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The European Portal for Energy Efficiency in Buildings

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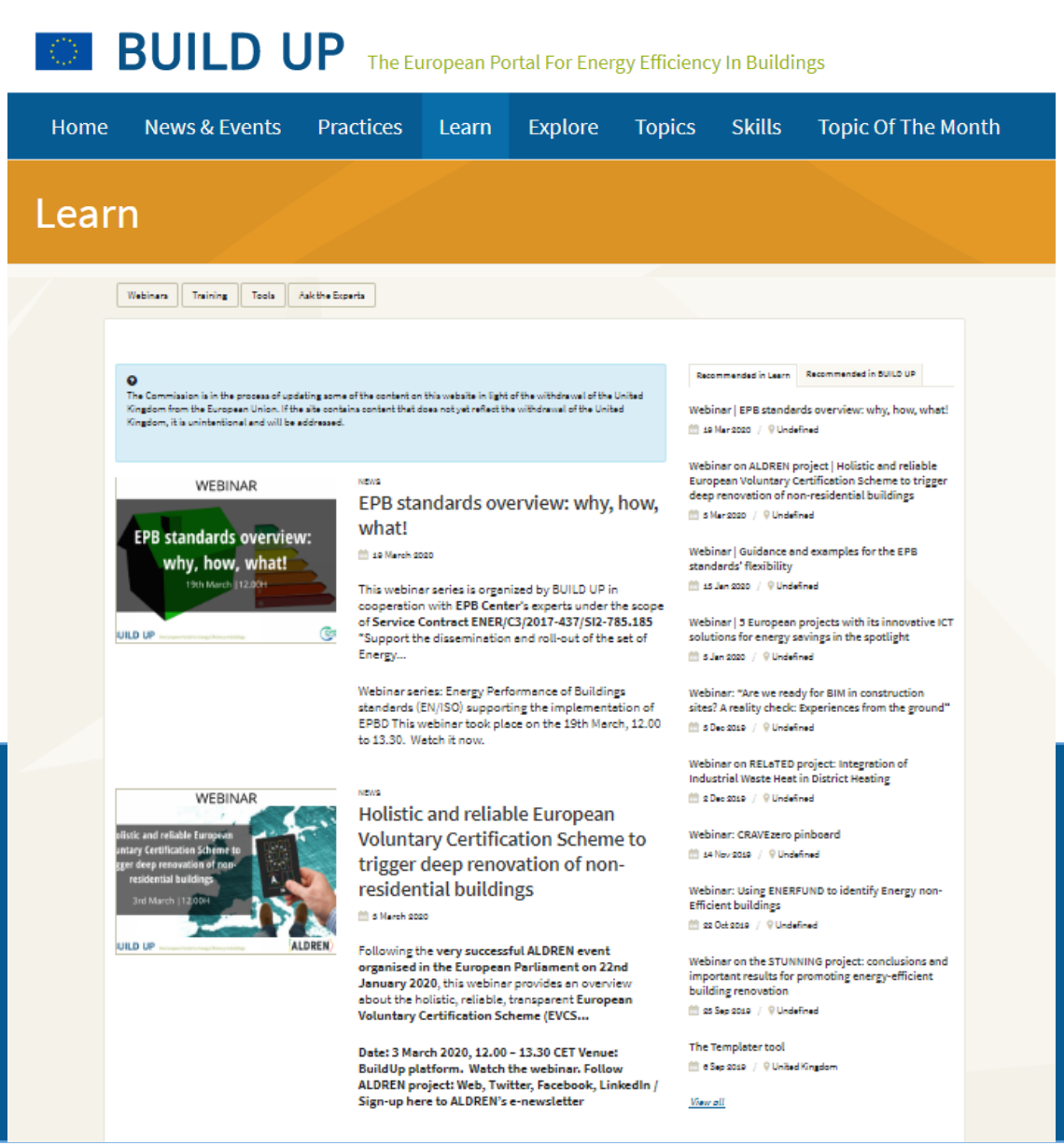


Check our Learn section!

EPB CENTER

BUILD UP The European Portal For Energy Efficiency In Buildings

Webinar 6 – 8th September 2020 (12h00-13h30 CET**)** – Heating systems in the EPB standards

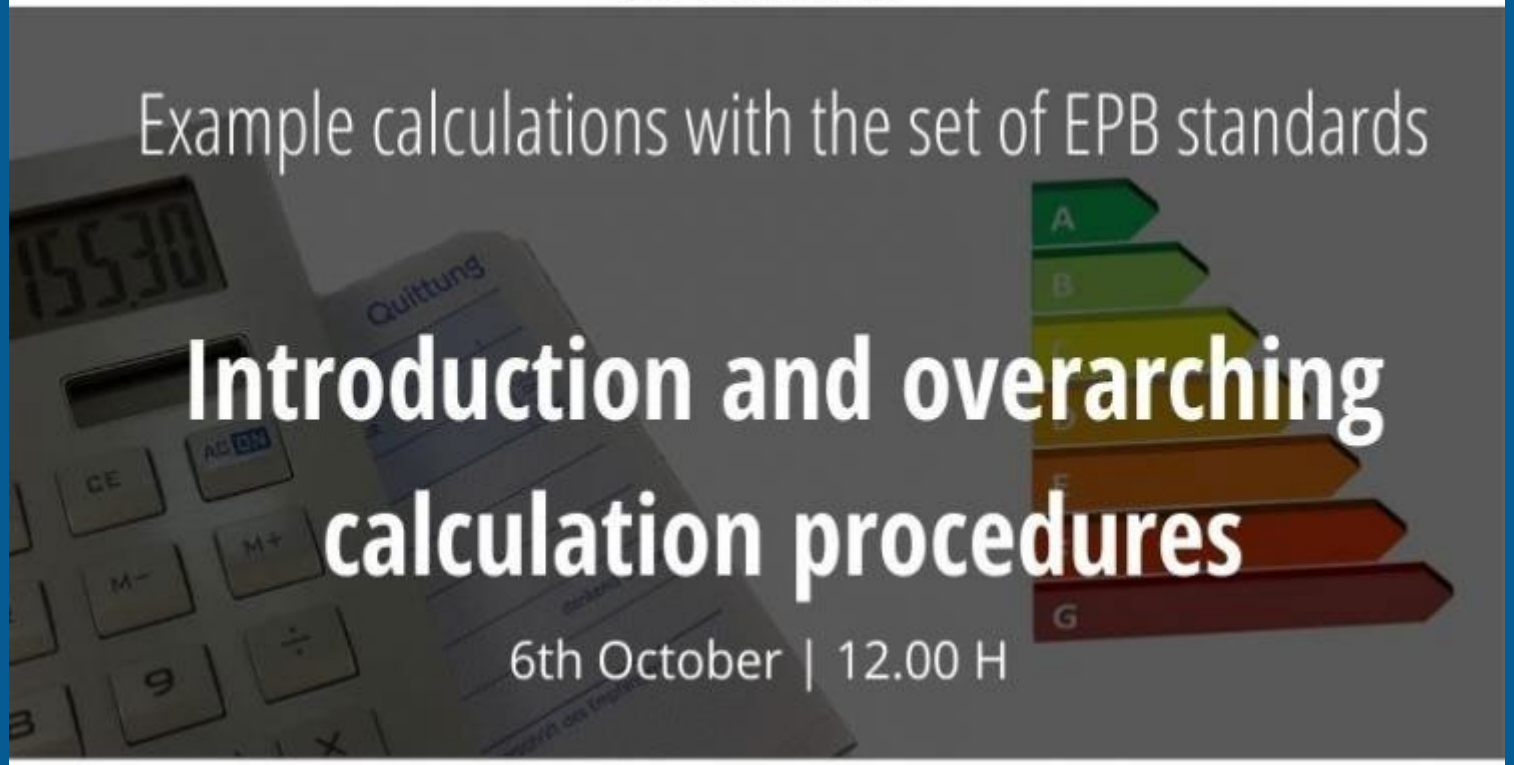
Webinar 7, Tuesday Oct. 6, Example calculations with the set of EPB standards – (1) Introduction and overarching calculation procedures

Webinar 8, Tuesday Oct. 20, Example calculations with the set of EPB standards – (2) Energy needs combined with specific systems

Webinar 9, **Tuesday Dec. 8**, Example calculations with the set of EPB standards – (3) Whole building calculations, from components to overall primary energy

Webinar 10, Tuesday Jan. 19, Example calculations with the set of EPB standards – (4) Energy needs combined with specific systems

WEBINAR



BUILD UP The European Portal For Energy Efficiency In Buildings
REHVA Federation of European Heating, Ventilation and Air Conditioning Associations
EPB CENTER

Your service center for information and technical support on the new set of EPB standards

Energy Performance of Buildings standards (EN/ISO) supporting the implementation of the EPBD

Jaap Hogeling
Manager international standards at ISSO
Chair CEN/TC 371 Energy Performance of Buildings project group
Member ISO/TC 163/WG 4: Joint Working Group (JWG) between ISO/TC 163 and ISO/TC 205: Energy performance of buildings using holistic approach
j.hogeling@isso.nl

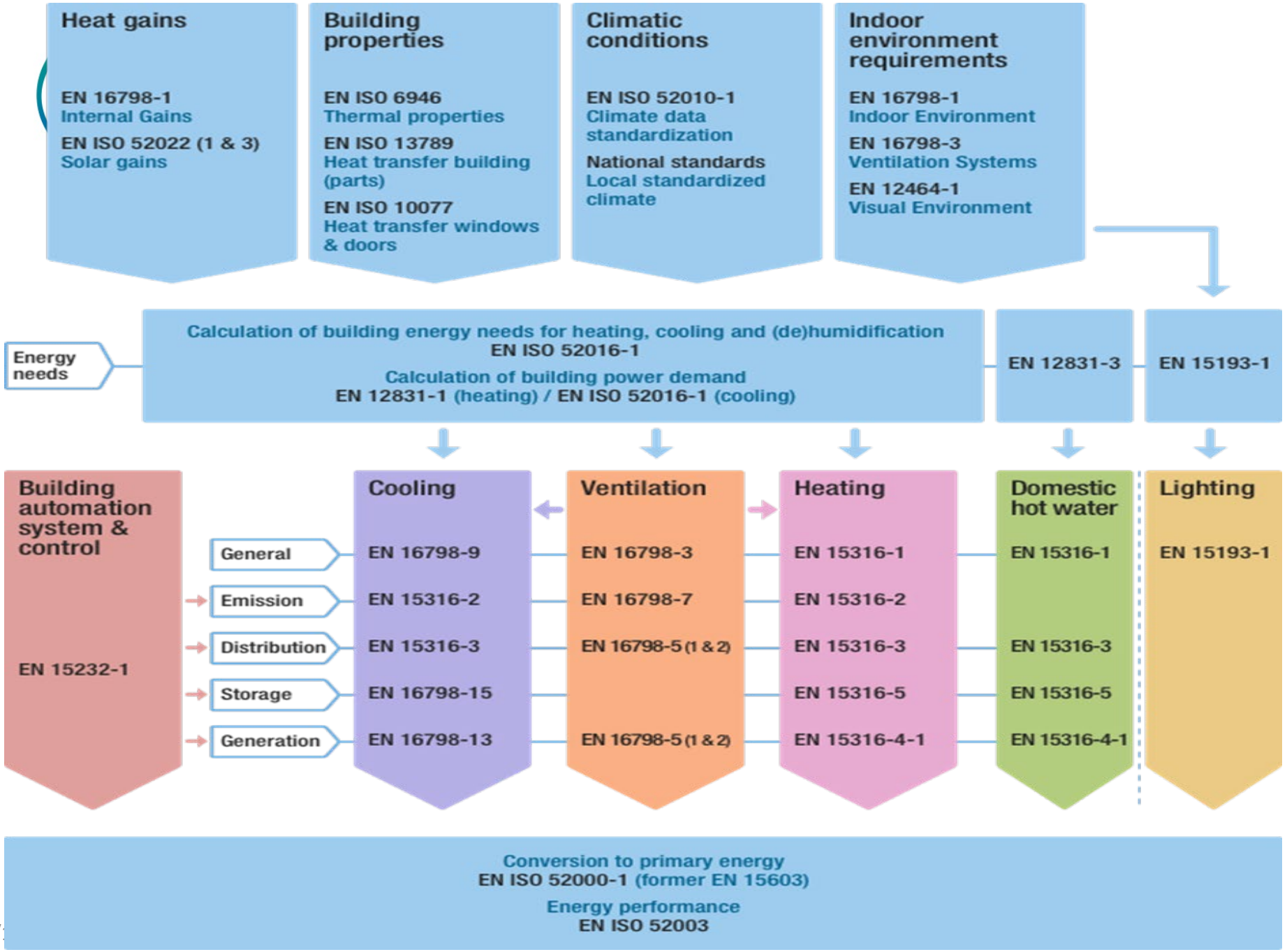
This EPB Center is supported by the EU-Commission Service Contract ENER/C3/2017-437/SI2.785185

Start 21 September 2018 for 3 years

BUILD UP Webinar series
Webinar 7:Example calculations with the set of EPB standards – (1) Introduction and overarching calculation procedures
05/10/2020

My background

- CEN/TC 371: Energy Performance of Buildings, chairperson since 2004
- Project leader of the EU Mandate/480 to CEN regarding the development of the set of EPB standards.
- Participation in 5 CEN/TC's and 2 ISO/TC's related to Energy Performance of Buildings
- Manager international standards at ISSO, Rotterdam, the Netherlands
- Initiator of EPB Center (an initiative of ISSO and REHVA)
- Fellow of ASHRAE and REHVA


Heat gains
EN 16798-1
Internal Gains
EN ISO 52022 (1 & 3)
Solar gains
Building properties
EN ISO 6946
Thermal properties
EN ISO 13789
Heat transfer building (parts)
EN ISO 10077
Heat transfer windows & doors
Climatic conditions
EN ISO 52010-1
Climate data standardization
National standards
Local standardized climate
Indoor environment requirements
EN 16798-1
Indoor Environment
EN 16798-3
Ventilation Systems
EN 12464-1
Visual Environment
Energy needs
Calculation of building energy needs for heating, cooling and (de)humidification
EN ISO 52016-1
Calculation of building power demand
EN 12831-1 (heating) / EN ISO 52016-1 (cooling)
EN 12831-3
EN 15193-1
Building automation system & control
EN 15232-1
General
Emission
Distribution
Storage
Generation
Cooling
EN 16798-9
EN 15316-2
EN 15316-3
EN 16798-15
EN 16798-13
Ventilation
EN 16798-3
EN 16798-7
EN 16798-5 (1 & 2)
EN 16798-5 (1 & 2)
Heating
EN 15316-1
EN 15316-2
EN 15316-3
EN 15316-5
EN 15316-4-1
Domestic hot water
EN 15316-1
EN 15316-3
EN 15316-5
EN 15316-4-1
Lighting
EN 15193-1
Conversion to primary energy
EN ISO 52000-1 (former EN 15603)
Energy performance
EN ISO 52003

The goal of example calculations is to demonstrate:

- the functionality (the calculation works all together on practical cases, available features to describe energy properties of buildings and HVAC installations)
- the sensitivity (impact of single data or group of data on selected calculation results), and
- the usability (clear data input; description of practical system configurations, useful results and avoiding unnecessary input complexity)

of individual calculation modules and of the whole building calculation procedure.

Webinar 7: Example calculations WHY & HOW.

- **WHY ?**
- A convincing way to demonstrate that the set of EPB standards is functioning
- Based on the current set of spreadsheets demonstrate the functionality and sensitivity of the individual calculation modules and of their combination

Webinar 7: Example calculations WHY & HOW.

- **HOW?**
- First we have to describe the building and its technical systems
  - For demonstration purpose it is not necessary to use a complicated building
  - However it is still an extensive task because this will still require long lists of elements , properties, and several alternative systems
- First we demonstrate that the individual modules work properly

Variations : climates and user profiles

- Climates:
  - Cold : Oslo
  - Mild : Strasbourg
  - Warm: Athens
- This choice represents more or less the varity of the climate in EU; This selection is also used, where relevant, as basis for the European Product Database for Energy Labelling
- We have to define the user profile: this will be based on the profiles in EN 16798-1

Coordination between modules

- Several modules will be tested together to see the effect of interrelation between modules, typically to see the effect of operating conditions.
- A collection of modules will be tested by connecting the spreadsheets. Software will be used to generate relevant input.
- For this task, this means: Identifying appropriate calculation cases and related input data sets

Expected Calculation cases

- Buildings to be selected:
- A detached single family house
- described as Example 1 in the Technical Report, CEN ISO/TR 52016-2, accompanying the EN ISO 52016-1
- Residential block building
- Office as a typical office block building

The expected output :

- a set of commented calculations on example buildings and systems that demonstrate that:
  - individual modules work properly;
  - coordination between modules works;
  - calculation procedures fit real cases;
  - the input for the hourly calculation does not require a high amount of work (on the contrary :see also webinar 4);
  - the procedure is sensitive to technologies

Final: presentation of results

- Description of the test cases
- Drawings of building and functional diagram of systems
- The collection of the used calculation spreadsheet
- The set of interconnecting spreadsheets with the preloaded calculation values
- Explaining notes how to use these and and observations regarding the results

The 2 presentations in this first webinar on example calculations

- Dick van Dijk:
- First series of example calculations, on **energy needs** (EN ISO 52016-1): starting with the calculation of the Heating and the Cooling of the building
- Laurent Socal:
- The overall energy performance indicator (EN-ISO 52000-1): starting with this overarching standard as this is the landing place for the results of all energy need (the building) and energy use (systems) calculations

Thank you!

More information on
the set of EPB standards:

www.epb.center

Contact: info@epb.center

This document has been produced under a contract with the European Union, represented by the European Commission (Service contract ENER/C3/2017-437/SI2-785.185).

