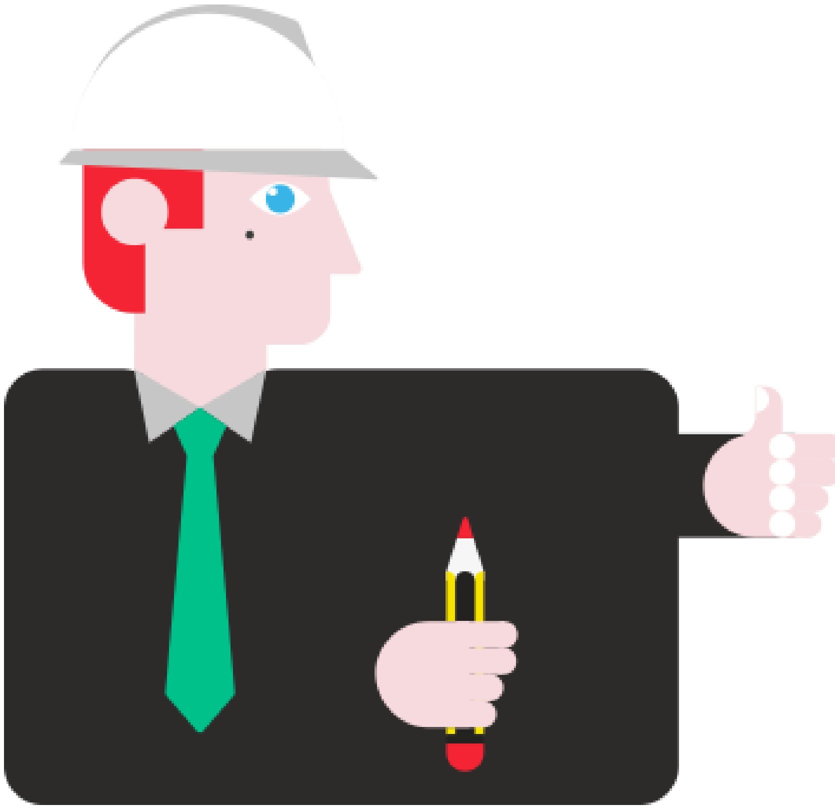

# CEN-CE

## CEN EPB Standards Certified Experts

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785018.

# 2nd Stakeholders' Workshop



CEN-CE

CEN EPB Standards Certified Experts

**REHVA Brussels Summit**

*4 November 2019*

*10h00 – 12h30*

REHVA BRUSSELS SUMMIT

4-5 November 2019

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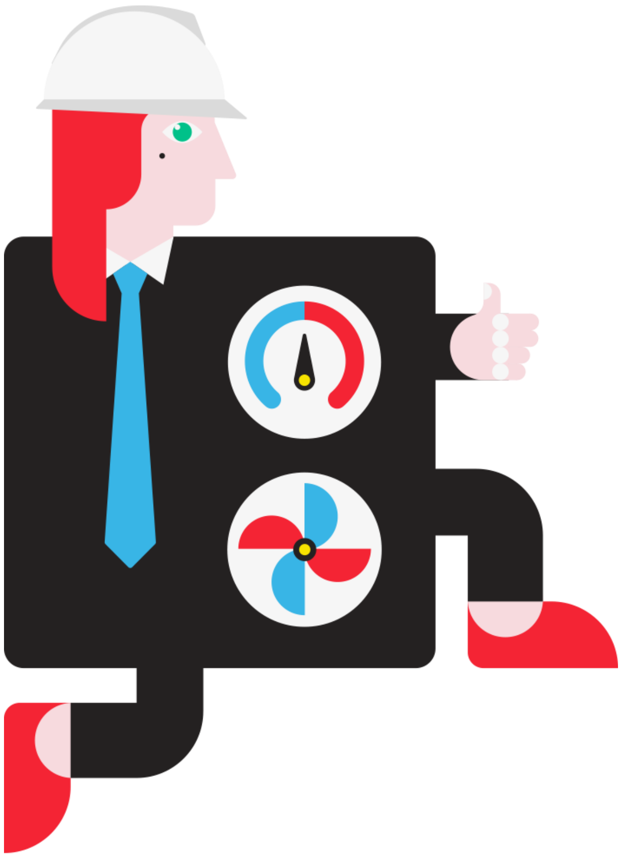
# AGENDA

## Moderator
Andrei Lițiu



| | | |
|---|---|---|
| *10h10* | ***Warm-up live poll*** | |
| *10h20* | **CEN-CE in a nutshell** | **Johann Zirngibl** |
| *10h30* | **CEN-CE certified experts** | **Jana Bendžalová** |
| *10h40* | **CEN-CE training: why, how, what?** | **Damir Dović** |
| *11h00* | **Professional tools integrating EPB standards** | **Laurent Socal** |
| *11h10* | **Online pilot training and e-learning** | **Andrei Lițiu** |
| *11h20* | ***Live poll and open discussion*** | |



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# Warm-up live poll



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# CEN-CE in a nutshell

**Johann ZIRNGBL & Emilien PARON,** CEN-CE coordinator
johann.zirngibl@cstb.fr & emilien.paron@cstb.fr

CSTB
le futur en construction

*10h20*



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# 1) What is CEN-CE – the key aims?

**CEN-CE: CEN standard Certified Experts**
***EU-wide training / qualification scheme based on EPBD mandated CEN standards***

**H2020 -** Project on increase **Construction skills of professionals**

related to

- ***Reducing energy consumption*** *and* ***carbon footprint (climate change) (EU commitments)***

CEN-CE is focused on use of **CEN standards** developed in
**CEN/TC 228 Heating and waterbased cooling systems**
**CEN TC/371 Overarching standard** for **global indicator**

A **sustainable business case** should to be defined.
**Training and certification materials** to be **used by other organizations**



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# CEN-CE is a piece of the EP-Building puzzle

Part of a **<u>European quality benchmark</u>** based on **EU CEN standards ( e.g.H2020 ALDREN project)**


ALDREN Alliance for Deep RENovation in buildings

Building professionals and users are asking for

- **quality / reliability (keep the promises)**
- **comparability (level playing field for products)**
- **transparency (technology neutral assessment)**

## Why CEN-CE now?

**European standards related to EPBD under Mandate 480 were positively voted in January 2017 and** published in 2017.

Training is needed to **bring them into application** and to **support the transposition of the EPB Directive**



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# Content of CEN TC228 standards (overview)

## (Heating, Domestic Hot Water, water based cooling systems)

- **heat load calculation** (the 12831 series e.g. for sizing);
- **energy calculation** (the 15316 – series e.g. for regulation)
  innovative approaches (e.g. on-site CHP);
  solutions including renewables (e.g. on-site wind turbines);
- **economical calculation** (cost optimum);
- **measured energy** (e.g. reliability)
- **inspection**.

Some are related to the **daily work of HVAC** professional (e.g. design), others are related to **upcoming challenges** (e.g. global cost calculation).

Training on **individual technical topics is not enough to ensure good quality** of installation. The training on **transversal know-how is needed (holistic approach)**.



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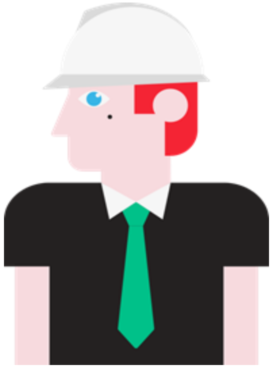
# 2) The CEN-CE results

## EU-wide training / qualification scheme based on EPBD mandated CEN standards

- **EU-wide training scheme per standard:**
  - PPT (fundamentals, main topics of the standard);
  - Handbook (resuming the calculation procedures);
  - Excel sheet (to evaluate impact of different parameters).



- **Qualification and certification schemes for CEN-CE experts**
  - Pre- requisites to enter the training, qualification scheme;
  - Exams;
  - List of experts;
  - Etc.



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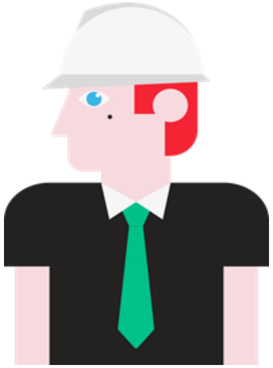
# 3.1 The advantages for HVAC created by CEN-CE

## For CEN-CE certified experts

- gain **recognition of the market** for:
  - quality / reliability;
  - comparability;
  - transparency;

by using **best know-how** based on **European standards** (state of art),

- gain on **visibility** (referenced in CEN-CE expert data base)
- **be trained on harmonized procedures** (training , tools) allowing professionals to **work EU wide**





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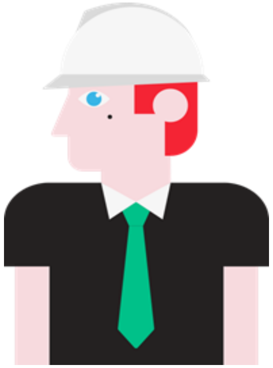
# 3.2 The advantages for HVAC created by CEN-CE

## For industrials

- **harmonized databases for products**
  because based on CEN standards in line with Ecodesign **u**
- **a coherent and transparent level playing field**
  technology neutral in Energy performance assessment of buildings. Fair competition between technical solutions
- Possibility to **show performance of their products EU - wide**





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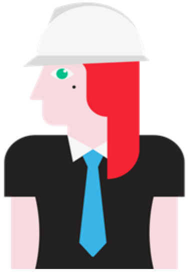
# 4) The next challenges – the market uptake

**CEN-CE particularity:**
**based on international standards (state of art = "security")**

**But where is market demand? Three potential drivers (resume)**



**1) Professional skills in design, energy consumption**
Pros: state of art, increased quality needed
(towards nZEB's, cost optimum, integration of renewables)
Cons: national mandatory procedures, double work

**2) Voluntary (e.g. HQE)** and **mandatory** certifications schemes **(e.g. EPC's)**
Pros: Discussion with HQE, Member States using more and more standards
Cons: Long time schedule

**3) Industrials**
Pros: Modular structure of standards related to product, Industrial trainings
Cons: Maybe not the right target group (installers)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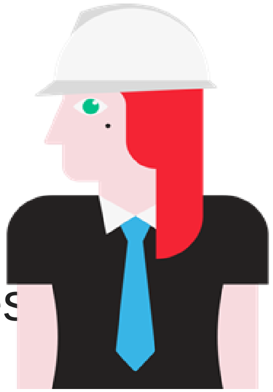
# 5) ...and finally

➢ **CEN-CE created**

a **EU wide common** training and qualification scheme for heating and cooling professionals

- **harmonizing daily work (heat load)** and
- **adding skills** on **upcoming challenges** (nZEB, renewables



to **reduce energy consumption** and **carbon footprint (EU commitments)**

➢ **To bring it to the market**

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# CEN-CE certified experts

**Jana BENDŽALOVÁ**
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ENBEE
Environment & Building Energy Efficiency

*10h30*



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# CEN-CE

## is a piece of the EPB puzzle supporting the EPBD implementation

by set up a large-scale training / qualification scheme
**to prepare certified experts on CEN EPB standards (M480)**

✓ Could stand alone or can be **included as a module in existing training scheme**

**Business case** → **depending on the demand**
→ mandatory or voluntary use of CEN standards

**Part of the business strategy is the promotion of CEN standards.**

→ CEN-CE provides feedback to CEN TC 228, proposal for amendment



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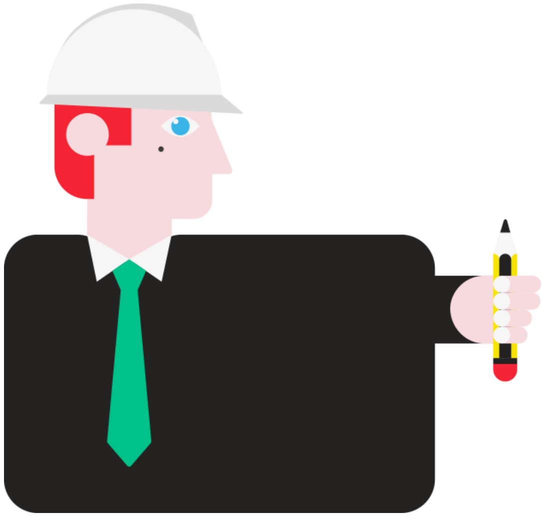
# The European Qualifications Framework (EQF)

Makes qualification more readable and understandable across different countries and systems



## CEN-CE certified expert

**Two levels of professionals (EQF):**
- ➢ Lower level (Level 4, installers)
- ➢ Higher level (Level 5+6, engineers, architects....)

## Knowledge – Skills - Competences

**Level 4**
- **skills required to generate solutions**
- self-management within the guidelines, supervise a routine work

**Level 5 + 6**
- **Comprehensive specialist, advanced knowledge,**
- skills required to develop **creative solutions to abstract problems demonstrating mastery and innovation, solve complex and unpredictable problems**
- management and supervision of work with unpredictable change, develop performance
- manage complex activities, decision making in unpredictable work or study.



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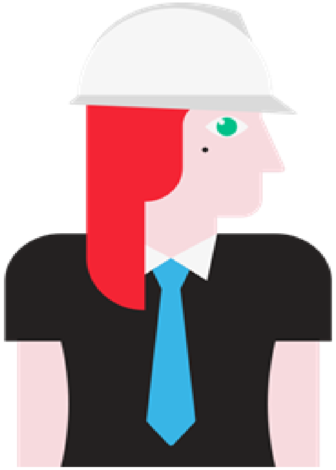
# CEN-CE certified experts – demand drivers



**Gain recognition** for performance, comparability, reliability by using the **best know-how** based on European standards.

| | |
|---|---|
| **Industry** | **Correct consideration of products** in EP of the whole building - level playing field for products - **participated in development of CEN standards**-occassion to bring them into practice |
| **Education institutions** | **Part of technical education on EP at Universities** |
| **Certification / accreditation schemes** | Accreditation of experts – eligibility, **quality** |
| **Professionals** | **New skills, know-how, recognition** of competence and quality by market |

CEN-CE

CEN EPB Standards Certified Experts



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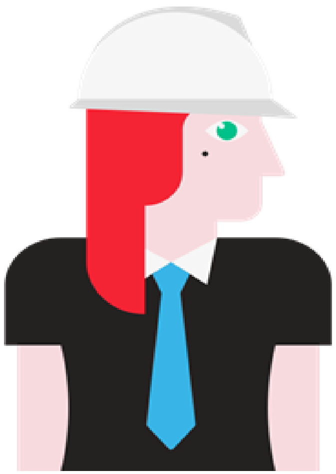
# CEN-CE certification context



**Based on**

- ✓ **survey of existing schemes**
  IngReeS, Build Up Skills Pillar II, Passive house, ASHREA, **how to keep the quality of operators EU / World wide,**
- ✓ **market needs,** requirements of the industry, national mandatory accreditation of experts,
  **Voluntary certification schemes e.g. EPBD Art. 11(9)**

- ✓ **Modular structure**
  - expert can be trained only for **selected standards** – allows different background of experts and **specific product based interest** by industry
  - offers training courses in a **short format** to enable **acquiring skills on a step-by-step basis**



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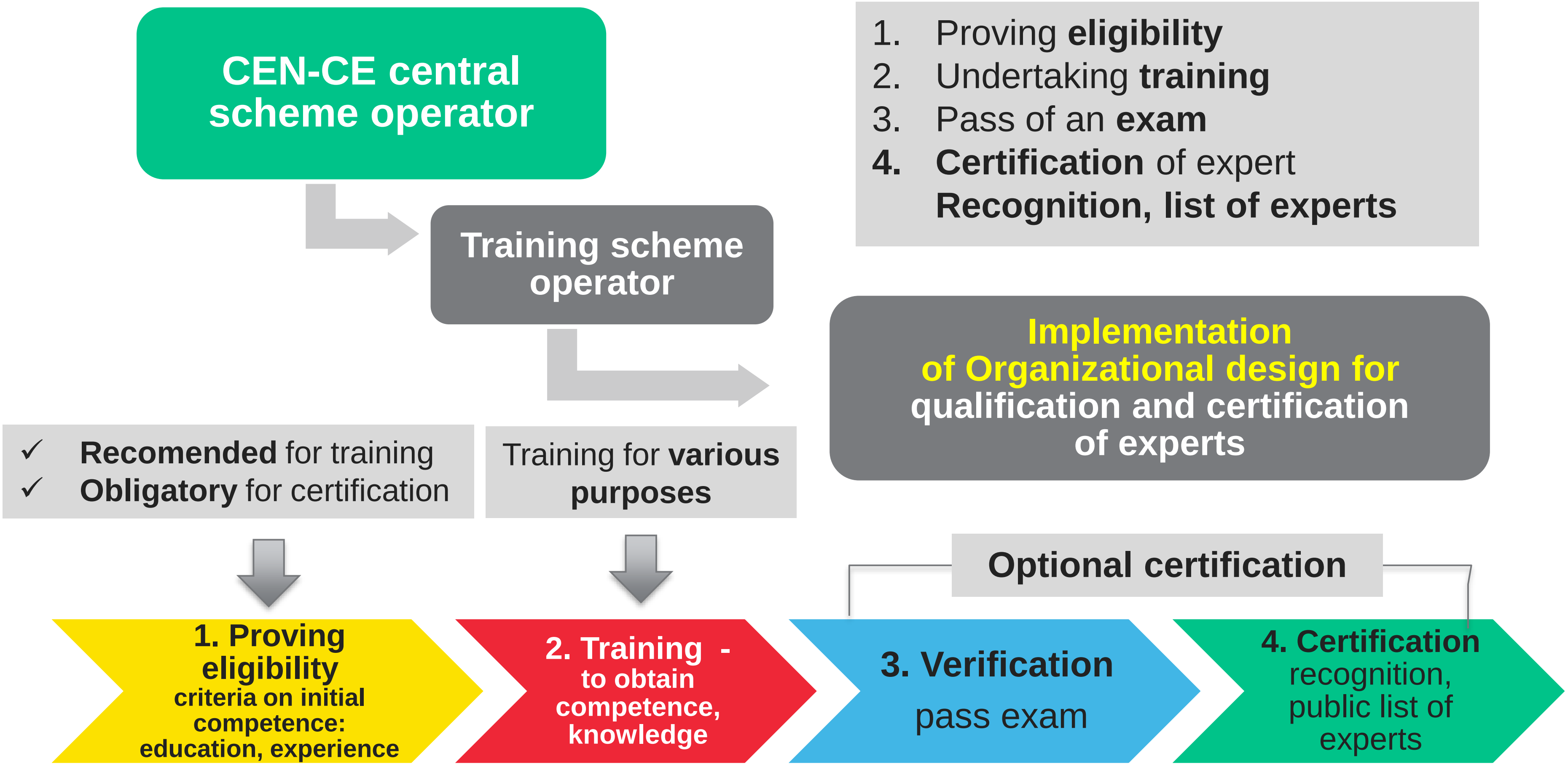
# Operational and organizational structure of the CEN-CE scheme



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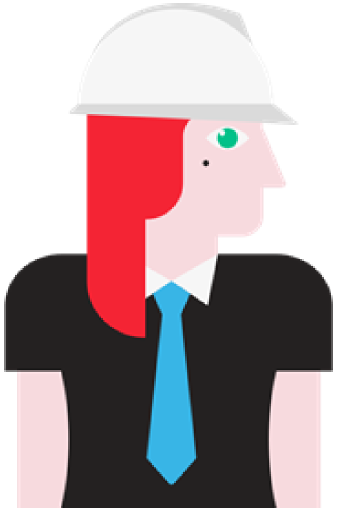
# The CEN-CE scheme



## 1. Proving eligibility

- **<u>only recommended</u>** for undergoing training for understanding the content of the training
- **<u>obligatory</u>** for certification to ensure the quality and reliability of certified expert

**Two levels of professionals (EQF):**

- ➢ Lower level (Level 4, installers)
- ➢ Higher level (Level 5+6, engineers, architects....)

