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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
Office building

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Final report

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Abbreviations and acronyms in this document:

AHU	**Air handling unit**
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 EN ISO 52000-1, CEN/TS 16628 and CEN/TS 16629 or later updates**
GDPR	**EU General Data Protection Regulation (2018)**
ISO	**International organization for standardization**
MFH	**Multi Family House**
NA (/ND)	**National Annex or National Datasheet for EPB standards**
NSB	**National Standards Body of CEN and/or ISO**
RER	**Renewable energy ratio**
SFH	**Single Family House**
TR	**Technical report (of CEN and/or ISO)**

1 Introduction

This document is the report of the case study on a sample office building to show how the energy performance can be calculated with the new (CEN and ISO) EPB standards.

This case study uses several key modules one at a time using the demo excel files. Generally, outputs of one module are copy pasted to the input of the next module.

The focus is on the consistency, ease of use and sensitivity of the calculation method.

2 Executive summary

This case study demonstrates the complete calculation of the energy performance of an office building and the related technical systems using the set of (CEN and ISO) EPB standards. The objective is to demonstrate that the connections between modules work so that it is possible to perform a complete energy performance calculation with the set of EPB standards. Some variants are also tested to cover the most likely cases coherently with the type of building. This is to check that the system works not only for a single case but for foreseeable configurations of building and technical systems and that the needed modules are available.

Two base cases have been selected:

- an existing office building (OFF), typically 20 to 30 years old that has not yet undergone a deep renovation;
- a new office building.

The energy performance of the existing office building has been calculated the average climate. The basic system configuration consists of fan coils, condensing boiler, natural ventilation, water-based chiller.

The effort has been concentrated on the new building because in this case it is more interesting to investigate alternatives about the technical systems.

The energy performance of the typical new building has been calculated at first for three representative climates, taking into account a building envelope insulation level in accordance with the climate. The basic system configuration is the same for all three climates: radiators, boiler for heating, cooling with local air conditioners. Local domestic hot water production has not been considered (domestic hot water needs are negligible for office buildings).

Then the maximum PV allowed by thew size of the building was added and the new performance calculated for average climate, with both k_{exp}=0 and k_{exp}=1 [1].

The case study confirmed that the EPB standards (modules) work together and the various building and technical systems configuration can be calculated: the method is functional and complete.

Concerning usability, the hourly method increases the calculation load on the computer but it does not require a higher effort on the assessor, since the description of building and systems is not significantly changing depending on the calculation interval. Setting the whole to work hourly requires some care in defining some details like use profiles, comfort requirement schedule, system operation schedule. Once solved, the assessor is left with just the choice between schedules linked to the space category and the type of system operation (which is nothing different from using monthly methods).

[1] k_{exp} is an important parameter for weighting the energy exported from the building site. For more information, see case studies and short videos on EN ISO 52000-1.

The hourly calculation for the entire year was successfully done with the Excel files only. Actually, some marginal modules were simulated with simple alternative models, due to the limited availability of time and the large number of calculations required. This indeed confirms that the Excel can be used to prepare and document reference cases to test software for productive use based on the same standards.

3 The context of the case study

The new (CEN and ISO) EPB standards have been published in the years 2017…2018. This revision supports the hourly calculation interval.

This case study demonstrates how to perform the entire calculation for some representative configurations of an office building.

The productive use of the set of EPB standards would require a professional software, just like any other method currently in use. This case study uses the demo Excel of the single modules, with some enhancements, to demonstrate that it is possible, it gives consistent and useful results and it doesn't require unreasonable effort for a standard calculation.

4 Coverage of the scope

4.1 Introduction

The scope is covered if:

- technologies that are likely to be included in the building and technical systems;
- possible installation configurations;
- required performance indicators;
- calculation interval;

are covered.

Two representative base cases are defined:

- existing office building;
- new office building.

Variants on these base cases are explored to cover the most likely configurations.

4.2 Coverage of technologies

The EPB standards cover all the most popular technologies on the market, for new and existing buildings. The technologies tested in this case study include:

- boilers;
- heat pumps;
- water based chiller;
- photovoltaic.

4.3 Coverage of installation configurations

The set of EPB standards have a modular structure that is designed to adapt to the actual installation configuration.

The concept of modularity has both the goal to adapt to virtually any configuration and to allow a progressive use of the new modules.

An office building is likely to have a complex configuration, including ventilation and air conditioning. More complexity can be found in non-residential buildings (commercial centers, offices blocks) where several space categories may be included in a single building, together with connected services and activities (restoration, educational, recreational activities).

4.4 Coverage of performance indicators

The calculated performance indicators include:

- global performance indicators, such as primary energy, CO_2 emissions, etc.
- partial performance indicators, such as system efficiencies, average transmittance, etc.

4.5 Coverage of calculation intervals

The case study is focused on hourly calculation.

5 Definition of the cases

5.1 Rationale of the selection of cases

The selection of cases shall cover:

- the different climates;
- the level of insulation of the building;
- the system technologies.

The intent is not to test all possible combinations with all examples but to use likely technologies at least once, in the context where they are most likely to be used.

5.2 Types of building envelope

The following types of buildings envelope have been considered

- existing building, with poor or moderate insulation (20…30 years old);
- new building with passive house or NZEB insulation level.

The insulation level is correlated to the climate.

5.3 Selected cases and variants

5.3.1 Case 1: Existing office building

5.3.1.1 Base case

The base case is a sample office building (OFF) defined in the preparatory work.

It is taken from Aldren example B1 and realistic in size. It has been reviewed to figure out the space for realistic technical installations:

- a technical room was added on each floor to provide a vertical connection and space for technical systems cabinets;
- the height of floors was increased by 40 cm to allow false ceilings for ventilation and other technical installations (sprinkler, lighting, heating / cooling distribution, etc.).

The building has 4 levels and its dimensions are:

- total net floor area: 1365 m^2
- total net volume: 4096 m^3

- total gross volume: 5356 m^3
- heat loss area: 1972 m^2
- shape factor: 0,37 m^{-1}

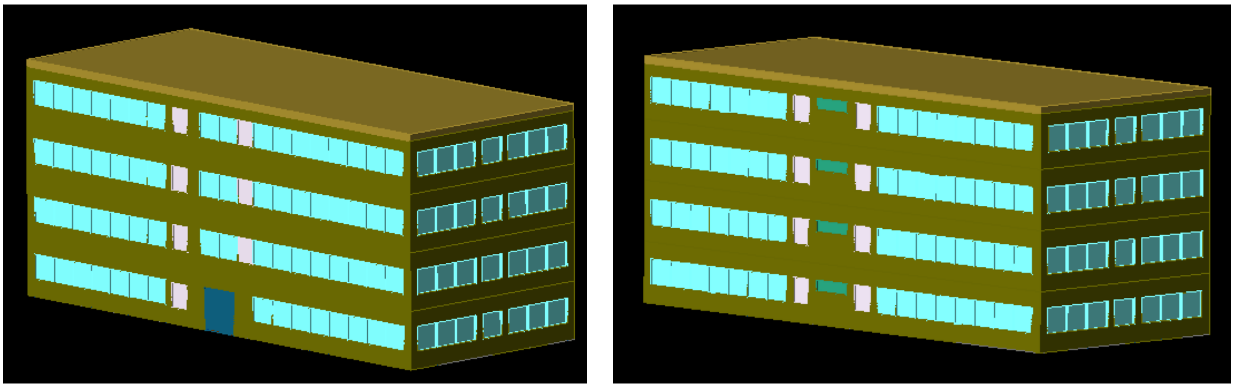


Figure 1 - Office block

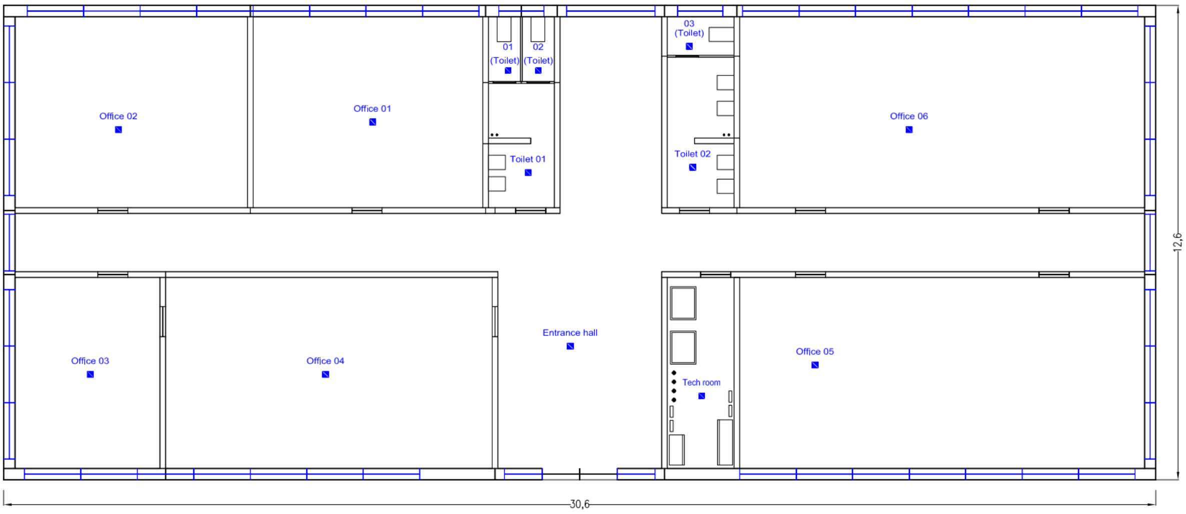


Figure 2 - Office block – Ground floor plan

Figure 3 - Office block – Typical upper floor plan

Both the useful floor area and the reference area are assumed to be the net floor area for this case study.

An insulation level that was likely 20...30 years ago is assumed, see table 1.

Table 1: Assumed U-value of building elements for the existing building

Building element	Cold climate	Average climate	Warm climate
Walls	0,60 W/m²K	0,80 W/m²K	1,20 W/m²K
Roof	0,40 W/m²K	0,60 W/m²K	0,60 W/m²K
Windows	1,40 W/m²K	1,80 W/m²K	2,60 W/m²K
Floor	0,80 W/m²K	1,20 W/m²K	1,20 W/m²K

Domestic hot water needs are not considered. Domestic hot water use in an office building are negligible and usually satisfied by simple electric heaters under the sink. Domestic hot water needs for offices are set to 0 as a default value in annex B to EN 12831-3.

Technical systems configuration:

- Heating: fan-coil with on-board thermostats, internal distribution, standard boiler;
- Domestic hot water: local direct electric production, not considered
- Ventilation: natural ventilation, air exchange rate according to comfort category II;
- Cooling: fan-coil for average and warm climate;
- Humidification and dehumidification: none.

5.3.1.2 Variant 1: climate

The calculation is repeated for the 3 typical climates defined in the preparatory work:

- Cold climate: Oslo
- Average climate: Strasbourg
- Warm climate: Athens

5.3.1.3 Variant 3: Photovoltaic

PV is added with the following properties:

- peak power: 20 kW (this means using most available space on the roof).

- orientation: south with 45° tilt angle

Default data for polycrystalline panels.

5.3.2 Case 2: New office building

5.3.2.1 Base case

The description is the same as for the existing building with the following changes.