Your service center for information and technical support on the new set of EPB standards

First example calculations, on energy needs (EN ISO 52016-1)

Dick van Dijk

dick.vandijk@epb.center

This project is facilitated by the EU-Commission Service Contract ENER/C3/2017-437/SI2.785185

Start: 21 September 2018 for 3 years

BUILD UP Webinar series
Webinar 7: Example calculations with the set of EPB standards – (1) Introduction and overarching calculation procedures
6th October 2020

My background

- EPB Center expert (> 2017)
- Involved in initiation, preparation and coordination of set of EPB standards (2012-2017)
- Co-convenor of ISO Joint Working Group on the overall set of EN ISO EPB standards, in collaboration with CEN

  ISO/TC 163 & ISO/TC 205, CEN/TC 371
- Convenor of ISO Working Group responsible for few key EPB standards:

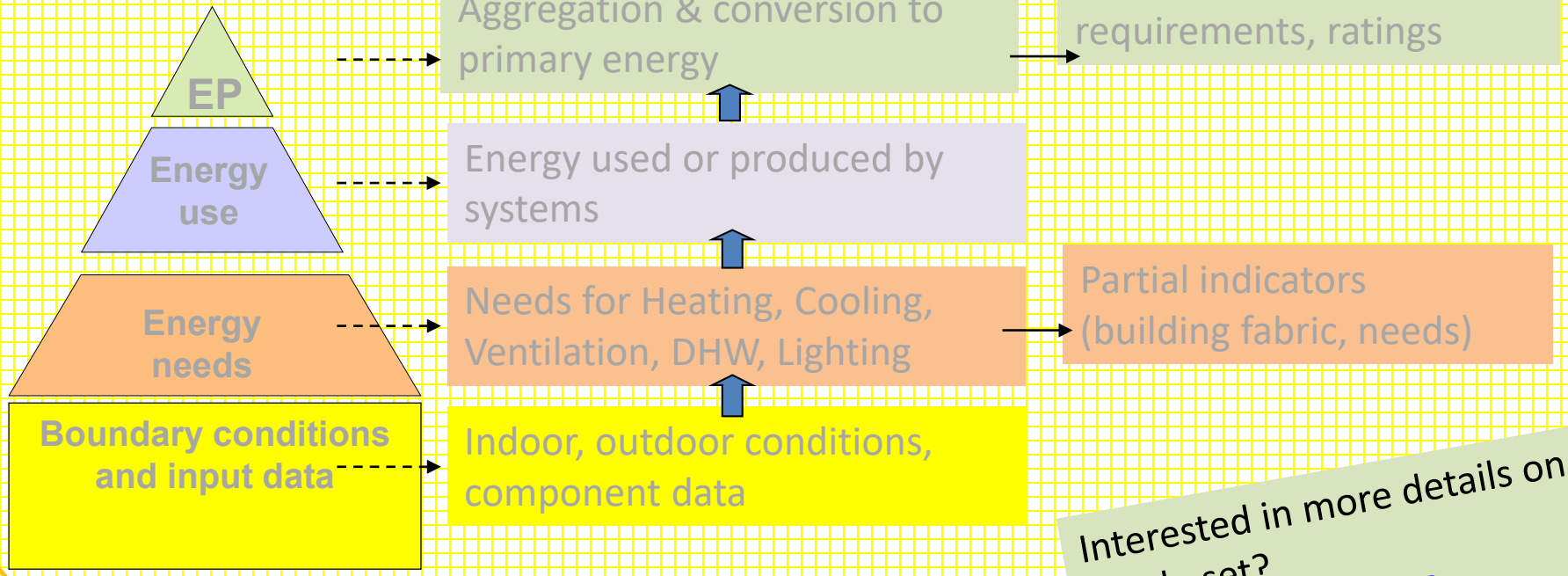
  Energy needs heating/cooling, Climatic data, Partial EP indicators (ISO/TC 163/SC 2/WG 15)

Set of (about 50) EPB standards.
1) The overarching EPB standard

'double-faced' standard: 1) the first step:

Framework:

EN ISO 52000-1, Overall EPB Framework (common terms, modular structure, …)

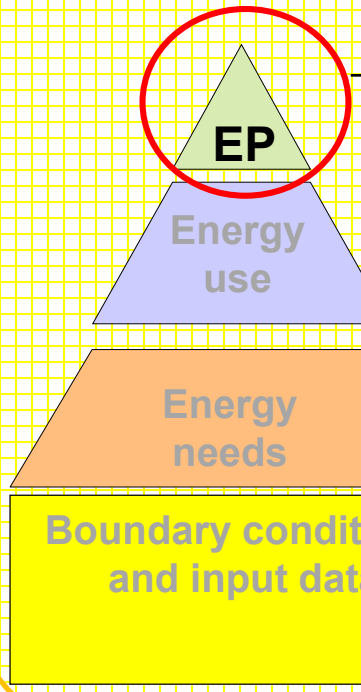


Interested in more details on whole set?
Recording webinar 2

Set of (about 50) EPB standards.
1) The overarching EPB standard

'double-faced' standard: 2) the last step of the calculation:

EN ISO 52000-1, Overall EPB Framework (common terms, modular structure, ...)



EN ISO 52000-1 Aggregation & conversion to primary energy

EN ISO 52003-1
Overall indicators, requirements, ratings

Energy used or produced by systems

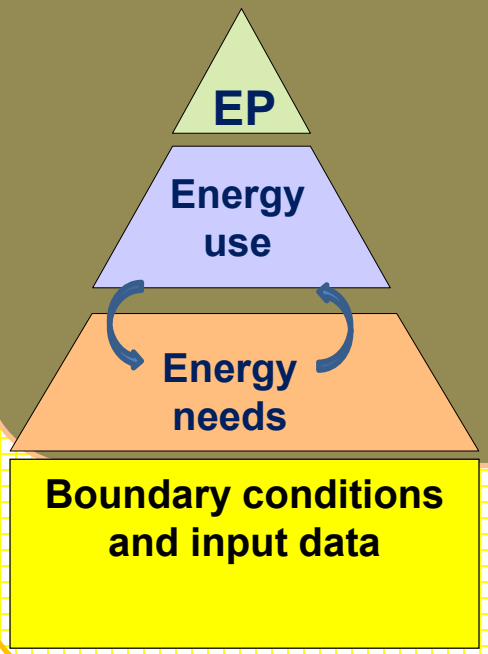
Needs for Heating, Cooling, Ventilation, DHW, Lighting

EN ISO 52018-1
Partial indicators (building fabric, needs)

Indoor, outdoor conditions, component data

Set of (about 50) EPB standards. The calculation **core** set

EN ISO 52000-1, Overall EPB Framework (common terms, modular structure, ...)



Calculation:

EN ISO 52000-1 Aggregation & conversion to primary energy → EN ISO 52003-1 Overall indicators, requirements, ratings

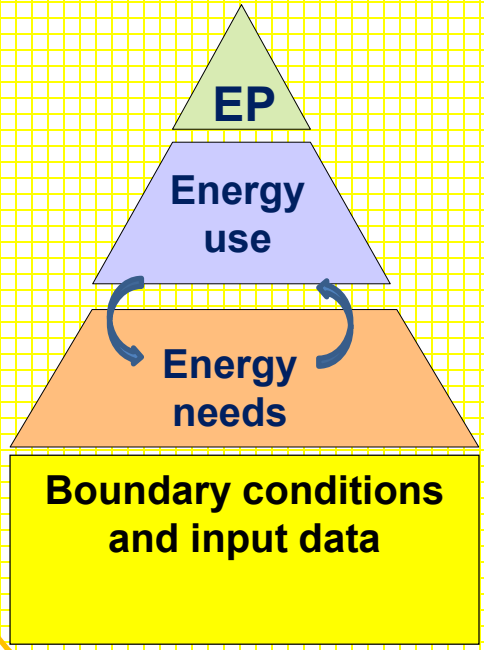
Several system standards: Heating, Cooling, Ventilation, DHW, Lighting

EN ISO 52016-1 Energy needs heating and cooling, ... → EN ISO 52018-1 Partial indicators (building fabric, needs)

Indoor, outdoor conditions, component data

Set of (about 50) EPB standards. Post-processing

EN ISO 52000-1, Overall EPB Framework (common terms, modular structure, ...)



EN ISO 52000-1 Aggregation & conversion to primary energy

<< Several system standards >>

EN ISO 52016-1 Energy needs heating and cooling, ...

Indoor, outdoor conditions, component data

Post-processing:

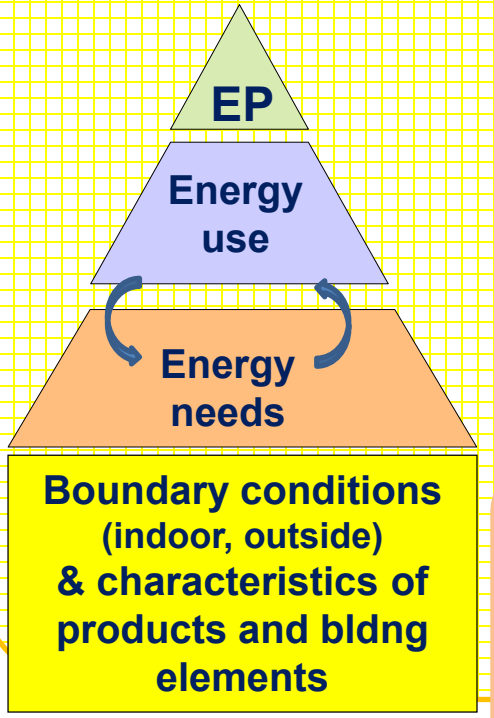
EN ISO 52003-1
Overall indicators, requirements, ratings

EN ISO 52018-1
Partial indicators (building fabric, needs)

(Choices are more policy driven)

Set of (about 50) EPB standards. Pre-processing

EN ISO 52000-1, Overall EPB Framework (common terms, modular structure, ...)



EN ISO 52000-1 Aggregation & conversion to primary energy → EN ISO 52003-1 Overall indicators, requirements, ratings

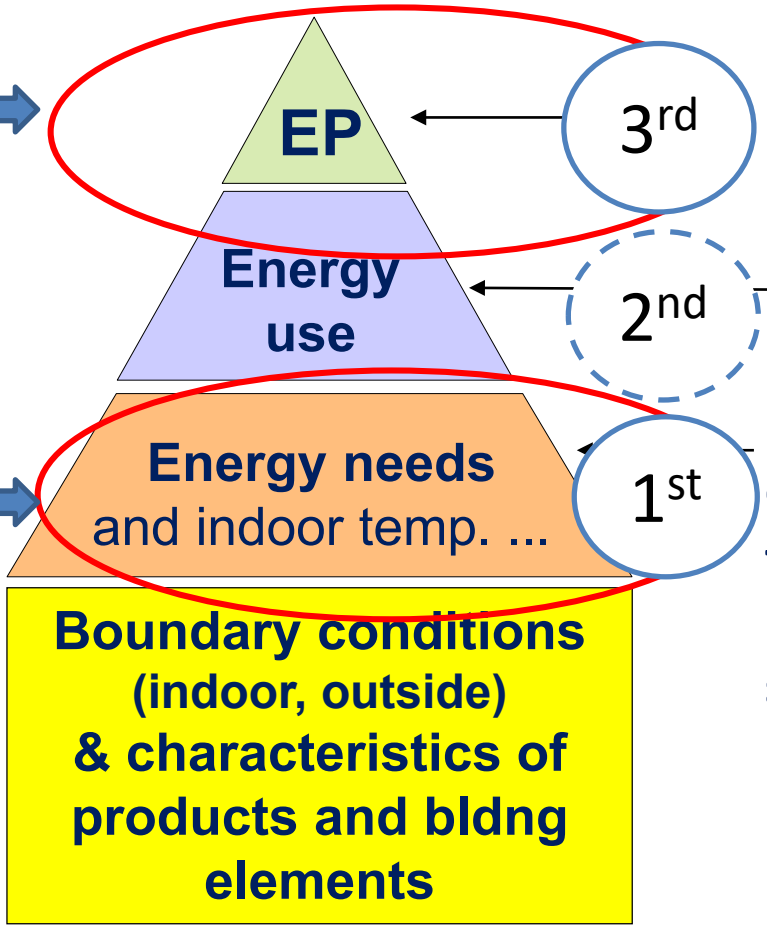
<< Several system standards >>

EN ISO 52016-1 Energy needs heating and cooling, ... → EN ISO 52018-1 Partial indicators (building fabric, needs)

EN ISO 52010-1, Climatic conditions
EN 16798-1, Indoor conditions
***Several standards:* input data from products and building elements**

Pre-processing

Set of (about 50) EPB standards. **First question: Where to start with calculation?**



The two core EPB calculation standards

3rd — **EN ISO 52000-1**
Overarching EPB standard

2nd — EN xxxx
Suite of system standards

1st — **EN ISO 52016-1**
Calculation of energy needs for heating and cooling, internal temperatures and sensible and latent heat loads

Interested in more details on on each EPB standard?
Documents page at website

Are system standards less important in the calculation??

- Not at all!
- But:
  - The energy **needs** for heating and cooling are the first important indicator
  - In some cases the system losses are not complex
  - Or system losses can be added to the needs as preliminary estimation
- There exists a wide variety of system technologies, some simple to describe, others more complex and e.g. interacting with needs

So we start with: calculation of heating & cooling needs (**EN ISO 52016-1**)

EN ISO 52016-1 spreadsheet tool
available at EPB Center website

- **Second question: How to get the input data for this calculation?**
- Five categories of input data:
  1. Outdoor environment (climatic data)
  2. Indoor environment: conditions of use
  3. Building component data
  4. Air infiltration and ventilation
  5. Special data
- Let's assume we want to do an **hourly** calculation

Remember:
EN ISO 52016-1: parallel hourly and monthly calculation methods

Hourly calculation of
- energy needs for heating and cooling
- both sensible and latent heat
- indoor temperatures
- heating and cooling load

Same input data and boundary conditions

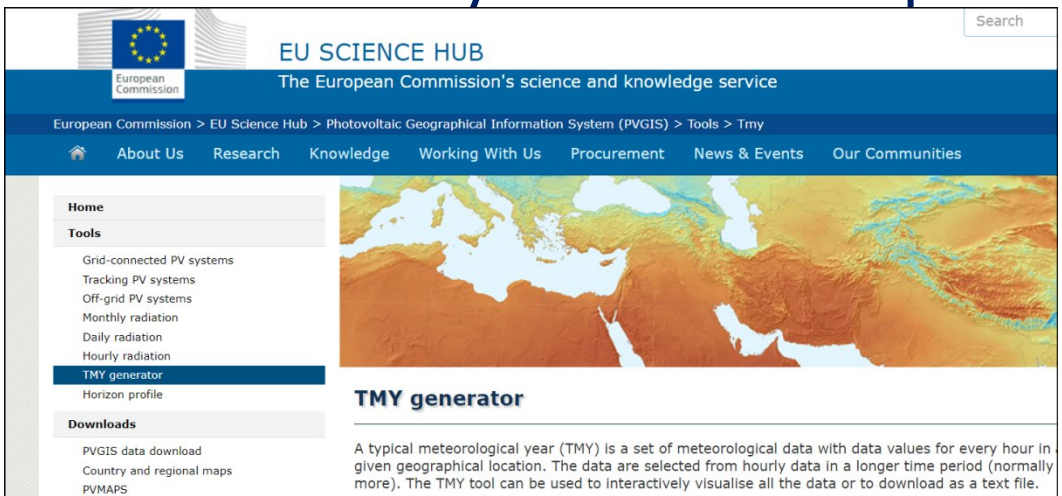
Extra output:
- Monthly characteristics
- Can be used as basis for generating or validating correlation factors for monthly method

Monthly calculation of energy needs for heating and cooling
- using national correlation factors to take into account dynamic effects
  - E.g. solar and internal gains, varying conditions of use (temperature and ventilation settings), ..

Interested in hourly versus monthly calculations?
Recording of webinar 4

1. Hourly climatic data

- So called **Test Reference Years** for given region or country (based on EN ISO 15927-4)
- If not available:
  - EC Joint Research Centre (**JRC**) tool: "Typical Meteorological Year **(TMY) generator**": hourly weather data for any location and period of choice



Climatic data: one extra step to go...