**The criteria on initial competence:**

✓ **<u>Education</u>:**

- ✓ level 4 - upper secondary school-leaving certificates
- ✓ level 5+6 - bachelor/graduation, university degree

✓ **<u>Relevant experience</u>**

2 years during the last 6 years.



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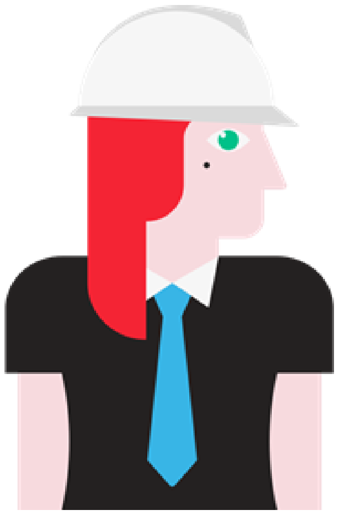
# The CEN-CE scheme



**Two levels (EQF):**
Level 4 - installers
Level 5+6 - engineers, architects ...

## 2. Training

provides knowledge, skills, competence.

**Training materials:**

- ✓ modular structure (per standard)
- ✓ common templates
- ✓ Handbook, Excel, ppt, matrix of slides for different EQF level, didactic, e-learning

Expert can be trained only for selected standards for dedicated level (lower level, higher level professionals).

**The length of training:** max. 4 h / standard depending on the complexity of the standard.

**Initial competence** (education, experience) just recommended for training for understanding topic



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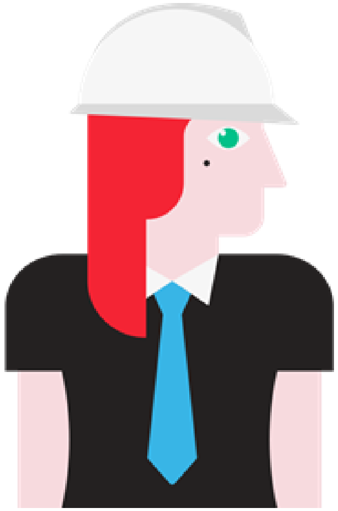
# The CEN-CE scheme



**Two levels (EQF):**
Level 4 - installers
Level 5+6 - engineers, architects ...

## 3. Pass of an examination - assessment of learning outcomes

According to the benchmark of exiting schemes the options for exam are:

- ✓ presence
- ✓ remote, e-learning
- ✓ self-assessment

More options will be possible.
The structure will  depend also on the IT tools development and testing.

Set of questions.



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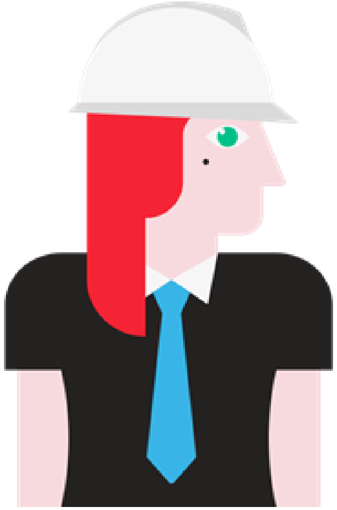
# The CEN-CE scheme



## 4. Certification, recognition of experts

The eligibility criteria for certification:

1) **education** and relevant **experience** (see point 1)
2) mandatory **training** (see point 2)
3) the successful **exam** (see point 3)

Certificates for different EQF levels will be provided (EQF level 4, 5 + 6)..

**Two levels (EQF):**
Level 4 - installers
Level 5+6 - engineers, architects ...

- ✓ Common template of certificate
- ✓ The database of certified experts will be publicly available on the website of scheme operator



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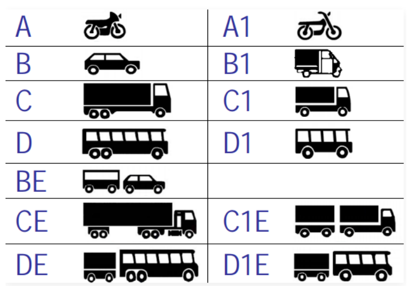
# The CEN-CE scheme

## 4. Certification, recognition of experts

### CERTIFICATE

- after passing exam
- all standards will be listed, relevant will be highlighted (as a driving license)


- **differentiation of experts according to competence** (few vs. all standards)
- **Dated versions of standards**
- List of certified experts on website

| | | | |
|---|---|---|---|
| **EN ISO 52000-1 – Overarching standard** | ✓ | | |
| **EN 15316-1 - General** | ✓ | | |
| **Heat load EN 12831- 1** | ✓ | Emission & controls EN 15316-2 | |
| **DHW needs EN 12831- 3** | ✓ | Distribution EN 15316-3 | |
| Meas. performance EN 15378-3 | | Gen – Boiler EN 15316-4-1 | |
| **System design EN 12828** | ✓ | Gen – Heat pump EN 15316-4-2 | |
| Installation & comm EN 14336 | | Gen – solar EN 15316-4-3 | |
| Instructions EN 12170 / 1 | | Gen – Cogen EN 15316-4-4 | |
| **Economics EN 15459** | ✓ | Storage EN 15316-5 | |
| | | **EQF level 4** | |

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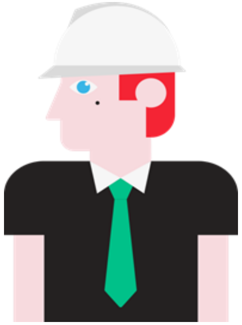
# Training scheme operators



CEN-CE scheme can be overtaken by any organisation

**CEN-CE central scheme operator**

**Training scheme operators**

Quality control
- launch training
- issuing licenses
- monitoring, surveillance
- issuing certificates
- registration, databases and on-line platforms
- list of certified experts

- market uptake
- provide trainings
- ensures that experts achieve learning outcomes

The **self-financing of the scheme** is important for quality assurance.
What price?



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# CEN-CE training: why, how, what? & examples

**Damir DOVIĆ**
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FSB

*10h40*



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# Why?

- To reach  EU 2030 climate/energy targets, a successful implementation of nZEB standards in new and renovated buildings is crucial
- Design of nZEBs requires more detailed/accurate calculations taking into account all technical system components and optimization of tech. solutions
- Implementation of nZEB standards is a challenge for engineers, installers and national methodology developers
- There is a lack of knowledge among engineers in EPB calculations (only energy certifiers are obliged to enroll the training courses)
- An adequate training supported by the calculation tool (software) is needed
- The experience of the consortium members show that the training on individual technical topics is not enough to ensure good quality of installation
- The awareness raising of professionals specialised in one of the skills on other skills (e.g. the sizing and the energy calculation) will help to increase the quality


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# Why?

EN 15316 standards can be used for:

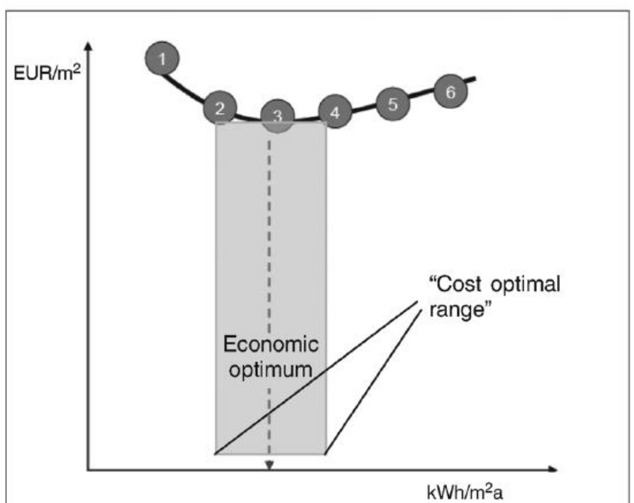
a) Performing energy performance calculations:

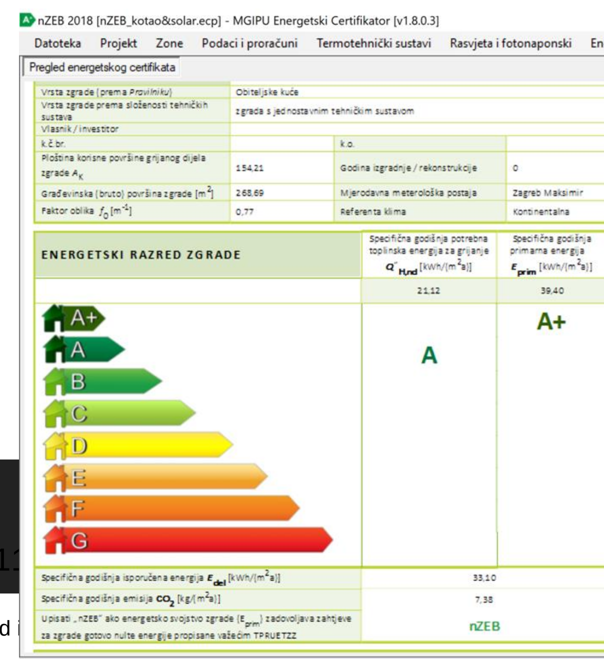
- verification of national min. energy performance requirements
- issuing EPC
- optimizing tech. systems at design stage (cost. optimal solutions)

b) Sizing of the system components (e.g. solar collectors, PV, boilers)

c) Comparison with measured and simulated energy consumption

Data input to calculation tool (spreadsheets, software) can be implemented in a a relatively fast and simple way, most of input values are available as default ones.







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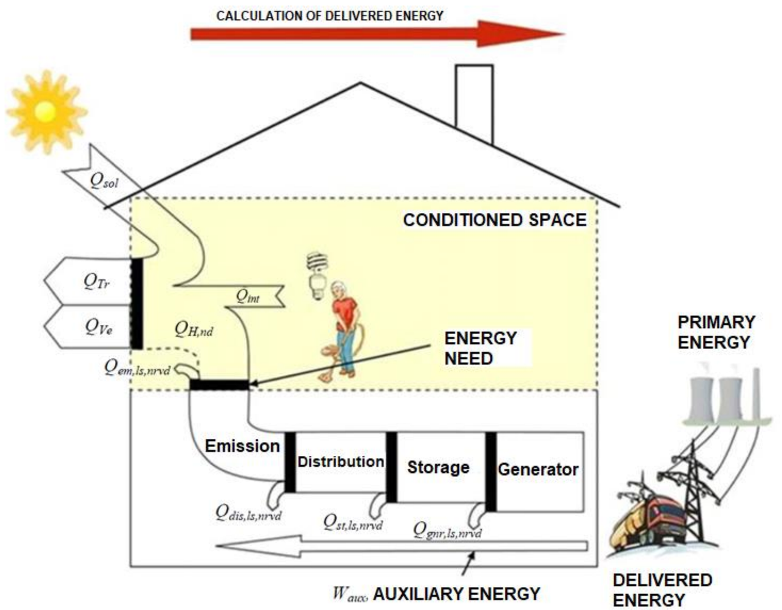
# How?

**The training comprises EN 15316 series related standards**

modular approach - expert can be trained separatelly for selected standards

Heating&DHW systems




| | | |
|---|---|---|
| Heat load EN 12831- 1 | EN 15316-1 - General | Emission & controls EN 15316-2 |
| DHW needs EN 12831- 3 | | Distribution EN 15316-3 |
| Meas. performance EN 15378-3 | | Gen – Boiler EN 15316-4-1 |
| System design EN 12828 | | Gen – Heat pump EN 15316-4-2 |
| Installation & comm EN 14336 | | Gen – solar EN 15316-4-3 |
| Instructions EN 12170 / 1 | | Gen – Cogen EN 15316-4-4 |
| Economics EN 15459 | | Storage EN 15316-5 |



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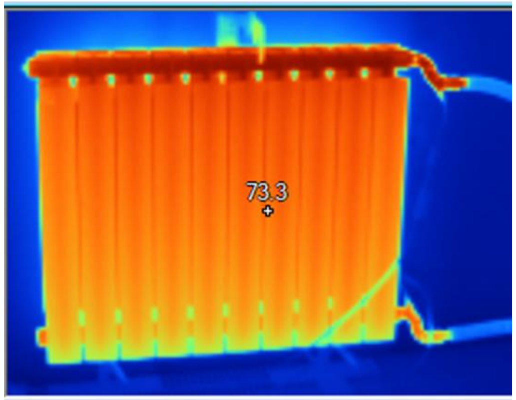
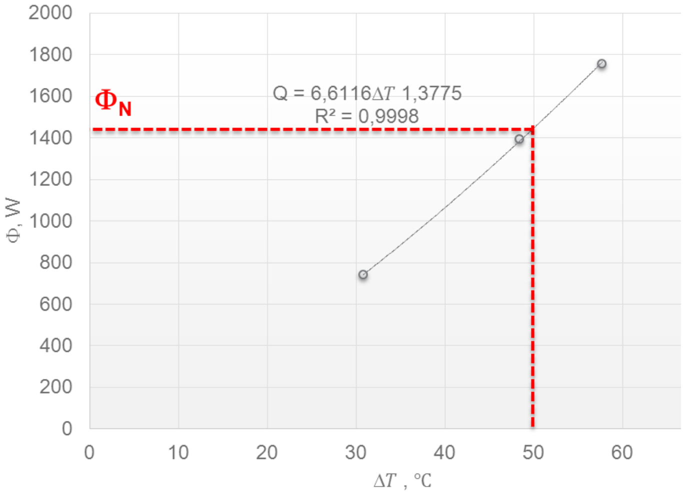
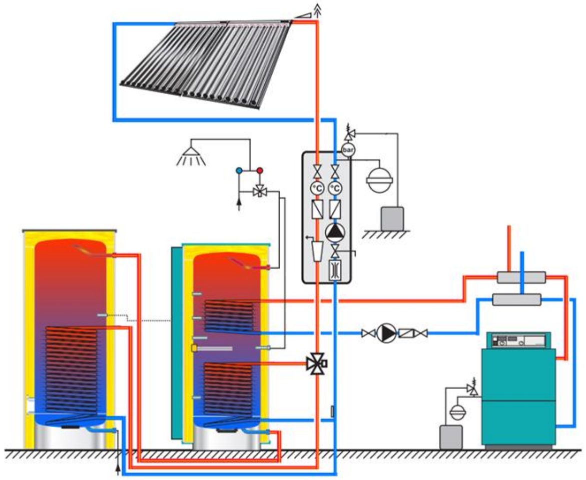
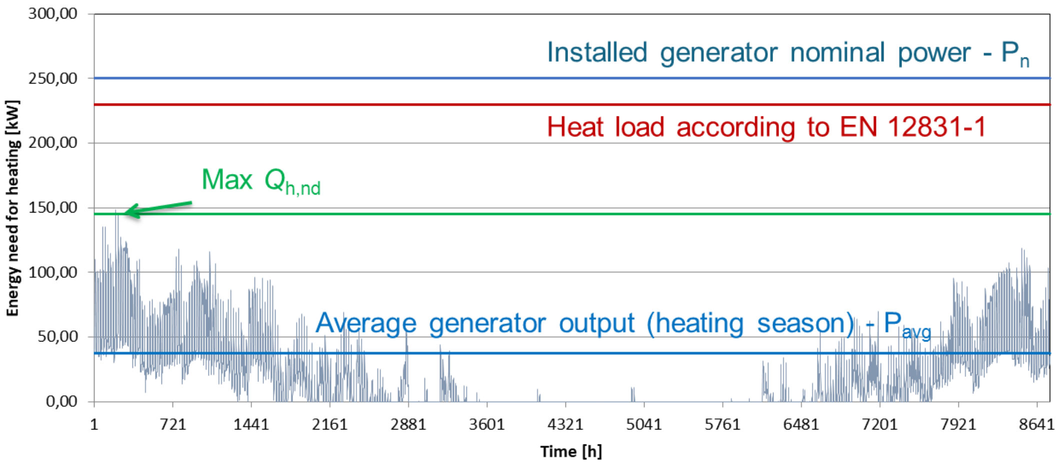
# How?

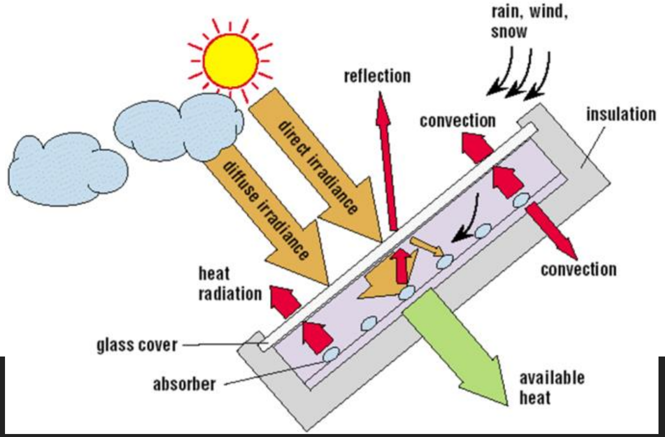
1. First part of each Module lecture is devoted to fundamentals and physics (e.g. types of solar collectors, influencing parameters on thermal output and efficiency, connecting schemes, etc.)







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# How?

