50	1,12	0,50	0,00
12	15,0	1,95	2,8	0,49	1,46	0,49	0,00
13	15,0	1,95	6,6	1,15	0,80	1,15	0,00
14	13,5	1,76	2,7	0,47	1,29	0,47	0,00
15	11,5	1,50	2,8	0,48	1,01	0,48	0,00
16	7,5	0,98	2,7	0,47	0,51	0,47	0,00
17	5,0	0,65	2,8	0,48	0,17	0,48	0,00
18	2,5	0,33	2,8	0,48	0,00	0,33	0,16
19	0,0	0,00	2,9	0,49	0,00	0,00	0,49
20	0,0	0,00	2,9	0,49	0,00	0,00	0,49
21	0,0	0,00	13,4	2,31	0,00	0,00	2,31
22	0,0	0,00	8,7	1,50	0,00	0,00	1,50
23	0,0	0,00	3,1	0,54	0,00	0,00	0,54
24	0,0	0,00	3,2	0,55	0,00	0,00	0,55
TOTAL	100,0	13,00	104,3	18,00	7,20	5,80	12,20

Could be used, based on daily total	D	13,00
Is used, based on sum of hourly balance	H	5,80
Matching factor, from daily to hourly	H/D	0,45

Intended use of this sheet

Demonstrate the concept of time mismatch between (electric) energy production and use
Demonstrate the concept of matching factor
Demonstrate the effect of the choices such as Kexp and primary energy conversion factors on the consequence of time mismatch between energy production and use.



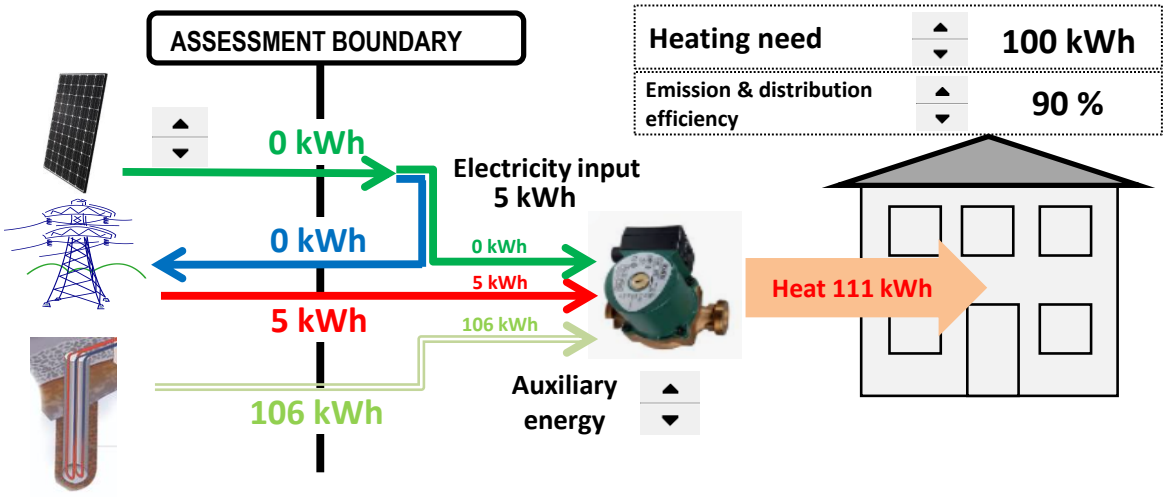
		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	**5**	**0,0**	**1,0**	0	5	5	
- Exported energy	PV	**0**	0,0	1,0	0	0	0	
+ Free cooling	FC	**338**	0,0	1,0	0	338		
+ Delivered energy	Grid	**0**	**2,3**	**0,2**	0	0	0	
TOTAL STEP A					***0***	***343***	***343***	***1,00***

STEP "A"

Kexp ☑	**1,0**							
TOTAL STEP A					**0**	**343**	**343**	
+ Exported energy	PV	**0**	0,0	1,0	0	0	0	
- Avoided grid gen	Grid	**0**	2,3	0,2	0	0	0	
Energy performance					**0**	**343**	**343**	**1,00**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	**0,00**	**1,00**	**1,00**
Free cooling	FC	**0,00**	**1,00**	**1,00**
Grid electricity	Grid	**2,30**	**0,20**	**2,50**