- TRY, TMY climatic data files:
  - Hourly solar irradiance on **horizontal** plane (total and diffuse part)
- EN ISO 52010-1 = conversion:
  - Solar irradiance on **tilted and vertical** planes, for any orientation

EN ISO 52010-1 spreadsheet tool available at EPB Center website

- New: EPB Center tool to convert JRC TMY datafile suitable as input for the EN ISO 52010-1 spreadsheet

Conversion spreadsheet tool available end of October

  - For the example calculations three European climates have been selected: Oslo, Strasbourg, Athens

2. Indoor conditions

- In the context of EPB regulations, to be specified by the public authorities:
  - Occupant schedules
  - Temperature and humidity set points
  - Internal heat and moisture loads
- These can be set for each hour and each day
  - E.g. a standard office schedule
  - E.g. a standard residential building schedule
  - ...
- Default schedules provided in EN 16798-1

Use Profile Generator spreadsheet tool available soon:
Profiles from EN 16798-1 and national: converted to a "calender": full year of hourly input for **EN ISO 52016-1 spreadsheet** and other EPB standards

3. Building component input data

- For hourly calculation no more input data needed than for monthly calculation

Explained in Webinar 4

- Each opaque construction:
  - Area
  - Orientation&tilt
  - *R*-value (**EN ISO 13789**)
  - Solar absorptance external surface
  - Type of contruction (heavy, light; homogeneous, sandwich, ..)
- Ground floor:
  - Same, but some extra data (e.g. ground properties), depending on floor type (**EN ISO 13370**)

Also for hourly calculation (**ground inertia!!**) => **Integrated** in **EN ISO 52016-1 spread-sheet tool**

- Each window:
  - Area
  - Orientation&tilt
  - *U*-value (thermal transmittance; **EN ISO 10077-1**)
  - *g*-value (total solar energy transmittance; **EN ISO 52022-3**)

3. Building component input data

- For hourly calculation no more input data needed than for monthly calculation
- Each opaque construction:
  - Area
  - Orientation&tilt
  - *R*-value (**EN ISO 13789**)
  - Solar absorptance external surf
  - Type of , ..)
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- Each wi
  - Area
  - Orientation&tilt
  - *U*-value (thermal transmittance; **EN ISO 10077-1**)
  - *g*-value (total solar energy transmittance; **EN ISO 52022-3**)

Explained in Webinar 4

***R*-value, *U*-value, *g*-value:**
Very conventional types of information, usually provided by component or building element suppliers

calculation (**ground inertia!!**)
=> **Integrated** in **EN ISO 52016-1 spread-sheet tool**

4. Air infiltration and ventilation

- Air flow rate provided by EN 16798-7
- (Mechanical) ventilation system data provided by EN 16798-5-1
  - Ventilation pattern
  - Supply air temperature and humidity (if other than outside)

EN 16798-7 and EN 16798-5 spreadsheet tools available
(with links to EN ISO 52016-1 spreadsheet tool in preparation)

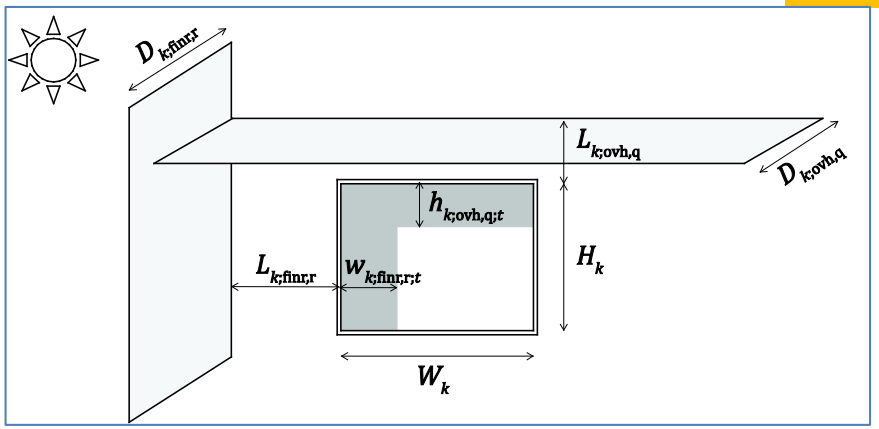
- But: it's possible to start calculation of energy needs with simplified assumptions of air flow rate pattern

5. Special

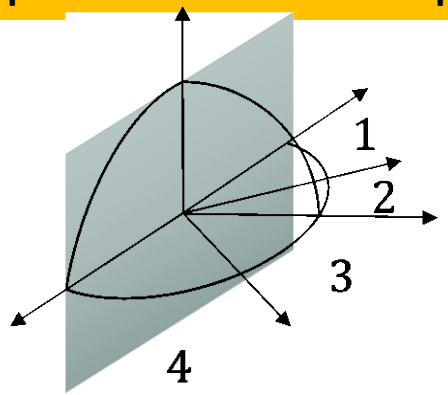
- **Mainly: solar shading** by external obstacles *(calc.procedures included in EN ISO 52016-1)*
  - Remote or from own building
  - Choice between simplified or detailed input
  - Calculation hourly

Solar shading spreadsheet tool *Available soon*

- Using hrly **output** from **EN ISO 52010-1** (solar rad.data)
- Providing hrly **input** for **EN ISO 52016-1 spreadsheet tool**



Side wings, overhangs

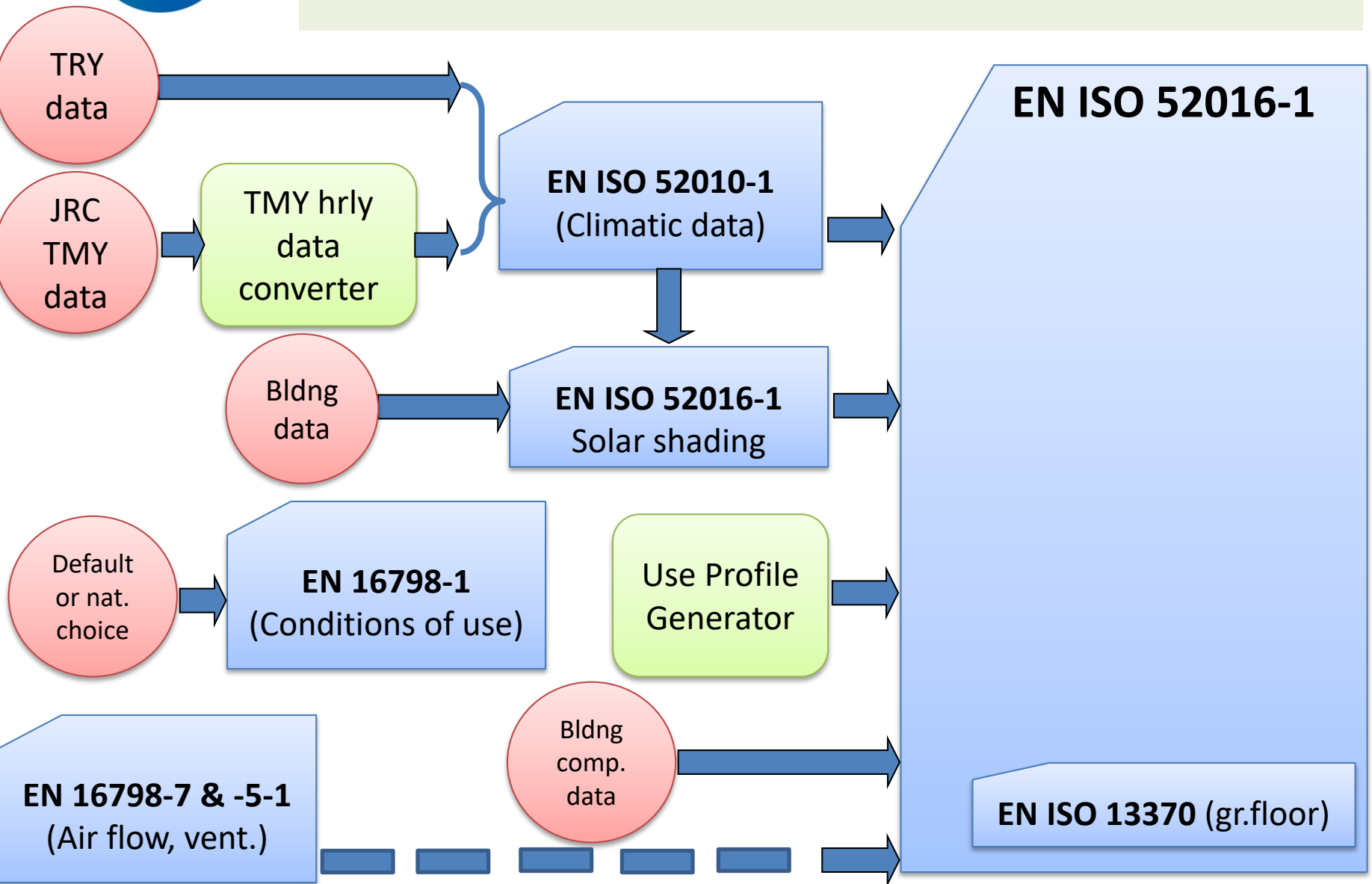


Sky segments to specify remote obstacles

Spreadsheets publicly available

- To demonstrate and validate each EPB standard
- (!) spreadsheet ≠ corresponding standard:
  - Spreadsheets have some limitations
    - Some 'practical' limitations on input data
    - Some special features not included (e.g.: multi-zone calculation, attached unconditioned spaces, ..)
  - Spreadsheets:
    - **Highest priority: technically correct and transparent**
      - **➔ where possible: all intermediate results are shown**
      - **At each step of calc.: references given to the corresponding clause or formula in the standard**
    - Lower priority: user friendliness and performance (speed)
    - Not intended for daily practice to assess EPB

Links between spreadsheets



EN ISO 52016-1 output
("hourly": only if hourly calculation)

EN ISO 52016-1

Different modes possible:

- **Basic energy loads & needs**
- **System specific loads & needs**
  (undersized or absent system, recoverable system heat losses, imperfect control, ..)
- **System design load**

→ Hourly sensible and latent heating and cooling load

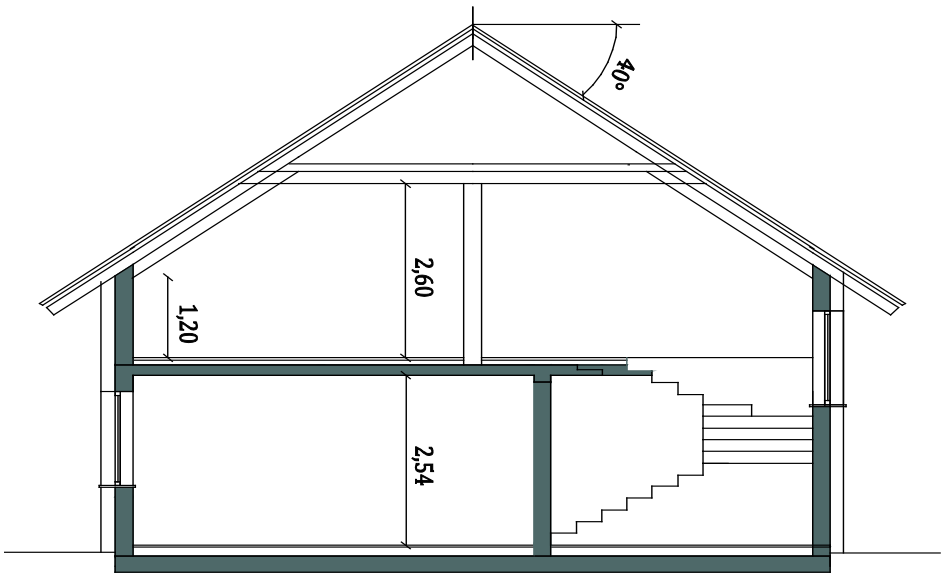
→ Hourly indoor (air and operative) temperatures
and relative humidity

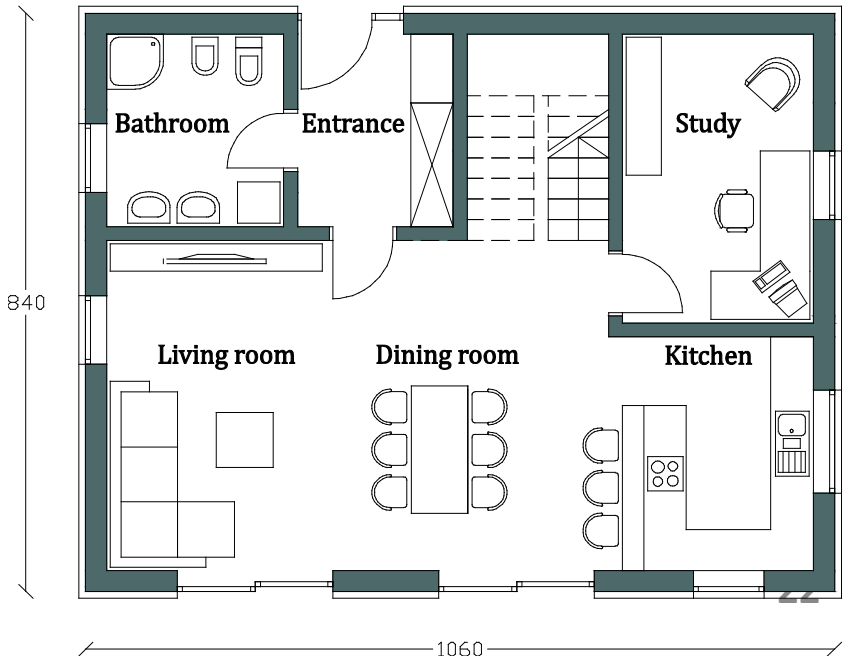
→ Monthly H&C energy needs
- From hourly calculation
- From monthly calculation

→ Of course also **statistics**:
- Peak load / Load distrib.curve
- Frequency over- and underheating
- Energy signature
- Key monthly parameters
- ...

Calculation cases

- First selected building:
- A detached single family house
  - described as Example 1 in the Technical Report, CEN ISO/TR 52016-2, accompanying EN ISO 52016-1



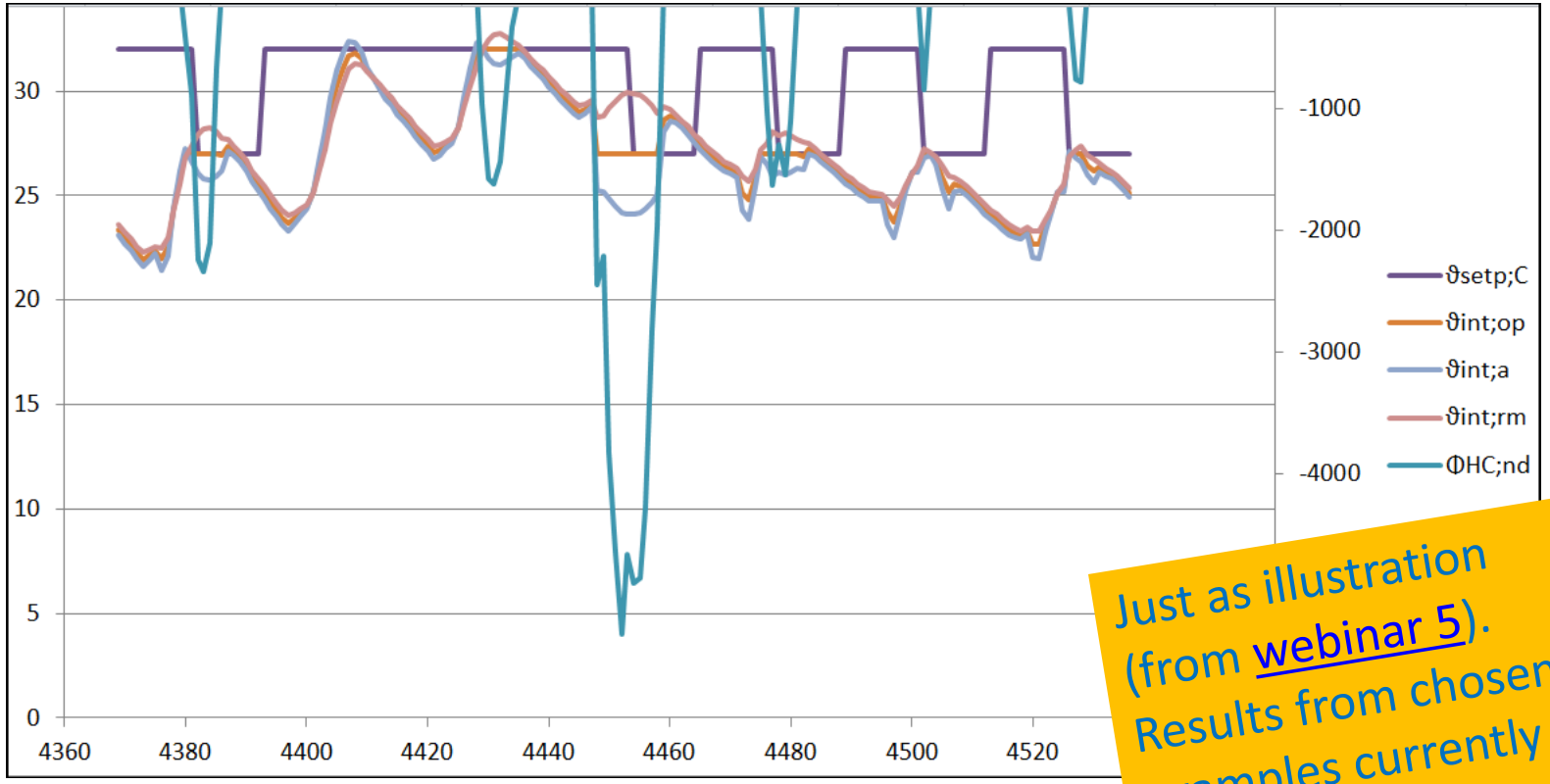


Variations

- 3 (European) climates:
  - Oslo, Strasbourg, Athens
- EP levels, e.g.:
  - Bad energy performance
  - Good energy performance
- System specific input:
  - Heating or cooling system:
    - sufficiently sized
    - Undersized
    - absent

Examples

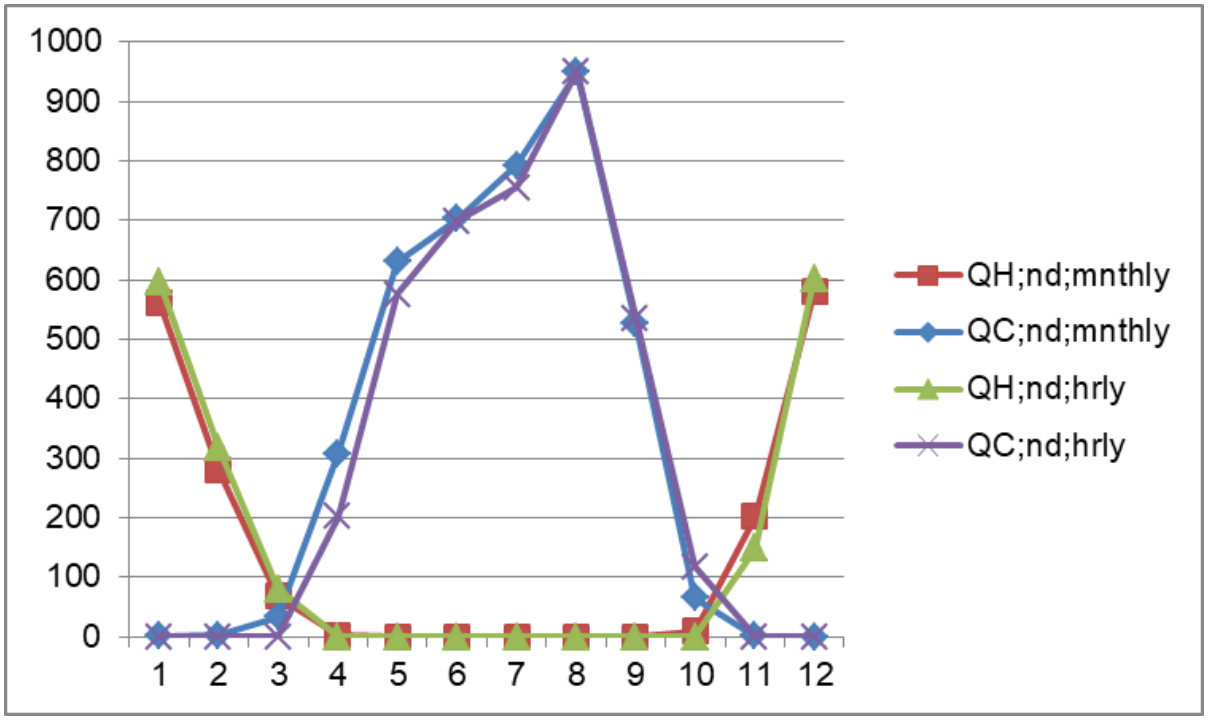
Just an illustration of a typical hourly calculated internal
air and mean radiant and operative temperatures and heating or cooling load