2. In the second part input values to the calculation procedure and their origins are explained

| Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results | | Licence Number | 011-7S2672 F |
|---|---|---|---|
| | | Date issued | 2017-01-13 |
| | | Issued by | Sommer |
| Licence holder | Viessmann Werke GmbH & Co. KG | Country | Germany |
| Brand (optional) | Viessmann | Web | http://www.viessmann.com |
| Street, Number | Viessmannstrasse 1 | E-mail | - - - |
| Postcode, City | 35107 Allendorf (Eder) | Tel | +49 (0)6452-70-0 |
| Collector Type | | Flat plate collector, glazed | |

| | Gross area ($A_G$) | Gross length | Gross width | Gross height | Power output per collector Gb = 850 W/m²; Gd = 150 W/m² ϑm - ϑa | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 K | 10 K | 30 K | 50 K* | 70 K* | 90 K* |
| Collector name | m² | mm | mm | mm | W | W | W | W | W | W |
| Vitosol 100-FM SV1F | 2.51 | 2 380 | 1 056 | 73 | 1 880 | 1 781 | 1 518 | 1 202 | 870 | 519 |
| Power output per m² gross area | | | | | 749 | 709 | 605 | 479 | 346 | 207 |

| Performance parameters test method | Steady state - indoor | | |
|---|---|---|---|
| Performance parameters (related to AG) | η0,hem | a1 | a2 |
| Units | - | W/(m²K) | W/(m²K²) |
| Test results | 0.749 | 3.542 | 0.042 |

| Incidence angle modifier test method | Quasi dynamic - outdoor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bi-directional incidence angle modifiers | No | | | | | | | | | |
| Incidence angle modifier | Angle | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| Transversal | $K_{\theta T,coll}$ | 1.00 | 0.99 | 0.97 | 0.94 | 0.89 | 0.80 | 0.62 | 0.32 | 0.00 |
| Longitudinal | $K_{\theta L,coll}$ | 1.00 | 0.99 | 0.97 | 0.94 | 0.89 | 0.80 | 0.62 | 0.32 | 0.00 |

| | | | |
|---|---|---|---|
| Heat transfer medium for testing | Water | | |
| Flow rate for testing (per gross area, $A_G$) | dm/dt | 0.018 | kg/(sm²) |
| Maximum temperature difference for thermal performance calculations | $(\vartheta_m-\vartheta_a)_{max}$ | 90 | K |
| Standard stagnation temperature (G = 1000 W/m²; $\vartheta_a$ = 30 °C) | $\vartheta_{stg}$ | 145 | °C |
| Effective thermal capacity, incl. fluid (per gross area, $A_G$) | C/m² | 5.33 | kJ/(Km²) |
| Maximum operating temperature | $\vartheta_{max\_op}$ | - - - | °C |
| Maximum operating pressure | $p_{max,op}$ | 600 | kPa |

| | | | |
|---|---|---|---|
| Testing laboratory | TÜV Rheinland Energy GmbH | http://www.tuv.com/solarthermie | |
| Test report(s) | 21232812.001<br>21238010.001 | Dated | 21.06.2016<br>23.01.2017 |

Comments of testing laboratory — Datasheet version: 5.01, 2016-03-01

*As the collectors is operating with a discontinuous performance curve behavior, the performance curve above the switching point of about 50°C (absolute temperature) will be described by the following parameter η0*, a1*, a2* (related to ...):*
[A Gross] 0.779 /// 5.549 /// 0.009
*The overall behavior (over the full temperature range) is approximately described by the following set of parameters (related to ...):*
[A Gross] 0.755 /// 4.468 /// 0.021 ; [A Aperture] 0.814 /// 4.813 /// 0.023

TÜVRheinland® Geschäftsführig. TÜV Rheinland Energy GmbH Am Grauen Stein 51105 Köln

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Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results

| Collector name | Gross area ($A_G$) m² |
|---|---|
| Vitosol 100-FM SV1F | 2.51 |

| Performance parameters test method | Steady state - indoor | | |
|---|---|---|---|
| Performance parameters (related to AG) | η0,hem | a1 | a2 |
| Units | - | W/(m²K) | W/(m²K²) |
| Test results | 0.749 | 3.542 | 0.042 |





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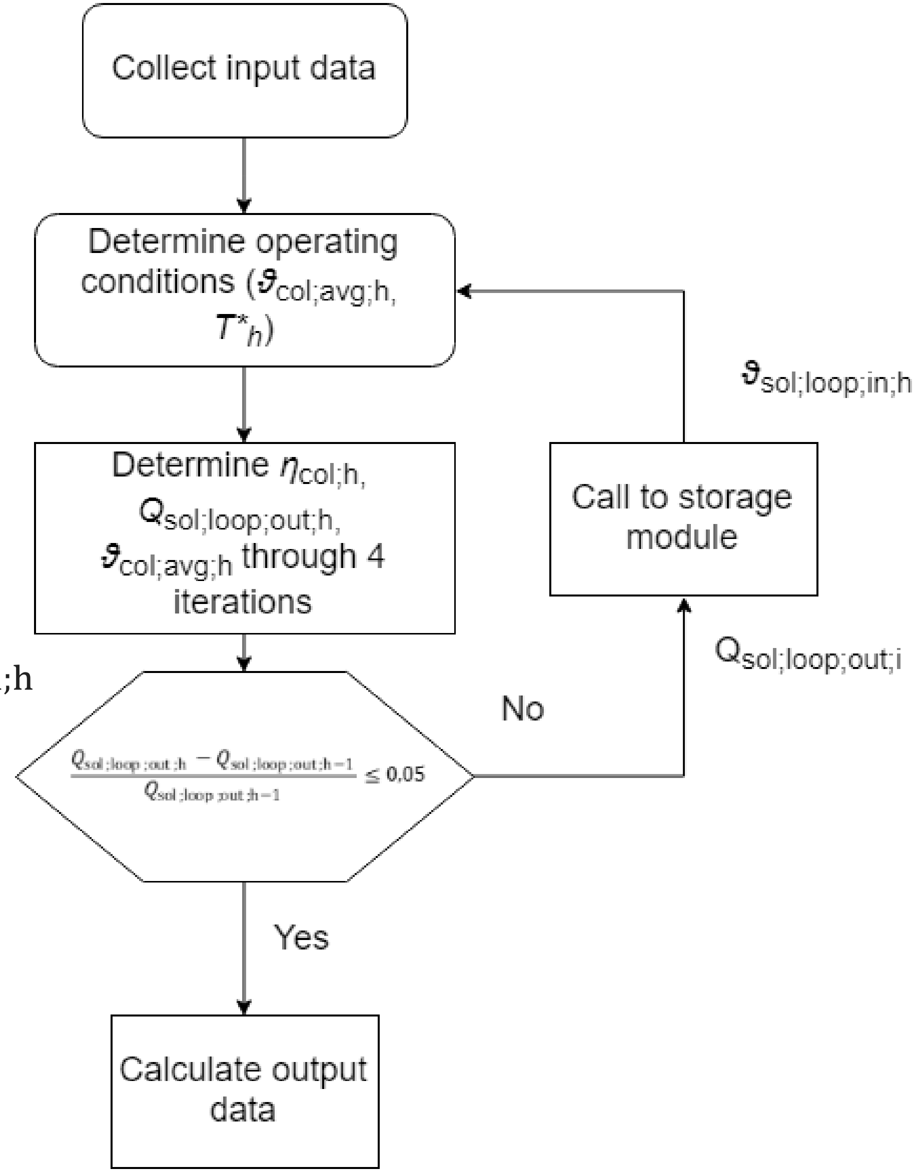
# How?

3. In the third part the calculation procedure is explained where calculation flow chart
and basic equations are presented

$$\eta_{\mathrm{col;h}} = \eta_0 \cdot K_{\mathrm{hem}}(50°) - a_1 \cdot T_{\mathrm{h}}^{*} - a_2 \cdot T_{\mathrm{h}}^{*} \cdot I_{\mathrm{sol;h}}$$

$$Q_{\mathrm{sol;out;h}} = \eta_{\mathrm{col;h}} \cdot I_{\mathrm{sol;h}} \cdot A_{\mathrm{sol}} \cdot t_{\mathrm{ci}} \cdot 0{,}001$$

$$\vartheta_{\mathrm{col;avg;h}} = \vartheta_{\mathrm{sol;loop;in;h-1}} + \frac{0{,}4 \cdot I_{\mathrm{sol;h}} \cdot A_{\mathrm{sol}}}{\dot{m}_{\mathrm{col}} \cdot C_{\mathrm{W}} \cdot 2}$$







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# How?

4. In the fourth part the output values are discussed

| Name | Symbol | Software name | Unit | Value | Range | Intended designation | Varying |
|---|---|---|---|---|---|---|---|
| **Energy flow data** | | | | | | | |
| Heat generated in the collector apsorber | $Q_{sol;gen}$ | Q_sol_gen | $W/(m^2.K)$ | | [0…∞] | M1-9 | YES |
| Collector heat output | $Q_{sol;col;out}$ | Q_sol_col_out | kWh | | [0…∞] | M1-9 | YES |
| Collector loop heat output | $Q_{sol;loop;out}$ | Q_sol_loop_out | kWh | | [0…∞] | M1-9 | YES |
| Collector loop heat losses | $Q_{sol;loop;ls}$ | Q_sol_loop_ls | kWh | | [0…∞] | M1-2 | YES |
| Recoverable heat losses of collector loop | $Q_{sol;loop;ls;rbl}$ | Q_sol_loop_ls_rbl | kWh | | [0…∞] | M1-2 | YES |
| Auxiliary (electrial) energy consumpiton in the collector loop | $E_{sol;aux}$ | E_sol_aux | kWh | | [0…∞] | M1-9 | YES |

$$W_{\mathrm{sol;aux;h}} = \left(P_{\mathrm{sol;crt}} + P_{\mathrm{sol;pmp}}\right) \cdot t_{\mathrm{ci}} \quad [\mathrm{kWh}]$$

$$Q_{\mathrm{sol;loop;rbl;h}} = Q_{\mathrm{sol;loop;ls;h}} \quad [\mathrm{kWh}]$$



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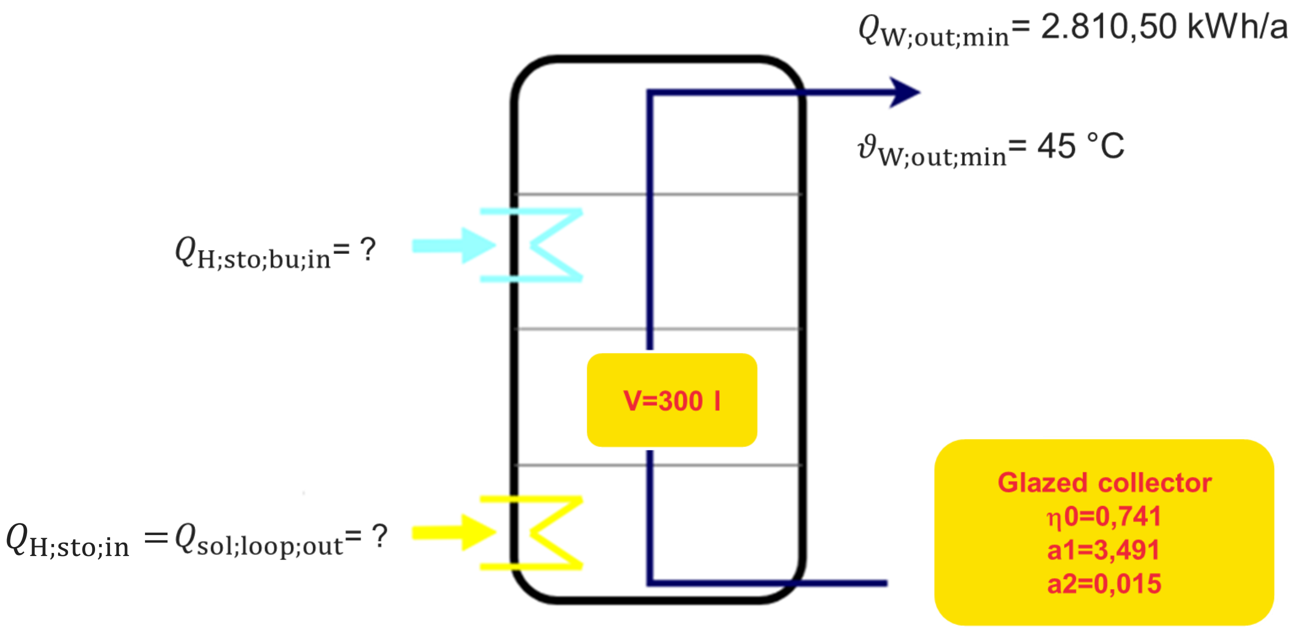
# How?

5. The fifth part is devoted to the work with spreadsheets through examples

*For this purpose trainers will use handbooks which provide array of equations following the order they are implemented in spreadsheets, along with the explanations that faciliate use of spreadsheets and understanding of calculation procedure*



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# Handbook examples (storage, solar)

DX.X – Handbook EN 15316-5

## 5.4 Energy calculation – Method B

*Table 9. Inputs to thermal loss calculations*

| Name | Symbol | Unit | Origin |
|---|---|---|---|
| Ambient temperature | $\vartheta_{amb}$ | °C | Table 7 |
| Part of the thermal losses transmitted to the room | $f_{room}$ | - | Table 7 |
| Stand-by losses coefficient | $H_{sto;ls}$ | W/K | For default data Eq. (1a)<br>For EcoDesign data Eq. (1b) |

Storage tank thermal losses are calculated by:

$$Q_{sto;ls} = f_{sto;dis;ls} \cdot \frac{H_{sto;ls}}{1000} \cdot \left(\vartheta_{sto;set;on} - \vartheta_{sto;amb}\right) \cdot t_{ci} \quad [\mathrm{kWh}]$$ *(30) EN 15316-5:2017* *(57)*

Note: $f_{sto;dis;ls}$ is defined in 5.2.10.

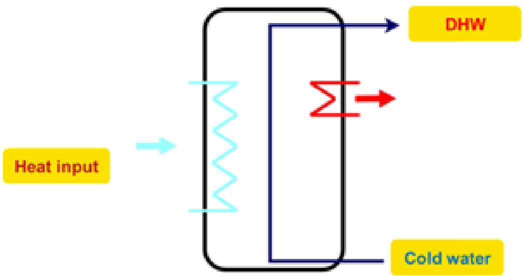


*Figure 6. Graphical representation of a storage module mathematical model (Method B)*

Storage tank water content temperature after the withdrawn of energy for DHW and thermal losses is calculated by:

$$\vartheta_{sto;tmp1} = \vartheta_{sto;t-1} + \frac{\left(-Q_{W;out} - Q_{sto;dis;ls} - Q_{W;dis;nocons;m}\right) \cdot 1000000}{\rho_W \cdot C_{p;w} \cdot V_{sto;tot}} \, [°C]$$ *(CEN-CE)* *(58)*

where $Q_{W;out} = \min\left(Q_{W;sto;out;req};\ \rho_W \cdot C_{p;w} \cdot V_{sto;tot} \cdot \left(\vartheta_{sto;t-1} - \vartheta_{W;cold}\right)/1000000\right)$.

NOTE: If $\vartheta_{sto;t-1} < \vartheta_{W;out\,min}$ $Q_{W;out} = 0$.

Energy to be supplied by other system is calculated:

DX.X – Handbook EN 15316-4-3

### 5.1.2 Energy calculation

*Table 9. Inputs to the calculation*

| Name | Symbol | Unit | Origin |
|---|---|---|---|
| Peak collector efficiency | $\eta_0$ | - | Table 11 or Ecodesign data |
| First order heat loss coefficient | $a_1$ | W/(m².K) | Table 11 or Ecodesign data |
| Second order heat loss coefficient | $a_2$ | W/(m².K²) | Table 11 or Ecodesign data |
| Hemispherical incidence angle modifier | $K_{hem}$ (50°) | - | Table 11 or Ecodesign data |

The flowchart of the calculation procedure is shown on Fig. 1.

The air temperature surrounding the collector loop is determined in relation to its location by:

SOL_LOC_HS (heated space): $\vartheta_{sol;amb;h} = \vartheta_{i;hr}$ [°C]
SOL_LOC_NHS) non-heated space): $\vartheta_{sol;amb;h} = (\vartheta_{i;hr} + \vartheta_{e;h})/2$ [°C]
SOL_LOC_OUT (outside): $\vartheta_{sol;amb;h} = \vartheta_{e;h}$ [°C] *(49) EN 15316-4-3:2017* *(5)*

where:
$\vartheta_{i;hr}$ – air temperature in heated room [°C];
$\vartheta_{e;h}$ – outside air temperature [°C].

The installed collector area is calculated by:

$$A_{sol} = A_{sol;mod} \cdot N_{col} \ [\mathrm{m}^2]$$ *(50) EN 15316-4-3:2017* *(6)*

NOTE: $A_{sol;mod}$ should be referred to the area (gross or aperture) used for determining collector efficiency parameter - EN 12975-2 (aperture area) or the current EN ISO 9806 (gross area).

*5.1.2.1 Initial calculations*

*Table 10. Constants and physical data*

| Symbol | Value | Unit |
|---|---|---|
| $c_W$ | 4186 | J/(kgK) |

The first estimation of the average collector water temperature determined by:

$$\vartheta_{col;avg;h} = \vartheta_{sol;loop;in;h-1} + \frac{0{,}4 \cdot I_{sol;h} \cdot A_{sol}}{\dot{m}_{col} \cdot C_W \cdot 2} \quad [°C]$$ *(51) EN 15316-4-3:2017* *(7)*

where
$\vartheta_{sol;loop;in;h-1}$ – storage outlet temperature to the collector loop from previous time step [°C], see Handbook on EN 15316-5
When h=1 (start of calculations) $\vartheta_{sol;loop;in;h-1}$ is equal to the initial temperature of the bottom volume of the storage tank

CEN-CE
CEN EPB Standards Certified Experts



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# Example of input data

## Spreadsheet interface for storage tank (Method A)

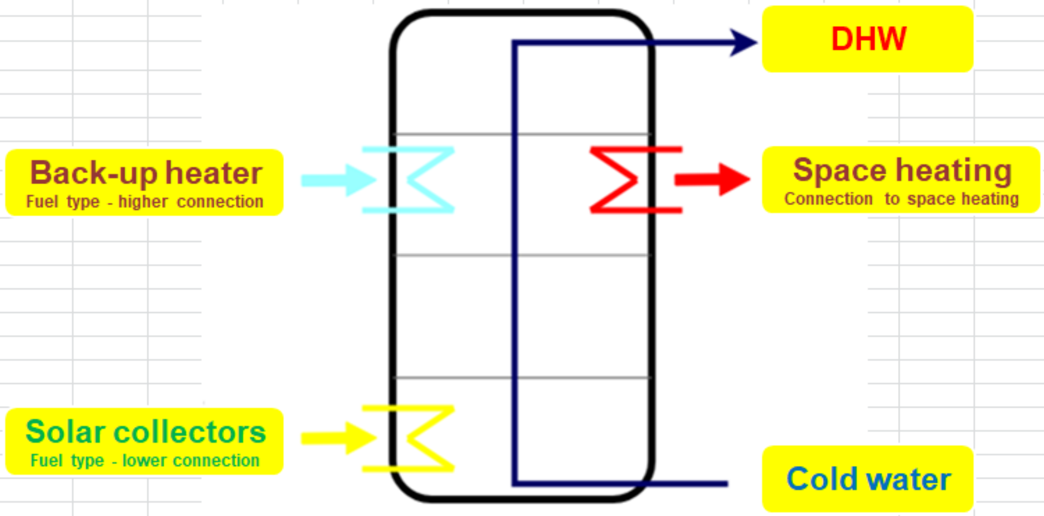
**PRODUCT DATA**

**Product descriptive data**

| | | |
|---|---|---|
| **Storage unit type** | | |
| Solar storage | STO_H_TYPE | |
| **Storage unit use** | | |
| Domestic hot water | STO_H_USE | STO_USE_W |
| **Fuel type - lower connection** | | |
| Direct connection | STO_H_FUEL_VOL1 | STO_FUEL_NOEXC |
| **Fuel type - higher connection** | | |
| No heat source | STO_H_FUEL_VOL3 | STO_FUEL_NO |
| **Hydraulic connection to space heating** | | |
| Exchanger (hot water) | STO_HCONN | STO_H_CONN_HEX |

**Product technical data**

| | | | | |
|---|---|---|---|---|
| Volume total | $V_{sto;tot}$ | *V_sto_tot* | L | 300 |
| Stand-by losses coefficient | $H_{sto;ls}$ | *H_sto_ls* | W/K | 2,77128129 |
| Stand-by losses correction factor | $f_{sto;dis;ls}$ | *f_sto_dis_ls* | - | 1 |
| Set temperature | $\vartheta_{sto;set;on}$ | *theta_sto_set_on* | °C | 60 |
| Heat exchanger - lower connection | $H_{sto;H;exh;vol;1}$ | *H_sto_H_exh_vol_1* | W/K | |
| Heat exchanger - upper connection | $H_{sto;H;exh;vol;3}$ | *H_sto_H_exh_vol_3* | W/K | |
| Heat exchanger - space heating service | $H_{sto;H;exh;out}$ | *H_sto_H_exh_out* | W/K | 4000 |
| Set temperature for back-up heater ON | $\vartheta_{sto;set;on;bu}$ | *theta_sto_set_on_bu* | °C | 50 |




**Graphical representation of a storage module mathematical model**

**SYSTEM DESIGN DATA**

| | | |
|---|---|---|
| **Storage location** | | |
| Boiler room | STO_LOC | STO_LOC_BLR |
| **Stand-by losses correction factor** | ideal case | |