Table 2: Assumed U-value of building elements for the new building

Building element	Cold climate	Average climate	Warm climate
Walls	0,15 W/m²K	0,20 W/m²K	0,30 W/m²K
Roof	0,10 W/m²K	0,15 W/m²K	0,20 W/m²K
Windows	1,00 W/m²K	1,20 W/m²K	1,40 W/m²K
Floor	0,20 W/m²K	0,30 W/m²K	0,60 W/m²K

Technical systems configuration:

- Heating: low temperature fan coils with room thermostats, internal distribution, air to water heat pump
- Domestic hot water: local production with local direst electric heater (not considered in the calculation).
- Ventilation: mechanical ventilation with heat recovery and controlled supply temperature (air handling unit with heating and cooling coils), air exchange rate according to comfort category II.
- Cooling on all climates with fan coils and water-based chiller.

5.3.2.2 Variant 1: climate

The calculation is repeated for the 3 typical climates defined in the preparatory work.

5.3.2.3 Variant 2 PV

PV is added with the following properties:

- peak power: 20 kW
- orientation: south with 45° tilt angle

Default data for polycrystalline panels.

5.3.3 Calculation cases summary

The resulting table of the calculation cases is given in the following table 3.

Table 3: List of considered cases and variants

Cases and variants	Building	Climate	PV	Cooling
OFF_E-AVG-II-CNT	Existing	Average	NO	YES
OFF_E-AVG-PV	Existing	Average	NO	YES
OFF_E-CLD	Existing	Cold	NO	NO
OFF_E-CLD-PV	Existing	Cold	NO	NO
OFF_E-WRM	Existing	Warm	NO	YES
OFF_E-WRM- PV	Existing	Warm	YES	YES
OFF_N-AVG	NEW	Average	NO	YES
OFF_N-AVG-PV	NEW	Average	YES	YES
OFF_N-CLD	NEW	Cold	NO	YES
OFF_N-CLD-PV	NEW	Cold	YES	YES
OFF_N-WRM	NEW	Warm	NO	YES
OFF_N-WRM-PV	NEW	Warm	YES	YES

The cases and variants are identified with a code which is built in the following way:

MFH-X-CLI-VRn

Where:

- **MFH** means single family house
- **X** can be:
  - **E** for existing building
  - **N** for new building
- **CLI** is the climate code
  - **AVG** for average climate
  - **CLD** for cold climate
  - **WRM** for warm climate
- **VRn** are the variants, which can be:
  - **TS** for thermal solar
  - **PV** for photovoltaic
  - **REN**_for renovation

The complete list of the calculation files is given in annex A.

6 Calculation details

6.1 Calculation chain

6.1.1 General

The following set of spreadsheets has been used:

- Climatic data: EN ISO 52010-1, TMY for Strasbourg, Athens and Oslo
- Conditions of use: EN 16798-1
- Domestic hot water needs: EN 12831-3
- Hourly heating and cooling needs or summer indoor temperature: EN ISO 52016-1

- Heating and domestic hot water, general part: EN 15316-1, with simplified models for emission and distribution
- Domestic hot water storage: EN 15316-5
- Thermal solar: EN 15316-4-3, hourly method for thermal solar coupled with storage EN 15316-5
- Photovoltaic: EN 15316-4-3, hourly method for PV
- Boiler: EN 15316-4-1
- Heat pump: EN 15316-4-2
- Cooling emission losses: emission losses have been calculated with decreased temperature set, according to EN 15316-2
- Cooling generation: EN 16798-13
- Ventilation and heat recovery: EN 16798-5-1
- Weighted energy: EN ISO 52000-1

Simplified models were used only for marginal modules.

Data transfer between modules has been done manually.

The whole sequence of files for each variant is saved in one individual folder.

See annex A for the complete list of the files.

6.1.2 Domestic hot water needs

No domestic hot water has been considered for this building category.

Domestic hot water use is negligible and it is often produced locally by electric heaters.

According to Annex B to EN 12831-3, domestic hot water needs for offices are zero.

6.1.3 Use profiles

As a simplification, all rooms are considered single offices. The actual composition of the sample office building would be:

- Office rooms 72,9 %
- Entrance and corridors 19,5 %
- Janitors 5,1 %
- Technical rooms 2,5 %

Use profiles are taken from annex B to EN 16798-1, default profile for office rooms, comfort category II.

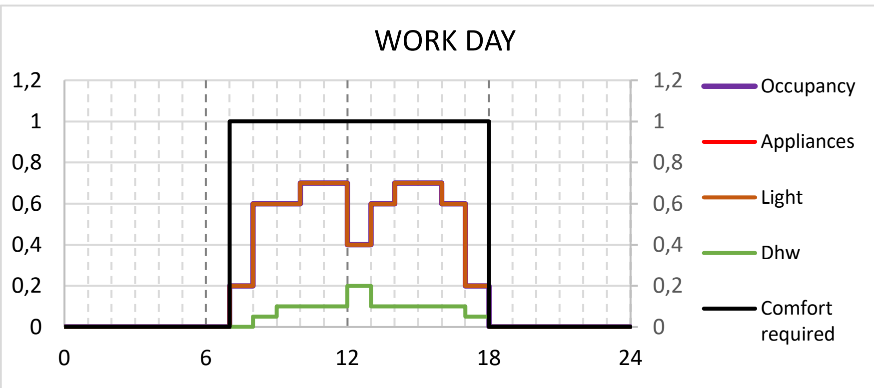


Figure 4 – Hourly profiles for office rooms – week-day

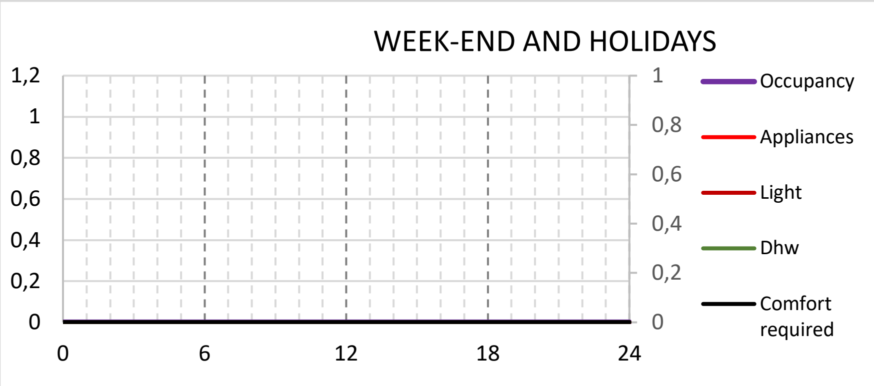


Figure 5 – Hourly profiles for office rooms – week-end and holidays

The following operating conditions are assumed during occupancy, according to comfort category II defined in EN 16798-1 annex B:

- Heating set-point 20 °C, intermittent operation
- Cooling (when available) set-point 26 °C, intermittent opertion
- Ventilation: flow rate according to perceived air quality criterion.

Other relevant basic internal operating conditions are summarised the following figure 6

BASE PARAMETERS	Value	Unit	Values per person		Space total		Average, one week	
Occupancy	10,0	m²/pers			132,60	p	56,0	m²/pers
Occupants total gains	11,8	W/m²	118,0	W/pers	15646,8	W	2,11	W/m²
Occupants sensible gains	8,0	W/m²	80,0	W/pers	10608	W	1,43	W/m²
Appliances sensible gains	12,0	W/m²			15912	W	2,14	W/m²
Lighting	3,0	W/m²			4000	W		
Lighting	500	Lux						
Moisture production	6,0	g/m²h	60,0	g/h pers	7956	g/h	60,0	g/pers h
CO2 production	1,87	l/m²h	18,7	l/h pers	2479,62	l/h	18,7	l/pers h
Ventilation, base flow rate	1,40	l/sm²	14,0	l/s pers	1856,4	l/s	0,55	l/sm²

Figure 6 – Reference values for operating conditions according to EN 16798-1 – Annex B

The profile is generally plausible.

To allow to reach the comfort conditions according to the standard schedule, the operation of technical systems has been anticipated by 2…3 hours, depending on climatic conditions, as shown in figure 7.

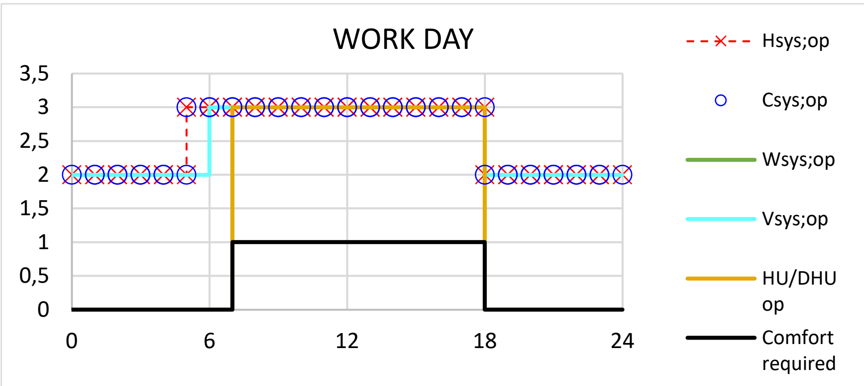


Figure 7 – Adopted operating time schedule

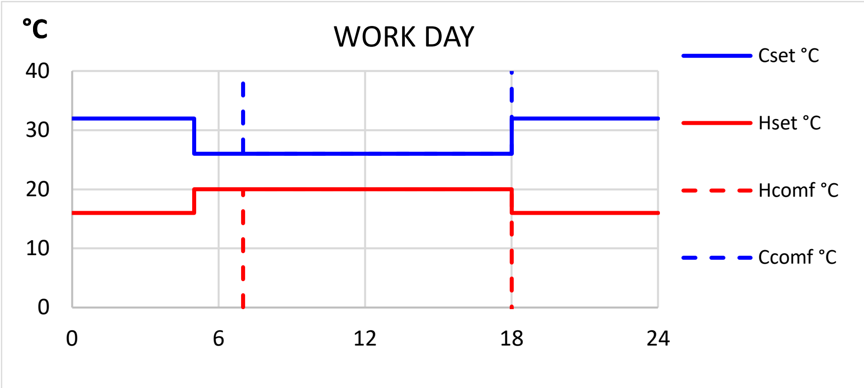


Figure 8 – Adopted set-point time schedule

6.1.4 Climatic data – EN ISO 52010-1

Climatic data are calculated with EN ISO 52010-1 module, using data from the JRC data-base.

Figure 9 shows the outdoor temperature for the typical year taken from JRC data-base

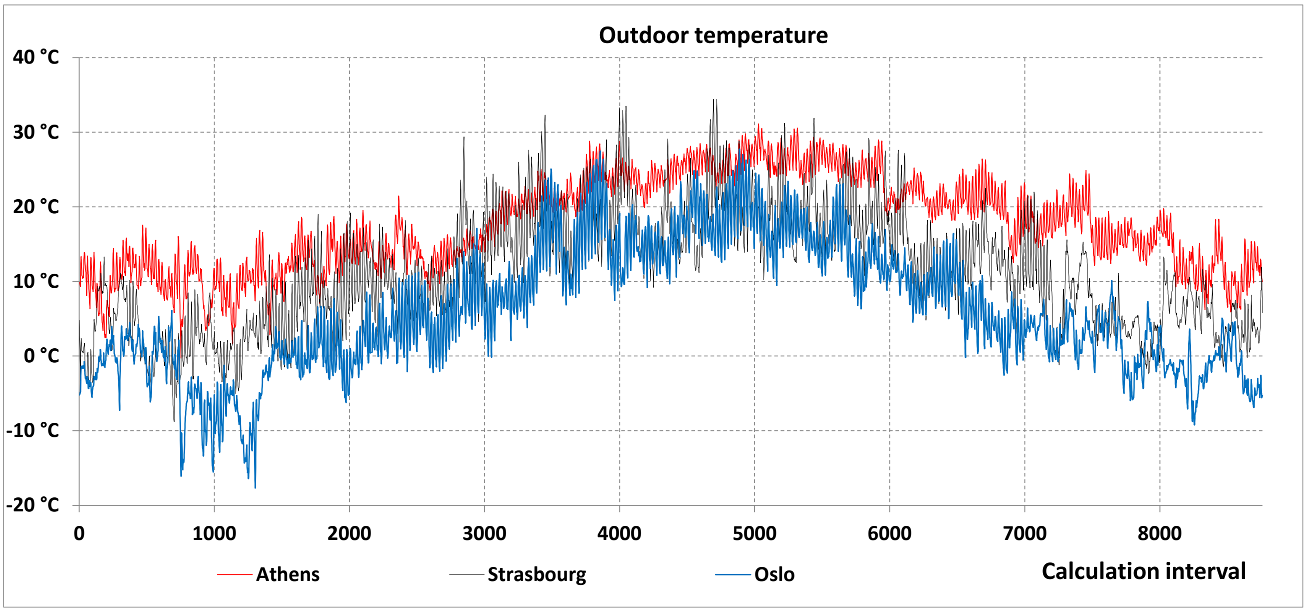


Figure 9 – Outdoor temperature for typical year taken from JRC data-base

See preparatory work document for further details.

