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Special issue

CEN-CE project

CEN-CE
CEN EPB Standards Certified Experts

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Contents

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COVID-19 and Climate crises

– a new reality to focus on the European Green Deal

Last year the main focus was on improving the energy performance of buildings. Reducing the use of fossil fuels and the direct and indirect CO_2 emission of buildings caused by heating, cooling and ventilating and at the same time improving or safeguarding the indoor environmental quality.

And yes, for those looking at the overall environmental impact of buildings, the overall reduction of the environmental footprint of buildings their systems and use by inclusion of issues like: durability, upgradability, ability to repair and Re-Use, ability to re-manufacture, recyclability, recoverability, and the use of recycled materials.

Health of the world population is currently of greater concern. All attention of our actions is focussed on preventing further spread, controlling the effect of the COVID-19 virus and how to overcome the economic impact of this epidemic. It is now the challenge to combine actions to improve the Energy Performance of Buildings (EPB) and the Indoor Environmental Quality (IEQ) as uptake of all energy saving and CO_2 reduction programs as planned before. The danger for the Climate crisis will not go away because we have to focus on safeguarding our health.

What does this mean for the professional HVAC community? We have to act, safeguard a healthy indoor environment. An indoor environment where the infection risk is minimal due to the correct use of ventilation and air conditioning systems. A first priority is to have a safe indoor environment in workplaces, office buildings, schools, nursing homes, hotels, etc. In most areas people slowly return from their homes to those places where more persons are working together with the now usual hygiene measures and at a lower density. The REHVA Task Force on COVID-19 prepared guidance on how to operate and use building services to prevent the spread of COVID-19, see: www.rehva.eu/activities/covid-19-guidance.

The REHVA TF should also look to the future, by answering questions on the design, renovation and maintenance of airborne virus proof building service systems. All Air systems where air is used not only for ventilation but also for energy transfer and by consequence require a considerable recirculation rate are not a strong European design practice. They are not energy efficient and do not offer the possibility to stop central recirculation. Renovation of these systems will serve the EPB and IEQ at the same time.

We need to develop proposals that enable the transition to remain on course in the short and longer term. Implementing the European Green Deal is the best way to green recovery, recovery measures should boost demand and encourage investment. We need a trampoline for renewed activity. Implementation of the national climate agreements provides an investment impulse of billions of euros in the economy. That money does not go to the import of fossil fuels, but to labor-intensive companies in the Europe.

The new reality brought about by the COVID-19 health crisis has reinforced the need to align the climate goals of the European Green Deal with the much-needed economic recovery efforts to build a more resilient, robust and sustainable EU economy. ■

JAAP HOGELING
Editor-in-Chief
REHVA Journal

Interview on new challenges of HVAC professionals

CEN-CE Interview on new challenges, common methods and EU wide upskilling of HVAC professionals with Emeritus Professor Francis ALLARD.

FRANCIS ALLARD
Emeritus Professor, La Rochelle University, Chair of the International Committee of AICVF, the French HVAC association

CEN-CE: There will be a huge financial support from the European Commission via the Green Deal. A building renovation roadmap is announced. New challenges are nearly Zero Energy Building (nZEB) and low carbon footprint. What could be in your opinion the contribution of HVAC professionals? Do you think that the HVAC professionals are sufficiently prepared for the new challenges?

Francis ALLARD: HVAC professionals refer to a wide range of professionals, from research, design, installation and maintenance. Most of them are already focusing on introducing their best practices on low energy systems, on-site renewable energy production and promotion of low carbon footprints solutions. For new buildings, there are already plenty of very nice examples of Nearly Zero Energy Buildings, even positive energy ones, in every country and for a huge variety of climatic solutions. A huge effort has been made all over Europe in recent years. HVAC professionals have already acquired consistent experience but they have to adapt their practice to the necessary target of very low carbon foot prints buildings without any compromises on the Indoor Environment Quality (ie: comfort, health and safety). This means an evolution towards the definition of optimal solutions in the system design in terms of IEQ, installed power, energy performance and global cost. This holistic approach cannot be reached without a strong effort in formation of our professionals and an adaptation of the design tools.

However, the real challenge of the coming years is without any doubt, the renovation of the building stock with a strong reduction of the primary fossil energy use and of the carbon footprint of these renovated buildings. In this aspect, the role of HVAC professionals is even much harder. Very often the knowledge of the building to be renovated is weak, even the geometric aspects, the envelope characteristics and the materials are not well-known. The systems have to be redesigned completely, and the technical solutions for introducing new installation for heating, cooling or ventilation are much more difficult to handle than in a new building. In order to ensure the effectiveness of the renovation to comply with long term objectives as the carbon neutrality in 2050, a real renovation road map is necessary in order to avoid any "lock in effect" when selecting a technical solution. In these aspects too, HVAC professionals certainly need more specific information or formation.

CEN-CE: Energy Performance Certificates (EPC) are mandatory in all European Member States. Today there are more than 30 different EPC's all over Europe. Sometimes national subsidies are directly related to the energy classes of national EPC's. Do you think that European funding should be based on national EPC's, to avoid double work, or based on a European Voluntary Certificate (EVC) mentioned in the Energy Performance of Building Directive (EPBD)? How in this case avoid double work and manage the coexistence of two EPC's, a national and a European one?

FA: The problem of EPCs is a hard one and it is not easy to have a clear statement. When EPCs were implemented, the idea was to have a very quick estimate of the real energy performance of any building anywhere in Europe. We have to remember that before EPBD

2002, when we were buying or renting a building, we had absolutely no idea of its energy performance. The quick and wide implementation of EPCs in Europe was certainly a key element in order to promote energy performant buildings, and a big success. However, they have certain limits in considering the indoor quality (Comfort, IAQ) and the quality of the energy performance evaluation may vary a lot from one place to another. Thus, they certainly need to be improved.

As every country in Europe already experienced EPCs for a while, it may look reasonable today to imagine a convergence of these national experiences towards a unified European system. The proposition of a European Voluntary Certificate is certainly a very positive initiative, but it will need time and very strong political incentives. It is doubtless that we will have a double system during sometimes, a national regulation frame and a European voluntary one. However, it looks rational today to promote a unified European EPC.

CEN-CE: The CEN-CE project provides a European Training and Certification scheme for HVAC professionals based on European Standards. This common structure could facilitate mutual recognition of the skills with existing skills if they exist.
Do you think that mutual recognition with existing schemes is useful and possible?

What are the conditions, how this common training and mutual recognition could be implemented in France?

FA: The CEN-CE initiative is obviously very valuable and useful for the HVAC community in Europe. Training professionals on the basis of European standards and giving them a recognition of acquired skills is certainly beneficial in order to promote a more unified vision, in complement to the national regulations.

This common recognition is certainly useful and necessary. In France, as in most Member States, the building regulation frame is not completely integrating the European standardisation effort. European standards are not mandatory in our domain, and by consequence they are not well-known and used. However, besides this cultural heritage of national regulation frame, a convergence between the national frame and the European one looks necessary and certainly suitable in the future. On the one hand, this convergence is the natural way of evolution, and on the other hand, our professionals are more and more exchanging in Europe and more often they have to work on projects with other European colleagues. Developing a common training and mutual recognition of their skills could be a very valuable contribution of HVAC associations like AICVF for the benefits of their own members. ■

CEN-CE in a nutshell

Upskilling HVAC professionals, the linchpin of the EU Green Deal

Energy efficiency, low carbon footprint are challenges linked to the EU climate change commitments. To bring the EU targets into application HVAC professionals needs to be trained on these challenges but also on EU common methodologies because there is a need for a standardised, reliable quality benchmark.

Keywords: energy efficiency, building renovation, heating systems, European Standards, EPBD, nZEB buildings


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What is CEN-CE – the key aims

CEN-CE is a European funded H2020 project related to the increase of construction skills of professionals in order to reduce energy consumption and the carbon footprint. This thematic is linked to the EU climate change commitments and related EU legislation.

CEN-CE stands for *CEN Standard Certified Experts.* The objective is to set up a European wide training and qualification scheme for building professional in the field of heating and water-based cooling systems (HVAC) recognised all over Europe.

CSTB	ENBEE	REHVA	FSB	SLR
France	Slovakia	Belgium	Croatia	Italy

The CEN-CE Team.

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CEN-CE training is based on the European (CEN) standards developed by CEN/Technical Committee 228 "Heating and water-based cooling systems" and CEN TC/371 "Overarching standard for global indicator".

The CEN-CE training and qualification scheme should run after the project as a non-profit self-funded business case in cooperation with other organisations including mutual recognition.

Why CEN-CE now – setting the scene

The European Commission charged CEN (European Committee of Normalisation) to develop standards to facilitate the implementation of EPBD (Energy Performance of Building Directive) requirements in the EU Member States. These standards were positively voted in January 2017 and published. To bring them into application training will be needed. CEN-CE is the first project proposing an EU wide common training scheme which could also be the basis of EU wide mutual recognition of construction skills.

Nearly 35 % of all buildings in the EU are over 50 years old, of which approximately 75 % are energy inefficient. But even though renovating existing buildings could substantially reduce energy consumption (by up to 60 %), only 0.4 to 1.2 % are renovated each year. Just 15 % of renovated buildings incorporate significant energy-efficiency improvements.

On the other side the EU targets are ambitious. EPBD ask for example new construction to be nearly zero-energy buildings as of 31 December 2020. The EU Green Deal target is to be carbon neutral in 2050. To bridge the gap between the energy performance of the actual building stock and the EU targets, qualified building workforce is needed. HVAC professionals will play an important role in implementing energy efficient solutions, especially in building renovation where HVAC systems are often replaced or upgraded in shorter intervals.

The Game changer - New challenges for HVAC professionals

Reaching the EU Commitments is a new challenge and request increased skills to perform high quality, reliable energy-efficient renovation. The results must be communicated in a way to be understood by all actors of the building value chain (common language, common indicators).

HVAC professionals should be aware on the new challenges linked to the requirements mentioned before. There will be a *game changer* because HVAC professionals must be able to:

- improve *significantly* the energy performance and *switch to low carbon renewables*;
- upgrade installations to be "*2050 compatible*" (avoid lock-in effect by sub-optimal installation in new buildings and in renovations);
- provide a *reliable* estimation of the real impact of the new installed or upgraded installation;
- *design* for performance and *communicate* on performance.

The needed technologies are available. Compliance with future building performance requirements *demands a higher degree of sophistication and details*, when moving towards nearly zero energy and carbon neutral building.

Why CEN-CE is different from other training schemes - the CEN-CE Unique Value Proposition

It is well known that there is a lack of motivation from building professionals to attend training courses which are not mandatory, and which cannot be valorised immediately in the daily work.

But the CEN-CE training and certification scheme addresses a strong market request, shown by the support of stakeholders of the whole building value chain and public authorities, including the EU Commission.

Qualification and training based on European (CEN) and International (ISO) standards is an advantage for mutual recognition of qualifications and certifications schemes among different countries. Standardisation is also key to a create level playing field for products European wide in order to reach a technical neutral assessment (fair competition between products and solutions).

The EU Green Deal and the associated building renovation wave will be the linchpin and game changer. This European funding must be associated to a clear taxonomy, to a common standardized European quality benchmark of building renovation, if the impact on climate should be real. It is not acceptable that the same building is evaluated "green" in one country and "black" in another because only the evaluation procedures are different. *European funding should be linked to European rules (European standards).*

The CEN-CE Unique Value Solution, the specific added values of the CEN-CE project, can be resumed as follows:

- CEN Standards are already used by many EU Member States. The training could be valorised for legally mandatory energy performance methodologies and/or voluntary schemes as the Green Deal, DGNB or HQE and BREEAM.
- CEN Standards allow an EU-wide evaluation of equipment performance, comparability of results and transparency based on a technology neutral assessment;
- Qualification and training of experts based on European standards is an advantage for mutual recognition of qualifications.

Overview of the CEN-CE training content

The standards developed by CEN under mandate M480 of the EU Commission are related to the daily work of HVAC professional, as e.g. the sizing of heating systems, or related to upcoming challenges like global cost calculation, integrating renewable energy sources, measured energy performance. Providing training on individual technical topics is no longer sufficient in the new context. Complementary training on transversal know-how is needed to express the impact of the HVAC system (new or renovated) on the overall performance of buildings on energy (e.g. non-renewable primary energy indicator, ratio of renewable source), but also on economics (global costs). To be able to check the real performance (measurements and inspection) become also more and more important.

CEN-CE team organized the 2nd Stakeholders' Workshop in Brussels 2019.

CEN-CE developed training programmes covering both: individual standards and 'big picture' issues. CEN-CE adopted a holistic approach to assess the building's energy performance towards NZEB buildings.

The CEN-CE outcomes

The training and qualification schemes are targeted towards middle and senior-level professionals. These training schemes equip architects, engineers, system designers and installers with the latest know-how in energy-efficient and low carbon building assessment and technologies at international level.

The training is organised by *training modules*. The training modules are linked to specific standards. Each training module includes a presentation on the:

- fundamentals of the technology;
- a handbook on calculation procedures;
- an Excel-based tool for evaluating the impact of different parameters.

To become a certified CEN-CE expert there are some pre-requisites to fulfil, such as the educational level, and the need to pass an exam. Once passed the exam, the participant will have their name added to the CEN-CE list of certified professionals. This list will be publicly available and can be used to easily find a qualified HVAC professional for building construction or renovation projects.

To resume, the advantages for HVAC experts provided by CEN-CE training and certification scheme are:

- be trained on harmonized procedures facilitating mutual recognition of skills, allowing professionals to work EU wide;
- gain recognition of the market on quality, reliability, comparability and transparency;
- gain on visibility (referenced in CEN-CE expert data base);
- use best available know-how based on European and international standards.

The CEN-CE market uptake and roll-out

HVAC professionals and building experts will only spend time and money for training and qualification if they can use the lessons learnt, if there is an immediate (and maybe mid-term) market request related to the training issues.

Hereafter are resume the main drivers of the market request.

- The first market request may be related to the needed increased professional skills in sizing, calculated and measured energy consumption. The CEN-CE experts will be better prepared for the new challenges related to nZEB's, cost optimum, integration of renewables, EU wide taxonomy based on EU standards.
- The second market driver, and probably the front runner of the market demand, may be industrials. The CEN-CE training and qualification scheme could be added to their professional academies. In addition to be trained on their products, installers and designers will be certified and may get credits for national mandatory regularly know-how update. The performance of their product can easily be implemented in calculation and communicated EU wide.
- The third market driver for the CEN-CE market uptake may be the request from voluntary schemes (e.g. HQE, Green Deal taxonomy) and mandatory certifications schemes (e.g. national EPC's) using the European standards.

For the practical roll-out of the CEN-CE scheme, the CEN-CE training and certification scheme may be stand-alone or complete existing schemes by the know-how and skills needed by the HVAC professional to meet tomorrow's challenges in building design and retrofitting. ■

BECOME A CEN EPB STANDARDS CERTIFIED EXPERT

– Register for free to the Online Pilot Training (July - September 2020)

CEN-CE online pilot training and certification for attaining new knowledge on two showcased CEN standards (heat pumps & measured energy) part of the improved set of Energy Performance of Buildings standards and actively contribute to the development process of this EU-wide training and certification by providing your valuable feedback.

CEN-CE certified expert operating EU wide

The CEN-CE project is a H2020 project that introduces a training and qualification scheme with the aim to increase the skills of professionals to be able to use a new set of CEN standards for energy performance of buildings assessment and design towards the Nearly Zero Energy Buildings (NZEB). Besides a high quality training the scheme also sets the conditions for becoming a CEN-CE certified expert recognised EU wide and the rules how become a CEN-CE training operator. Building capacities and skills for using European standards will support the quality and harmonisation in the construction sector.

Keywords: training, qualification, heating, global cost, measured energy, European Standards, energy performance

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Why training on new EPB standards is needed

The EU energy and climate targets require qualified professionals able to design nearly zero energy buildings and proof it by calculation of energy performance indicators as primary energy, CO_2 emissions, ratio of renewable energy and others, set by public authorities as requirement for NZEB. The calculation methodology for the energy performance of buildings (EPB) in several EU Member States refers fully or partly to European standards. New versions of CEN and ISO standards (M/480) were approved in 2017 and are implemented into national standardisation systems since 2018.

The reproducibility of the results from calculation of energy performance by different experts and the neutrality and level playing field for products is the advantage of harmonised calculation methodology based on CEN standards. **The training of professionals** is important to eliminate the unintentional systematic errors or occasional mistakes in calculation that can result in non-compliance with the minimum requirements and finally lead to under performance of new and renovated buildings.

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Manufacturers will profit from correct calculation for their specific products as CEN standards ensure they are correctly and consistently considered in the building performance assessment.

CEN-CE has a flexible modular structure that takes into account the harmonization with existing training schemes. **Training providers** can extend their training offers by CEN-CE training as stand-alone or implement just specific modules in their existing commercial or official trainings (e.g. Chambers of engineers). Qualified and/or certified independent experts for energy performance of buildings assessment based on European standards are needed also for **existing or future new certification schemes** for buildings (e.g. Voluntary common European Union certification scheme for the energy performance of non-residential buildings according to Art. 11(9) of the EPB Directive).

Why become a CEN-CE certified expert?

The aim of CEN-CE training and certification is to increase the comparability, quality and confidence in the professional competence for the European single market by offering professionals:

- **market advantage** by EU-wide **recognized competence** (quality mark) and possibility to be included in the public list of CEN-CE certified experts,
- helping and **saving time** for studying and understanding the new CEN standards,
- **training materials** tested and validated by building professionals that include examples on how to achieve NZEB with focus on current challenges (integration of RES, wind turbines, PV panels), measured energy and economic evaluation procedures,
- understanding of inputs and sensitivity on results **for correct use of software**;
- **corrections** of standards in training materials and proposal for amendment of standards where relevant.

CEN-CE training and certification scheme

As a first step, the CEN-CE training scheme focuses on heating and domestic hot water preparation systems, economic evaluation procedures (global costs, payback period), measured energy and inspection, that are standards in the responsibility of CEN/TC 228. The overarching standard EN ISO 52000-1 related to CEN/TC 371 is also included in the CEN-CE training to provide the holistic view and way of aggregation of partial calculations in the overall energy performance indicators. In the future, it is expected that the similar trainings will be processed also for other technical services (thermal envelope, ventilation, cooling and lighting).

Modular structure

The advantage of the CEN-CE modular structure is that professionals can be trained only for selected standards. This allows the different initial background of experts or specific product oriented interest by industrials (e.g. in heat pumps, PV). The courses are offered in a short time format maximum 4 hours per standard based on its complexity. This allows professionals acquiring skills on a step-by-step basis gradually over a longer period of time and does not require long interruption from their usual daily business.

All standards for which it is possible to complete the training are listed in the achieved certificate and highlighted are those standards for which a particular person has passed the exam. This enables distinguish between competence of experts who are trained and certified for the whole set of CEN standards from someone who is certified just for few of them. The list of standards for which CEN-CE training is prepared and an example of a certificate issued for expert who passed exam only on some of standards is shown in **Figure 1**.

To make qualification and outcome from CEN-CE training more readable and understandable across different countries and education systems the reference is made to the list of knowledge, skills and competences defined by European Qualifications Framework (EQF).

Training and qualification are focused on two levels of professionals. Training for higher level of professionals (EQF level 5+6) is suitable for architects, engineers, designers, auditors, software developers and developers of national calculation methods. Simplified training for lower level professionals (EQF level 4) is designed to understand the basic principles by installers but it is also suitable for building managers or public authorities without specific initial technical education.

The common structure of training materials for all standards emphasizes the understanding of the fundamentals and sensitivity to input data in the calculation of EPB. Each presentation contains an introduction,

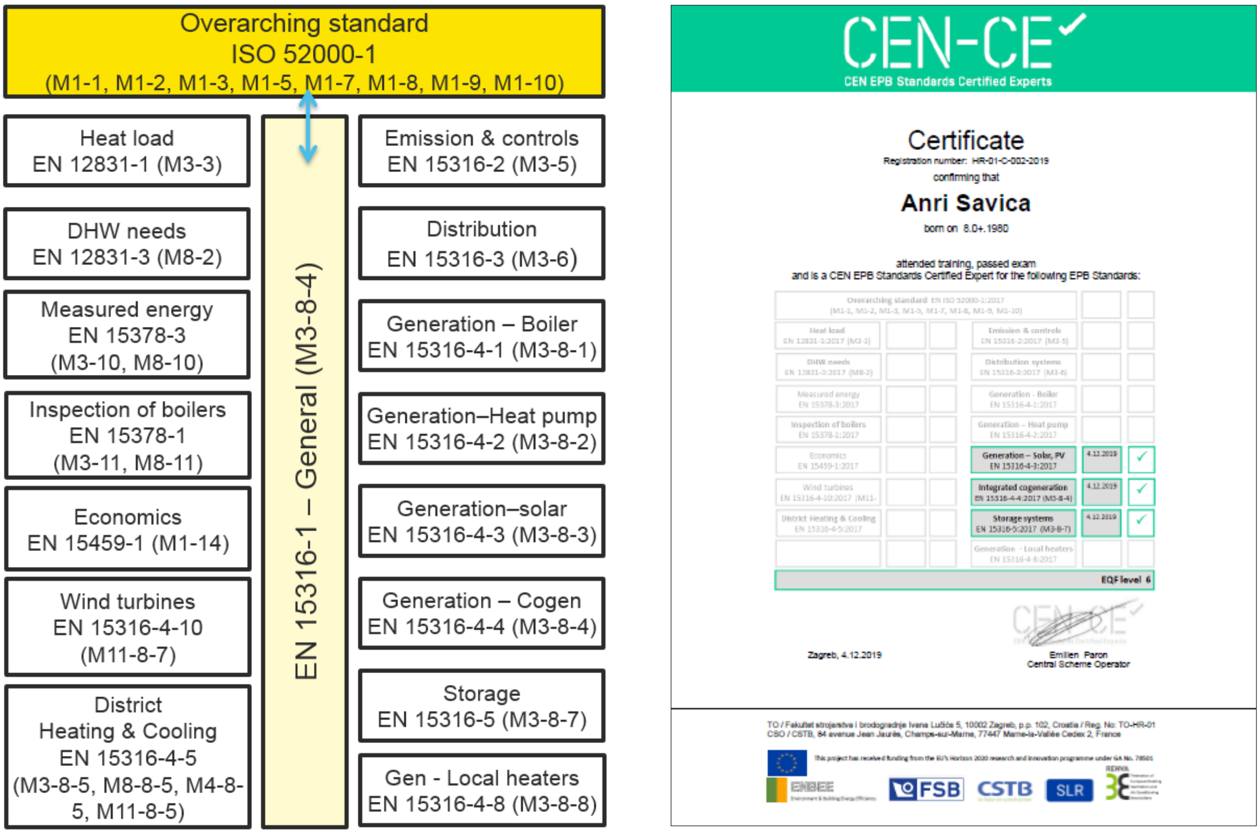

Figure 1. List of standards for CEN-CE training an example of CEN-CE certificate.

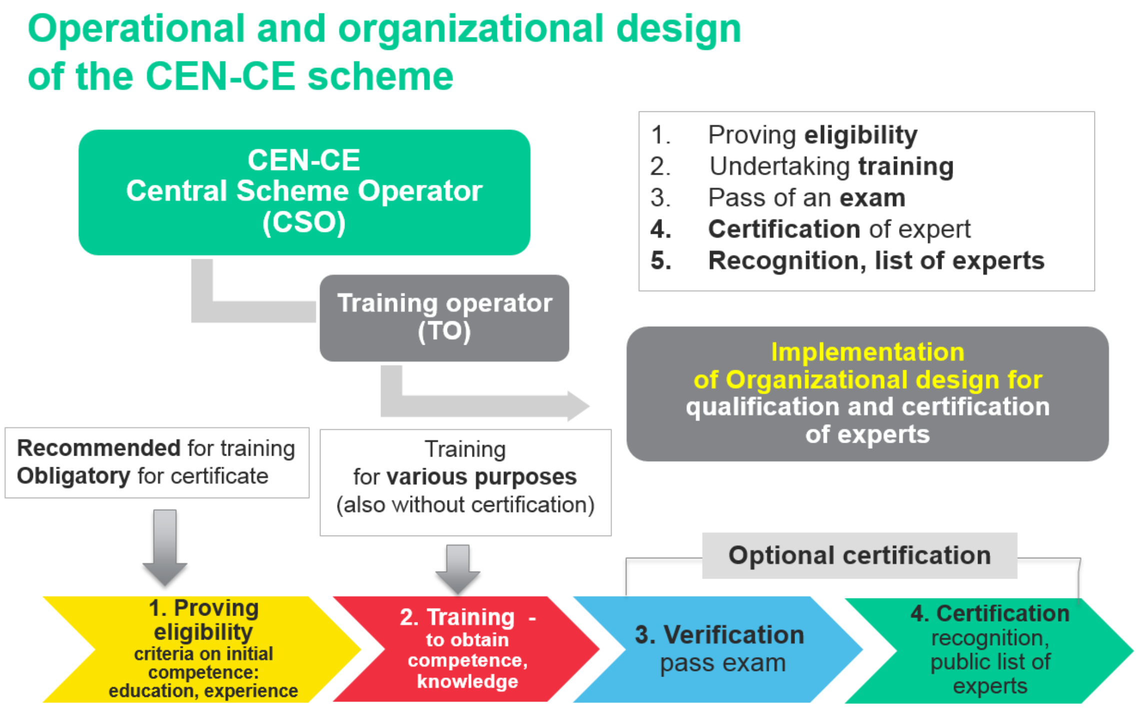

Figure 2. The organizational structure of the CEN-CE training scheme.

basic principles, input and output data, calculation procedure and examples. Several standards developers are members of CEN-CE consortium that guarantees the high quality and **uniqueness of training.**

Organisational structure of the CEN-CE training scheme

The CEN-CE scheme will be coordinated by a Central scheme operator (CSO) at the European level. The CSO will delegate (license) the trainings to different interested organizations (training operators) who will run the training. Pass exam after training will be optional. Training operators (TO) will entered into a contract with the CSO. The main principles of CEN-CE scheme operation are described in **Figure 2.**

How to become Certified expert

After completion of the training, trainee have to pass successfully exam to become CEN-CE certified expert.

Anyone can attend the training without limiting conditions. The initial education level is just recommended for proper understanding the content of the training. However, to become a CEN-CE certified expert several requirements for proving eligibility will be required in order to guarantee the quality of qualification. Expert has to prove the level of initial education and experience to become a CEN-CE certified expert. The university degree for Certificate of EQF level 6 is required and high school/secondary school-leaving certificates for EQF level 5. Any lower education will be sufficient for EQF level 4 certificate. The 2 years of relevant experience during the last 6 years is also eligibility criteria for certification. Common template of certificate is proposed and the database of certified experts will be publicly available on the website of the Central scheme operator.

Only after attendance of training it is possible to take an exam. The exam consists of a series of questions to verify the understanding of the topic.

The CEN-CE certificate for EQF Level 4 ensures that expert can generate specific standard solutions, can build, optimise, tune, and repair an existing system. This is related to installers, building managers and other professionals who may have different level of initial education.

The learning outcomes for EQF Level 5 and 6 ensure a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems, solve complex and unpredictable problems. Experts can design a new system and calculate the energy performance of a new or existing systems.

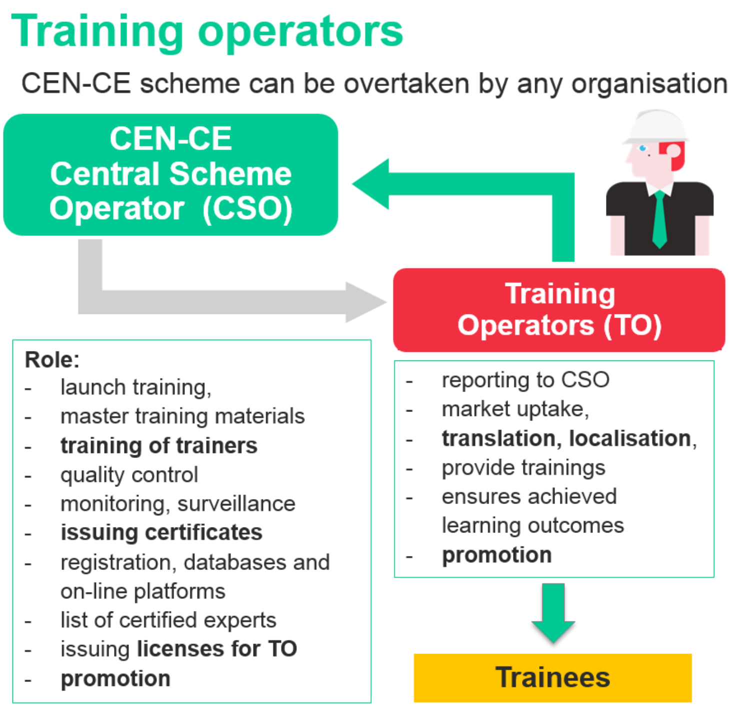

Figure 3. The roles of CEN-CE training scheme operators.

CEN-CE scheme will provide flexibility on passing an examination for assessment of learning outcomes by options for exam by presence, remote (e-learning platform) or self-assessment (informative for learning process). The options will depend also on the Learning Management System (LMS) currently under development.

The quality control, monitoring and surveillance as shown in **Figure 3** based also on feedback from trainees will be the role of Central scheme operator who will also maintain the master training materials. These materials will be translated into the consortium languages but can be latter translated by training operators to any other language.

The certification process addresses also trainers who will be trained by the Central scheme operator.

