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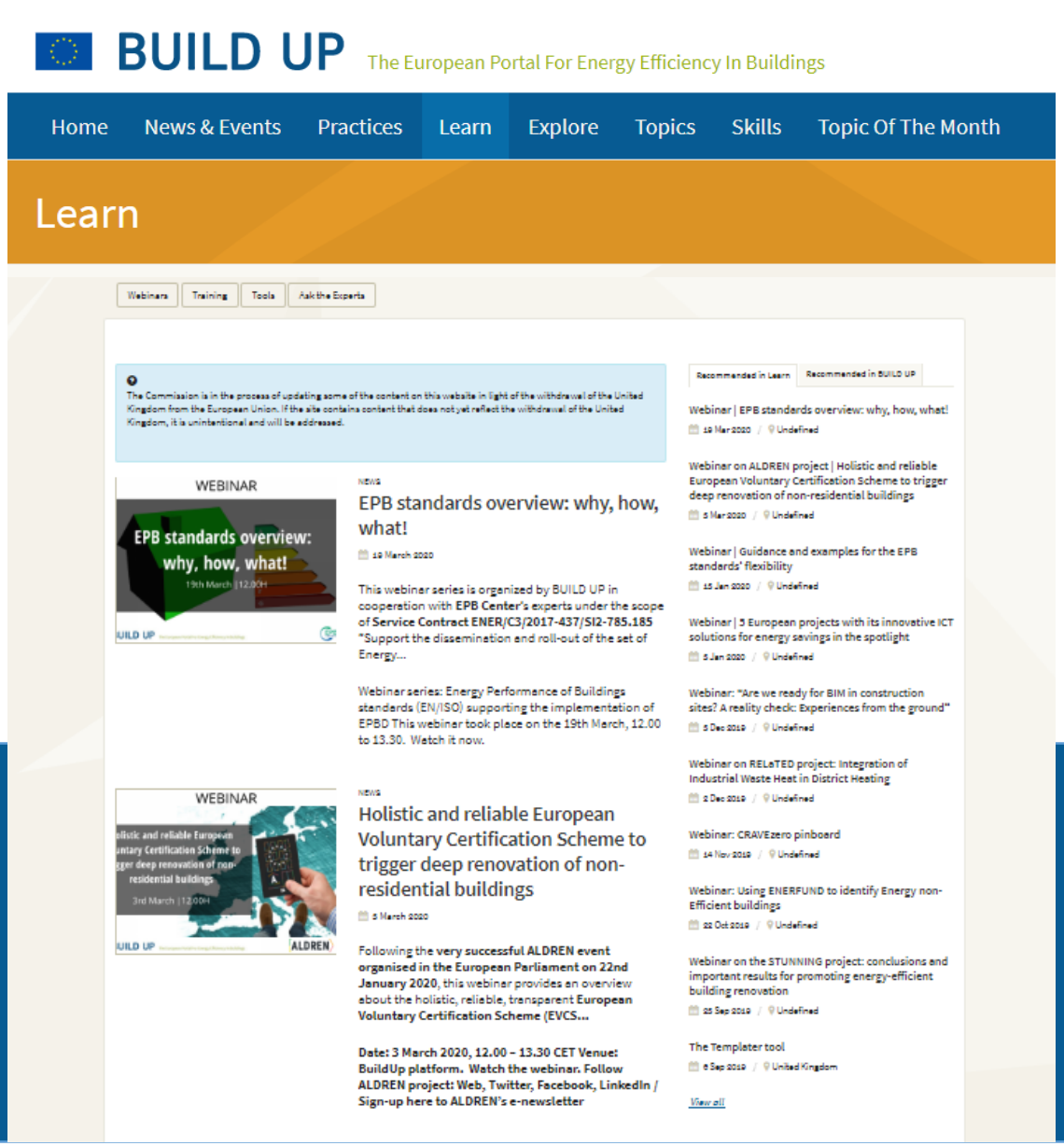


Check our Learn section!

WEBINAR

AGENDA:

Introduction by the moderator

Introduction and overview of current EU practices: Jaap HOGELING, Chairperson CEN/TC 371, Energy Performance of Buildings project group, European Committee for Standardization (CEN)

Energy need and indoor temperatures calculation: hourly or monthly?: Dick VAN DIJK, EPB expert, EPB Center

Hourly or monthly? What about technical systems?: Laurent SOCAL, independent EPB expert

Moderated Q&A

February – March – April – May – June – September 2020

- **Webinar 1** – **4th February 2020 –** Guidance and examples for the EPB standards' flexibility
- **Webinar 2** – **19th March 2020) –** EPB standards overview: why, how, what!
- **Webinar 3** – **16th April 2020** – How to make good use of the outputs of the EPB assessments
- **Webinar 4** – **26th May 2020 (**12h00-13h30 CET**)** – EPB standards hourly vs monthly methods
- **Webinar 5** – **16th June 2020 (**12h00-13h30 CET**)** – EPB standards linked to health and wellbeing
- **Webinar 6** – **8th September 2020 (**12h00-13h30 CET**)** – Heating systems in the EPB standards

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

Introduction and overview of current EU practices

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 4: EPB standards hourly versus monthly methods,
May 26, 2020

My background

- CEN/TC 371: Energy Performance of Buildings project group, 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

2010: EU Mandate/480 to CEN, …. supporting the EPBD implementation.

- FOR THE ELABORATION AND ADOPTION OF STANDARDS FOR A METHODOLOGY CALCULATING THE INTEGRATED ENERGY PERFORMANCE OF BUILDINGS AND PROMOTING THE ENERGY EFFICIENCY OF BUILDINGS, IN ACCORDANCE WITH THE TERMS SET IN THE RECAST OF THE EPBD (2010/31)

  The set of EPBD standards shall:

  - be systematic, clear and comprehensive package
  - benefit professionals, **EU** Member States and **relations with third countries**.
  - Have a **continuous but modular overall structure enabling a step-by-step implementation** by EU MS's.
  - have a **balance between the accuracy and level of detail**,
  - Have **flexibility: Not a "one size fits all", but: harmonized with national choices (-> see webinar 1)**
  - **Follow a holistic approach, as key driver for technological innovation and change**

Revised EPBD 2018: Towards more transparency (Annex I) and better data

New obligation to describe national calculation methodology following the national annexes of the overarching EPB standards
(EN ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1 developed under mandate M/480)

- Considerations for the **calculations of Primary Energy Factors (PEFs)**
- National calculation methodologies must reflect the energy needs of a building respecting the **IEQ in buildings** (where people are for > 80% of time)
- Pursuing the **optimal EP of the building envelope**
- Requirement for EPC databases to allow gathering data for the (measured or calculated) energy consumption of buildings

EPBD Annex 1: Common general framework for calculation of EP of buildings:

- Member States shall describe their national calculation methodology following the national annexes of the overarching standards, namely ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1, developed under mandate M/480 given to the European Committee for Standardisation (CEN). This provision shall not constitute a legal codification of those standards.';.
- **Transposition** Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with the EPBD by 10 March 2020.

The overarching standards referred in EPBD: to describe national calculation methodology following the national annexes or datasheets of:

- EN ISO 52000-1: Overarching EPB assessment —General framework and procedures
- EN ISO 52003-1:Indicators, requirements, ratings and certificates —General aspects and application to the overall energy performance
- EN ISO 52010-1: External climatic conditions —Conversion of climatic data for energy calculations
- EN ISO 52016-1: Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Calculation procedures
- EN ISO 52018-1: Indicators for partial EPB requirements related to thermal energy balance and fabric features — Overview of options

Transposition date of March 10 did all MS's report?

- Due to the Covid Crises this seems an ongoing action for many MS's
- There are several MS's that reported accordingly: e.g. Estonia and Germany and more MS's of which we expect (like Italy, France, Netherlands, Romania, Croatia) but do not know yet
- Switzerland is not obliged to report to the EU. However, national implementation of CEN standards is mandatory.
- We are aware that many countries are in process, due to the fact that the CA-5 seminars in March had to be cancelled there is limited information on the progress.

Status and plans of adoption or implementation in a few countries

EPB Center is collecting information.
No full overview yet

Status and plans implementation in various countries

- To be distinguished:
  1. EPBD Annex 1: Reporting the current national methods using the National Annexes of the five so called overarching EPB standards by March 10, 2020
     - Feed back: sometimes not easy for the current methods
     - Guide and examples are available at EPB Center website
  2. (Near) future: Bringing the national methods more in line with the total set of EPB standards
     - Asked for e.g. by industry
     - More efficient
     - Makes comparisons and status reports more transparent
     - But: takes time:
       - Especially if a national method has recently already been revised
       - Need to develop new tools, etc.

How are the EPB standards adopted or implemented?

- Some countries adopt almost all EPB standards ➔ fill in National Annexes of these standards to specify the national choices
  - And are preparing proposals for improvement of the EPB standards where needed (!!)
  - E.g. Italy, Croatia, ..
- Some countries copy/translate most of the content of the EPB standards into the national method e.g.:
  - The Netherlands: (ranging from 60% to 98%),
  - Germany (some standards for 100% others ranging from 60 to 90%; source DIN WS 09-12-2019)
- Some countries copy elements of the content of the EPB standards into the national method

On choice between hourly and monthly calculation method

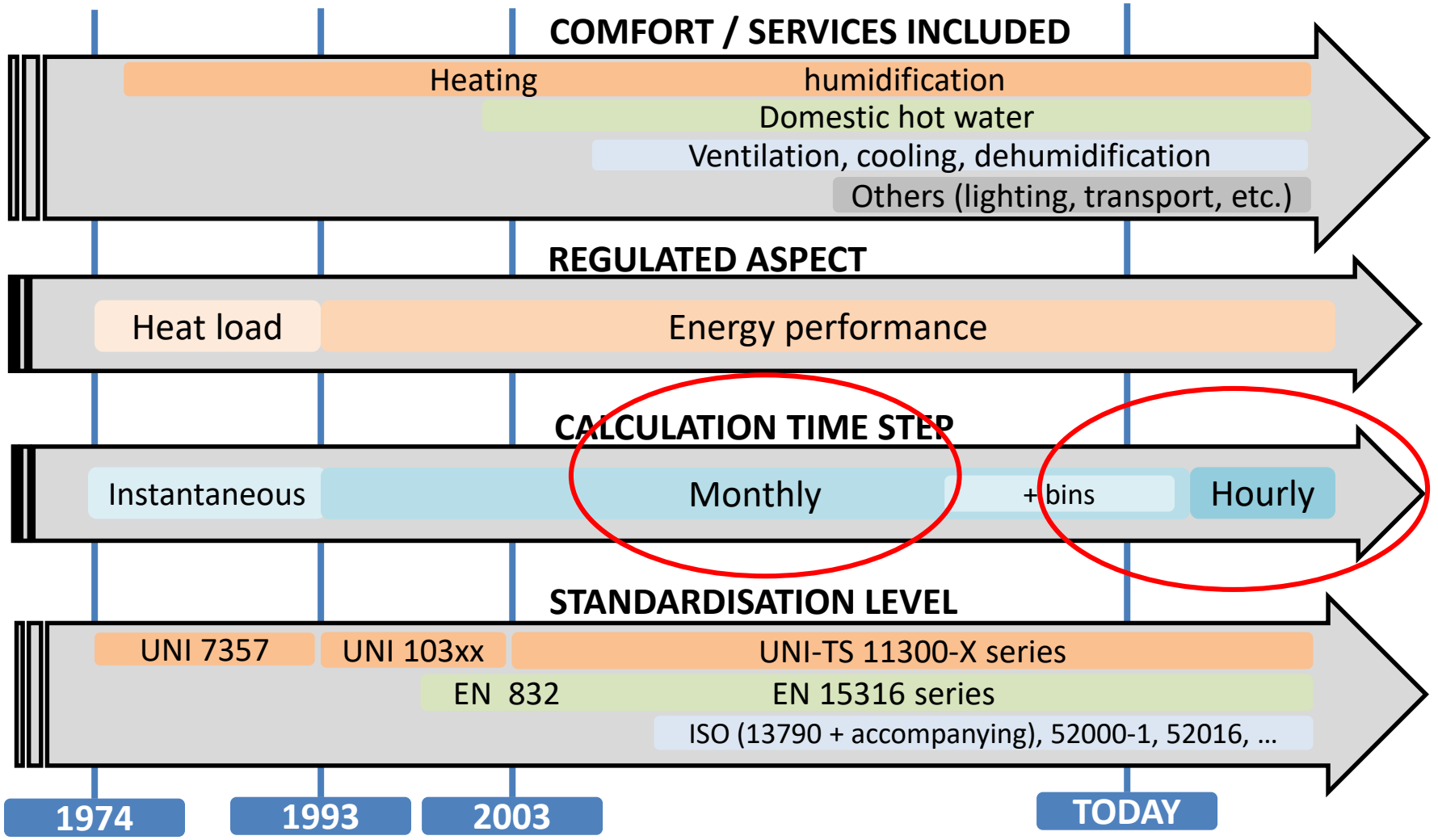
- Several countries had already adopted an hourly calculation procedure
  - E.g. France, Spain. Often for non-residential buildings
- Several countries intend to change over to hourly method (for all buildings or for more complex building types & nZEB buildings)
  - e.g. Italy, Croatia..
- Several countries discuss to change over, but no decision yet, several German experts expect that this is likely next revision round
- Many countries express a need for (common core?) software

EPB standards implementation in Italy

- Based on presentation by Laurent Socal
  - ISO international workshop, Seoul, Sept. 23, 2019

- and also REHVA article by Laurent Socal, Oct. 2019
- https://www.rehva.eu/rehva-journal/chapter/status-of-implementation-of-en-epb-standards-in-italy

History of EP calculation in Italy



Why updating the current set of standards in Italy

Illustration of the rationale

The regulation asks to consider energy performance for all services

- Italy has a great variety of climates, from cold to warm, and of technical systems
- Current standards for ventilation and cooling are very basic.
  There is the need for more flexible and comprehensive standards
- Current time step is monthly.
  This is not suitable for cooling needs with the Italian climate, a minimum of dynamics of the building envelope has to be taken into account.
  Dynamics is relevant for technical systems as well, in high performance buildings, taking into account the effect of controls.
- Standard conditions of use should be representative.
  Monthly makes it difficult to describe intermittent use of several interfering services with associated controls
- The current set of standards is more than 10 years old

→ Calculation method shall be updated

Some rationale for the revision of standards in Italy

- Time step should be hourly
- Standards are required for legal purposes: energy performance calculation is required for comparison with requirements and references to get a building permit and to issue an EPC
  - → **the calculation procedure should be traceable**
- Professionals need training and tools (software) to apply new calculation standards
  - → **changes shall be limited in number and adequate time is required to develop application software once the procedure is defined**

Using EN ISO 52016 means that the description of the building doesn't change and the calculation procedure is fully detailed

What' going on in Italy

Illustration of the process

- The basic plan is adopting as far as possible the new EN-EPB standards, with the hourly time step. Monthly time step could be residual for some cases.
- Working groups in CTI (*) are developing the needed national annexes (replacement for default values in annex B of EN-EPB standards) and supporting documents, defining links between standards and complementary information. Examples:
  - Link between required time interval of comfort and system operation
  - Hourly method: define the reference year (to know which days in the year are week-end)

  More than 2/3 of national annexes to EN-EPB standards are ready for enquiry

  Active experts are collaborating with EPB center and CEN-CE projects to share experience.
- Some national modules are being developed as well within the frame of EPB standards modular structure, which will be presented as proposals to the relevant TCs
- When this work is finished and the whole new package is ready (mid 2020?), the regulation will have to be updated to refer to it.
- Then some time shall be left for the manufacturers to prepare the application software and to have it validated by CTI.

New package adopted END 2020?

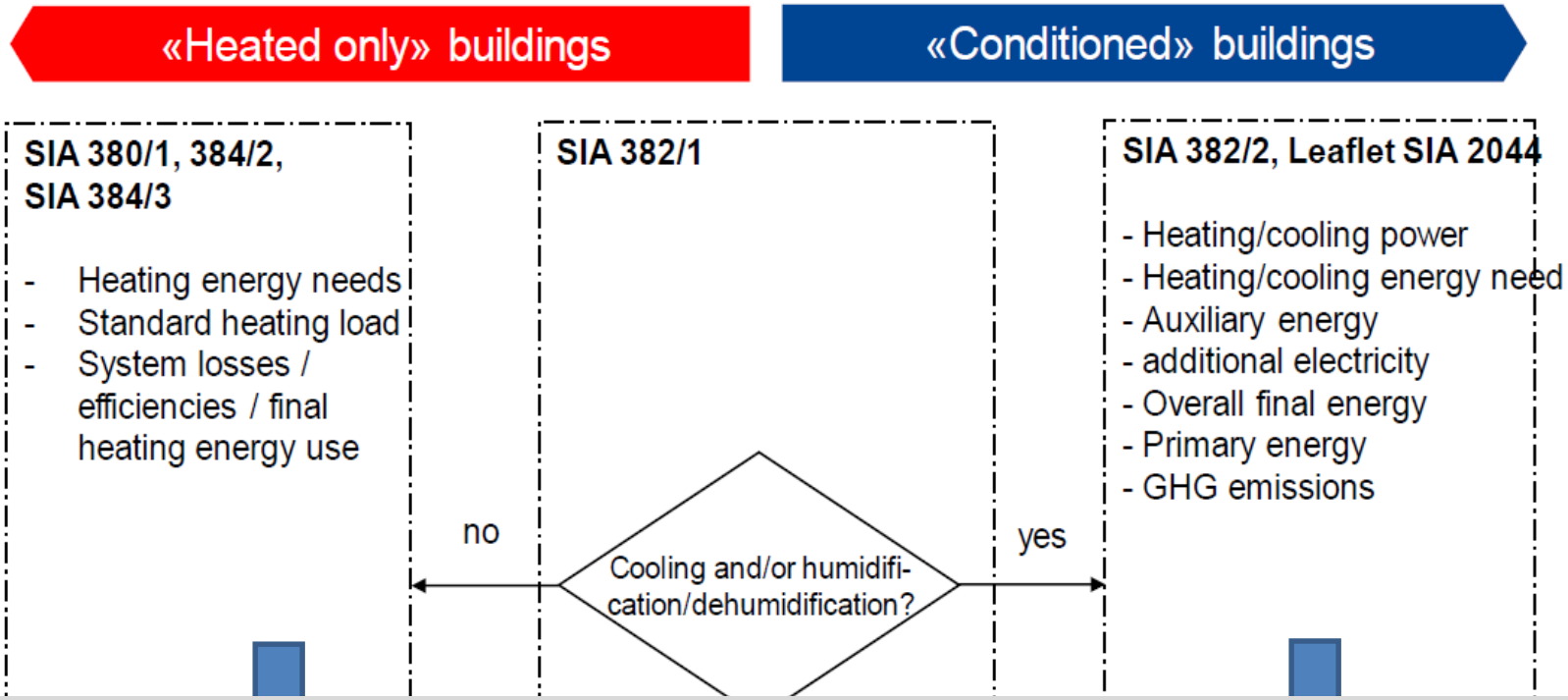
(*) CTI "Comitato Termotecnico Italiano", www.cti2000.it, is the organization in charge of standardization in the field of HVAC on behalf of UNI.