6.1.5 Heating and cooling needs – EN ISO 52016-1

An enhanced version of the spreadsheet about EN ISO 52016-1 has been used for the case study.

The spreadsheet has been used without direct coupling with other sheets. When needed (mechanical ventilation with heat recovery), the interacting spreadsheets have been run several times. The saved version is the result after stabilisation.

For more details about this spreadsheet, see the case study about EN ISO 52016-1.

The input parameters have been organised in a set of supporting file:

- Climatic data:
  ISO_52010-1_TMY_[Location]_8_planes.xlsx (*)

- Building description and operating conditions:
  ISO_52016-1_SFH_[Case descriptor]_DESC.xlsx (**)

(*) [Location] may be Strasbourg, Athens or Oslo for the 3 climates

(**) [Case_descriptor] is shown in table 3.

Detailed results can be found in the “Graph” sheet of the respective calculation spreadsheet.

The data input consists of the geometrical description of the building and relevant properties of building elements, just like any current method according to EN ISO 52016-1 (or its predecessor EN ISO 13790), monthly or hourly.

The spreadsheet uses a simplified version of the input of the building envelope, due to interface and calculation complexity limitations in Excel. The simplification concerns specifically the shading factors, which have an important influence on solar gains. Accuracy in the evaluation of the shadings is crucial for the calculation of well insulated buildings. This issue is mostly geometrical and is the same for the monthly and the hourly method. The version of the spreadsheet used for EN ISO 52016-1 (that available when running the calculations for the case study) uses constant shading coefficients. The average shading coefficients have been calibrated by comparison with results obtained with a commercial software using EN ISO 52016-1 hourly calculation method for the needs. For further information see the case study on “*EN ISO 52016-1, Annex F, Solar shading reduction factors*”.

6.1.6 Heating and domestic hot water system, general part – EN 15316-1

The demo spreadsheet on EN 15316-1 was used, primarily to calculate operating conditions and to replace the calculation of selected sub-systems with simplified modules.

The specific input required for the calculation of operating conditions is shown in figures 10 and 11 for the existing building case.

			Heating service area 1
Emitters nominal power of service area i	$\phi_{H;em;nom;sah,i}$	kW	100
Type of emitters in service area i			Fan-coil

Circuit type, GEN i			Type 2 - Independent flow
Generator i nominal power	$\phi_{X;gen;n}$	kW	80
Generator i nominal Δθ	$\Delta\theta_{X;gen;n}$	°C	20

Figure 10 – Product technical data for heat emitters

The product technical data is the type of emitters and their rated power, as well as the power, nominal temperature difference of the generator. If not known, the rated power can be assumed equal to the heat load, which is easily calculated from the data input for the heating need calculation. A default value can be readily proposed by any software. Only in special cases, heat emitters may be intentionally oversized to reduce operating temperature.

Floor area	$A_{sah;1}$	m²	1365
Is service area operational?			YES
Emitter power control type			Type 4 - By bass
Flow temperature control type			Type 3 - Constant flow temperature

Figure 11 – Process design data sample

Figure 11 provides a sample of the required input data about process design, that is :

- the type of emitter control (room temperature control);
- the type of control of water flow temperature, in this case constant for fan-coils.

The remaining data are default data depending on the previous choices that may need to be changed only for very special configurations. An example of such data is provided in figure 12 and 13.

	Emitters nominal Δϑ air	Emitters exponent n	Emitters nominal Δϑ water
	°C		°C
Radiator	50	1,3	20
Floor heating	15	1,1	5
Fan-coil	25	1	10
Special option 1	30	1,2	10
Last option	50	1,3	10

Figure 12 – Typical default data depending on emitter type

Max flow temperature SAH,i	$\theta_{H;em;flw;max;sah,i}$	°C	80
Max Δθ flow / return SAH,i	$\Delta\theta_{H;em;w;max;sah,1}$	°C	20
Desired return temperature SAH,i	$\theta_{H;em;ret;req;sahz,1}$	°C	20
Mixing valve for SAH,i	$MIX_{sah,i}$	0/1	0
Mixing valve Δθ for SAH,i	$\Delta\theta_{H;em;mix;sahz,1}$	°C	2
Desired load factor with ON-OFF for SAH,i	$\beta_{H;em;req;sah,1}$	%	80
Minimum flow temperature for SAH,i	$\theta_{H;em;flw;min;tz,1}$	°C	30

Figure 13 – Typical default data depending on temperature control type

This input and the consequent calculation are crucial for a correct determination of distribution and generation performance. See the case studies on EN 15316-4-2 (heat pump) and EN 15316-1 (heating and domestic hot water system general part, this standard) for more information.

6.1.7 Photovoltaic - EN 15316-4-3

The calculation of the thermal solar system was performed using the hourly method of EN 15316-4-3 for solar panels.

The input interface is shown in figure 14.

Area of PV module	$A_{pv;mod}$	m^2	1,63
Number of PV module	$N_{pv;mod}$	-	82
Azimuth angle of PV modules	α	°	0
Tilt angle of the PV modules	β	°	45
Total area of PV modules			133,4
Peak power	P_{pk}	kW	20,0

Figure 14 – Data input for the PV solar panels

The electricity production is proportional to the installed peak power. The productivity in the 3 reference locations per kW peak installed with the given orientation and tilt is the following:

- Athens 1.513 kWh/kW
- Strasbourg 1.015 kWh/kW
- Oslo 886 kWh/kW

It has to be noted that the hourly calculation also provides the hourly distribution of this generation so that the match with electricity use can be verified.

The possible optimisation of orientation and tilt has not been explored in this case study.

6.1.8 Boiler - EN 15316-4-1

The calculation of the boiler was performed using the hourly method of EN 15316-4-1.

The data input consists of product data that are given in the product fiche according to ERP regulation, as shown in figure 15.

Generator output at full load	P_n	kW	80
Generator output at intermediate load	P_{int}	kW	24
Generator efficiency at full load	$\eta_{gen;Pn}$	-	0,89
Generator efficiency at intermediate load	$\eta_{gen;Pint}$	-	0,87
Generator efficiency at full load - return water temperature 60° *	$\eta_{gen;Pn;60}$	-	0,00
Generator efficiency at full load - return water temperature 30° *	$\eta_{gen;Pn;30}$	-	0,00
Stand-by heat losses as a function of generator power output	$f_{gen;ls;P0}$	-	0,01
Auxiliary energy at full load	$P_{aux;Pn}$	kW	0,37
Auxiliary energy at intermediate load	$P_{aux;Pint}$	kW	0,12
Auxiliary energy at stand-by load	$P_{aux;P0}$	kW	0,02

Figure 15 – Data input for the boiler – Standard boiler

The method also uses some default parameters, such as the fraction of recovered losses, which are identified based on qualitative information about the installation (boiler location and similar).

6.1.9 Heat pump - EN 15316-4-2

The calculation of the heat pump was performed using the hourly method of EN 15316-4-2, according to the last draft version sent to public enquiry in CEN-TC 228. The calculation is performed according to path A and data declared according to EN 14511.

Figures 18 and 19 summarize the basic data input for the heat pump.

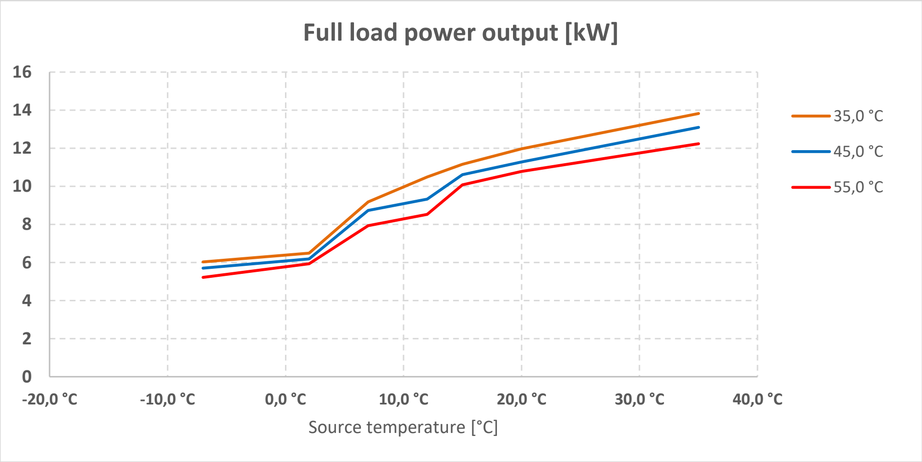


Figure 16 – Full load power output

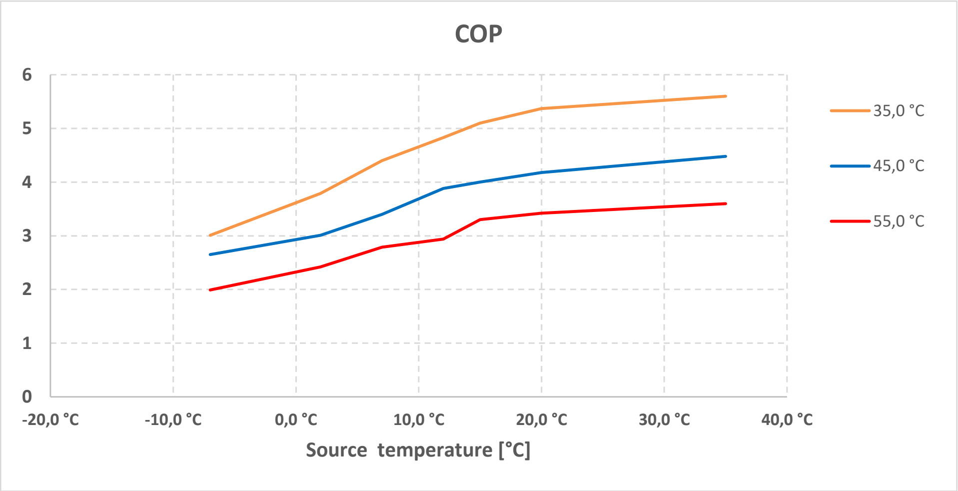


Figure 17 – COP at full load

The size of the heat pump has been adapted by multiplying by a constant factor all data concerning power output, input and auxiliaries.

See clause 6.3.2 of the case study about EN 15316-4-2 (heat pumps) for a detailed description of the input data.

6.1.10 Cooling generation - EN 16798-13

The calculation of the cooling generation was performed using the hourly method of EN 16798-13.

The data input consists of the nominal power and EER in 4 operating conditions declared in the product fiche, as shown in figure 18.