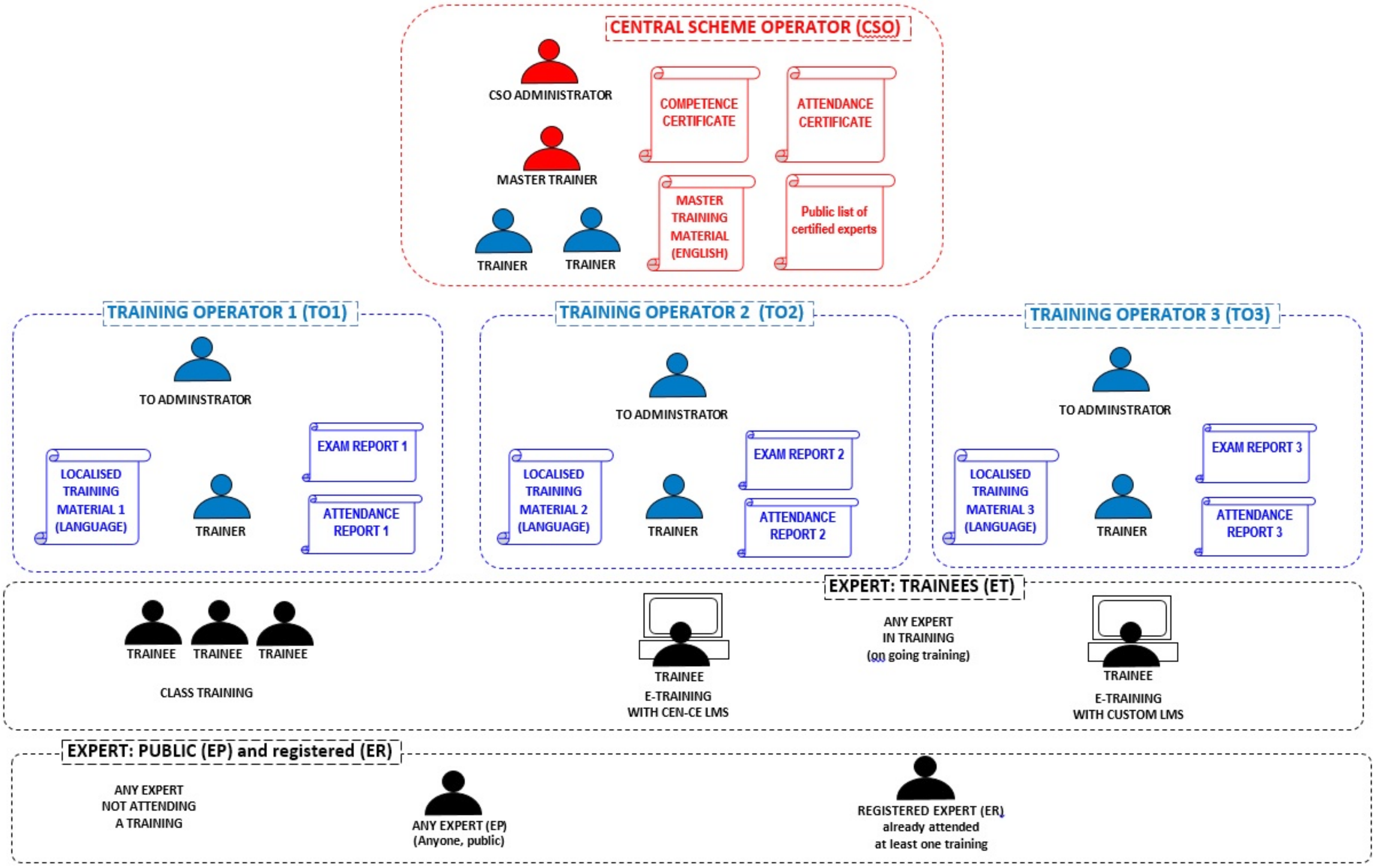

Figure 4. The types of trainings and roles of involved entities.

How to become Training operator

The scheme will be of pan-European significance. The CEN-CE training system will be commercial. The project consortium verifies the training scheme and training materials in trainings organized for free within the duration of the project. The first training took place in December 2019 at the University of Zagreb, second took place in February in Italy. Next training was planned for April in Slovakia organised by Slovak Chambers of civil engineers responsible for official training and accreditation of experts, but has been postponed due to the developments with Covid-19.

E-learning infrastructure will be developed with three types of training possible, class training, e-learning using CEN-CE Learning Management System or e-learning by other the custom learning management system (**Figure** 4). ■

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[4] REHVA - Federation of European Heating, Ventilation and Air Conditioning Associations, https://www.rehva.eu/

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CEN-CE training on EN 15459 on economic evaluation procedures

The CEN-CE project introduces a training and certification of experts on several EPB standards. One of them is EN 15459-1:2017 for economic evaluation procedures. The main aim of this standard is support for designers, building owners and managers in the decision making process on energy related investment and finding the cost optimal solution. The CEN-CE training provides the overview of the methodology, basic principles and gives recommendations for practical use of this standard with caution for risk mitigation by consideration of different scenarios for most influencing input parameters.

Keywords: economic evaluation, global cost, payback period, EPB Standards, energy performance of building

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EN 15459 as a tool for economic evaluation for energy related investments

EN 15459-1:2017 provides a method for economic evaluation procedures for building, building components and energy systems. The aim of this standard is the support for the decision taking on technologies applied in building construction and renovation process and help to find the cost optimal solution by aggregation of present and future costs in two main indicators described in this standard that are:

- global costs
- payback period of investment.

Global costs are the sum of the present value of the initial investment costs, annual running costs and replacement costs referred to the starting year as well as disposal costs if applicable. If the lifespan of the last replacement cost exceeds the end of calculation period, the final value of a component at the end of calculation period is determined and referred to the beginning of the calculation period. The global costs approach allows to find the optimal option from comparison of unlimited number of solutions.

CEN-CE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785018. The sole responsibility for the content of this project lies with the authors. It does not necessarily reflect the opinion of the European Commission.

Payback period is the time when the investment costs are balanced with the monetary savings occurring. The payback period is used to compare the cost efficiency of investment against the reference case. Usually the solution under consideration is compared to a reference situation that can be situation before investment in case of renovation or the minimum requirements in case of new building construction. EN 15459-1:2017 provides calculation for the discounted payback period.

The potential applications of the methods described in the EN 15459-1 are:

- evaluation of economic performance of an overall design of the building,
- evaluation of economic feasibility of specific energy related investment,
- comparison of energy saving options and finding the cost efficient and cost optimal solutions.

An important part of this standard is the informative data for components provided in Annex D referenced also by the Commission delegated regulation (EU) No. 244/2012 supplementing EPPBD for calculating **cost-optimal levels** of minimum energy performance requirements for buildings and building elements. EN 15459-1 after revision in 2017 is in line with this Regulation in terms, definitions and calculation methodology and therefore this training could also support the cost optimal level of energy performance calculation by national authorities.

The informative data for components provided in Annex D and referenced in Regulation No. 244/2012 are:

- the life span of components in years (Min – Max),
- annual maintenance cost (% of initial investment),
- disposal cost (% of initial investment).

Connection with other EPB standards is based on delivered energy per energy carrier calculated according to Overarching standard EN ISO 52000-1 that is input for energy costs calculation. For finding the cost optimal solution also link with the primary energy calculated according to EN ISO 52000-1 is recommended.

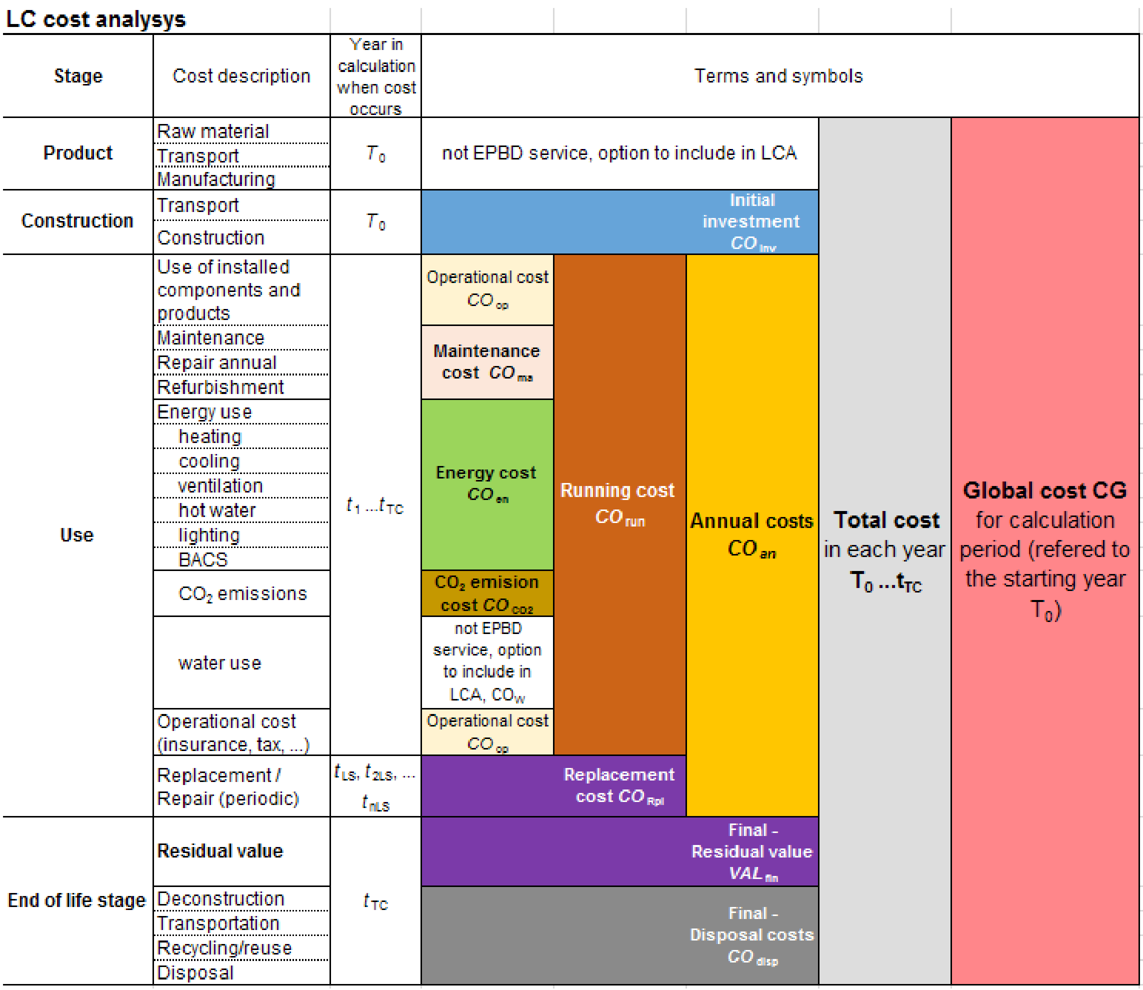


Figure 1. The structure of costs considered for economic evaluation of energy related investment.

The CEN-CE training materials

The CEN-CE teaching materials on EN 15459 are focused on presentation and understanding of:

- the structure of data considered in economic calculation;
- required inputs;
- calculation method (formulas);
- resulting outputs;
- recommendation for interpretation of results, reporting and use in design practice.

The specific of this standard is wide variety of level of detail and uncertainty of some inputs as it presents an aggregation of present and future costs over a long calculation period (20 – 50 years). Therefore, the reporting and interpretation of the results needs special attention. Sensitivity analysis on most important inputs and consideration of different scenarios for future development is recommended in CEN-CE training for practical use of this standard and failure risk mitigation.

The structure of the costs considered in calculation are detailed in **Figure 1**. They are in line with the Commission delegated regulation (EU) No. 244/2012 for calculating **cost-optimal levels** of minimum energy performance requirements.

The flowcharts help to understand the calculation steps (**Figure 2**) and the spreadsheet allows the demonstration of calculation and influence of different input parameters.

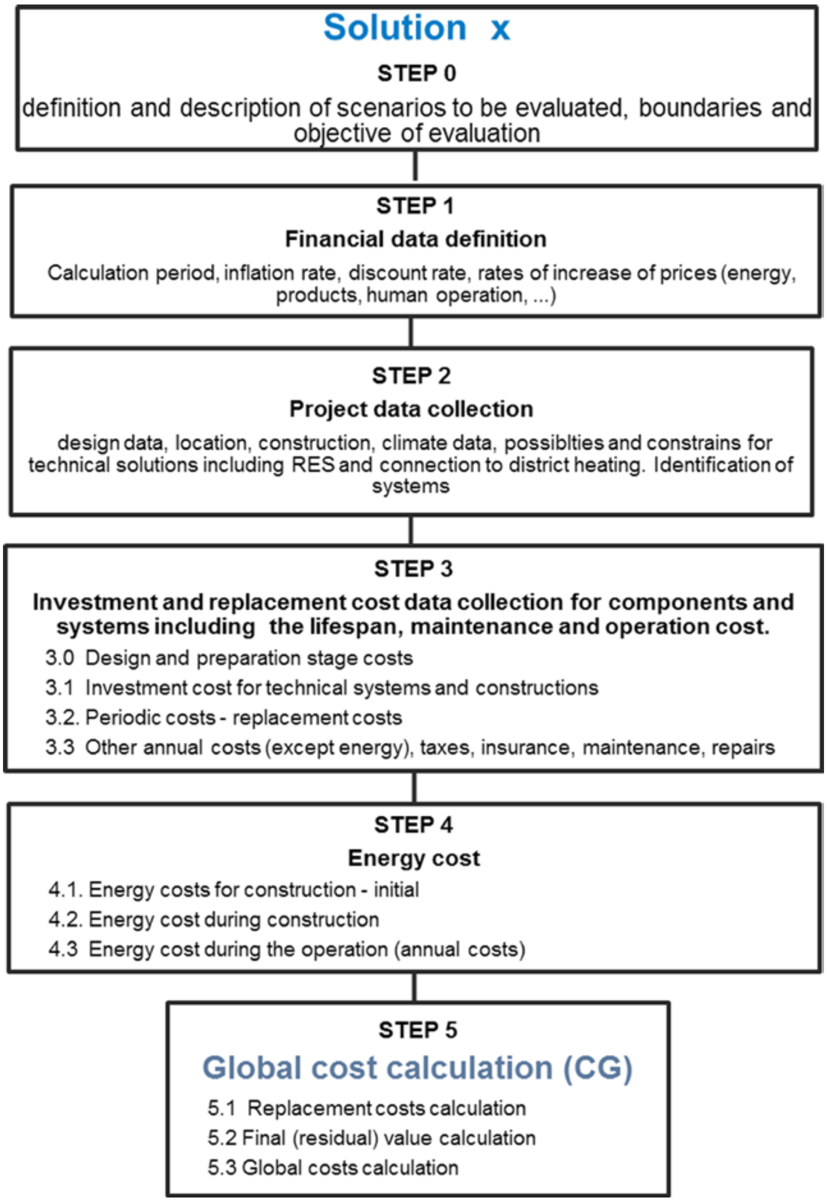


Figure 2. Example of flowchart for calculation of global costs.

Example of definition and presentation of input data in spreadsheet is shown in **Figure 3** and of output in **Figure 4**.

Input parameters, scenarios and boundaries

All input data shall be consistent and shall be based on local conditions at the time of the analysis. Some optional informative default values and options can be presented in National Annex A if it exits or default inputs for CEN option can be find in Annex B to standard.

The description of scenarios (solutions) under consideration with the boundaries specification is needed before input data collection. The **scenarios** have to be defined and described by:

- the time (duration) of calculation (whole life cycle, economic lifespan);
- physical limits (whole building, part of the building, only building system);
- costs considered (overall costs, only selected specific cost items for specific systems or products);
- financial data (discount rate, inflation)
- evolution of prices (energy, products, services, human operation)
- scenarios for maintenance and replacement cost

Sensitivity on most influencing parameters

Economical results are closely related to the project under consideration. The NZEB are costly and the potential solutions to achieve NZEB should be carefully evaluated. The sensitivity of results increases depending on the complexity and number of parameters taken into account in calculation and it may be difficult to come to the conclusion.

Part of CEN-CE training is focused on the sensitivity analysis for the most influencing input parameters with important uncertainty. The CEN–CE certified expert

Initial investment and periodic cost (replacement, substitute investment that is necessary for age reasons according to their lifespan)

Variant 1 Current stage Var 0 Average thermal insulation, condensing boiler

Description	Building envelope - specific information data										
		Walls		Roof		Floor, basement ceilings		Internal partitions		Windows	Total (envelope) €
Lifespan (years) LS =	LS =	30	LS =	20	LS =	30	LS =	20	LS =	20	
Price evolution rate RAT_{pr} =	RAT_{pr} =	1.0%	RAT_{pr} =	0.0%	RAT_{pr} =	0.0%	RAT_{pr} =	0.0%	RAT_{pr} =	0.0%	
Maintenance cost (rate from investment) RAT_{ma} =	RAT_{ma} =	1.0%	RAT_{ma} =	1.0%	RAT_{ma} =	1.0%	RAT_{ma} =	1.0%	RAT_{ma} =	1.0%	
Disposal cost (rate from investment) RAT_{disp} =	RAT_{disp} =	1.0%	RAT_{disp} =	1.0%	AT_{disp} =	1.0%	RAT_{disp} =	1.0%	RAT_{disp} =	1.0%	
Initial investment cost CO_{inv}	CO_{inv} =	**7 000**	CO_{inv} =	**4 800**	CO_{inv}	**5 000**	CO_{inv} =	**0**	CO_{inv} =	**1 700**	**18 500**

Figure 3. Example of input data in spreadsheet.

	A	B	C	D	E	F	G	H	I
1		**Presentation of results**							
2									
3		**Solution 1**					**Solution 2**		
4		Average thermal insulation, condensing boiler		**Var 0**			Thermal insulation (CO level), condensing boiler		**Var 1**
5		Reference floor area A_{ref}=	105.00	m^2			Reference floor area A_{ref}=	105.00	m^2
6		Calculation period t_{TC}	50	years			Calculation period t_{TC}	50	years
7		Discount rate RAT_{disc}	3%				Discount rate RAT_{disc}	3%	
8		Macro / micro economic (with / without CO2)	**macro**				Macro / micro economic (with / without CO2)	**macro**	
9		Energy (gas, electricity) price evolution =	2.0%				Energy (gas, electricity) price evolution =	2.0%	
10									
11		Primary energy PE (with export)	**232**	kWh/(m^2.a)			Primary energy PE (with export)	**158**	kWh/(m^2.a)
12		Global costs *CG*	**143 907**	€			Global costs *CG*	**128 716**	€
13		Unitary Global Cost	**27.4**	€/m^2			Unitary Global Cost	**24.5**	€/m^2
14									
15		**Results**	Solution 1				**Results**	Solution 2	
16		$CO_{INIT\ Initial}$ Investment	21 800	**8%**			$CO_{INIT\ Initial}$ Investment	28 200	**12%**
17		CO_{per} Periodic, replacement investment	28 134	**10%**			CO_{per} Periodic, replacement investment	34 209	**14%**
18		CO_{ma} Maintenance cost	12 550	**4%**			CO_{ma} Maintenance cost	15 500	**6%**
19		**CO_{op} Operation (insurance, tax, servicies)**	10 900	**4%**			**CO_{op} Operation (insurance, tax, servicies)**	14 100	**6%**
20		CO_{en} Energy cost (subtracted income from export)	187 510	**67%**			CO_{en} Energy cost (subtracted income from export)	133 476	**56%**
21		CO_{CO2} External GHG Cost	19 451	**7%**			CO_{CO2} External GHG Cost	13 199	**6%**
22		CO_W water use cost (optional - not EPBD	0	**0%**			CO_W water use cost (optional - not EPBD	0	**0%**
23		COdisp Disposal cost	687	**0%**			COdisp Disposal cost	851	**0%**
24		Sum of costs for calculation period	281 032				Sum of costs for calculation period	239 535	
25		Sum of earnings from exported energy	0				Sum of earnings from exported energy	0	
26			5 621	€/year				4 791	€/year

Interface_1 / Interface_2 / Method_input_1 / Method_input_2 / Method_calculation_1 / Method_calculation_2 / Method_output / **Output_interface**

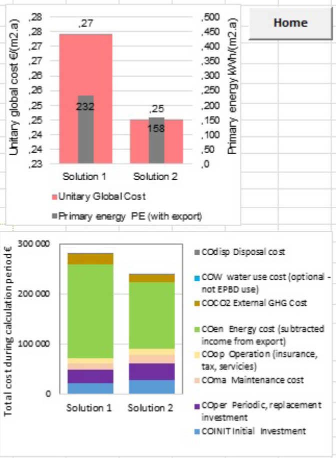


Figure 4. Example of method output presentation in spreadsheet for economic evaluation for two options.

should be aware about the dependency of the results on a good estimation of all input parameters used in calculation with regards to their future developments (e.g. the prices evolution).

The different scenarios consideration is recommended to be calculated and presented as the results. This will allow the risk mitigation of uncertainty of input data e.g. by consideration of the most-likely, optimistic and pessimistic scenario. The most influencing parameters and choices in economical evaluation to be considered are:

- the discount rate (lower highlights benefits from the investment in energy savings);
- prices of energy carriers (must be consistent for a place and time of the calculation);
- the evolution of energy prices (increase will favour the energy related investment);
- lifespan of components that indicates the period for replacement and new investment needed. Cheaper product may have a shorter lifespan and could lead finally to higher global costs. Correct and consistent way of estimation of life span of components and measures is important for comparison between products and solutions. This is why the revision of the data for components (life span, annual maintenance and disposal costs) listed in Annex D has been agreed by CEN/TC 228 and inputs from manufactures will be needed.

Examples of sensitivity analysis on some of most influencing parameters are in **Figure 5** and an example of combination of influencing parameters in different scenarios is in **Figure 6.**

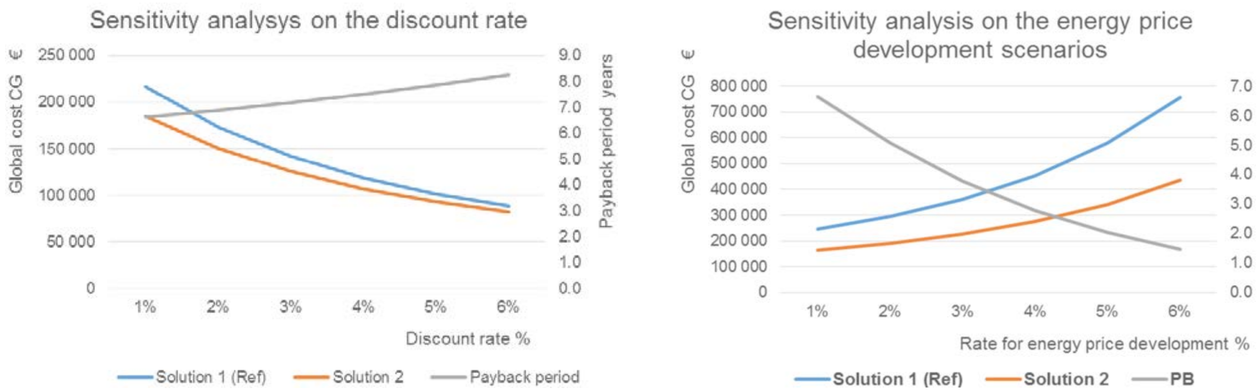


Figure 5. Example of sensitivity analysis on the most influencing parameters.

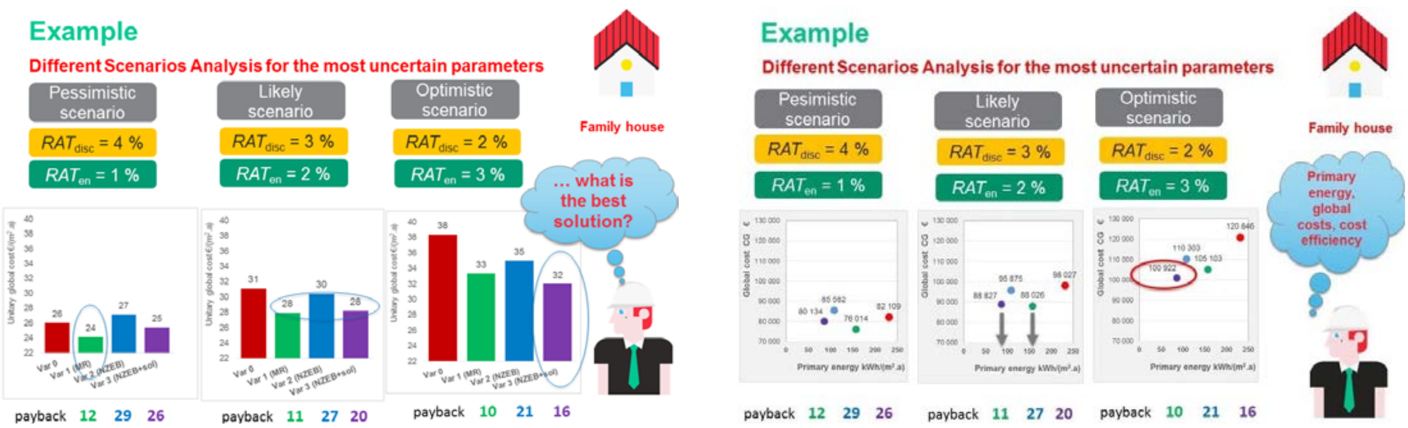


Figure 6. Examples of different scenarios (pessimistic, likely and optimistic) for most influencing parameters.

Comparison of different options and reporting

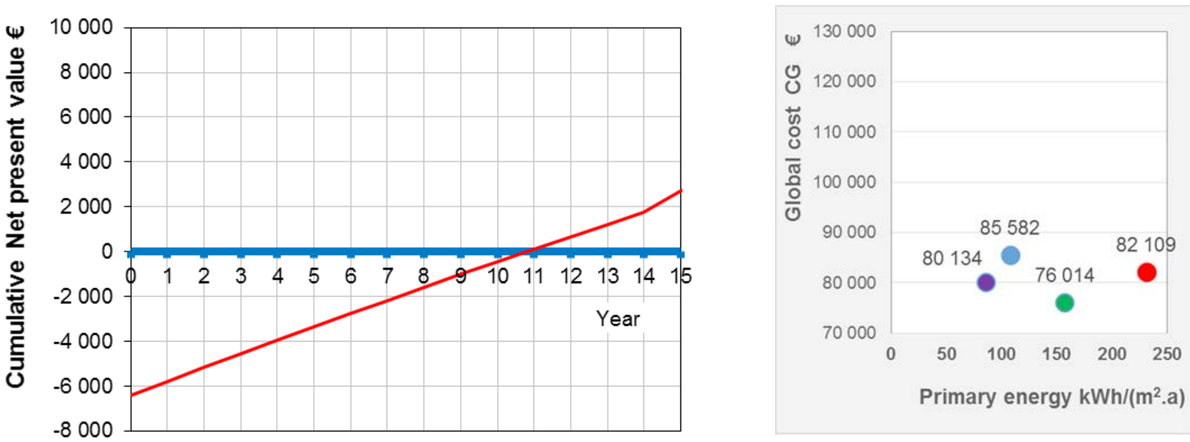
The global costs approach allows comparison of unlimited number of solutions.

The payback period is used to compare the cost efficiency of the solution under consideration to a reference situation. For existing buildings, the reference is usually the actual state (doing nothing). For new buildings, the reference could be a building that satisfies the minimum requirements of the national regulation.

The cost efficiency of proposed solution is usually ensured if the life span of investment is greater than or equal to the payback period.

Examples of reporting outputs and application in the decision making process for cost efficiency and cost optimality of solutions are in **Figure** 7 and **Figure 8.**

As shown in **Figure 6** not only global costs should be the main driver for the recommended cost optimal solution. The **primary energy** and the **energy class** in EPC are important aspects for climate commitments and future obligations for building owner that could bring him the non-energy benefits or cause losses (subsidies, green/brown taxes, attractiveness, better/worse IAQ, secure for increase of energy prices). Therefore, in the case of similar global costs for different solutions the solution with lower primary energy should be recommended.



a) Payback period **b) Global costs**

Figure 7. Example of reporting the outcome from calculation of Payback period and Global costs

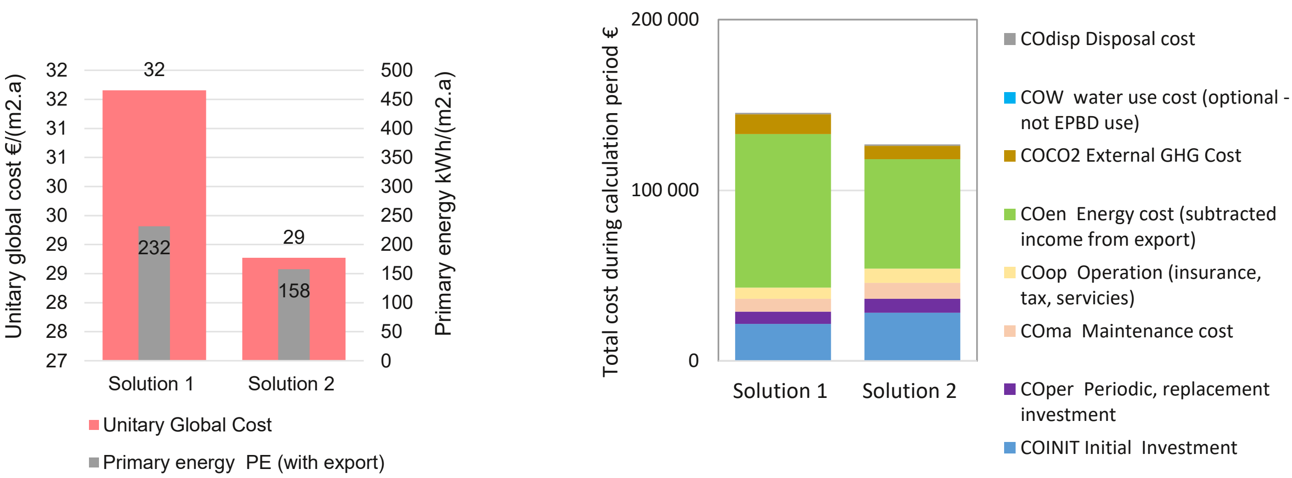


Figure 8. Example of more detailed reporting of global costs for two different solutions.

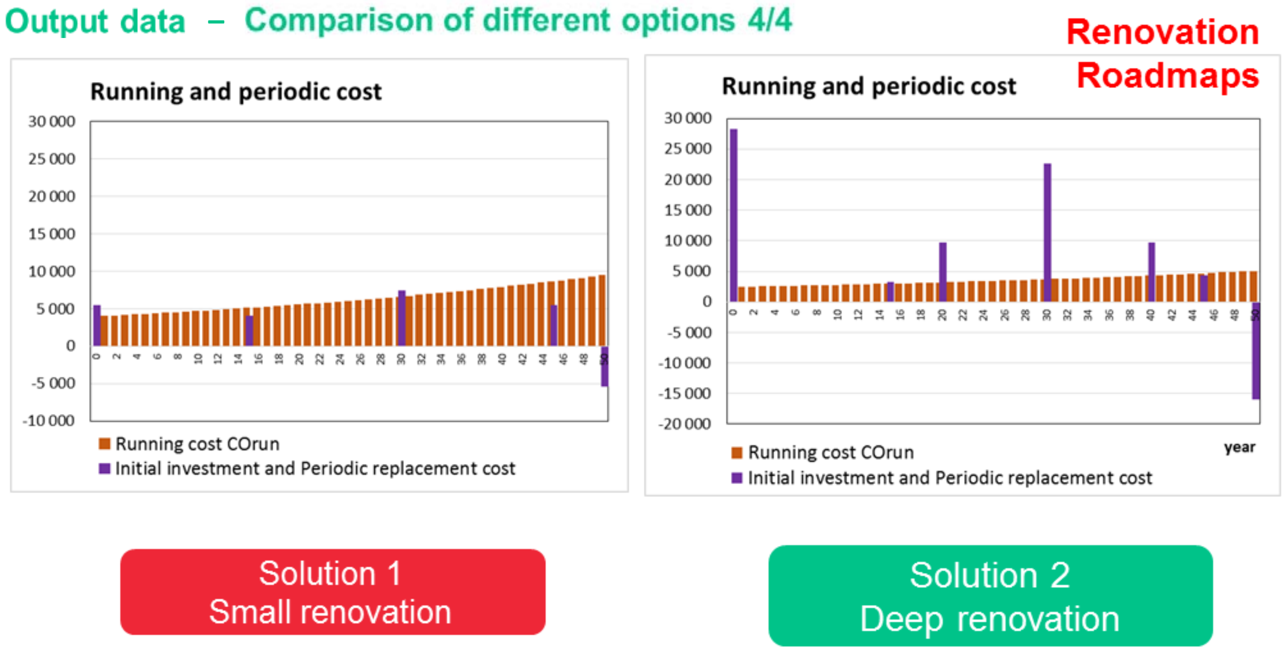


Figure 9. Example of comparison of the annual running and periodic replacement costs for different level of renovation

Graphs with the annual costs as presented in **Figure 9** allow to schedule the investment in renovation based on the life span of components taking into account the running costs and periodic replacement costs as well as the evolution of energy and components prices.