EPB standards implementation in Switzerland

- Based on REHVA article, Oct. 2019 by prof. Gerhard Zweifel
- https://www.rehva.eu/rehva-journal/chapter/implementation-of-en-epb-standards-in-switzerland
- Switzerland is not obliged to report to the EU. However, national implementation of CEN standards is mandatory.

Current and planned standards in Switzerland

SIA 380:2015:



Revision: expected to be completed 2021/2022:

From EN ISO 13790:2008, monthly to EN ISO 52016-1:2017, **monthly**

➔ EN ISO 52016-1:2017, **hourly** (plus room for other hourly methods)

EPB standards implementation in France

- See also REHVA article by Johann Zirngibl and Emilien Paron (CSTB), Oct. 2019
  - the article is focusing on EN ISO 52000-1 only
  - https://www.rehva.eu/rehva-journal/chapter/the-use-of-epb-standards-in-epbd-implementation-in-france

Current and planned methods in France

Current:

Energy needs: EN ISO 13790:2008, **simple hourly**

Systems: partly national methods, **hourly**

Planned:

Next French regulation

Energy needs: EN ISO 13790:2008, **simple hourly**

Systems: partly national methods, **hourly**

??

Under discussion

Next big update of French software (in 3-5 years)

Energy needs: EN ISO 52016:2017, **hourly**

Systems: CEN EPB standards, **hourly**

Current and Planned methods in Croatia

Past:

Energy needs: EN ISO 13790:2008, **simple hourly**

Systems: monthly

Current:

New set of EPB standards adopted as national standards (2017)

Energy needs: EN ISO 52016:2017, **hourly**

Systems: CEN EPB standards, **hourly**

Introduction of nZEB calculations imposed a need for more accurate/sensitive calculation methodology with hourly time step

Planned:

Will be implemented in regulations as soon as appropriate/verified calculation tool available on the market

Ministry of construction is in favor of development of common EU open source kernel

Ministry is not going to finance any new calculation tool (software) based on the new EPB standards

Public Information on several of these EPB standards see: www.rehva.eu

https://www.rehva.eu//rehva-journal/detail/05-2019

More information on the set of EPB standards:
www.epb.center
Contact:
info@epb.center

Thank you!

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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

Energy need and indoor temperatures calculation: hourly or monthly?

Dick van Dijk

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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 4: *EPB standards hourly vs monthly methods*
26 May 2020

My background

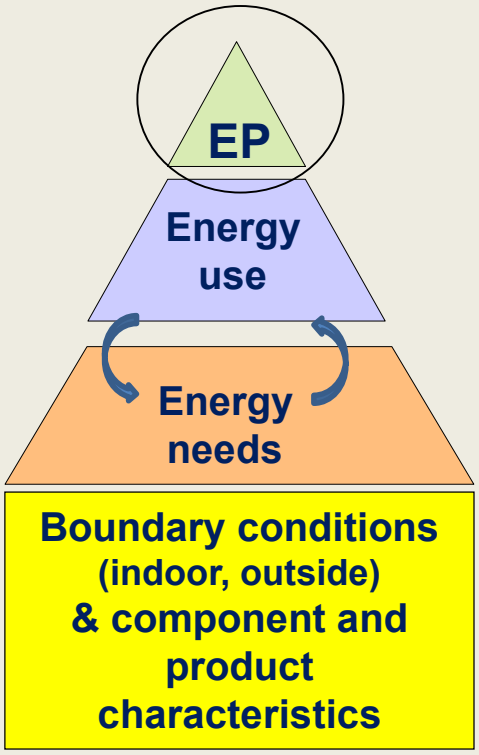
- EPB Center expert (> 2017)
- Involved in initiation, preparation and coordination of set of EPB standards (2012-2017)
- Co-convenor of ISO Joint Working Group on the overall set of EN ISO EPB standards, in collaboration with CEN

  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. The core set

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

Harmonized but flexible

- The set of EPB standards:
  - Consistent and transparent package of **harmonized** procedures
  - Fit for use in the context of building regulations
- But clearly identified **options** and **national data** remain necessary due to differences in
  - climate
  - culture and building tradition
  - building typologies
  - policy
  - legal frameworks (including the type and level of quality control and enforcement)

Annex A (normative template)

Annex B (informative default choices)

➔ ***National Annexes for national or regional choices***

Harmonized but flexible

- The set of EPB standards:
  - Consistent and transparent package of **harmonized** procedures
  - Fit for use in the context of building regulations
- But clearly identified **options** and **national data** remain necessary due to differences in
  - climate
  - culture and [illegible]
  - [illegible]
  - [illegible]
  - legal frameworks (including the type and level of quality control and enforcement)

One of the "main" choices is the time interval for the calculation of the energy performance

plate)

[illegible]formative default choices)

➔ ***National Annexes for national or regional choices***

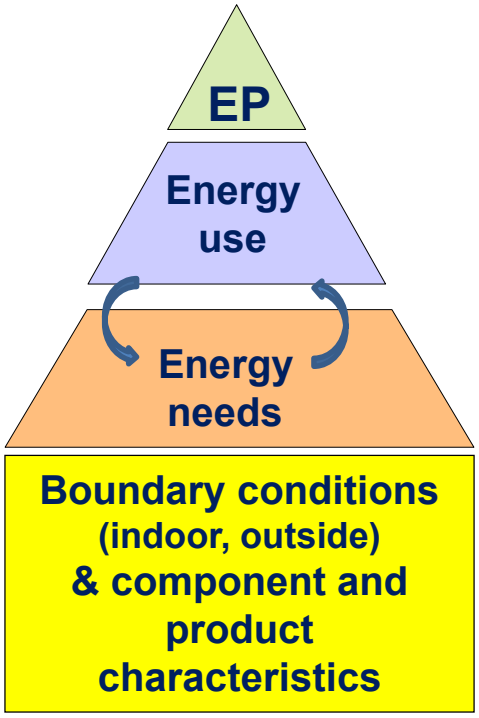
From yearly to hourly calculations

- EN ISO 52000-1, the overarching EPB standard, lists different options for the time interval for the calculation of the overall energy performance:
  - Hourly
  - Monthly
  - Seasonal
  - Yearly
  - Bin

From yearly to hourly calculations

- Choices may differ per element:
  - Example: **thermal resistance** usually fixed annual value

- But: **holistic approach** = system performance is part of overall EP calculation
  - Dynamic interactions between energy needs, indoor temperatures and system performance
  - Dynamics require hourly calculations

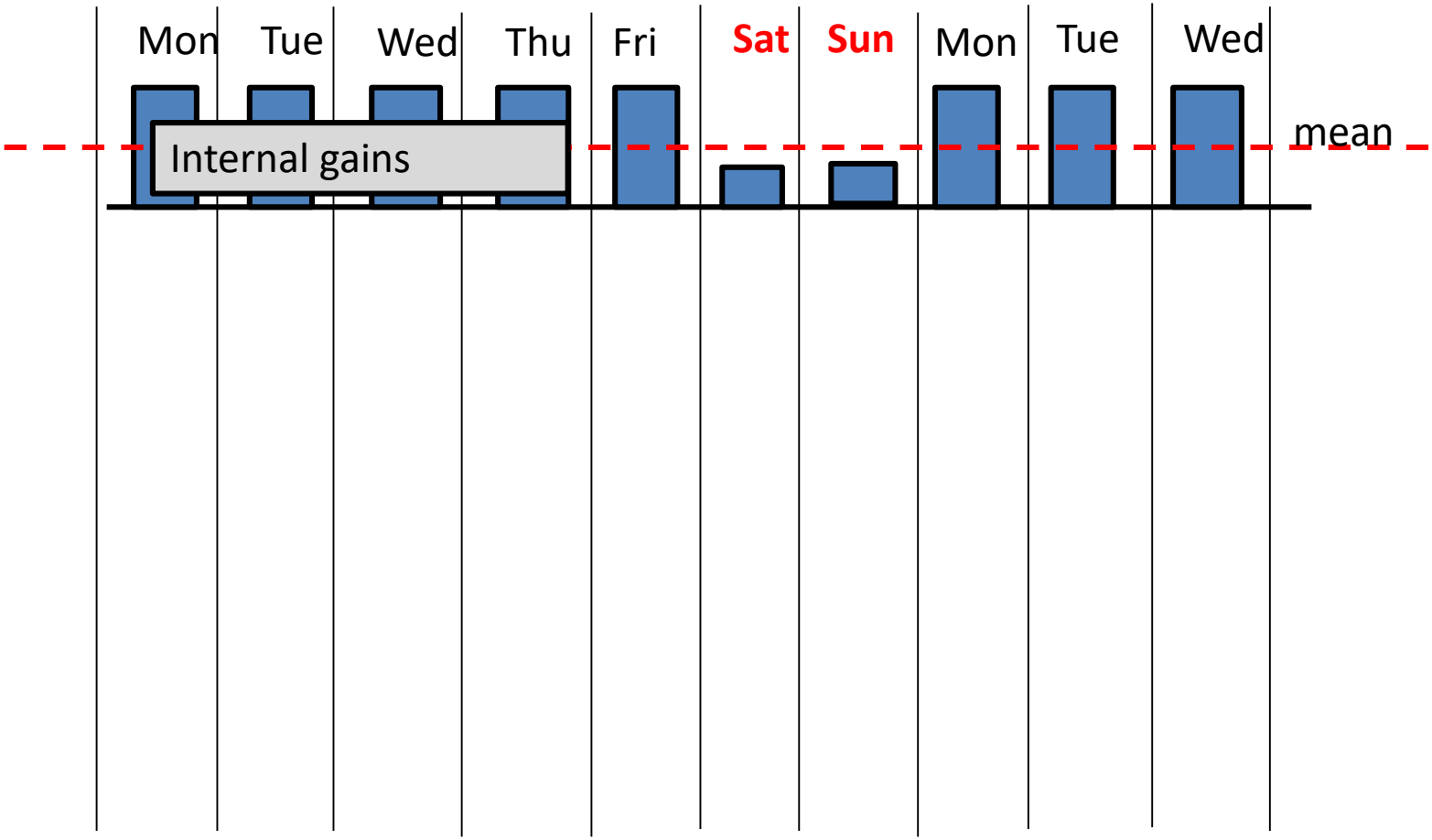


Monthly or hourly calculations

- Many technologies, in particular for low energy buildings:
  - hourly and daily variations with weather and operation
  - strong and dynamic interactions.
- For instance:
  - Solar blinds
  - Temp.settings
  - Needs
  - Occupation
  - Accumulation
  - Mechan.ventilation
  - Ventilative cooling
  - weekend operation
  - etc.
- ➔ strong effect on heating and cooling calculation
- Limitations of monthly method:
  - Only monthly mean values available, with corrections for dynamic effects

Monthly mean vs hourly....

Simplified illustration (office building)



Monthly mean vs hourly....

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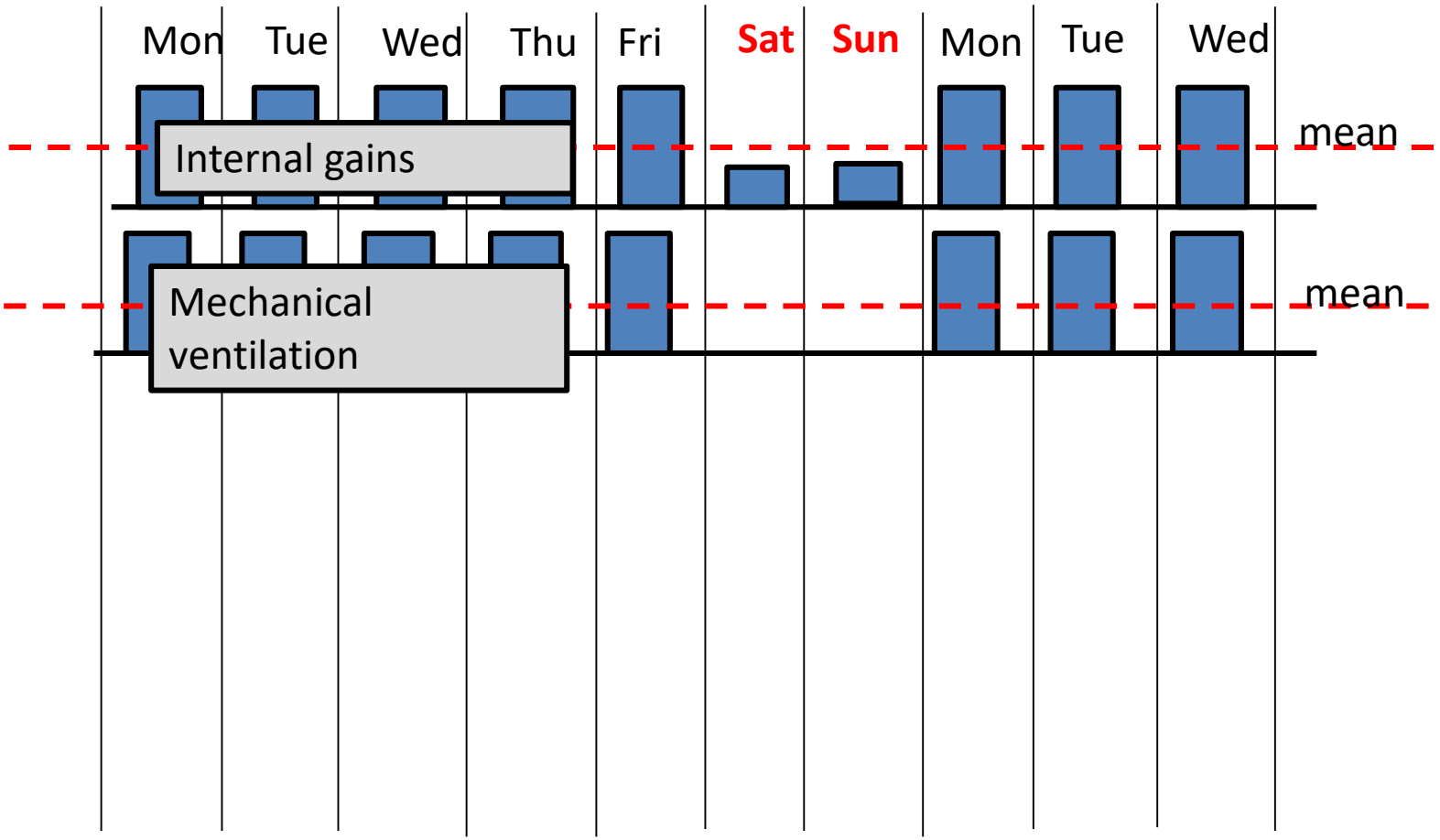

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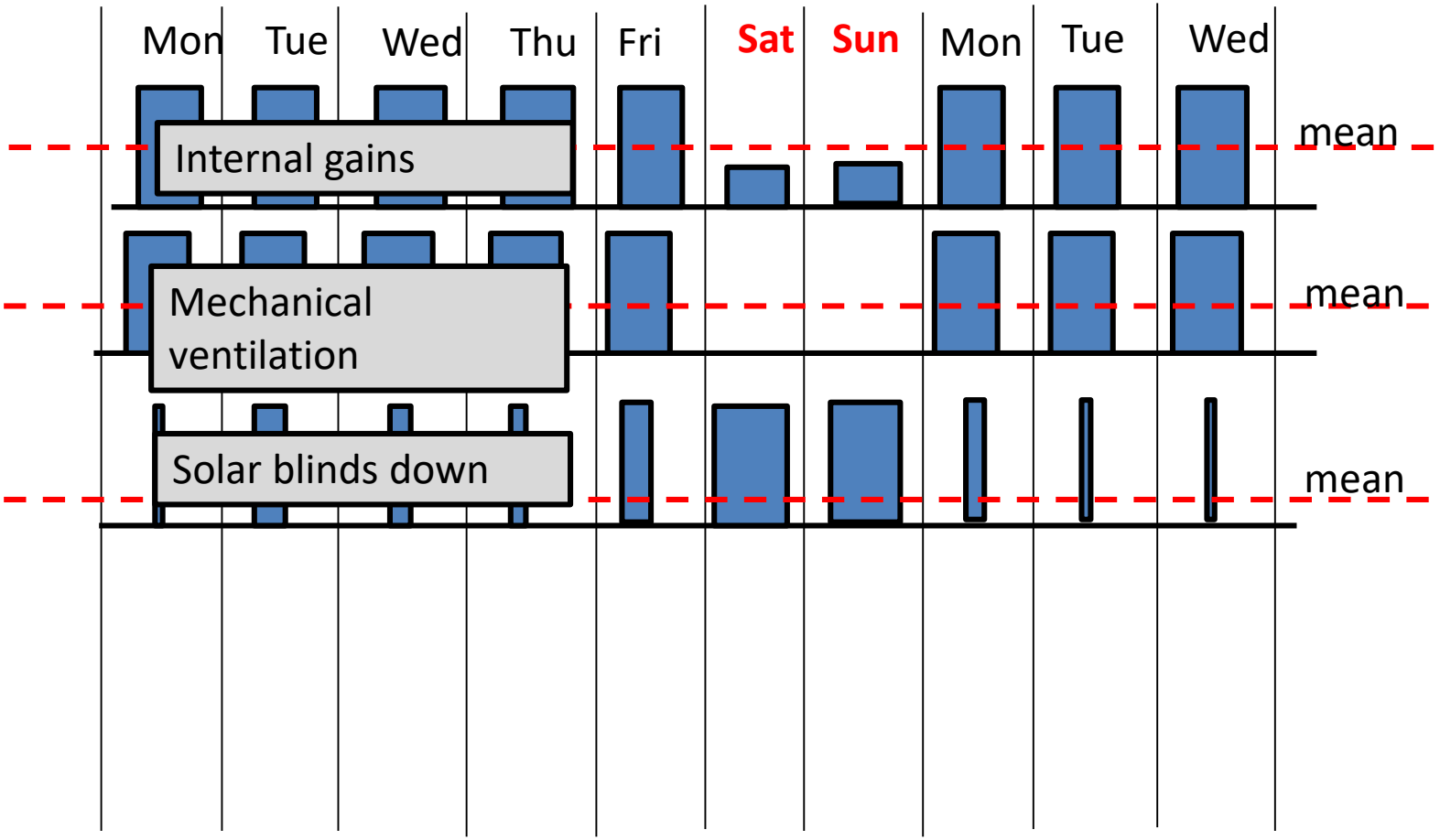