Nominal thermal power extracted from chilled water circuit	$\Phi_{C;gen;n}$	kW	6
Energy efficiency at part load condition A	EER_A	-	3,21
Energy efficiency at part load condition B	EER_B	-	5,12
Energy efficiency at part load condition C	EER_C	-	7,18
Energy efficiency at part load condition D	EER_D	-	10,20

Figure 18 – Sample data input for the cooling generation

The nominal thermal power has been adapted according to the size of the heat pump.

The method also uses other parameters, such as the part load factor and the evaporator and condenser temperature in the four test points, which are standardized values for the testing conditions A to D. Data on a fifth point can be added or estimated.

6.1.11 Ventilation and heat recovery - EN 16798-5-1

The calculation of the mechanical ventilation (only for the new building case) was performed using the hourly method of EN 16798-5-1.

The assumed type of mechanical ventilation is:

- double flux with heat recovery
- constant supply and extraction flow rate during occupancy
- mechanical ventilation only provides primary air at a preset supply temperature
- the residual sensible heating and cooling load are satisfied by the fan-coils.

The configuration of the air handling unit (AHU) unit for the new building has been set as shown in figure 22.

General	A	B	C
AHU Leakage class	Frost protection / ground preheating/-cooling	Exhaust air fan	Heat recovery
L1			
Air handling unit localisation	Ground air preheating and -cooling	localisation	Heat recovery type
COND	NO_CTRL	UP_HR	PLATE
Supply air temperature control	Frost protection type		only for PLATE and ROT_HYG
ODA_COMP	BYPASS		Non residential
Control of the volume flow rate	Control of the frost protection		Control of the heat recovery device
NO_CONTR	DIRECT		BYPASS
System testing type			☐ Free-cooling
else			☐ Free-heating

Figure 19 – Mechanical ventilation configuration options

The technical data for the heat recovery unit and fans have been input as shown in figure 20 and 21.

Heat recovery			
Maximum heat transfer power of the heat recovery device	$\Phi_{hr;max}$	kW	70,00
Design air velocity in the heat recovery unit	$v_{hr;des}$	m/s	3,5
Limit for the exhaust air temperature after the heat recovery	$\vartheta_{EHA;hr;lim}$	°C	-5
Pressure drop of the heat recovery device in the supply and extract air stream at design conditions	$\Delta p_{SUP+ETA;des;hr}$	Pa	50
Plate heat recovery data			
Nominal heat recovery temperature efficiency at design air velocity	$\eta_{hr;nom}$	-	0,8
Heat recovery efficiency reduced due to defrost operation at ϑ_e = -7°C, according to EN 13053:2006	$\varepsilon_{D;-7}$	-	0,7
Heat recovery efficiency reduced due to defrost operation at ϑ_e = -15°C, accor-ding to EN 13053:2006	$\varepsilon_{D;-15}$	-	0,4
Maximum (design) supply air flow rate of the system	$q_{V;SUP;hr;nom}$	m^3/h	6688

Figure 20 – Heat recovery technical data

System head losses			
Supply fan design pressure difference	$\Delta p_{SUP;des}$	Pa	250
Extract fan design pressure difference	$\Delta p_{ETA;des}$	Pa	220
Controlled portion of the design supply pressure difference	$f_{\Delta p;SUP;ctrl}$	-	0,8
Controlled portion of the design extract pressure difference	$f_{\Delta p;ETA;ctrl}$	-	0,8
Product data of fans			
Nominal efficiency of the supply fan, taken from manufacturer's data, provided according to EN ISO 5801	$\eta_{fan;SUP;nom}$	–	0,45
Nominal pressure difference over the supply fan, taken from manufacturer's data according to EN ISO 5801	$\Delta p_{fan;SUP;nom}$	*Pa*	250,0

Figure 21 – Fans technical data

6.1.12 Weighted energy - EN ISO 52000-1

The calculation of the weighted energy was performed using the hourly method of EN ISO 52000-1.

The data input consists of the weighting factors and the k_{exp} value[2]. The matching factor is not required because the calculation is hourly.

The calculation was performed with the default values of the weighting factors given in annex B of EN ISO 52000-1, as shown in figure 22.

	fPnren kWh/kWh	fPren kWh/kWh	fPtot kWh/kWh	fCO2 kg_{co2}/kWh	fcost €/kWh
Natural gas	1,10	0,00	1,10	0,22	0,08
Grid delivered electricity	2,30	0,20	2,50	0,42	0,25
Grid exported electricity	2,30	0,20	2,50	0,42	0,25
Thermal solar	0,00	1,00	1,00	0,00	0,00
Photovoltaic	0,00	1,00	1,00	0,00	0,00
Environment heat	0,00	1,00	1,00	0,00	0,00

Figure 22 – Weighting factors

[2] See footnote in Chapter 2.

The cost weighting factor is an estimate. No value is provided in annex B to EN ISO 52000-1 for the cost of energy carriers.

The default value for k_{exp} given in annex B to EN ISO 52000-1 is 1,0. In this case study, the value of k_{exp} is intentionally set to 0,0 or 1,0 to demonstrate the influence of this important parameter. See case study on EN ISO 52000-1 for more information.

6.2 Case 1 – Existing building

6.2.1 Base case for average climate

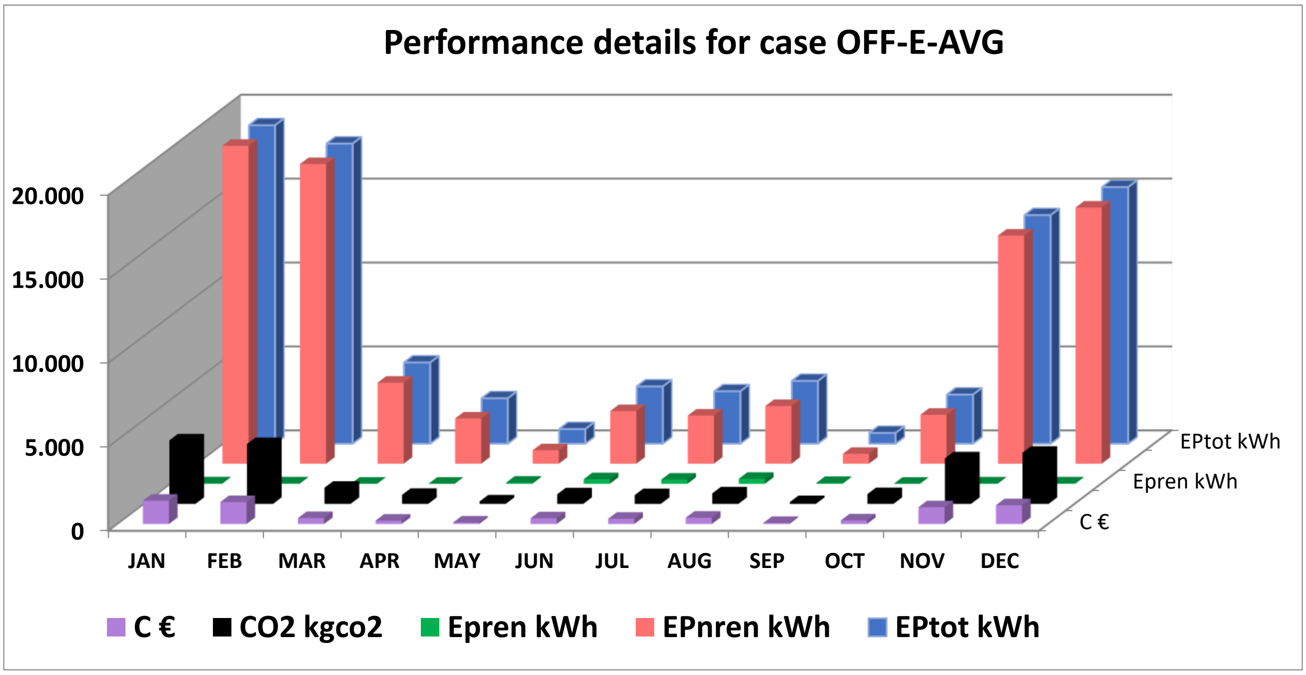
6.2.1.1 Description

Case and variant ID : OFF-E-AVG								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	Existing	Average	Fan-coil Boiler	None	None	Natural	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.1.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-AVG					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**63,7**	*kWh/yr*	**86.943**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**0,8**	*kWh/yr*	**1.056**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**64,5**	*kWh/yr*	**87.998**
CO2 emission	CO_2	*kg/m² yr*	**12,6**	*kg/yr*	**17.177**
Cost	C	*€/m² yr*	**4,95**	*€/yr*	**6.760**
Reference area	A_{ref}	m²	1365		



6.2.1.3 Discussion

Results are plausible. Energy use in summer provides some cooling. The high internal gains inside an office contribute to overheat them.

The system is running mostly on fossil fuels. Electricity is used only for cooling.

6.2.2 Variant for average climate and PV

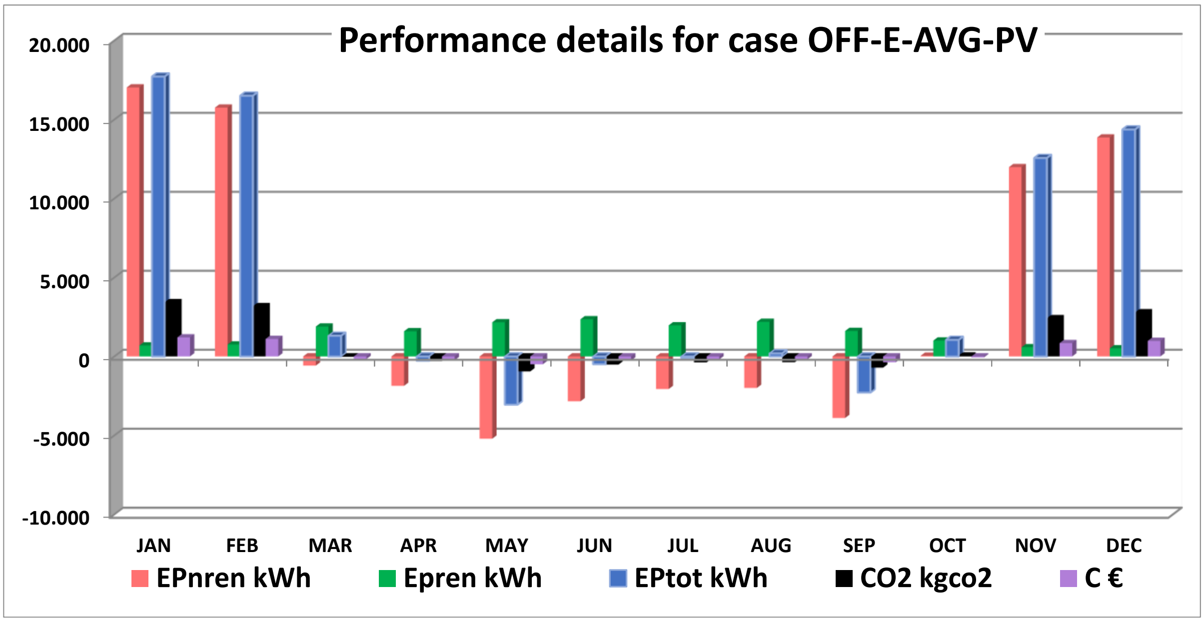
6.2.2.1 Description

Case and variant ID : OFF-E-AVG-PV								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	Existing	Average	Fan-coil Boiler	None	None	Natural	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.2.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-AVG-PV					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**29,5**	*kWh/yr*	**40.222**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**12,7**	*kWh/yr*	**17.306**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**42,1**	*kWh/yr*	**57.528**
CO2 emission	CO_2	*kg/m² yr*	**6,3**	*kg/yr*	**8.646**
Cost	C	*€/m² yr*	**1,60**	*€/yr*	**2.185**
Reference area	A_{ref}	m²	1365		



6.2.2.3 Discussion

Over a full year, the total PV compensates parts of the uses for EPB purpose.