These graphs could be part of **renovation roadmaps** and building **renovation passports** as they can indicate the years with important investments needed.

Conclusion

EN 15459-1 is a powerful tool for the decision making process with many possible applications. It allows the comparison of different solutions and find the most effective approach for building owner for renovation or new building construction towards NZEB.

The specific of this standard is that many inputs are not as exact as for energy performance calculation because of uncertainty of several inputs looking far in the future. Economic results are closely related to the project under consideration, and it may be difficult to make general conclusion. Consideration of different scenarios is therefore recommended in the daily professional work for risk mitigation.

The corrections needed in the standard, discovered during the development of the CEN-CE training, are addressed and corrected in the training materials. The proposal for changes will be delivered for the next revision of this standard. The non-energy benefits as better commercialisation of building due to attractiveness and better indoor environment quality will be also recommended to be considered for future revision of this standard. ■

References

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, amended by Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency,

[2] The Commission delegated regulation (EU) No. 244/2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

[3] EN ISO 52000-1:2017 - Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures

[4] EN 15459-1:2017 - Energy performance of buildings - Economic evaluation procedure for energy systems in buildings - Part 1: Calculation procedures

[5] CEN-CE, Horizon 2020 project, www.cen-ce.eu

New EPB standards and system design

CEN-CE scheme is not only yet another collection of lessons on energy performance calculation standards. It aims at giving professionals full control of the topic and to leverage the information provided by the energy performance to improve sizing and optimisation of buildings and technical systems. The innovative approach is the integration of sizing and energy performance calculation methods.

Keywords: EPBD, CEN, standards, sizing, design

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Sizing versus energy performance calculation

The design activity always includes the "sizing", that is determining the size of the components and appliances that need to be installed to fulfil the design objectives.

Sizing is based on the expected worst-case conditions and the criteria is "the system must make it". Fearing a fail, a lot of safety factors are introduced whilst potential favourable factors are ignored, all figures are rounded-up and finally the available commercial sizes of components are a limited number and you round-up again. For a pipe you have the choice in the list of the available DNs, if it is a radiator you select the number of elements. The consequence is that installations are oversized.

Another design phase, which is not always done, is checking how the selected (sized) components behave in everyday operating conditions. This should be done anyway because there are two risks, especially with HVAC systems:

- as a consequence of the sizing phase, components and appliances are selected for an operating condition (the maximum expected load) which will seldom occur, if ever; so they nearly always operate in a condition which was not the base for their selection!
- part load operation is an issue for most appliances and components.

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The heat load calculation is the first task in the design of HVAC systems which has been standardised and subjected to regulatory requirements. This happened about half a century ago in Europe (years 1970…1980). At that time the goal was to size the emitters and the heat generator (a boiler) so that the building would be kept warm even in the coldest days. Energy conservation was not a primary issue.

In the years 1990…2000, several European countries introduced regulatory requirements on the energy performance for heating. This required an energy performance calculation, that is the evaluation of the performance in the average operating conditions along a reference season. In the last decade this has been extended to all the comfort services covered by EPBD and it becomes more and more challenging to take into account all the interactions between building envelope and systems and the effect of controls in the context of well insulated buildings (in practice, "NZEBs" are well insulated buildings where we pretend all comfort services using little resources…).

A first consequence and the new burden, is that the energy performance is now part of the design objectives: calculating the energy performance is a design tool. It is not enough to size components; you have to verify that the designed building and systems will operate efficiently. You might have to correct your design because you don't meet the performance requirements, even if the sizing looks correct.

A second consequence is that the energy performance calculation should be performed at the same time of the sizing calculation. Using the same input data would give the advantage of describing only once the building and get both results. This is (nearly) already the case for heating where it is easy to calculate the heat load and the energy needs with the same description of the building envelope, e.g. surface and U-value of building elements, length and linear transmittance of thermal bridges, etc.

In the meanwhile, technology progressed and a more accurate sizing is required. Sizing some radiators and a boiler is an easy task. Sizing a heat pump or optimising the sizing of emitters for a condensing boiler is more demanding.

The progresses in energy performance calculation methods is bringing-up a great opportunity: the energy performance calculation can provide very useful information for the accurate sizing of components and appliances. The new EN-EPB standards did big steps and provide a lot of new opportunities in that sense.

These concepts and context explain two basic choices of the CEN-CE training scheme.

Of course, CEN-CE scheme is based on EN-EPB because they are European. CEN EPB standards are also the most advanced concerning the opportunities to link energy performance calculation and sizing. Even if now they are explicitly used only in few countries, several others are close and this is the natural convergence point with time and the concepts.

Another choice is not to limit the teaching to the bare understanding of the standard. Each module includes:

- the underlying fundamentals of the topic covered, which are universal and essential to understand properly what is covered by the standard, how it is covered and the limitations as well;
- of course, the detailed description and analysis of the corresponding standard;
- application examples, that cover optimisation of energy performance calculation but also applications to design and sizing.

These choices allow trainees to get the most to support their everyday design work with a energy performance calculation standards, not only for energy performance itself but also to support sizing and optimisation activities. Even if trainees are working with similar national standards, they will still benefit of the acquired knowledge.

In the following you will find a few examples of the potential use of the energy performance calculation according to EN-EPB standards to assist sizing and optimisation of technical systems. Some features are still potential developments but they are already worth mentioning, indeed.

Heat load or energy performance for sizing?

The first example is about heat load. It has been successfully used to size emitters and boilers since decades. However, it is well known that the heat load brings a lot of oversizing because heat gains are neglected, the ventilation rate is assumed to be the maximum, etc.

If sizing heat emitters, some oversizing is no harm if there is a good room temperature control system. It could be even beneficial if it is identified and exploited by reducing the operating temperatures.

If sizing a condensing boiler, a slight oversizing will force a modulating boiler to operate at reduced power, which is again beneficial for efficiency.

If sizing a heat pump, there are several reasons to avoid oversizing:

- the specific initial cost of the heat pump in €/kW, which is about 3…5 times higher than that of a boiler;
- high power electric connections are more demanding than equivalent gas connections;
- for air source heat pumps, when the external temperature is reduced, the load decreases and the available maximum power increases, therefore the load factor falls quickly to very small values and efficiency drops.

Presenting the results of energy need calculation as a design energy signature, as suggested by EN ISO 52016-1 and discussed in the CEN-CE module about measured energy performance, provides a graphic evidence of the right sizing of the heat pump, as shown in **Figure 1**.

For this building, the heat load is 8.8 kW at –5°C. The design energy signature (red line) is based on the daily aggregation (blue dots) of hourly needs and shows that the design condition is 5.2 kW at –2.6°C. A correctly sized air to water heat pump would have the power output shown with the green line, that is less than 5 kW at –5°C. The oversizing using the heat load is about 80%. This is not relevant if the smallest available boiler has a power of 15 kW, it is indeed when selecting a heat pump. The reason for that big difference is that the heat load ignores heat gains and ventilation losses are evaluated with the maximum flow rate. An optional correction of the heat load according to gains has been introduced in EN 12831 as well but it is not supported by a specific calculation.

Of course, such a tight sizing implies communication with the customer who has to be instructed on how to use correctly the building, that is never turn off the heating during the colder months and do not open the windows if you have a mechanical ventilation! Not to speak about the correct insulation of the building.

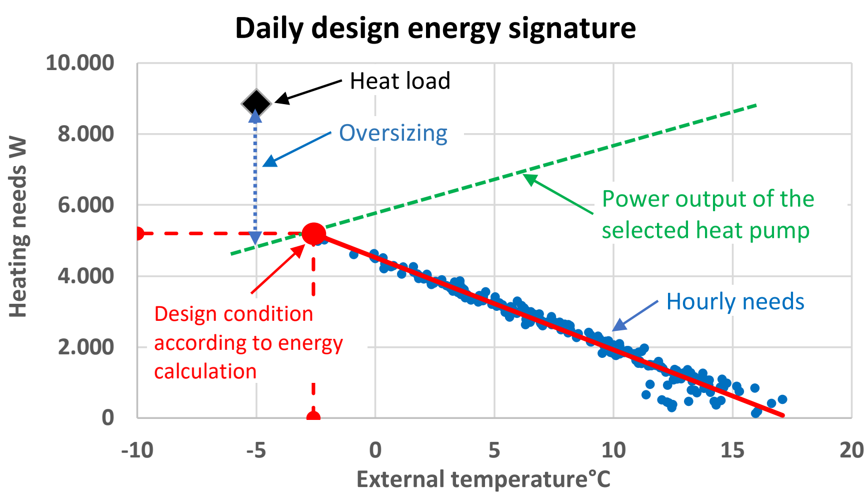

Figure 1. Relationship between heat load and energy performance-based sizing.

Domestic hot water power versus storage volume

The challenge when sizing a domestic hot water system is the correct balance between the power of the domestic water heater (heat generator and/or heat exchanger) and the volume of the store. This can range from highest power with no storage volume (instantaneous systems, that is 24 kW for a single shower) to minimum power and very large volume (accumulation systems, that is 300…400 W average power per average building unit) and there is plenty of intermediate solutions. This sizing is usually based on empirical correlations and/or rules of thumb.

EN 12831-3 standard includes a specific simulation method to test the reaction of a defined configuration (available power, storage volume, control strategy) under a design load profile.

The hourly method defined in EN 15316-5 can be used on a shorter time-interval for the same purpose and with similar results. The advantage of the latter is that it natively includes consideration of any simultaneous heating need and the description of the storage is the same for sizing and energy calculation.

Concerning domestic hot water, this is half the story. The second half is providing representative design load profiles.

Thermal solar and storage

EN 15316-4-3:2007 only had a monthly method based on components data. Being monthly, it couldn't capture issues like storage overheating and system lock-down. This implied the hidden assumption that the system always worked fine. Additionally, the fundamental equation is a correlation derived for extensive simulations on a representative configuration. This made the method suitable for most energy performance calculation but useless for the sizing of components or to check special configurations.

The new EN 15316-4-3:2016 contains an hourly calculation method coupled with the hourly calculation of the connected storage. CEN-CE team added some custom development, that is part of the training, that enables to identify the overheating of the solar circuit and take into account possible issues due to insufficient storage volume, oversized systems, wrong settings or low use. The result is that the same calculation method can be used both for improved energy performance calculation and to check the sizing of the system. An example of identifying an overheating condition (e.g. insufficient storage volume and/or oversized collectors) is given in **Figure 2** which shows the results for three days of hourly calculation of a solar collector loop. In the first day on the left, the solar radiation is low (cloudy day) and the collector loop is working. In the next two day after seven hours

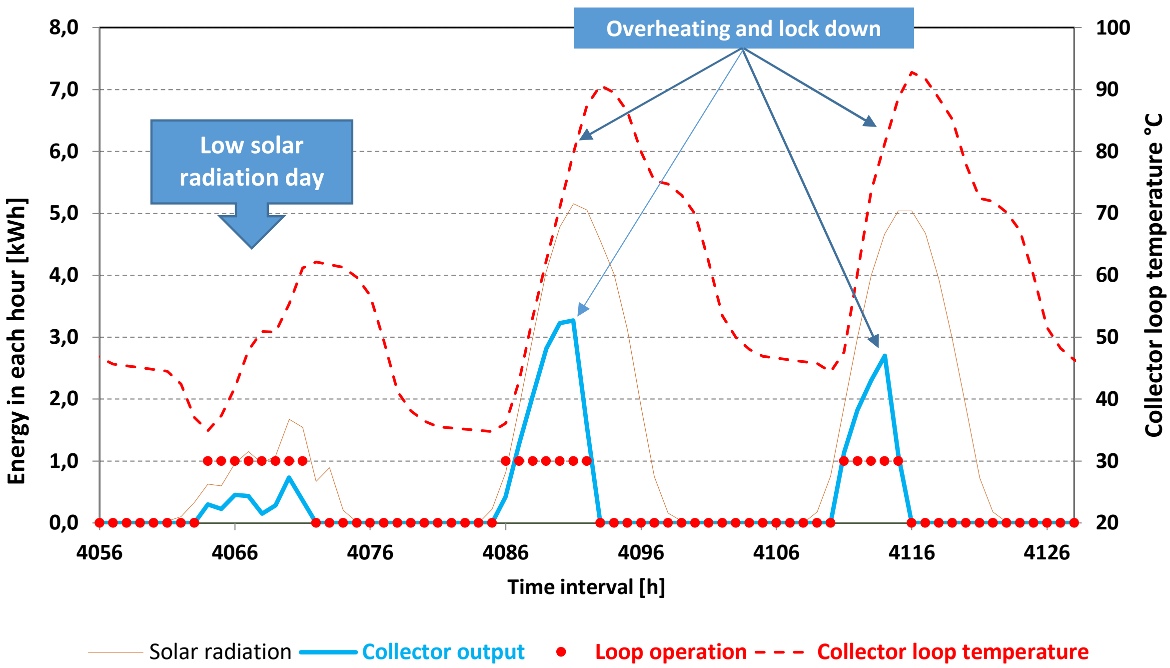

Figure 2. Identifying overheating and lock-down of collector loop.

of operation, the collector loop locks down. On the third day, the collector loop locks-down after three hours because the store was hotter (previous day complete heating). Data on back-up energy use will then indicate if the issue is low storage volume or collectors oversizing.

Operating temperature calculation

The efficiency of condensing boilers and heat pumps depends on the operating temperatures, return temperature to the boiler for the condensing boiler, flow temperature for the heat pump. In turn, these temperatures depend on the sizing of the emitters, on the type of hydraulic connection and on the control options. The general module for heating systems, EN 15316-1:2017, includes a systematic approach to calculate the operating temperature in all sections of the heating and domestic hot water system.

This allows one step further the basic design, which would use the heat load to determine the size of emitters. You may now check, based on the actual heating power that will be required in each calculation interval, the operating temperature and the efficiency of the heat generator. So, the design of emitters can be based on the desired maximum temperature of the heating fluid. **Figure 3** shows the result of such an approach.

The emitters are radiators and they have been sized so that the flow temperature will never exceed 45°C because the generator is a heat pump. The calculation shows that the return temperature to the generator is higher than the return temperature of emitters and distribution system because the flow rate in the generator is higher than in the distribution. This is no harm for a heat pump, it is for a condensing boiler, indeed.

This information comes from the energy performance calculation and is quite useful for the design.

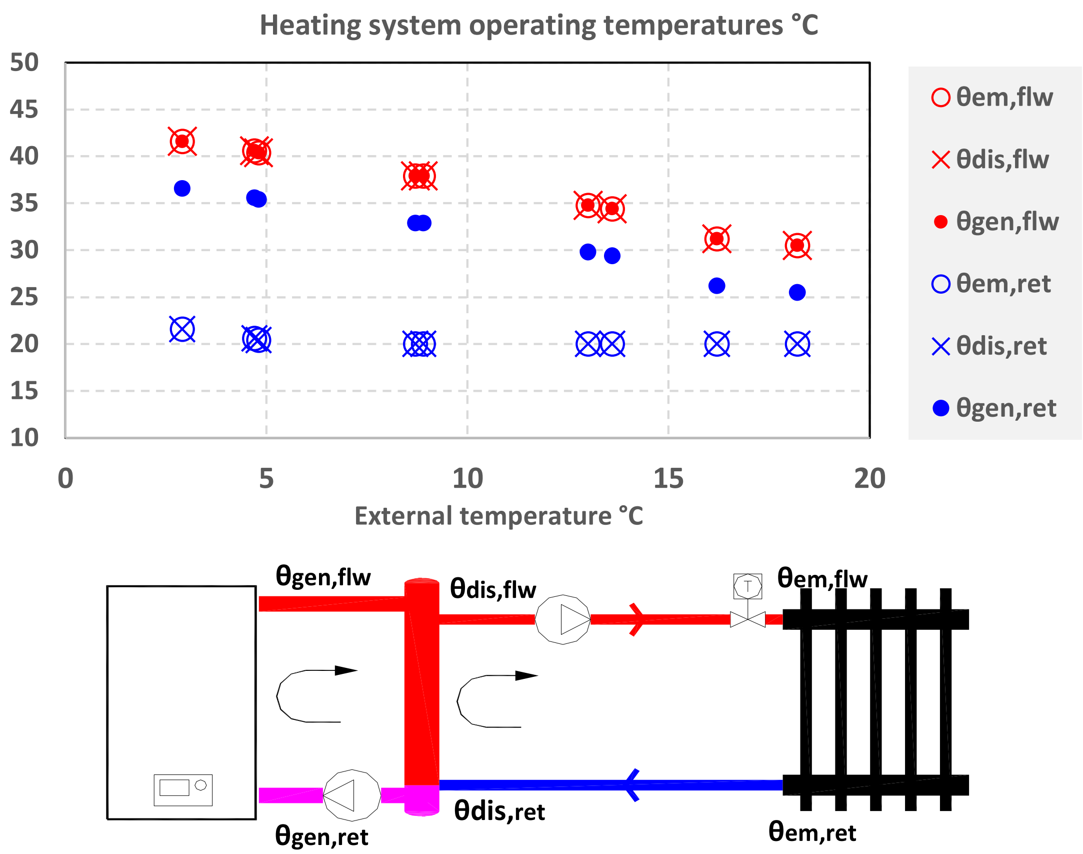

Figure 3. Operating temperatures of a heating system as a function of external temperature.

Cooling

Dynamics cannot be ignored when dealing with cooling in the mild European climate. It is common practice to use tabulated time series distributions of gains to determine the cooling load. This is effective but necessarily based on a limited number of precalculated time series. To be on the safe side, oversizing cannot be avoided.

EN 52016 allows a dynamic calculation which is specific for the building configuration and use, which may lead to less oversizing. Also, the test profile is not limited by the assumption of repeating the same cycle every 24 hours. A typical weekly profile can be used to include into the design analysis the recovery after a step-back in the week-end.

Again, the advantage of using EN ISO 52016 for the calculation of the cooling load is that this the same description of the building used for the energy performance calculation, both heating and cooling.

Ventilation and air conditioning

Sizing a ventilation and AIRCO system is everyday work. Introducing energy efficiency features and functions (free cooling, VAV, etc.) is more and more common practice.

However, very seldom the energy performance of the ventilation and air-conditioning system is investigated under all operating conditions. Some examples for that.

It is common practice to size the ventilation flow rate, the ducts, etc. Then a heat exchanger is installed to recover heat and maybe a by-pass for free cooling operation, which are both energy conservation measures. It is recent practice to evaluate how much energy will be saved by the heat exchanger, how much energy will be used by the fans to achieve that and the energy calculation method is still very rough. Trying to calculate how much energy is saved by the free-cooling depending on the control strategy is not that common.

In the Mediterranean climate in summer you may need more dehumidification than sensible cooling. You install AHUs with dehumidification function and then you may have fan-coils that can also contribute to dehumidification. The consequence is that you may have several control options. It is far from common calculating the behaviour of the whole, which has to be handled hourly.

The new EN-EPB package of standards has been designed natively to support hourly calculations. This allows to perform a representative calculation of the behaviour of technical systems. The calculation can be easily extended to design conditions for sizing purpose, you just need to define a "sizing profile" and run it (it could be a "design week") to be able to check if the system will made it and the load factor during the peak. You can do both a reasonable sizing and the energy performance calculation for legal purpose using the same description of the building, and this is good news.

Of course, there are more advanced modelling and simulation tools that are already used for research purpose and to solve special issues on important buildings. The real progress is when a technology is available to everybody and used. EN-EPB standards can bring the hourly calculation of all EPB services into the daily routine and make use of the same description of the building for sizing, energy performance calculation and compliance check, all in one.

It's an opportunity worth considering.

Conclusion

EN-EPB standards calculation methods cover both the building envelope and technical systems using the monthly or the hourly method. The energy performance calculation also provides a lot of information for the sizing. The nice thing is that it does not require an extra input effort: the amount of data is the same for the hourly and monthly approach and the most time-consuming task is describing the building envelope. You just need to avoid doing the same mistake as people reading a quotation: they go directly to the last figure at the bottom of the last page. The energy performance is the last figure at the bottom of the last page of an energy performance calculation report: there is a whole world of information inside. Don't miss it.

The CEN-CE training scheme is based on EN standards, it is not just a training scheme on these specific standards. CEN-CE scheme is designed to enable professionals to fully leverage the amazing amount of information that can be extracted from the energy performance calculation. That's why fundamentals and sizing and optimisation application were included in the course contents. ■

CEN-CE
CEN EPB Standards Certified Experts

Energy calculations CEN-CE

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Two interrelated CEN standards, EN 15316-5 (Storage) and EN 15316-4-3 (Solar thermal systems) are described along with the corresponding training materials, as an example of the work done within Task 3.3 of the CEN-CE project and applicability of the training materials. The proposals for considered CEN standards corrections and improvements are provided as well.

Keywords: energy calculation, CEN EPB standards, training materials, storage, temperature stratification, solar thermal system, parametric analysis

Introduction

Energy calculations are often formally required for issuing energy performance certificates (EPCs) and to obtain the building permit for new or renovated buildings, i.e. for verification of the national minimum energy performance requirements.

Design of nZEBs (Nearly Zero Energy Buildings) requires more detailed dynamic calculations with hourly time step, taking into account all technical system components and optimization of technical solutions. The new CEN EPB standards (ed.2017) enable to some extent such a step up from the previous edition (2007–2008) that was based on monthly steady state calculations.

As there is a lack of knowledge / skills among designers and engineers in energy calculations, especially for nZEBs and complex buildings/technical systems, an adequate training supported by the calculation tool is needed.

CEN-CE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785018. The sole responsibility for the content of this project lies with the authors. It does not necessarily reflect the opinion of the European Commission.

Task 3.3 of the CEN-CE project deals with the energy calculation of space heating and domestic hot water systems according to the new CEN EPB standards developed under M/480 in CEN TC/228 [1]. Also, on-site wind mills are included based on EN 15316-4-7 / TR 15316-6-12 Wind turbines.

The developed training materials for each standard comprise ppt presentations, handbooks, spreadsheets, commented input / output list of data, didactics for trainers, exam questions and answers.

In addition to the training purposes, CEN-CE training materials (handbooks, spreadsheets) can be used for correcting the first edition of new EN 15316 series [1] and in development of integral software for energy performance calculations.

Once the software is developed, it can be used not only for issuing EPCs and building permits, but also for optimizing technical systems at design stage (cost. optimal solutions), sizing of the system components (e.g. solar collectors, PV, boilers) and comparison with measured energy consumption.

EN 15316-5 (Storage)

One of the highlights of new CEN EPB standards [1] is a separate, stand-alone standard for the water-based space heating and domestic hot water (DHW) storage systems. As in the previous set of EPB standards (ed. 2007–2008) the calculation procedures included only monthly (and seasonal) methods, storage calculations were described within the energy generation sub-systems. In these calculation methods, the role of the storage tank was only to increase the thermal losses of the analyzed technical system (except in the case of solar thermal system calculations, where the volume of the storage tank is also used in the f-chart based methods)

EN 15316-5 [2] together with EN 15316-4-3 [3] are the only fully dynamic methods in the entire set of new EN 15316 series [1] and, as such, gives a dynamic character to the entire calculation method (emission, distribution, storage and generation sub-system). The standard describes two calculation methods: Method A and Method B. Method A considers temperature stratification inside a tank, while Method B treats the tank with a uniform temperature. Due to the multi-node model, Method A enables temperature stratification inside the tank which allows more realistic modeling of technical system and allowing better predictions of the renewable energy appliances operation (e.g. solar collector heat output, [4]). In this paper, the CEN-CE proposed procedure for Method A is described more in detail.

Calculation procedure

CEN-CE proposal of the calculation method based on the EN 15316-5 standard (**Figures 1 and 2**) is shown on flowchart on **Figure 3**. After determination of product descriptive and technical data, and system design data, the calculation procedure consists of 10 steps in total (one more than the in the standard).

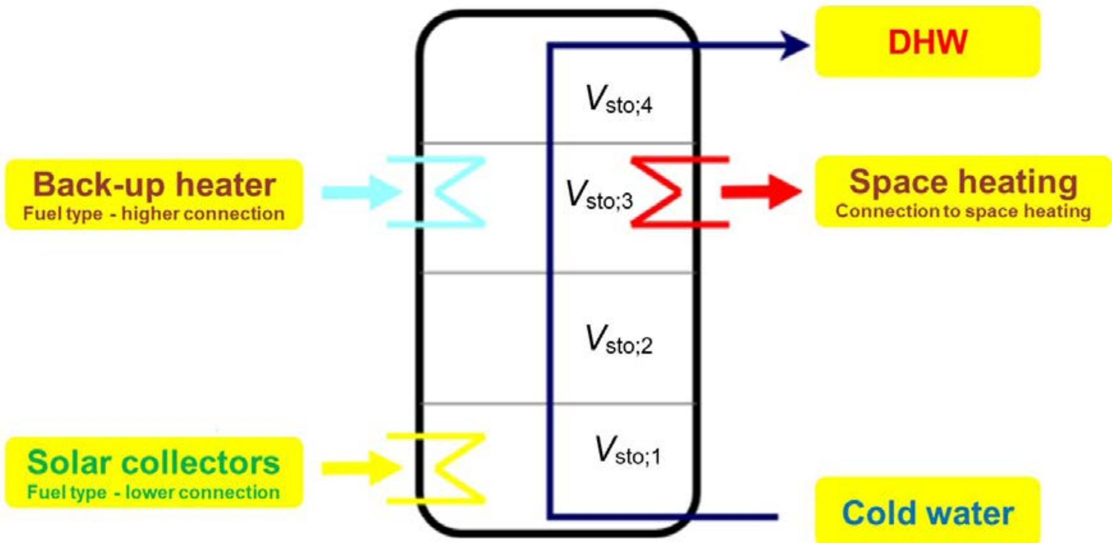


Figure 1. Graphical representation of a storage module mathematical model (Method A).

In the developed spreadsheet calculator, the volume of the storage tank is divided into 4 segments of arbitrary volume (**Figure 1**), although the described procedure can be applied to a user-defined number of segments. **Figure 1** shows standard solar storage tank, where entry of cold water and solar thermal collectors' connections are introduced in the lowest segment (Segment 1). Back-up heater and space heating connections are introduced in Segment 3. Exit of the DHW is introduced in Segment 4. Heating element can be modelled as internal (e.g. electric back-up heater), by heat exchanger (internal or external) or by direct connection of fluid. Position of each connection can be modified.

Step 1 – Initialization

In the first step, temperatures of each storage tank segments are collected from the previous hour (except the first hour in a year when the storage set point temperature can be used).

Step 2

Step 2 is, in some way, a modification of a procedure described in Annex D of the standard. The calculation of the withdrawn volume from the storage for DHW is calculated by taking into account stored $Q_{sto;W;vol,i}$ and usable $Q_{sto;W;vol;i;ubl}$ energy of each module:

$$Q_{\mathrm{sto;W;vol,i}} = V_{\mathrm{sto;vol,i}} \cdot \rho_{\mathrm{W}} \cdot c_{\mathrm{W}} \cdot \left(\theta_{\mathrm{sto;vol,i}} - \theta_{\mathrm{W;cold}}\right)\ [\mathrm{kWh}]$$

$$Q_{\mathrm{sto;W;vol;i;ubl}} = \begin{Bmatrix} Q_{\mathrm{sto;W;vol,i}} & if\ \vartheta_{\mathrm{sto;vol;i}} \geq \vartheta_{\mathrm{W;out;min}} \\ 0 & if\ \vartheta_{\mathrm{sto;vol;i}} < \vartheta_{\mathrm{W;out;min}} \end{Bmatrix}\ [\mathrm{kWh}]$$

Step 3

In the Step 3, full mathematical description of the calculation procedure graphically shown in Annex D of the standard has been developed within the CEN-CE project. The entire set of equations have been written in the Handbook and programed in the spreadsheet calculator.

In general, the total volume of withdrawn water from the storage tank unit is replaced with the identical quantity of cold water. It is assumed that the water of the upper module is ideally mixed with the quantity of withdrawn water at the temperature of the lower segment. This is graphically shown in **Figure 2**.

Step 4

Step 4 explains how to consider DHW distribution system losses when there is no DHW consumption (e.g. distribution losses of the circulation loop). These losses were not originally taken into account.

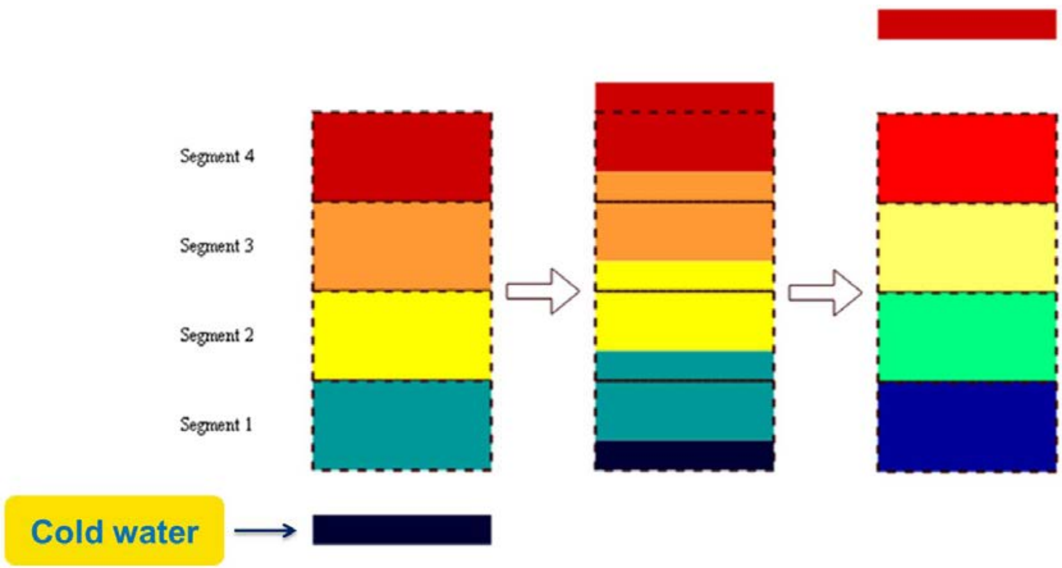


Figure 2. Graphical representation of Step 3.