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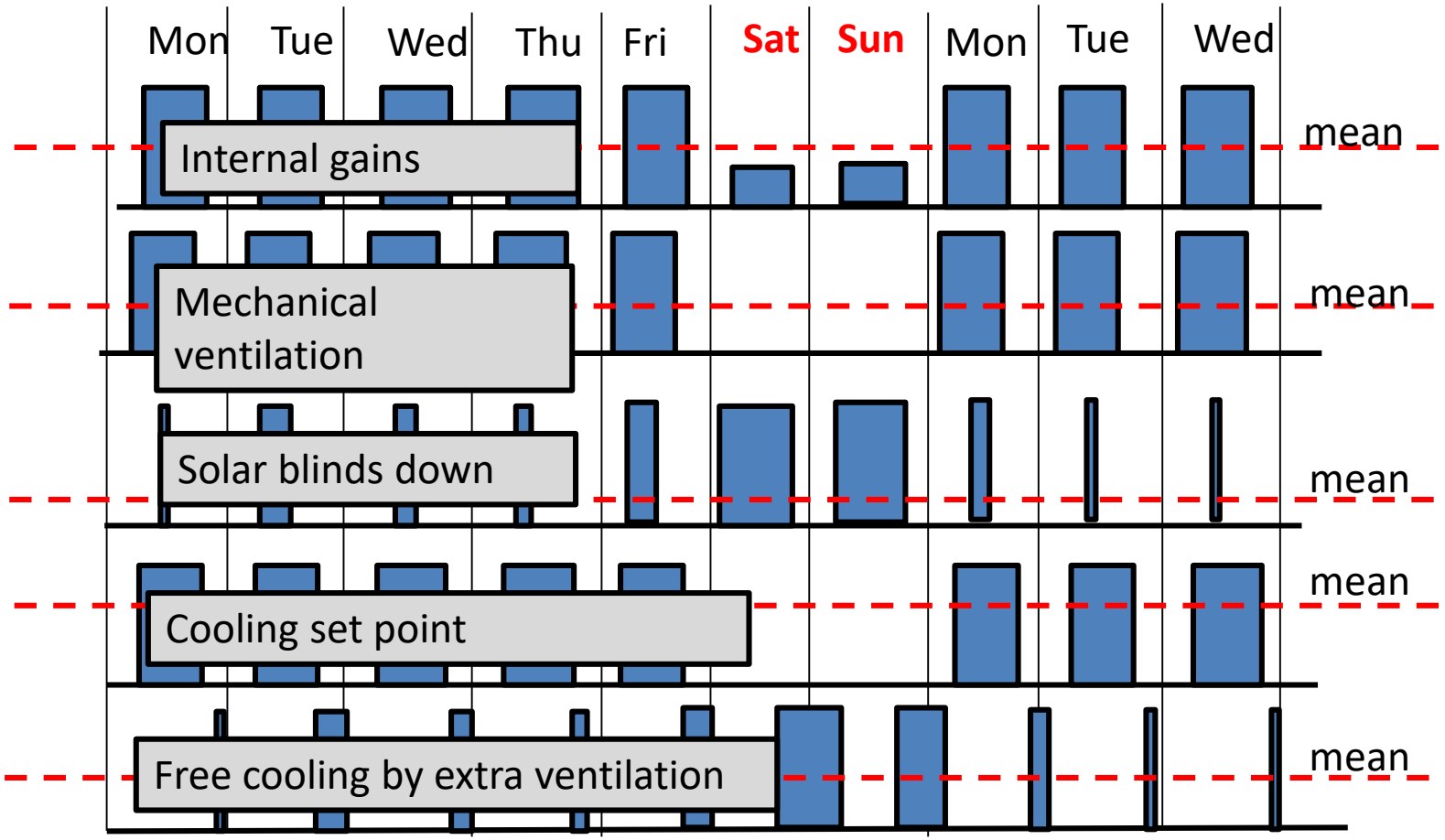
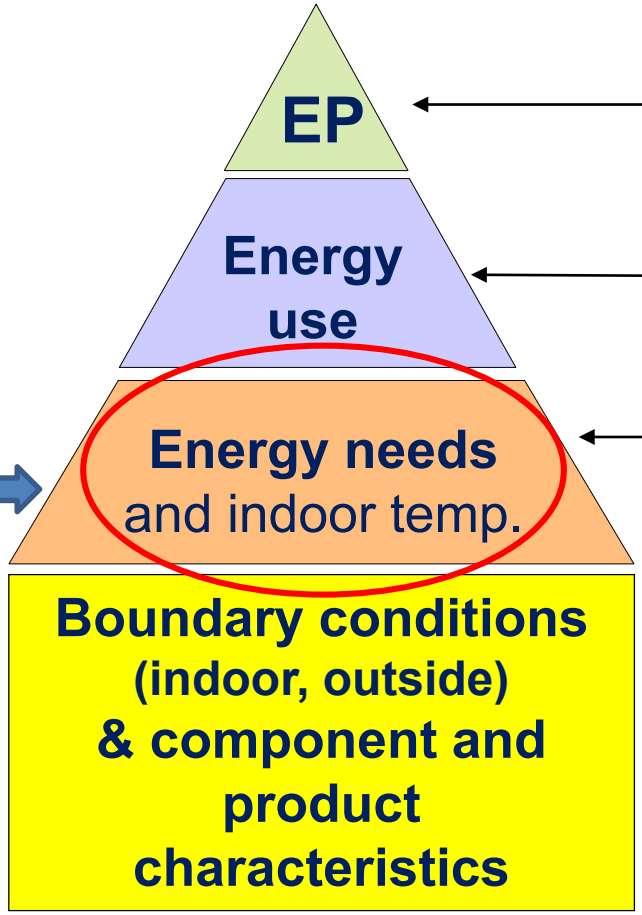


Hourly calculation procedures of energy needs and indoor temperatures

The core standard for the choice between monthly or hourly calculations



EN ISO 52000-1
Overarching EPB standard

EN xxxx
Suite of system standards

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

Description of EN ISO 52016-1

Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads– Part 1: Calculation procedures (2017)

- Replaced EN ISO 13790:2008
  - Contains (slightly improved) **monthly** calculation method
  - Contains (significantly improved) -fully described- **hourly** calculation method

Description of EN ISO 52016-1

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  - Contains (significantly improved) -fully described- **hourly** calculation method
  - NEW! Hourly method = tailored to goal:
    input data asked from the user for the hourly method is the same as for the monthly method
  - ➔ *Easy for EP regulators to switch ("upgrade") from monthly to hourly calculations*

Description of EN ISO 52016-1

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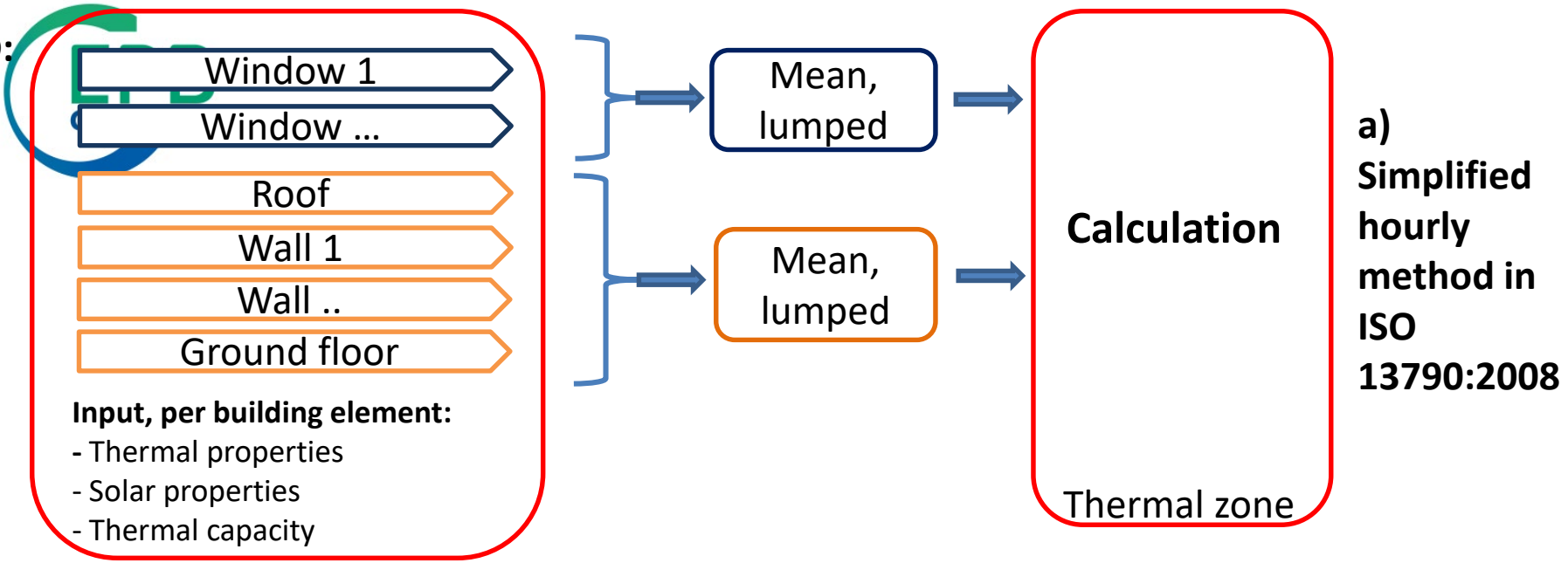
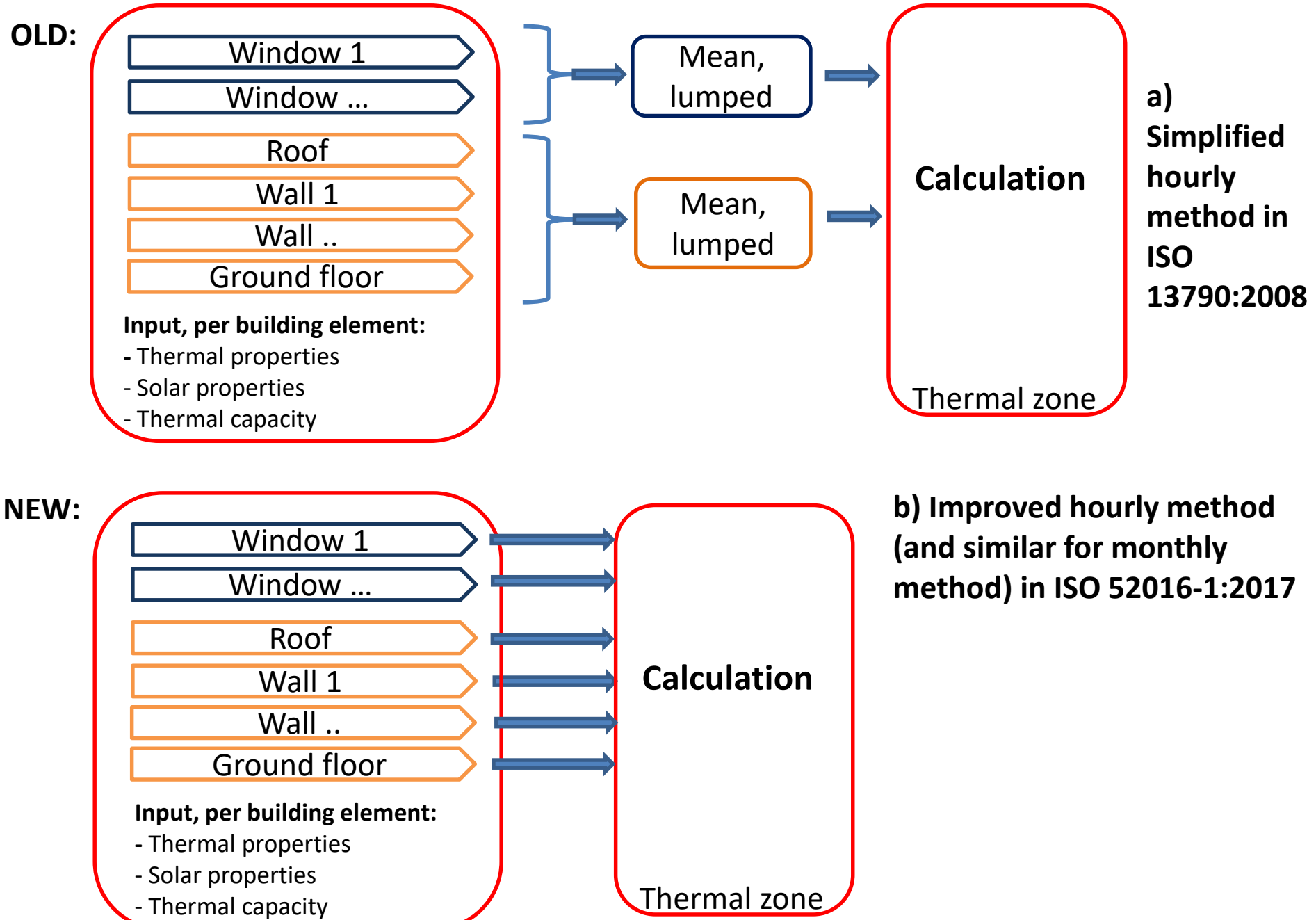
  - NEW! Hourly method has been tailored to the goal:
    input data asked from the user for the hourly method the same as for the monthly method
  - ➔ *Easy for EP regulators to switch ("upgrade") from monthly to hourly calculations*
  - *Why would they want to switch?*
    "Because the thermal balance has become much more dynamic (=time varying) than in the past, due to low energy demand (nZEB) and more dynamic and interacting technologies"

OLD:


Window 1
Window …
Roof
Wall 1
Wall ..
Ground floor
Input, per building element:
- Thermal properties
- Solar properties
- Thermal capacity
Mean, lumped
Mean, lumped
Calculation
Thermal zone
a) Simplified hourly method in ISO 13790:2008


OLD:
Window 1
Window …
Roof
Wall 1
Wall ..
Ground floor
Input, per building element:
- Thermal properties
- Solar properties
- Thermal capacity
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Mean, lumped
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Ground floor
Input, per building element:
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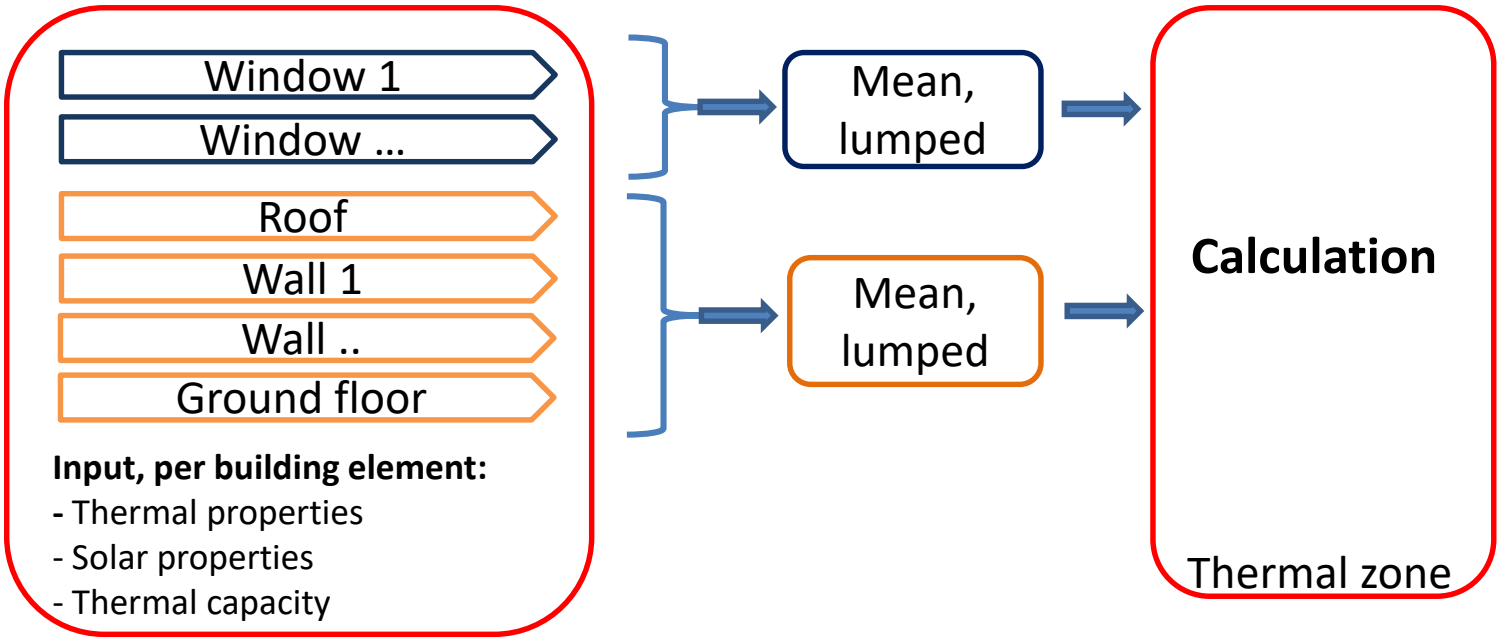
Calculation
Thermal zone
b) Improved hourly method (and similar for monthly method) in ISO 52016-1:2017

OLD:



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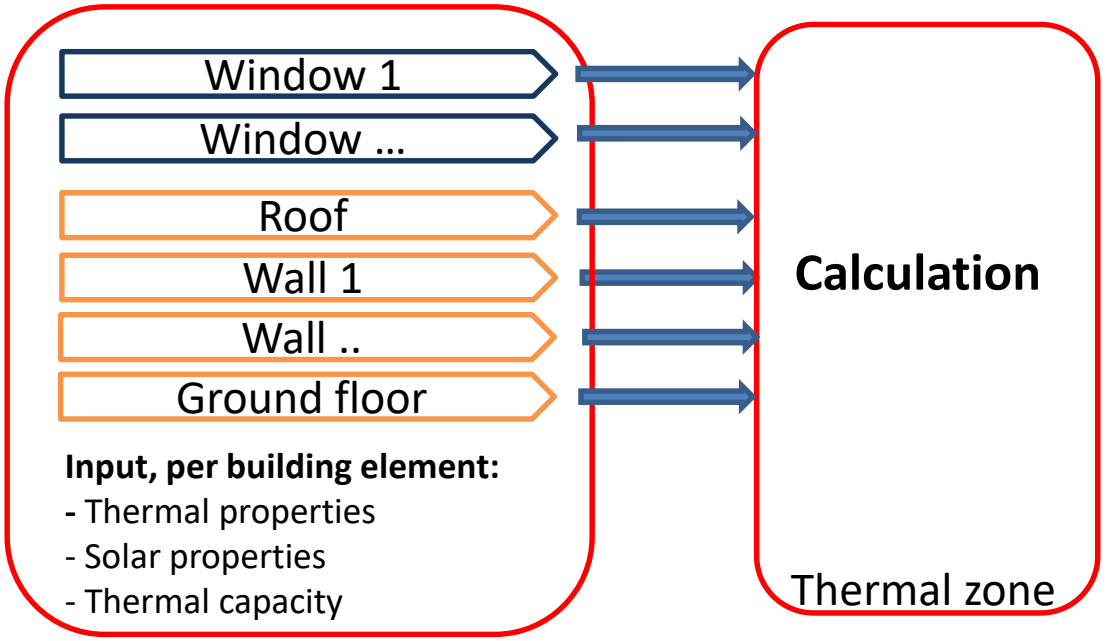

b) Improved hourly method (and similar for monthly method) in ISO 52016-1:2017

Result:

- **No** longer **loss of information** per building element
- **Differences** in individual building elements are **respected**

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

- Weather
- Temperature and ventil. settings
- Internal heat sources

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), ..