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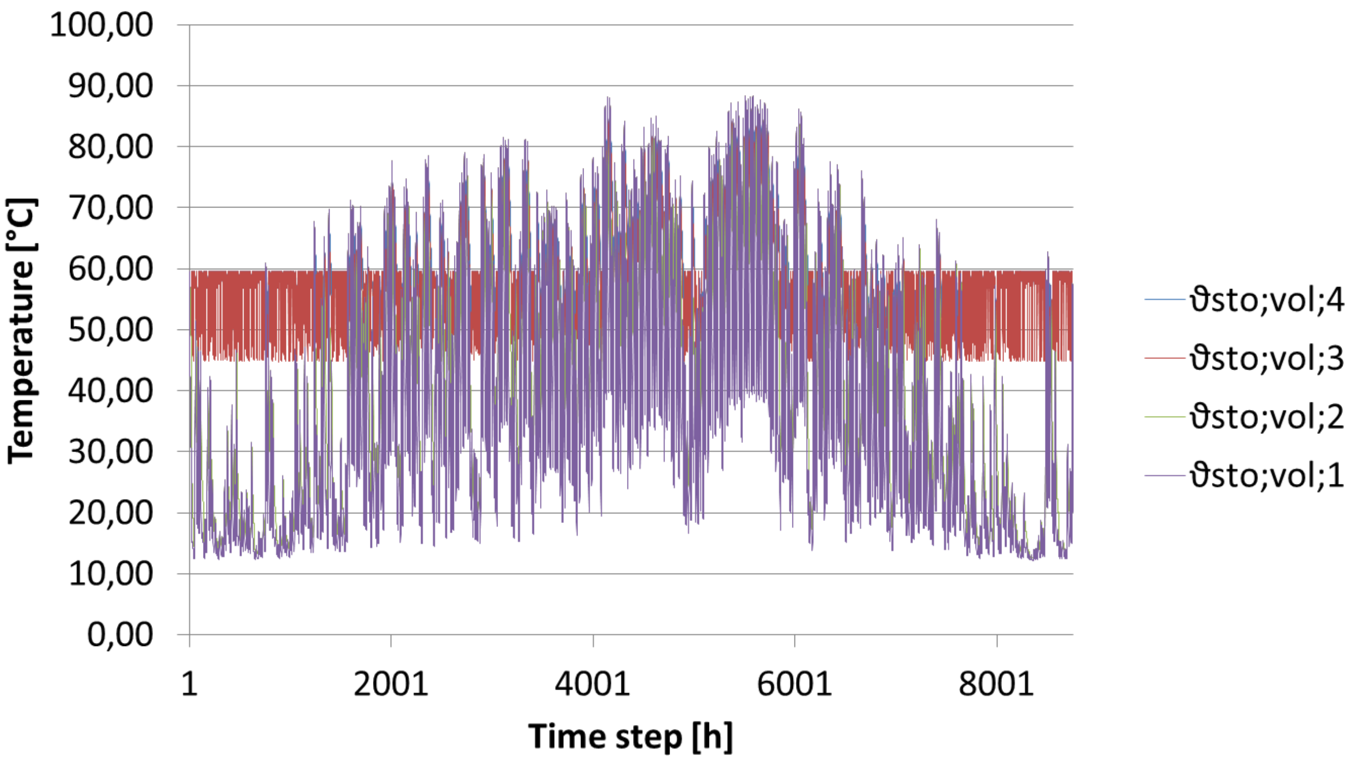
# How?

6. The last part of Module lecture deals with analysis of the most influencing parameters on the intermediate values and final result (sysbstem energy output)







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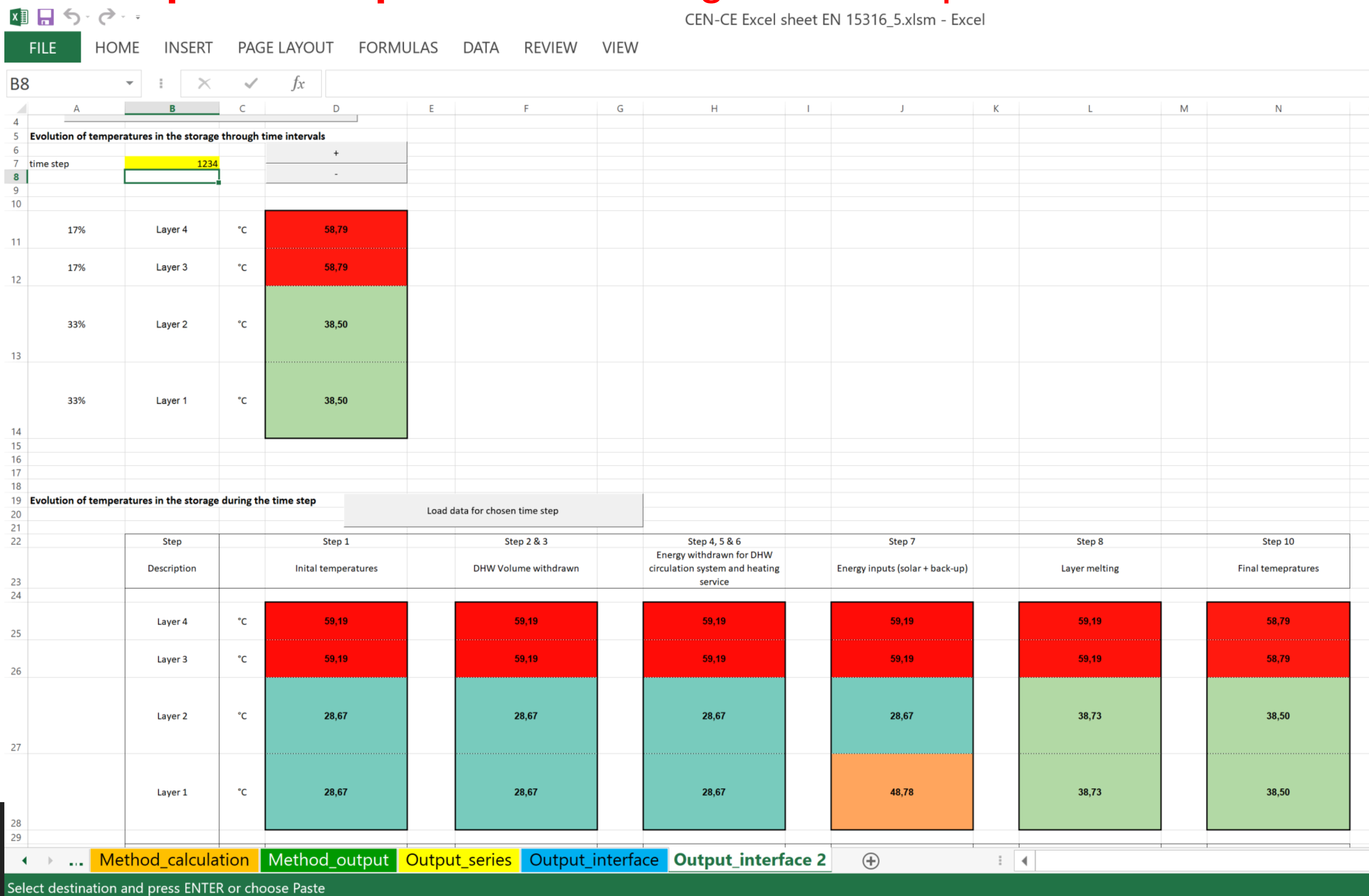
# Example of output data - storage tank temperatures

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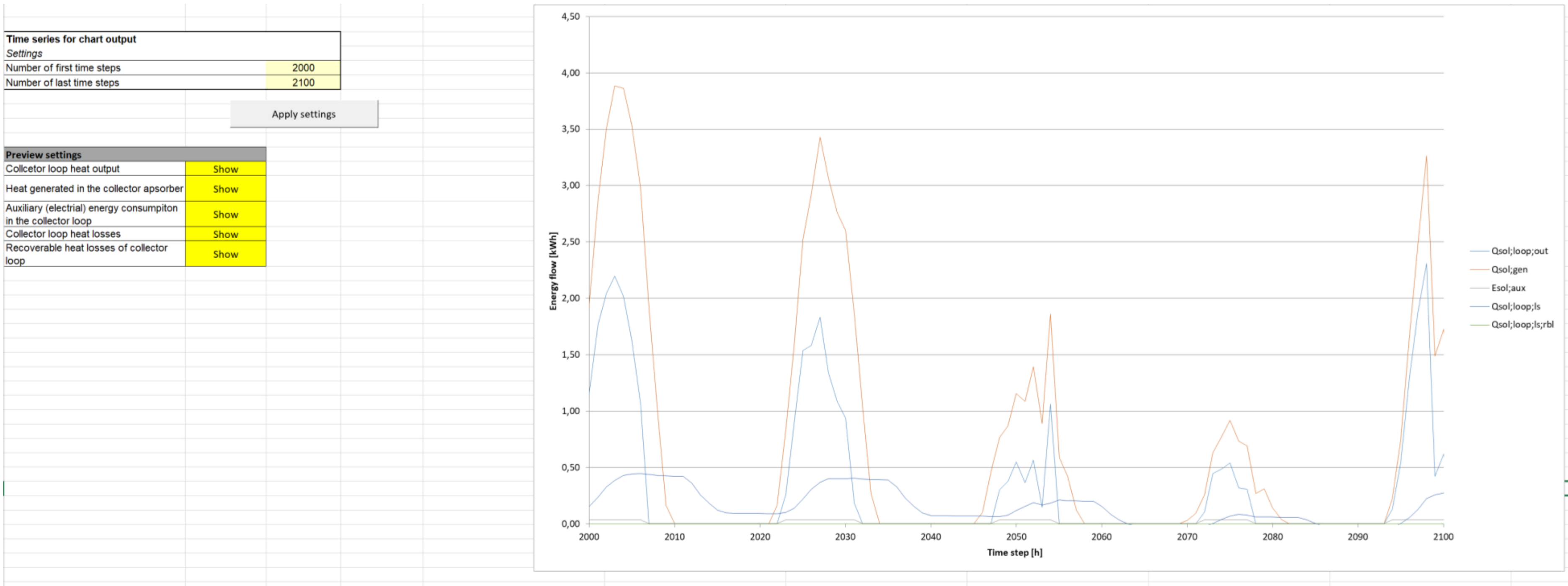
# Example of output data

## Solar system energy flows

| Annual values | | | |
|---|---|---|---|
| Heat generated in the collector apsorber | kWh | $Q_{sol;gen}$ | 5.218,16 |
| Collector heat output | kWh | $Q_{sol;col;out}$ | 3.245,20 |
| Collector loop heat output | kWh | $Q_{sol;loop;out}$ | 2.631,93 |
| Collector loop heat losses | kWh | $Q_{sol;loop;ls}$ | 1.154,46 |
| Recoverable heat losses of collector loop | kWh | $Q_{sol;loop;ls;rbl}$ | 0,00 |
| Average solar collector efficiency | | $\eta_{col,h}$ | 0,46 |
| Auxiliary (electrial) energy consumpiton in the collector loop | kWh | $E_{sol;aux}$ | 125,03 |



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# Example of output data

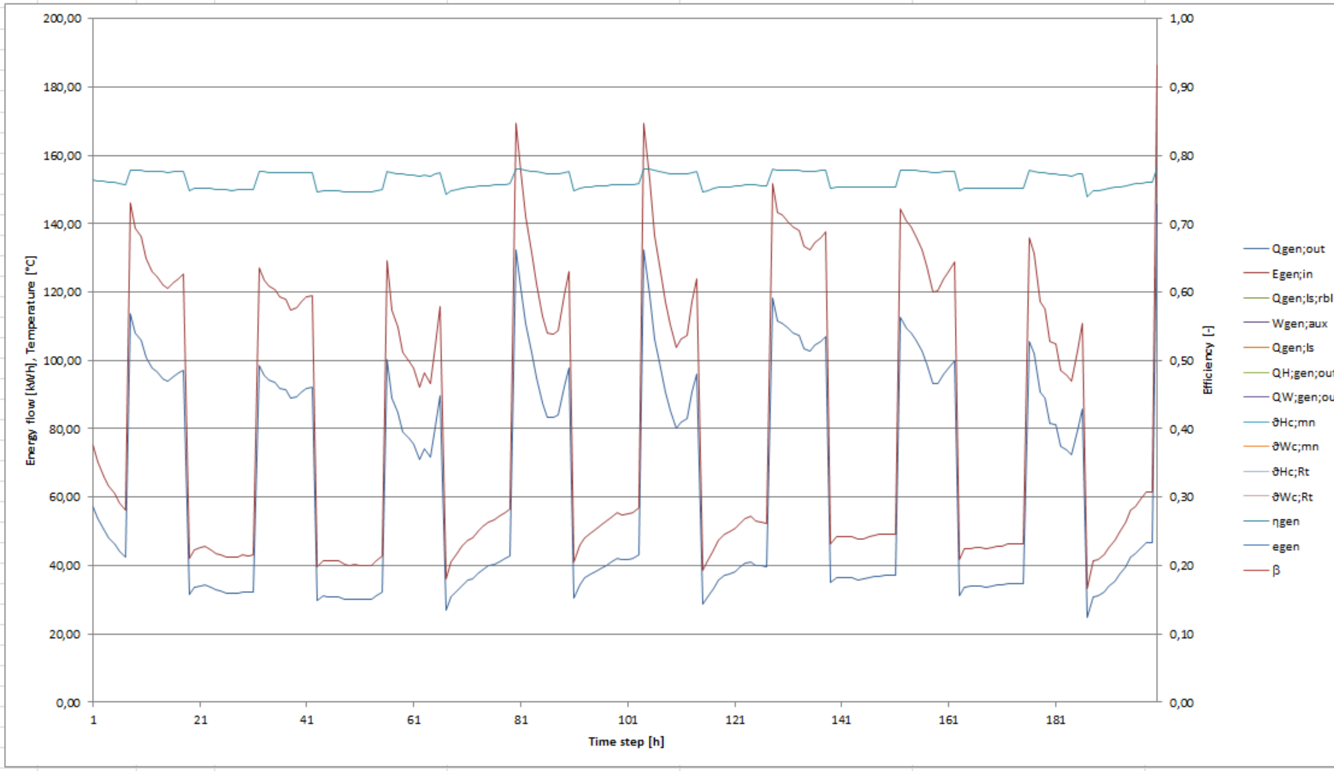
## Hot water boiler energy flows

| Annual values | | | |
|---|---|---|---|
| Generator heat output | kWh | $Q_{gen;out}$ | 1.478,42 |
| Fuel heat input | kWh | $E_{gen;in}$ | 1.928,06 |
| Total heat losses | kWh | $Q_{gen;ls}$ | 450,33 |
| Total recoverable heat losses | kWh | $Q_{gen;ls;rbl}$ | 30,73 |
| Total auxiliary energy | kWh | $W_{gen;aux}$ | 0,91 |
| Total heat output deficiency | kWh | $Q_{gen;bu}$ | 0,00 |
| Total load factor | - | $\beta$ | 0,30 |
| Generator efficiency (gross calorif value) | - | $\eta_{gen}$ | 0,77 |
| Expenditure factor | - | $\varepsilon_{gen}$ | 1,30 |

| Time series for chart output | |
|---|---|
| *Settings* | |
| Number of first time steps | 1 |
| Number of last time steps | 200 |

Apply settings

| Preview settings | |
|---|---|
| Total generator heat output | Show |
| Generator heat output - SH | Dont show |
| Generator heat output - DHW | Dont show |
| Fuel heat input | Show |
| Total heat losses | Dont show |
| Total recoverable heat losses | Dont show |
| Total auxiliary energy | Dont show |
| Generator efficiency (gross calorific value) | Show |
| Expenditute factor | Dont show |
| Load | Dont show |
| Average water temperature - heating | Dont show |
| Average water temperature - DHW | Dont show |
| Return water temperature - heating | Dont show |
| Return water temperature - DHW | Dont show |







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# Example

## Solar hot water system - influence of storage tank volume

**Lowest energy consumption!**

| V=500 l<br>$m_{col}$=0.02 kg/sm² | V=300 l<br>$m_{col}$=0.02 kg/sm² | V=200 l<br>$m_{col}$=0.02 kg/sm² |
|---|---|---|
| $Q_{sto;ls}$= 1.166,23 kWh/a<br>$Q_{H;sto;bu;in}$= 1.125,81 kWh/a<br>$Q_{sol;loop;out}$= 2.840,38 kWh/a | $Q_{sto;ls}$= 935,96 kWh/a<br>$Q_{H;sto;bu;in}$= 1.101,48 kWh/a<br>$Q_{sol;loop;out}$= 2.631,93 kWh/a | $Q_{sto;ls}$= 782,77 kWh/a<br>$Q_{H;sto;bu;in}$= 1.138,71 kWh/a<br>$Q_{sol;loop;out}$= 2.449,12 kWh/a |



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# Example

## Solar hot water systems - influence of $m_{col}$ and $Q_{W;sto,out,req}$

| Basic case | | |
|---|---|---|
| **V=300 l**<br>**$m_{col}$=0.02 kg/sm²** | **V=300 l**<br>**$m_{col}$=0.01 kg/sm²** | **V=300 l**<br>**$m_{col}$=0.02 kg/sm²**<br>**$Q_{W;sto,out;req} = 5.621,04\ kWh/a$ (50% increase)** |
| $Q_{sto;\,ls}$= 935,96 kWh/a<br>$Q_{H;sto;bu;in}$= 1.101,48 kWh/a<br>$Q_{sol;loop;out}$= 2.631,93 kWh/a | $Q_{sto;\,ls}$= 921,32 kWh/a<br>$Q_{H;sto;bu;in}$= 1.119,85 kWh/a<br>$Q_{sol;loop;out}$= 2.604,81 kWh/a | $Q_{sto;\,ls}$= 790,78 kWh/a<br>$Q_{H;sto;bu;in}$= 3.124,03 kWh/a<br>$Q_{sol;loop;out}$= 3.279,03 kWh/a |



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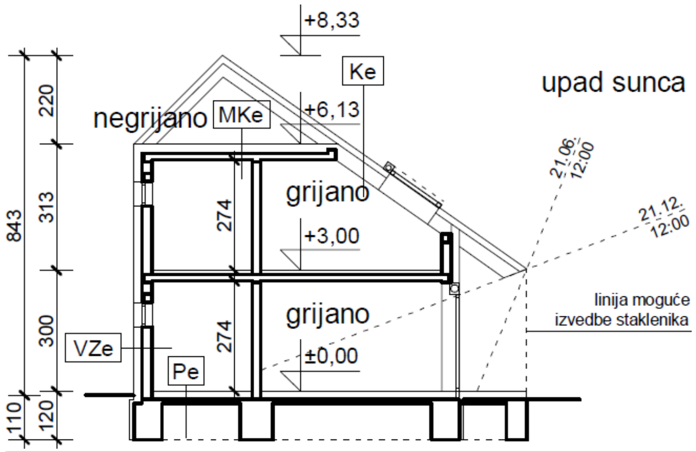
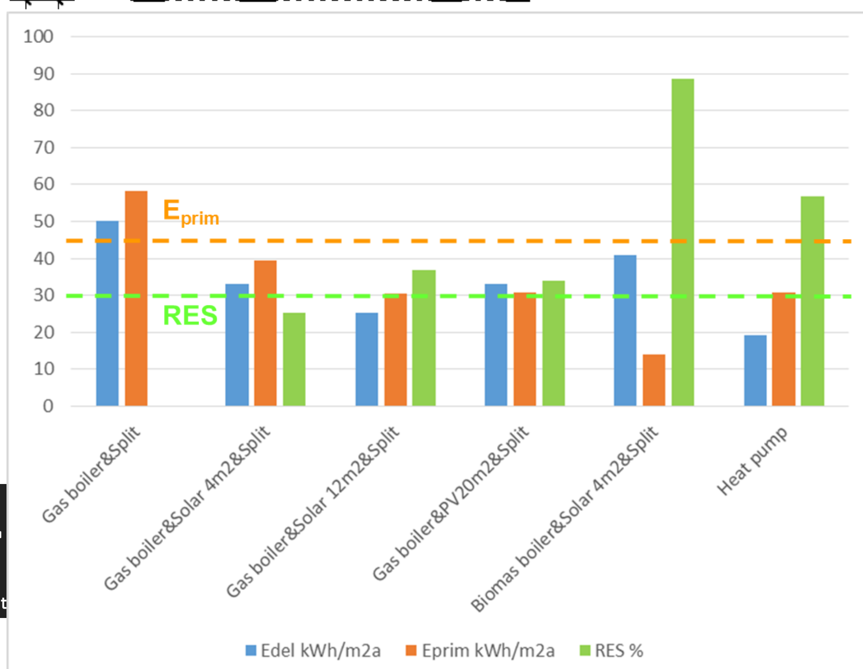
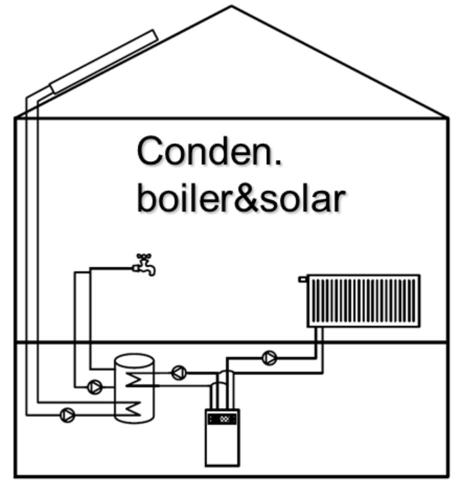
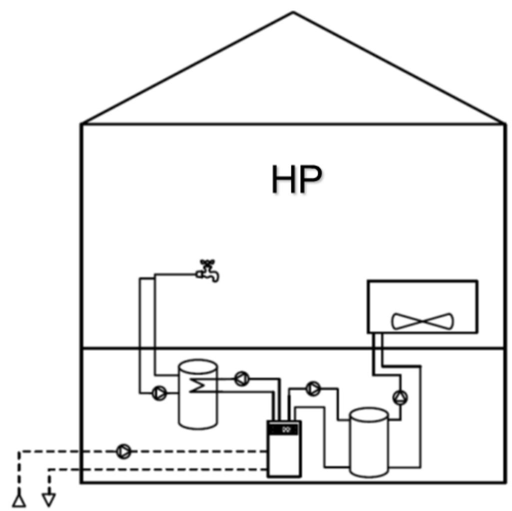
# How?