Step 5
Energy supplied to space heating $Q_{H;out}$ is calculated by taking also into account simultaneous heating of the storage tank with the back-up heater:

$$Q_{H;out} = \min(Q_{H;sto;out;req}; Q_{sto;H} + Q_{sto;bu;max}) \quad [kWh]$$

where $Q_{sto;H}$ is total usable energy for space heating. Simultaneous heating of the storage tank with the back-up heater $Q_{sto;bu;max}$ has only been considered for Method B of the standard.

Furthermore, in the CEN-CE proposal energy stored for space heating service of each segment is moved from the Step 1 to Step 5 and can be calculated as:

$$Q_{sto;H;vol;i} = \max[\rho_W \cdot C_{p;w} \cdot V_{sto;i} \cdot (\vartheta_{sto;vol;i} - \vartheta_{H;out;min}); 0] \quad [kWh]$$

where usable energy $Q_{sto;H;vol;i;ubl}$ accounts only for energy stored in segments where the connection to space heating is placed and in segments below. This is also not clearly defined in the standard.

Step 6
In step 6, temperature drop caused by energy delivered to DHW distribution losses and space heating are calculated. Method uses simplification of storage unit mathematical model, employing only one segment for the energy and mass balance.

Step 7
Energy input from heaters to the storage tank unit are calculated in Step 7. CEN-CE proposed procedure takes into account maximum energy available from the heating element and the rise of heated water inside the tank (temperature stratification).

Step 8.
Mixing of the segments is described in Step 8. If the temperature of the segment *i* is higher than the one of the upper segments, two segments are ideally mixed.

$$\vartheta_{sto;vol;i} = \vartheta_{sto;vol;i+1} = \frac{\vartheta_{sto;vol;i} \cdot V_{sto;vol;i} + \vartheta_{sto;vol;i+1} \cdot V_{sto;vol;i+1}}{V_{sto;vol;i} + V_{sto;vol;i+1}} \quad [°C]$$

Originally written in standard, this iterative process is proceeded until the temperature of the segment *i* is lower or equal to the temperature of the segment *i*+1. In the CEN-CE proposal, a method for solving this iterative procedure in a defined number of steps has been developed. Thus, for 4 segments selected, 5 steps are required to obtain the final vertical temperature distribution. This procedure is especially convenient for implementing in the commercial software as it significantly shortens the time needed for calculation.

Step 9
Step 9 includes corrected procedure from the standard for determining the needed temperature regime of the generation sub-system. CEN-CE proposed procedure takes into account heat exchange rate of the heat exchanger ($H_{exh;i}$) and segments temperature ($\vartheta_{sto;vol;i}$):

Step 10
In Step 10 thermal losses of each segment and final temperatures are calculated.

EN 15316-4-3 (Thermal solar systems)

Standard EN 15316-4-3 is part of EN 15316 series [1] that defines calculation procedure to determine energy performances of solar thermal systems for heating of DHW and space heating, as well as of PV systems for electricity production. This standard provides six methods to calculate the energy performance from which three address solar thermal applications (Method 1, Method 2, Method 3) and other three address PV systems (Method 4, Method 5, Method 6). This paper deal only with solar thermal applications.

Method 1 allows to estimate the energy performance of solar DHW systems, using overall system performance data in conformity with product standards.

Method 2 is based on *f*-chart monthly method (as it was in older version of the standard) and it can be used to estimate the fraction of the required output energy covered by the thermal solar system. Method 3 is valid for the calculation of solar system thermal output that can be used for domestic hot water and space heating, using specific component data with a time step of one hour. It is important to note that this method takes into the account dynamic effects within the solar collectors.

In this paper, the CEN-CE proposed procedure for Method 3 is described in more detail.

Calculation procedure

The efficiency of solar thermal collector is related to the temperature of water in storage tank which calls for iterative calculation with Method A from EN 15316-5. In the first step, the average collector water temperature is estimated with assumed collector efficiency of 40% according to:

$$\vartheta_{\text{col;avg;h}} = \vartheta_{\text{sol;loop;in;h}-1} + \frac{0.4 \cdot I_{\text{sol;h}} \cdot A_{\text{sol}}}{\dot{m}_{\text{col}} \cdot c_{\text{W}} \cdot 2} \, [°\text{C}]$$

Calculation then enters iteration loop. In the first step the reduced temperature difference is calculated. Afterwards, the collector efficiency obtained from specific product data is calculated in dependence on the operating conditions (reduced temperature difference T^*_{h} and solar radiation $I_{\text{sol;h}}$):

$$\eta_{\text{col;h}} = \eta_0 \cdot K_{\text{hem}}(50°) - a_1 \cdot T^*_{\text{h}} - a_2 \cdot T^{*2}_{\text{h}} \cdot I_{\text{sol;h}} \, [-]$$

This standard provides default values for efficiency parameters, incidence angle modifier, first and second order heat loss coefficients. For more precise results product data efficiency parameters should be used. With calculated efficiency, thermal performances, such as collector output heat, heat losses can be calculated. At the end of iteration loop new average collector water temperature is calculated:

$$\vartheta_{\text{col;avg;h}} = \frac{\vartheta_{\text{sol;loop;in;h}-1} + \vartheta_{\text{sol;loop;in;h}}}{2} + \frac{Q_{\text{sol;loop;out;h}} \cdot 1000}{\dot{m}_{\text{col}} \cdot c_{\text{W}} \cdot 2} \, [°\text{C}]$$

The iteration is performed three times and after final iteration loop, the auxiliary energy consumption of solar pump and controller and recoverable thermal losses of the solar loop are calculated.

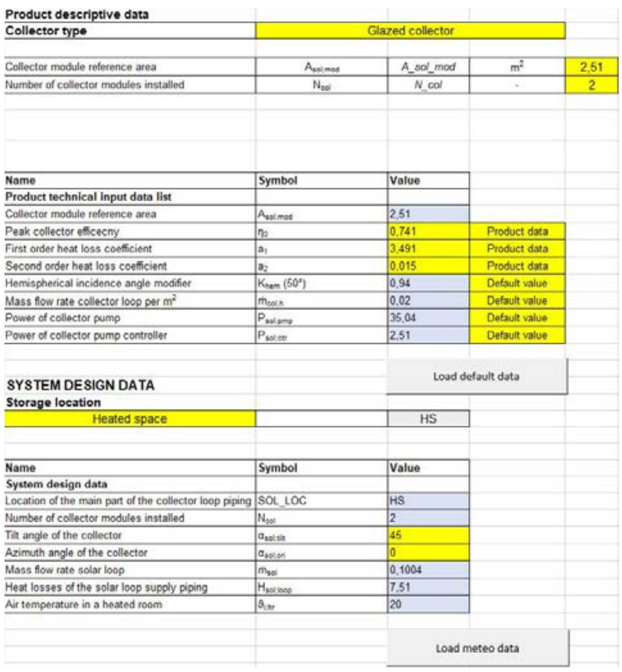
The novelty added by CEN-CE team to this standard is that stagnation operating regime is also included into the calculation method. At each time step, collector output temperature is limited with the reference temperature setpoint (e.g. 90°C). If the collector output temperature is above the threshold value, the absorbed incident solar radiation is not transferred to the storage tank. If the absorbed energy $Q_{\text{sol;stag;h}}$ is greater than collector heat losses $Q_{\text{col;ls}}$ at given temperature, the average water temperature in collector will increase until the collector heat losses become greater than the absorbed energy, when collector starts cooling down.

$$Q_{\text{sol;stag;h}} = \eta_{\text{col;h}} \cdot I_{\text{sol;h}} \cdot A_{\text{sol;mod}} \cdot t_{\text{ci}} \, [\text{kWh}]$$

$$Q_{\text{col;ls}} = A_{\text{sol;mod}} \cdot \Delta\vartheta_{\text{col}} \cdot (\text{a}_1 + \text{a}_2 \cdot \Delta\vartheta_{\text{col}}) \cdot t_{\text{ci}} \, [\text{kWh}]$$

CEN-CE Training materials: Power Point presentation, Handbook and Excel

For each series of standard, a PowerPoint, Handbook and Excel file are created. The concept of the handbook is that it follows calculation procedure created within Excel, becoming in this way a calculation algorithm. Handbook provides information about input data, calculation procedure, influencing factors and output data. Excel file uses several sheets to perform calculation described in standard. Each Excel file is designed to be used as a standalone module or in combination with other standards. The first and, for an user, the most important sheet is "Interface" **Figure 3** in which all information regarding solar collector e.g. type of the collector, heat loss coefficients, reference module area and number of collector modules, location of the main part of collector loop piping, orientation and tilt of the collector are defined. Sheets "Input series" and "Output series" are used to perform calculation for whole year or specific interval (e.g. only summer period). Sheets "Method input" and "Method output" provides information about input and output data to



Product descriptive data				
Collector type	Glazed collector			
Collector module reference area	$A_{sol;mod}$	A_sol_mod	m²	2,51
Number of collector modules installed	N_{sol}	N_col	-	2

Name	Symbol	Value	
Product technical input data list			
Collector module reference area	$A_{sol;mod}$	2,51	
Peak collector efficecny	η_0	0,741	Product data
First order heat loss coefficient	a_1	3,491	Product data
Second order heat loss coefficient	a_2	0,015	Product data
Hemispherical incidence angle modifier	K_{hem} (50°)	0,94	Default value
Mass flow rate collector loop per m²	$\dot{m}_{col;h}$	0,02	Default value
Power of collector pump	$P_{sol;pmp}$	35,04	Default value
Power of collector pump controller	$P_{sol;ctr}$	2,51	Default value

Load default data

SYSTEM DESIGN DATA

Storage location

Heated space		HS

Name	Symbol	Value
System design data		
Location of the main part of the collector loop piping	SOL_LOC	HS
Number of collector modules installed	N_{col}	2
Tilt angle of the collector	$\alpha_{sol;tilt}$	45
Azimuth angle of the collector	$\alpha_{sol;ori}$	0
Mass flow rate solar loop	$\dot{m}_{sol}$	0,1004
Heat losses of the solar loop supply piping	$H_{sol;loop}$	7,51
Air temperature in a heated room	$\vartheta_{i;hr}$	20

Load meteo data

Figure 3. Excel sheet "Interface" example.

the method, while in the sheet "Method calculation" calculation procedure for single time step is shown with the list of all applied equations and their reference to the handbook. Sheet "Output interface" (**Figures 4a, 4b and 5**) enables easy manipulation with calculated data (table and various graphical output data presentation). In **Figure 4a** the final step temperature stratification is shown for the hour when solar system starts heating up the tank. **Figure 4b** presents graphically all calculation steps for the case from **Figure 4a**. **Figure 5** shows chosen output data by user over a desired time period. In this particular case, backup heater and solar system operation periods during a day can be monitored vs. storage tank average temperature, which can be used in designing the system, e.g. for avoiding overheating, system control operation adjustment, changing of solar collector area and/or storage tank volume.

Power Point training presentation is structured in six major chapters: Introduction, Fundamentals, Input data, Calculation method, Output data and Example. Introduction gives a brief information about standard, what is calculated and relationship and interaction with other standards. In the next chapter Fundamentals detailed information regarding particular standard related systems, equipment and physics are provided, e.g. solar radiation, variance due to orientation and inclination etc. is given. Furthermore, collector types, how to obtain efficiency curves and influencing parameters on operation of solar collector are extensively discussed. Chapters Input data, Calculation method and Output data explains how to use Excel file for this method. Finally, in the last chapter, numerical example calculated with this method is presented, including parametric analysis.

Integral solar system & storage calculation: parametric analysis

As the collector efficiency depends on the temperature of the heat storage tank that is in turn related to the collector heat output, i.e. collector efficiency, calculation procedures described in EN 15316-4-3 and EN 15316-5 requires a detailed description of the standards interconnection. The iterative procedure is needed in order to determine the final calculation conditions. This interconnection described within EN 15316-4-3. In the CEN-CE project, a separate spreadsheet calculator was developed for connecting calculations between two standards.

Example calculation using EN 15316-5 and EN 15316-4-3 solar DHW system is shown in **Table 1**. The analyzed case is family house with 4 household members. The total solar collector area is 5.02 m². The parametric analysis, with the Case 1 (2 flat plate solar collectors, 400 ℓ storage tank) as a reference case, describes influence of the storage tank volume and type of collector on solar system energy output, i.e. on energy from back-up heater to be delivered to the storage as well as the solar system thermal efficiency. The parameter being changed is shown bold in the table.

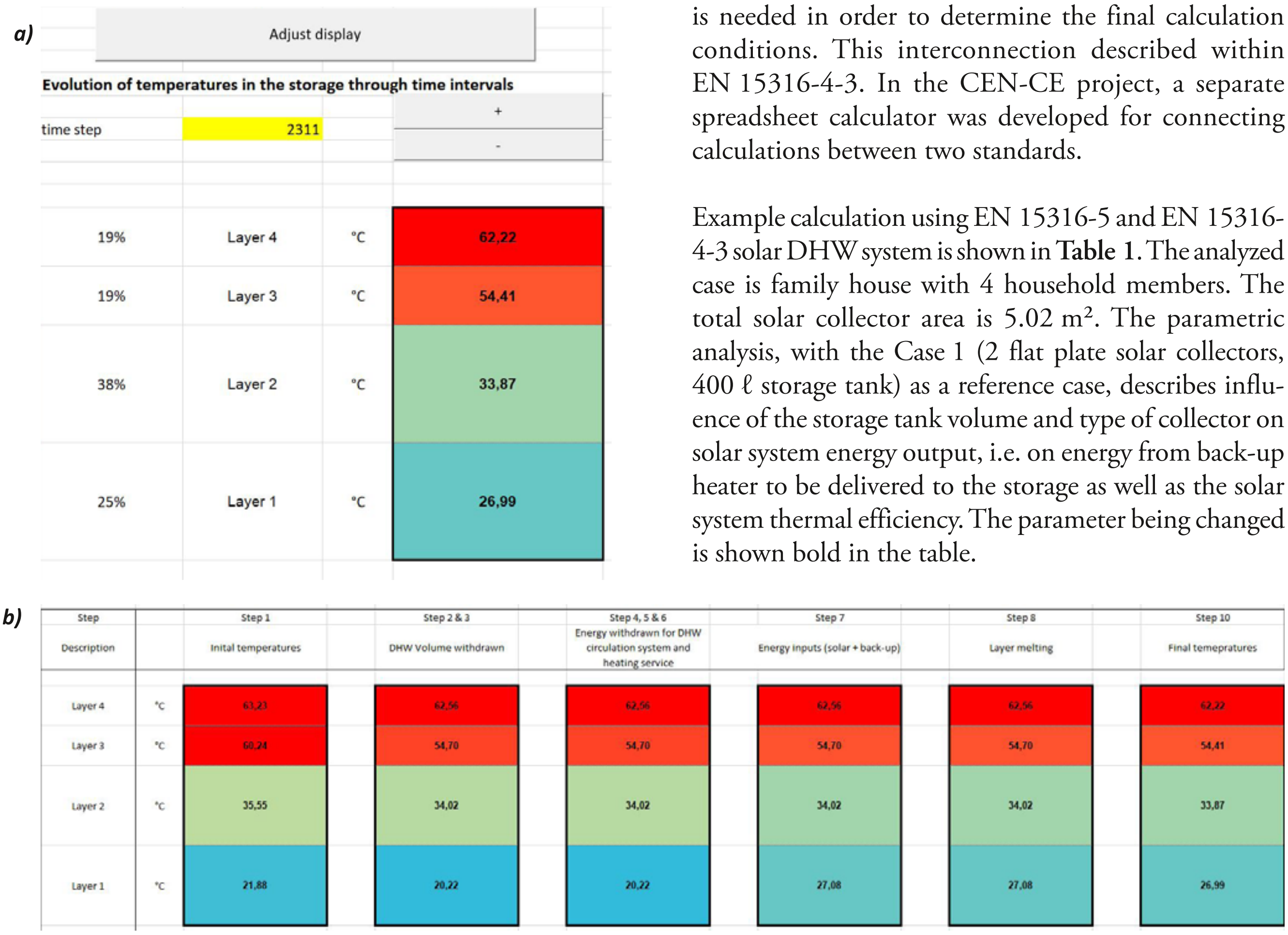


Figure 4. a) Storage tank temperatures in a chosen hour;
b) Insight of each calculation step temperature stratification).

In Case 2 storage tank volume is decreased. Compared to the reference Case 1, the energy input from solar collectors is lower due to reduced collector efficiency as a consequence of higher storage tank temperatures and overheating in the summer period. This entails higher amount of delivered back-up energy. In Case 3, storage volume tank is increased, resulting in the increased collector efficiency and consequently the higher input from solar collectors. The delivered back-up energy is also decreased in spite of the higher thermal losses of the storage tank. In Cases 4, 5 and 6, flat plate collectors are replaced with the evacuated tube ones. In the all cases, 500 ℓ storage tank was used with the various total collector area. In Case 4, the collector efficiency is notably the highest while the storage tank losses are the lowest, all as a consequence of the least pronounced overheating in the summer period and higher efficiency in the winter period compared to the cases with plate solar collectors. Although the total collector area in Case 6 is higher than in Cases 4 and 5, the delivered back-up energy is also higher, due to prevailing effect of longer overheating period in summer months (with no solar energy input and higher storage tank thermal losses).

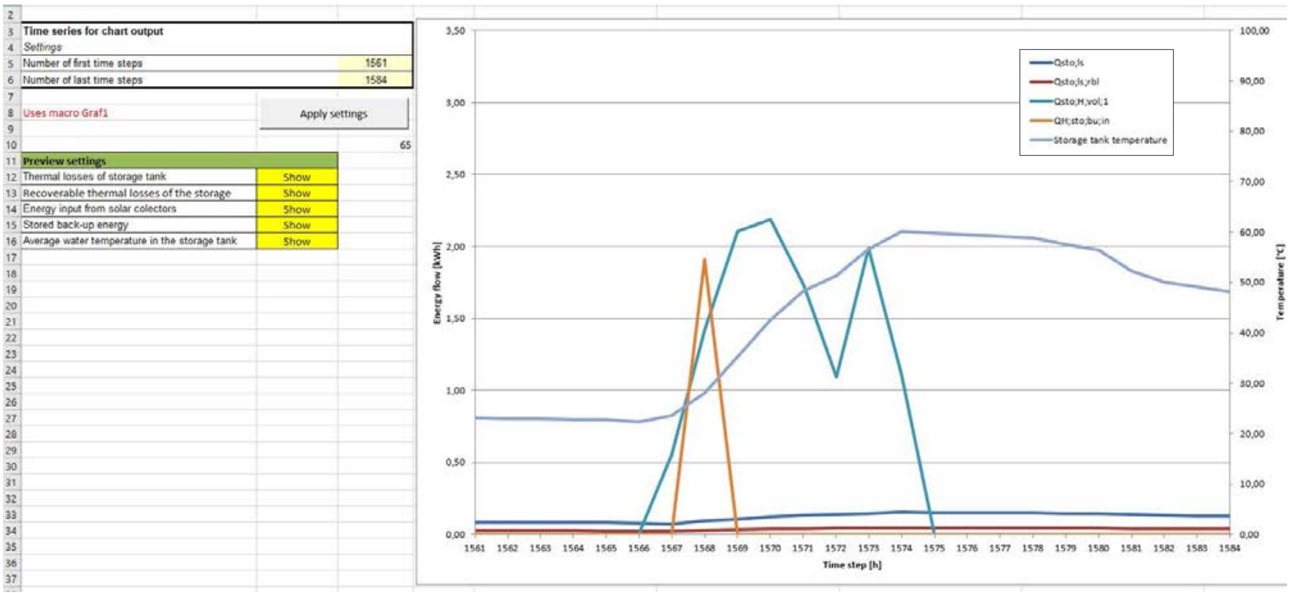


Figure 5. "'Output interface" sheet diagrams with energy output data in a selected time period.

Table 1. Parametric analysis results.

Input value	Unit	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Storage tank volume	ℓ	400	300	500	500	500	500
Daily energy required for DHW	kWh	4.8	4.8	4.8	4.8	4.8	4.8
Collector type	–		Flat plate			Evacuated tube	
Collectors reference area	m^2	5,02	5,02	5,02	3.48	4.64	5.02
Solar loop mass flow rate	kg/m^2s	0.02	0.02	0.02	0.02	0.02	0.02
				Output data (annual)			
Thermal losses of storage tank	kWh	655.1	520.1	705.4	598.9	723.0	792.2
Energy input from solar collectors	kWh	1813.5	1648.2	1912.9	1657.8	1835.31	1795.0
Delivered back-up energy	kWh	581.1	611.4	532.0	680.7	647.2	736.7
Average collector efficiency	%	25.8	23.4	27.2	34.0	28.2	25.5

To resume, comparison at fixed storage volume shows that Case 3 results in the lowest delivered back-up energy, while Case 4 in the highest collector efficiency. Direct comparison between plate (Case 3) and evacuated tube collectors (Case 6), at the same storage tank volume and total collector area, indicates better energy performances of the solution with plate solar collectors (less delivered back-up energy, lower storage tank thermal losses and higher collector efficiency).

Similar parametric analysis can be performed in each subsystem as a part of the overall system optimization. However, the final choice of the solar system configuration (and of the all other subsystems) is dependent on the overall system energy performance as well as on the economic aspects (equipment, installation and energy costs). ■

References

[1] CEN standard series 15316:2017 see: https://epb.center/support/overview-epb-standards/m3/

[2] EN 15316–4-3 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 4–3: Heat generation systems, thermal solar and photovoltaic systems, Module M3–8-3, M8–8-3, M11–8-3.

[3] EN 15316–5 Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 5: Space heating and DHW storage systems (not cooling), Module M3–7, M8–7.

[4] Piana, E., Grassi, B. and Socal, L., 2020. A Standard-Based Method to Simulate the Behavior of Thermal Solar Systems with a Stratified Storage Tank. Energies, 13(1), p.266.

ALDREN and CEN-CE

– Two EU projects grounding the EU Green Deal and Renovation Wave on EU standards and EU skills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To be efficient, the EU Green Deal must be consistent from the political top level to the application by qualified building professionals. For the EPBD, these coherence stops at 34 different national / regional implementation. ALDREN proposes a common EU wide building quality benchmark and CEN-CE an EU wide training and certification scheme based on EU standards.

Keywords: Green Deal, construction skills, Energy Performance of Building Directive, HVAC systems

From the EU to the national / regional level - a need for a coherent, comparable and reliable implementation of the Green Deal

There is a consensus in Europe that the Green Deal needs a clear associated taxonomy* defining the sectors, actions and targets to orientate and justify the related EU funding. Several taxonomies have already been worked out at high political level (EU Parliament, EU Council, EU Commission) and by the European Investment Bank (EIB).

The problem is that to realise energy efficient buildings, low carbon and healthy buildings in practise (and not only on the paper), the general taxonomies need to be completed by detailed technical rules and methods. This is well-known by HVAC professionals when designing HVAC systems.

As the Green Deal will be related to EU funding, it should be associated to a common EU wide Building quality benchmark. There is a need for transparency, technical neutral assessment and EU wide comparability to measure the results. The effort and results cannot be measured with different metrics.

It is not surprising that the taxonomy defined at the highest EU level is a general framework. This is also the case at national level. The approach is top-down: from the law, to the decree, to the regulation, to the technical rules. But at EU level this "top – down" approach is sometimes stopped at Member State level.

For some directives (e.g. the Ecodesign Directive) the implementation is straightforward, from the EU level to the national application. There is no possible deviation at national level. This is not the case for the Energy Performance of Building Directive (EPBD). For the EPBD the final implementation is made at national / regional level. Therefore, there are today 34 different methods, 34 different metrics in Europe.

To implement the Directive at the national level not all Member States have the same experience, the same

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* Taxonomy is the process of naming and classifying into groups within a larger system, according to their similarities and differences.

funding capacities. These differences are among the reasons why there are now in Europe different qualities of implementation, without any possibility of comparison: the m², the kWh primary energy, the calculation methods, the way how to export energy, the way how to define renewables, all is different.

Hereafter these differences are illustrated by an example. The EPBD requires that "*the energy performance of a building shall be expressed by a numeric indicator of primary energy use in kWh/m².y*". But the EPBD does not provide the assessment method neither the associated boundary conditions. As mentioned, this is done 34 times at the national/ regional level. **Figure 1** shows that for the same building, the same climate, the numeric indicator of primary energy may vary from 73.5 kWh (a rather normal building) to minus 5 kWh (a nearly zero energy building), only by changing the boundary conditions.

How in that case the EU policy objectives can be coherently implemented and measured?

The European Commission is aware about the need of improving the reliability of the transposition. This is underlined in the revised Directive EPBD 2010/31/EU (2018/844/EU). To reach a more harmonised transposition and to support the Member States in implementation, the EU Commission funded European Standards (Mandate 432 and Mandate 480) and European projects (e.g. H2020 projects ALDREN and CEN-CE). The use of standards and project outcomes, based on the best available European practice, would allow a coherent, comparable, reliable implementation and at the same time still consider potential national / regional characteristics of building.

ALDREN in a nutshell

The ALDREN project (ALliance for Deep RENovation in Buildings) is the extended development and the implementation of the European Voluntary Certification Scheme (EVCS) for non-residential buildings based on the EPBD Art. 11 (9) and CEN / ISO standards.

The core objectives of the ALDREN project are:

- to provide a harmonized European energy performance rating methodology, based on the European Voluntary Certification Scheme (EVCS),
- to design and verify by measurements the deep renovation energy performance in order to increase comparability and confidence by standardized solutions (CEN/ISO standards). We should definitely reduce the gaps in between predicted (calculated) and actual energy performance and make all efforts to avoid a "Buildinggate".
- to associate low energy renovation with high quality indoor environments (ALDREN TAIL) to promote solutions supporting health and well-being. A step-by-step renovation process is integrated in a Building Renovation Passport, the ALDREN BRP;
- to align market recognition of high quality with enhanced building value and capacity building.

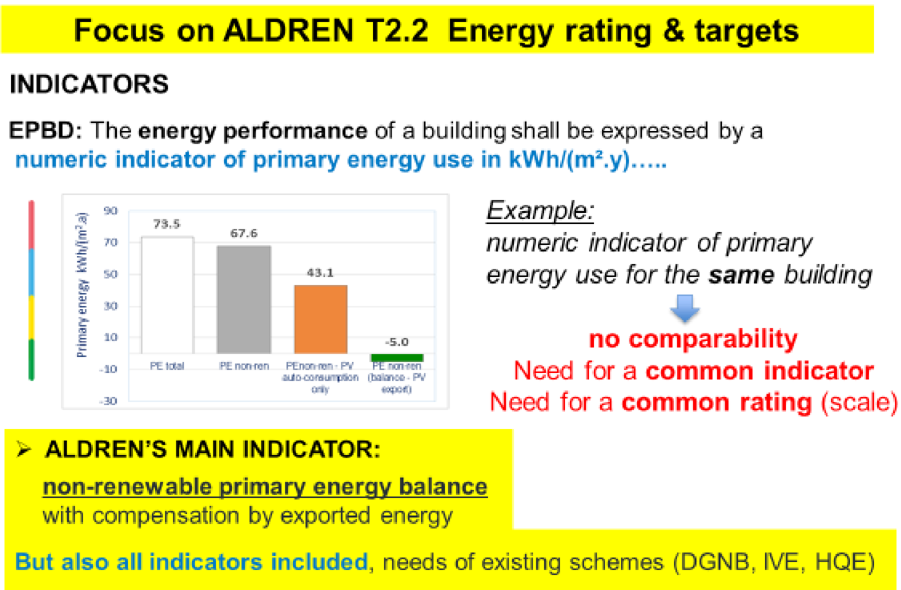

Figure 1. Indicators expressed in primary energy (total, non-renewable) and on the consideration of photovoltaic electricity production and export.

The ALDREN outcomes support directly the EU policies. The non-residential sector (office buildings and hotels) is to be considered as a first step.

ALDREN is a holistic approach tackling not only energy performance, but also health /wellbeing and finance. Theses aspects are also requested by the revised EBPD amending Directive 2010/31/EU which must be transposed at national / regional level.

Table 1 shows how the different ALDREN tasks (T2.1-T3.2)

Table 1. ALDREN outcomes supporting revised EPBD.

DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 **amending Directive 2010/31/EU** on the energy performance of buildings and **Directive 2012/27/EU** on energy efficiency

	T2.1 Overall integration	T2.2 EVCS	T2.3 Measured energy	T2.4 Health Wellbeing	T2.5 Financial evaluation	T2.6 Building passport	T3.2 Training
Art 1 Amendments Directive 2010/31/EU							
'(1) Article 2							
'(2) Article 2a Long-term renov. strategy							
'1 highly energy efficient and decarbonised building stock by 2050,							
(b) cost-effective approaches considering potential relevant trigger points,							
(c) introducing an optional scheme for building renovation passports;							
(f)… as well as skills and education in the construction and energy efficiency sectors;							
(g) evidence of expected energy savings and related to health, and air quality.							
2. roadmap with measures and measurable progress indicators							
(4') Article 7 existing buildings							
high-efficiency alternative systems and shall address healthy indoor climate'.							
(5) Article 8 Technical building systems,							
'1 overall energy performance, proper installation, appropriate dimensioning,							
(6) Article 10							
'6. link their financial measures to the targeted or achieved energy savings							
6a. Databases for energy performance certificates shall allow data to be gathered							

address the recast EPBD requests and support the transposition at national level.

CEN-CE – training expert on common methodologies

ALDREN provides a common methodology, the EU building quality benchmark. This is the needed first step of harmonisation. The second step is to bring the methodology into application, into professional practise. Therefore, a qualified building workforce and training is needed.

CEN-CE provides an EU wide training and certification scheme for HVAC professionals. CEN-CE focus on the following parts of the ALDREN outcomes:

- the energy performance assessment based on European standards. CEN-CE train HVAC professional on CEN TC228 standards (EN 15316 and EN 12831 series) and EN ISO 52000;
- cost optimality. CEN-CE train HVAC professional on EN 15459;
- measured energy and inspection. CEN-CE train HVAC professional on EN 15378 pArt 1 and 3.

The CEN-CE project is described widely in this special issue of REHVA Journal.