Just as illustration (from webinar 5). Results from chosen examples currently being reviewed

Examples

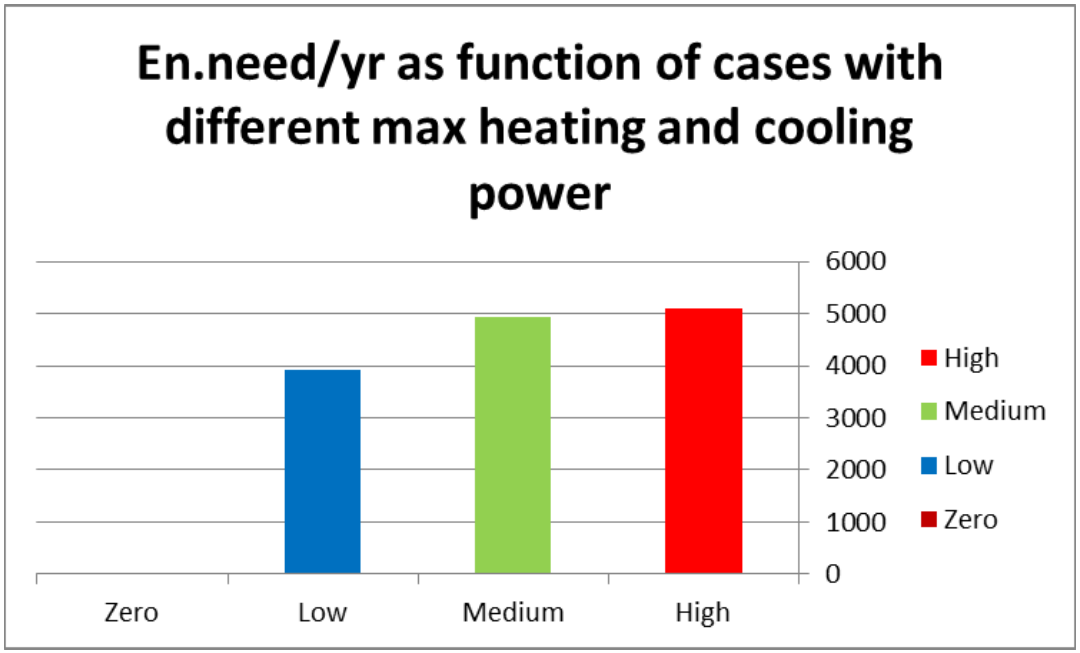
Illustration of monthly heating and cooling needs, calculated with (a) hourly and (b) monthly method



Match between hourly and monthly results will e.g. be bad if undersized system (which the monthly method will not detect)

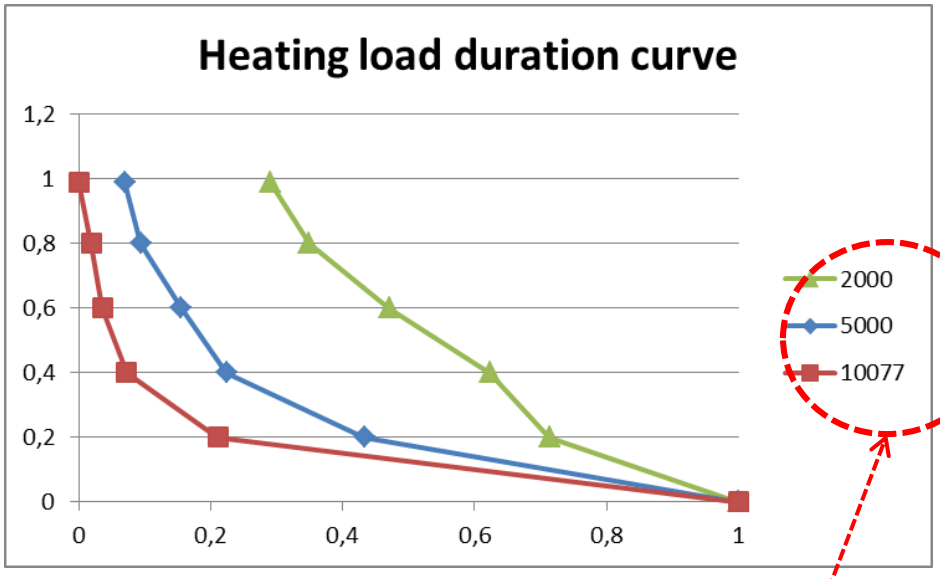
Examples

4 cases,
each with different maximum heating and cooling power

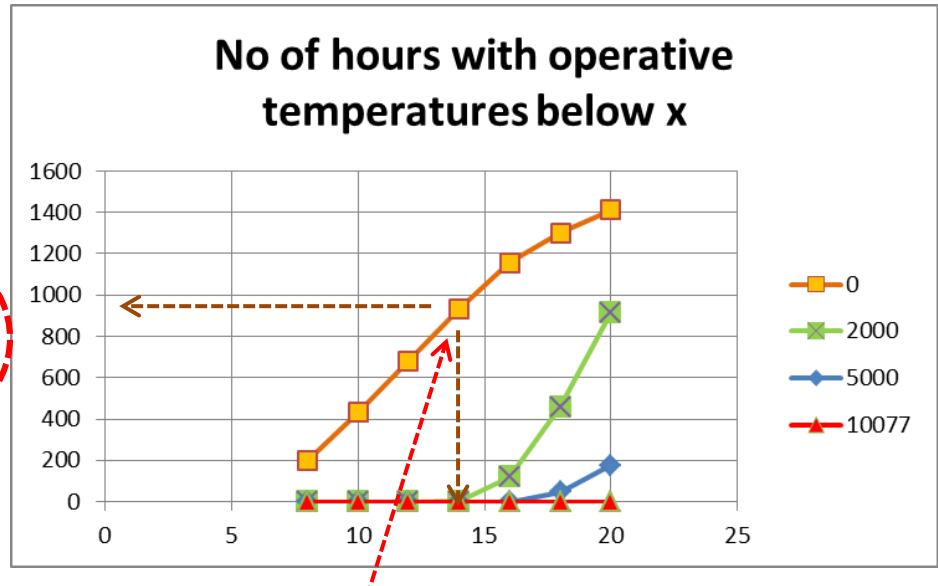


Just as illustration (from webinar 5). Results from chosen examples currently being reviewed

4 cases, heating part



January

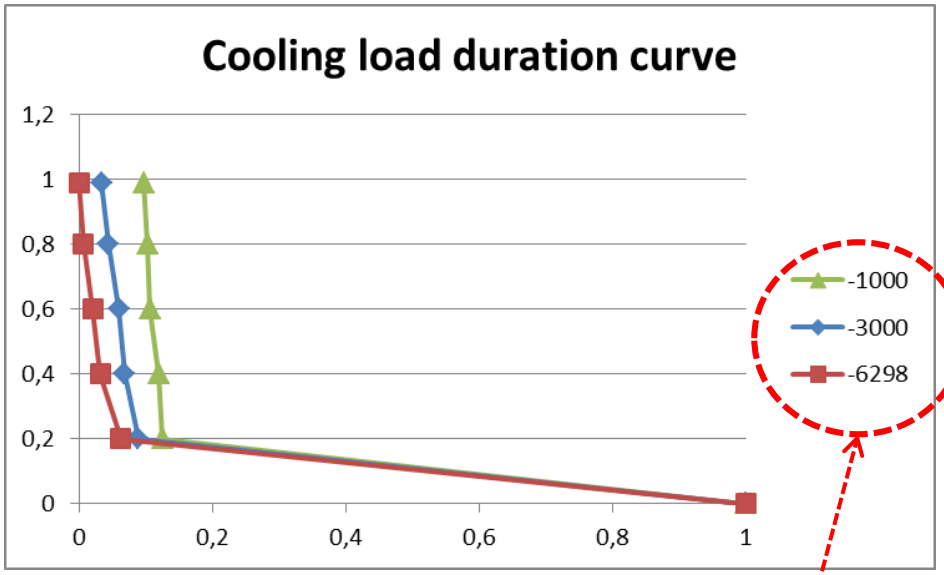


Full year

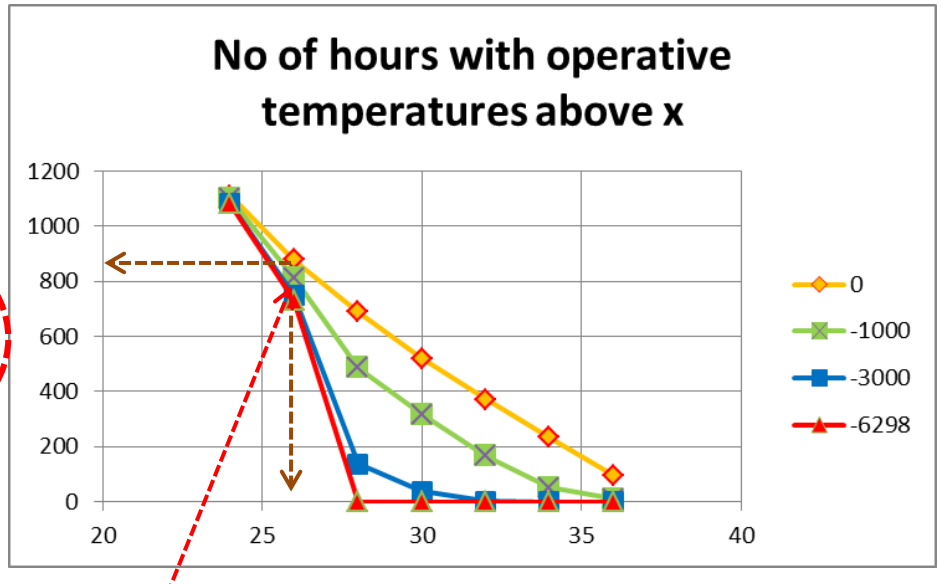
4 cases with different max.heating power

Number of hours per year with operative temperature below 14 °C
(only hours counted when high comfort level is required)

4 cases, cooling part



January



Full year

4 cases with different max.cooling power

Number of hours per year with operative temperature above 26 °C
(only hours counted when high comfort level is required)

Conclusion

- **EN ISO 52016-1**: One of the core EPB standards for calculating the overall EPB
- Tools available to perform EN ISO 52016-1 calculations, to demonstrate:
  - **Functionality**
    - Calculation works all together on practical cases, available features to describe energy properties of buildings (and HVAC installations where relevant)
  - **Sensitivity**
    - Impact of single data or group of data on selected calculation results
  - **Usability**
    - Clear data input; description of practical system configurations, useful results and avoiding unnecessary input complexity
- **Tools and example calculations: *Work in progress***

Thank you!

EPB Center is also available for specific services requested by individual or clusters of stakeholders

More information on
the set of EPB standards:

www.epb.center

Contact: info@epb.center

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Your service center for information and technical support on the new set of EPB standards

The overall energy performance indicator (EN-ISO 52000-1)

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Start: 21 September 2018 for 3 years

BUILD UP Webinar series
Webinar 7: Example calculations with the set of EPB standards – (1) Introduction and overarching calculation procedures
6th October 2020

My background

- Various professional experience as installer, designer, commissioning, software analysis, standardisation and training activity related to the HVAC sector.
  Also working in the industrial sector (pharma) on environmental (IPPC) and energy issues (energy audits, energy management systems)
- Convenor of the Italian mirror group on heating systems
- Task leader for the development of several EN standards,
  - ***EN 15378-3*** *on measured energy performance*
  - ***EN 15378-1*** *on the inspection of heating system*
  - ***EN 15316-4-8*** *on local and radiant heaters*
  - ***EN 14336*** *installation and commissioning of heating systems*
- Active member of CEN/TC 228 WG4 and WG1
- Involved in the preparation and coordination of the set of **EPB standards** under **Mandate 480** (2012-2017)
- **EPB center expert** (> 2017)

Introduction

EN 52000-1 is a double-face standard

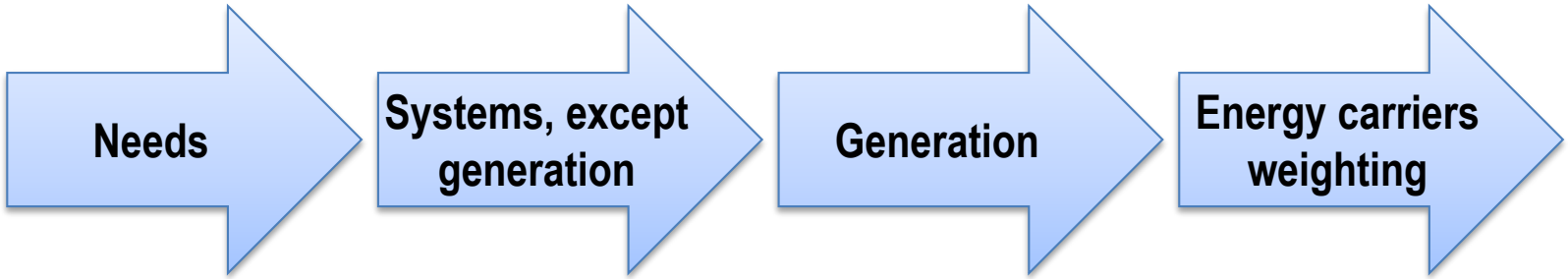
It is used

- **before** doing any calculation because it sets-up the general framework
- **after** that the calculation of building and technical systems is finished to
  - determine the **global balance of electricity**, which can be
    - delivered from the grid
    - produced on site (PV, cogeneration, wind, …)
    - accumulated on site (batteries)
    - and exported to the grid,
  - determine the overall **weighting of the energy carriers**.

Here we focus mainly on the final balance

How to "stress" EN-ISO 52000-1?

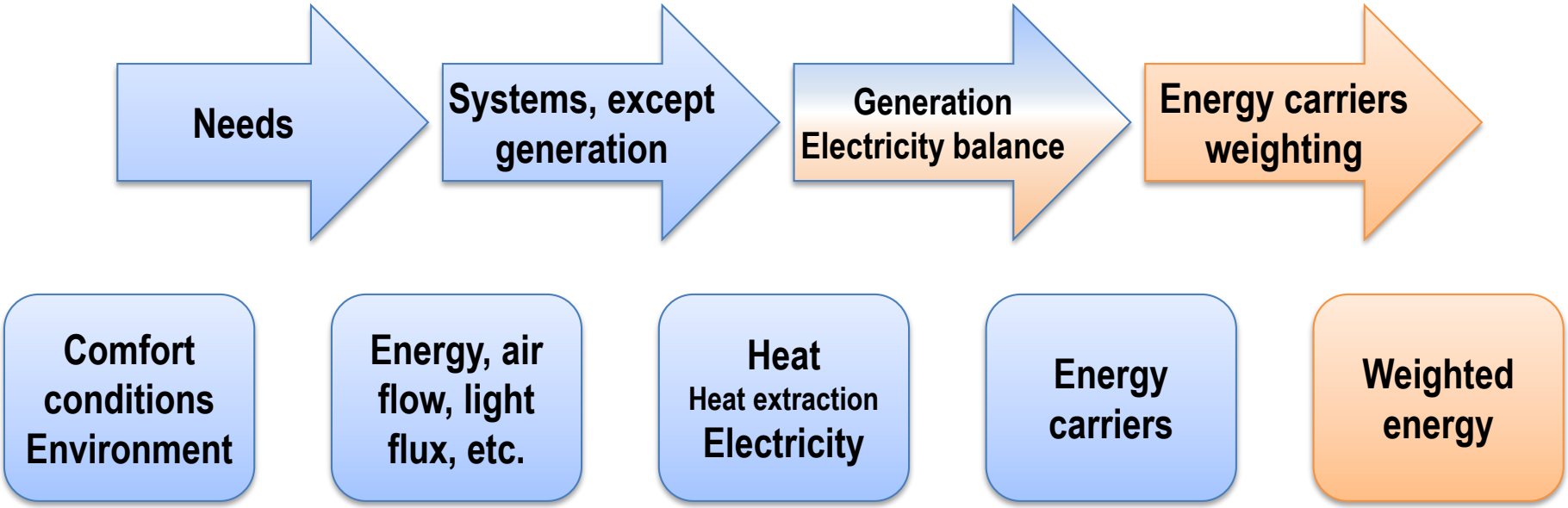
The overall calculation flow: simplified



Comfort conditions Environment	Energy, air flow, light flux, etc.	Heat Heat extraction Electricity	Energy carriers	Weighted energy

You start from the needs: some can be reduced (insulation) others can't.
Technical systems, up to generation, loose some energy and use auxiliary energy
Generators provide heat, heat extraction and electricity using energy carriers
Energy carriers are weighted to provide the energy performance