If k_{exp} is set equal to 0, then the PV electricity can only contribute when it is simultaneous with the EPB use. The comparison of the results without PV, with PV and with PV and k_{exp} = 0 is given in the following table.

CASE ID#	E_{Pnren} kWh/m² yr	E_{Pren} kWh/m² yr	E_{Ptot} kWh/m² yr	CO_2 kg/m² yr	C €/m² yr
OFF-E-AVG	63,7	0,8	64,5	12,6	4,95
OFF-E-AVG-PV	29,5	12,7	42,1	6,3	1,60
OFF-E-AVG-PV-K0	57,8	2,8	60,6	11,5	4,31

There is little simultaneity in this case because there is only little electric energy use in summer.

6.2.3 Variant for cold climate

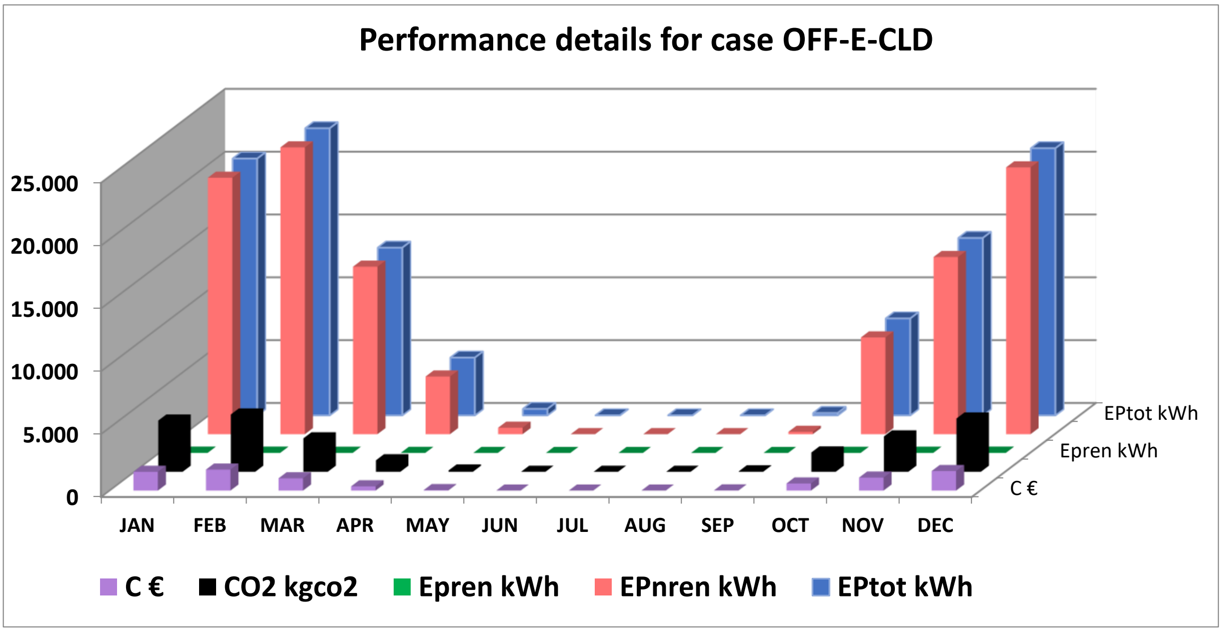
6.2.3.1 Description

Case and variant ID : OFF-E-CLD								
Building	*Type*	*Climate*	*Heating*	*DHW*	*Cooling*	*Ventilation*	*PV*	*Kexp*
OFF	Existing	Cold	Fan-coil Boiler	None	None	Natural	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.3.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-CLD					
Non renewable primary energy	E_{Pnren}	kWh/m² yr	76,9	kWh/yr	104.907
Renewable primary energy	E_{Pren}	kWh/m² yr	0,1	kWh/yr	145
Total primary energy	E_{Ptot}	kWh/m² yr	77,0	kWh/yr	105.052
CO2 emission	CO_2	kg/m² yr	15,3	kg/yr	20.952
Cost	C	€/m² yr	5,63	€/yr	7.690
Reference area	A_{ref}	m²	1365		



6.2.3.3 Discussion

No cooling in this case, pure heating in winter.

6.2.4 Variant for cold climate and PV

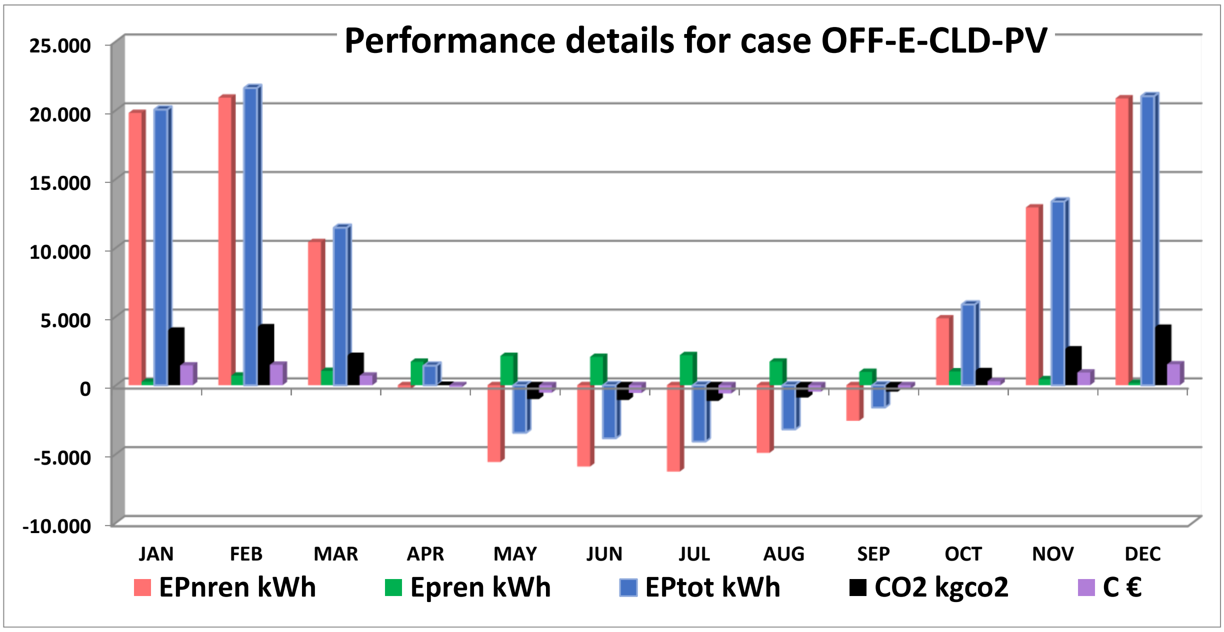
6.2.4.1 Description

Case and variant ID : OFF-E-CLD-PV								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	Existing	Cold	Fan-coil Boiler	None	None	Natural	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.4.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-CLD-PV					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**47,0**	*kWh/yr*	**64.144**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**10,5**	*kWh/yr*	**14.323**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**57,5**	*kWh/yr*	**78.467**
CO2 emission	CO_2	*kg/m² yr*	**9,9**	*kg/yr*	**13.509**
Cost	C	*€/m² yr*	**2,77**	*€/yr*	**3.783**
Reference area	A_{ref}	m²	1365		



6.2.4.3 Discussion

Same remarks as for the average climate case OFF—E-AVG. Comparison table below.

CASE ID#	E_{Pnren} *kWh/m² yr*	E_{Pren} *kWh/m² yr*	E_{Ptot} *kWh/m² yr*	CO_2 *kg/m² yr*	C *€/m² yr*
OFF-E-CLD	**76,9**	**0,1**	**77,0**	**15,3**	**5,63**
OFF-E-CLD-PV	**47,0**	**10,5**	**57,5**	**9,9**	**2,77**
OFF-E-CLD-PV-K0	**76,4**	**0,3**	**76,7**	**15,3**	**5,59**

6.2.5 Variant for warm climate

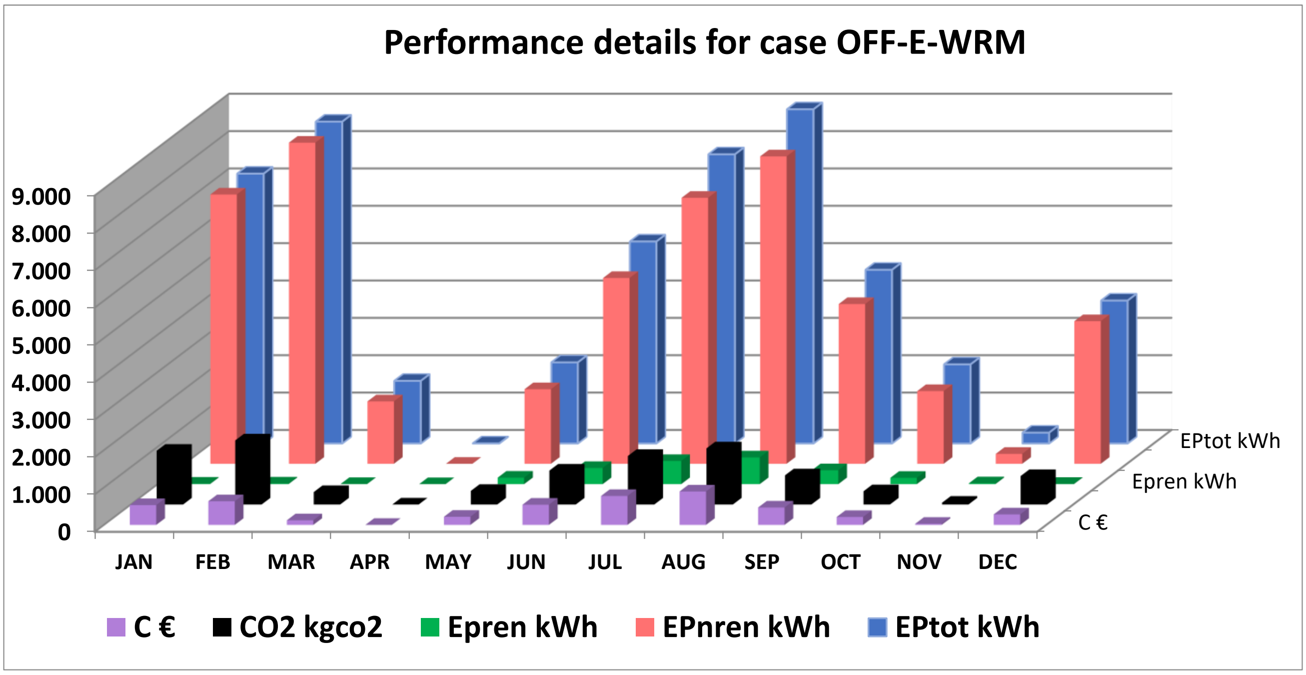
6.2.5.1 Description

Case and variant ID : OFF-E-WRM								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	Existing	Warm	Fan-coil Boiler	None	None	Natural	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.5.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-WRM					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**36,7**	*kWh/yr*	**50.102**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**1,9**	*kWh/yr*	**2.547**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**38,6**	*kWh/yr*	**52.649**
CO2 emission	CO_2	*kg/m² yr*	**7,0**	*kg/yr*	**9.511**
Cost	C	*€/m² yr*	**3,44**	*€/yr*	**4.697**
Reference area	A_{ref}	m²	1365		



6.2.5.3 Discussion

Even with an existing building, the cooling needs exceed the heating needs.