Resume

To be efficient, the EU Green Deal for building renovation must be coherent form the political top level to the application by qualified building professionals in practise. To be coherent, the taxonomy is to be based on one single and common method (one common EU building quality benchmark) developed from the European best practice (the European Standards). The EU building quality benchmark must be precise and detailed, without any ambiguity so that the EU Green Deal can refer to it (European funding should be linked to European methods). This is the proposal of the ALDREN methodology.

The common ALDREN methodology will facilitate recognition of the professionals skills EU wide. Then the European professionals would be able to be trained on and to work with the same European tools. Qualified and upskilled experts will be the guarantee that the European Commitments on energy saving and CO_2 emissions are reached in reality.

ALDREN is contributing to display the quality of buildings and CEN-CE to increase the skills of European professionals. Both favour innovation by creating a European level playing field and quality jobs. ■

REHVA-guidebook No. 30: Hygiene in potable water installations in buildings

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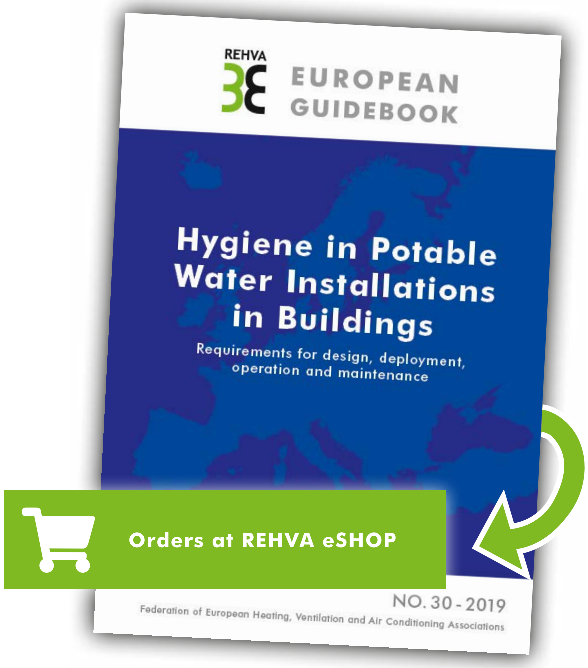
The interrelationships between water quality, health and the well-being of users require that all parties involved have a specific responsibility for aspects of hygiene in specifying the requirements for potable water installations in buildings. This guidebook gives an overview about the fundamentals of hygiene and water quality and contains the main information on the design, installation, start-up, use, operation and maintenance of potable water installations in buildings. It gives also suggestions for the practical work (maintenance, effects on microbiology, potential causes and measures in practical work, checklists). It is a useful guide for hygienic planning of water piping systems inside buildings. All requirements described in this guidebook apply equally to existing buildings, particularly in the case of conversions, extensions and demolition.

Statistics generated by the World Health Organisation (WHO) show that globally people cannot assume that these standards for potable water are being met. Diseases related to contamination of water cause a significant burden in human healthcare. Interventions to improve the quality of water provide significant benefits to health. Even in the European WHO sector, many people suffer with discontinuous supplies of water as well as aesthetic-related and health-related quality issues for potable water. The most significant worldwide contributory factor is microbiological contamination of water (that, in particular, causes infection of the gastrointestinal tract), which mean that its control must always be of paramount importance.



The most effective means of consistently ensuring the safety of drinking water supplies is through the use of a comprehensive risk assessment and risk management approach incorporated in a Water Safety Plan (WSP) that applies to all steps of a water supply, including the distribution system. In the case of distribution systems, it is assumed that water is safe to drink at the point of entry, so the aim becomes to maintain safety by preventing contamination after treatment. In simple terms, this includes:

- constructing systems with materials that will not leach hazardous chemicals into the potable water;
- maintaining integrity to prevent the entry of external contaminants;
- maintaining the supply of potable water to consumers; and
- maintaining conditions to minimize the growth of microbial pathogens (e.g. *legionella*) and biofilms, scaling and accumulation of sediments.

Hygiene means the totality of all efforts and measures taken to prevent direct or indirect impairments of health and well-being (discomfort) in individual users. The goal is to maintain proper water quality within the building's water installations. The REHVA-guidebook applies to all water installations on sites, in buildings and on ships (sanitary distribution system). A high standard of water quality has been taken for granted as something that can be relied on for many decades. It is generally expected that water may be used at anytime and anywhere and without endangering our health – if possible, for drinking but also for other purposes such as washing, cooking, cleaning, sport etc. Central waterworks supply over 95% of the population with potable water round the clock and with virtually no interruptions. Potable water is available to us at home and at work wherever we need it.

In most cases, under poor conditions, a multiplication of all microorganisms including pathogenic bacteria results in hygiene issues that are attributable to technical deficiencies. The growth of the biofilm plays a decisive role here, in particular regarding the subsequent removal of the microbiological contamination. The following examples list technical deficiencies which may pose hazard factors that exacerbate microbiological contamination (bacterial growth, release of microorganisms relevant for hygiene) in the cold and hot water systems of buildings:

- Improper storage and transport of components (damaged packaging of components)
- improper design (over-dimensioning of storage and pipes)
- improper commissioning (delays between filling and use)
- stagnation (disuse, dead legs)
- use of unsuitable materials and components (hoses and uncertified materials and components)
- incorrect material combination (corrosion, dezincification)
- defective system components (e.g. heat exchanger, circulation pumps)
- pump capacity and balancing valves not adjusted
- corrosion damage or significant limescale in the pipes
- temperatures below 55°C in the hot water system
- temperatures in excess of 25°C in the cold-water system
- insufficient thermal insulation of pipes
- hygienic deficiencies at the taps (e.g. aerators)
- sources for nutrients, e.g. polyphosphate by dosing corrosion inhibitors
- lack of regular inspection and maintenance

The concentrations of the metals lead, copper, and nickel in potable water samples taken from the consumer's extraction point ("tap") primarily depend on the following influencing factors:

- materials employed in the water installations in buildings,
- design of the water installations in buildings, operating conditions (flow and stagnation times, consumer behaviour),
- age of the potable water installation,
- chemical and physical properties of the potable water.

Maintaining potable water quality

For maintaining water quality basic requirements that should be applied to potable water installations in buildings:

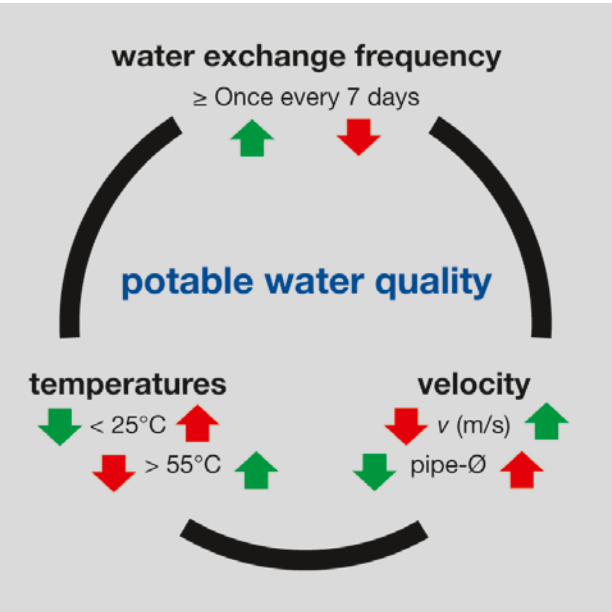
- Suitable pipe materials
- Delivering potable water
- Matching demand (comfort) – water quantity, temperature and noise control (avoidance of excessive flow velocities)
- Reliable system operation and good value – safe, sustainable, energy-efficient

These requirements are the classical goals, while the last one - energy-efficiency in relation to hygienic water quality - only came into focus in recent years.

Cold water should flow from an outlet with a temperature of less than 25°C. It is assumed that for the normal water consumption no critical growth of microorganisms takes place below this temperature. *Legionella* bacteria rank among the most important sources of environmental infections in all buildings, especially in installations with a centralised water heating system (but also decentralized). Their preferred habitat is heated, stagnant water, e.g. in pipes and stores, where they can proliferate best at temperatures between 25°C and 50°C. While *legionella* can occur in cold water, they are unable to proliferate at temperatures under 20°C (low risk). It is also known from practical experience that evidence of *legionella* is very rarely found with potable water temperatures under 20°C (they may also be present in a VBNC (viable but not culturable)-state). Circulation systems for potable hot water are to be operated in such a way that temperatures of at least 55°C are maintained in all individual sections, but local national regulations have to be observed.

Water exchange is defined as a complete exchange of the water volume contained in the respective pipe section by consumption or draining. Water in the installation should be drawn through every tap at least once every seven days.

Potable water installation should have the smallest possible water volume and should enable an effective, hygienically appropriate, water transfer – without stagnating pipe sections. The pipe network should be designed as simply and clearly structured as possible. To avoid dimensioning which might jeopardize hygienic operation, the design of the potable water system should be specifically tailored to requirements in consultation with the client.



Interdependency triangle for maintaining potable water quality. [According to Kistemann et al. 2012]

From the beginning of the design the hygienic aspects have to be taken into account. It is referred to the intended use of the building (or segments). A detailed sanitary room book can be coordinated with the owner of the building including a description of the intended use, and a comprehensive concept of the potable water installation.

It would also be recommended to approach projects with an "integrated design" concept (BIM = Building Information Modelling), that would also include in the initial building/space/room planning the structural architect, designers, contractor and the responsible operator (the project team). The position and types of lights, windows, glazing and any covering materials are likely to have an impact on water temperatures in piping systems (thermal radiation and heat transmission).

Minimum requirements to be met by the room sanitary room book as part of the room data sheet. In particular the following must be documented:

- use of the room, in particular temperatures to be expected
- number and type of taps
- frequency of use (expected simultaneous use)
- location and number
- backflow prevention (if required)
- maintenance requirements

The planner has to provide at least the following:

- arrangement of the pipes giving particular consideration to the temperatures (cold potable water: as cold as possible with a maximum of 25°C, hot potable water at least 55°C)
- materials in contact with the potable water
- required sampling points/taps (see below)
- connection(s) to extinguishing and fire protection systems as per national regulations
- protection of the potable water according to EN 1717
- accessibility for maintenance
- space requirements

Examples for Technical deficiencies and their potential effect on the hygiene quality of the potable water installation. [according to DVGW-worksheet W 556]

Type of deficiency	Deviation from	Potential effect on the microorganisms [a]							Comment
Use of unsuitable components	Technical rules (e.g. EN 806, EN 1717)		2	3	4	5	6		Depending on the type of unsuitable component
Defective components (e.g. hot water tank with decomposing coating, safety and safeguarding fittings)			2	3		5	6		With temperatures > 60 °C, the abnormality has no negative effects on microbiology
Connection to non-potable water systems	EN 1717		2	3	4	5			Exposure of the potable water to risks depending on the non-potable water connected to the installation
Critical temperature range (cold potable water > 25 °C, heated potable water in the circulation system < 55 °C)	CEN/TR 16355, EN 806-2		2				6		Lack of hydraulic balancing of the pipes in the circulation system, lack of thermal insulation of the pipes for cold or heated potable water, e.g. in the circulation system
Use of unsuitable materials	EN 16421		2	3		5	6		Depending on the type of unsuitable material
Missing or improper labeling of the pipes; disturbances	EN 806-4	1							There is the risk of impermissible connections with non-potable water systems, resulting in the following microbial disturbances
Non-intended use, stagnation, lack of regular flow-through of the pipelines	EN 806-2, EN 1717		2	3	4	5	6		Subsequent modifications to the potable water installation, e.g. excessively low consumption, water saving measures, stagnation
Slimy-sludgy coatings	EN 16421		2	3		5		7	Material not suitable for potable water
Connection of firefighting water or emergency water supply	DIN 1988-600		2	3		5			Insufficient water exchange, retroactive effects
Connection of eye and body showers	EN 1717		2	3		5			Insufficient water exchange, retroactive effects
Missing, defective, or improper safeguarding devices	EN 1717		2	3		5	6		Hazards for the potable water quality due to non-potable water and other factors
Unused pipelines, „dead legs“	EN 806		2	3		5	6		Extraction point has been removed

[a] Explanation on the table: 1 = none, 2 = heterotrophic plate counts, 3 = coliform bacteria, 4 = E. coli, 5 = Pseudomonas aeruginosa, 6 = Legionella spec., 7 = fungi and protozoa

Pipe sizes shall be calculated as specified in EN 806-3 and/or national standards or regulations. Recent research has shown that DIN 1988-300 provides a better fit for real water consumption than does EN 806-3. Simultaneous water demand is determined as a function of the data given in the sanitary room book (type of use).

The maintenance measures required for ensuring hygienically proper operation must be taken into account in maintenance planning to cover all valves, apparatus and water pipes planned and installed in the building. The intended operation of a potable water installation, as per the sanitary room book, must be ensured. Periodic, competent maintenance of a potable water installation is required for the intended operation to be hygienically acceptable. The operator shall rule out any risks that may ensue from the operation of the potable water installation, giving particular consideration to the organisational responsibility and the duties to maintain safety.

As required by national requirements, building administrators, owners and managers should regularly undertake and refresh the risk evaluation as circumstances demand. This should be revised in case of refurbishment, change of building use/destination or detection of an infection. Depending on the output of the risk evaluation, a control and maintenance plan shall be drafted. The control plan includes sampling operations, which means that from the outset of the project plan, those sampling points should be anticipated and located at appropriate points.

In order to keep a water system as safe as possible, all relevant risk factors should be considered at the start of the project, during the design stage. A project team should be established, including all relevant parties, ranging from the investor to the architect through to the planner and contractors. Correct sizing, positioning, installation and commissioning and use that conforms to the intentions of the initial project: these are all important steps to ensure good water quality. Disinfection may take place when needed, in case of bacteria growth that has been detected after scheduled water sampling, or after particular consideration, possibly by continuous disinfection however a general statement cannot be provided as it will be site specific. If water is contaminated due to stagnation, disinfectants are unlikely to reach sections where water flow is poor (as would also apply for thermal shock). It is clear that, in this case, filtration at the point of use should be considered. Also, piping material reaction with chemical disinfectants must be considered, as oxidation and corrosion leads to the creation of nutrients for bacteria.

Maintenance measures for potable water installations in buildings include preventive maintenance, inspection, corrective maintenance and improvement. They shall be carried out when a defect has occurred (corrective maintenance), at a defined interval (inspection and preventive maintenance) or for specific reasons (improvement).

The type and scope of all the required maintenance measures shall be specified, taking into account the potential hazards and the instructions given by the manufacturers of the systems, valves or apparatus, in the maintenance plan or in a sub-plan's preventive-maintenance plan, inspection plan or hygiene plan.

Technical deficiencies may indicate a potential microbial contamination. To determine whether there is such contamination, microbiological investigations are required. For example, the table show examples for various technical deficiencies which, as experience has shown, may affect the microbiological situation in the potable water installation. The effects on microbiology are similarly shown by way of example. The effect of these deficiencies on human health must likewise be evaluated. The evaluation of health risk requires hygiene-medical expert knowledge.

The information in this chapter also provides pipe system operators with information which allows them to take immediate measures at an early stage or to initiate detailed examinations for identifying the causes.

Conclusion

Because of the significant relevance of water quality to healthy living and working conditions, effective communication and agreement are essential between all parties responsible for design and construction, operation and maintenance. Health risks cannot be ruled out if the necessary technical and hygiene requirements are disregarded, if the water installation is not operated as specified, or if water installation maintenance activities are neglected.

We should, by no means, assume that drinkable water is available as a matter of course: On the contrary, it is something to which we should pay significant attention. We need to keep in mind that it requires a great deal of scientific, technological, regulatory and operational effort and care to ensure that people have access to high-quality water. ■

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An analysis of the transmission modes of COVID-19 in light of the concepts of Indoor Air Quality

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Introduction

The doubts raised by the author regarding the importance that health authorities, both nationally and internationally, give to the role that different modes of transmission play in the spread of viral infections and the consequences that may arise from this were the main motivation for writing this text.

It has been repeatedly affirmed that the transmission takes place mainly by contact and through the drops that, emitted by the infected person, reach the sensitive receiver in its path, so that a safety distance of the order of 1 to 2 m is maintained, the risk of contamination and spread of the disease will be greatly minimized.

The author considers that, without there being scientific evidence to justify it, the role that can be played by transmission through the airborne particles mode has been diminished and that, consequently, some of the protective measures that, probably, have been discouraged in some European countries, will be at the basis of the more modest epidemic spread rates in some Asian countries.

Particulate Matter in Indoor Air

While there is no doubt that the Corona virus SARS 2, which originates the disease COVID-19, is transmitted mainly through the particles exhaled by infected patients, it is important to start with a basic explanation of how the particulate matter, usually designated by the acronym PM, is classified. When we are referring to particle size classes, after PM a number is written that corresponds to the equivalent diameter expressed in microns (1 µm = 0.001 mm). Thus, for example, the designation PM10, should be understood as the set of all particles with a size less than 10 µm in the air sample that we are analysing.

Figure 1 shows the main types of particles present in indoor air, classified according to their size ranges.

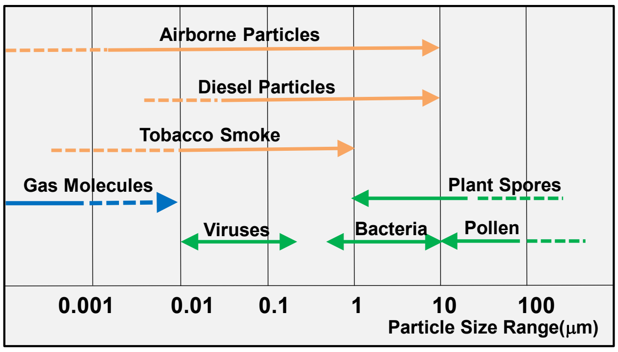
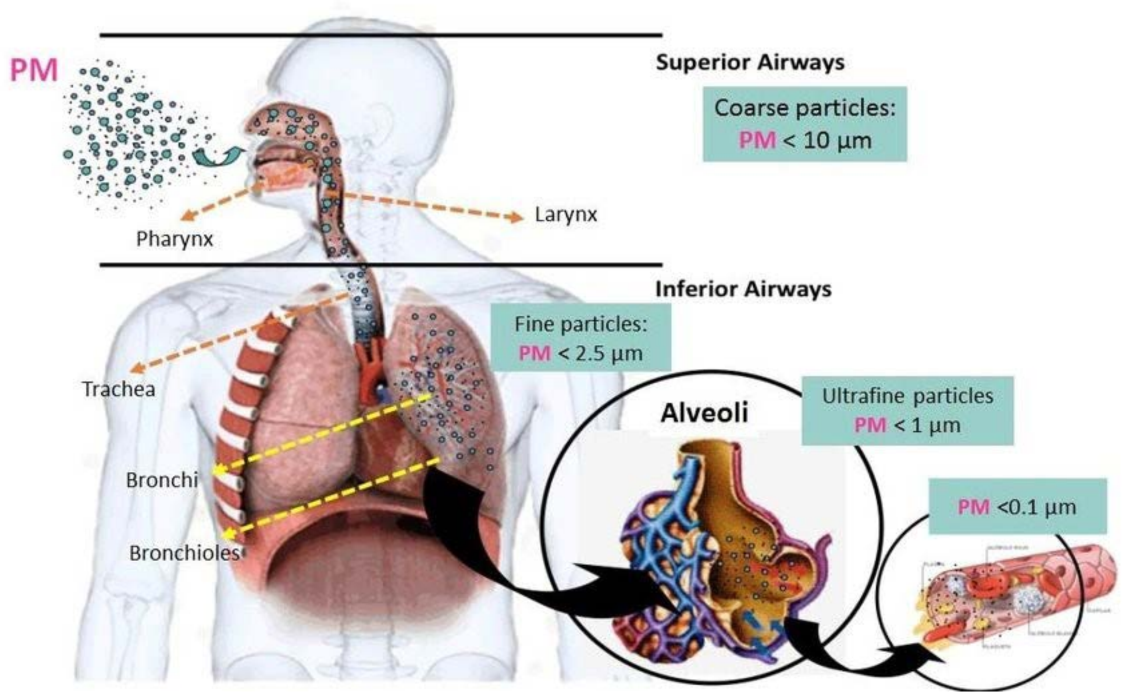


Figure 1. Size ranges of the main types of particulate matter in indoor air.

In terms of how these particles interact, from a strictly physical point of view, with our respiratory system, they are classified, according to their level of penetration, into inhalable, thoracic and breathable, being the correspondence between this classification and the size ranges shown in **Figure 2**. The inhalable particles are retained in the hair existing in the nose or by the mucus in the oral, nasal or larynx cavities. The thoracic particles are able to penetrate up to the trachea and the bronchi, being retained by the mucus that exists there, while the breathable particles go until the bronchioles and the alveoli. Regardless of their degree of infectivity, from a strictly physical point of view, the most dangerous particles are the smallest ones, since they can lodge in the alveoli and cause their clogging, preventing or harming the gas exchanges carried out there, fundamental for human life.

Depending on their size, particles can behave differently in relation to their trajectories in the air. This diversity of behaviour results from the different balances between the forces that act on the particles in their movement in the air. The main forces that are considered to act on a particle are the force of gravity and the aerodynamic forces. The relationship between these two types of forces is different according to the size of the particles,



Diameter (µm)	Penetration Level	Classification
> 7	Oral and Nasal Cavities	Inhalable
4.7 – 7	Larynx	
3.3. – 4.7	Trachea and Bronchi	Thoragics
2.1 – 3.3	Secondary Bronchioles	
1.1 – 2.1	Bronchioles	Breathable
0.65 – 1.1	Alveoli	

Figure 2. Classification of particles according to the level of penetration into the respiratory system.

with the result that, for equivalent particle diameters smaller than 10 µm, the aerodynamic drag forces are more important than the forces of gravity (the weight of the particle), and, thus, the particle floats, following the flow current lines, in a similar way to what happens to a surfer when surfing a wave. In the case of larger particles, their trajectory is usually parabolic, and they will settle on the ground or other surfaces, because the force of gravity, due to its weight, is greater than the vertical component of the aerodynamic force. The greater or lesser distance travelled horizontally by the particles will depend on their size, the flow velocity field and also on their initial velocity. These different types of behaviour are shown in **Figure 3**.

The justification for what was previously described, results from the fact that the aerodynamic resistance coefficient of a spherically shaped body is not constant, relatively to a dimensionless coefficient called Reynolds number. This coefficient represents the relationship between the pressure forces and the viscous forces that originate from the interaction of a body with a fluid. In its calculation one of the variables is a geometric dimension characteristic of the body, in this case the diameter. Thus, in the graph shown in **Figure 4**, if we

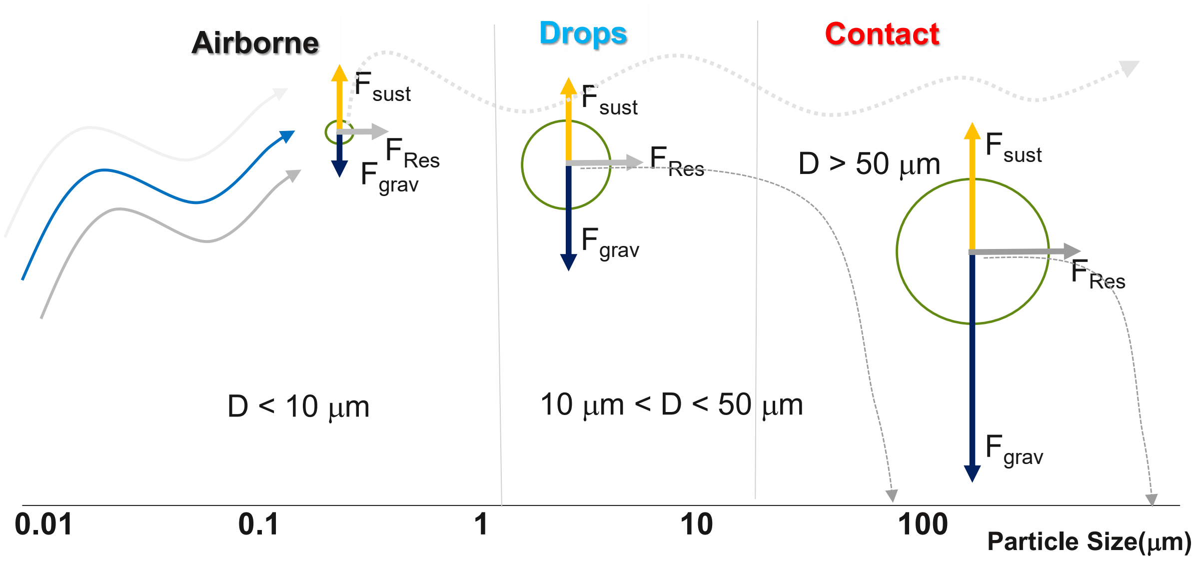


Figure 3. Typical trajectories of particles in the air, depending on their size.

$$Cd = \frac{F_d}{\frac{1}{2}\rho v^2 A} \qquad Re = \frac{\rho v D}{\mu}$$

F_d	Aerodynamic drag force(N)
ρ	Air specific mass(kg.m^{-3})
v	Air Velocity(m.s^{-1})
A	Front Area(m^2)
D	Characteristic dimension(m)
µ	Air Dynamic Viscosity(kg.m^{-1}.s^{-1})

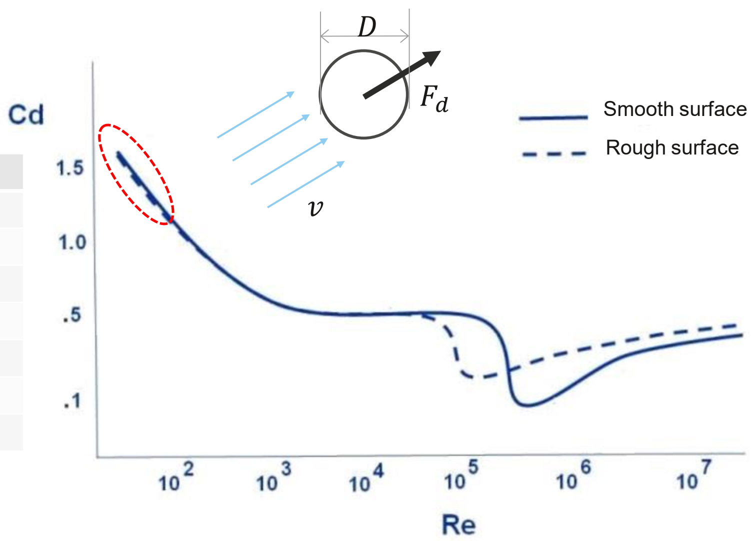


Figure 4. Aerodynamic resistance coefficient as a function of Reynolds Number for a sphere.

have two particles of different diameters subject to the action of the same fluid, the smaller particle will be more to the left, with a higher coefficient of resistance and the larger particle will be more to the right, with a lower resistance coefficient. This will have the consequence that the smallest particle will be more dragged and will follow the air currents more easily, reason why it is classified as a airborne particle, while the larger particle after some time will be deposited because its weight is the dominant force and makes it fall down.

The area in which the typical phenomena that occur with particles in the natural ventilation or mechanical ventilation flows inside the buildings is marked on the left side of the graph by the dashed red ellipse.

As a curiosity, the difference between the behaviour of bodies with smooth or rough surfaces, for the zone of the Reynolds number, in the range of 10^5 to 10^6, is what justifies the fact that golf balls have a protruding surface. This roughness causes the occurrence of the so-called critical regime that corresponds to an abrupt decrease in the value of the resistance coefficient to occur earlier, which allows the ball to travel longer distances.

It is also this graph that explains the reason why water vapor molecules in clouds remain in suspension and also the occurrence of rain due to the condensation of these molecules and the appearance of drops that coalesce and gain dimension, in such a way that the force of gravity becomes dominant.

Corona Virus 2 (SARS-CoV-2) and Transmission Modes

Corona Virus 2 (SARS-CoV-2) has a spheroid shape, with diameters in the range of 80 to 140 nm (≈0.1 µm). **Figure 5** shows a comparison of its dimensions with some of the classes commonly used for suspended particulate matter.

There are three possible modes of transmission from pathogens that have been expelled in the respiratory process of infected people: infection by suspended particles (bioaerosols), droplets and contact. **Figure 6** shows an adapted image of a brochure from the Office of the Prime Minister and the Ministry of Health, Labor and Welfare of Japan, recently published in a joint Position Paper by the Japanese Society of Heating,

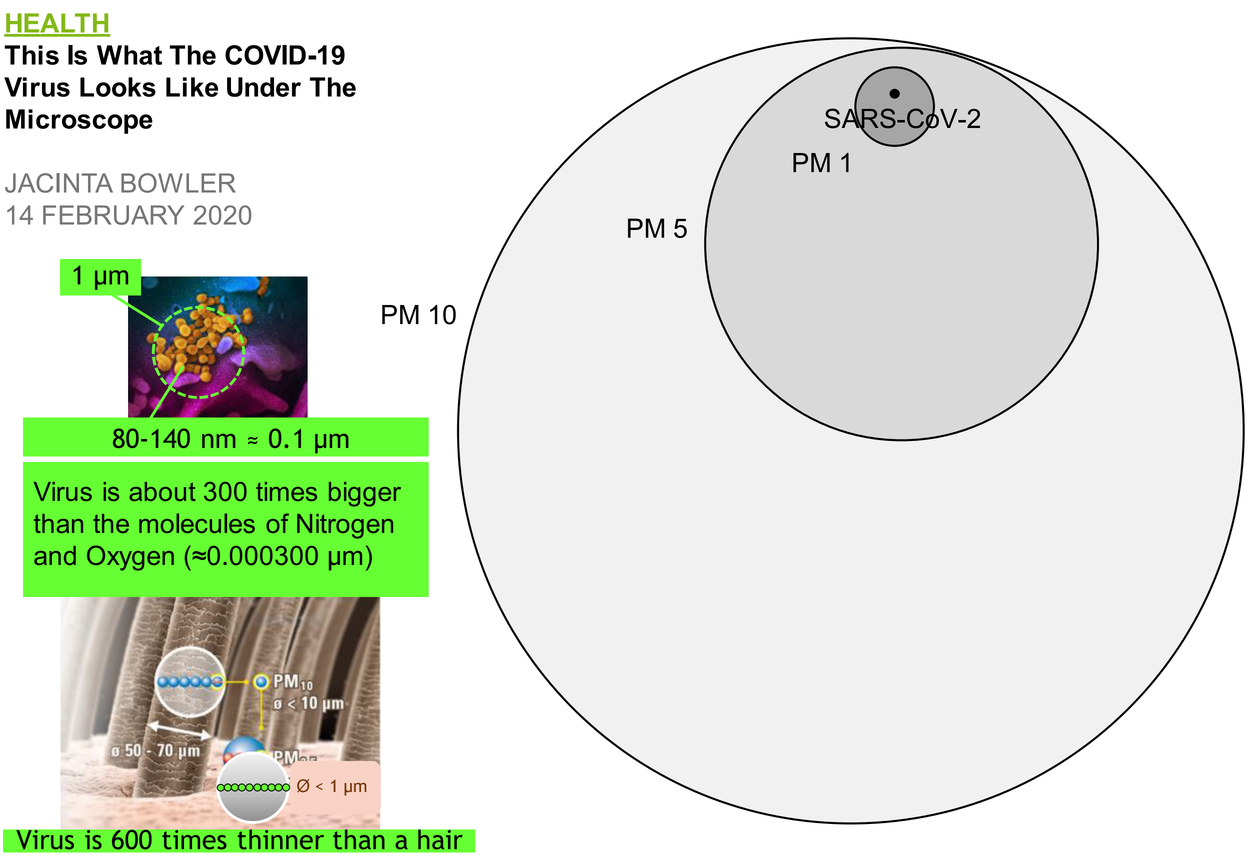


Figure 5. Comparison of the dimensions of SARS-CoV-2 with some classes of particulate matter.