		E	fPnren	fPren	EPnren	EPren	EPtot	RER
		kWh			kWh	kWh	kWh	
+ Delivered energy	PV	**0**	**0,0**	**1,0**	0	0	0	
- Exported energy	PV	**0**	0,0	1,0	0	0	0	
+ Free heating	FC	**106**	0,0	1,0	0	106		
+ Delivered energy	Grid	**5**	**2,3**	**0,2**	12	1	13	
TOTAL STEP A					***12***	***107***	***119***	***0,90***

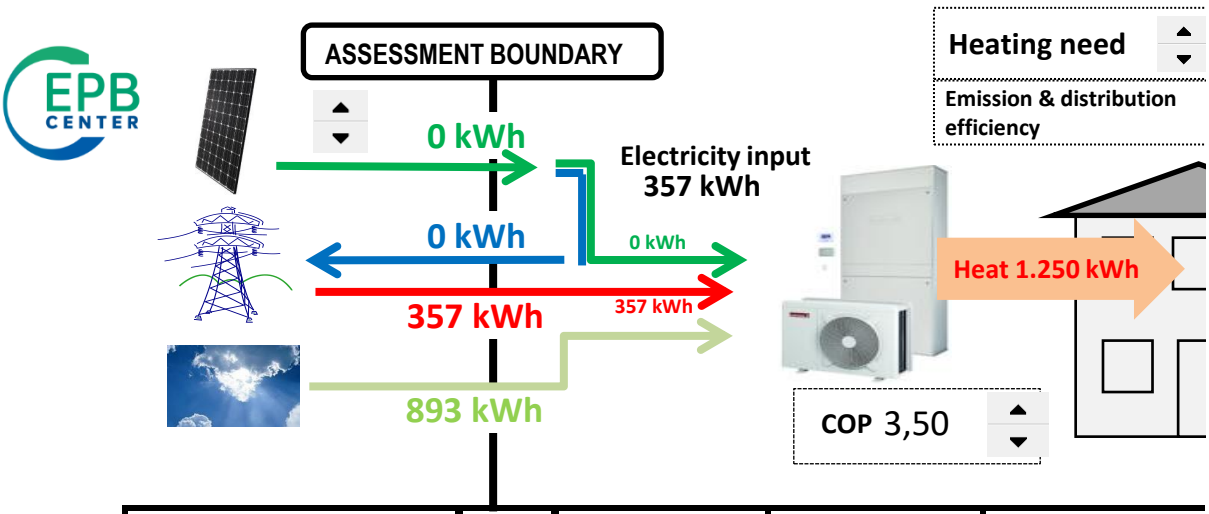
STEP "A"

Kexp ☑	**1,0**							
TOTAL STEP A					**12**	**107**	**119**	
+ Exported energy	PV	**0**	0,0	1,0	0	0	0	
- Avoided grid gen	Grid	**0**	2,3	0,2	0	0	0	
Energy performance					**12**	**107**	**119**	**0,90**
Energy available ext.		0	0,0	1,0	**0**	**0**	**0**	**n.a.**

STEP "B"

Primary energy factors		fPnren	fPren	fPtot
Photovoltaic	PV	**0,00**	**1,00**	**1,00**
Free heating	FC	**0,00**	**1,00**	**1,00**
Grid electricity	Grid	**2,30**	**0,20**	**2,50**

EPB CENTER



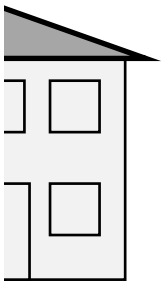
		E	fwe	Euros	
		kWh	€/kWh	€	m²
+ Delivered energy	PV	**0**	0,00	0	1,07
- Exported energy	PV	**0**	0,00	0	
+ Environment heat	HP	**893**	0,00	0	Weightin
+ Delivered energy	Grid	**357**	0,30	107	
TOTAL STEP A				***107***	

Kexp ☑	**1,0**			
TOTAL STEP A				**107**
+ Exported energy	PV	**0**	0,00	0
- Avoided grid gen	Grid	**0**	0,15	0
Weighted performance				**107**
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
Electricity imported from grid	2,50	0,30	0,40
Electricity exported to the grid	2,50	0,15	0,40

1.000 kWh

80%



100
€/m²yr

g type

EPB CENTER