The cooling needs may be controlled by:

- appropriate shadings, to limit solar gains;
- ventilative cooling, as far as possible.

These techniques are taken into account by the set of EPB standards, see specific case studies on this topic.

6.2.6 Variant for warm climate and PV

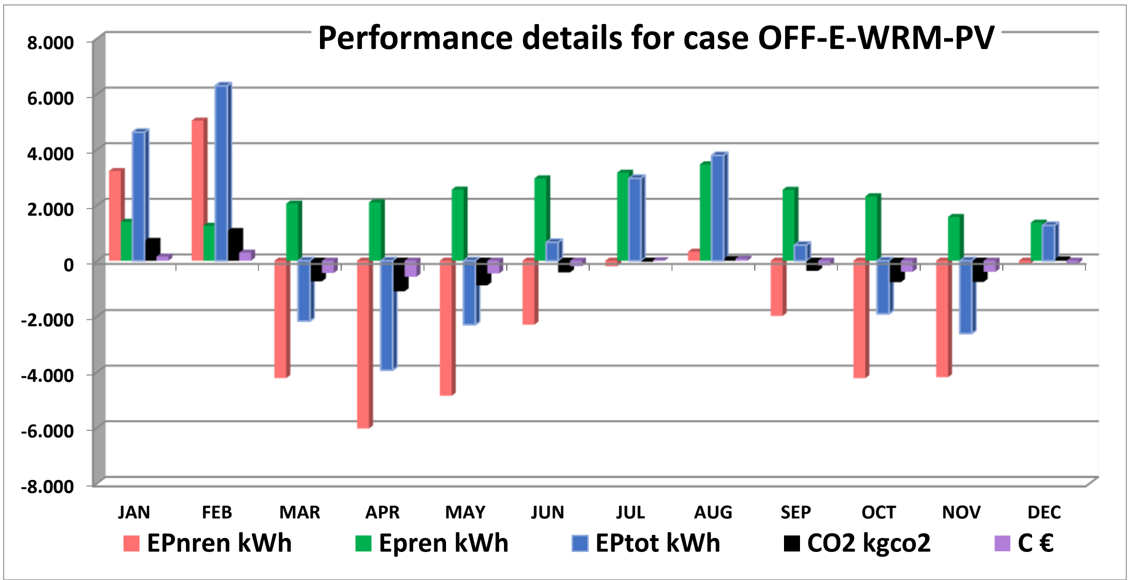
6.2.6.1 Description

Case and variant ID : OFF-E-WRM-PV								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	Existing	Warm	Fan-coil Boiler	None	None	Natural	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.2.6.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-E-WRM-PV					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**-14,3**	*kWh/yr*	**-19.519**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**19,6**	*kWh/yr*	**26.763**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**5,3**	*kWh/yr*	**7.244**
CO2 emission	CO_2	*kg/m² yr*	**-2,3**	*kg/yr*	**-3.202**
Cost	C	*€/m² yr*	**-1,62**	*€/yr*	**-2.210**
Reference area	A_{ref}	m²	1365		



6.2.6.3 Discussion

The energy performance becomes negative because the exported electricity is accounted into the energy performance in the building (k_{exp} = 1) and it exceeds the building energy use. The following table shows the comparison with a different setting of k_{exp}.

Note: the building is still heated by natural gas.

CASE ID#	E_{Pnren} *kWh/m² yr*	E_{Pren} *kWh/m² yr*	E_{Ptot} *kWh/m² yr*	CO_2 *kg/m² yr*	C *€/m² yr*
OFF-E-WRM	36,7	1,9	38,6	7,0	3,44
OFF-E-WRM-PV	-14,3	19,6	5,3	-2,3	-1,62
OFF-E-WRM-PV-K0	22,8	6,7	29,5	4,4	1,93

6.3 Case 2 – New building

6.3.1 Base case for average climate

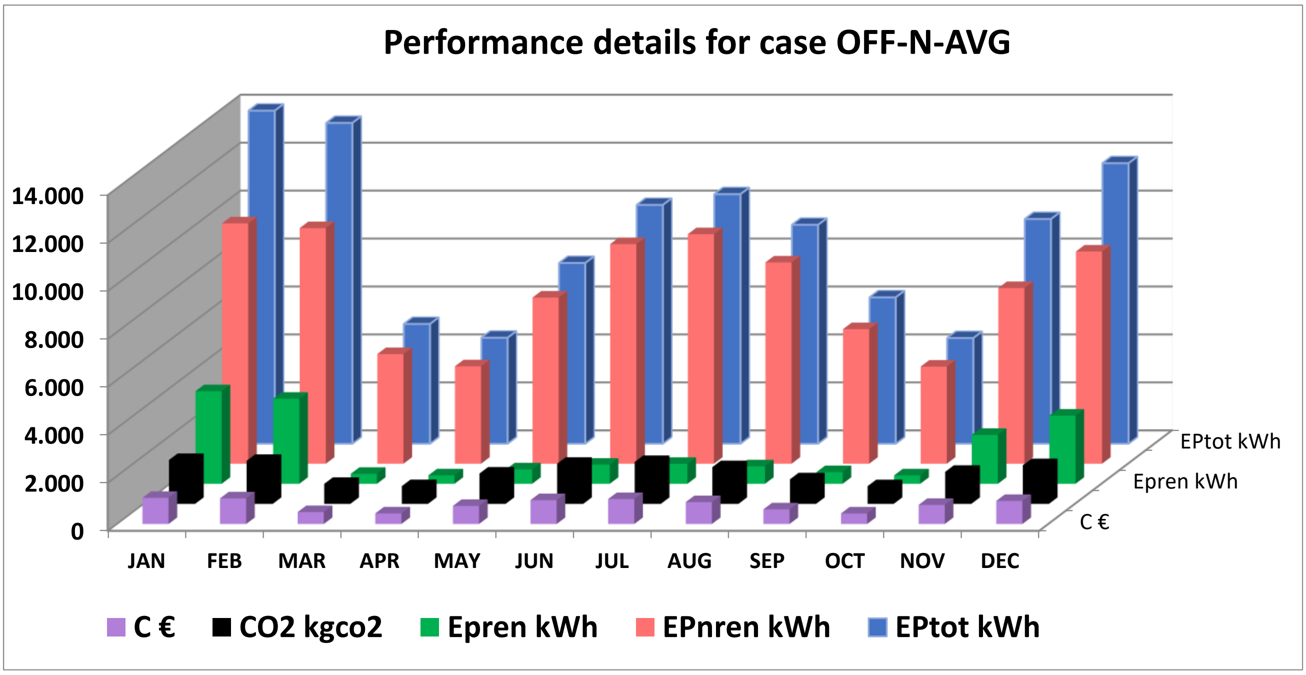
6.3.1.1 Description

Case and variant ID : OFF-N-AVG								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	New	Average	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.1.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-AVG					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**64,8**	*kWh/yr*	**88.412**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**12,4**	*kWh/yr*	**16.872**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**77,1**	*kWh/yr*	**105.284**
CO2 emission	CO_2	*kg/m² yr*	**11,8**	*kg/yr*	**16.145**
Cost	C	*€/m² yr*	**7,04**	*€/yr*	**9.610**
Reference area	A_{ref}	m²	1365		



6.3.1.3 Discussion

The global value of the energy performance is similar to that of the existing building, due to high energy use for cooling and ventilation.

CASE ID#	E_{Pnren} *kWh/m² yr*	E_{Pren} *kWh/m² yr*	E_{Ptot} *kWh/m² yr*	CO_2 *kg/m² yr*	C *€/m² yr*
OFF-E-AVG	63,7	0,8	64,5	12,6	4,95
OFF-N-AVG	64,8	12,4	77,1	11,8	7,04

However, it must be noted that

- ventilative cooling and/or shadings can reduce the cooling needs;
- the new building is more comfortable;
- the mechanical ventilation guarantees the air exchange rate;
- the energy use is now electric, this allows using renewable sources;
- the energy use is in summer and during the day, when PV is available.

6.3.2 Variant for average climate and PV

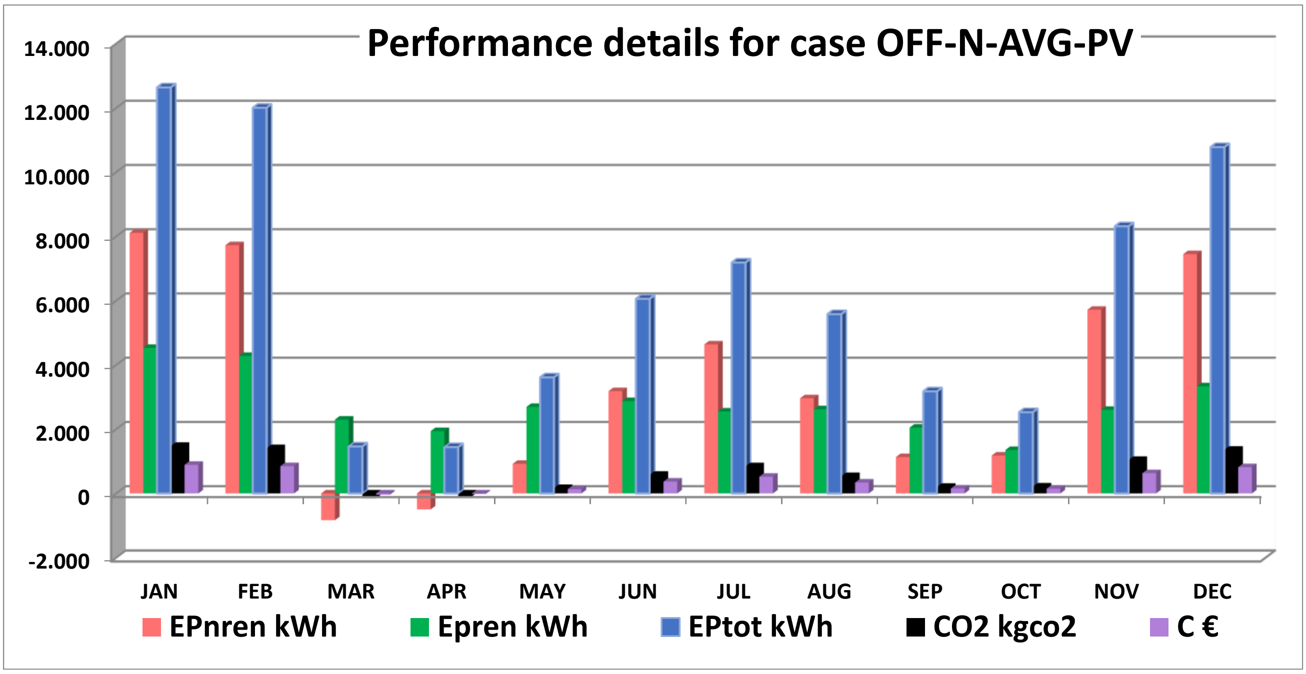
6.3.2.1 Description

Case and variant ID : OFF-N-AVG-PV								
Building	*Type*	*Climate*	*Heating*	*DHW*	*Cooling*	*Ventilation*	*PV*	*Kexp*
OFF	New	Average	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.2.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-AVG-PV					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	30,5	*kWh/yr*	41.691
Renewable primary energy	E_{Pren}	*kWh/m² yr*	24,3	*kWh/yr*	33.123
Total primary energy	E_{Ptot}	*kWh/m² yr*	54,8	*kWh/yr*	74.814
CO2 emission	CO_2	*kg/m² yr*	5,6	*kg/yr*	7.613
Cost	C	*€/m² yr*	3,51	*€/yr*	4.793
Reference area	A_{ref}	m²	1365		



6.3.2.3 Discussion

Obviously, PV production has compensated most energy use for cooling. In the intermediate season there is less heating and cooling and some electric energy is exported.