Air Conditioning Sanitary Engineering (SHASE) and the Japan Institute of Architecture (AIJ), which illustrates the modes of transmission mentioned above. The origin of the emission of the droplets from the infected individual may come from different processes, such as coughing, sneezing, vomiting, speaking and breathing, with naturally different amounts and distributions by size classes of the exhaled particles, depending on the type of process.

In the airborne transmission mode, where particles will typically have dimensions less than 10µm, the phenomenon usually involves the evaporation of a substantial part of the droplet's water mass, which is reduced to what is called the droplet nucleus where there may be some viruses or bacteria, which can be inhaled by the infected susceptible host.

In **Figure** 7, a figure transcribed from Morawska (2006) is presented, showing the evaporation times of

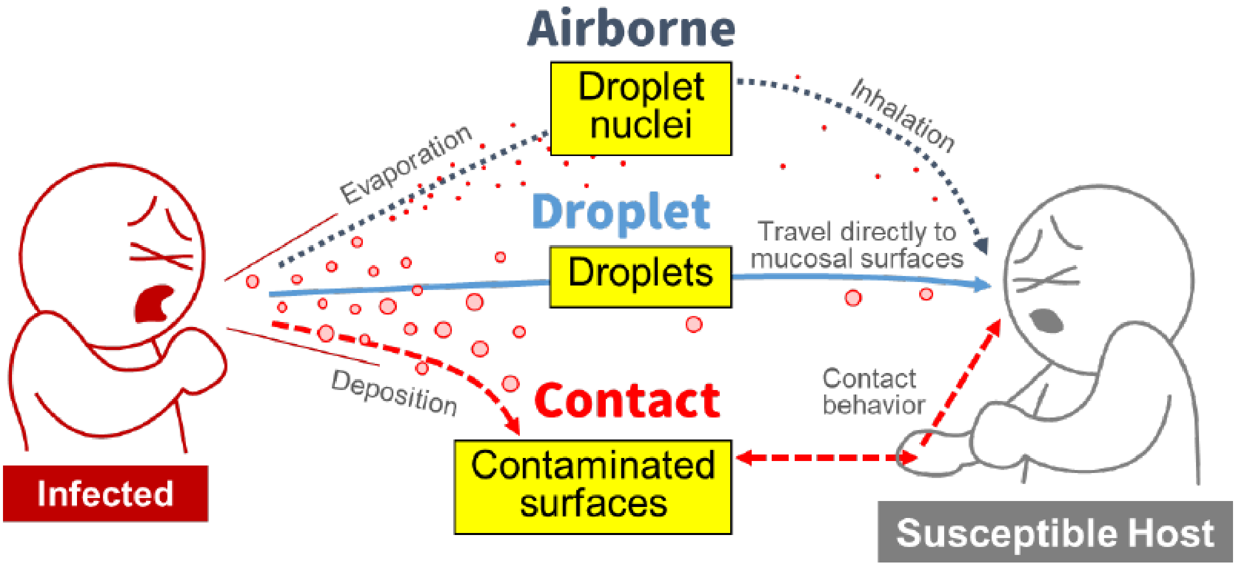


Figure 6. Modes of Transmission from Exhaled Pathogens (adapted from leaflet of the Office of the Prime Minister and the Ministry of Health, Labor and Welfare of Japan (2020)).

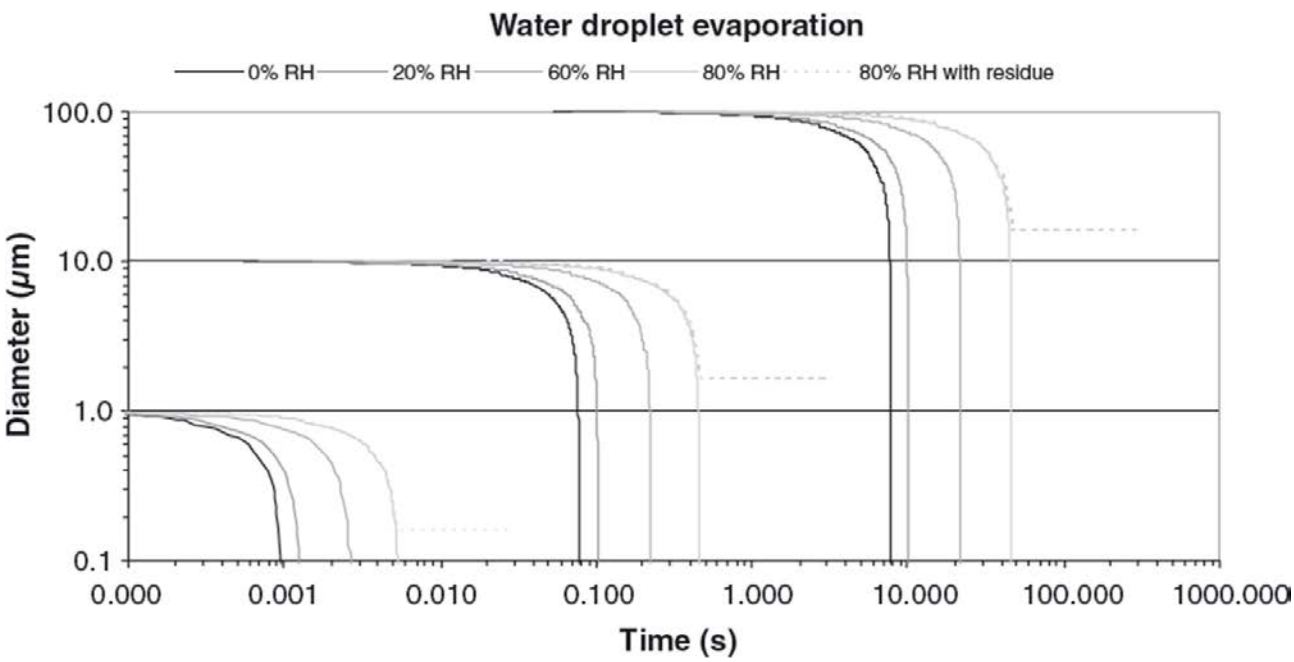


Figure 7. Evaporation times of the liquid phase in water droplets depending on its size and local relative humidity.

the water droplets, depending on their diameter and the relative humidity of the environment. The smaller droplets (1 µm) evaporate quickly and are reduced to what is called the droplet nuclei or or residue core. If the drop is contaminated with viruses, they will remain in suspension, its persistence depending on factors such as temperature, humidity and the component of ultraviolet radiation existing at the site. There is a significant number of studies on the survival of viruses in the air, which are also reported in Morawska (2006), with different behaviour depending on whether viruses have or not an outer shell of fat. Thus, in the case of Corona Virus-type viruses that have a protective outer layer of fat, the conclusion is that this layer persists better in dry environments and that it is destabilized in more humid environments, unlike what happens with viruses that do not have a protective layer of fat (Roe (1992) and by Pillai and Ricke (2002)). As regards the effect of temperature, typically, virus persistence is higher in cold temperatures than in hot temperatures. Solar radiation has a component of ultraviolet radiation that impairs the persistence of viruses so that, in indoor environments without direct natural light, there are more favourable conditions for the persistence of viruses as airborne particles. In summary, the persistence of SARS CoV-2 type viruses as a bioaerosol, following the trajectories of existing air streams at the site, is greatest in cold, dry environments without natural lighting.

The second mode of transmission referred to in **Figure 6** is direct transmission by droplets that travel from the infected emitter to the susceptible host and which are inhaled by the latter. It happens normally with drops with an intermediate dimension, between about 10 µm and 50 µm, that may fulfil the path between the emitter and the receiver before its complete evaporation. In a coughing or sneezing episode, the initial velocity of the jet that leaves the mouth of the emitter can have typical values of 10 to 30 m/s, so the particles quickly make the paths of about 1 m between the emitter and the receiver, in an approximately horizontal trajectory, due to the situation of balance between the aerodynamic lift forces and the force of gravity, which present similar magnitudes and opposite directions.

The largest droplets, with diameters between 50 µm and 300 µm, are the ones that originate the contact transmission mode. As, in its case, the force of gravity is dominant because the forces of an aerodynamic nature lose relative influence, these particles fall faster and settle on surfaces, creating what is called fomites (objects or materials contaminated by pathogenic elements). There are several types of behaviour that can contribute for the pathogens to be transported in order to come into contact with an area of entry into the body of the receptor element (mouth, eyes, nose). A relevant set of papers on this mode of transmission has been published, for example, articles by Rheinbahen et al. (2000) and Barker et al. (2001).

It is more or less consensual that the contact transmission mode and the droplets transmission mode are present in virus transmissions of the SARS-2 type, but there was, until some time ago, the conviction that the airborne particles contamination mode was not relevant in cases of viral infections and it happened mainly with bacteria (tuberculosis, legionella, ...). Probably the difficulty of establishing the cause-effect relationship, because it is a more difficult type of investigation and involves the need for much more sophisticated means, is at the basis of this fact, although it is already known that, for example, in the case of measles, which is viral, there is also transmission by suspended particles. There was no complete unanimity on the role of aerosol airborne transmissions, but the evidence for its existence in cases of viral transmissions has increased substantially in the most recent articles. **Table 1** presents some of the articles that support the existence of transmission of viral infections through the mode of airborne particles.

In an article published in Indoor Air, by Li et al. (2007), a group of experts from several countries, made a systematic multidisciplinary analysis of 40 articles on the role of airborne particulate transmission mode, published between 1960 and 2005, considering that 10 of the 40 articles were conclusive, with strong evidence the relationship between building ventilation and transmission/dissemination through airborne particles of diseases such as measles, tuberculosis, smallpox, influenza, bird flu, and SARS.

In an attempt to explain the differences in the spread rate between SARS-1 and SARS-2 (COVID-19), several American authors carried out a comparative study in terms of the survival of the two types of viruses in different environments and surfaces. On March 17, 2020, in a letter to the editor of the New England Journal of Medicine, they state that both remain viable and infectious for more than 3 hours in aerosols.

Following this information, the World Health Organization (WHO) considered that "precautions regarding particulate matter" should be taken by health professionals. The Director of the Division of Urgent Diseases, Dr. Maria Van Kerkhove, informed the media during a press conference on March 23, 2020 that

"When a clinical procedure that generates aerosols is performed in a health care unit, there is the possibility of aerosolizing these particles, which means that they can remain in the air a little longer".

She added: "It is very important that health workers take additional precautions when they are working with patients and do this type of procedures".

Table 1. *Some of the articles that support the existence of transmission of viral infections through the mode of airborne particles.*

Author(s)	Virus	Ambiance	Case / Evidence
McLean (1961)	Influenza	Veterans Nursing	80% reduction in floor to floor transmission due to the installation of ultraviolet
Moser et al. (1979)	Influenza	Airplane on the ground in Alaska with ventilation system off	1 person infected 54 people sitting on board (72%). Aircraft ventilation systems today have much more efficient filtration systems
Klontz et al (1986)	H1N1	US Navy airplanes	Episode of generalized transmission between people sitting more than 2 m away
Mendell et al. (2002)	Various	Military Buildings	Influence of air recirculation on the incidence of infectious diseases
Yu et al (2005), Li et al (2005)	SARS	Amoy Gardens building park (Hong-Kong)	Transmission to neighbouring buildings from bathrooms exhaust system
Li et al. (2005b)	SARS	Prince of Wales Hospital, Hong-Kong	Contamination pattern in hospital ward strongly correlated with ventilation flow pattern
Sun et al. (2011)	Influenza	Student Dormitories	Reduction of 35% of infected to 5%, due to air exchange rate

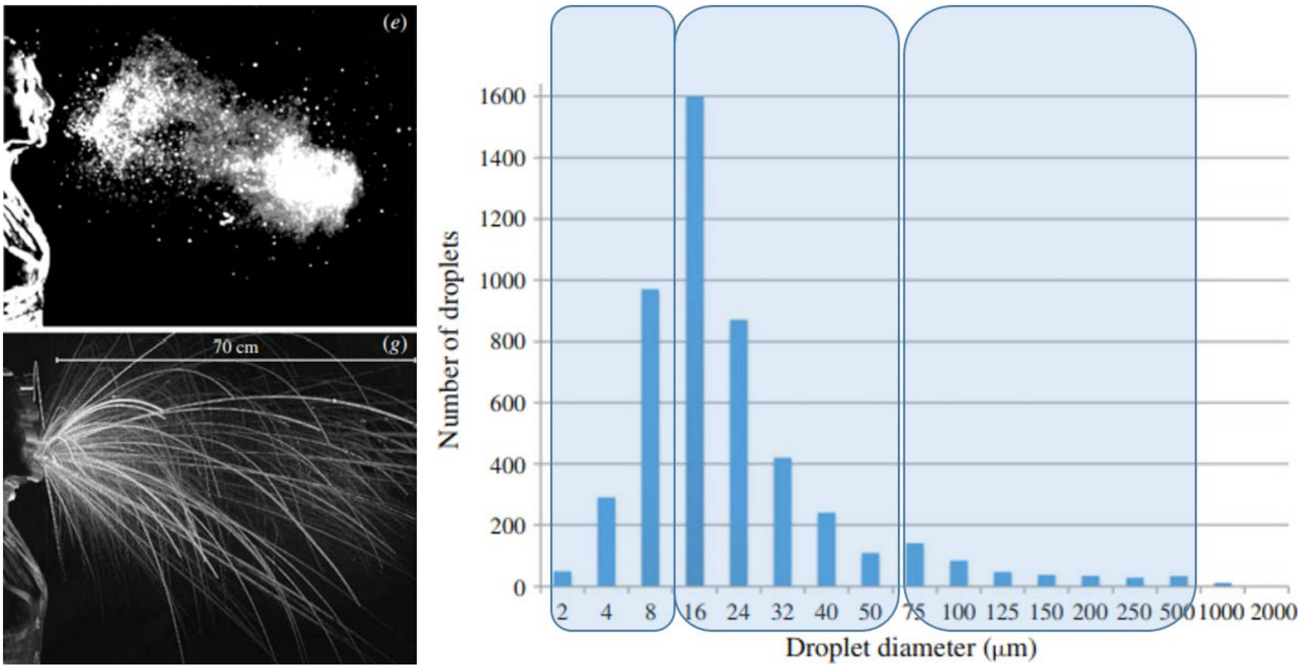


Figure 8. Distribution by size classes of the drops exhaled in the cough.

It is hard to understand that, at the level of the WHO directive board, there is no perception that aerosolization does not occur only when performing clinical acts with some type of equipment in a hospital environment, but also occurs naturally in the processes related to the person's respiratory system (coughing, sneezing, verbalization, breathing, etc.).

Thus, the implications of recent knowledge about the persistence of SARS-2 in aerosols should be much wider, namely in terms of redefining the concept of safety distance between people and the need for widespread use of upper airway protection equipment. (masks and visors) Whenever it is anticipated that someone will be in an environment with multiple occupancy.

Analysing, for example, the size distribution of the droplets that are emitted when a person coughs (Bourouiba et al. (2014)), shown in **Figure 8**, it turns out that an important part has the potential to aerosolize because this is expected to happen, on account of the loss of water by evaporation, up to a dimension of 16 µm, at the time of exhalation.

In an article published in Building and Environment, Jianjan Wei and Yuguo Li (2015), present the results of a computer simulation for the destinations of exhaled particles, with dimensions of 10 µm, 50 µm and 100 µm by a person who coughs , with an initial jet velocity coming out of the mouth of 10 m/s. **Figure 9** shows an image assembled from the results of that article, in which it is clear that there is a risk that the airborne particles are inhaled by people who are at distances greater than 2 m recommended as a safety distance.

It should be noted that the viral load will, in principle, be proportional to the size of the drops or droplets, so in smaller particles, the probability of causing infection, surely will be not zero, but may l be lower than in larger ones. Anyway, in case measures are taken only for the Contact and the Droplets transmission modes, as it is happening in various countries, the transmission will not be broken and the Airborne transmission mode may become the dominant one.

The main strategies to combat an eventual possibility of transmission are:

For the Contact Transmission Mode: Frequent cleaning and disinfection of workplaces and surfaces that can function as transmission sites in buildings and transportation means. Disinfection of tools and other objects. Frequent hand washing.

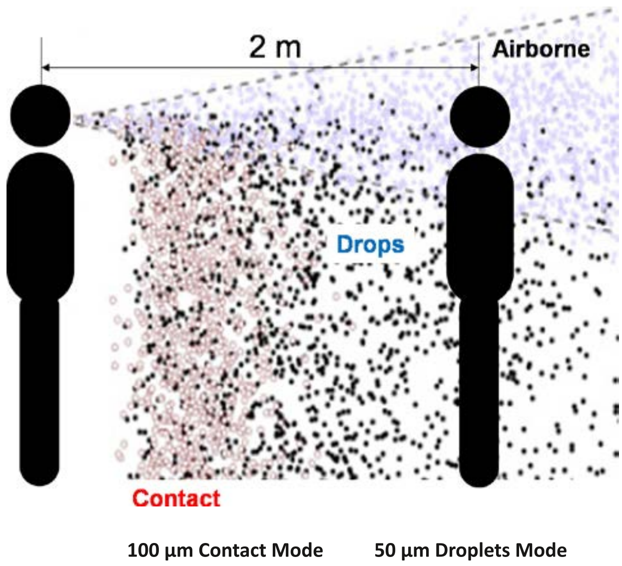


Figure 9. Spatial zones potentially occupied by 10 µm, 50 µm and 100 µm particles exhaled by a person with a cough. (adapted from Jianjan Wei and Yuguo Li (2015))

For the Droplets Transmission Mode: Social distancing and restrictions on the movement and agglomeration of people

For the Airborne Transmission Mode: To decrease the concentration of these particles by diluting them with fresh air provided by the ventilation process. To minimize the risk of inhalation through the airways through the use of masks and visors

Suggestions / Conclusions

Since most of the countries, implemented the combat measures against Contact and Droplets modes the following complementary measures should be put in place:

- As long as the epidemic crisis continues, face-to-face meetings should not be held;
- Indoor spaces with human occupancy must be heavily ventilated, exclusively with fresh air, to decrease virus concentrations, in the event of a possible contamination by suspended particles, and, thus, reduce the risk of infection;
- When planning an exit, to places frequented by other people, you should wear a mask and, if possible, a visor. Normal masks are not completely effective in retaining the smallest particles, so the use combined with a visor substantially increases the retention effectiveness;

- Those who work in public places must wear a mask and visor to protect the upper airways.
- Extreme protection measures should be applied to health professionals due to their high risk of infection. ■

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Understanding the indoor environment and its effects

– Part 2: SenseLab studies with 335 primary school children

This article presents the SenseLab studies performed with 335 primary school children based on integrated analysis approach, to collect information on 'Stressors and effects', 'Preferences and needs' and 'Interactions at human level'.

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Keywords: indoor environmental quality, primary school children, the integrated analysis, stressors and effects, interactions, preferences and needs

Even though the guidelines for indoor environmental quality are met, problems can occur. To cope with this descrepancy, recently, a new research model was introduced to determine requirements (to prevent negative effects) and preferences (to stimulate positive experiences) for (re)designing healthy and comfortable buildings [1]. To fill and validate this model for children of primary schools, a field study and a series of lab studies were held. The field study was reported in Part 1 [2], while the SenseLab studies with 335 children from 7 primary schools, are reported here. Primary school children from previous studied schools were invited to take part in a series of tests in a semi-laboratory environment (the SenseLab), to investigate preferences, needs and responses to single components (sound, thermal, light and air) and interactions of different environmental configurations more in depth.

Procedure

The SenseLab comprises of four test chambers (one for each IEQ factor: air, light, acoustics and thermal aspects) and the Experience room (a room for integral perception) [3]. 335 children from seven different primary schools visited the SenseLab at 10 days in the spring of 2018. Maximum three groups per day were formed: group 1 started in the Experience room (maximum 16 children), group 2 in the test chambers (maximum four children per test chamber) and group 3 in the Science Centre where the SenseLab is located. After 35 minutes, group 1 went to the test chambers, group 2 to the Science Centre and group 3 to the Experience room. In the Experience room an *exposure study* [4]; and a *workshop* [5] was held, while in each of the test chambers, a test was performed that relates respectively to thermal [6], air (smell) [7], lighting [8] and acoustical quality [9].

Exposure study

To test the main, cross-modal and interaction effects of 36 different combinations of environmental conditions on the evaluation of temperature, noise, light and smell by the children [4], a four-way factorial design (**Figure 1** shows the combination 'All acoustical panel's and with 'soft light on') was applied:

- *With 'all' versus 'fewer' acoustical panels:* creating a different interior, view outdoors and acoustical quality.
- *Two ventilation principles*: mixing and displacement ventilation with a ventilation rate of 600 m^3/h to provide 30–40 m^3/h per person at 21 degrees Celsius.
- *Three types of led-lighting*: direct, indirect and soft light (setting 100%).
- *Three types of background sound*: no sound, traffic and children talking, both at 60 dB(A).

Figure 1. Set-up in Experience room (with acoustical panels and with soft light on).

The results showed a clear influence of 'fewer' acoustical panels on children's' evaluation of smell, draught and light. More acoustical panels had a positive effect on the children's assessment of sound. Sound type, especially 'children talking', affected the assessment of both sound and smell.

Workshop

To conceptualize design solutions by primary school children to solve IEQ-problems in their classrooms, children participated in a workshop, comprising of two parts [5]. In Part 1, the children were asked to choose an IEQ-problem in their own classroom that they are bothered with, while in Part 2, they were asked to imagine they are an inventor or scientist in 2040 with all resources available and to make a design for the future. Noise-related problems were most frequently reported (58%), followed by temperature (53%), air (22%), and light (16%). Girls reported more problems than boys. 47% of the children proposed solutions related to more than one IEQ-problem. Solutions ranged from existing solutions, such as headphones to protect against noise to far-fetched solutions for example send noisy children away by means of a rocket [5].

Thermal test chamber

A three-way factorial randomized design was used to test the effect of different colours of walls and floor on the thermal comfort and draught feeling in a winter situation (sunlight coming in: heat) and in a summer situation (opening window: draught) [6]. The different classroom situations (colours of walls: red, blue or white; and floor: green, grey or blue) (combination white walls and blue floor is shown in **Figure 2**), were created with Virtual Reality in combination with a construction lamp (simulating the heat of the sun) and a fan (simulating the draught of fresh air).

Figure 2. Virtual classroom with blue flooring and white walls.

A statistical relevant relationship between feeling of draught and feeling of temperature was found, as well as a significant difference in temperature feeling for different floor colours when the wall colour was red in the winter situation.

Air test chamber

The aim was to expose children to different sources of smell (container 1: perfume; container 2: mint leaves; container 3: carpet/MDF/vinyl; container 4: crayons; in **Figure 3**), and to evaluate and identify those sources at individual level with their noses [7]. The possible effect of plants on the reduction and/or production of smells was tested in the CLIMPAQ (number 5 in **Figure 3**). Children found the smell in general more acceptable, when they recognized the smell. In general, children did not like the smell of the building/furnishing materials and in most cases they could not identify the source of smell. The effect of (passive) plants on the perception of smells showed no effect.

Lighting test chamber

Children assessed six school desks table tops (brown, yellow and grey wood and normal, matt and reflective white) (**Figure 4**), under three different light conditions: energizing (650 lux; 12000 K), calming (300 lux; 2900 K), and focusing (1000 lux; 6500 K) [8]; using a two-way randomized design. For all surfaces, the calming light was perceived as the worst and the energizing light as the best (except for the brown wood surface). For the wooden-like surfaces these differences were statistically significant. The children preferred the brown wood under focusing light the best and the brown wood under calming light the worst. For energizing light, grey wood scored the best, while for focusing light, brown wood.

Acoustical test chamber

The effect of reverberation time (RT) on children's cognitive performance (phonological processing), noise evaluation and emotional attitude was studied [9]. Two

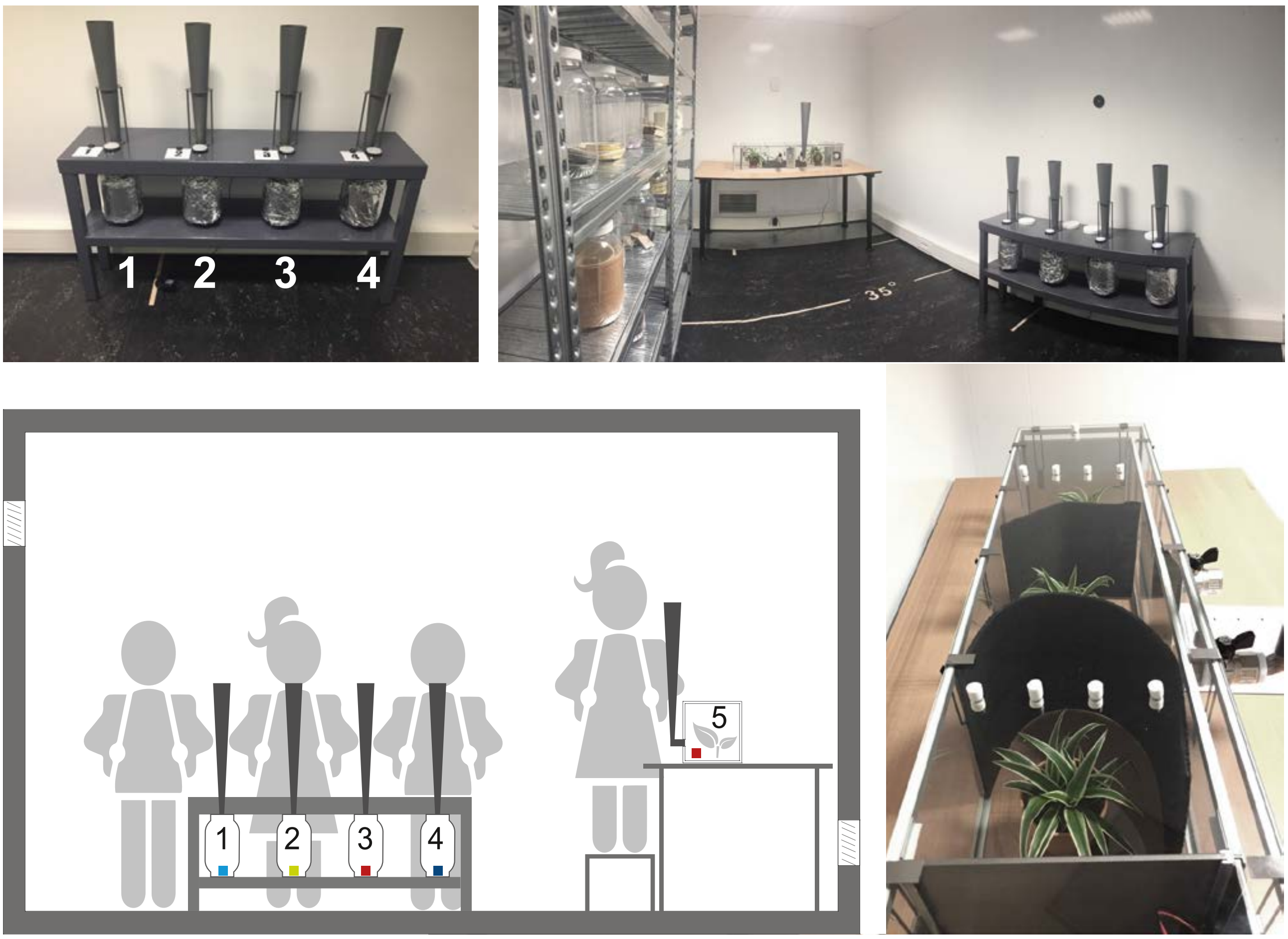

Figure 3. Pictures of air test chamber set-up.