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

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Same input data and boundary conditions
- Weather
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- Internal heat sources

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
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Monthly calculation of energy needs for heating and cooling

using national correlation factors to take into account dynamic effects
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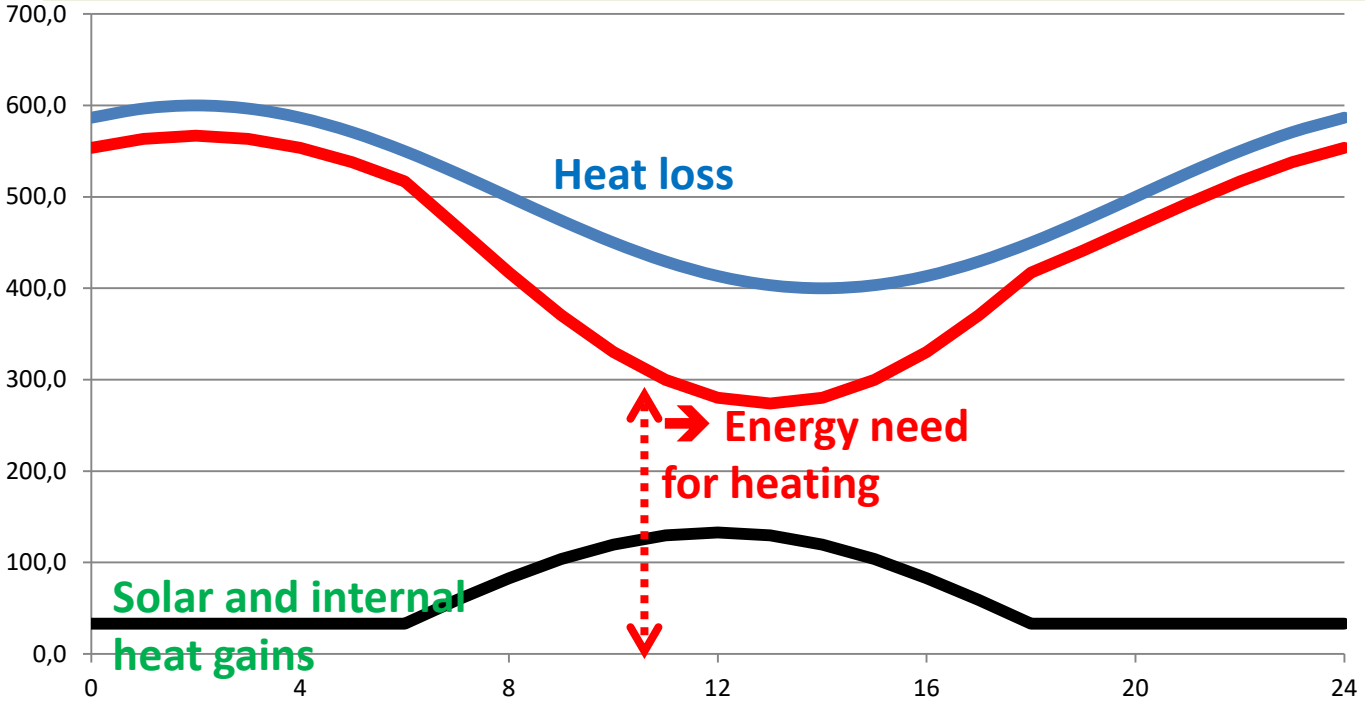
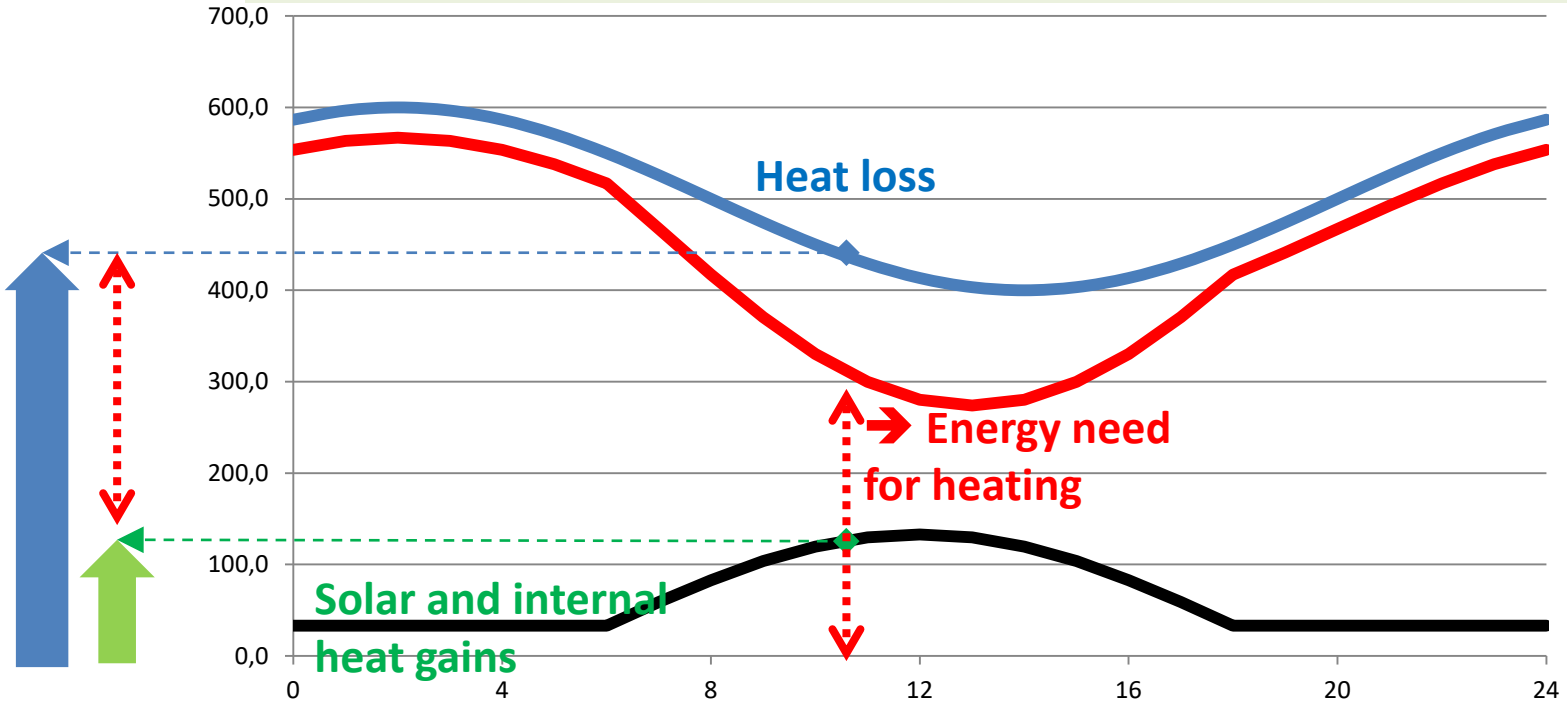
Demonstrated in Spreadsheet (updated Nov. 2019)

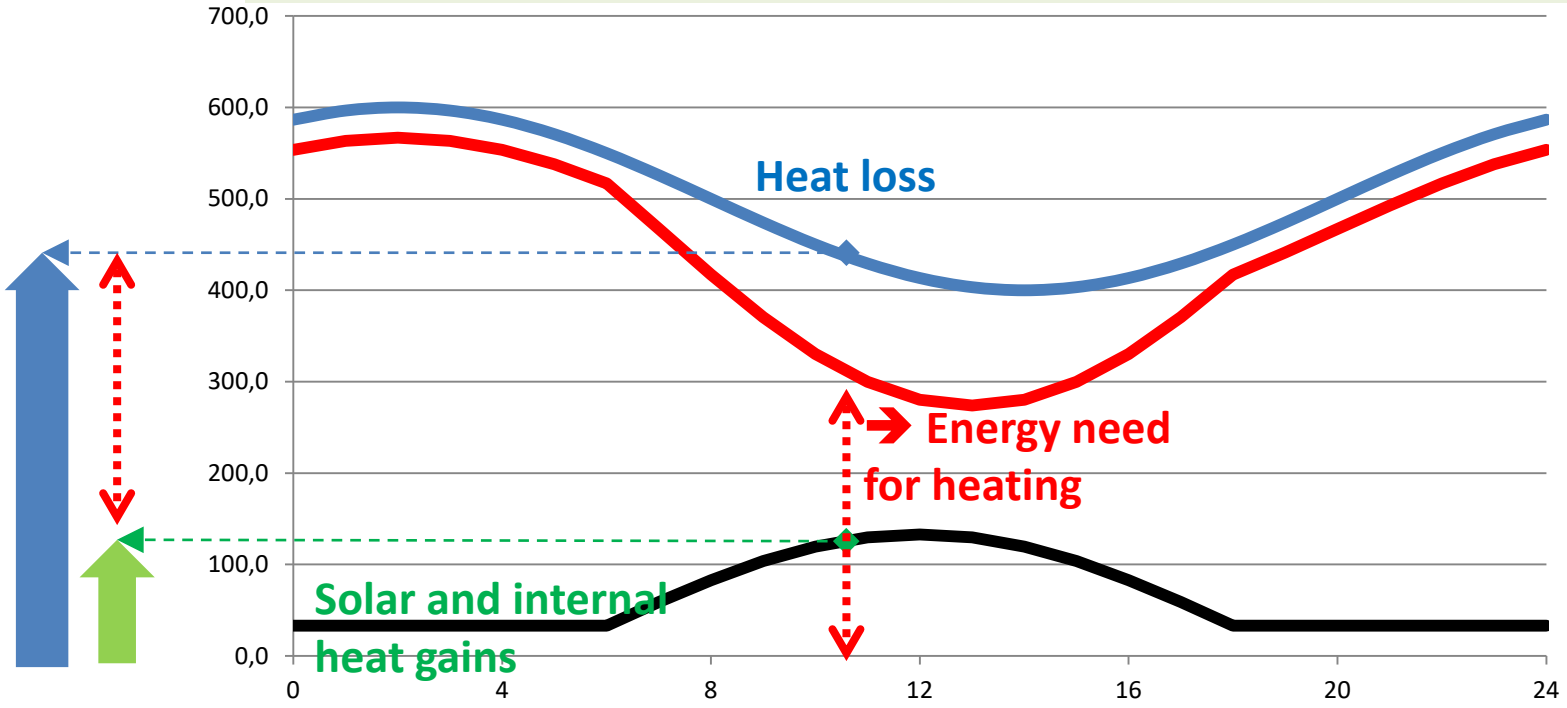
Buildings in the past



Buildings in the past



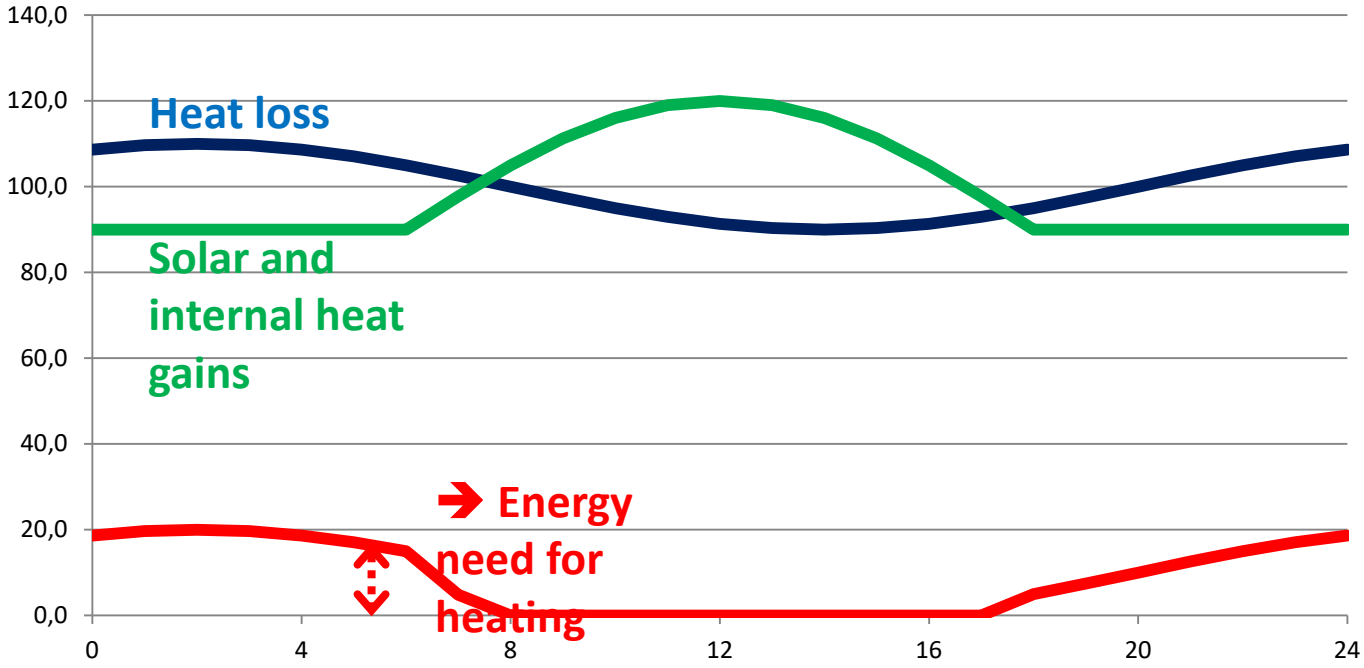
Buildings in the past



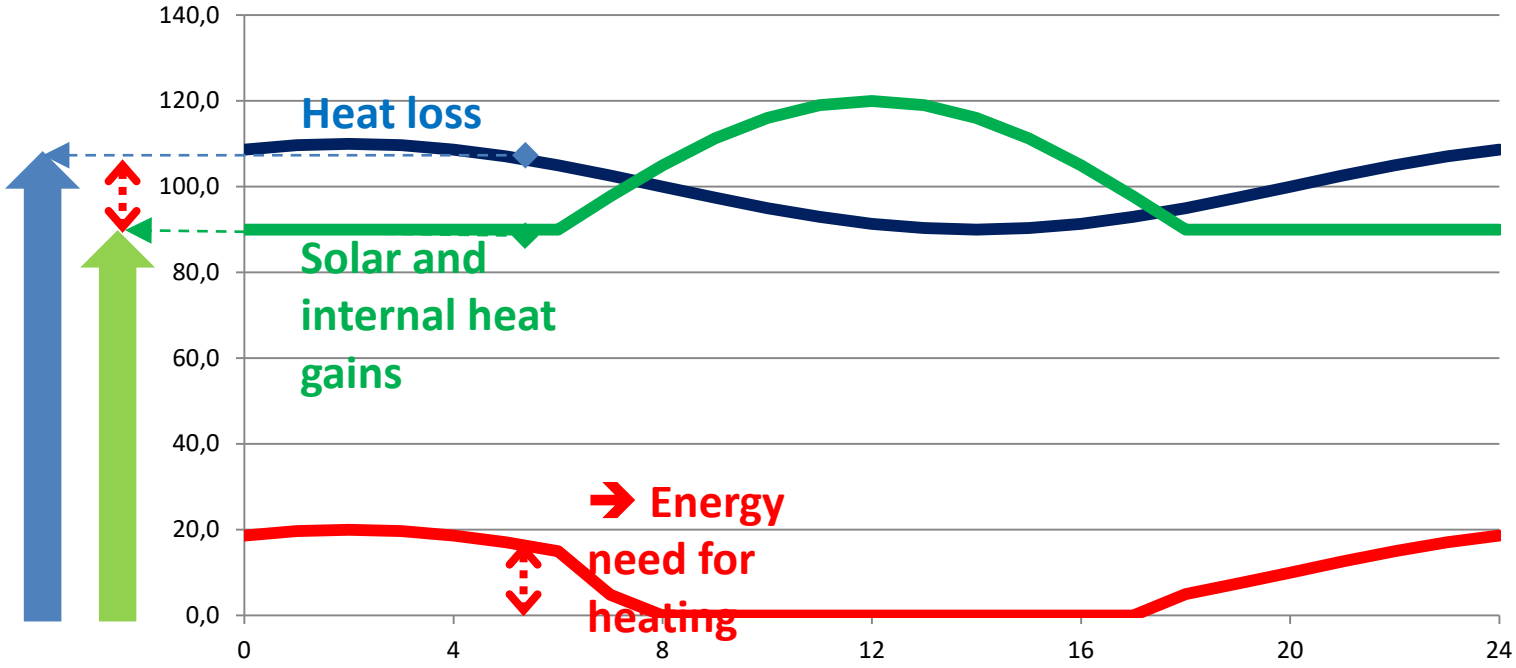
In the past:

- The high heat losses dominated the thermal balance
- A monthly calculation method leads to sufficiently accurate, transparent and robust results

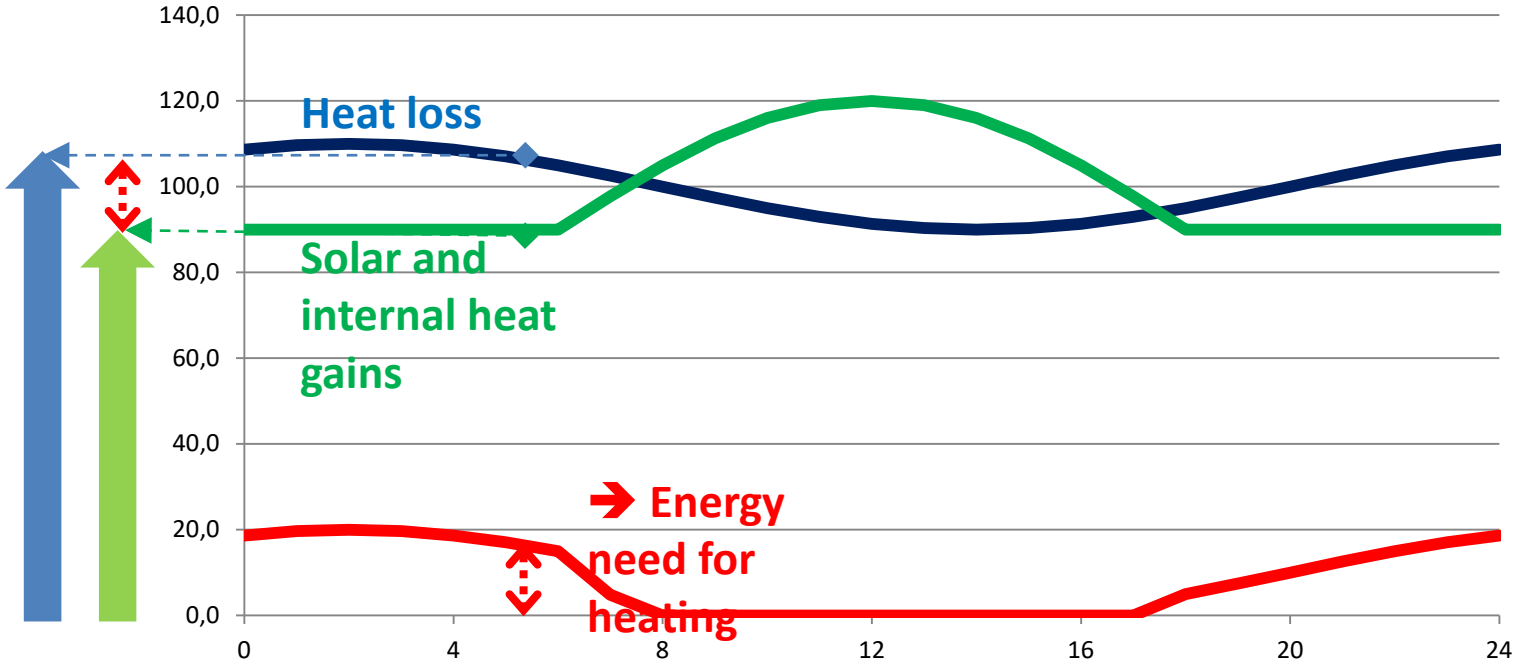
Low energy buildings



Low energy buildings



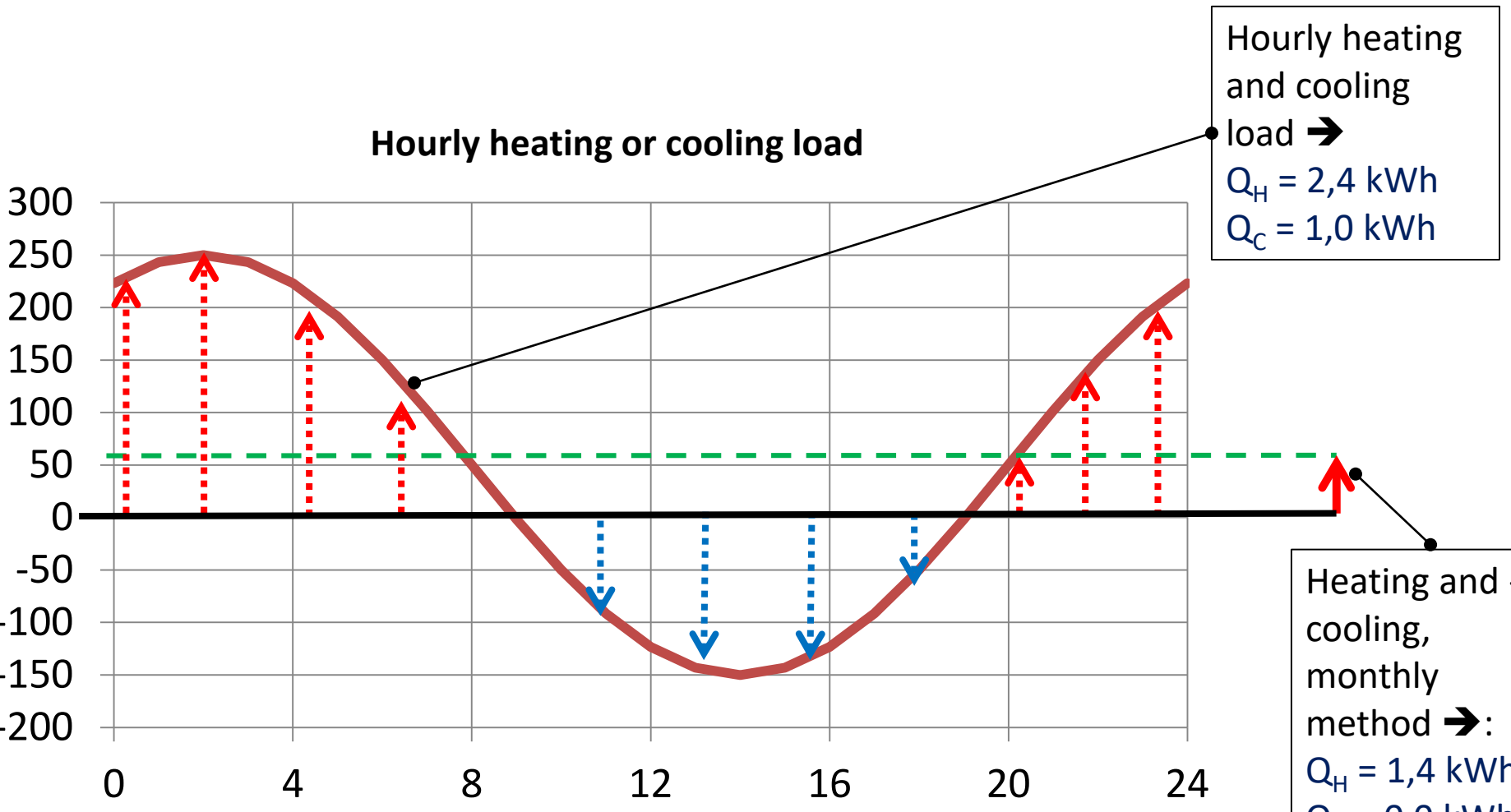
Low energy buildings



Now (new buildings or major renovation):

- The heat losses are low and no longer dominating
- Very difficult to find proper and robust correction factors for the monthly calculation method
- The monthly calculation method becomes **less** accurate, **less** transparent and **less** robust

Even possible:



In short: hourly method in EN ISO 52016-1

- Can be run with same input data as needed for the monthly method
- Is easier to understand and more transparent
  - More direct: no need for correlation factors to account for dynamic interactions
- Gives additional insight in hourly indoor temperature and heating or cooling load
  - Monthly method: only monthly average

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- Gives additional insight in hourly indoor temperature and heating or cooling load
  - Monthly method: only monthly average
- Calculates heating and cooling needs in same calculation: reveals possible interaction
  - E.g. effect night time temperature set back on next day's cooling needs
  - Monthly method: no interaction between heating and cooling needs:
    - Heating needs = 12 months calculated with conditions of use assumed for heating (temp., blinds, vent.)
    - Cooling needs = 12 months calculated with conditions of use assumed for cooling (temp., blinds, vent.)

New developments

EN ISO 52016-3, *Energy performance of buildings -- Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads -- Part 3: Calculation procedures regarding* ***adaptive building envelope elements***

- Under development (2018-2021)
- "Expansion" of EN ISO 52016-1, specifically for adaptive facade elements

EN ISO 52016-5, *Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads – Part 5: Specific criteria and* ***validation procedures***

- Started late 2019
- Opening up EN ISO 52016-1, to a certain extent, to alternative calculation models, without jeopardizing reproducibility

EN ISO 52016-1: bridge from energy needs to systems

- EN ISO 52016-1 can also be run in a so called "**system specific mode**", taking into account the impact of e.g.:
  - **undersized** heating or cooling **power**
  - **recoverable** system heat **losses**
  - **Imperfect** system **control**

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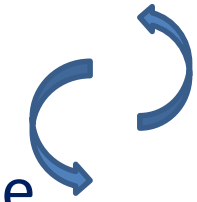

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Also ready for possible future (more realistic) Smart Readiness Indicator....

Example: ventilative cooling systems (VCS)

- Hourly method:
  - Simple, transparent rules for extra ventilation under specific conditions, directly applied

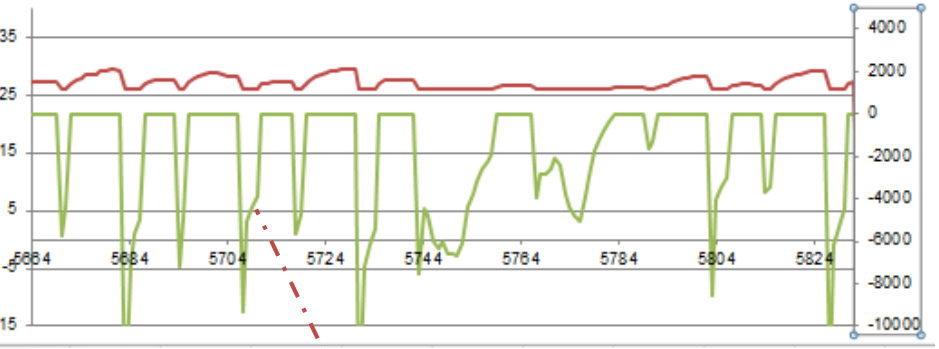
- Monthly method:
  - Introduction of extra (monthly mean) ventilation rate,
  - with monthly weighting factor accounting for number of hours/month that VCS is feasible
  - Weighting factor depends on building inertia, monthly gains/losses (heat balance), occupancy rate, ...
  - Values? Via **hourly calculation runs**
    - with **model** that also introduces noise, because of slightly different type of input data and boundary conditions....
      (unless EN ISO 52016-1 itself is used for these hourly calculation runs!)

Ventilative Cooling rules hourly calculation

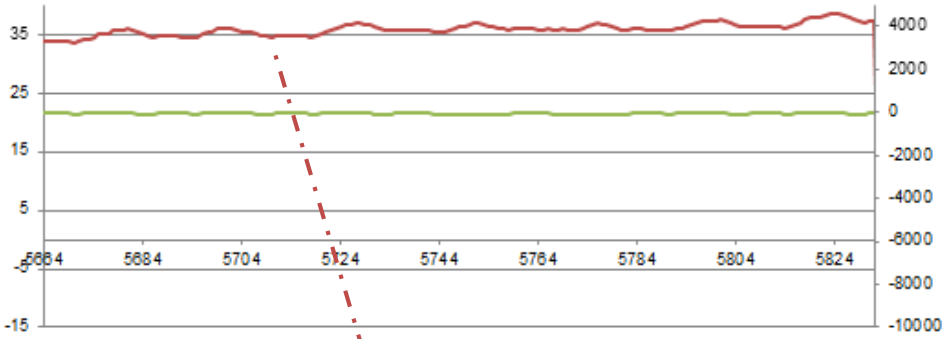
- For **hourly calculation**: **simple** and **transparent** rules, directly applied:
  For example
  - Increased ventilation if:
    - indoor-outdoor temperature difference > 3 K
    - and outdoor temperature > 12 C
    - and indoor temperature exceeds (cooling setpoint - 2 K)
  - Amount of increased ventilation depends on occupancy (cq the required comfort level):
    - Unoccupied or low comfort required: 5 x nominal ventilation
    - Semi-occupied (e.g. daytime resid.bldngs): 3 x nominal ventilation
    - Fully occupied, high comfort level required: 2 x nominal ventilation

Examples of calculation results, hourly method

With mechanical cooling

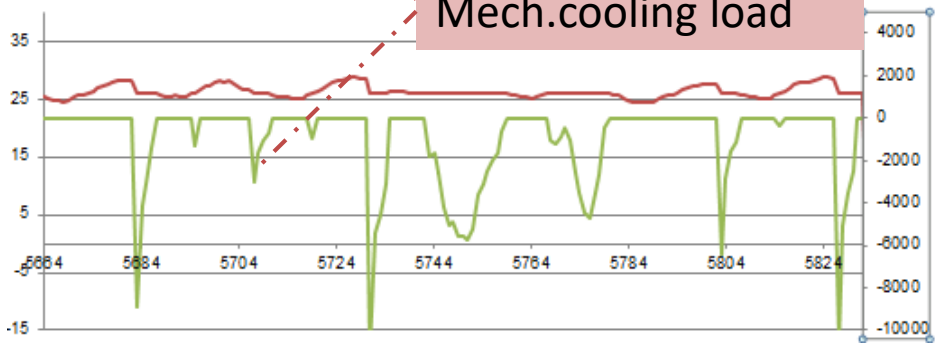


No mechanical cooling



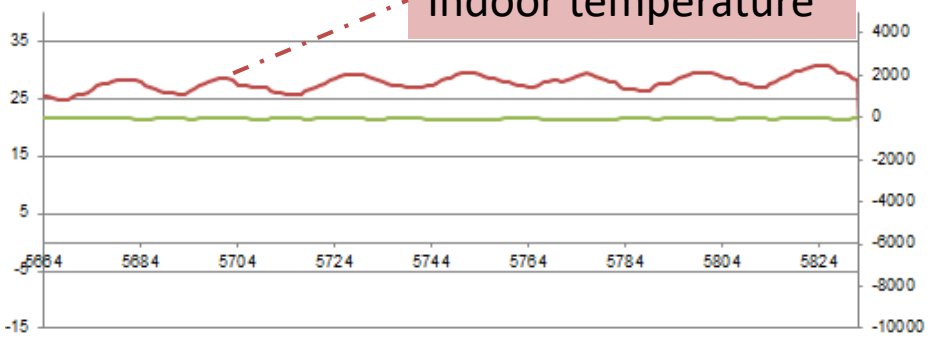
With mech.cooling plus ventilative cooling

Mech.cooling load



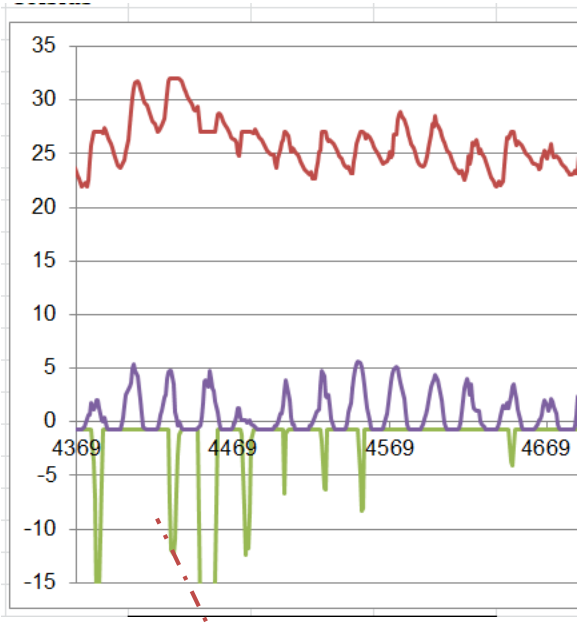
No mechanical cooling, with ventilative cooling