Even though it looks like that there is little energy exported, thew hourly method with the option k_{exp}=0 still detects a significant time mismatch between productions and use, as shown in the following table where E_{Pnren} decreases about 15 kWh/m² yr.

CASE ID#	E_{Pnren} kWh/m² yr	E_{Pren} kWh/m² yr	E_{Ptot} kWh/m² yr	CO_2 kg/m² yr	C €/m² yr
OFF-N-AVG	64,8	12,4	77,1	11,8	7,04
OFF-N-AVG-PV	30,5	24,3	54,8	5,6	3,51
OFF-N-AVG-PV-K0	45,2	19,2	64,4	8,3	4,92

6.3.3 Variant for cold climate

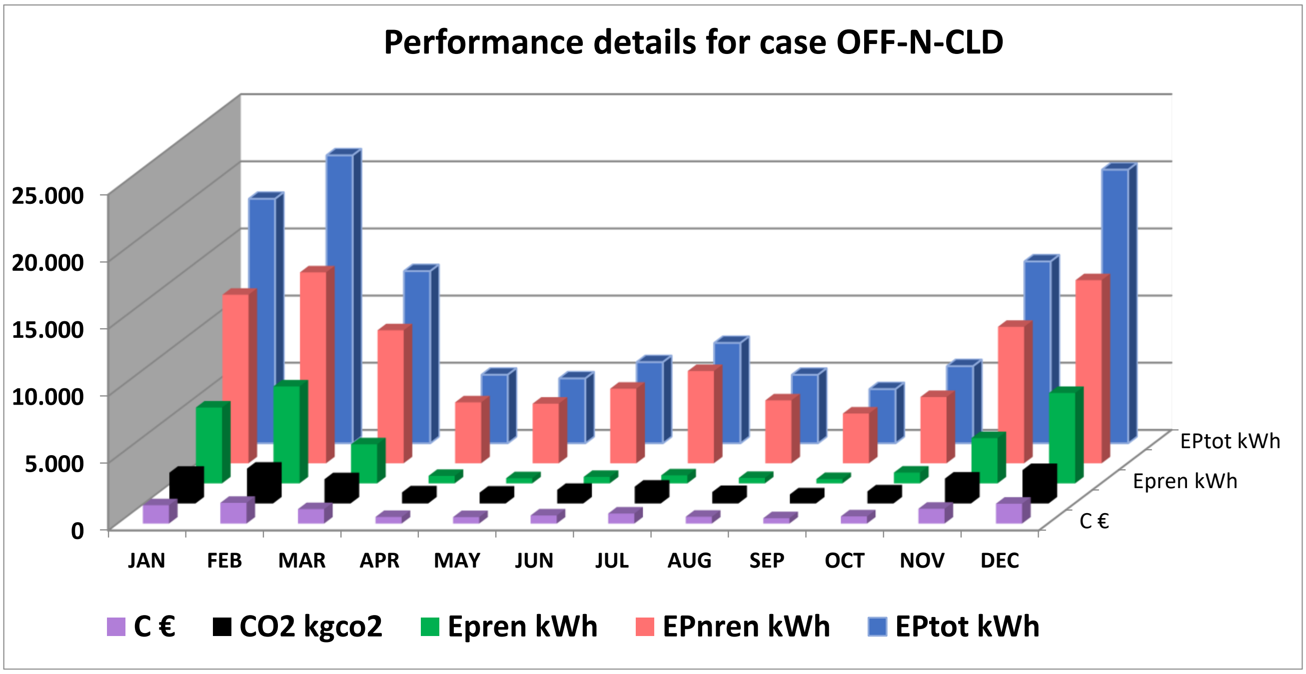
6.3.3.1 Description

Case and variant ID : OFF-N-CLD								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	New	Cold	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.3.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-CLD					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**69,7**	*kWh/yr*	**95.201**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**21,6**	*kWh/yr*	**29.446**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**91,3**	*kWh/yr*	**124.647**
CO2 emission	CO_2	*kg/m² yr*	**12,7**	*kg/yr*	**17.384**
Cost	C	*€/m² yr*	**7,58**	*€/yr*	**10.348**
Reference area	A_{ref}	m²	1365		



6.3.3.3 Discussion

The same remarks about the case for the average climate apply.

In the context of the cold climate, ventilative cooling is likely to greatly reduce the cooling needs.

6.3.4 Variant for cold climate and PV

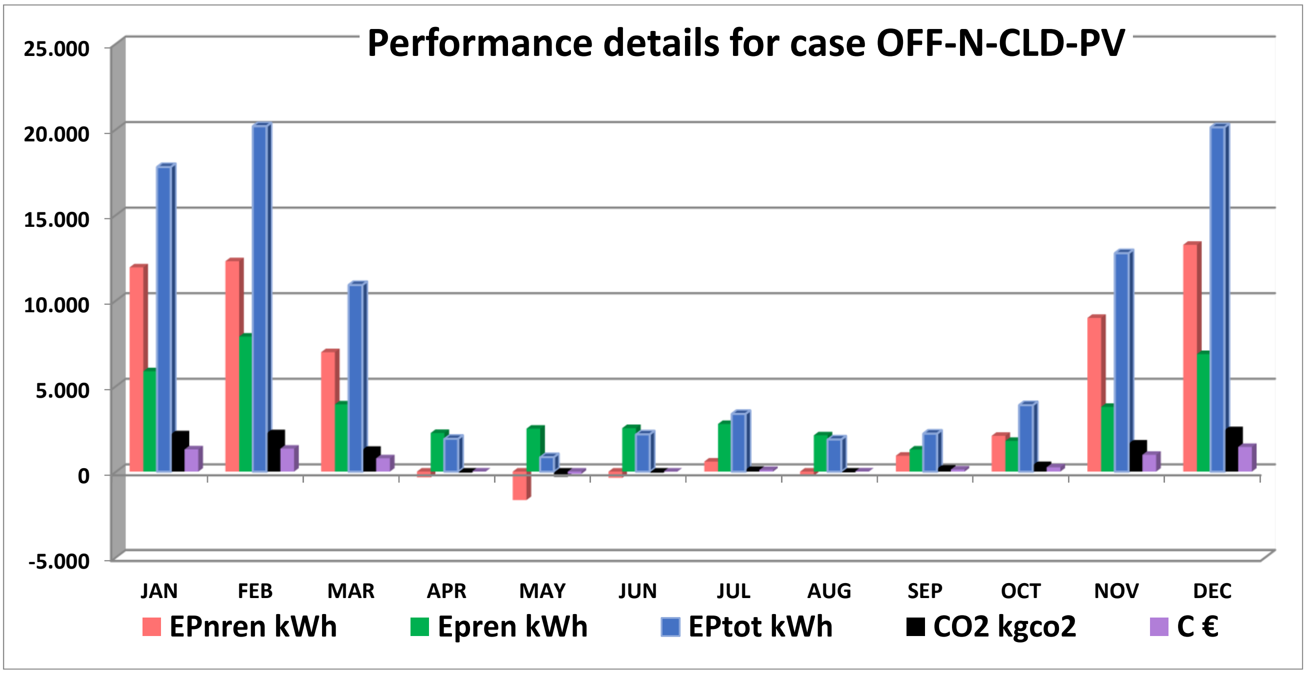
6.3.4.1 Description

Case and variant ID : OFF-N-CLD-PV								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	New	Cold	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.4.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-CLD-PV					
Non renewable primary energy	E_{Pnren}	$kWh/m^2 yr$	39,9	kWh/yr	54.438
Renewable primary energy	E_{Pren}	$kWh/m^2 yr$	32,0	kWh/yr	43.625
Total primary energy	E_{Ptot}	$kWh/m^2 yr$	71,8	kWh/yr	98.062
CO2 emission	CO_2	$kg/m^2 yr$	7,3	kg/yr	9.941
Cost	C	€/m² yr	4,53	€/yr	6.181
Reference area	A_{ref}	m²	1365		



6.3.4.3 Discussion

The same remarks about the case for the average climate and PV apply. The following table shows the comparison of the performance with and without PV.

CASE ID#	E_{Pnren} $kWh/m^2 yr$	E_{Pren} $kWh/m^2 yr$	E_{Ptot} $kWh/m^2 yr$	CO_2 $kg/m^2 yr$	C €/m² yr
OFF-N-CLD	69,7	21,6	91,3	12,7	7,58
OFF-N-CLD-PV	39,9	32,0	71,8	7,3	4,53
OFF-N-CLD-PV-K0	54,7	26,8	81,5	10,0	5,95

6.3.5 Variant for warm climate

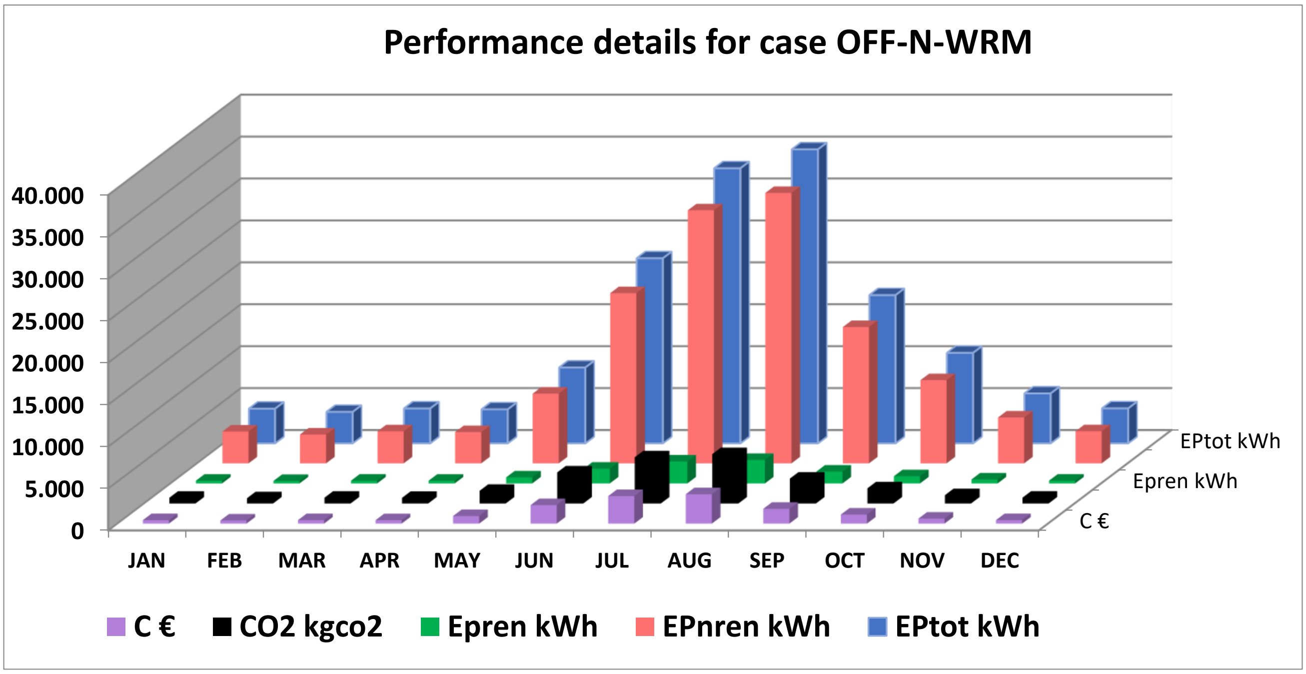
6.3.5.1 Description

Case and variant ID : OFF-N-WRM								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	New	Warm	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	None	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.5.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-WRM					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	**103,6**	*kWh/yr*	**141.356**
Renewable primary energy	E_{Pren}	*kWh/m² yr*	**9,0**	*kWh/yr*	**12.292**
Total primary energy	E_{Ptot}	*kWh/m² yr*	**112,6**	*kWh/yr*	**153.648**
CO2 emission	CO_2	*kg/m² yr*	**18,9**	*kg/yr*	**25.813**
Cost	C	*€/m² yr*	**11,26**	*€/yr*	**15.365**
Reference area	A_{ref}	m²	1365		



6.3.5.3 Discussion

There are no heating needs, only cooling needs. The performance can be improved by shading and ventilative cooling. However, this special situation is identified.