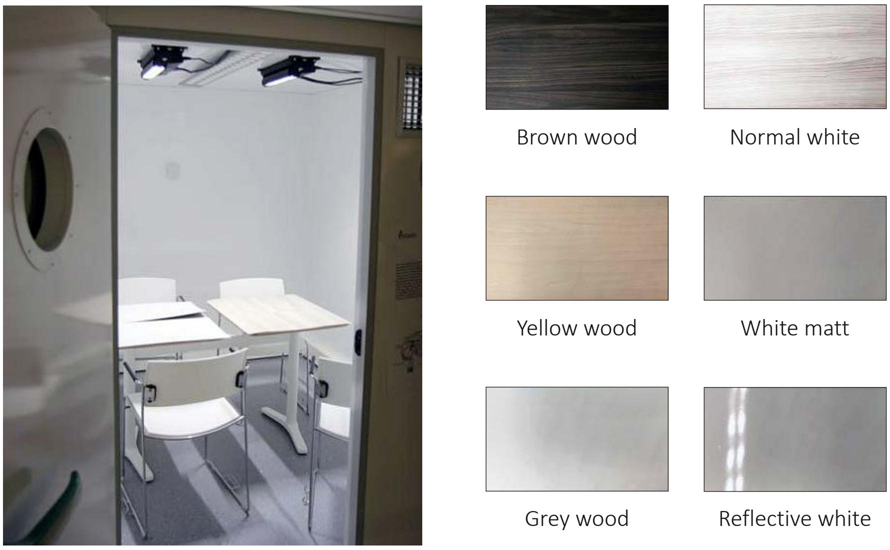

Figure 4. a. Set-up light experiment b. Six types of surfaces: from top left: brown wood, white matt, yellow wood, normal white, reflective white, grey wood).

series of listening tests and evaluations were performed in chamber A (untreated: RT=0.33 seconds) and chamber B (acoustically treated: RT=0.07 seconds) respectively (see **Figure 5**), while at the same time one of seven background sounds (45 dB or 60 dB traffic noise, 45 dB or 60 dB children talking, 45 dB or 60 dB music, or no sound) were randomly played. The positive effect of the acoustical treatment was demonstrated by the statistically significant difference of children's sound perceptions between the acoustically

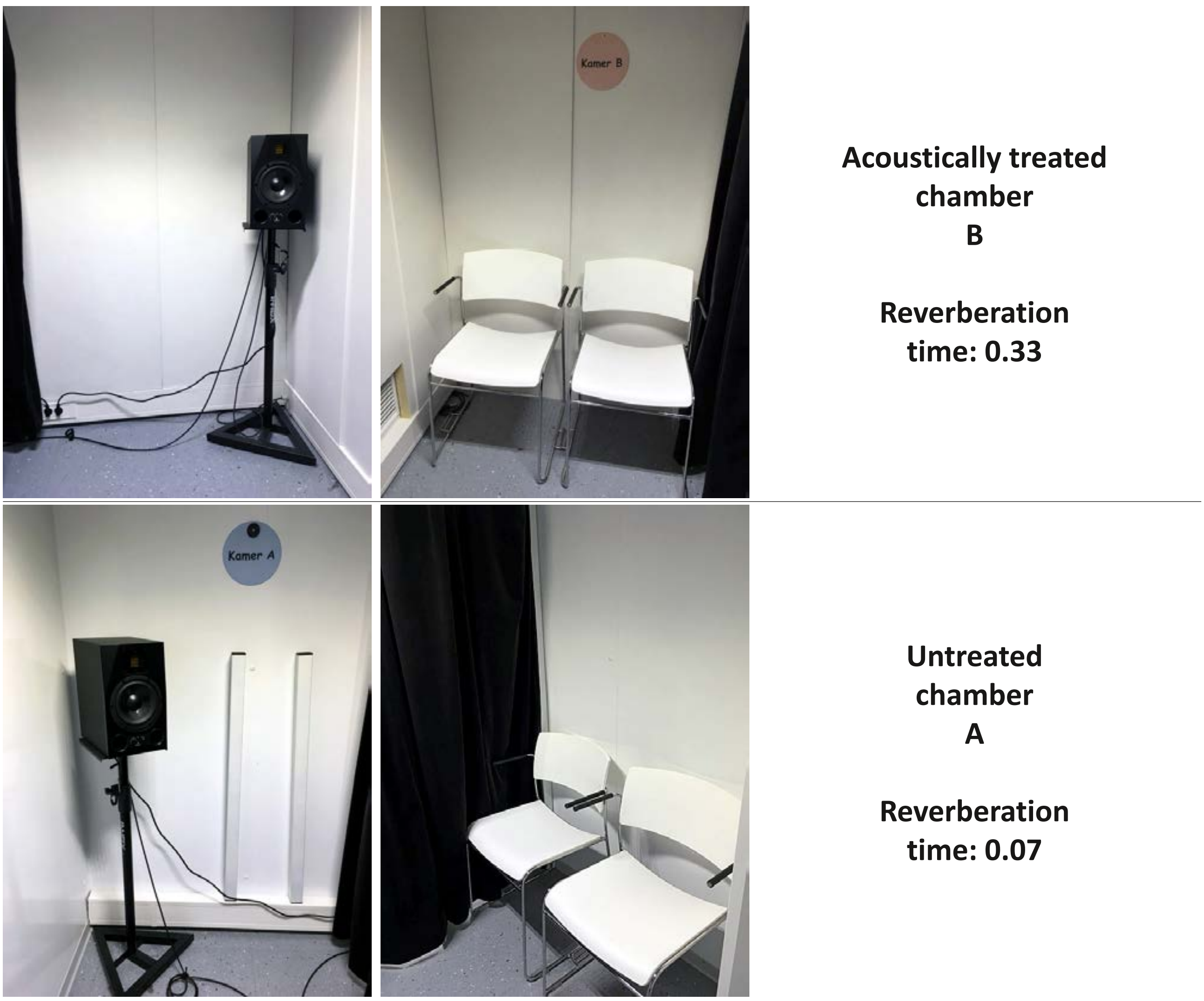

Figure 5. Treated and untreated chamber.

treated chamber and the untreated chamber. However, especially with the 'children's talk' as the background sound, overtreatment seemed to have adverse effects on children's performance. Children preferred the acoustically treated environment when there was a background sound.

Findings

From the exposure studies and the workshop held in the Experience room, the following can be said:

- Interaction effects of different IEQ-factors seem to take place at human level.
- Sound type, especially 'children talking' affected the assessment of both sound and smell, indicating that children are perhaps pre-conditioned in their response by hearing children talk.
- Children were very able to provide problems and solutions for IEQ-problems at different levels (building, classroom, desk, child etc.).
- Girls reported more problems than boys, which is possibly related to a better recollection of negative feelings towards those problems in their classrooms.

The tests in the different test chambers (thermal, air, light and sound) showed that:

- When the wall colour was red in the winter situation, a significant difference in temperature feeling for different floor colours was found.
- The smell was in general assessed more acceptable, when the children recognized the smell.
- Different surfaces most likely require different types of lighting, and vice versa.
- When there was a background sound, the acoustically (over)treated environment was preferred by the children.

Conclusion

Both the field (reported in [2]) and the SenseLab studies with the primary school children were an attempt to fill and validate the newly introduced research model [1]. The outcome of both studies confirmed the need for this model, and the need for more studies to determine requirements (to prevent negative effects) and preferences (to stimulate positive experiences) per scenario (e.g. schools, homes, offices) and situation (for example traditional and non-traditional). Interactions at environment and human level need to be explored, as well as patterns of stressors for different profiles of occupants. ■

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The EU green recovery plan and the impact of the COVID-19 crisis on EU building sector policies

ANITA DERJANECZ, REHVA Managing Director

The von der Leyen Commission presented its Green recovery plan with a revamped EU budget on 27 May 2020. The plan considers the building Renovation Wave as a key route to boosting the economy while greening the energy system. The European Parliament ITRE committee is working on a report targeting the Renovation Wave plan. Both documents consider the health aspects linked to the renovation wave and the EP shows a strong support to consider improved IEQ and healthier living conditions as a requirement of the building renovation.

The "Next Generation EU" package

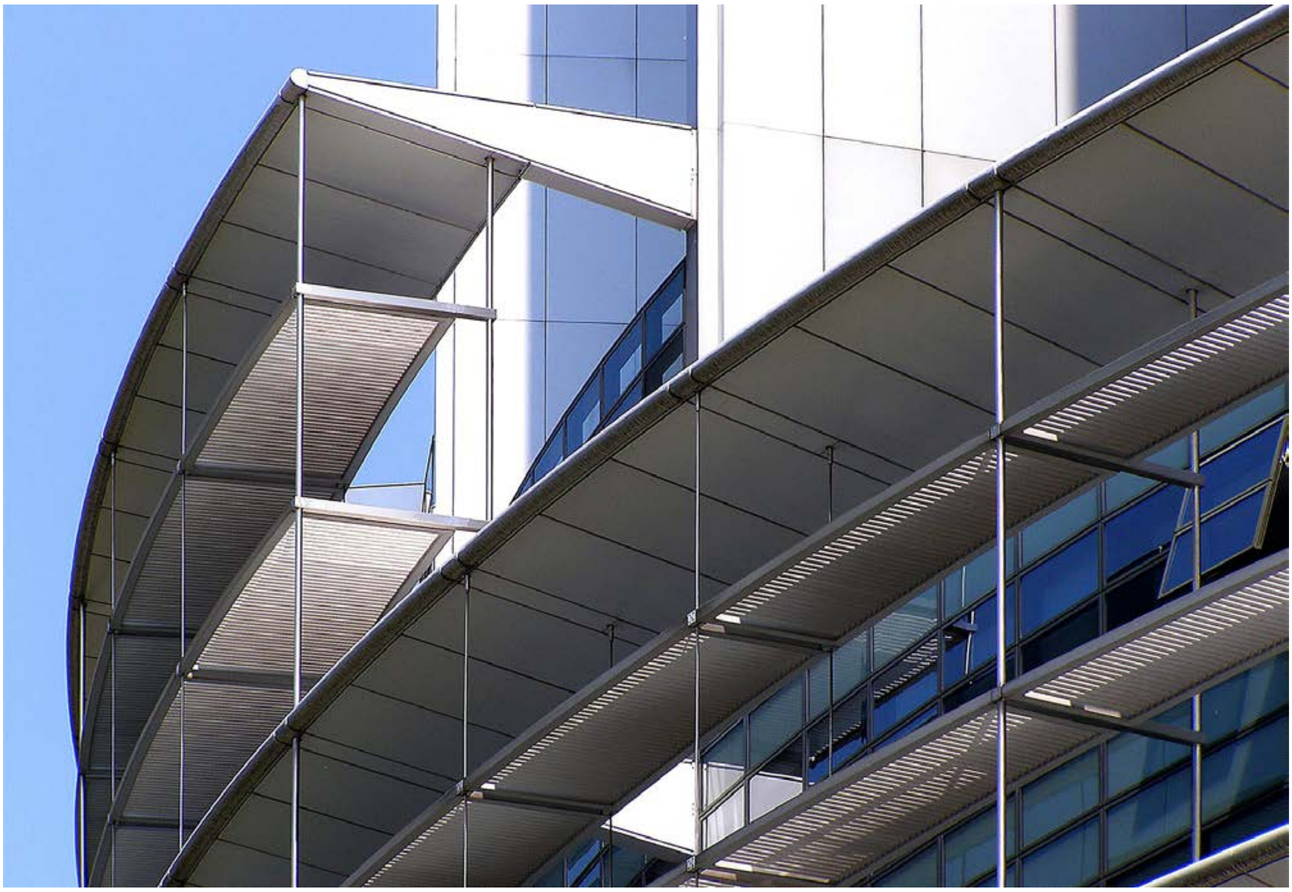
On 27 May 2020, the European Commission presented its Green recovery plan as a respond to the economic recession caused and to the shortcomings unveiled by the coronavirus pandemic. The EU economy is forecasted to shrink by 7.4% this year with the economic impact being uneven across the EU and across the different economic sectors. European leaders managed to back a progressive recovery plan providing additional financial resources to tackle the challenge. The EC Communication titled “Europe’s moment: “Repair and Prepare for the Next Generation” details a €1.85 trillion recovery plan linked with a revamped EU budget that contains new instruments and financial sources (including €750 billion borrowed by the EU on the financial markets) and with an adjusted Work Programme for 2020, and defines new own financial resources of the EU.

The recovery plan, summarized in a fact sheet, lays on 3 pillars: securing public financial resources with the “Recovery and Resilience Facility” (€560 billion) to fund public investment and reform that are essential for a sustainable recovery; stimulating private investments in strategic sectors with the *Strategic Investment Facility* (an enhanced version of Junker’s InvestEU instrument) and strengthening those EU instruments that helped during the COVID-19 crisis like Horizon Europe and creating a standalone EU4Health programme (€9.4 billion).

Commission President Ursula von der Leyen said that the European Green Deal will be the “motor for the recovery” and the Next Generation EU Communication confirms that public investments in the recovery should respect the green oath to “do no harm” and that the financial instruments should prioritize green investments. 25% of the revamped EU budget is supposed to be spent on climate investments.

Renovation Wave kickstarting with schools and hospitals

The building Renovation Wave, announced by EU Commission vice-president Frans Timmermans end of 2019, moved up in the EU’s order of priorities as a fast track to drive the European economy out of the COVID-19 recession. The European Commission’s energy chief, Kadri Simson referred in his speech at the Energy Solutions high-level online debate to the Renovation Wave as “a clear route to boosting the economy while greening the energy system” stressing that the need to rebuild the EU economy after the crisis also provides an opportunity for Europe to “fast-forward the conversation on climate neutrality in



2050". Simson promised to present the 'Renovation Wave' strategy in September 2020 as a plan to minimise regulatory barriers and boost building renovation across the EU to at least double the current annual renovation rate to 2%. Simson told in an online event to aim "for hospitals, schools and SMEs as the first target areas for investment because these sectors are particularly affected by the crisis". The construction sector, a labour-intensive industry is considered a key sector to restart the economy and boost local employment.

The renovation wave should be financed by the InvestEU tool and Member States can use the Recovery and Resilience Facility to distribute grants and loans. Member States will have to design their own tailored national recovery plans, based on the investment and reform priorities identified as part of the European Semester, in line with National Climate and Energy Plans, Just Transition Plans and Partnership Agreements and Operational Programmes under EU funds.

Awareness on health aspects in relation to the Renovation Wave

The awareness on health aspects linked to building performance and energy renovation raised at EU policy level as a positive development during the 2nd EPBD review. REHVA and several other stakeholders have been campaigning and advocating healthy buildings in the past two years that shows its effect. In 2019, the European Commission DG Energy initiated a Build4People programme as a future public-private partnership under Horizon Europe that considers indoor climate quality and comfort during energy renovation and NZEB construction.

This awareness was further increased by the current COVID-19 pandemic and the resulting public health crisis. Kadri Simon pointed out in his referred speech that "If we can enhance building renovation rates across the EU, we get healthier and more energy efficient homes." The Next Generation EU communication states that the Renovation Wave "will help save money on energy bills, provide healthier living conditions, and reduce energy poverty" at the same time.

EP support for healthy buildings and improved indoor climate quality

The European Parliaments (EP) ITRE (Industry, Research and Energy) committee is working on an own initiative report targeting the "Renovation wave" and the EU Green Deal of the von der Leyen Commission. The report on Maximising the energy efficiency potential of the EU building stock aim to drive the related legislative actions of the European Commission.

Rapporteur Ciarán Cuffe [Verts/ALE] tabled his first draft mid-April 2020, to which the shadow-rapporteurs then drafted their amendments. REHVA also contributed to this process by submitting comments to shadow-rapporteurs. The compiled Amendments of ITRE were approved on 15 May. The document signals high awareness and strong support of healthy buildings by the EP and a clear intention to push for increasing IEQ along building renovation. Several IAQ, indoor climate quality and health related comments were proposed by shadow-rapporteurs and rapporteurs along the entire report. Shadow-rapporteur Ms. Kumpula-Natri proposed a standalone section called **Healthy buildings and indoor environmental quality (IEQ)** including that the EP "*Calls on the Commission to take account in legislative proposals, such as the Renovation Wave, the requirement of healthy buildings in addition to the energy efficiency first principle.*"

The ENVI (Environment, Public Health and Food Safety) committee will approve an Opinion to the same dossier, their draft Opinion contained a point on healthy buildings with good indoor air quality in the context of building energy renovation before commenting. Given the support by different MEPs across the aisle, it is very likely that the final compromise amendment of ITRE that will be voted later in June will contain a strong point on IEQ and healthy buildings in relation to energy renovation which will be hopefully approved by the EP Plenary on the vote scheduled in September-October 2020.

Read more about the ITRE report an REHVA comments in the REHVA website Expert Area. ■

SUCCESS STORY UTEK, ITALY

A "small" product enables a great solution.

How the differential pressure switch optimises air handling units and makes them safer.

In early 2017, Belimo introduced a new product range of duct sensors for ventilation applications and pipe sensors for water applications. The new product range was presented to the original equipment manufacturer UTEK. The differential pressure switch 01APS especially caught their interest. UTEK develops and produces air handling and heat recovery units for residential and industrial applications and already utilises various damper actuators from Belimo.

TYPE OF BUILDING
All types of buildings

PROJECT
Plant engineering for residential and industrial applications

SECTOR
Air handling and heat recovery units

PRODUCTS
Differential pressure switch 01APS

BELIMO®

Focus on operational safety and customer value.

UTEK was founded 1999 in Italy and is known as a leading, competent and innovative manufacturer of AHU (Air Handling Units). UTEK offers planning, development and production of ventilation, air-handling and air-conditioning systems. They focus on energy recovery – a field of application that has become their core business. In 2019, UTEK was acquired by CLA SRL, a well-known company for the production of components for air conditioning systems.

The OEM (Original Equipment Manufacturer) relies on technically excellent and custom products, which are developed and sold under their brand to commercial enterprises in the European market. Its customer base includes some of the most respected and well-known brands in the ventilation, air handling and air-conditioning industries on the continent.

“We guarantee the quality, reliability and competitiveness of our products as well as essential consulting services and technical training that enriches knowledge and enhances sales promotion and the marketing of our customers”, Luigi Lapsus, owner and managing director of CLA, describes his company.

CLA has been successfully working with Belimo for many years. Belimo meets their customers on eye-level and creates value with innovative products, increasing the success of everyone involved. Belimo also appreciates close customer contact. A successful customer-supplier relationship was established thanks to CLA’s quality support from Giovanni Micale.

"We support our clients in implementing their projects. With Belimo, we have a strong partner, with whom we can constantly improve ourselves and our products."

Luigi Lapsus, Sole Shareholder and Managing Director CLA, with Giovanni Micale, Belimo Sales Manager

CLA air conditioning and heat recovery unit with built-in differential pressure switch 01APS-10R, under the brand of UTEK

Differential pressure switch - ideal for use with small ventilation units.

CLA uses the differential pressure switch 01APS in air handling units for filter and fan monitoring. The 01APS-10R has an adjustable pressure range of 20...300 Pa and is therefore ideal for use with smaller air handling units.

In these applications, the air handling units are used for central, primary air conditioning in controlled residential apartment ventilation. For control, CLA relies on specially developed control devices that fulfil their function either analogously or via Modbus or BACnet.

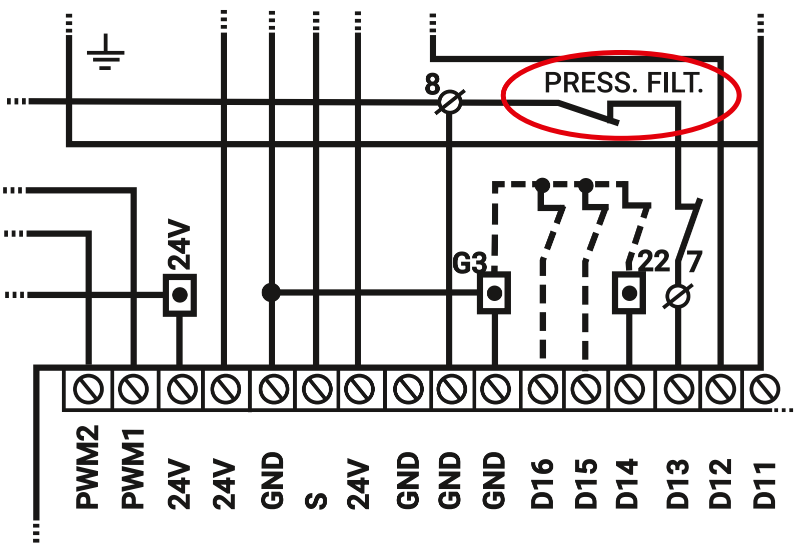
01APS-10R for filter monitoring

"Small" products with a big impact.

Belimo offers a steadily growing product range of high-precision, long-lasting sensors that provide optimum room comfort and as a result have a major impact on people's well-being and productivity. The Belimo sensor product range has a unique housing design.

Find out additional information about our further sensor product range at www.belimo.eu/sensors.

Differential pressure switch 01APS-10R in the electrical diagram, connected to controller UTEK brand



All inclusive.

As a global market leader, Belimo develops innovative solutions for the regulation and control of heating, ventilation and air-conditioning systems. In doing so, actuators, valves, and sensors make up the core business.

With a consistent focus on customer value, we deliver more than just products. We offer you the complete product range of actuator and sensor solutions for the regulation and control of HVAC systems from a single source. At the same time, we rely on tested Swiss quality with a 5-year guarantee. Our worldwide representatives in over 80 countries guarantee short delivery times and extensive support through the entire product life. Belimo does indeed include everything.

The "small" Belimo products have a major impact on comfort, energy efficiency, safety, installation and maintenance. In short: small devices, big impact.

- 5-year guarantee
- On site around the globe
- Complete product range
- Tested quality
- Short delivery times
- Comprehensive support

EN – 08.2019 – Subject to technical modifications

BELIMO Automation AG
Brunnenbachstrasse 1, 8340 Hinwil, Switzerland
Tel.: + 41 43 843 62 63, info@belimo.ch, www.belimo.com

Hygiene requirements

for ventilation and air-conditioning systems

After COVID-19 lockdowns and buildings reopening, it will be very important to comply with industry standards and the attention will have to be put on the cleanliness of the ventilation systems. REHVA Guidebook No. 9: Hygiene Requirement for Ventilation and Air Conditioning provides guidance on hygiene requirements for planning, installation, maintenance and operation and describes appropriate test procedures and test criteria for ventilation and air-conditioning systems and air-handling units.

This Guidebook applies to all ventilation and air-conditioning systems and air-handling units and their central or decentralised components which influence the quality of the supply air. It is intended to provide a holistic formulation of hygiene-related constructional, technical and organisational requirements supplementing current regulations, ISO–, EN-standards and VDI standards. This guidebook addresses all those involved in the planning, manufacture, execution, operation and maintenance of ventilating and air-conditioning systems. ■

EPB Center at your service!

The EPB Center works for the benefit of all stakeholders who are concerned with the implementation of the **Energy Performance of Buildings Directive** (EPBD)[1] by acting as a dedicated information service centre for the **set of Energy Performance of Buildings** (EPB) **standards**[2] developed under the **European Commission's** (EC) **Mandate M/480**[3] to the **European Committee for Standardization** (CEN)[4]. Whichever way you want to get involved - whether by following developments, accessing our services or providing feedback - the **EPB Center is there for you!**

Join the discussion and stay informed

Join the discussion by becoming member of the **LinkedIn EPB Standards Community #EPBstandards**[5] and the **BuildUp Thematic Topic 'Energy performance calculation procedures and CEN standards'**[6].

Subscribe to EPB Center's emailing at epb.center

Follow us on **Twitter** and **LinkedIn**

European Commission Service Contract[7]

The **European Commission awarded a service contract to support the uptake of the Energy Performance of Buildings standards** by providing tailored information, technical assistance and capacity building services for involved stakeholders. The **EPB Center will be the communication platform** to offer these services. *Service Contract ENER/C3/2017-437/SI2-785.185 "Support the dissemination and roll-out of the set of Energy Performance of Buildings standards developed under EC Mandate M/480" (duration September 2018 - September 2021).*

Contact us[8]

The EPB Center provides **tailored information and technical assistance** for **all involved stakeholders**, such as industry, researchers, engineers, building professionals, financial institutions, national standards bodies, EU Member States (e.g. public authorities involved in the application of energy performance of building regulations).

If you are one such stakeholder and have unanswered question or would just like to share your experience, we highly encourage you to go ahead and please contact us.

- Drop us a line also if you are interested in the **EPB Center guide on how to fill in National Annexes or National Data Sheets.**
- Also available upon request a file with **editable Annexes A/B of (EN) ISO 52000-1, 52003-1, 52010-1, 52016-1 and 52018-1.**
- Regarding **National Annexes** check out the **available examples**[9] of specific EPB standards that are being collected from various countries (if made available for publication). The examples are as a rule anonymized, unless explicitly agreed otherwise.

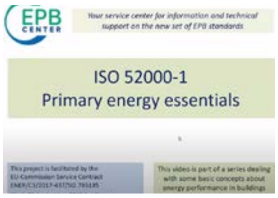
1 https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en
2 https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en#energy-performance-of-buildings-standards
3 https://epb.center/epb-standards/background/
4 https://www.cen.eu/Pages/default.aspx
5 https://www.linkedin.com/groups/13619324/
6 http://www.buildup.eu/en/topics/energy-performance-calculation-procedures-and-cen-standards
7 https://epb.center/about/ec-service-contract/
8 https://epb.center/contact/
9 https://epb.center/implementation/national-annexes/examples-na/

Supporting services

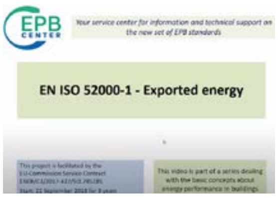
EPB Standards Explained[10]

EPB Center experts noticed a strong need of short introductions to specific subjects. As a result, a **series of short videos** has been produced to explain in a few minutes specific subjects. More short videos may be added at later date. **Suggestions are welcome!**

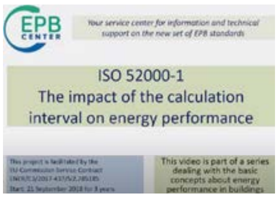
Your map for the EPB standards



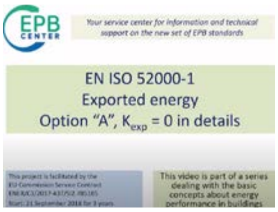
Primary Energy



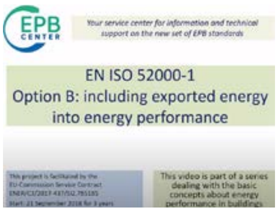
Exported energy, basics



Exported energy and impact of calculation interval



Exported energy, Option A in detail



Exported energy, Option B in detail

EPB standards webinar series[11] *on Build Up portal*

This webinar series is jointly organized by BUILD UP[12] and EPB Center's experts. Please see below the so far webinars that have taken place or are already planned. **More to come soon!**

Webinar 1 - Guidance and examples for the EPB standards' flexibility (recording)

Webinar 2 - EPB standards overview: why, how, what! (recording)

Webinar 3 - How to make good use of the outputs of the EPB assessments (recording)

Webinar 4 - EPB standards hourly vs monthly methods (recording)

Webinar 5 - EPB standards linked to health and wellbeing (recording)

Webinar 6 - 8th September (registration soon) - Heating systems in the EPB standards

10 https://epb.center/support/short-videos/

11 https://epb.center/news/news_events/webinar-series-energy-performance-of-buildings-sta/

12 https://www.buildup.eu/en

Updated tools on individual EPB standards (spreadsheets)

The **spreadsheets related to the EPB standards** are provided to **demonstrate specific elements** and **features** of the **calculation procedures** in the relevant standard(s). Consequently, **they do not replace the EPB standards**, but they shall be **used along with the EPB standards.**

EN ISO 52016-1:2017	EN ISO 52010-1
• Tool to perform a full annual calculation of the heating and cooling loads and needs and indoor temperatures, with both the hourly and the monthly calculation method.	• Tool to perform the conversion of climatic data for energy calculations.

EN 16798-5-1	EN 15316-4-2
• Tool to calculate the energy performance of a ventilation and air conditioning system.	• Tool to calculate (e.g. hourly) the energy performance of a heat pump system.

The use of EPB standards at the end of 2019 in several European countries

For a previous issue, REHVA Journal asked several persons, informed about the developments in their country, about their personal observation regarding the **status of the implementation of the EPBD** (Energy Performance Buildings Directive) and in connection to this the **use of the set of EPB standards.** Check out REHVA Journal 5th issue 2019[13] and learn about the situation in the countries below.

France | Italy | the Netherlands | Croatia | Romania | Switzerland | the United Kingdom

Questions?

Check out the **FAQ**[14] available at epb.center!

EPB Center team is **continuously publishing frequently asked questions** on a wide range of topics related to the EPB standards.

- What is the set of EPB standards?
- Are the EPB standards only relevant in Europe?
- How does the set of EPB standards take into account national differences?
- How should I fill in a so called "National Annex"?

You find something unclear or maybe wrong in one of the EPB standards?

- Part of the services of the EPB Center is to collect presumed errors and questions on the content of EPB standards and their accompanying technical reports. First overviews have been prepared and published.[15]

In case of unanswered questions, please go ahead and contact us!

13 https://www.rehva.eu/rehva-journal/detail/05-2019
14 https://epb.center/support/overview-epb-standards/epb/
15 https://epb.center/support/overview-epb-standards/epb/#faq-5535 ■

IEQ-GA pandemic initiatives:

COVID-19 Task Force and web Information Centre

The IEQ-GA Global Alliance, global society launched in 2019 and providing guidelines and knowledge on the indoor environmental quality in buildings and places of work around the world, has set up some initiatives aiming to tackle the **COVID-19 issue from the IEQ perspective**.

The IEQ-GA has organized an **IEQ-GA Task Force** consisting of representatives from member organizations who have specific knowledge, capabilities and expertise in the field. It is the intent of the Task Force to work together to develop consensus documents and position statements on behalf of the IEQ-GA. Its work and activities will continue to evolve as the COVID-19 pandemic spreads throughout the world.

The IEQ-GA COVID-19 Task Force Members are the following:

- Jaap Hogeling, Chair of the Task Force
- William Bahnfleth, ASHRAE
- Georgi Popov, AIHA
- Frank Hovorka, REHVA
- Jarek Kurnitski, REHVA
- Peter Wouters, AIVC
- Vishal Kapur, ISHRAE
- Livio Mazzarella, AiCARR
- Donald Weekes, ACGIH

Thanks to the work of this Task Force, the **IEQ-GA's Members guidance and position documents on COVID-19** have been gathered on the IEQ-GA website in the dedicated COVID-19 Information Centre. This webpage provides users with information and position documents from the IEQ-GA's member organizations as a public service, as well as a FAQs section aiming to give further information regarding some of the most common questions about COVID-19 transmission and IEQ.

The IEQ-GA Position Statement on Airborne Transmission of COVID-19

The IEQ-GA has addressed the big concern about transmission through the air of infectious diseases, especially COVID-19, among the healthcare workers and administrators in healthcare facilities -including long-term care facilities- office workers, retail workers and patrons, manufacturing workers, and residents in private and public facilities. Taking as reference the work of Morawska and Cao (Morawska, L. and J. Cao. 2020. Airborne transmission of SARS-CoV-2: The world should face the reality. Environment International v. 139), the statement affirms that "*there is substantial evidence to suggest the possibility of airborne transmission*", and therefore "*IEQ-GA supports the position that airborne transmission of COVID-19 is sufficiently likely as a route of infection that airborne exposure to the SARS-CoV-2 virus should be controlled by effective measures, including ventilation, filtration and air cleaning*". The complete statement is available online on the IEQ-GA website.■

IEQ-GA: ASA JOINS AS FULL MEMBER

ASA (Acoustical Society of America) is now officially Full Member of the IEQ-GA – Indoor Environmental Quality Global Alliance. The decision of accepting ASA as Member has been taking unanimously on the 23rd of April by the Board of Directors.
ASA's mission is to generate, disseminate, and promote the knowledge and practical applications of acoustics.

REHVA 2020 General Assembly

The 64th REHVA General Assembly took place online, due to the government's COVID measurements the 18 May 2020. Despite the General Assembly being held online, we greeted 68 participants from 25 member countries. The President of REHVA Frank Hovorka has moderated the both the pre working session meeting (held on Friday 15 May 2020) and the General Assembly itself. He welcomed all the attendees with a festive glass of wine mentioning that it is the first time in history of REHVA that we do not meet face-to-face and then jumped in onto business. The General Assembly went on with the agenda, focusing on the general overview of REHVA's past activities and on the key points of REHVA's future activities.