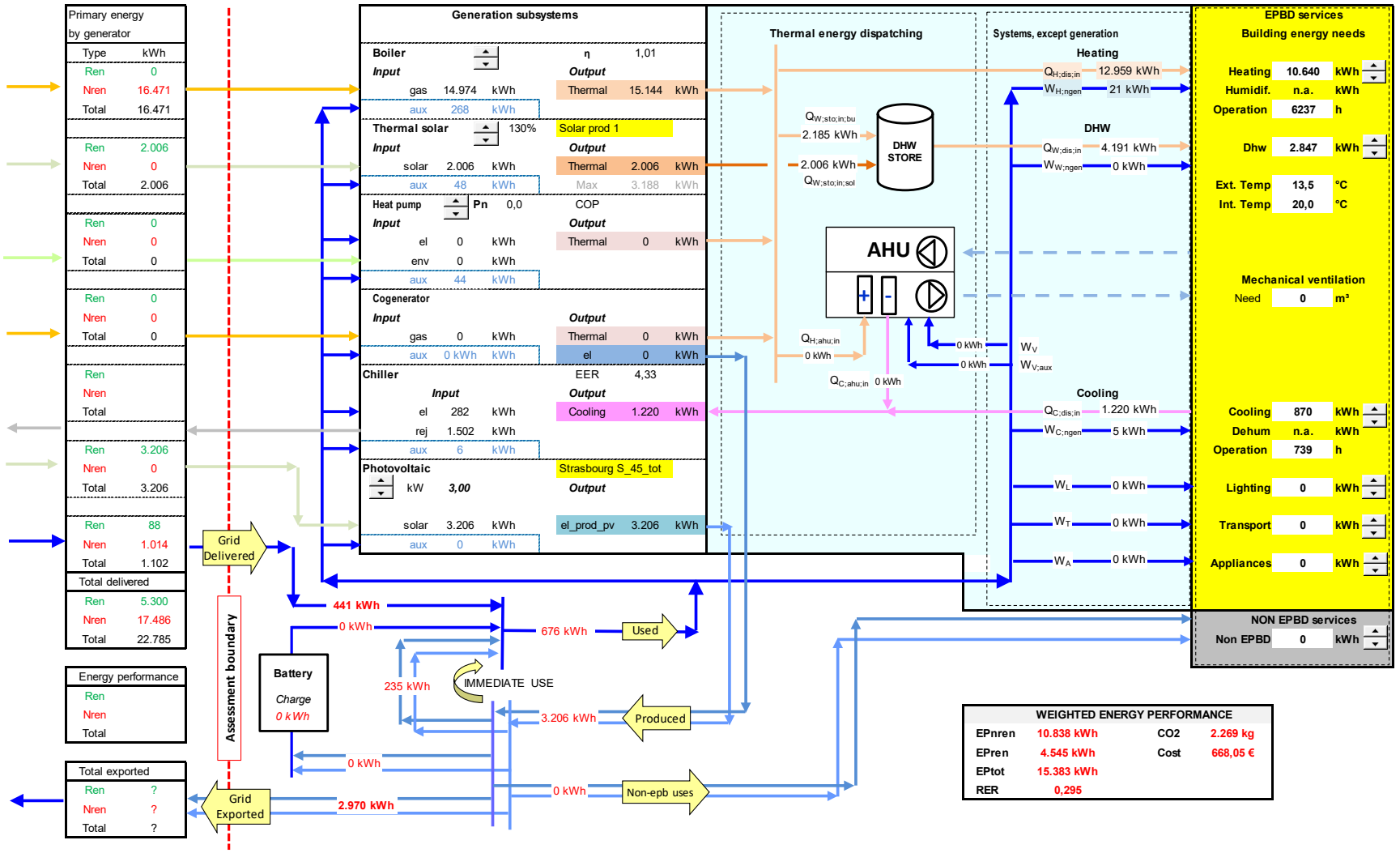
The role of EN-ISO 52000-1



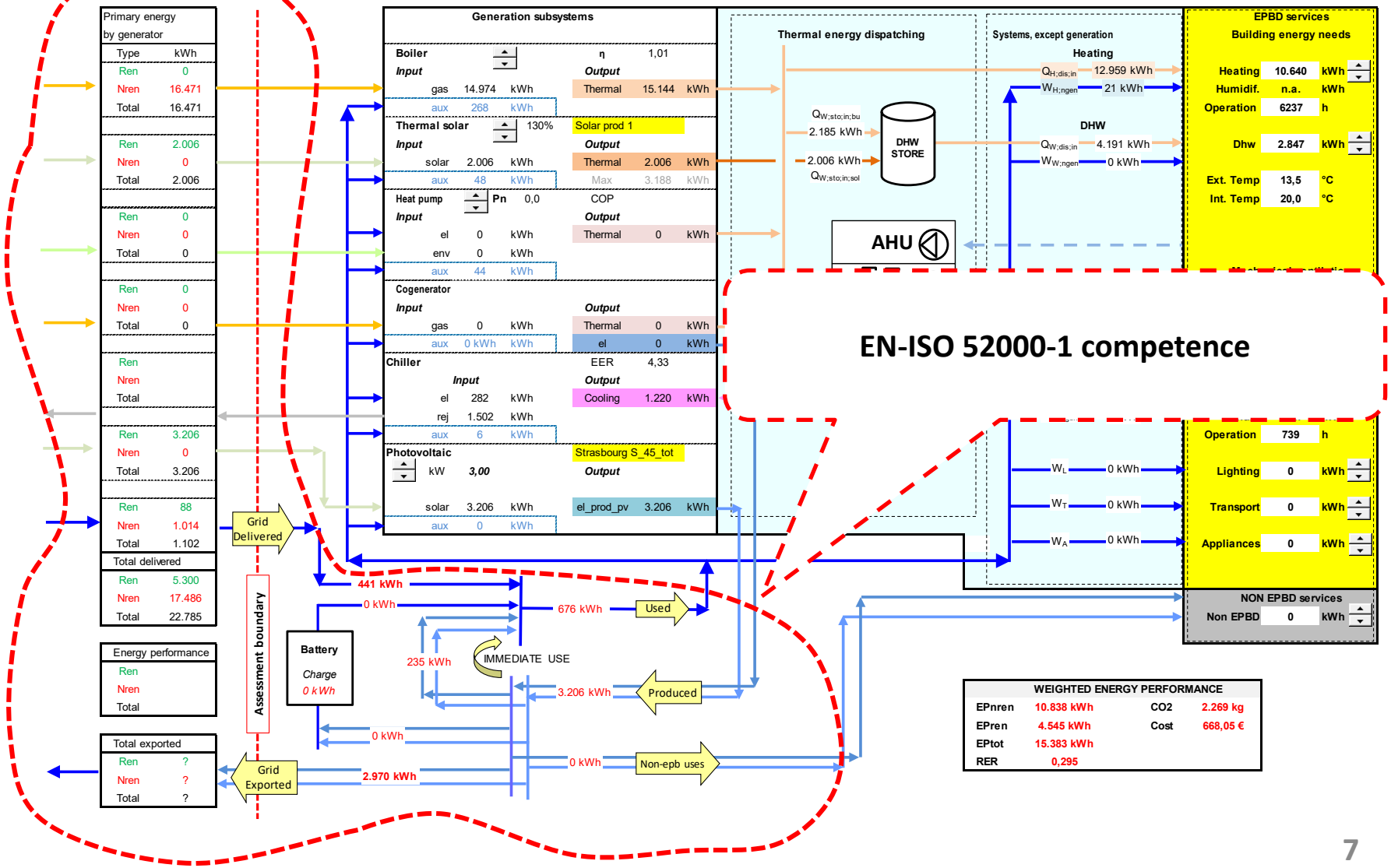
Electricity balance: depends on possible on-site generation and battery

Given the amount of energy carriers and some parameters, you get the weighted performance