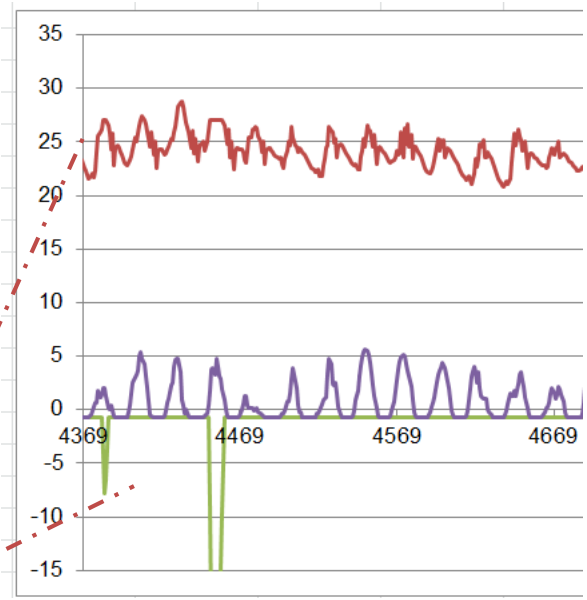
Indoor temperature



Graph shows, as example, results for last week in July

Office room





Indoor temperature

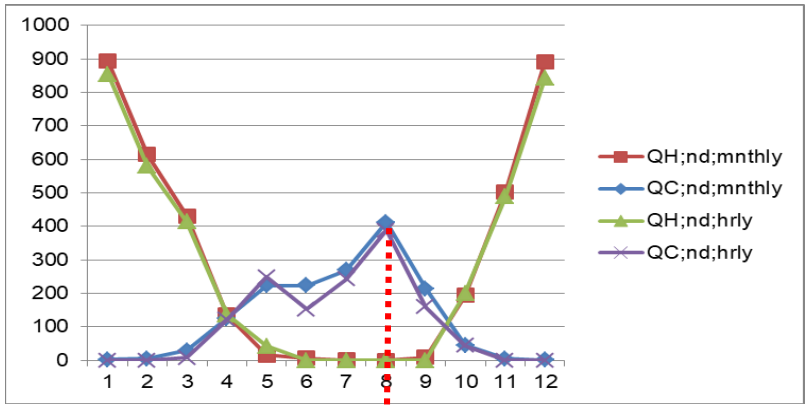
Mech.cooling load

With mech.cooling no ventilative cooling

With mech.cooling plus ventilative cooling

Hourly versus monthly method

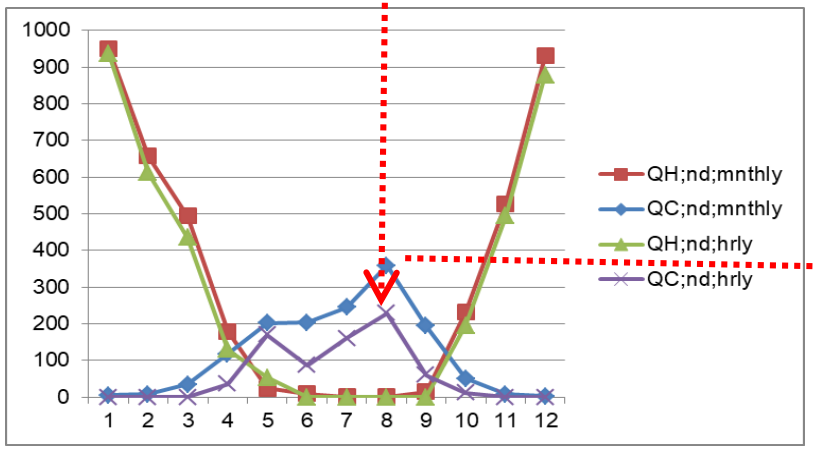
Mechnical cooling, no VCS



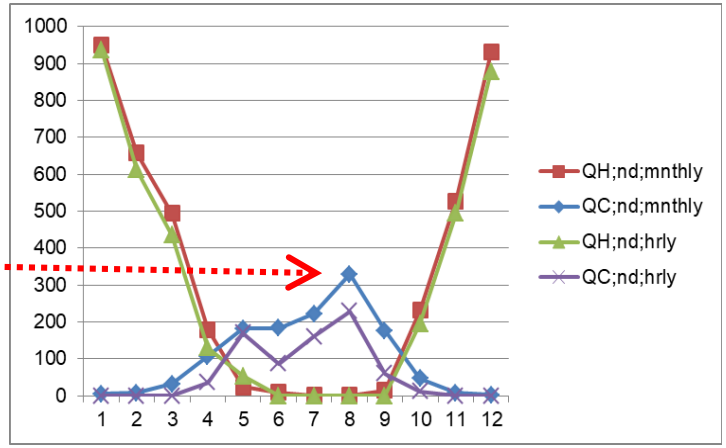
Monthly energy needs for heating and cooling by hourly and by monthly method

VCS = Ventilative Cooling System

Mechnical cooling,
VCS in hourly method



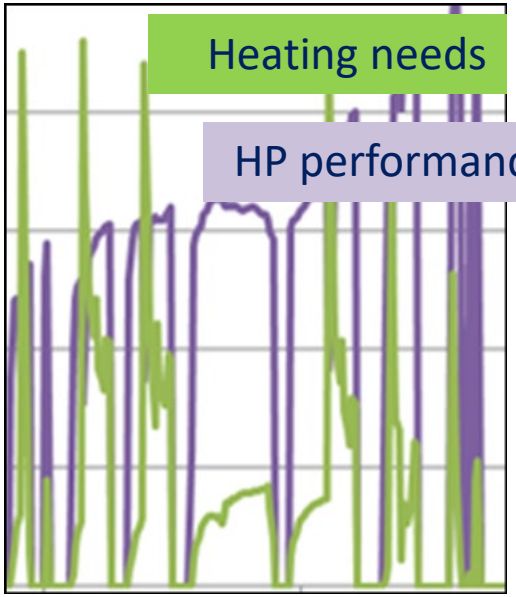
Mechnical cooling,
VCS in hourly method
Extra vent. assumed in monthly method

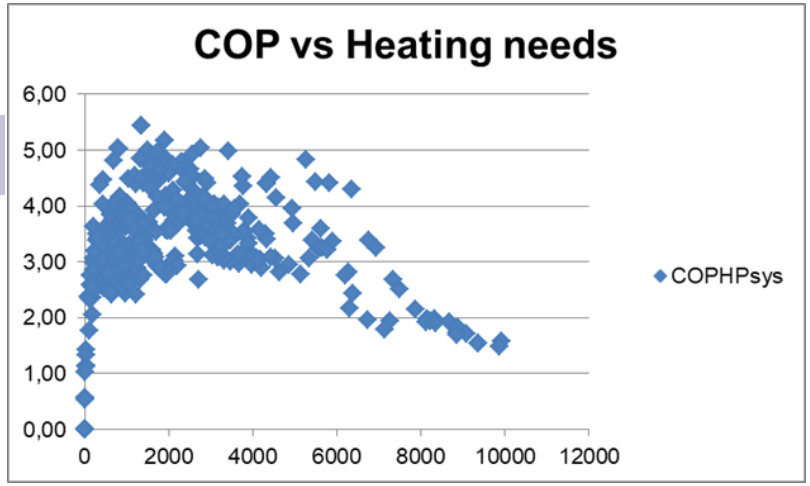


Heat pumps

- Similar examples being made by linking
  - calculation of energy needs and indoor temperature (EN ISO 52016-1 spreadsheet), with
  - heat pump power and performance calculation (EN 15316-4-2 spreadsheet)

Illustration of preliminary results (subject to review): hourly overall COP of HP system versus hourly energy load for heating





January, office room, mild climate

Conclusion

- One of the key EPB standards is (EN) ISO 52016-1 (2017) to calculate heating and cooling loads and needs and indoor temperatures
  succeeding (EN) ISO 13790:2008
- ISO 52016-1 contains both a monthly and an hourly calculation method
- The hourly method in ISO 52016-1 is tailored
  - to deal with the **dynamic interactions** between building, climate, users and systems
  - While requiring **no more input data** from the user than the monthly method

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

Hourly or monthly? What about technical systems?

Laurent Socal

socal@iol.it

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 4: *EPB standards hourly vs monthly methods*
May 26, 2020

Seasonal or intervals?

Energy performance calculation should tell us what happens during a whole year or season, which is the "**calculation period**".

The simplest way is one single calculation using **average values** of all properties.

Issues:

- which average value?
- how to take into account different operation schedules?

Solution:

- divide the calculation period into "**calculation intervals**" and then repeat the calculation for each calculation interval.

Current typical approach **HVAC regulatory**: **monthly** intervals

Classification of methods

When splitting into calculation intervals…

- You may select the **calculation interval length**
  - **Constant**: monthly, weekly, daily, hourly, …
  - **Variable**: bins → actually another constant parameter is used to identify calculation intervals
    The most common is outdoor temperature.
- Decide if the calculation of each interval **depends on the result of previous intervals**
  - **Static**: no dependency
  - **Dynamic**: they depend on previous intervals

Bins cannot be dynamic because they are non-consecutive intervals

The level of details is another independent story

Why monthly?

Historically, the first attempt of energy calculation by calculation intervals (EN 832). That was fine for

- heating needs that was the main service
- domestic hot water as well
- technical systems were simple and the main (if not only) generation technique was a boiler.

It has been improved over time

(EN 832 → EN ISO 13790 → EN ISO 52016)

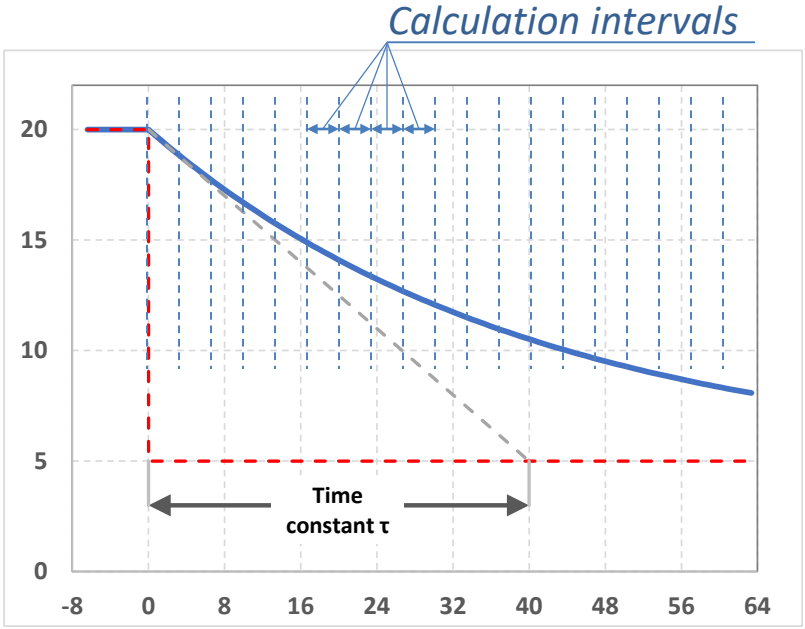
But hard to deal with cooling needs, other services than H and W, multiple generators and interacting technical systems

Why hourly?

- **If there are independent schedules of systems**, then it is difficult to represent by appropriate averages all interactions
  → goal is having enough resolution so that operating conditions are uniform during the calculation interval.
- **Most operating conditions may be considered constant during each hour**
  → hourly is the minimum resolution to describe adequately most operation schedules within a building
  … the next step in the progress of the resolution of energy calculation
- **Hourly is straightforward to describe the use of a building**…
  but somebody might like 15 minutes as well which is synchro with electricity meters. However
  - Domestic hot water: draw off is a question of minutes…
  - Shadings react in minutes

Why dynamic?

- Dynamic calculation is required if the accumulation of energy or other properties is significant
- Is it adequate and reliable?
  … Compare the calculation interval with the time constant of your system…
  - **Short calculation interval** : dynamics is likely to be reproduced correctly
  - Long calculation interval: Nearly regime but an averaging factor may be required to take care of some dynamics
  - Same order of magnitude: that's an issue…



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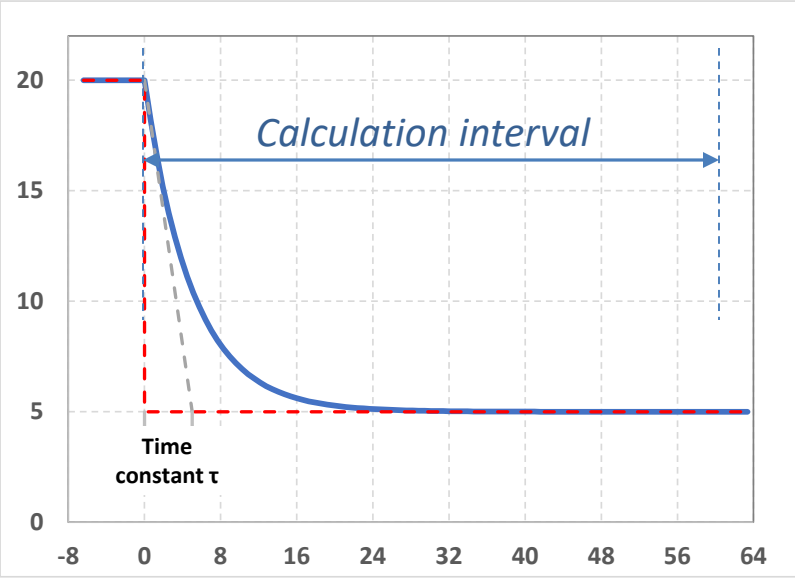

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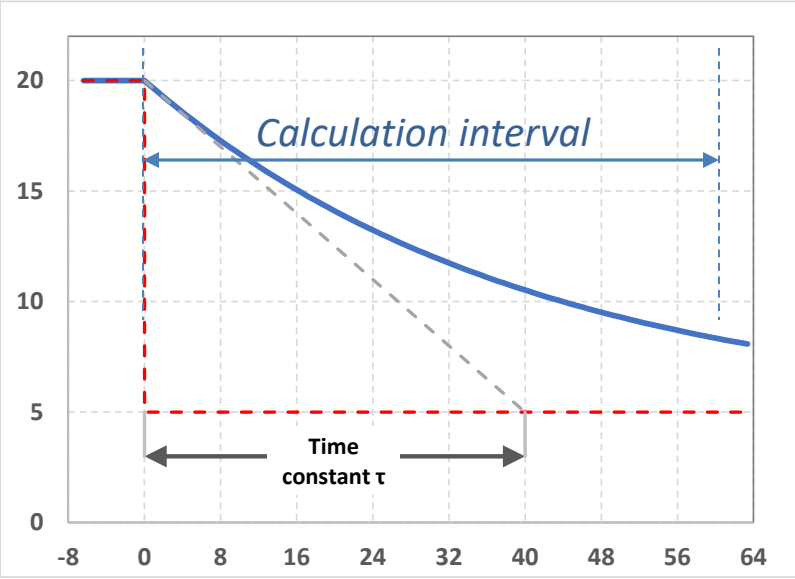
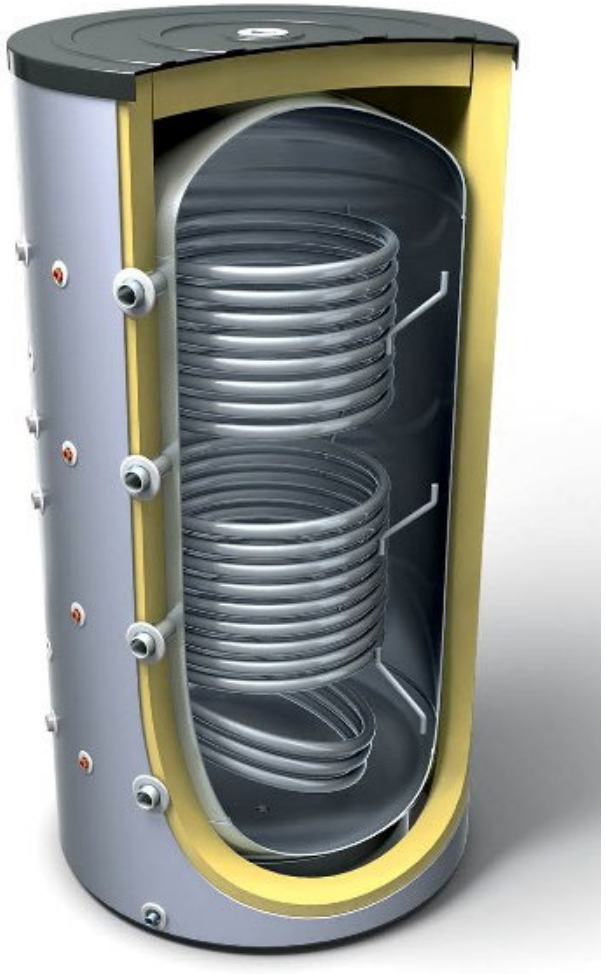


Example of dynamics

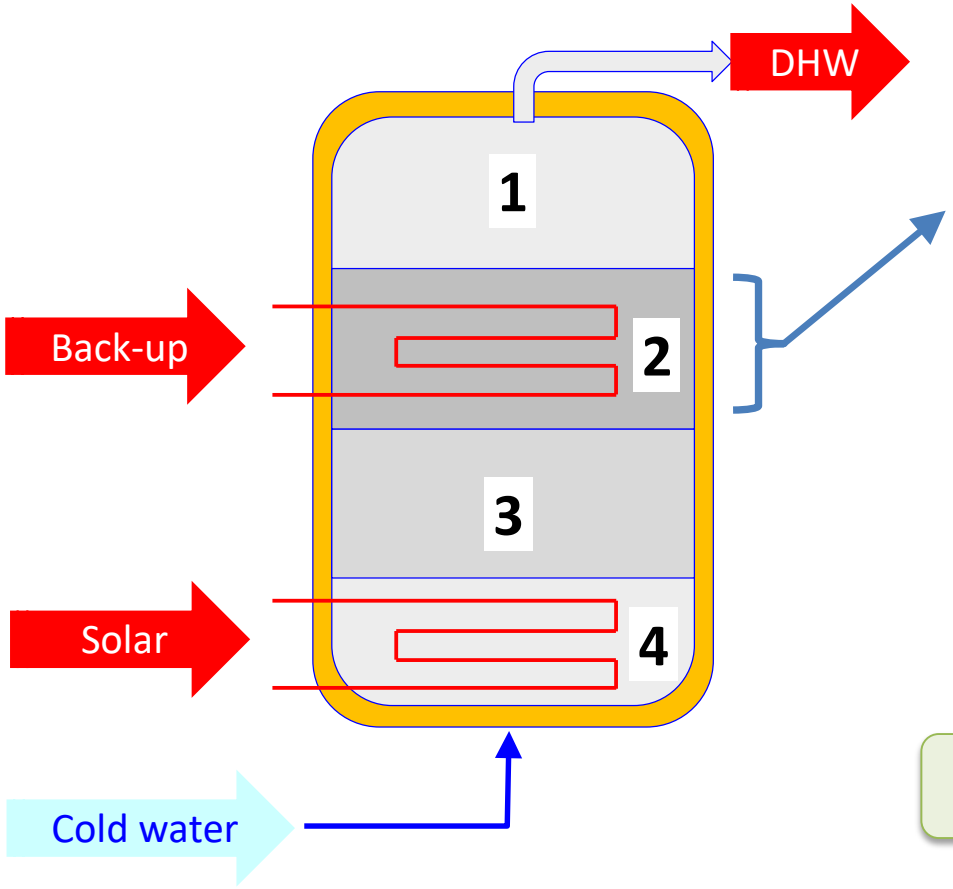
DHW storage

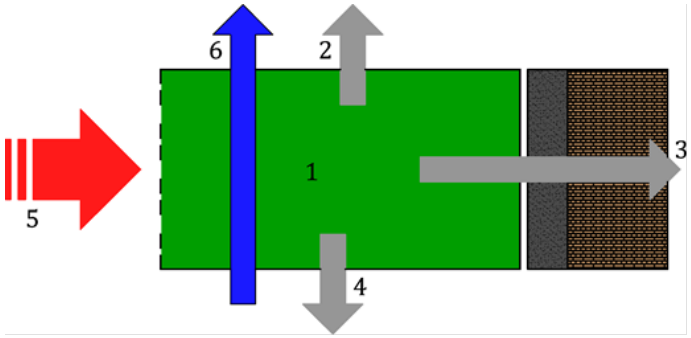
- Looks like obvious that there is dynamics: by definition you accumulate energy to decouple time of use and time of production
- Typical thermal time constant: 40…400 hours so hourly looks quite appropriate for water storage dynamics
- EN 15316-5 introduces a dynamic calculation with 1 hour calculation interval. Looks fine for thermal solar