One of the most discussed topics in the last months, and a point of REHVA's strategic activities for the future is the REHVA COVID-19 Guidance (as well published in the REHVA Journal 02/2020). Once again, we would like to thank the Task Force leader Jarek Kurnitski and the whole team for the immense work they have put into this. During the General Assembly, Arash Rasooli, the winner of the REHVA student competition and the REHVA World Student Competition 2016 presented the new REHVA project 'REHVA Community of Young Professionals'. One of the most important moments of the assembly was the election of the last remaining seat in the REHVA Board of Directors. A big congratulations to Catalin Lungu who has been elected in this position for the next 3 years' mandate.

The most awaited point of the agenda was the nomination of REHVA AWARDS and FELLOWS. Frank Hovorka wished to give the awards during the traditional gala dinner of the Annual Meeting. Exceptionally online, he named the awardees one by one inviting them to join the WebEx meeting. Find out all the 2020 REHVA winners on page 74.

During the REHVA Annual meeting, the main strategic issues were discussed also during REHVA Committee meetings and by the REHVA Board of Directors in the board and working meetings, in the week prior to the General Assembly. Although the 2020 Annual Meeting needed to be held online, all the meetings were very productive, and we are very much looking forward meeting you face-2-face in the REHVA Brussels Summit in November 2020. ■

REHVA AWARDS 2020

Professional Award For DESIGN

Adileno BOECHE
AiCARR
Italy

Akdeniz HIÇSÖNMEZ
TTMD
Turkey

Professional Award For EDUCATION

Jana PERÁCKOVÁ
SSTP
Slovakia

Ole TEISEN
Danvak
Denmark

Professional Award For SCIENCES

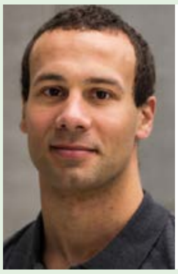
Alberto CAVALLINI
AiCARR
Italy

Professional Award For TECHNOLOGY

Christian FELDMANN
AICVF
France

YOUNG SCIENTIST Award

Julien BERGER
AICVF
France



Hicham JOHRA
Danvak
Denmark

Award of RECOGNITION

Francesco FRANCHIMON
the Netherlands

REHVA FELLOWS 2020

REHVA grants the status of REHVA Fellow for significant contributions to REHVA i.e. contributions to the board, to committees and to task forces.

In 2020, REHVA granted the status of REHVA Fellow to:

Tuba Bingöl ALTIOK
TTMD
Turkey

Ole TEISEN
Danvak
Denmark

During the REHVA General Assemby, Arash Rasooli presented the newly created REHVA Community of Young Professionals!

The REHVA Community of Young Professionals will be facilitating professional activities and knowledge exchange between young professionals (below 35 years) in the fields of indoor climate management, HVAC and building services. We reach out first to former participants of the REHVA student competition and invite them to join our initiative.

REHVA will support the joint activities defined later together with the community members and offer advantages relying on the existing REHVA knowledge sources and services, such as free or discounted access to REHVA guidebooks, events and trainings, publication possibility in the REHVA Journal, specific sessions at REHVA events for the community. Our aim is to create an online community and information hub tailored to the interest of community members.

For any inquiries, please contact us at rcyp@rehva.eu. Find the LinkedIn group through the QR code. ■

REHVA COMMUNITY OF YOUNG PROFESSIONALS

Interview with Hicham Johra

– Winner of the REHVA Young Scientist Award

Hicham Johra

- Postdoctoral Researcher at Aalborg University (AAU), Department of the Built Environment
- Ph.D. Degree in Civil Engineering (AAU), thesis on “Integration of a magnetocaloric heat pump in energy flexible buildings”
- Master’s Degree in Civil Engineering at the National Institute of Applied Sciences (INSA)
- Participated in 13 international research projects with combined budget of 18 million €.
- Teaching & supervision of master thesis projects at AAU
- Publications: https://orcid.org/0000-0003-4177-9121
- Received the REHVA Young Scientist Awards in 2020

AD: Congratulations to receiving the REHVA Young Scientist Award. Tell us a few words about you and your career so far.

HJ: After graduating from the National Institute of Applied Sciences (Rennes, France) as a Civil Engineer, I started my scientific career as a Research Assistant and Laboratory Engineer at Aalborg University. The first few years of my academic career were dedicated to various experimental investigations on the performance of HVAC systems and elements of the building envelope. I was also involved in teaching activities (measurement of indoor climate and energy, control of HVAC systems), and the development of computer interfaces for the automation of the laboratories. After 3 years, I started my Ph.D. (funded by the ENOVHEAT project). During this Ph.D., I had the chance to collaborate with world-specialists working in the field of innovative magnetocaloric systems (Technical University of Denmark, University of Southern Denmark, University of Ljubljana), and in the field of building energy flexibility (International Energy Agency EBC Annex 67 Project). In 2018, I completed and defended my Ph.D. thesis titled “Integration of a magnetocaloric heat pump in energy flexible buildings” and have been employed as a Postdoc Researcher as Aalborg University.

It is a great pleasure and an honour to receive this award from REHVA. I am very happy to see that my work is appreciated by the scientific and professional community, and I hope to have the chance to continue my career in the research and development of efficient energy systems for sustainable buildings. I would like to thank all my great colleagues from Aalborg University and the fantastic people I have collaborated with during those nice years doing research, and hopefully for the many more to come.

AD: What is your main research field, on what are you working recently?

HJ: For the past 2 years, I have been employed as a Postdoc Researcher in the InterHUB Project where I continue my work on building energy flexibility and its employment in clusters of buildings connected to a district heating network. Buildings can modulate their energy needs over short periods of time, which can help the different energy smart grids to balance the intermittence of renewable energy sources. Understanding the interaction between energy flexible buildings (including the households and building occupants) and district heating networks is a key element to develop future sustainable energy systems with 100% renewables. In addition, I continue my teaching activities, together with the development of the new experimental facilities of the Laboratory of Building Material Characterization, and the Laboratory of Building Energy and Indoor Environment at the Department of the Built Environment of Aalborg University. I also have some very fruitful collaborations with the Department of Chemistry of Aalborg University, and the participants of the IBPSA Project 1 (Modelica framework for the modelling of buildings and district heating networks).

AD: How and when did you hear first about REHVA? Are you involved in the network?

HJ: I have heard for the first time about REHVA during my studies (Erasmus) at Aalborg University. Students are encouraged to read relevant standards and guidelines for building energy systems and indoor comfort. It is thus very appreciable to read the REHVA Guidebooks that give you state-of-the-art and comprehensive overview of those topics. During my Ph.D., I participated to 2 REHVA congresses at CLIMA 2016 in Aalborg and at the latest CLIMA 2019 organised in Bucharest. Due to workload during my Ph.D., I did not have so much time dedicated to networking, but I follow the news of REHVA, and I appreciate the articles and events that REHVA organizes regularly. I hope to participate to the next CLIMA conference in 2022. I am not currently much involved in regional, national, and international associations and networks such as REHVA, IBPSA-Nordic or Danvak (network for professionals in HVAC, energy and indoor climate in Denmark), but I am looking forward to become an active member and explain, promote and receive feedbacks on the current R&D projects that we are carrying out. Building energy systems and indoor comfort are tremendous challenges, and I believe they can only be tackled by the close collaboration between researchers, the educational institutions, policymakers, and professionals.

AD: What do you consider as the main technological and research challenge of our sector?

HJ: In my opinion, the greatest technological challenges of our sector is to drastically reduce the embodied energy (CO_2 emission due to production) of all the great technical solutions we have developed to decrease the energy demand during operation and to improve the comfort of newly built and newly renovated buildings. We need to develop solutions with the same performance in terms of service, but with lower impact during fabrications, operation, and decommissioning (recycling). This is the only way to ensure a truly long-term sustainable building sector providing better comfort, health and well-being at a minimum energy expenditure, CO_2 emission and environmental impact. I think this could be (partly) achieved through the integration of more renewable energy sources in energy systems and the use of buildings and electrical transports to balance intermittence. The global optimization of buildings and their systems should also take more into account local climate, local resources, local circular economy, and local production. The integration of innovative materials from the fields of material sciences into the building sector is another promising path to take.

Another technical challenge that is very specific to the field of building energy, is the proper understanding and modelling of building users and households, as they have an ever-increasing impact on the performance of low-energy buildings.

Although technical challenges are real, I think there are even larger challenges from the political, social, and economic sides, and I believe that engineers, researchers, and professionals can contribute there too. The cleanest energy is the one we do not have to produce. Only a strong political will can induce economic incentives to massively renovate the existing building stock that is, by far, the number one target for global reduction of the energy demand, and also for the improvement of people's well-being and health. New social acceptability and agreements must be found for the future sustainable cities, most probably including a paradigm shift in our way of using buildings, cities, and transportations. New business models must be created to incentivize the development of renewable energy sources, building sustainability, indoor comfort and building quality. ■

Interview with Ole Teisen

– New REHVA Fellow and winner of the Professional Award for Education

Ole Teisen

- Chief advisor – building commissioning, Sweco Danmark
- 20+ years' experience in commissioning process and related standardisation and education
- 10-years' experience as contractor, technician, project manager in the Building Automation and Controls sector
- Co-Chair of the REHVA Commissioning Task Force
- Co-author of REHVA GB #29 "Quality management for buildings", editor of REHVA GB #28 on Commissioning
- Teaching & developed a Danvak Commissioning Course
- Co-author of ASHRAE Standard 202-2018 & ASHRAE Guideline 1.4-2019
- Received a REHVA Professional Award for Education & became REHVA Fellow in 2020

AD: Congratulations to receiving both the REHVA fellow status and our professional award for education. Tell us about you, your specialisation and career.

OT: First, I thank REHVA for awarding me. I am proud and honored to be granted the status of a REHVA Fellow and to receive REHVA's professional award for education. The Commissioning Process is gaining momentum, and I am very proud to be part of it now and in the time to come. I am glad that the coming generations are interested and want to be involved.

On my career: from a job teaching blacksmithing at an institution for young criminals (!) I became a BACS-contractor at a Danish engineering company, where I have worked as a technician, project manager and trouble shooter for 10 years. The same company was bought during my career by different investors until it became part of Sweco, where I still work today. Our team provides, beside the consultancy work, training for practitioners about commissioning, which I consider very important. I have spent the past more than 20 years with developing the Commissioning Process and standards for the Danish, American and now for the European, market. I am also member of ASHRAE technical groups and co-author of two of their standards on commissioning. The secret here is to keep on doing the practitioner work, reserving time for actual Commissioning jobs to avoid losing ground control.

AD: How and when did you hear first about REHVA? Why do you think it is worth to invest time in the REHVA network as volunteer?

OT: I heard of REHVA through Danvak and the Danvak magazine that I have received in various forms since 1997. I wrote articles for the magazine at the beginning of my career for a while, writing articles on BMS. I got deeper involved in the work of REHVA more recently, 5-6 years ago, contributing to guides and seminars on the commissioning process and on monitoring-based commissioning. I enjoyed being a speaker at a REHVA-ISHRAE seminar in India, exchanging with Indian professionals.

REHVA and Sweco are now involved in two important initiatives in the field of the Commissioning Process and Technical Monitoring. One is the Eurovent-initiative COPILOT that is about a certified Commissioning Process (Cx). When Cx is not patented or a registered trademark, it happens that it is offered by "turbo commissioners" without the necessary skills and at an inexpensive price. The COPILOT certification will help to ensure a consistent Commissioning Process. The other is the EU Horizon2020 funded research project QUEST. The research in QUEST should lead to a hands-on tool, that can visualize the value of the investment in Quality Management of a building process through The Commissioning Process and Technical Monitoring.

I am also working with Danvak again, we have developed a 4-days course on Commissioning that goes through the entire process. Participants can get started with their own commissioning job after this course. We use an innovative teaching method, based on a role-play of the different roles involved in a commissioning process.

I am honored for having received the REHVA professional award that Danvak nominated for this educational work. To me REHVA is the no. 1 place for networking in Europe when it comes to HVAC, energy in buildings, building performance and IEQ or building installations in general. There is no upper limit for how much you can work as a volunteer. If anyone feel bored, just come and let's talk about a couple of tasks to be done in The Commissioning Task Force…! Another advantage of volunteering is that I love you all as professionals and as humans, we do move things and we do have a great time. Come and join us!

AD: What do you consider as the main challenge of our sector and how commissioning can help?

OT: The challenge now is to make sure that the societies in Europe focuses on climate and sustainability. It is right NOW when countries are reopening after the corona pandemic that we can contribute to increase awareness on sustainable resources and technologies, and on buildings as key objects for investments necessary to avoid a too big post-corona recession. I am also convinced that that we, in Europe, could have a greater focus on the UN Sustainable Development Goals (SDG), more concretely we can map what we can contribute to every separate SDG and where our services might have interactions, positive or negative, with those SDG's. Invest to get out of the crisis but invest wisely!

Our work through the last decades in the Sweco Denmark Facilities Management unit has shown, that when a new building is handed over to the owner, it almost never performs according to the owners' expectancies. The same conclusion can be found in international studies. Systems, that should interact, do not do so, resulting in poor technical performance. Indoor climate is sweating hot with ice-cold draft at the same time. Energy bill is on a race to the sky, and the paint on the sustainability certification plaquette is cracking.

The Commissioning Process is designed to handle all this. You might ask: If the contractors are not doing a proper job, shouldn't I take them to court and let my lawyers fix that? But that will not give you a functional building, things are not that simple. When we visit "sick" buildings, the root causes for the sicknesses are often found in the initial specification of the new building, that is, with the owner. If luckily the Owners Project Requirements happen to be unambiguous, the next challenge is the design, where there are often lots of misinterpretations and mismatches between different subjects, e.g. ventilation, electricity, and automation. If we have luck once again and the design is according to the Owners Project requirements, there still will be no guarantee that the contractor is building according to the design. And yet we have not mentioned balancing, quality assurance, documentation, training and all the other tasks to support the operations and assure the skills and the tools of the O&M staff.

With other words: The Commissioning Process needs to start before design with assuring unambiguous and measurable requirements that we can use as accept criteria for the coming activities. It needs to be cross-disciplinary to break down the "silos" of the design and construction. It includes operations-focused reviews of design and submittals. We need to do inspections, tests, user training and systems manuals in the construction phase and Technical Monitoring of the actual performance before handover and in the operations. Isn't that costly? Sure, but it is more expensive if you do not do so! In Sweco we have made detailed cost-benefit analysis on a couple of our own Commissioning projects and we found a simple payback-time less than a year. International studies show around 2–3 years. ■

Donald Leeper OBE in Memoriam

REHVA is saddened to announce that Donald Leeper, Vice–president 2008–2011, died in April, a victim of COVID–19. His career spanned half a century, as did his service to CIBSE, BSRIA, the Construction Industry Council and REHVA.

Donald served on the board of REHVA from 2008 to 2011. He was particularly involved in the elaboration of REHVA's 5–year strategic plan presented at CLIMA 2011 in Antalya. We keep in mind a strong member of the board, who really contributed to REHVA's goals, aims and objectives with a great professionalism and a very strong ethical approach.

Donald was also a key actor of CIBSE, Council and Executive Committee of CIBSE in the 1990's and 2000's, as a Vice President from 1999–2000 and CIBSE President from 2005–2006. He has been promoting the building services engineering profession in involving young engineers by creating the Young Engineers Network.

A first degree in maths was followed by an MSc in Mechanical Engineering, won at Imperial College which underpinned Donald's passion for accuracy and logic. He had a long and distinguished career which led to him to Senior partner at Zisman Bowyer Consulting Engineers Zisman Bowyer were recruited as a BSRIA member company in 1971. Donald had a passion for research and quickly became a BSRIA Council member. He remained an energetic supporter of the Association for the whole of his working life and was instrumental in the creation of BSRIA Ltd in March 2000. A founder non-executive Board member from 1991 to 2002 he also served as Chairman in 1994 and 1995.

We shall keep Donald in mind as a highly skilled professional, promoting our domain with a strong conviction, one of the personalities we only had a chance to meet via REHVA and whom we all benefitted from. ■

FRANCIS ALLARD
REHVA President 2008–2011

FRANK HOVORKA
REHVA President 2019–2022

Send information of your event to Ms Giulia Marenghi gm@rehva.eu

Exhibitions, Conferences and Seminars in 2020 & 2021

Exhibitions 2020

1–4 September 2020	SHK Essen	Essen, Germany	https://www.shkessen.de/branchentreff/

Conferences and seminars 2020

1 September 2020	Danvak Dagen 2020	Copenhagen, Denmark	https://danvak.dk/produkt/danvakdagen2020/
6–9 September 2020	NSB 2020 Building Physics Conference	Tallinn, Estonia	www.nsb2020.org/
14–15 September 2020	CIBSE Symposium	Glasgow, UK	https://www.cibse.org/technical-symposium-2020
13–14 October 2020	BuildSim Nordic 2020	Oslo, Norway	https://buildsimnordic2020.ibpsa-nordic.org/our-travels/
13–15 October 2020	Chillventa 2020	Nurnberg, Germany	https://www.chillventa.de/en
29–31 October 2020	Refcold	Delhi, India	https://www.refcoldindia.com/home
1–5 November 2020	Indoor Air 2020	Seoul, Korea	www.indoorair2020.org
4–6 November 2020	Brussels Summit	Brussels, Belgium	https://www.rehva.eu/events/details/rehva-brussels-summit-2020

Conferences and seminars 2021

10–12 January 2021	Climamed	Lisbon, Portugal	http://www.climamed.org/en/
14–17 February 2021	Roomvent 2020	Torino, Italy	http://roomvent2020.org/
17–21 April 2021	Cold Climate	Tallin, Estonia	https://www.scanvac.eu/events.html
26–29 April 2021	13th IEA Heat Pump Conference	Jeju, Korea	http://hpc2020.org/
15–18 August 2021	13th International Industrial Ventilation Conference for Contaminant Control	Toronto, Canada	https://www.ashrae.org/conferences/topical-conferences/ventilation-2021
29 Sept – 2 Oct 2021	ISK Sodex 2021	Istanbul, Turkey	http://www.sodex.com.tr/

! **Due to the COVID19 circumstances, the dates of events might change. Please follow the event's official website.** !

1st CEN-CE Classroom Pilot Training and Certification

CEN-CE team, under the auspices of FSB, organized the 1st CEN-CE classroom pilot training and certification during 3–4 December 2019 in Zagreb, Croatia.

The 1st CEN-CE classroom pilot training and certification was organised by FSB (University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture) within the framework of the Croatian education improvement programme for energy certifiers and auditors (NN 73/15, 133/15).

In terms of popularity, the pilot training and certification was fully booked within 24 hours of publication and furthermore there was higher demand than available seats. The main aim was testing if the overall mindset of CEN-CE scheme is effective and collecting valuable feedback from trainees.

The 1st CEN-CE classroom pilot training and certification was attended by 34 trainees (40% architects and civil engineers 60% mechanical and electrical engineers). 28 trainees took the exams with a pass rate of over 80% for most of the modules.

The overall impression based on the experience of this 1st CEN-CE classroom pilot training and certification is that there is a high interest among the experts for this type of training.

For more details about the content of this 1st CEN-CE classroom pilot training and certification, please download the **agenda** PDF (**QR-code** below).

The 2nd CEN-CE classroom pilot training and certification will be under the leadership of Laurent Socal in Italy during February 2020. ■

CEN-CE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785018. The sole responsibility for the content of this project lies with the authors. It does not necessarily reflect the opinion of the European Commission.

2nd CEN-CE Classroom Pilot Training and Certification

CEN-CE team organized the 2nd CEN-CE classroom pilot training and certification session ion the 11th of February in Pordenone, Italy, luckily just in time before the virus spread.

The 2nd CEN-CE pilot classroom training and certification was organized by Laurent Roberto SOCAL, a partner of CEN-CE team. The training was held in Pordenone, a town in the region Friuli.

The training was organized with the collaboration the local organizations of professionals, both high school level and graduated, engineers and architects (Ordine Periti Industriali della Provincia di Pordenone, Collegio Geometri e Geometri Laureati della provincia di Pordenone, Ordine degli Ingegneri della provincia di Pordenone and Ordine degli Architetti Pianificatori, Paesaggisti e Conservatori della provincia di Pordenone).

They approved the contents of the training session so that attendees could obtain valid credits to keep their official registration. The approving of the local organizations of professionals is key for the roll-out of the CEN-CE scheme in other countries and for the recognition EU-wide. For example, if the training content of the CEN-CE scheme will also be approved by local organizations of other countries, then the Italian experts could valorize their CEN-CE certificates to valid credits and keep an official registration also in other countries if they work EU-wide.

The location chosen was a small city (50.000 inhabitants) and the course was announced with a short notice (two weeks). Indeed, the audience was quite good and included both experts on technical systems and architects.

The course was held in Italian to test the translation of the teaching material. The CEN-CE modules about storage, thermal solar, heat pumps and measured energy performance were integrated by an introduction on EU and Italian regulatory news about energy performance in buildings and an overview of the whole EN-EPB package of standards, including the hourly method for the calculation of building energy needs and ventilation systems.

27 experts attended the teaching and 26 attempted the certification exams. The success rate has been between 73% and 88%, depending on the module (storage, thermal solar and heat pumps).

The mix of participants was 60% experts of the mechanical systems and 40% experts of the building envelope. The part about fundamentals allowed experts in the building envelope to grasp the basic concepts on technical systems. Symmetrically, the introduction on energy needs was appreciated by experts in technical systems. Understanding each other topic will greatly facilitate the collaboration between experts, which is one the key issues to obtain real high-performance buildings.

For more details, please use the **QR-code** below.

The regular training modules will start end 2020 or early 2021.■

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Virtual 14th TTMD Symposium

AHMET ARISOY, Prof. Dr. Scientific committee chair

14th TTMD Symposium which was held between the 1st and 4th of June, 2020 was the first virtual conference in HVAC sector worldwide. Therefore, we believe that this experience is invaluable for all the actors in this community. The symposium turned out advantageous in terms of many aspects and we are now ready to share this experience with all of you.

The Symposium, which was strongly supported by REHVA hosted 25 internationally renowned keynote speakers. Selected 18 scientific papers have been presented and two panels were organized within the symposium.

TTMD Symposium served more than 2000 participants who were online with us from more than 80 different countries. Number of participations was the highest compared to the TTMD Symposiums held in previous years.

We will upload the recorded sessions of the Symposium and full papers on the web. The abstracts are already in the web for those who would be interested. All the registered members will be able to reach these documents.

Some important points which have been issued during the symposium are summarized below:

Resiliency and sustainability; these are the most important concepts of the recent years which are closely related with our future. Actually, built environments need to be developed that are both resilient and sustainable.

We have discussed sustainable energy use in buildings during the last symposium.

Resilience to energy demand, climate change and natural disasters in buildings were new demanding specifications of buildings recently. The challenge is how to improve resiliency and performance in the built environment. The building community needs new strategies, design practices, and other tools to make buildings more resilient.

For this very reason we have selected "resilient HVAC system and building solutions" as the main theme of the Symposium. However, we could not imagine how important the recent virus attack would be for resilient HVAC systems and buildings just a year ago when we were choosing this theme. It turned out to be the most important issue today. And then, very timely, we have discussed resilient HVAC systems and built environment against the threat of COVID-19 in this symposium.

Micro climate, climate change and urban heat island issues have to be definitely considered in the future design methodology. System design based on conventional outdoor design conditions do not comply with the current real outdoor conditions in big cities. The local temperature is quite different than the temperature measured at the airport-based stations. The dense settlement, concrete structures instead of green areas, solar reflections from doubled-façade buildings, heat release from outdoor units of air conditioners create an artificial micro climate around the considered buildings. Heat gains are much more than the same building in the rural area. Design methodology is much more complicated than the standard design methodology today. The most advanced method is integration of microclimate and the building simulation models. Technical solutions to these challenges are needed and these solutions include research, standards and guidelines, and educational materials.

Outdoor average temperatures will increase 3-10°C depending on the different scenarios due to **the climate change**. Air conditioning requirements will increase dramatically. In residential applications, this demand will increase 320% to 2570% depending on the different scenarios again until the year 2050. With global warming, cooling loads will increase, COP values decrease and peak heat gains increase and all these cause an increased electricity demand. Precautions should be taken seriously and immediately against this threat. The COVID-19 spread can be used as an opportunity for this purpose.

Living with nature can be a key approach for solution. **Action plans** should cover an integrated approach considering both green areas, renewable energy, resiliency etc. Policy-setting entities worldwide need to encourage sound, balanced, and innovative actions to address broad issues of resiliency and the specific technical concerns.

Indoor air quality requirements are evolving in different directions. First of all, indoor air quality cannot be taken into account regardless of outdoor air quality considerations. After the pandemic, we have to consider the outdoor air quality to protect indoors from contaminants, viruses, etc.

The other issue for indoor air is individual control ability and to increase indoor air quality by considering this as a principle design criterion. The requirement of healthy and comfortable buildings in addition to the energy efficiency is the most important principle today.

Occupant centric BPM (Building Performance Management) is another developing concept. **IAQ label** besides the energy certificate of buildings should be considered. There is a connection between value of the building and the level of IEQ well-being. In case of office buildings, productive and healthy environment is important. Impact of emerging smart technologies on building performance management and on the quality of our indoor environments need to be considered. **Digitalization in the built environment** creates new opportunities for more efficient building performance management. We have no clear-cut metrics for determining the market value of good IEQ and good BPM. However, this issue is being studied intensively today.

Building simulation is a cutting-edge approach for our profession. Without building and its HVAC system simulation tools, we cannot design a proper system, we cannot assess the performance of buildings and its systems, we cannot manage the systems properly and we cannot control the systems and equipment efficiently. We have developed many computer programs and we use these tools extensively in our design studies. Still, there is a gap between predicted and measured energy use. Root causes of energy performance gap has to be studied.

Rule based control is simple. **Model predictive control** (MPC) of systems and equipment is needed to include simulation programs in the process. However, this control methodology is complicated. Machine learning (data-driven) control is simpler and faster and more effective. Reinforcement learning is the most recent control strategy.

District heating and cooling, an important alternative for energy resilient cities and districts. It can use any kind of energy source and the overall efficiency is high. New generation district heating systems integrate renewable energy sources and heat storage. Water is the heat carrier and due to huge thermal inertia, new generation systems should be controlled effectively. Predictive control is the key concept here. The difference between supply and return water temperatures is the key parameter defining the most efficient distribution system. This difference should be kept as high as possible. Optimized operation of systems can be maintained by controlling this parameter.

Energy storage is also a very useful tool especially for efficient cooling of the buildings. This element can be used wisely in designing buildings in hot and continental climates. Energy storage for buildings of the future contains solar and heat-pump assisted heating and cooling systems, smart controls, cold storage, building integrated systems.

Revised EPBD 2018 draws more attention to **renovation strategy**. The aim is reduction of green gas emissions (GGE) and increase the use of renewable energy. Also revised EPBD brings the idea of Technical Building Systems and their control systems and automation.

Revised EPBD introduces a new concept which is the **smart readiness** and **smart readiness indicator** (SRI). SRI measures the capacity of buildings to interact with the connected energy grid and the storage systems, optimizing the overall energy performance (EP) of the building. This is directly related to energy resiliency of the buildings. SRI will characterize the ability of building to manage itself and to interact with its occupants. The motivation is recognition of process toward smart building systems and their added value.

Ecodesign directive in EU is a regulation on minimum product requirements. It regulates the minimum requirement on energy efficiency of a product to be allowed in EU market. Energy using products need to declare this and a database is currently set-up. Performances of HVAC systems play a major role in energy performance of buildings.

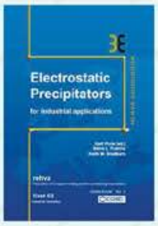
As Mevlana said: "We have said everything to be said today my dear, and we have to say new things tomorrow". I am sure we will say new things in our next symposium. Until then stay safe, healthy and well. I hope to see all of you in our next symposium. With our best wishes. ■

REHVA
Federation of European Heating, Ventilation and Air Conditioning Associations

EUROPEAN GUIDEBOOKS


No.01: DISPLACEMENT VENTILATION IN NON-INDUSTRIAL PREMISES


No.02: VENTILATION EFFECTIVENESS


No.03: ELECTROSTATIC PRECIPITATORS FOR INDUSTRIAL APPLICATIONS

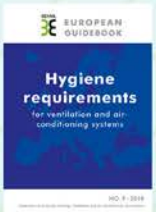

No.04: VENTILATION AND SMOKING


No.05: CHILLED BEAM APPLICATION GUIDEBOOK

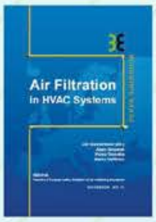

No.06: INDOOR CLIMATE AND PRODUCTIVITY IN OFFICES


No.07: LOW TEMPERATURE HEATING AND HIGH TEMPERATURE COOLING


No.08: CLEANLINESS OF VENTILATION SYSTEM


No.09: HYGIENE REQUIREMENTS FOR VENTILATION AND AIR-CONDITIONING SYSTEMS


No.10: COMPUTATIONAL FLUID DYNAMICS IN VENTILATION DESIGN


No.11: AIR FILTRATION IN HVAC SYSTEMS

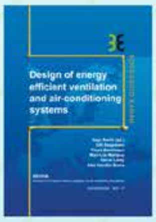

No.12: SOLAR SHADING

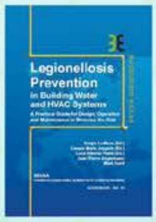

No.13: INDOOR ENVIRONMENT AND ENERGY EFFICIENCY IN SCHOOLS - PART 1


No.14: INDOOR CLIMATE QUALITY ASSESSMENT


No.15: ENERGY EFFICIENT HEATING AND VENTILATION OF LARGE HALLS


No.16: HVAC IN SUSTAINABLE OFFICE BUILDINGS


No.17: DESIGN OF ENERGY EFFICIENT VENTILATION AND AIR-CONDITIONING SYSTEMS


No.18: LEGIONELLOSIS PREVENTION IN BUILDING WATER AND HVAC SYSTEMS


No.19: MIXING VENTILATION


No.20: ADVANCED SYSTEM DESIGN AND OPERATION OF GEOTABS BUILDINGS

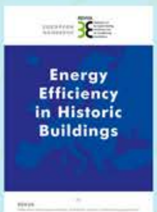

No.21: ACTIVE AND PASSIVE BEAM APPLICATION DESIGN GUIDE


No.22: INTRODUCTION TO BUILDING AUTOMATION, CONTROLS AND TECHNICAL BUILDING MANAGEMENT


No.23: DISPLACEMENT VENTILATION


No.24: FIRE SAFETY IN BUILDINGS


No.25: RESIDENTIAL HEAT RECOVERY VENTILATION


No.26: ENERGY EFFICIENCY IN HISTORIC BUILDINGS


No.27: HVAC COMMISSIONING PROCESS (REHVA-ISHRAE)


No.28: NZEB DESIGN STRATEGIES FOR RESIDENTIAL BUILDINGS IN MEDITERRANEAN REGIONS


No.29: QUALITY MANAGEMENT FOR BUILDINGS