7. At the end of the training, an integral calculation example will be presented in order to demonstrate use of the standards for design, sizing and energy optimization of the technical system solution



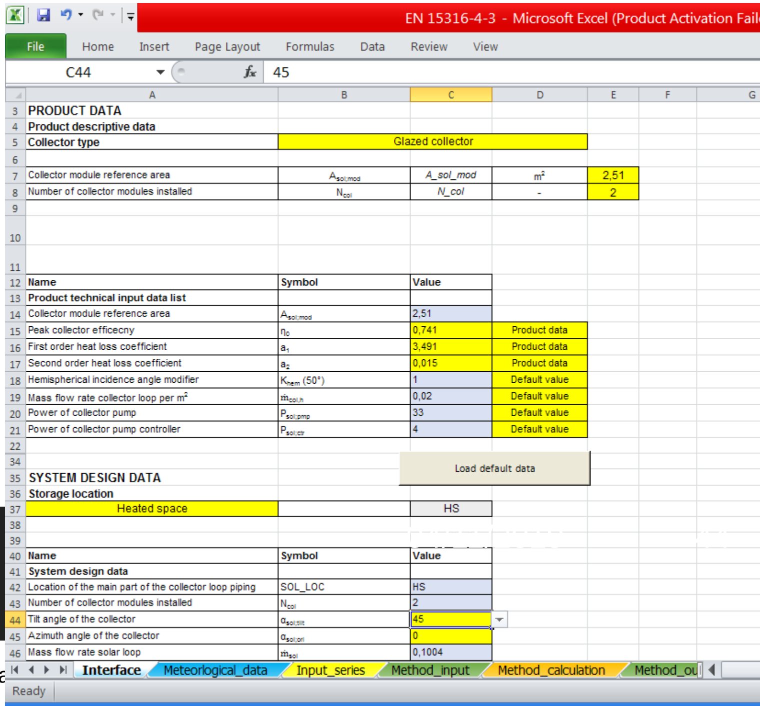




0 research and innovation programme under grant agreement No. 785018

# How?

- The training is interactive
- Trainees participate in training during spreadsheet exercises, by filling in input data for a given example and by performing parametric analysis
- The emphasis in on nZEBs
- At the end of the training each trainee will define heating/DHW system for a given building of nZEB class
- The proposed technical solution will be discussed in light of technical and economical feasibility as well
- The exams consisting of multiple choice questions will be written after each module
- After completition of the training and passing exams for particular Modules, the trainees will be given a corresponding certificate



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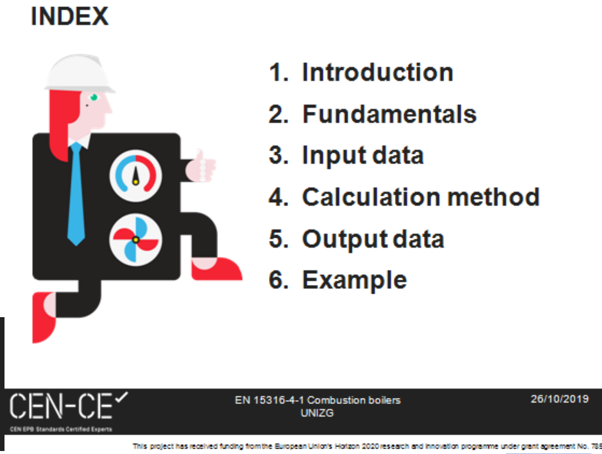
# What?

## Training outcomes

**Provide knowledge – skills – competence – reliability**


## Training materials (for each standard) :

- handbook
- one page presentation of the topic
- ppt presentation with comments for trainers
- spreadsheets with examples to show the main influences and possibilities
- commented input / output list of data
- didactics for trainers (2 pages/standard).
- questions and answers (correct and 3 incorrect answers) for exam (15 questions/standard)




English version of training materials will be translated as primary in French, Italian, Croatian and Slovak language.



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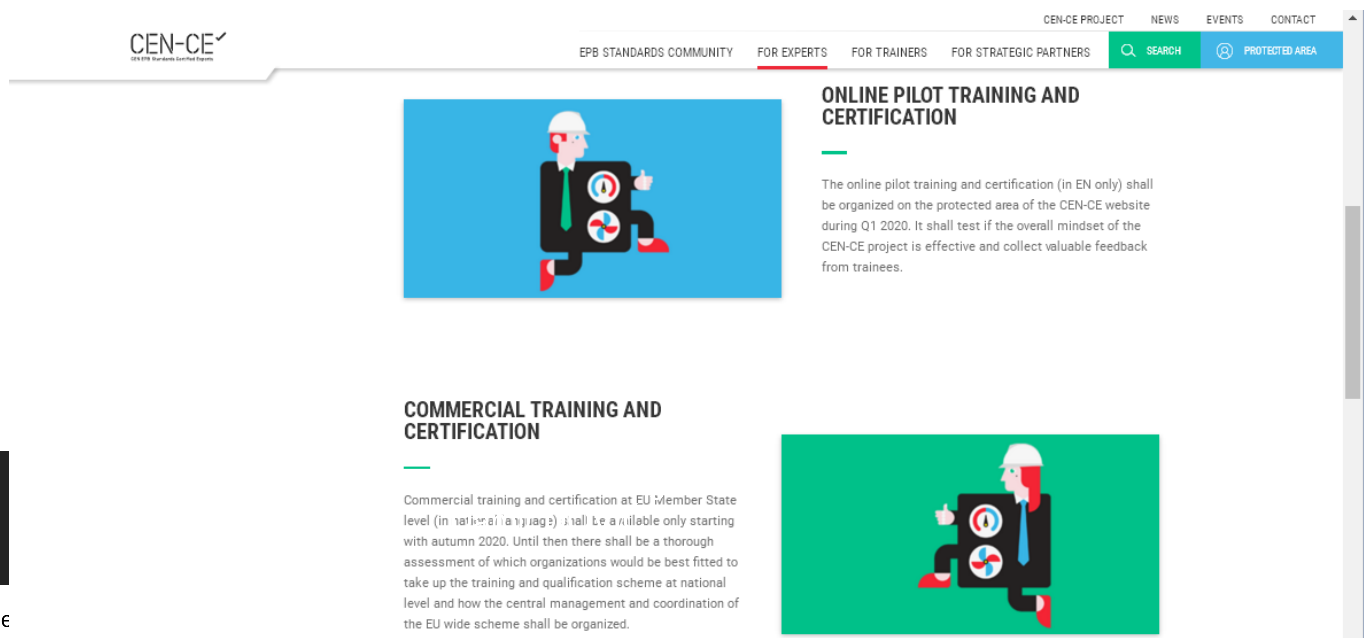
# What?

are the steps of becoming a CEN-CE standards certified expert:

- Application and proof of eligibility (initial competence criteria);
- Undertaking training (competence, knowledge);
- Verification (passing examination);
- Certification & recognition (public list)

**Targeted groups:** designers, installers (level 4 in EQF), engineers, architects, national calculation methodologies developers (level 5, 6 in EQF)

The training and certification is available also online as e-learning.



# Professional tools integrating EPB standards

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SLR

*11h00*



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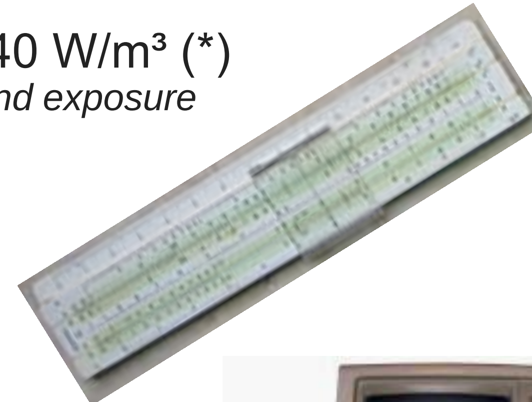
# Background

- **Up to ≈ the years '70** it was just heat load → 20…40 W/m³ (*)
  *(*) values depending on climate, type of building, space position and exposure*
- **Then** the worry was energy need for heating
  → *losses minus useful gains*
- **Then** came primary energy and renewables
- **Now** we care about primary energy
  for all confort services (H, C, W, V, HU/DHU, L, …)
- **Buildings and systems are more an more complex**
- There are new technologies available
- Technical systems are more and more complex
- **Performance requirements are tough**
- **Calculation methods** for legal purposes have to follow to be representative and to evaluate correctly the effect of the various technologies.



**Software calculation tools are needed**



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# Why professional calculation tools

The «***designer***» has two tasks that need calculation:

- **Sizing**: assemble a set of objects and/or devices so that services can be provided even in the worst case operating conditions
- **Energy calculation**: Check how does the whole behave along a reference year of operation and check legal requirements

## Professional tools are needed to facilitate the following steps

- **Description** of the building and systems → graphics input
- Finding **data** about components → integrated data-base
- Performing the **calculation** as required by standards → algorithms
- Presenting **results** and giving feed-back → graphic output
- Checking **compliance** with legal requirements → checks
- Compiling standardized **reports** for legal purpose → XML output *(EPCs, building permits, incentive application, energy audits, …)*


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# Basic tool: hand held calculator

- Totally flexible but no predefined algorithm
- Limited computation capability
- No helpful interface
- No data base
- Elementary output
- Requires experienced user, understanding the topic, and knowing benchmarks
- **Typical application**:
  - **Rough sizing**
  - **Screening** for mistakes of software results (rule of thumb calculation)




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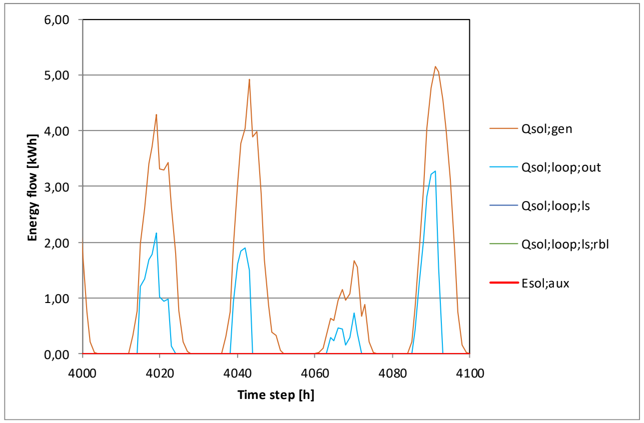
# Experimental tool: Excel sheet

- **Totally traceable**
- Some interface capability
- Some data-base capability
- Hard to calculate an entire building + systems
- Slow calculation compared to software
- **Can be customized** but this requires expertise
- **Typical application**:
  - **Standards development**
  - **Software validation (documenting test cases)**
  - **Teaching and training**
  - Calculation of simple cases
  - Custom design approach

| Product technical input data list | | | | | |
|---|---|---|---|---|---|
| Collector module reference area | $A_{sol;mod}$ | m² | 2,51 | | Default data |
| Peak collector efficiency | $\eta_0$ | p.u. | 0,741 | Product data | 0,800 |
| First order heat loss coefficient | $a_1$ | W/m²K | 3,491 | Product data | 3,500 |
| Second order heat loss coefficient | $a_2$ | W/m²K² | 0,015 | Product data | 0,000 |
| Hemispherical incidence angle modifier | $K_{hem}$ (50°) | p.u. | 0,94 | Default data | 0,94 |
| Mass flow rate collector loop per m² | $\dot{m}_{col,h}$ | kg/s m² | 0,02 | Default data | 0,02 |
| Power of collector pump | $P_{sol;pmp}$ | W | 33 | Product data | 40,06 |
| Power of collector pump controller | $P_{sol;ctr}$ | W | 4 | Product data | 2,51 |
| Collector liquid specific contents | | l/m² | 0,2 | | Load default data |
| System design data | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Latent specific heat | $c_{ev;loop}$ | kJ/kg | 2160,0 | | |
| Maximum latent energy stored | $Q_{coll;sto;max}$ | kWh | 0,9 | | $Q_{coll;sto;max} = \frac{c_{ev;loop} \times m_{coll;w}}{3600}$ |
| Loss factor at boiling temperature | $a_{\theta;coll;boil}$ | W/mK | 5,6 | | $a_{\theta;coll;boil} = a_1 + a_2 \times (\theta_{coll;boil} - \theta_e)$ |
| Radiation needed to keep boiling | $I_{\theta;coll;boil}$ | W/m² | 1161,5 | | $I_{\theta;coll;boil} = \frac{a_{\theta;coll;boil} \times (\theta_{coll;boil} - \theta_e)}{\eta_0 \cdot K_{hem}}$ |
| Radiation during the hour | $I_{sol;h}$ | W/m² | 0,0 | | |
| Stored energy change | | | | | |
| Net solar irradiance above boiling | $I_{sol;ev}$ | W/m² | 0,0 | | $IF\ COLL\_STA_{h-1} = TRUE:\ I_{sol;ev} = I_{sol} - I_{\theta;coll;boil}$ <br> $IF\ COLL\_STA_{h-1} = FALSE:\ I_{sol;ev} = 0$ |




**Nowadays Excel = Manual calculation**

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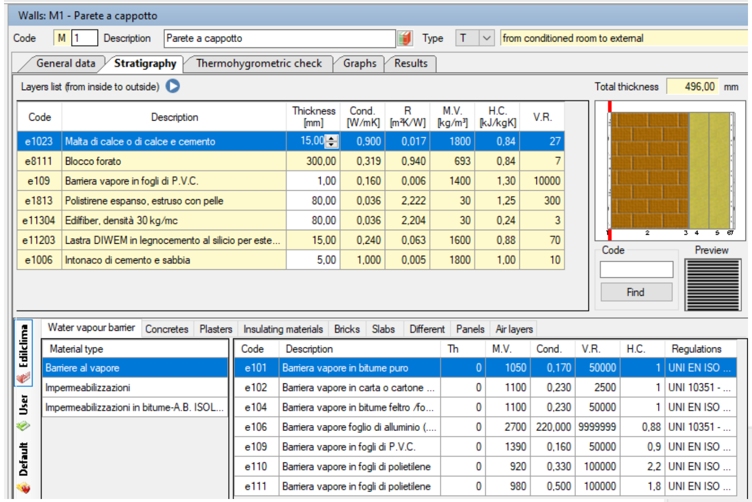
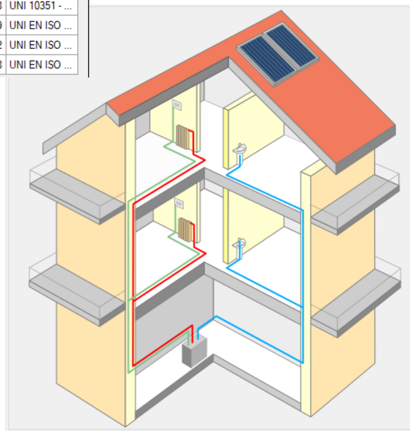
# Professional tools: application software

- Well developed interfaces
- Integrated databases
- Fast calculation
- Little modeling skills required
- Declared algorithms
- Some countries require validation
- Cannot be customized beyond integrated options
- **Typical application:**
  - **Professional productive use**
  - **Energy performance calculation** of any type building



***Professional software is developed for methods in use in a country (need a market)***

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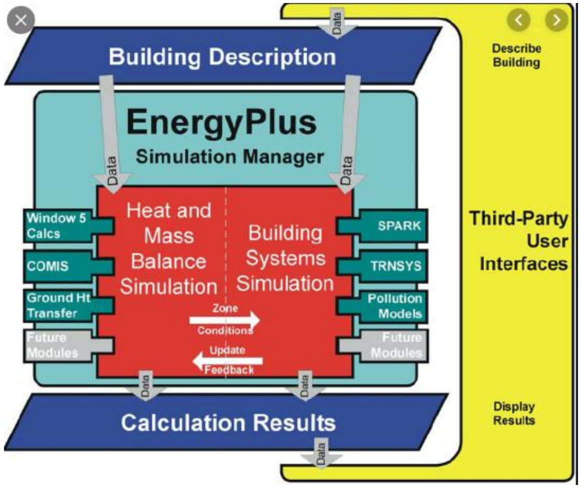
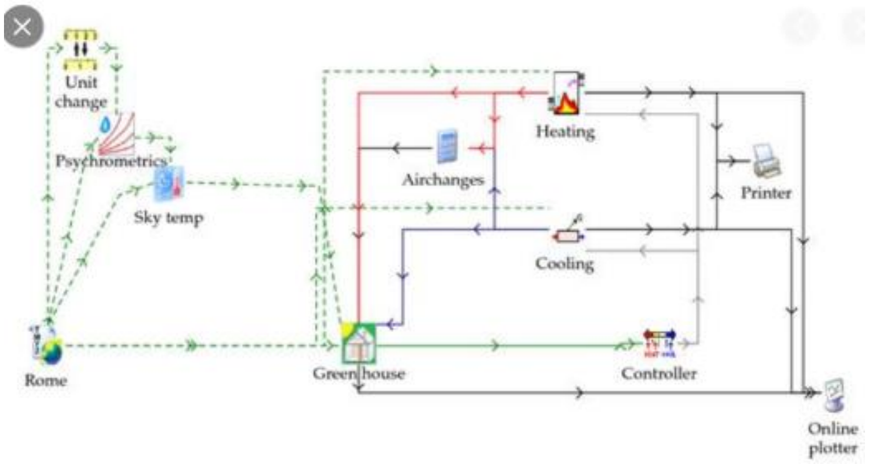
# Simulation tools (E+, TRNSYS, …)