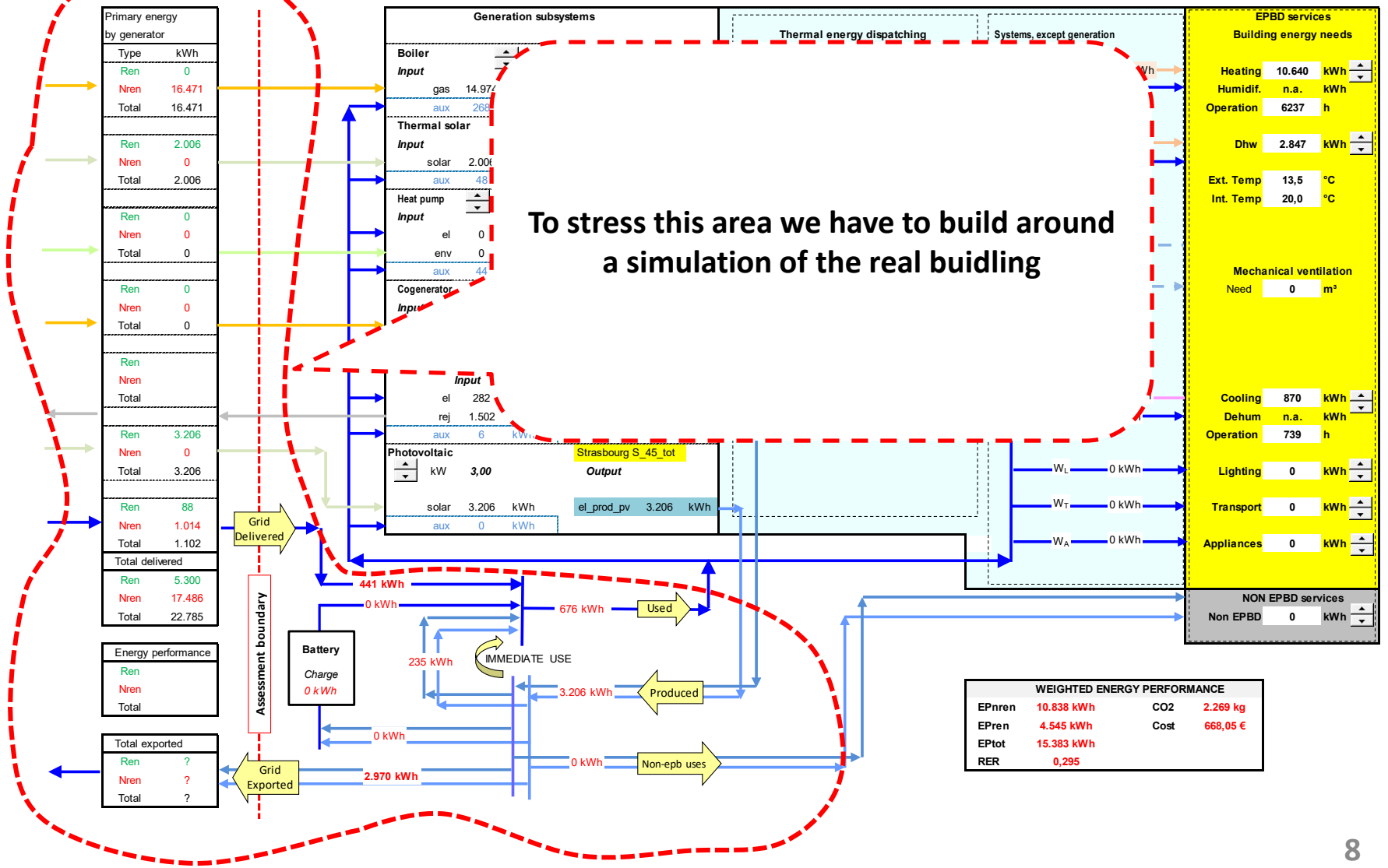
The overall calculation/energy flow



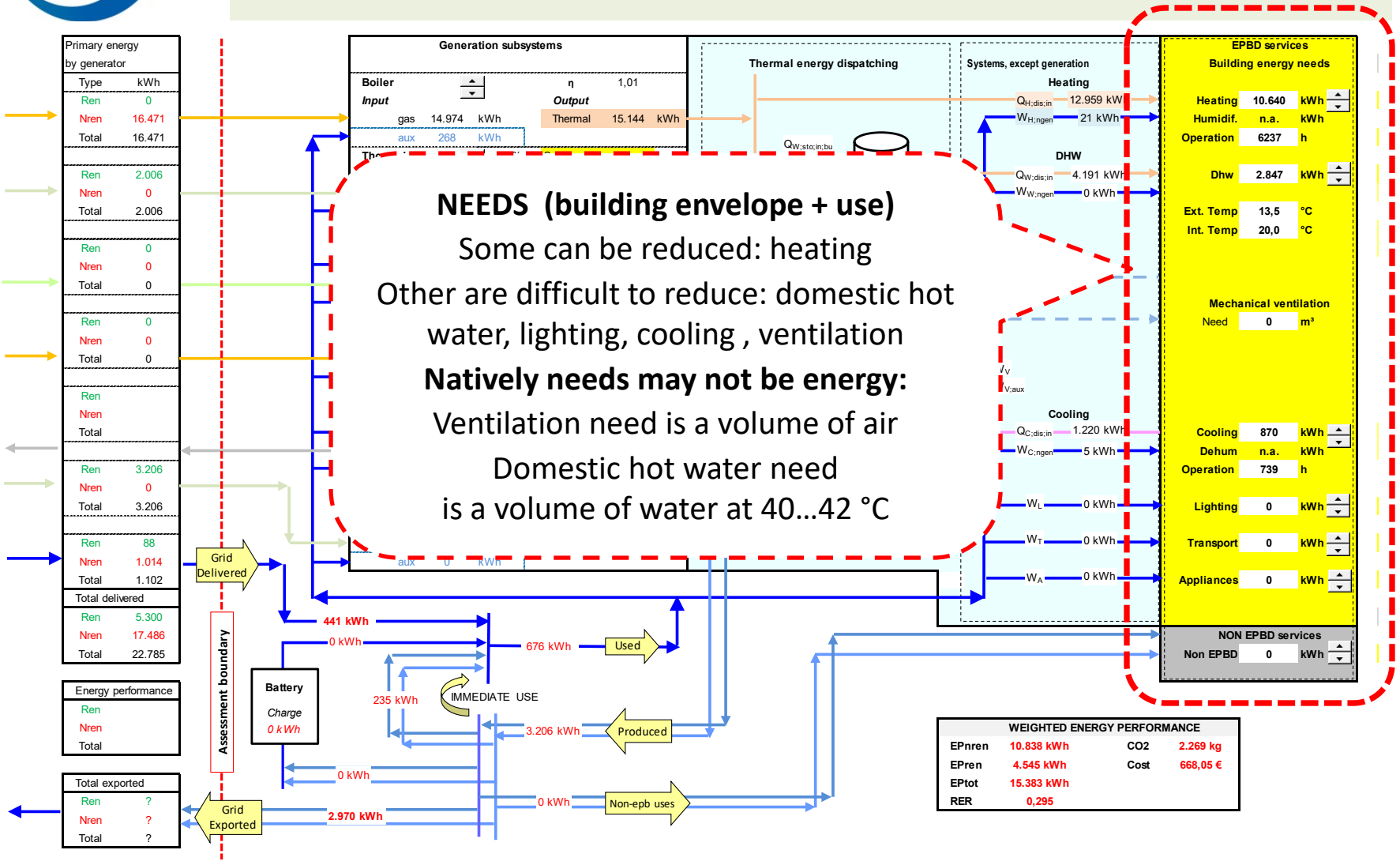
The overall calculation/energy flow



The overall calculation/energy flow



The overall calculation/energy flow

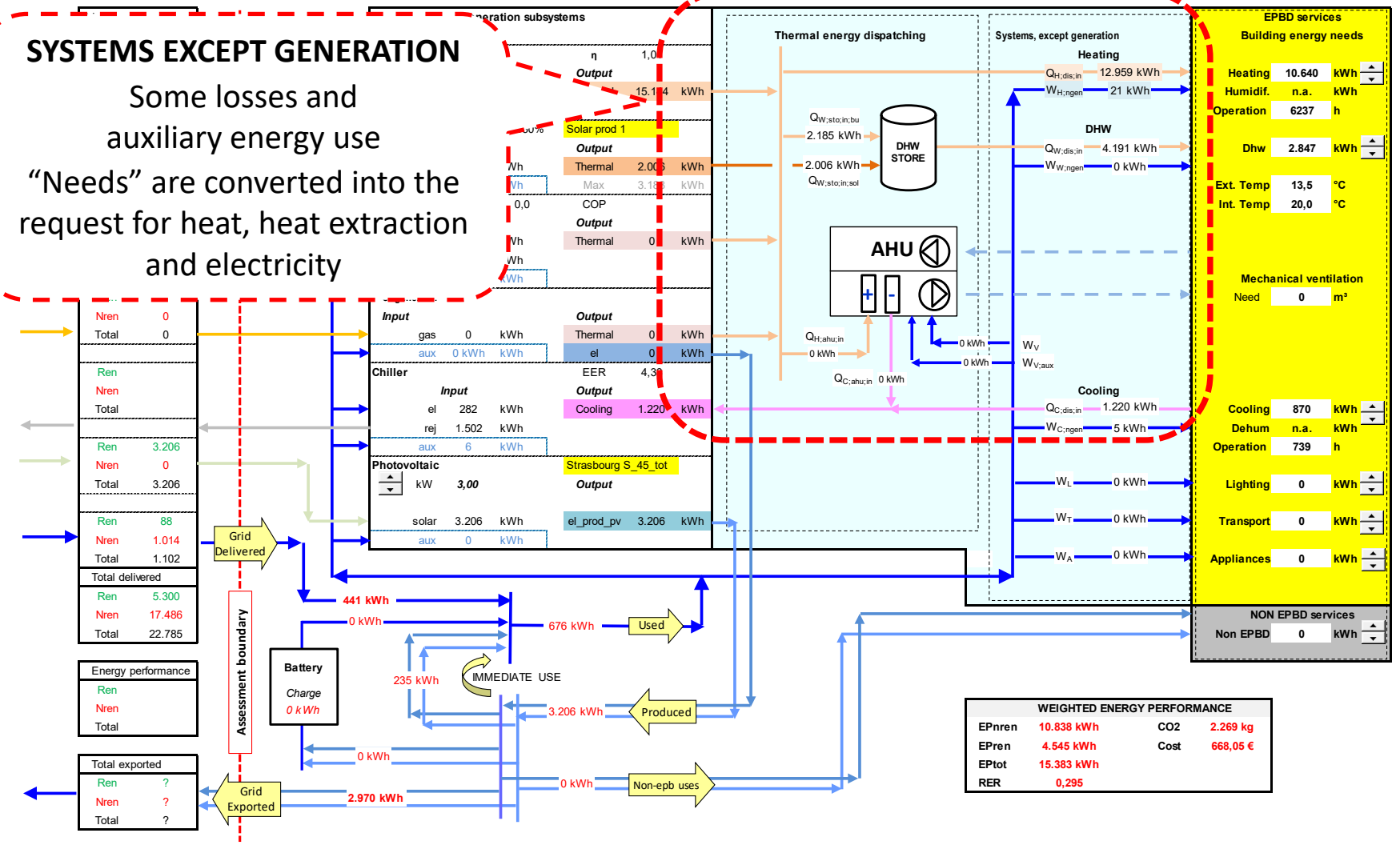


The overall calculation/energy flow

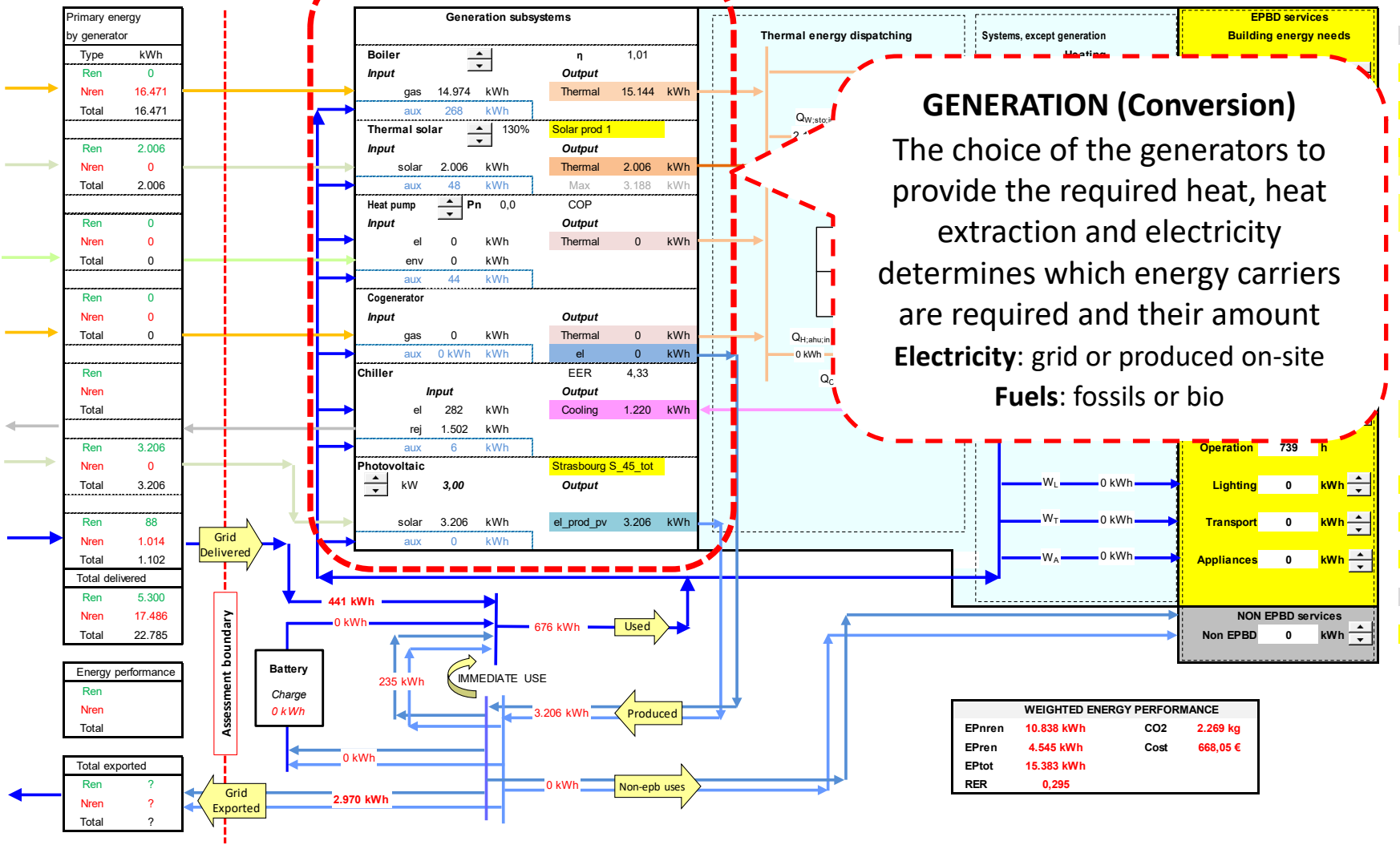
SYSTEMS EXCEPT GENERATION

Some losses and auxiliary energy use

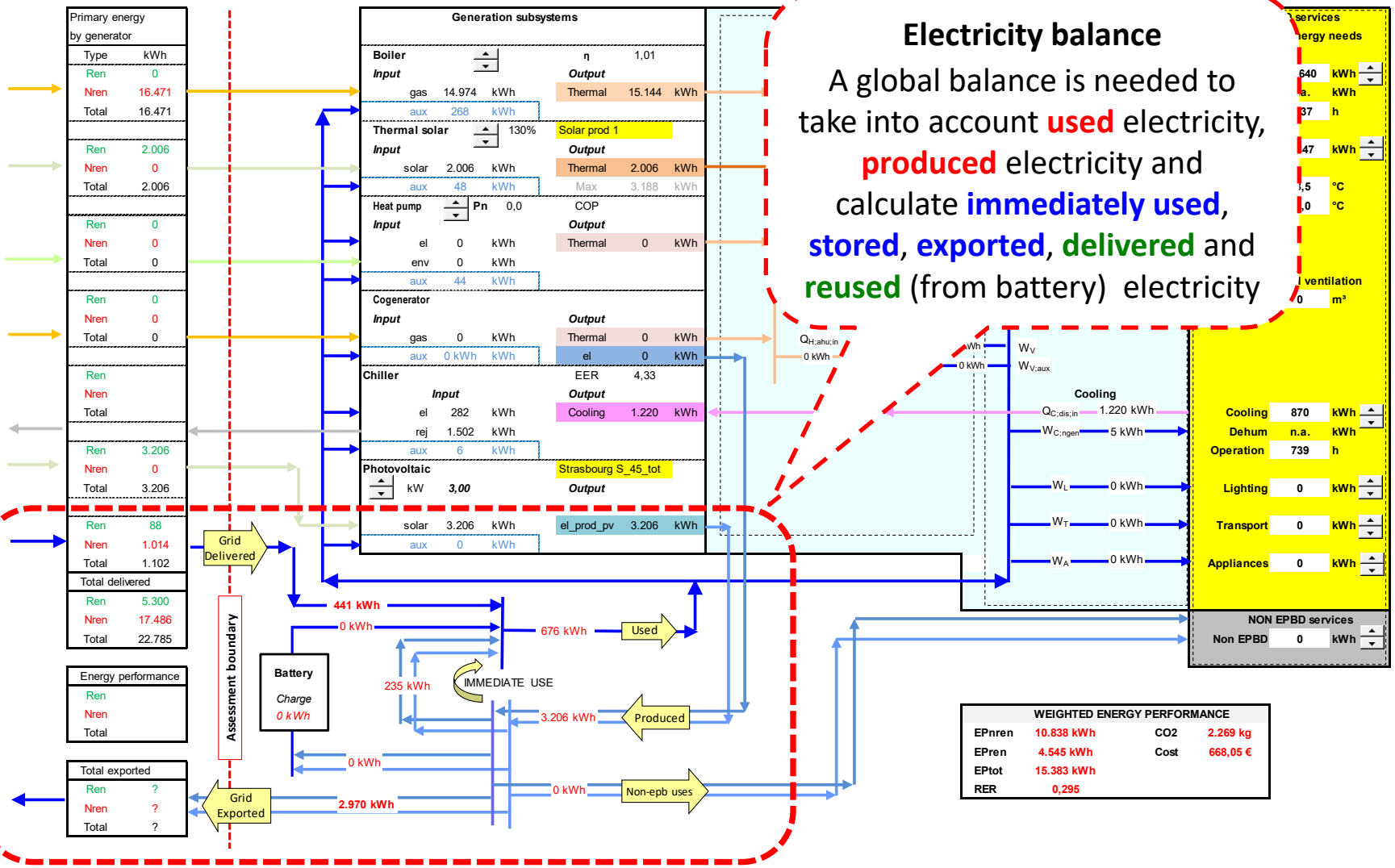
"Needs" are converted into the request for heat, heat extraction and electricity



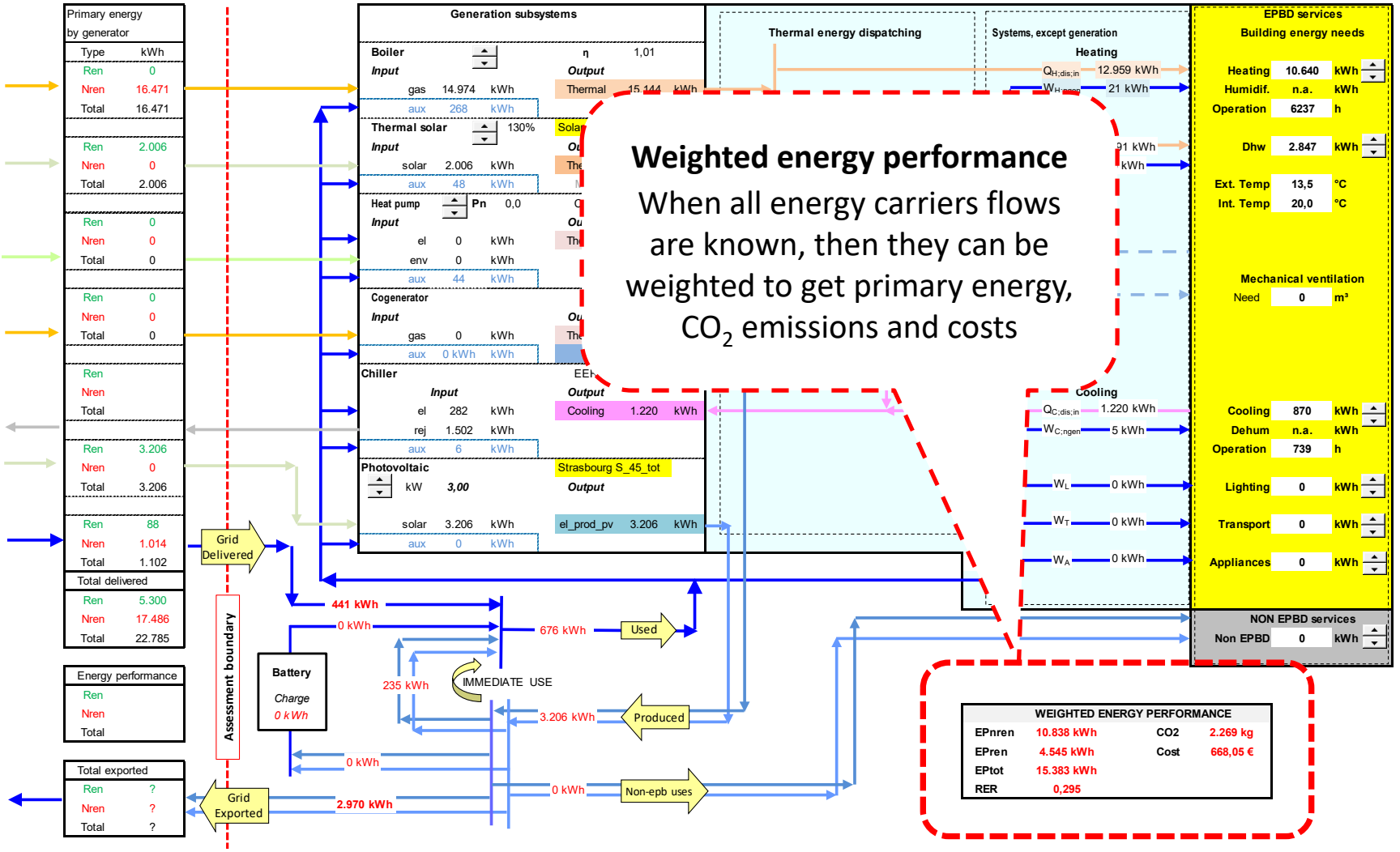
The overall calculation/energy flow



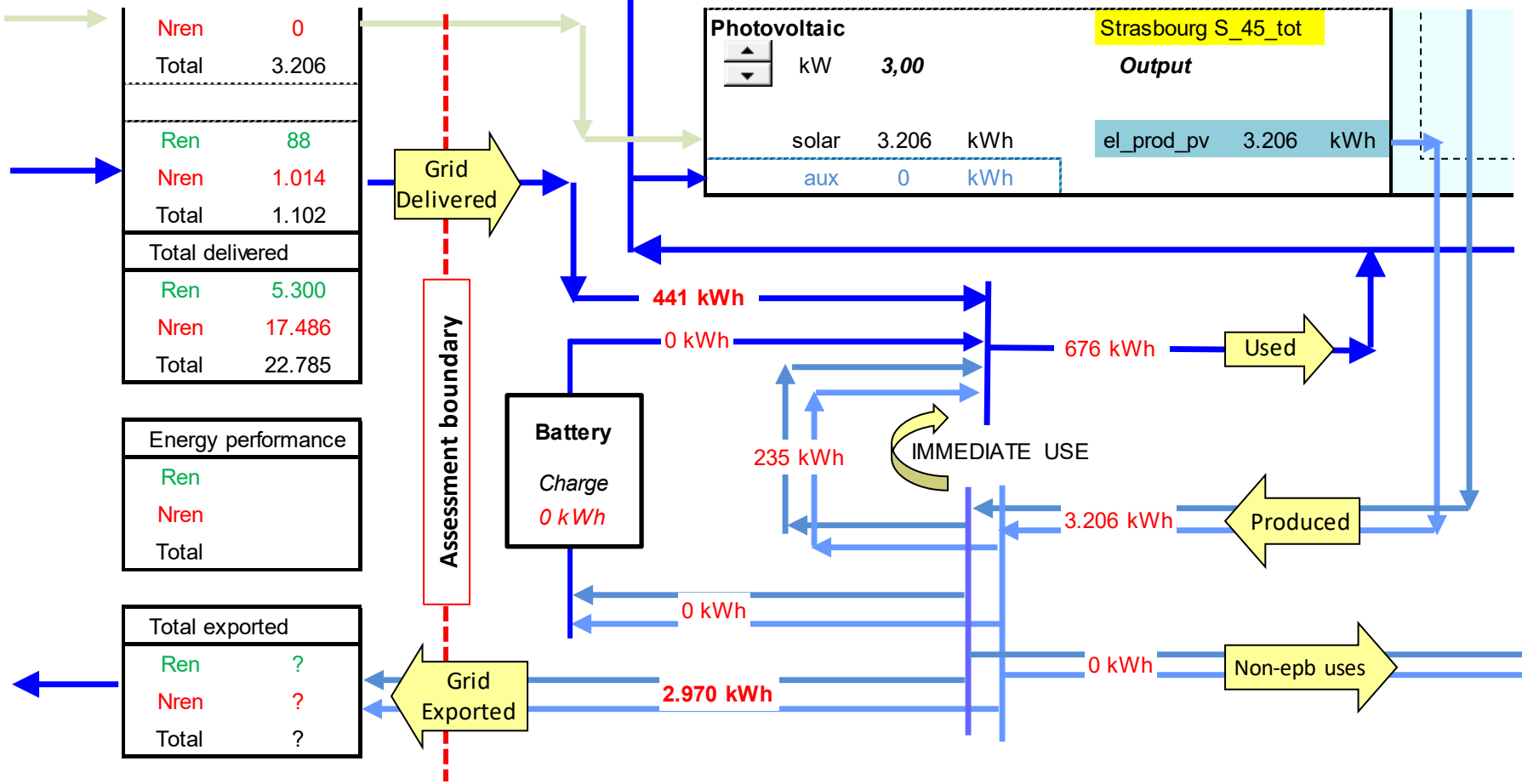
The overall calculation/energy flow



The overall calculation/energy flow



Electric energy balance

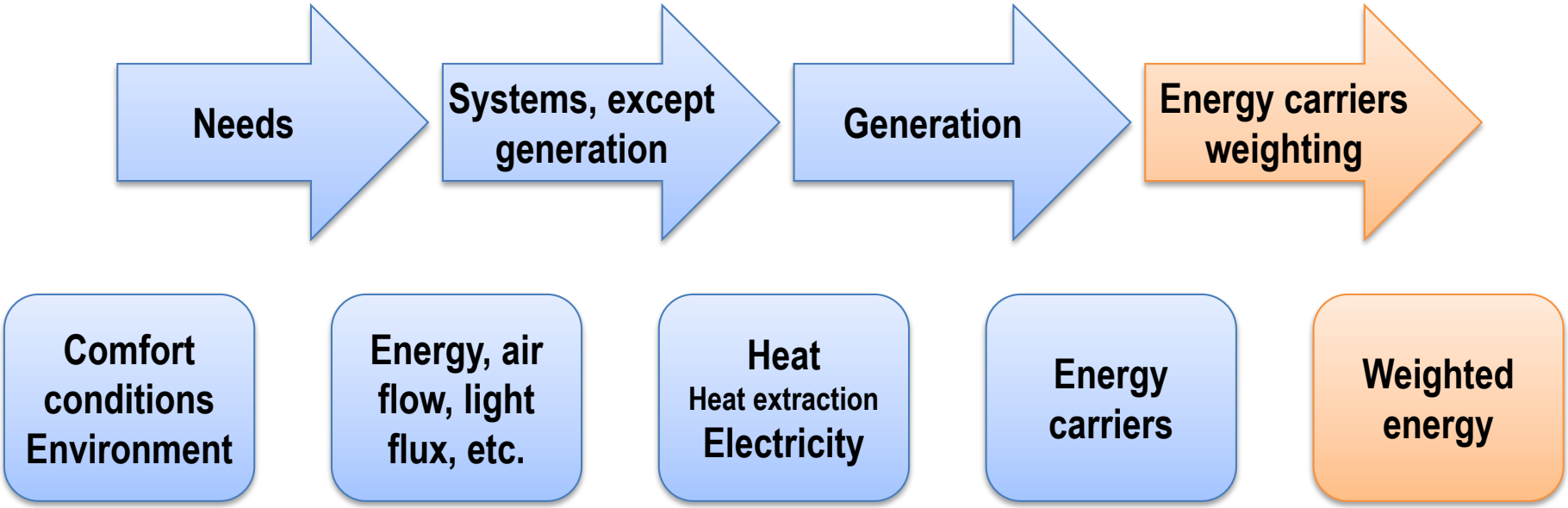


EN-ISO 52000-1 - Parameters

The main **parameters** in EN-ISO 52000-1 are:

- **Weighting factors**
  - Decided by MS, usually not varying that much
- **Kexp**
  - Kexp states if exported energy is accounted in the energy performance of the building.
- **Other parameters**
  - RER "perimeter" → defines which renewable energy components to take into account to calculate the overall RER
  - Matching factor → for the monthly method

The influence of EN 52001



The choice of weighting factors influences the result in terms of weighted performance

Parameters – Weighting factors

Main weighting types:

- **Primary energy**
  non-renewable, renewable and total

https://epb.center/documents/short-video-primary-energy-explained/

- **CO_2 emission**
- **Cost**

Factors for exported energy may be different from those for imported energy and time dependent (example: cost)

These parameters should be given nationally to reflect the origin of available energy carriers.