Water storage model

The water storage model of EN 15316-5 in short





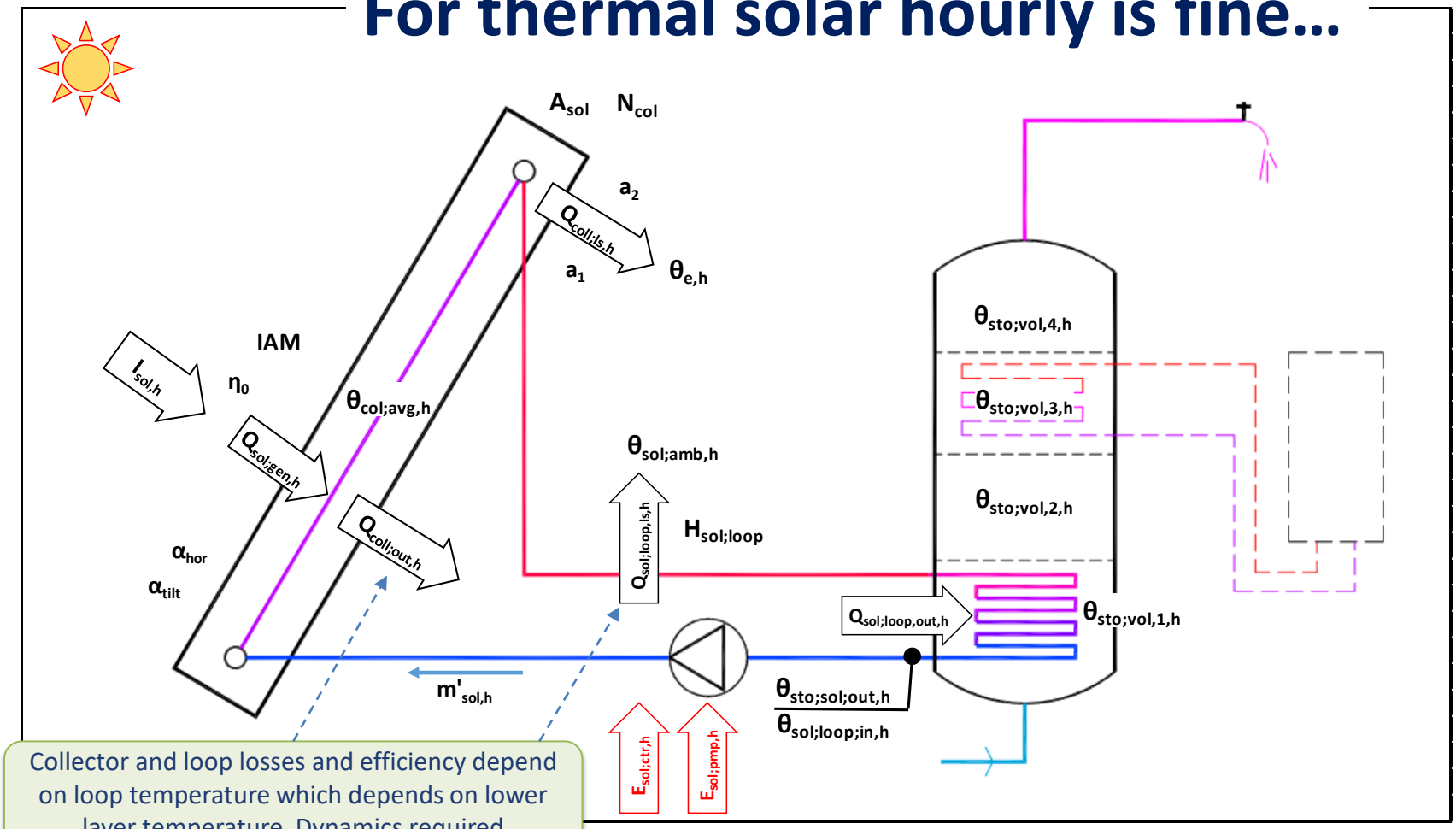
Key

1 layer *i*
2 thermal conduction with the upper layer
3 contribution of layer *i* to thermal losses
4 thermal conduction with the lower layer *i-1*
5 energy input into volume *i*
6 energy exchange due to mass transfer (flow of water draw off)

The model also includes heat extraction for heating, not shown here for simplicity

Coupling storage with thermal solar

For thermal solar hourly is fine…

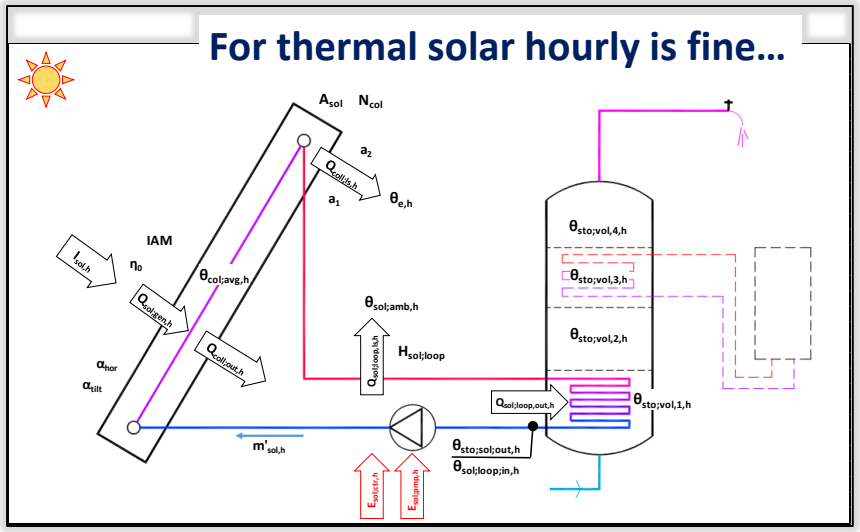


Collector and loop losses and efficiency depend on loop temperature which depends on lower layer temperature. Dynamics required

Benefits of hourly dynamics

DHW Water storage coupled with thermal solar

- Time constant: you need to store energy for one day so hourly looks appropriate for water storage dynamics.
- You remove the hidden assumption that the system will always work: detect overheating and lock-out
- May help sizing and design…
- **Does not require significant additional input…**



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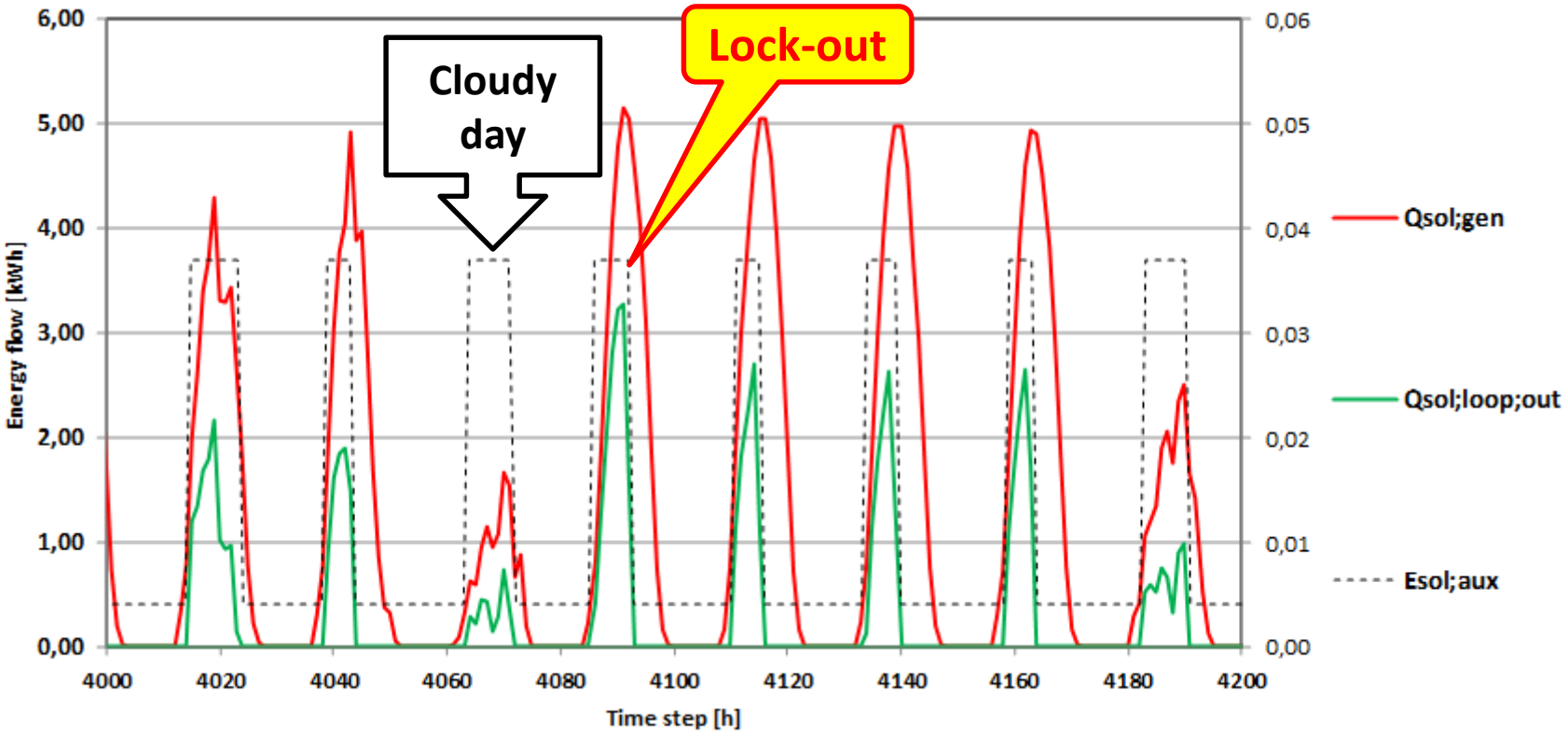

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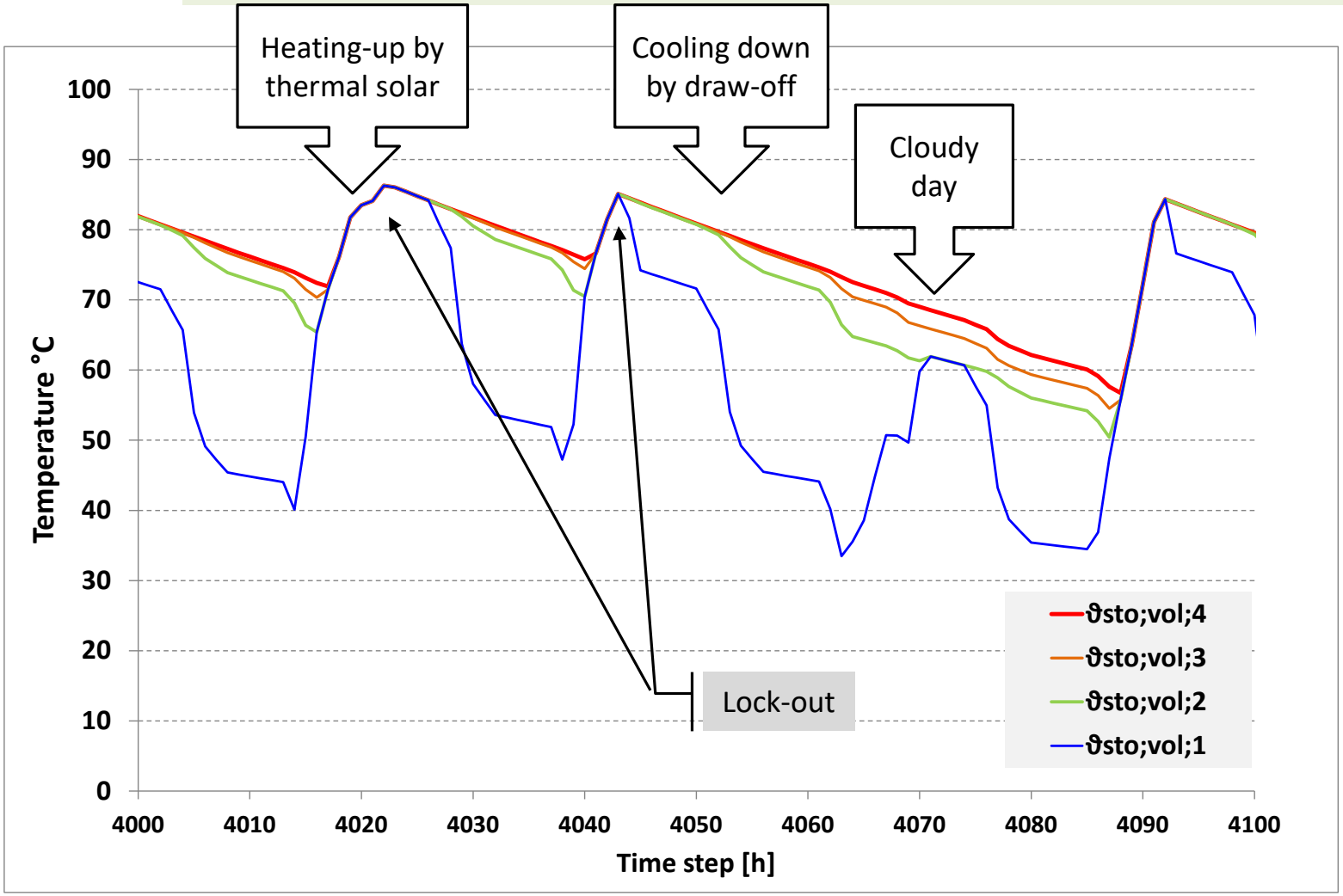
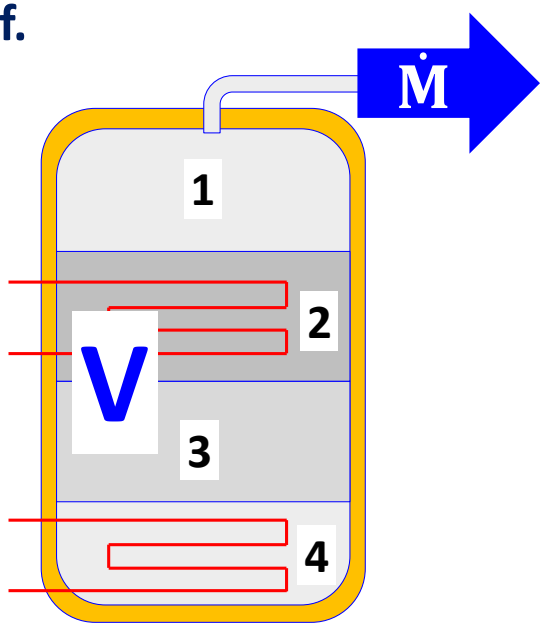


Is hourly always OK?

There is not only the thermal time constant: draw off.

- **If mixing,** time constant = volume V / flow rate $\dot{M}$
- **If piston,** if the draw off volume in one calculation interval exceeds the layer volume, then it's an issue. If it exceeds the tank volume then it is probably wrong.