- General purpose scientific tools
- Text interface or third party interface
- Little traceability, a lot of “black boxes”
- Applies its own algorithm or to be programmed
- Not linked to data bases
- Long calculation time
- Each case shall be developed on its own
- Expert modeling skills required
- Generally intended to cover either building physics or systems
- **Typical application:**
  - **Research**
  - **Design of specific comfort solutions**







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# EPB standards: software-proof and regulation-fit

**EPB standards are intended to support energy performance regulation and the required application software. DTR (CEN-TS 16629:2014) established a set of rules for that purpose.**

| Objectives | Solution |
|---|---|
| Software proof modules | Demonstration Excel |
| Tested links between modules | Software tool |
| | Processing several modules together |
| Use for regulation | Traceable equations |
| | Traceable options |
| Application software validation | Demonstration excel to build and document test cases |
| Connecting with data bases | Type of input data |



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# The link between software and EPB standards

- Without **professional software**, no energy performance calculation scheme can be applied effectively.
  XLS tools are limited to algorithm testing, test case development and software validation.
- It is a big investment to develop a professional energy performance calculation software from scratch (some millions Euros) and then you have to maintain and update it and support users.
  You need a significant market to pay the effort
- An EPB professional software is likely to be developed if a large EU country adopts EN-EPB standards

  EXAMPLE of such a country: Italy
  - Software based on EPB standards is already being developed
  - Already available: hourly method for needs, systems configuration, etc


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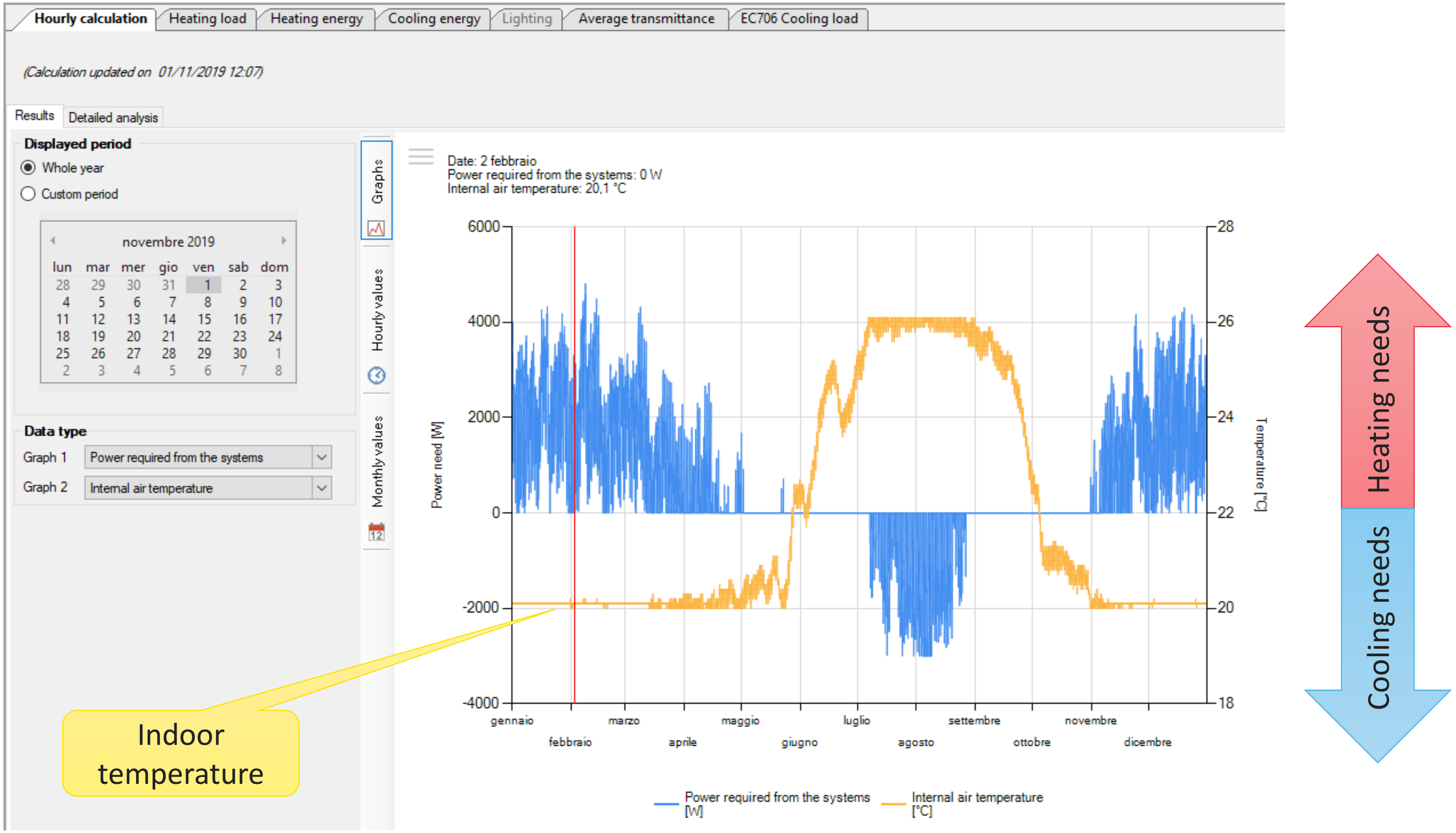
# Hourly needs calculation according to EN 52016







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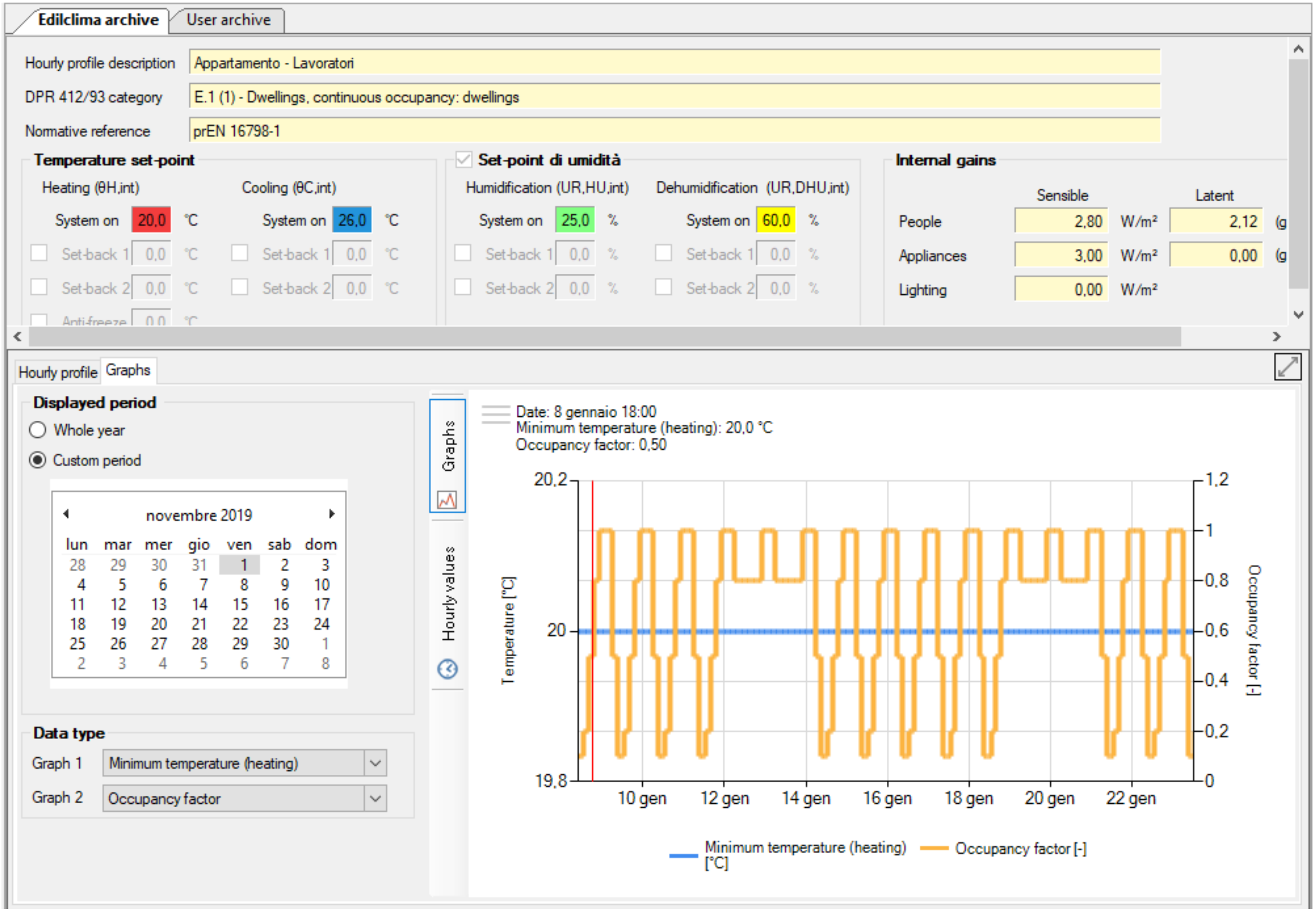
# Defining hourly profiles




**Defining hourly operating conditions means selecting the room category, just like monthly.**

**If needed , profile can be easily tailored for audit purpose**

**The graph gives the feed-back**



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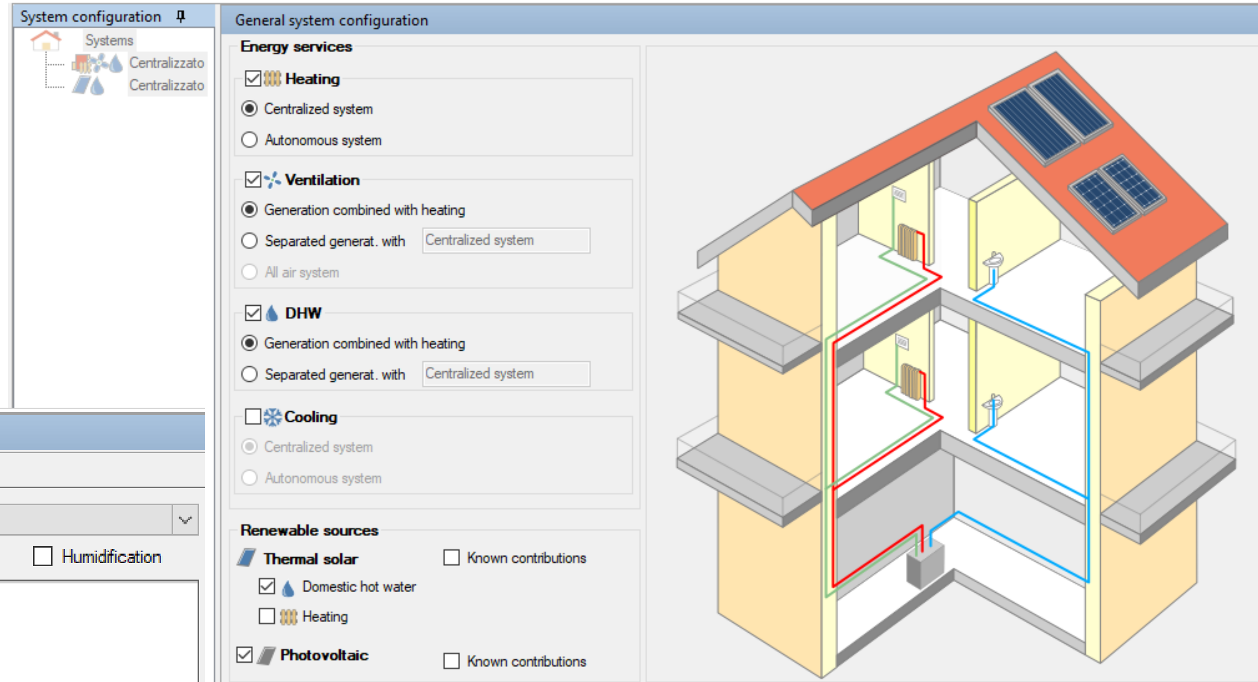
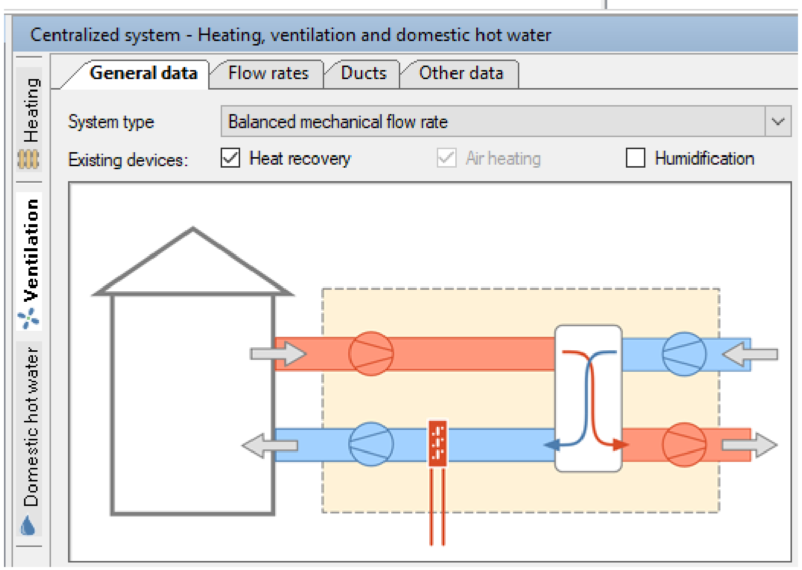
# Technical system configuration

General configuration of systems for all services




Detailed configuration of system for each service



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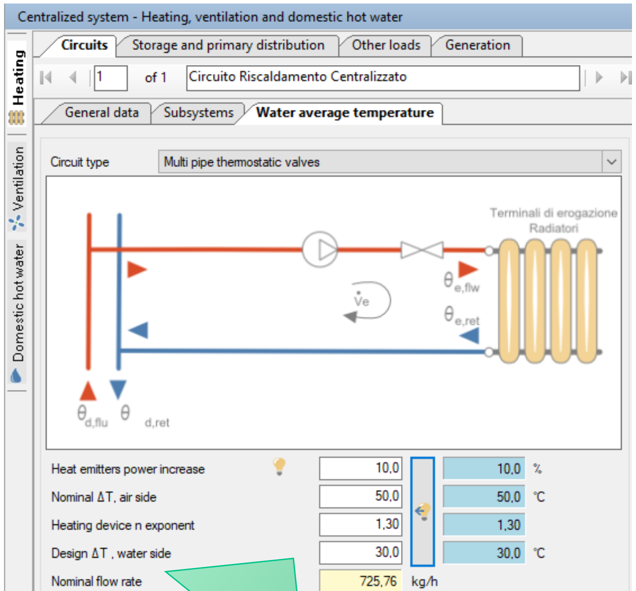
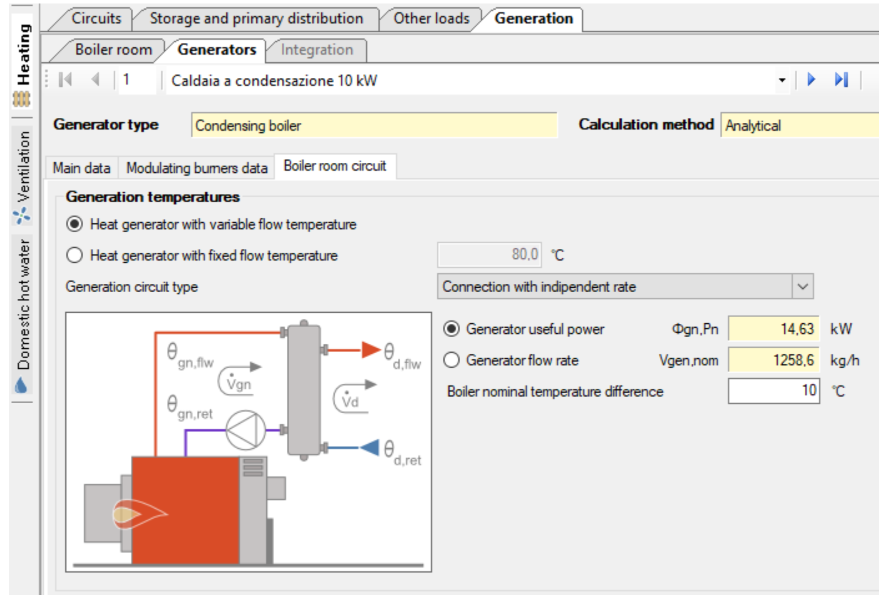
# Calculation of operating conditions: EN 15316-1

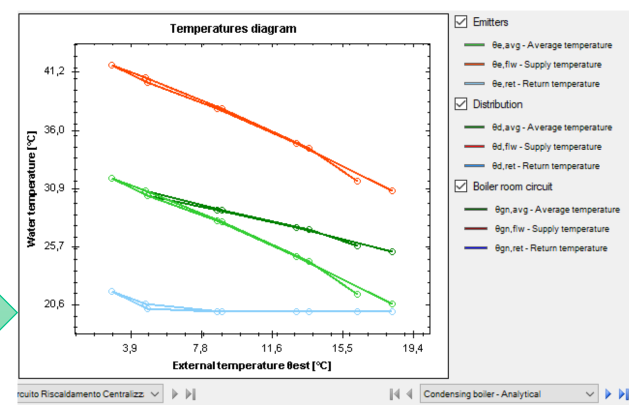



1: Emission and control configuration

2: Generation configuration

3: Operating conditions em, dis and gen temperatures



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# Calculation tools are just big calculators

**An energy performance calculation software is just a big calculation machine with an extended keyboard**

- **Who uses a calculation tool** …
  - **shall know** which is the right **input data**
  - **shall always be aware of what is calculated and how**
    → *check intermediate and final results to keep control*
- **The calculation tool**
  - **Shall have a clear interface** to facilitate use …
    "*An interface, if you have to explain it, then it is wrong…*"
  - **Shall give adequate feed-back** so that
    the user knows what's going on and
    is always in control of the calculation procedure (avoid black box)