Primary energy factors and CO_2 emission factors are often given in MSs regulations since these indicators are used for legal purposes

Parameters – Weighting factors

Please select here the desired weighting factor data set

Your selection EN ISO 52000-1 1

Table A/B.16 - Weighting factors (based on gross or net calorific value)					
Description	**Symbol**	**Energy carrier**	**Unit**	**Value**	**Perim**
	Name of the data set			**EN ISO 52000-1**	
Non renewable primary energy factor	f_{Pnren}				
gas	$f_{Pnren,del;gas}$	gas	*kWh/kWh*	1,10	dist
oil	$f_{Pnren;del;oil}$	oil	*kWh/kWh*	1,10	dist
coal	$f_{P;nren,del;coal}$	coal	*kWh/kWh*	1,10	dist
Renewable primary energy factor	$f_{P,nen}$				
gas	$f_{P;ren,del;gas}$	gas	*kWh/kWh*	0,00	
oil	$f_{P;ren,del;oil}$	oil	*kWh/kWh*	0,00	
coal	$f_{P;ren,del;coal}$	coal	*kWh/kWh*	0,00	
CO2 conversion factors	UNIT				
gas	$K_{CO2;del;gas}$	gas	kg_{co2}/kWh	0,220	
oil	$K_{CO2;del;oil}$	oil	kg_{co2}/kWh	0,290	
coal	$K_{CO2;del;coal}$	coal	kg_{co2}/kWh	0,360	

Parameters - K_{exp}

K_{exp} = 0 excludes exported energy from the energy performance

K_{exp} = 1 includes exported energy from the energy performance

- The energy performance is very sensitive to this choice when there is exported energy
- Consequences of Kexp = 1
  - Cross compensation between energy carriers
    → electricity export can compensate for fossil fuel use
  - Compensation between electric energy produced and used at a different time
    → the grid is like a battery
- One different value is possible for each type of weighting
- See short videos for further details

https://epb.center/documents/short-video-exported-energy-explained/

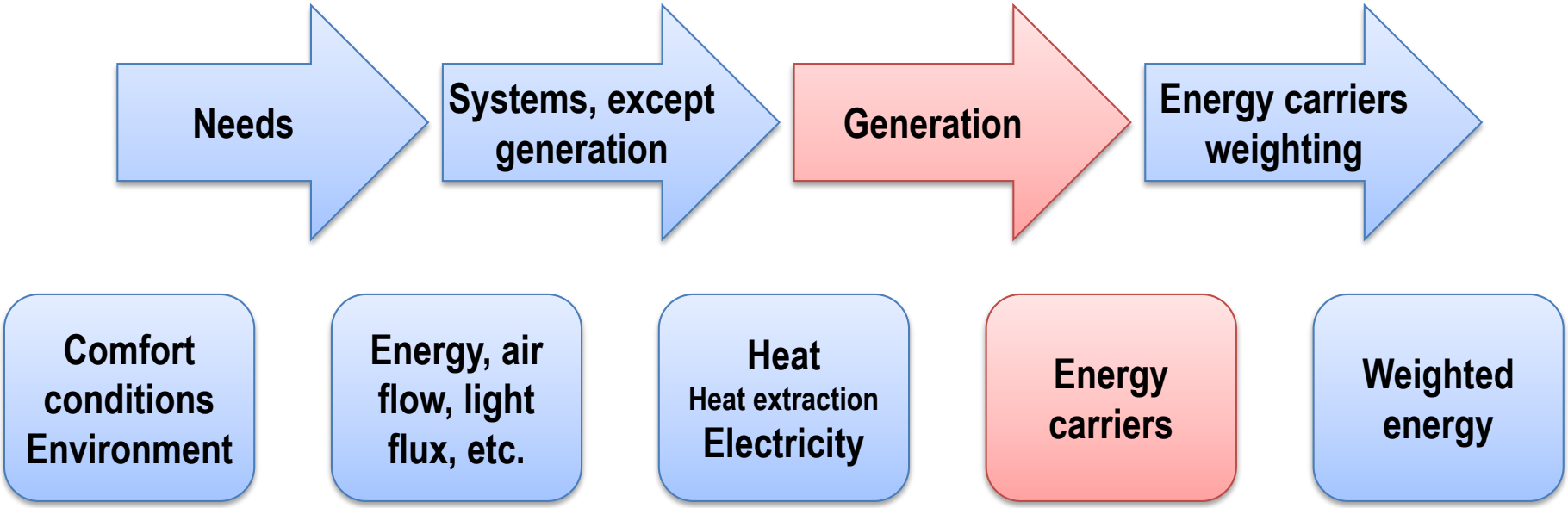
Table A-B.17 Kexp factor

Please select here the desired parameter set

Your selection EN ISO 52000-1 | 1

Selected set	EN ISO 52000-1
Kexp for primary energy	1,0
Kexp for CO2 emission	1,0
Kexp for cost	1,0

The influence of EN 52001



The choice of the generation technology defines which energy carriers may be used

→ This has an impact on the achievable performance, especially in terms of renewable energy use (RER)

Generation technologies

The type of building and climate gives **the first mix** between

- **Heat**
  - Heating, cold climate, uninsulated buildings, low use buildings
  - Generators can use both fuels and electricity
- **Heat extraction**
  - Cooling, warm climate, insulated and use intensive buildings
- **Electricity**
  - Mechanical ventilation, lighting, transport, auxiliaries…

required by the systems

Technologies

- Combustion boiler
  - Limited efficiency
  - Provides only heat
  - May use biofuels, even through the grid
- Heat pumps and chillers
  - Higher efficiency, use mostly electricity
  - May use fuels (absorption)
- Thermal solar:
  - for domestic hot water (summer)
  - needs storage
- Photovoltaic
  - generates electricity on site
  - available mostly in summer
  - not available at night
- Cogeneration
  - Generates both heat and electricity
  - Effective if all electricity and heat are used
- District heating and cooling
- Wind turbines

Heat pumps and chillers may use electricity for heat and heat extraction and shift the balance of energy carriers towards electricity

Other functions of EN-ISO 52000-1

- RER indicator, including the possibility to define a “perimeter” e.g. which contributions to take into account
  If used as a regulation requirement, this may limit the choice of the generation technology
- Matching factor between produced and used electricity
  - To be taken into in the monthly calculation
- Priority of on-site electricity use
  - If there are several electricity generators, a priority is defined to deci which is used on-site first, the other is exported
- Allowed uses of generated electricity
  - May exclude from certain uses of on-site generated electricity (e.g. PV to direct heating)

Why hourly parameters

Weighting factors may be time-dependent

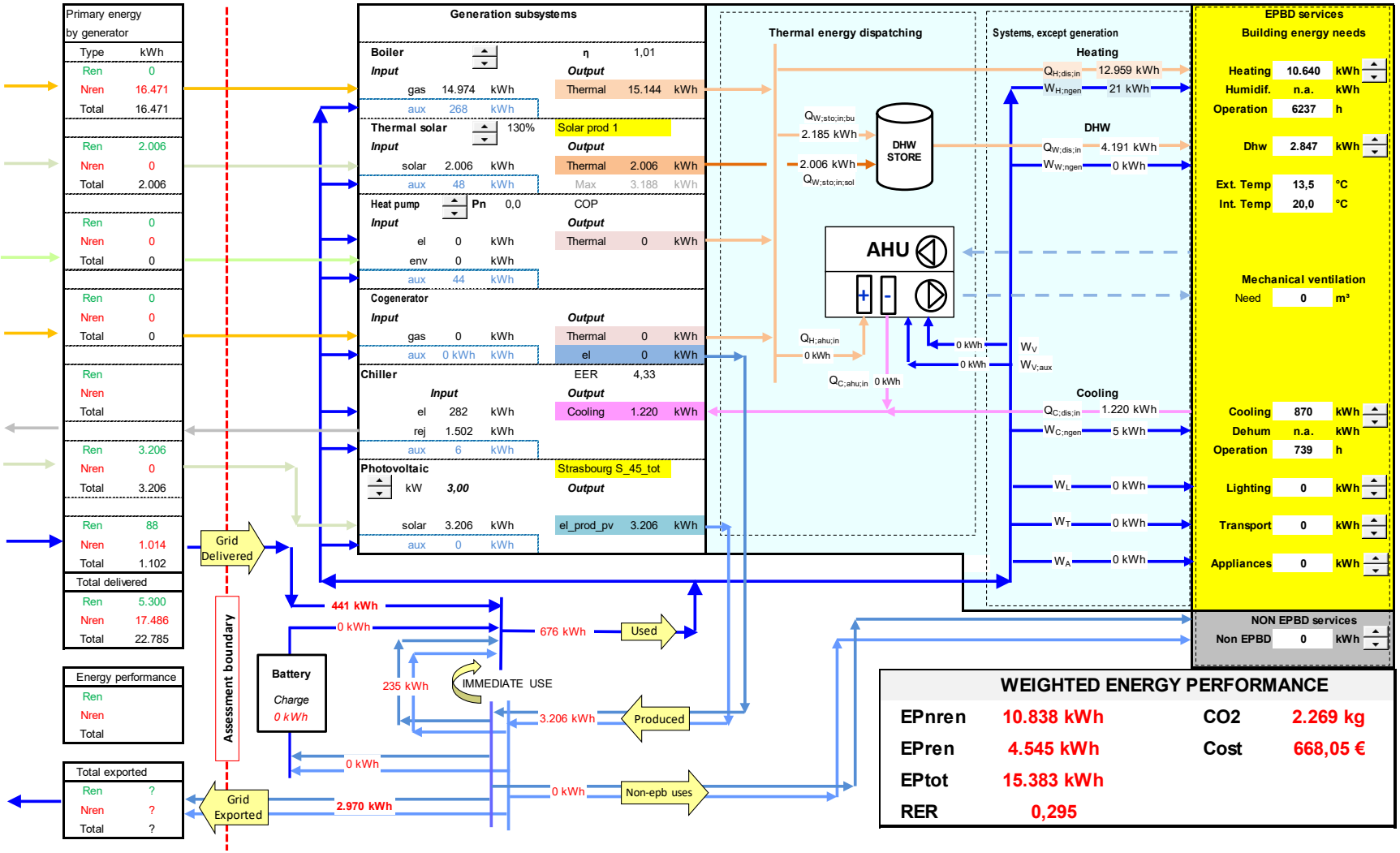
- Cost of grid electricity is very often time dependent
- Electricity weighting factor may be time dependent
  (which grid generators are in use at different times)
- The effect of exported energy on the grid may be time dependent

Boiler & PV - Kexp=1

Case description

- Recent single family house
- Gas boiler + split air conditioner
- Thermal solar for domestic hot water
- 3 kW peak photovoltaic
- Kexp = 1 and default conversion factors

Yearly diagram



Aggregated results by month

	Non renewable primary energy	Renewable primary energy	Total primary energy	CO2 emission	Cost	RER
	EPnren	*EPren*	*EPtot*	*CO2*	*Cost*	*RER*
	kWh	kWh	kWh	kg co2	€	
MAX	10,802	4,832	10,836	2,154	0,80	0,446
MIN	-6,0	0,0	-3,8	-1,1	-0,6	0,0
AVG	1,2	0,5	1,8	0,3	0,08	0,295
TOT	10.838	4.545	15.383	2.269	668,05	0,295
MONTHLY						
January	3.540	192	3.732	711	255,62	0,051
February	2.615	224	2.839	527	186,59	0,079
March	1.327	468	1.795	279	80,07	0,261
April	339	417	756	79	10,01	0,552
May	-720	530	-190	-128	-73,17	-2,791
June	-562	546	-16	-100	-55,89	-35,036
July	-254	510	256	-43	-25,39	1,990
August	-489	517	28	-86	-49,56	18,415
September	-476	425	-51	-83	-49,68	-8,349
October	431	346	777	93	22,70	0,446
November	1.935	211	2.146	390	138,12	0,098
December	3.150	160	3.310	631	228,64	0,048
Year	10.838	4.545	15.383	2.269	668,05	0,295

EPB uses of electricity	Produced electricity	EPB produced and used electricity	Grid exported, t	Grid delivered electricity, t
EEPus;el;t	*Epr;el;t*	*r;el;used;EPu*	*Eexp;el;grid;t*	*Edel;el;t*
kWh	kWh	kWh	kWh	kWh
1,269	2,627	0,686	2,612	0,939
0,015	0	0	0	9E-05
0,1	0,4	0,0	0,3	0,1
676	3.206	235	2.970	441
66,7	131,4	14,1	117,3	52,6
52,7	144,3	12,9	131,4	39,8
42,7	371,1	14,4	356,7	28,3
26,0	313,0	9,7	303,3	16,3
14,2	412,4	7,3	405,2	7,0
93,1	410,1	37,4	372,7	55,7
154,6	338,7	62,7	276,0	91,9
84,1	373,0	43,6	329,4	40,5
16,2	307,7	6,5	301,1	9,6
23,8	197,1	7,0	190,1	16,8
42,3	110,6	8,6	102,0	33,7
59,8	96,3	11,3	85,0	48,6
676	3.206	235	2.970	441

Aggregated results by month

	Non renewable primary energy	Renewable primary energy	Total primary energy	CO2 emission	Cost	RER
	EPnren	*EPren*	*EPtot*	*CO2*	*Cost*	*RER*
	kWh	kWh	kWh	kg co2	€	
MAX	10,802	4,832	10,836	2,154	0,80	0,446
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April	339	417	756	79	10,01	0,552
May	-720	530	-190	-128	-73,17	-2,791
June	-562	546	-16	-100	-55,89	-35,036
July	-254	510	256	-43	-25,39	1,990
August	-489	517	28	-86	-49,56	18,415
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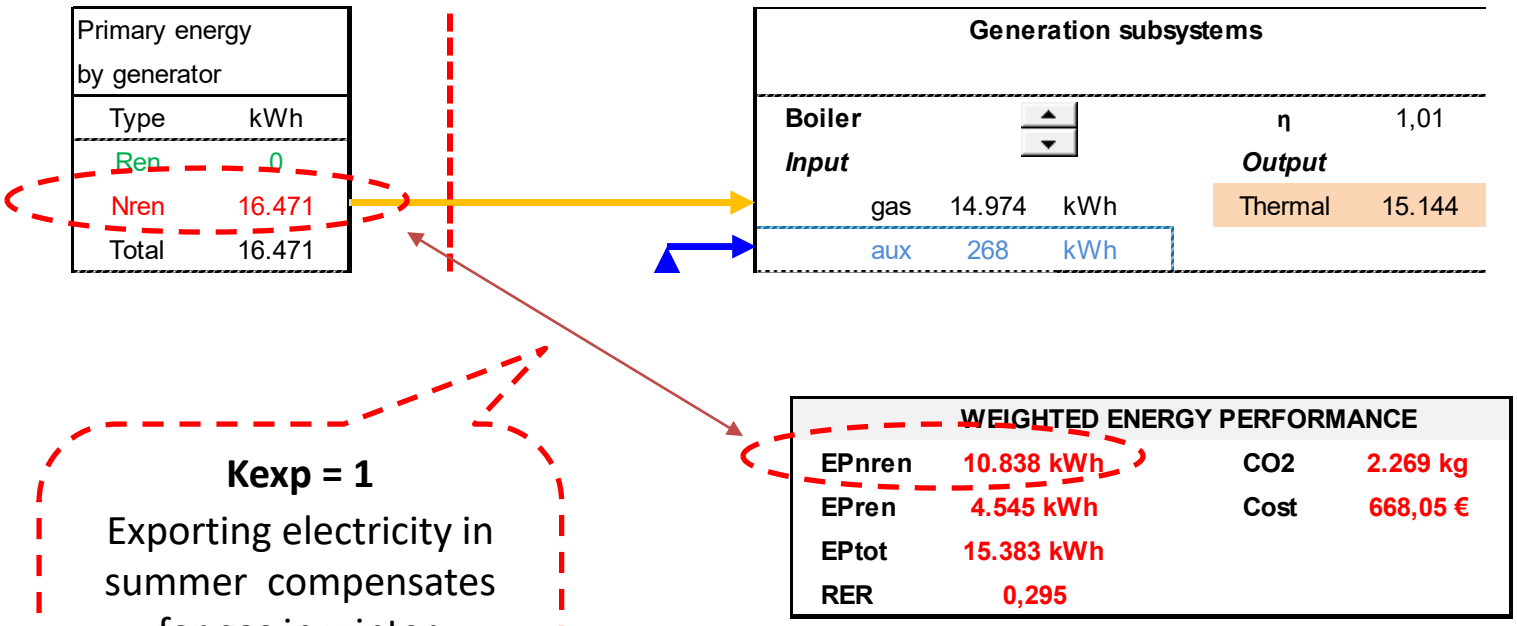
EPB uses of electricity	Produced electricity	EPB produced and used electricity	Grid exported, t	Grid delivered electricity, t
EEPus;el;t	*Epr;el;t*	*r;el;used;EPu*	*Eexp;el;grid;t*	*Edel;el;t*
kWh	kWh	kWh	kWh	kWh
1,269	2,627	0,686	2,612	0,939
0,015	0	0	0	9E-05
0,1	0,4	0,0	0,3	0,1
676	3.206	235	2.970	441
66,7	131,4	14,1	117,3	52,6
52,7	144,3	12,9	131,4	39,8
42,7	371,1	14,4	356,7	28,3
26,0	313,0			
14,2	412			
154,6				
84,1	373			
16,2	307			
23,8	197			
42,3	110			
59,8	96,3	11,3	85,0	48,6
676	3.206	235	2.970	441