6.3.6 Variant for warm climate and PV

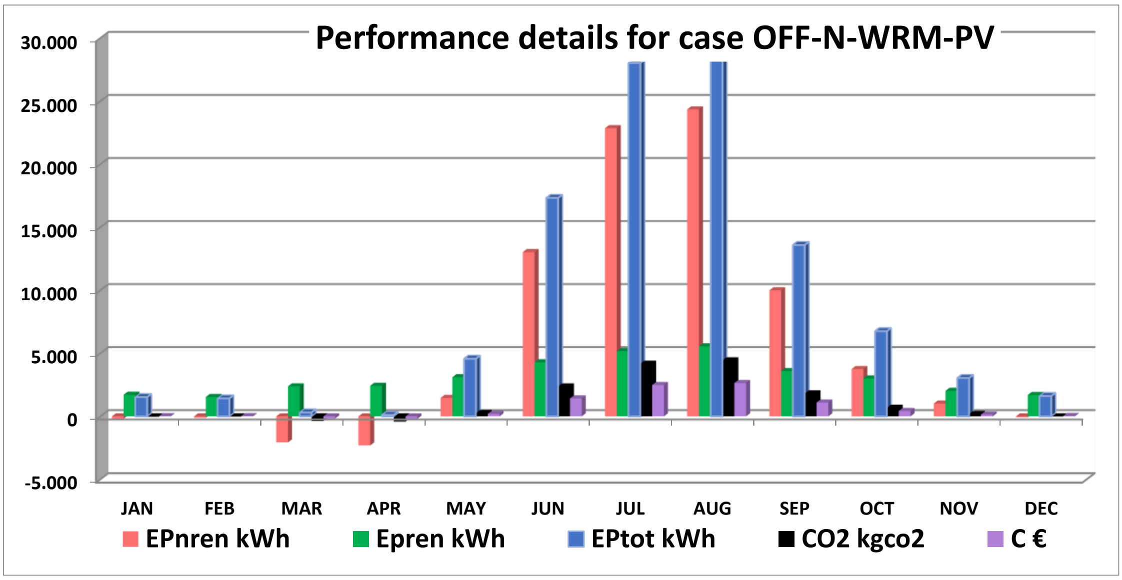
6.3.6.1 Description

Case and variant ID : OFF-N-WRM-PV								
Building	***Type***	***Climate***	***Heating***	***DHW***	***Cooling***	***Ventilation***	***PV***	***Kexp***
OFF	New	Warm	Fan-coil HP	None	Fan-coil Chiller	Mech. AHU	20 kW	1,0

The detailed description of the building and technical systems properties is given in clause 5.

6.3.6.2 Calculation results

PERFORMANCE SUMMARY FOR CASE OFF-N-WRM-PV					
Non renewable primary energy	E_{Pnren}	*kWh/m² yr*	52,6	*kWh/yr*	71.735
Renewable primary energy	E_{Pren}	*kWh/m² yr*	26,7	*kWh/yr*	36.508
Total primary energy	E_{Ptot}	*kWh/m² yr*	79,3	*kWh/yr*	108.243
CO2 emission	CO_2	*kg/m² yr*	9,6	*kg/yr*	13.099
Cost	C	*€/m² yr*	5,95	*€/yr*	8.119
Reference area	A_{ref}	m²	1365		



6.3.6.3 Discussion

The high cooling needs are satisfied by the PV production only during the intermediate season.

CASE ID#	E_{Pnren} *kWh/m² yr*	E_{Pren} *kWh/m² yr*	E_{Ptot} *kWh/m² yr*	CO_2 *kg/m² yr*	C *€/m² yr*
OFF-N-WRM	103,6	9,0	112,6	18,9	11,26
OFF-N-WRM-PV	52,6	26,7	79,3	9,6	5,95
OFF-N-WRM-PV-K0	70,6	20,5	91,1	12,9	7,68

It has to be noted that the assumed PV panels are already covering most of the roof.

7 Analysis

7.1 Completeness

The case study demonstrates that the set of EPB standards allows a calculation of the building energy performance:

- starting from building elements and product properties, new and existing;
- taking into account climatic data;
- taking into account operation schedules and control strategies;
- covering heating, cooling, ventilation, air conditioning, domestic hot water, lighting (not shown in the case study but available)
- taking into account the interactions with supply grids and networks, also leveraging features allowed by an hourly calculation method
- taking into account several possible weighting criteria (e.g. primary energy, GHG emissions).

Only few special technologies are not covered (e.g. battery, heat pumps for simultaneous heating and cooling) but inclusion should be easy thanks to the modular structure.

7.2 Functionality

The set of EPB standards provides all the information needed to generate adequate indicators to highlight the features of the building (including systems); including indicators that have not been, but could have been extracted from the calculated values, such as needs per service and systems efficiencies

The set of EPB standards can cover virtually any building and technical systems configuration.

7.3 Sensitivity

The set of EPB standards reacts correctly to all expected parameters.

The changes in overall results are consistent with the assumed changes between cases and variants.

See the specific case studies for an analysis of the sensitivity to situations and characteristics evaluated in the individual modules (such as characteristics of incorporated technologies).

7.4 Usability

The set of EPB standards is generally easy to use as a whole, thanks to the detailed and consistent specification of the inputs and outputs of each module.

The case studies could be performed with a full hourly calculation using exclusively the demo spreadsheets.

8 Conclusions and recommendations

Specific recommendations are given in the case studies dedicated to individual modules.

Concerning the overall set, some more guidance and further specifications are needed about handling the connection between modules when dealing with complex systems.

The spreadsheet tools used for the case studies are primarily intended to validate and demonstrate the individual standards in a transparent way: in the spreadsheet, each step in the calculation can be followed. As a result, they are not suited (but also not intended) for use in daily practice. On the other hand, the spreadsheet programs are very suitable for software developers to check the calculation algorithms in their programs. For daily practice of an EPB assessment, a software tool will be needed, with user-friendly interface and connecting the successive modules needed for the overall EPB calculation and evaluation. Consequently, guidance will also be needed to ensure the quality of these software tools.

Annex A

List of calculation files

A.1 Folders

The set of calculation files for each variant in the case study are grouped in a separate folder named with the code of the variant. For small changes, only specific changing files are included.

The names of the folders are built in the following way:

OFF-X-CLI

where

- **OFF** means single family house
- **X** can be:
  - **E** for existing building
  - **N** for new building
- **CLI** is the climate code
  - **AVG** for average climate
  - **CLD** for cold climate
  - **WRM** for warm climate

The resulting folders are:

- OFF-E-AVG
- OFF-E-CLD
- OFF-E-WRM
- OFF-N-AVG
- OFF-N-CLD
- OFF-N-WRM

A.2 File name coding

The file names are constructed in the following way.

NNa - STANDARD_BBB_X_CLI_C_OP__OTH.

where

- **NNa** is
  - a progressive number **NN** identifying the calculation order
  - an optional letter **a** to identify the files related to cases and variants
- **STANDARD** is the standard code
  - EN_12831-3 domestic hot water needs
  - EN_16798-1 Use profiles
  - ISO_52016-1 building description and heating needs calculation
  - …

- **BBB** is the building type
    - **SFH** for Single Family house
    - **MFH** for Multi Family house
    - **OFF** for office
- **X** can be:
    - **E** for existing building
    - **N** for new building
- **CLI** is the climate code
    - **AVG** for average climate
    - **CLD** for cold climate
    - **WRM** for warm climate
- **C** indicates the comfort category
    - **I / II / III**
- **OP** indicates operation type of heating
    - **INT** for continuous
    - **INT** for intermittent (night set back)
- **OTH** indicates other information
    - **TS** for thermal solar
    - **PV** for photovoltaic

A.3 File list

A.3.1 General

One file list is given here for the new and the existing building.

The basic lists of files for different climates is the same with few obvious exceptions, such as the additional file for cooling generation for the warm climate.

A.3.2 List of files for the existing buildings

- 00 - ISO_52010-1_TMY_Strasbourg_8_planes.xlsx
- 15 - EN_16798-1_OFF_X-AVG-II-INT_HUDU.xlsm
- 20 - ISO_52016-1_OFF_E-AVG-II-INT_DESC.xlsx
- 21 - ISO_52016-1_OFF_E-AVG-II-INT-CALC-DTinc.xlsm
- 21 - ISO_52016-1_OFF_E-AVG-II-INT-CALC.xlsm
- 30 - EN_15316-1_OFF-E-AVG-II-INT-WFC.xlsm
- 40 - EN_15316-4-1_OFF-E-AVG-II-CNT-RAD.xlsm
- 50 - EN16798-13_A_OFF-E-_AVG.xlsm
- 60 - EN15316-4-3-PV_XXX-X-YYY.xlsm
- 90 - EN_ISO_52000-1_OFF-E-AVG-II-CNT-K0-PV20.xlsm
- 90 - EN_ISO_52000-1_OFF-E-AVG-II-CNT-K1-PV20.xlsm
- 90 - EN_ISO_52000-1_OFF-E-AVG-II-CNT-K1.xlsm

A.3.3 List of files for the new buildings

- 00 - ISO_52010-1_TMY_Athens_8_planes.xlsx
- 15 - EN_16798-1_OFF_X-WRM-II-INT_HUDU.xlsm
- 20 - ISO_52016-1_OFF_N-WRM-II-INT_DESC.xlsx
- 21 - ISO_52016-1_OFF_N-WRM-II-INT-CALC-DTinc.xlsm
- 21 - ISO_52016-1_OFF_N-WRM-II-INT-CALC.xlsm
- 25 - EN_16798-5-1_OFF_N-WRM-II-CNT.xlsm
- 30 - EN_15316-1_OFF-N-WRM-II-INT-WFC.xlsm
- 40 - EN_15316-4-2_OFF-N-WRM-II-CNT-FCL.xlsm
- 50 - EN16798-13_W_OFF_N-WRM-II-CNT.xlsm
- 60 - EN15316-4-3-PV_XXX-X-YYY.xlsm
- 90 - EN_ISO_52000-1_OFF-N-WRM-II-CNT-K0-PV20.xlsm
- 90 - EN_ISO_52000-1_OFF-N-WRM-II-CNT-K1-PV20.xlsm
- 90 - EN_ISO_52000-1_OFF-N-WRM-II-CNT-K1.xlsm

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[4] ENERC32017-437-SI2-785.185, Case study on EN 15316-1, Heating and domestic hot water systems, general part, October 31, 2021

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[7] ENERC32017-437-SI2-785.185, Case study on EN ISO 52016-1, Annex F, Solar shading reduction factors October 31, 2021

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[11] ENERC32017-437-SI2-785.185, Case study on Single-family House October 31, 2021

[12] ENERC32017-437-SI2-785.185, Case study on Multi-family House 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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