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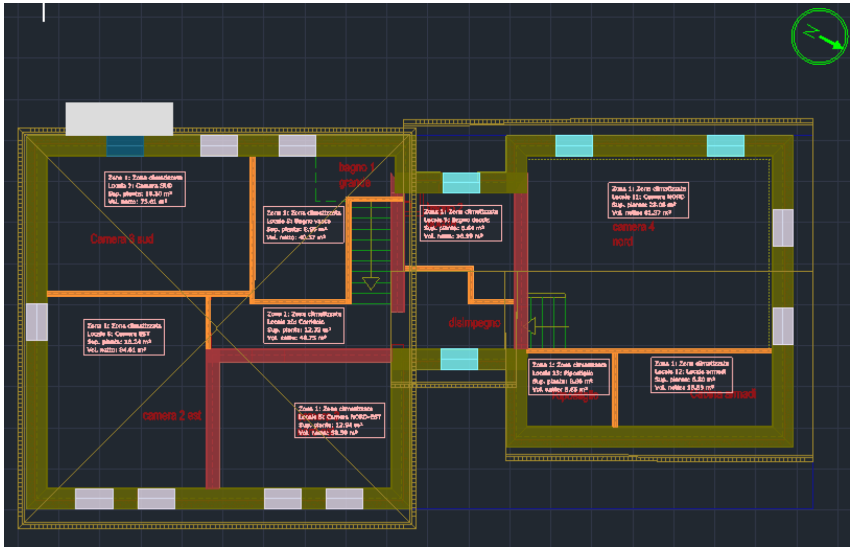
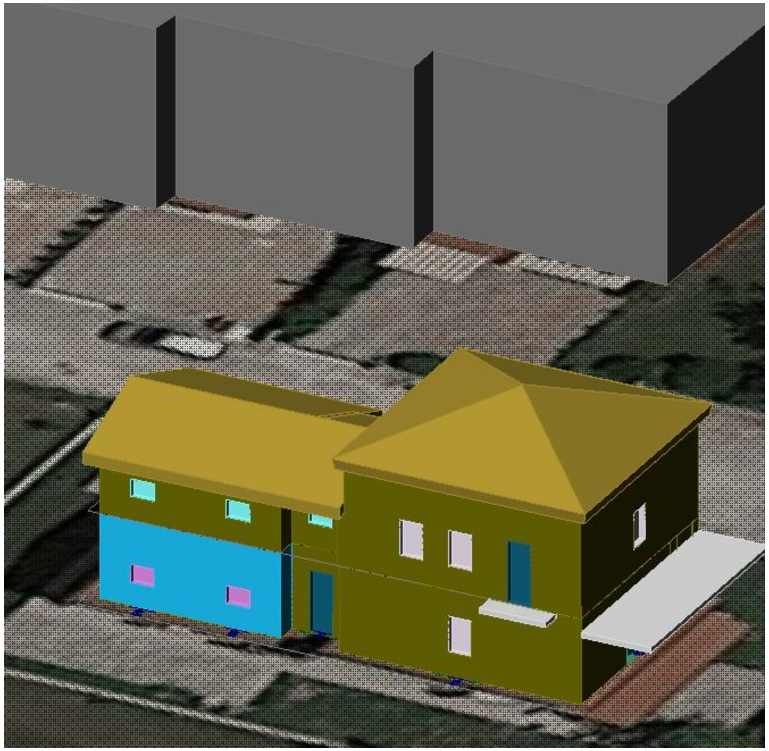
# Clear interface…





Drawing 2D with a drawing
in the background.
Simple input of building description.
Less mistakes in inserting building
elements length and area

Result is presented 3D
Feed-back on what has been input
in 2 D like overhangs
and neighboring buildings
Plot on Google maps top check
orientation and obstructions



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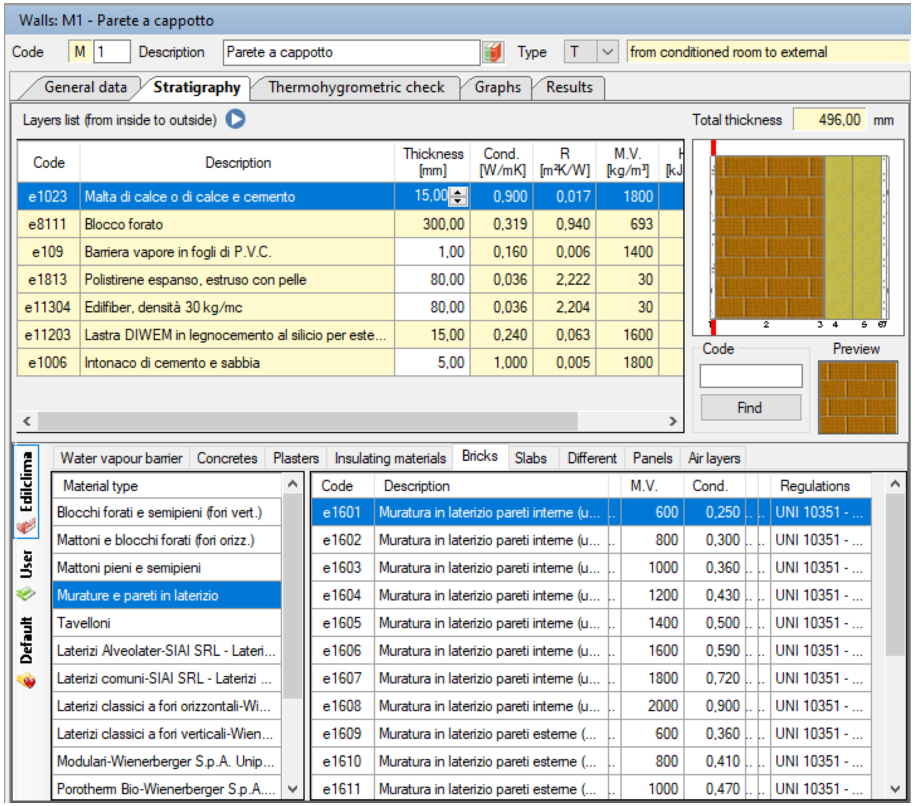
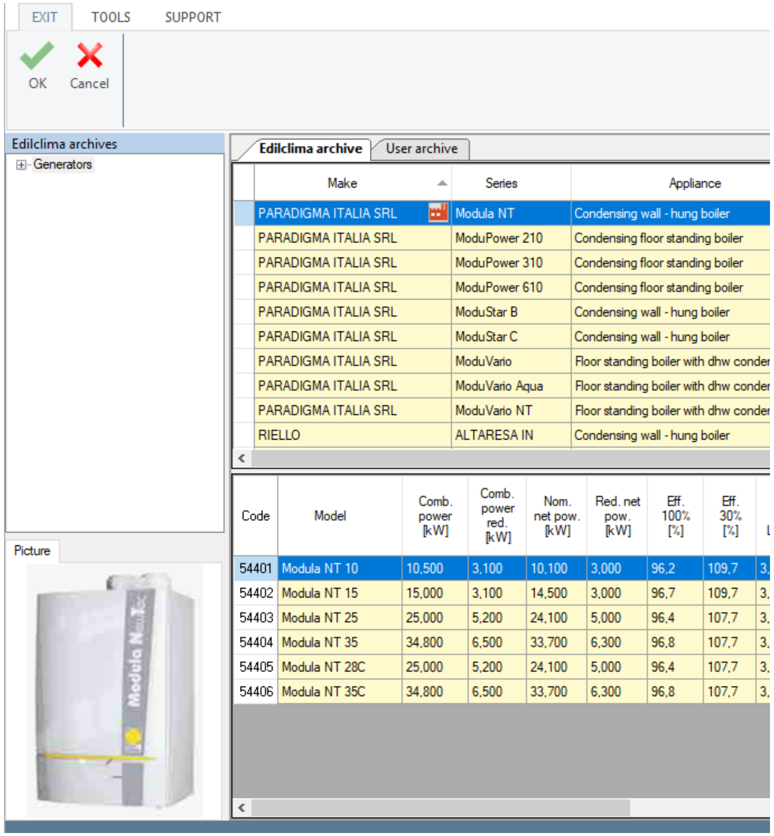
# Data base…




Data base may include simple materials properties and entire product description
Reduced risk of wrong input, **connection with manufacturer data (EPREL?)**



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# What is the software doing?

To get the correct results you need to apply …

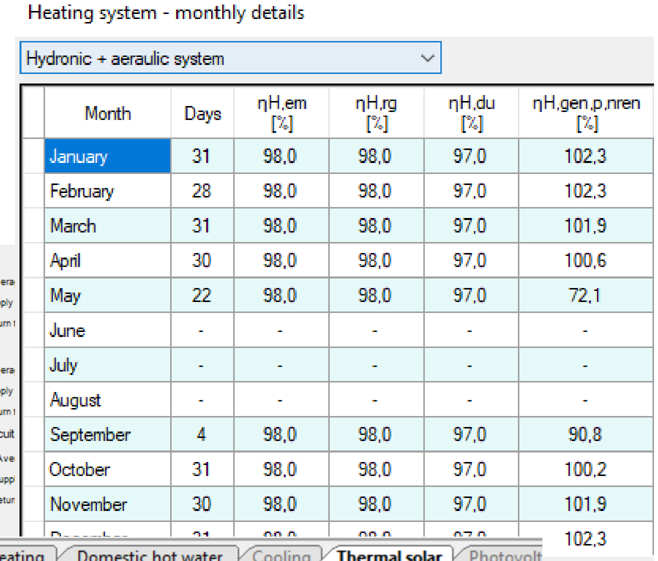
- the right calculation
- to the right input data

Validation of software

- gives some confidence that algorithm is correct
- but doesn't protect against wrong input

**The user is responsible for input**

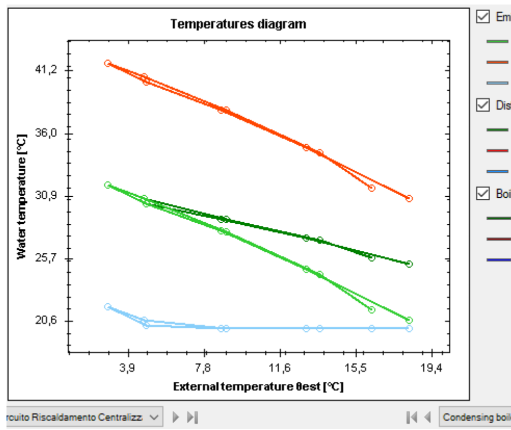
- **A good interface** prevents wrong input (feed-back, checks)
- **A good training and experience** are needed to identify the right input and reduce the risk of mistakes

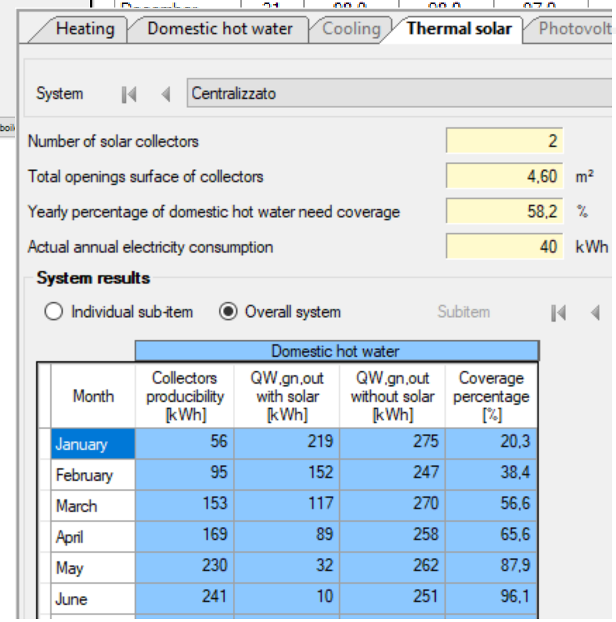


Heating system - monthly details

Hydronic + aeraulic system

| Month | Days | ηH,em [%] | ηH,rg [%] | ηH,du [%] | ηH,gen,p,nren [%] |
|---|---|---|---|---|---|
| January | 31 | 98,0 | 98,0 | 97,0 | 102,3 |
| February | 28 | 98,0 | 98,0 | 97,0 | 102,3 |
| March | 31 | 98,0 | 98,0 | 97,0 | 101,9 |
| April | 30 | 98,0 | 98,0 | 97,0 | 100,6 |
| May | 22 | 98,0 | 98,0 | 97,0 | 72,1 |
| June | - | - | - | - | - |
| July | - | - | - | - | - |
| August | - | - | - | - | - |
| September | 4 | 98,0 | 98,0 | 97,0 | 90,8 |
| October | 31 | 98,0 | 98,0 | 97,0 | 100,2 |
| November | 30 | 98,0 | 98,0 | 97,0 | 101,9 |
| | | | | | 102,3 |



Heating | Domestic hot water | Cooling | Thermal solar | Photovolt

System Centralizzato

| | | |
|---|---|---|
| Number of solar collectors | 2 | |
| Total openings surface of collectors | 4,60 | m² |
| Yearly percentage of domestic hot water need coverage | 58,2 | % |
| Actual annual electricity consumption | 40 | kWh |

**System results**

Individual sub-item / Overall system / Subitem

| Month | Domestic hot water: Collectors producibility [kWh] | QW,gn,out with solar [kWh] | QW,gn,out without solar [kWh] | Coverage percentage [%] |
|---|---|---|---|---|
| January | 56 | 219 | 275 | 20,3 |
| February | 95 | 152 | 247 | 38,4 |
| March | 153 | 117 | 270 | 56,6 |
| April | 169 | 89 | 258 | 65,6 |
| May | 230 | 32 | 262 | 87,9 |
| June | 241 | 10 | 251 | 96,1 |

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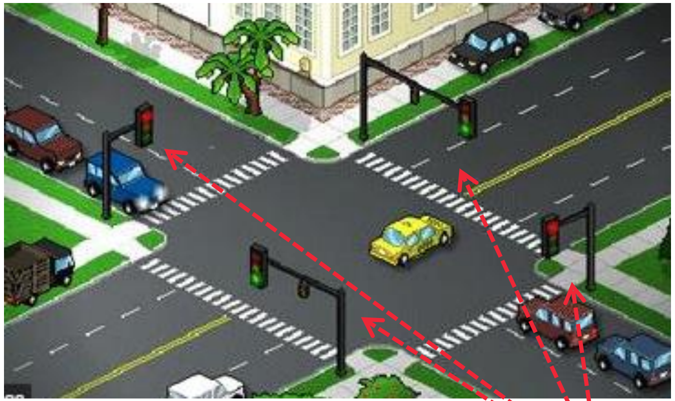
# The principle: parallel, asymmetric processing

Case study: **PLCs and safety**
(traffic lights, oxygen control, etc.)

«*Safety Integrity Level*»
SIL required for safety critical tasks



**Basic approach**: 2 identical PLCs.

- Protects again hardware failures
- Doesn't protect against software issues and failures

**Better approach**: 2 different PLCs with different software shall produce the same results/commands.

- Protects against hardware failures *(sync needed to avoid false errors)*
- Good for software issues and failures: it's very unlikely to have the same mistake in two different software programmed by two different people



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# Parallel, asymmetric processing in action…

**Processor 1**
**Software**

Strictly obeys to input and algorithm
No fantasy
No initiative
No awareness
Damn fast
Can handle tons of details
**Shall be programmed**
Doesn't learn from experience
(… not yet)

**For optimum performance they have to work in parallel**

**Processor 2**
**Brain**

Evaluates input
Has fantasy
Has initiative
Can invent new solutions
Should be aware
Damn slow in calculation
Can handle few numbers
**Shall be trained**
Learns from experience
(… not always)



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# Procedures, software and training

- **Professional software** based on standards is required for massive application, e.g.  EPCs and building permits production.
  This is coming in countries that are going to use EPB standards
- **When selecting software…**
  … look for ease of input, data base availability and user feed-back
- **When using software, keep your brain on-line**:
  always check if intermediate results are consistent
  and final result is plausible (parallel asymmetrical processing)
- **Be prepared and trained to understand what happens**
  **Training is the key to maximize the benefit of experience…**

**Procedures and software do not replace expertise**
Standards, tools and software may help experts, suggest values, guide calculation, define and perform detailed and complex algorithms but there is no automatic design or energy calculation software (at least not yet…)



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# Conclusion and summary

- **Calculation tools** are needed to support HVAC design activities
  → software
- **Setting legal requirements** requires
  → traceable and comprehensive methods
- **EPB standards** are designed to be software proof and unambiguous
- **Professional software** is the right level of tools for productive use
- **A market** where EPB standards will be used already exists.
  Professional software based on EPB standards
  is already under development there
- **Software is a tool**,
  → it has to be user friendly and give clear **feed-back**
- **Professionals** using software tools shall keep control of calculations
  → **experience and training**



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# Online pilot training and e-learning


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REHVA
Federation of European Heating, Ventilation and Air Conditioning Associations


*11h10*




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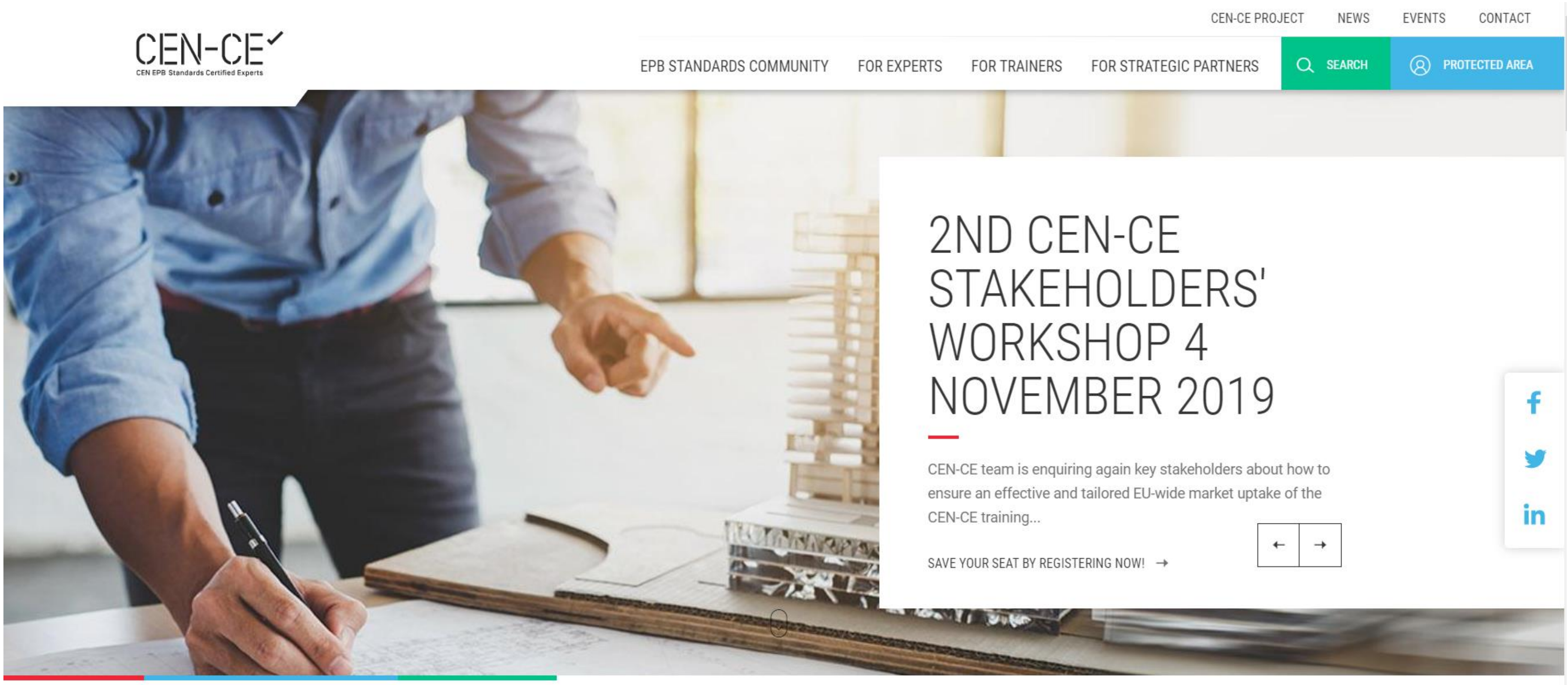
# CEN-CE website