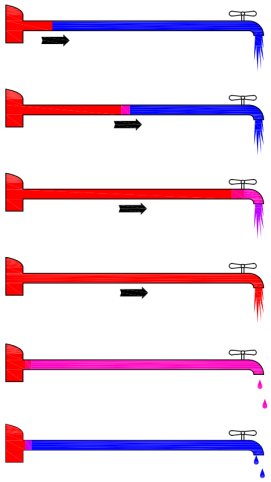
This is much more demanding and sub-hour intervals should be used for high draw-off relative to layer volumes

EN 12831-3 introduces a minute by minute calculation so that no draw off can upset the layers

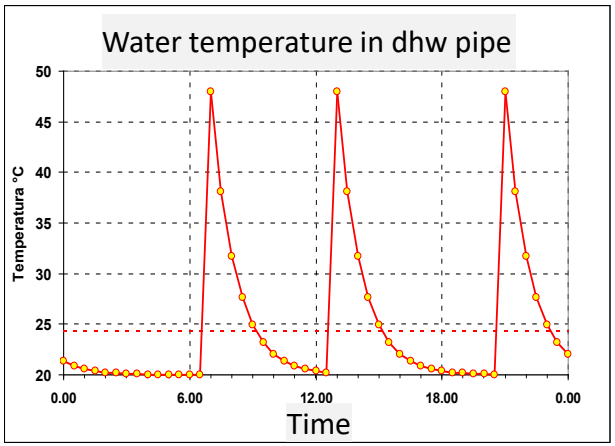
Training required to master all these details and features of hourly methods

Distribution

- Time constant of a pipe: 0,3…6 hours for pipes of common HVAC and DHW technical systems
- Dynamic effects are significant in DHW final piping: loss of heat of water trapped in the final stubs after draw-off is usually around 20% of needs in the residential sector
- Losses don't stop as soon as circulation is off
- Dynamic effects may be included in the monthly method by increasing the on-time *(1 stop = 1 extra τ operation)*



One single tapping cycle



Water temperature all day long
It is equivalent to operation at maximum temperature x 3 τ

Example of hourly: PV and grid

- Hourly is appropriate to describe the interaction between the building and the electricity grid.
  No dynamics needed. Explicit matching.
- Elementary dynamics has to be added to include a battery in the calculation.
- Monthly requires matching factors …

See videos on exported energy for more information on the influence of time step over energy performance

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

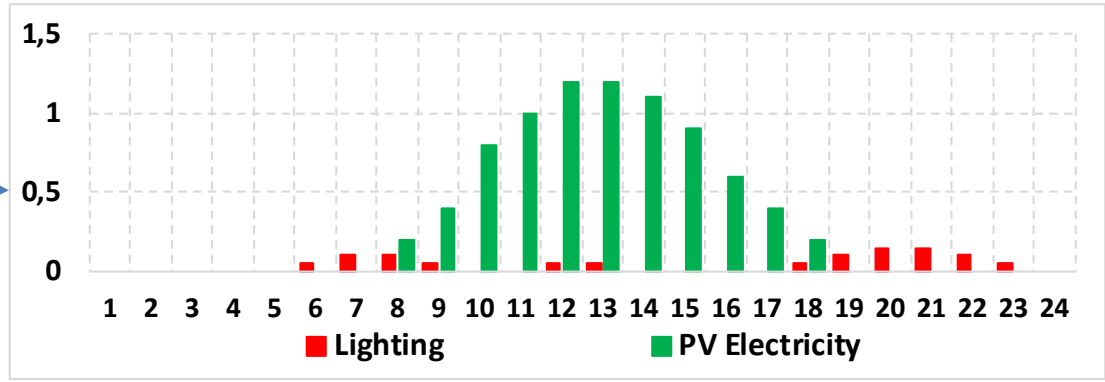
https://epb.center/documents/short-video-impact-calculation-interval/

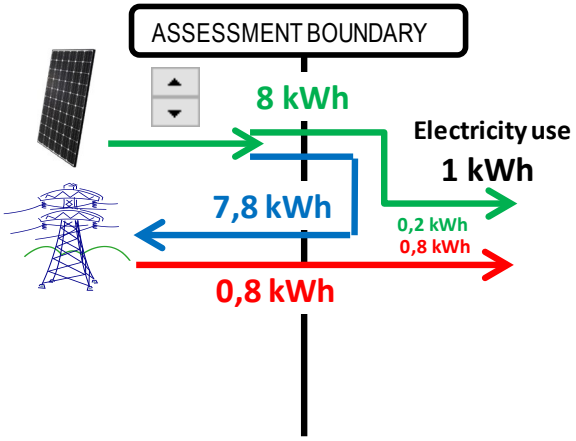
Using PV for lighting

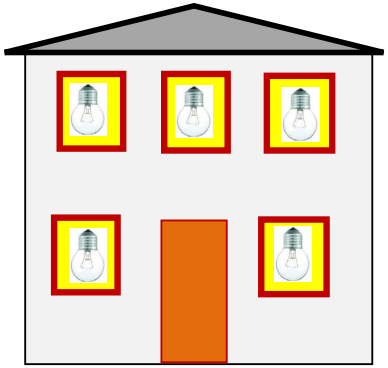
Full day hourly profile

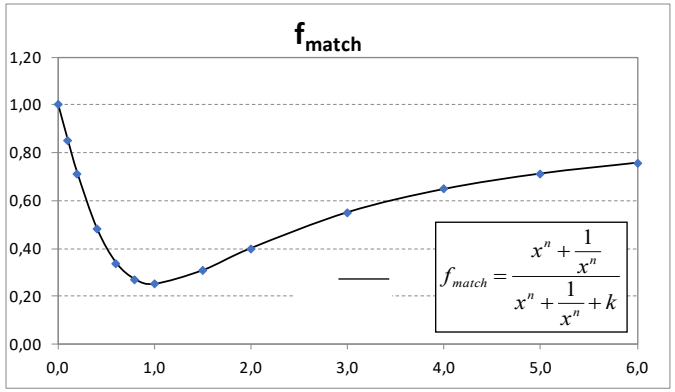
Hourly calculation explicitly takes into account matching of production and demand for that specific configuration

Monthly calculation requires a statistical matching factor





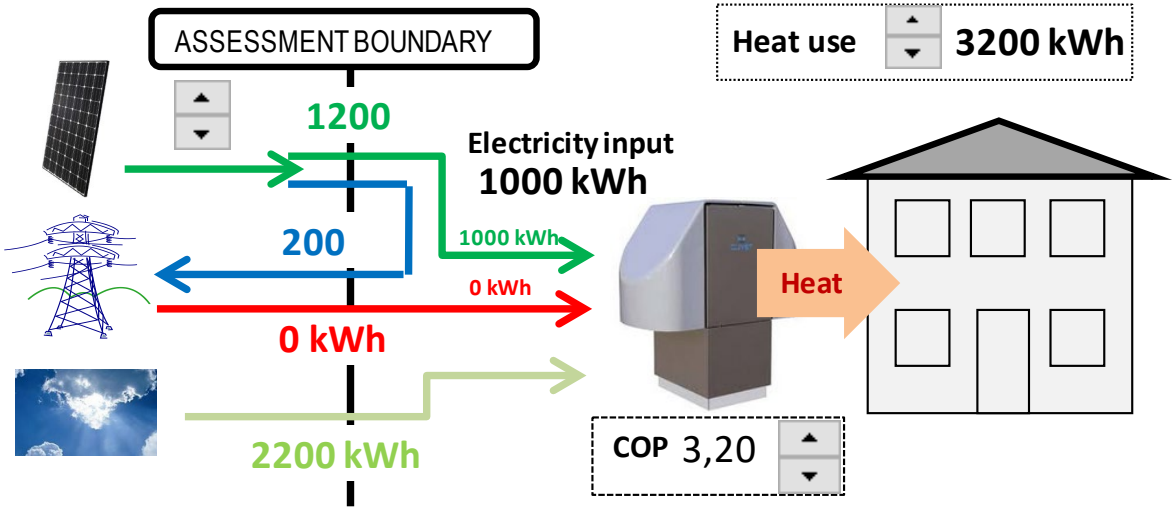




n	1	<-- factor controlling "sharpness" of the correlation
k	1,5	<-- factor controlling the minimum value at 1 (1-K/2)

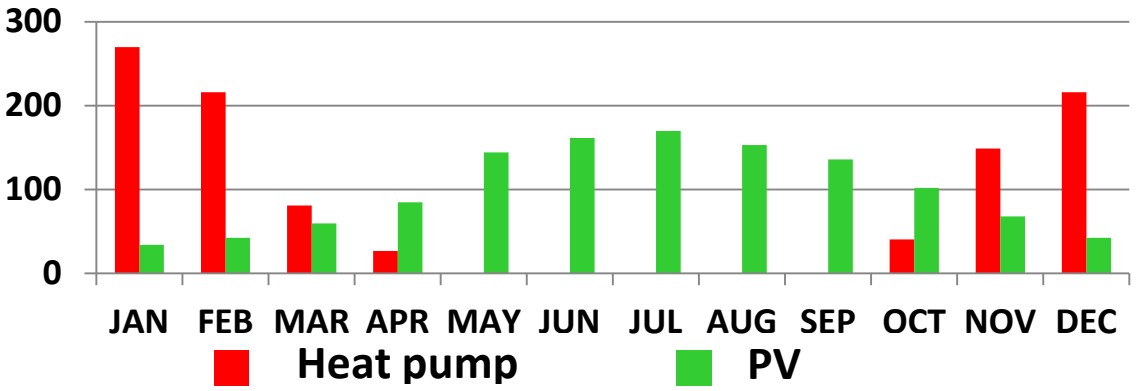
Using PV for a heat pump

Hourly calculation explicitly takes into account matching of production and demand for that specific configuration hour by hour.



Monthly may identify matching month by month but fails to identify night/day marching between production and demand

→ Matching factor needed



Other H&W sub-systems

In general, there is no significant dynamic effect for boilers , cogeneration units, heat pumps, space heating emission and control. The same calculation methods may be used for monthly and hourly calculation…

Problem: generators sequence

- Monthly method: tricky to identify the part of load left to a back-up generation device. Statistical factors needed
- Turn-around: use the bin method for the generation so that you explore the full range of loads and not only average loads
- Solution: hourly method identifies the load to back-up heater but shall be mitigated to identify “false alarms”

Ventilation and dynamics

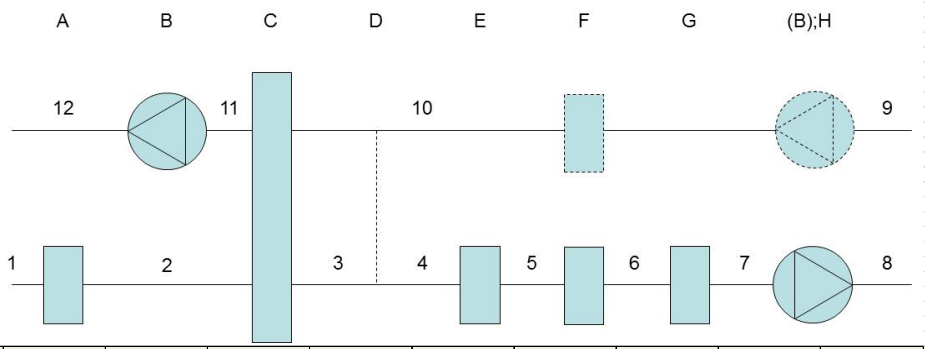
- Time constants and accumulation of energy within the ventilation systems are negligible.

- The building is a volume that may accumulate humid air, CO_2 and pollutants

→ hourly dynamics useful for indoor environment evaluation and ventilation need estimation

Ventilation and hourly

- Air treatment requires a lot of energy, also for de-humidification
- Conditions are varying along the day and may be influenced by accumulation in the conditioned space
- Usual design routine: calculate air treatment in one design condition.
- New EN standards: calculate air treatment for all hours
- Describe the building and systems only once
- Get results for all hours
- Use stress profiles



General	A	B	C	D	E	F	G	H	Distribution
AHU Leakage class	Frost protection / ground preheating/-cooling	Exhaust air fan	Heat recovery	Recirculation	Cooling / dehumidification	Humidification	Heating	Supply fan	Ducts
L2									
Air handling unit localosation	Ground air preheating and -cooling	localisation	Heat recovery type	Inside HR		Humidifier type		Fan motor localisation	Volume flow rates
NC	BYPASS	UP_HR	ROT_HYG	yes		CONTACT		OUTS AIR	Detailed
Supply air temperature control	Frost protection type		only for PLATE and ROT_HYG	Recirculation control		humidifier control		System type for variable air volume flow rate fan energy calculation	Ductwork leakage class
ODA_COMP	PREH		Residential	VARIABLE		ON_OFF		SINGLE_ZONE	B
Control of the volume flow rate	Control of the frost protection		Control of the heat recovery device			humidification energy carrier		Control of the fan	
ODA_COMP	INDIRECT		SPEED			HUM_CR_EL		DIRECT	
System testing type						Adiabatic cooling		localisation	
else						no		DOWN_HR	

Ventilation and hourly

- Air treatment requires a lot of energy, also for de-humidification
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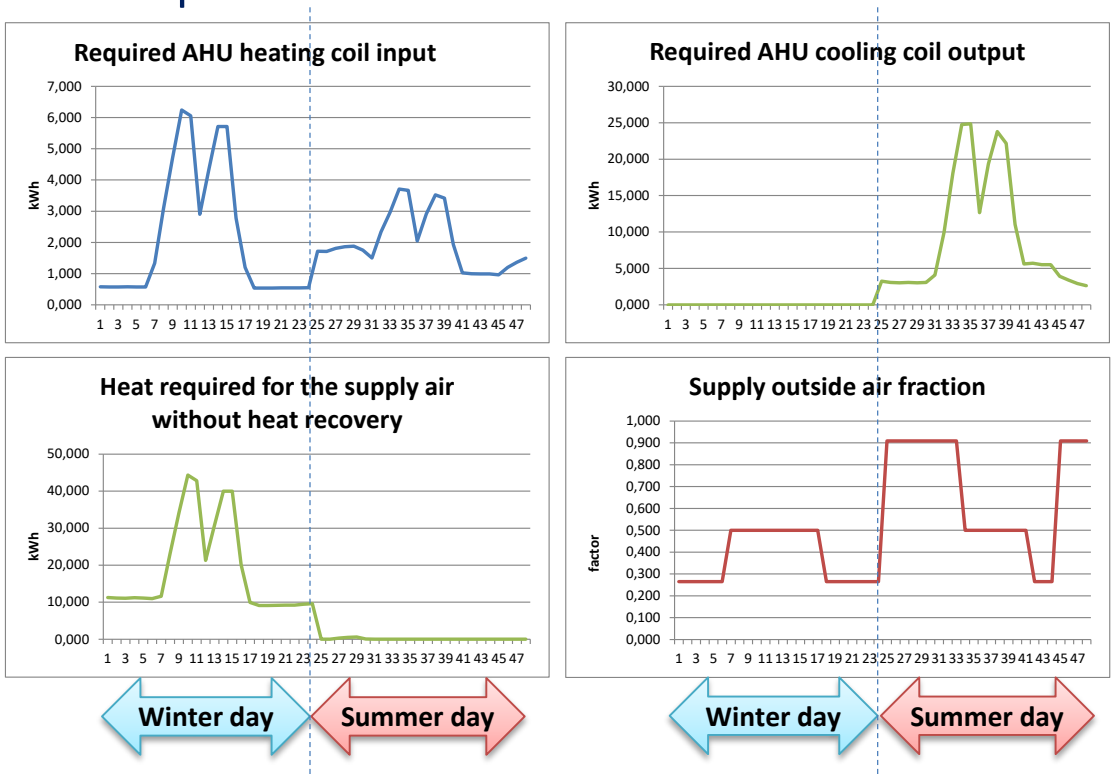
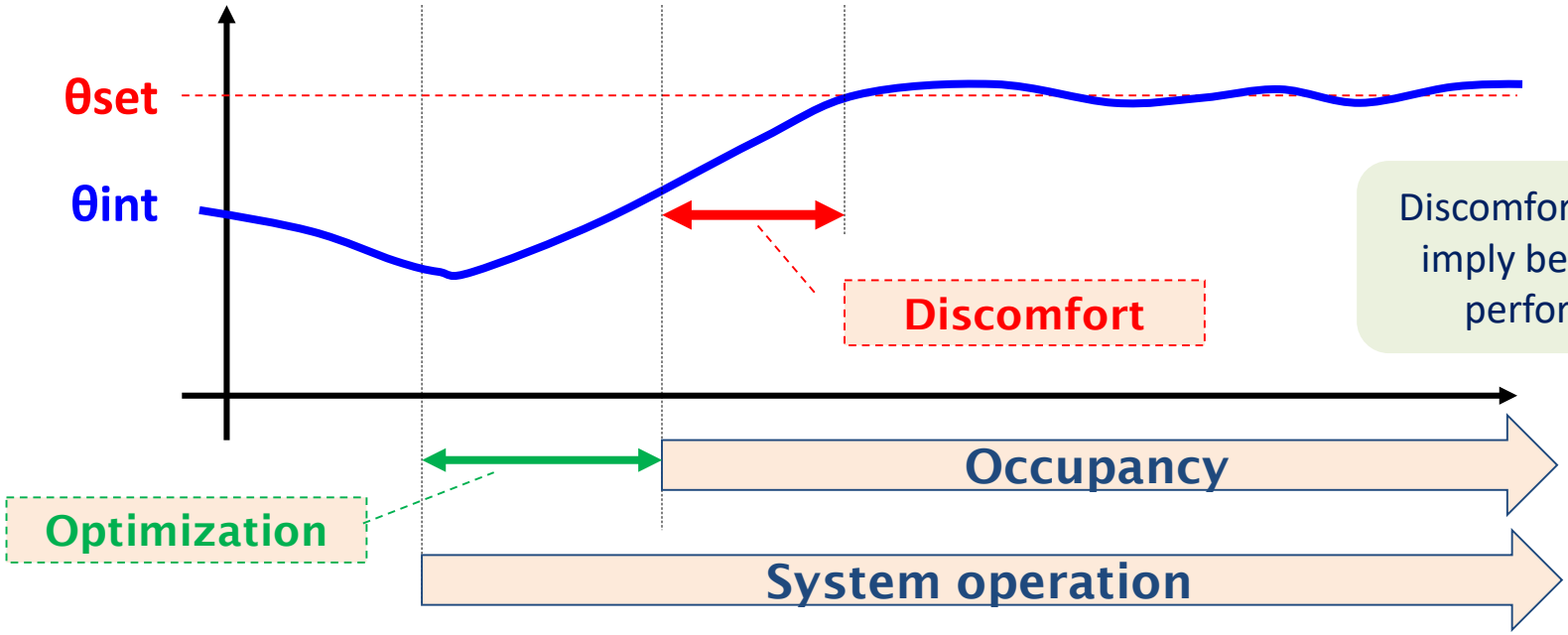


System operation schedule



Discomfort should not imply better energy performance…

Requirement: comfort during occupancy schedule → Consequence: system operation schedule

- **Hourly method**
  - can identify time required to reach comfort conditions
  - can take into account accumulation of energy during non-occupancy
  - can estimate the benefit of optimized start-stop (BACS)
- **Monthly method**: hard to take into account transients and dynamics – default factors required

Input data?

For standard use there is no or quite little difference between user input for monthly or hourly method.

- Use profiles
  - **Selecting a space category determines the whole standard use profile** → no additional effort for standard user
  - Explicit profiles reveal any potential interaction between technical systems
  - **For custom applications such as energy audit** there is the possibility to tailor use profiles
  - Using «**stress profiles**» may allow using the hourly method also for sizing purpose (iteration revolving peak day or peak week)
- Description of products may include additional information on dynamic parameters, such as the volume of each layer of a storage tank → not a significant effort
- Description of the building elements and geometry is the same

Summary

- **Hourly:** allows to describe in a straightforward manner the use of complex buildings.
  Easier to take into account interactions between multiple technical systems
- **Dynamics**: allows to take into account accumulation of energy in the building envelope and in the technical systems
- **Hourly and dynamics**
  - No or **quite low extra effort** on standard user input
  - **Natural progressing** of calculation techniques
  - Required to consider **indoor environment** in more details
  - allow convergence of energy performance and sizing calculation, possibly with the help of some sub-hourly calculation

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!