Kexp = 1

Exporting electricity in summer compensates for gas in winter

Yearly diagram

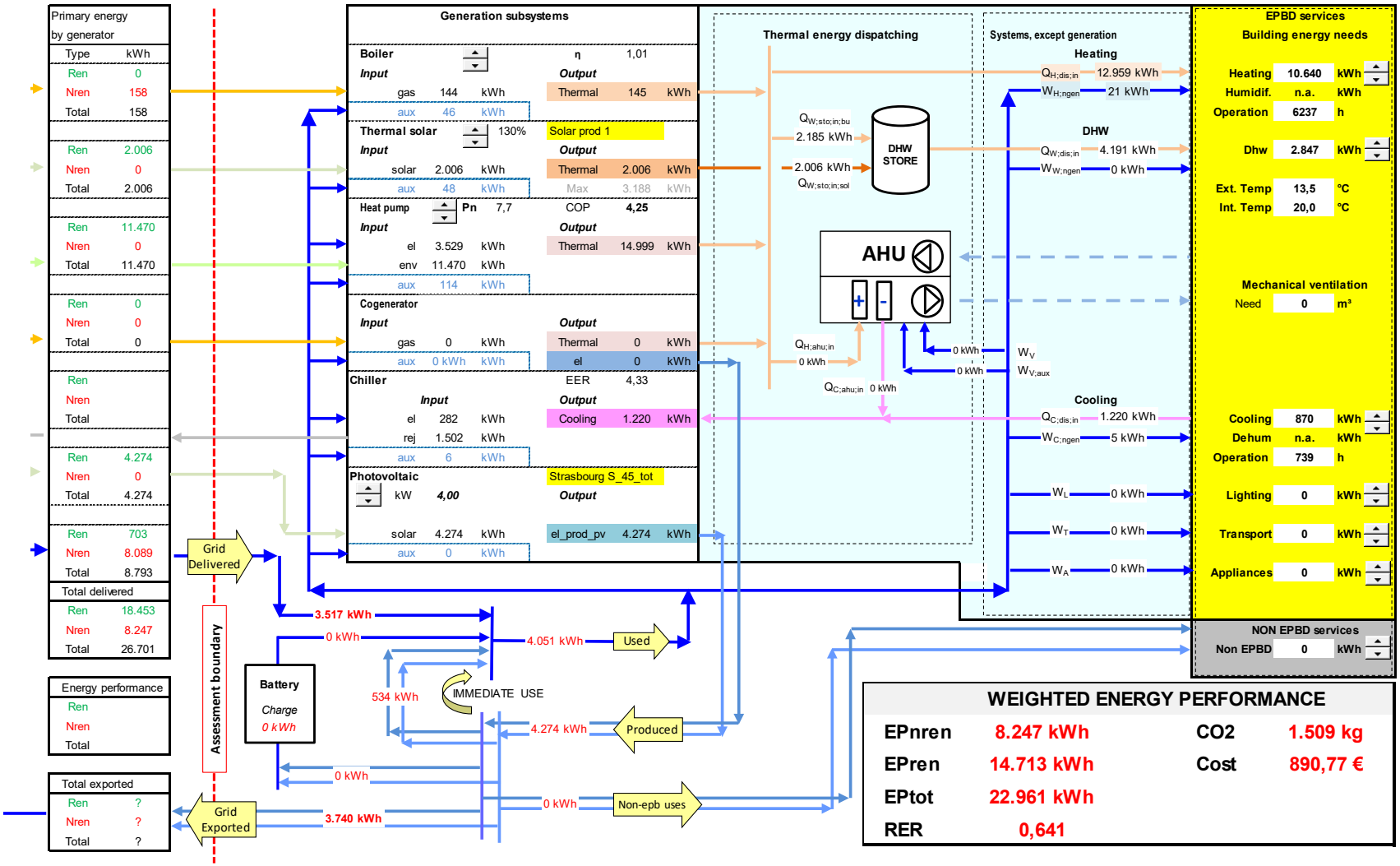


HP & PV – Kexp = 0

Case description

- Recent single family house
- Heat pump + split air conditioner
- Thermal solar for domestic hot water
- 3 kW peak photovoltaic
- Kexp = 0 and default conversion factors

Yearly diagram



Aggregated results by month

Description	Non renewable primary energy	Renewable primary energy	Total primary energy	CO2 emission	Cost	RER		EPB uses of electricity	Produced electricity	EPB produced and used electricity	Grid exported, t	Grid delivered electricity, t
Symbol	*EPnren*	*EPren*	*EPtot*	*CO2*	*C*	*RER*		*EEPus;el;t*	*Epr;el;t*	*pr;el;used;EPus*	*exp;el;grid,*	*Edel;el;t*
Unit	kWh	kWh	kWh	kg co2	€			kWh	kWh	kWh	kWh	kWh
Origin												
MAX	9,724	8,206	13,303	1,854	0,89	0,617		2,273	3,503	0,884	3,487	2,273
MIN	0,00015	0,003	0,015098	2,75E-05	0,00	0,199		0,015	0	0	0	6,54E-05
AVG	0,9	1,7	2,6	0,2	0,10	0,641		0,5	0,5	0,1	0,4	0,4
TOT	8.247	14.713	22.961	1.509	890,77	0,641		4.051	4.274	534	3.740	3.517
MONTHLY												
January	1.958	2.778	4.736	359	210,32	0,587		891,6	175,2	70,6	104,6	820,9
February	1.355	2.246	3.601	248	146,47	0,624		642,6	192,3	63,1	129,2	579,5
March	800	1.831	2.631	146	86,87	0,696		422,4	494,8	75,8	419,0	346,6
April	372	970	1.342	68	40,46	0,723		195,5	417,3	33,6	383,7	161,8
May	101	347	448	18	10,98	0,774		54,8	549,9	10,9	539,0	43,9
June	184	373	557	34	20,02	0,669		124,6	546,8	44,5	502,3	80,1
July	261	417	678	48	28,39	0,615		185,9	451,6	72,3	379,3	113,6
August	159	383	542	29	17,31	0,706		117,9	497,3	48,7	448,6	69,2
September	121	317	438	22	13,11	0,724		60,0	410,3	7,5	402,7	52,5
October	330	849	1.179	60	35,87	0,720		165,6	262,8	22,1	240,8	143,5
November	968	1.723	2.691	177	104,88	0,640		451,5	147,4	34,7	112,7	416,7
December	1.638	2.479	4.117	300	176,09	0,602		739,1	128,4	50,3	78,0	688,8
Year	8.247	14.713	22.961	1.509	890,77	0,641		4.051	4.274	534	3.740	3.517

Aggregated results by month

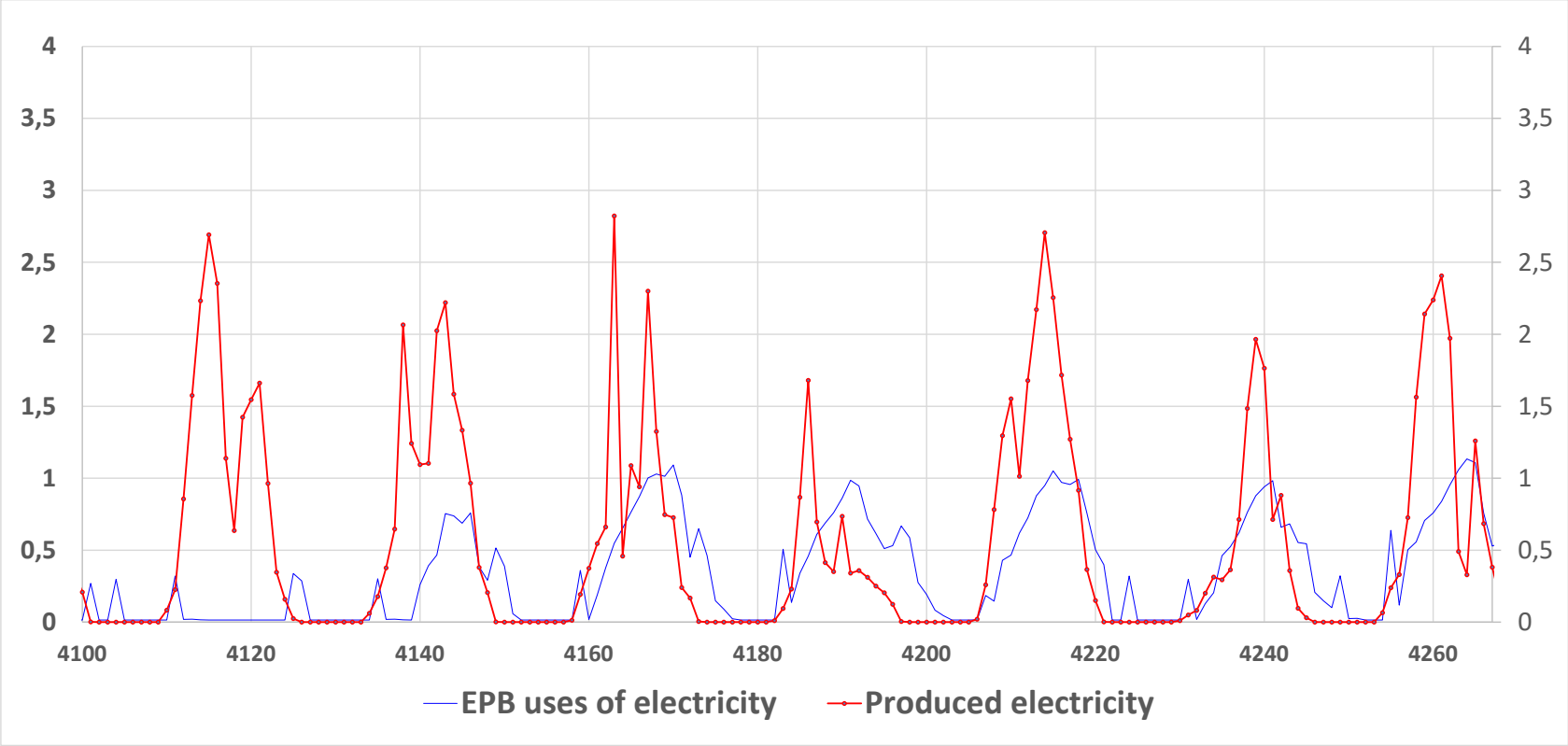
Description	Non renewable primary energy	Renewable primary energy	Total primary energy	CO2 emission	Cost	RER		EPB uses of electricity	Produced electricity	EPB produced and used electricity	Grid exported, t	Grid delivered electricity, t
Symbol	*EPnren*	*EPren*	*EPtot*	*CO2*	*C*	*RER*		*EEPus;el;t*	*Epr;el;t*	*pr;el;used;EPus*	*exp;el;grid,*	*Edel;el;t*
Unit	kWh	kWh	kWh	kg co2	€			kWh	kWh	kWh	kWh	kWh
Origin												
MAX	9,724	8,206	13,303	1,854	0,89	0,617		2,273	3,503	0,884	3,487	2,273
MIN	0,00015	0,003	0,015098	2,75E-05	0,00	0,199		0,015	0	0	0	6,54E-05
AVG	0,9	1,7	2,6	0,2	0,10	0,641		0,5	0,5	0,1	0,4	0,4
TOT	8.247	14.713	22.961	1.509	890,77	0,641		4.051	4.274	534	3.740	3.517
MONTHLY												
January	1.958	2.778	4.736	359	210,32	0,587		891,6	175,2	70,6	104,6	820,9
February	1.355	2.246	3.601	248	146,47	0,624		642,6				9,5
March	800	1.831	2.631	146	86,87	0,696		422,4				6
April	372	970	1.342	68	40,46	0,723		195				8
May	101	347	448	18	10,98	0,774						9
June	184	373	557	34	20,02	0,669						1
July	261	417	678	48	28,39	0,615		185,9				6
August	159	383	542	29	17,31	0,706		117,9				2
September	121	317	438	22	13,11	0,724		60,0				5
October	330	849	1.179	60	35,87	0,720		165,6				5
November	968	1.723	2.691	177	104,88	0,640		451,5				7
December	1.638	2.479	4.117	300	176,09	0,602		739,1				88,8
Year	8.247	14.713	22.961	1.509	890,77	0,641		4.051	4.274	534	3.740	3.517

Kexp = 0

No negative components.

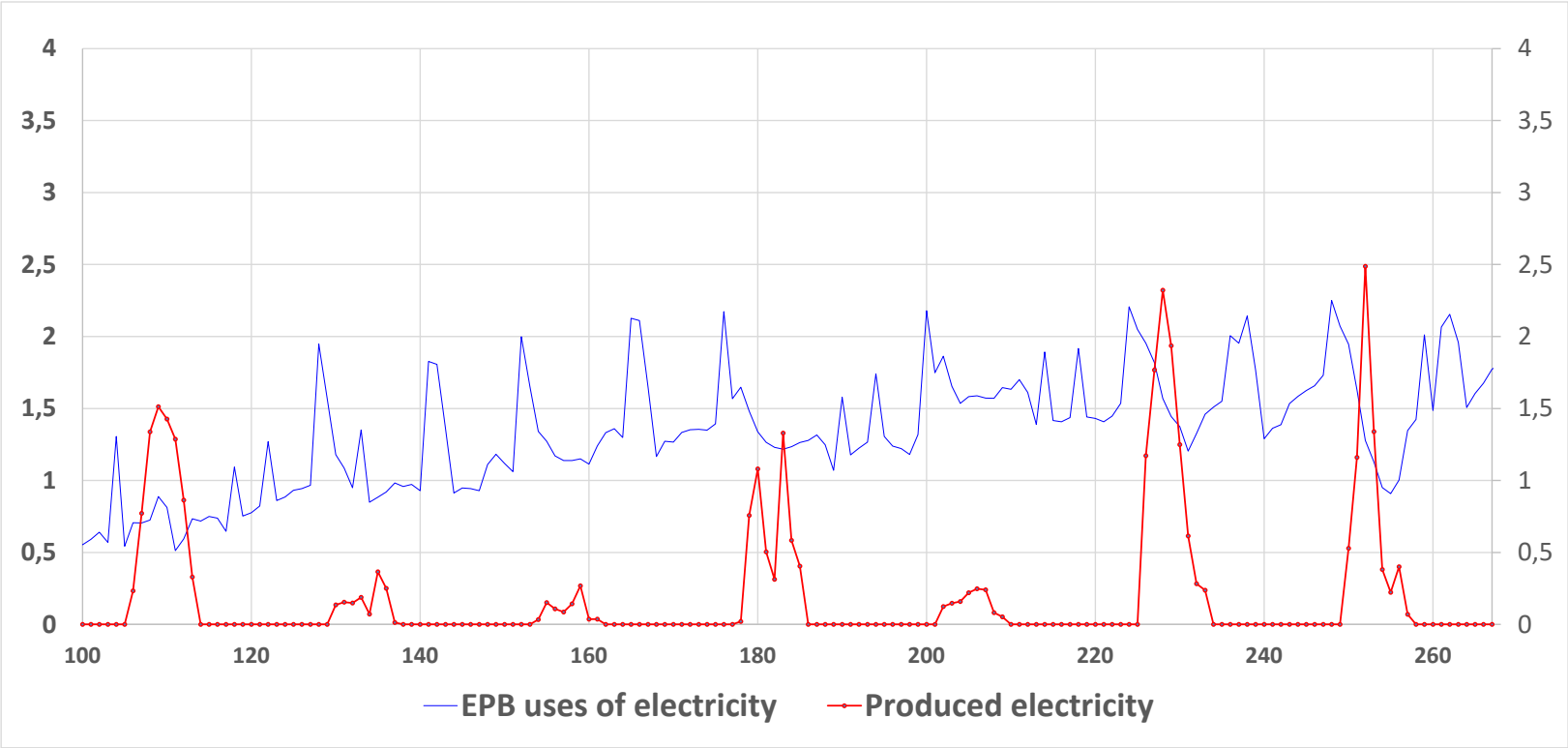
Only the cost of what is used in the building is accounted. No benefit from exported energy

Matching electricity



Summer: beginning of cooling

Matching electricity



Winter: heating + dhw with heat pump

Conclusion

52000-1 parameters impact energy performance.

The most impacting choice is that on $\mathbf{k_{exp}}$ → see videos for details

https://epb.center/documents/short-video-exported-energy-explained/

The achievable performance range depends on the generation technology
→ limitations set on performance may limit viable technologies

Timing is more and more important → hourly calculation

https://epb.center/documents/short-video-impact-calculation-interval/

Modern calculation tools and **trained experts** are needed to take into account all technologies.

Modern tools does not necessarily mean more complex input data

Thank you!

EPB Center is also 'available' for specific services requested by individual or clusters of stakeholders

More information on
the set of EPB standards:

www.epb.center

Contact: info@epb.center

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Q&A

Submit your question!