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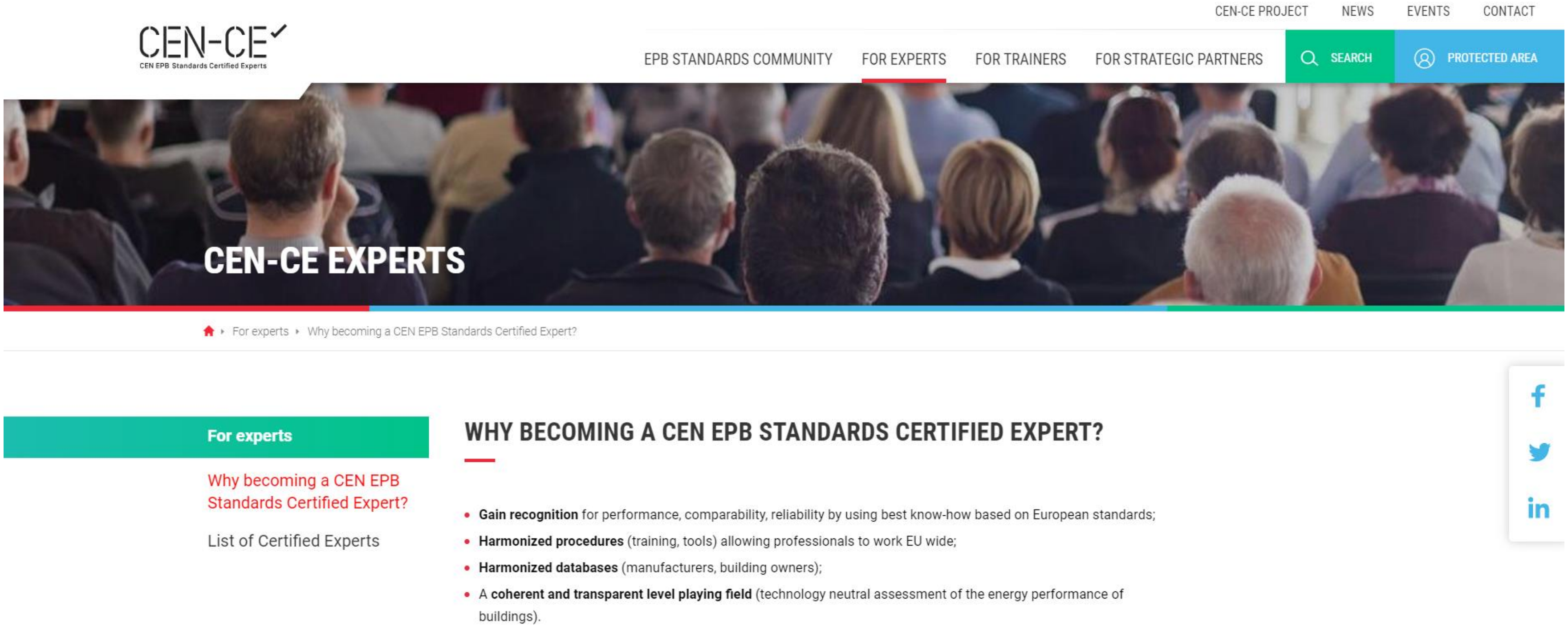
# CEN-CE online pilot training and certification



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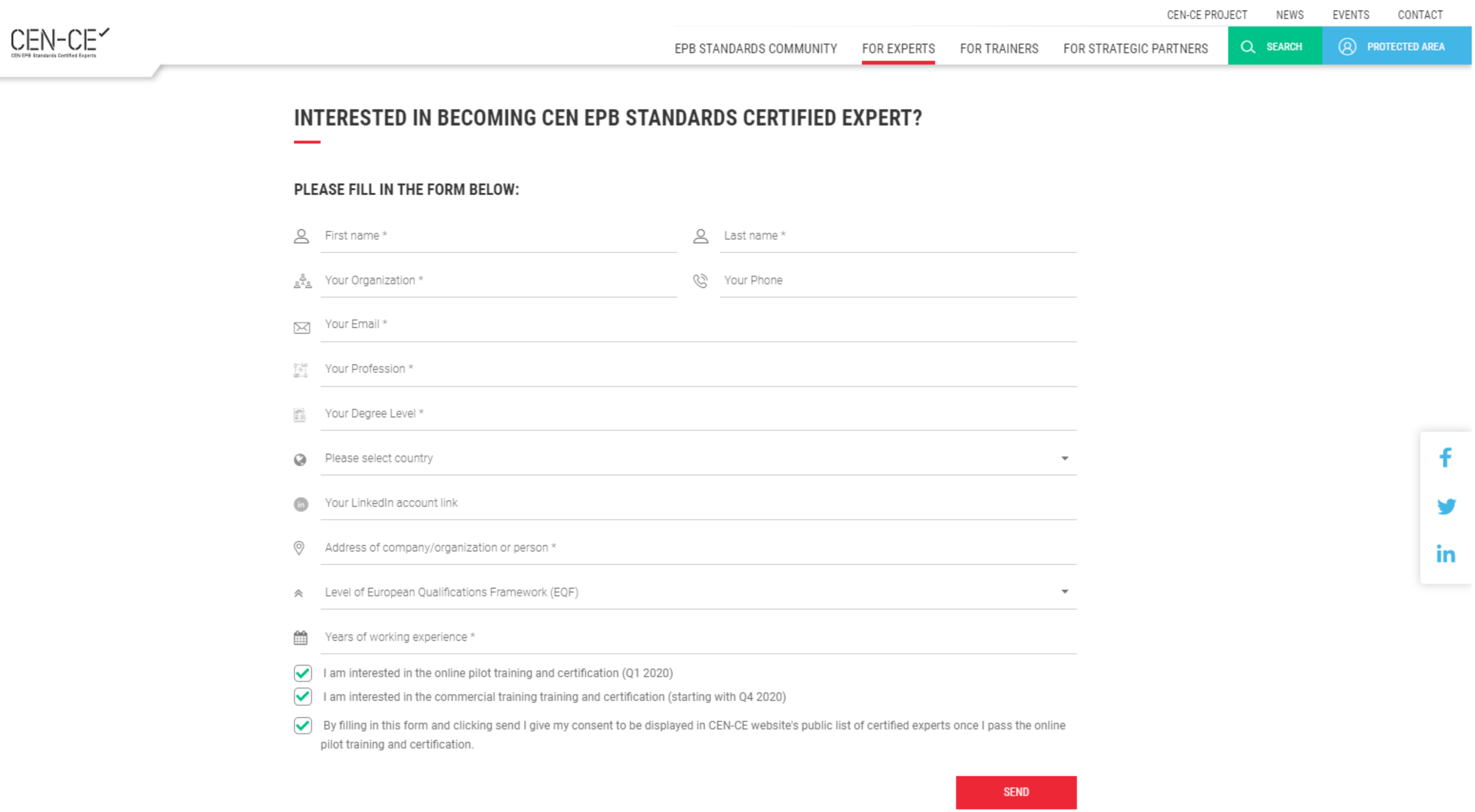




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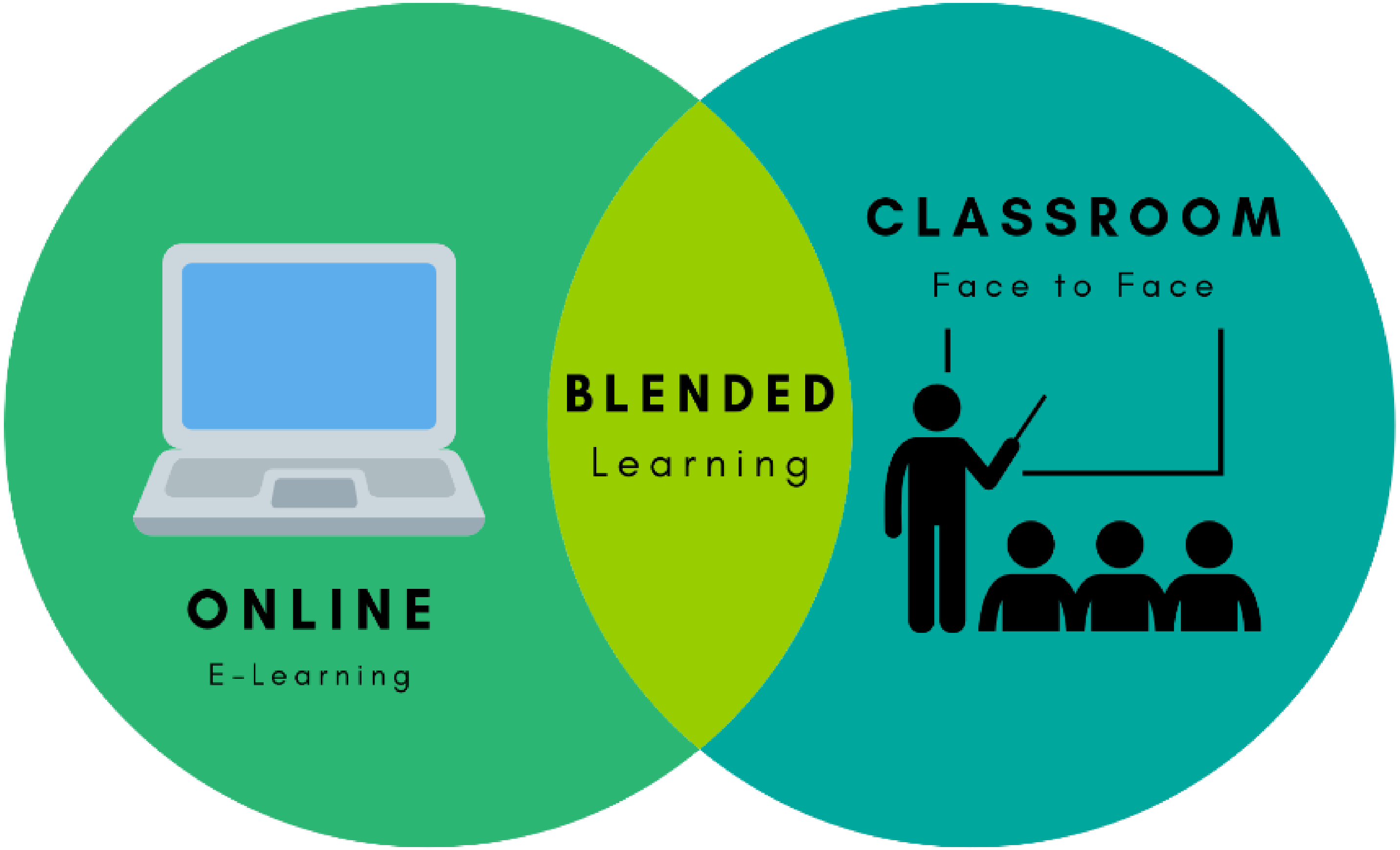
# CEN-CE e-learning tailored to needs of SMEs







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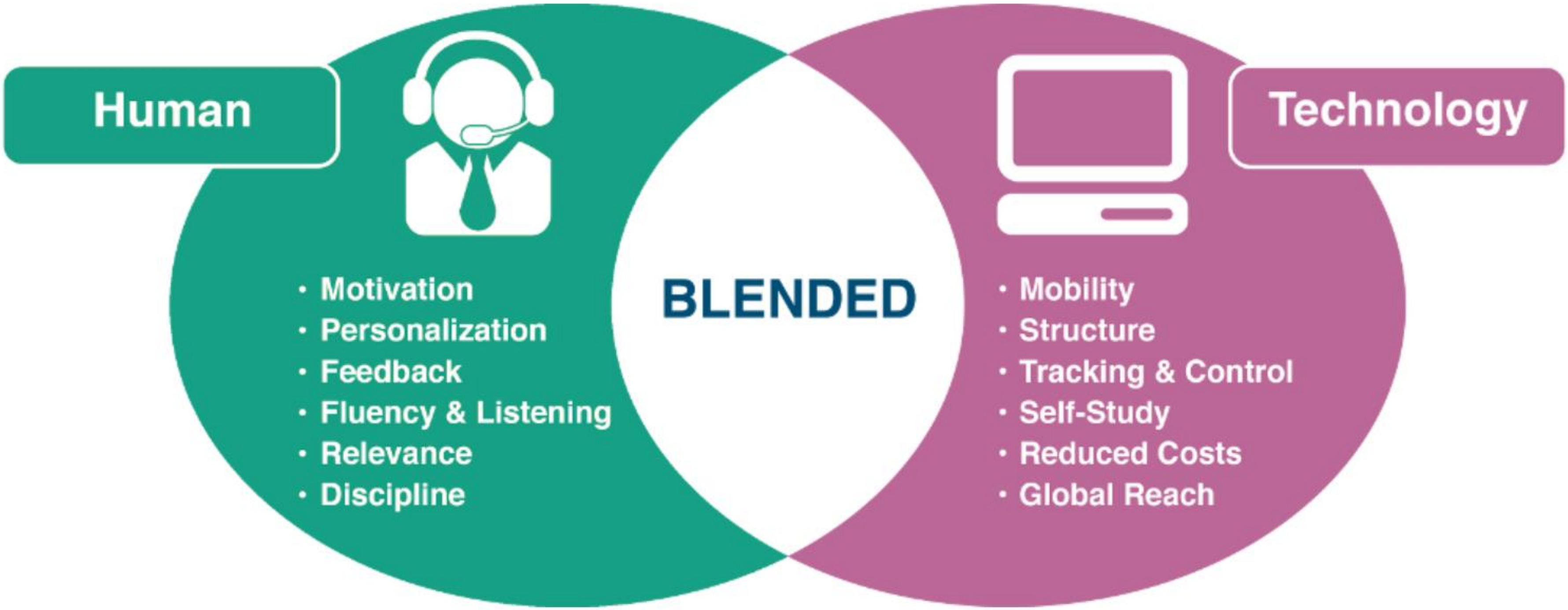




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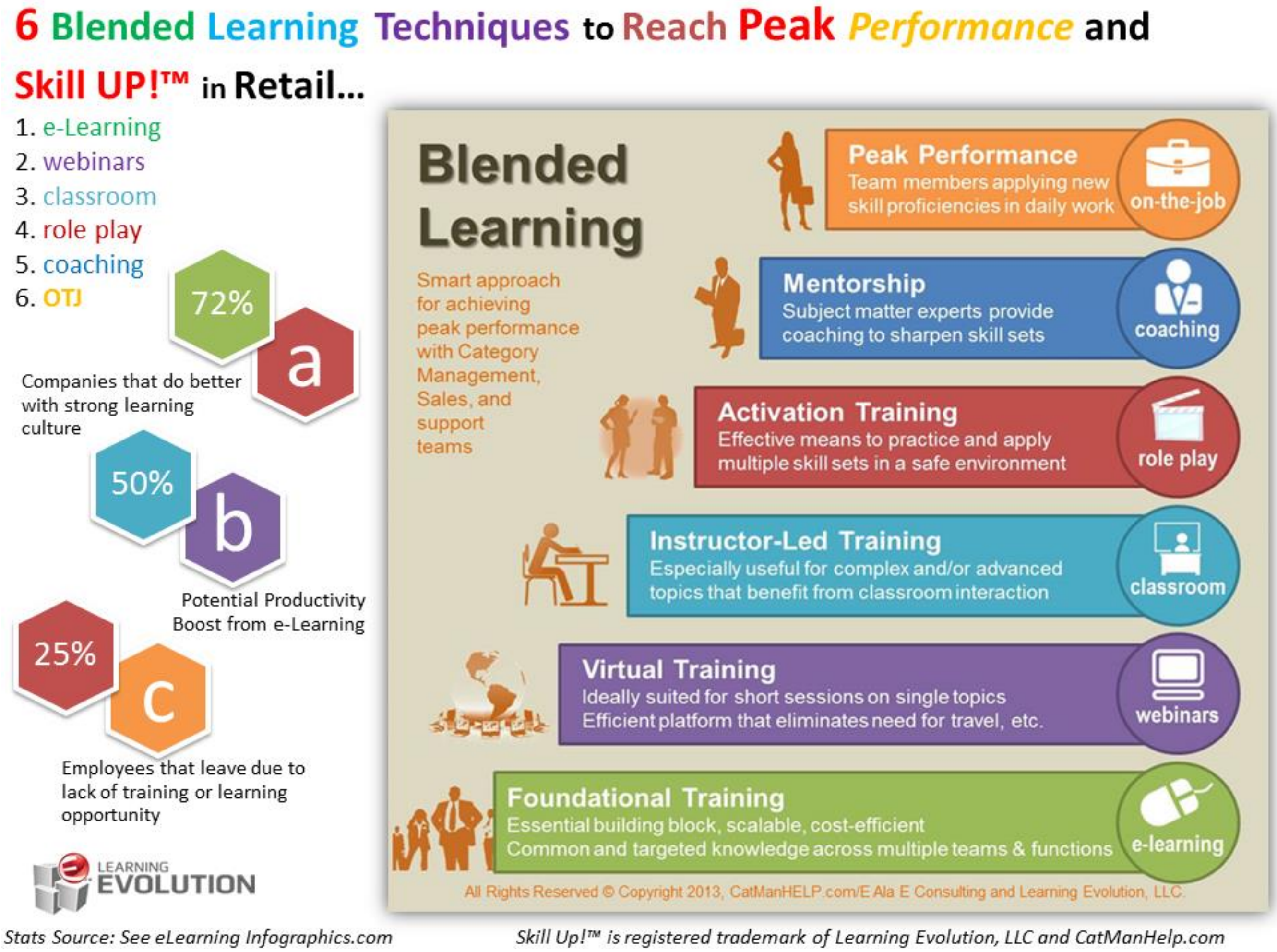




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# EU-wide building performance e-learning ?!



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# Live poll



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# Open discussion



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# CONTACT

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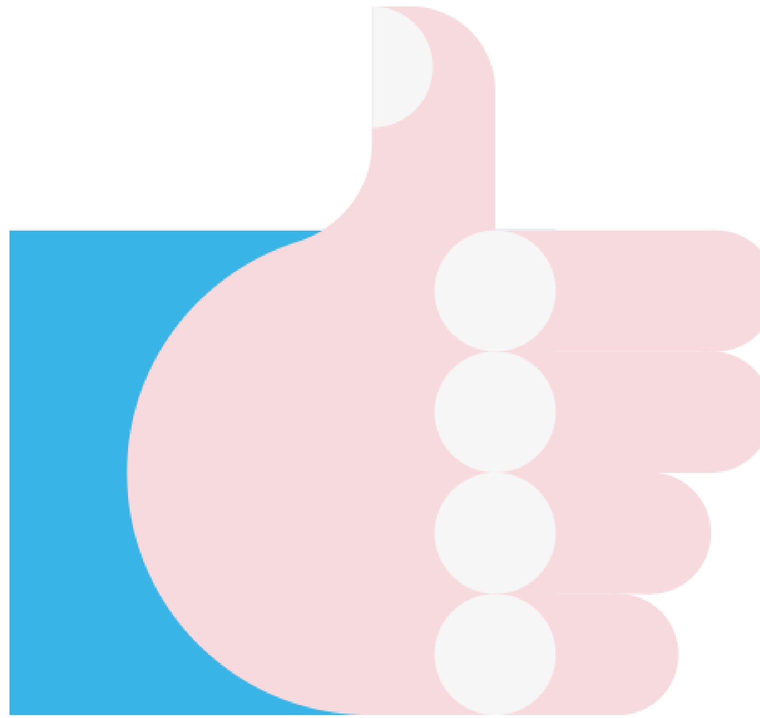
# THANK YOU!



CSTB le futur en construction

ENBEE Environment & Building Energy Efficiency

FSB

REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

SLR

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CEN-CE

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