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REHVA OFFICE:
Washington Street 40
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Tel: +32-2-5141171
info@rehva.eu, www.rehva.eu

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Decarbonization and digitalization of buildings – the future of HVAC

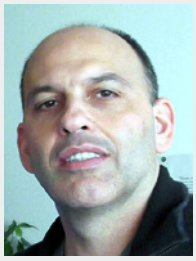
Our HVAC sector is called to play a crucial role in the main energy and environmental challenges of the European Union, and the definition and implementation of strategic actions in our domain can really lead the European transition towards a post-carbon society. The practical implementation of the pillars of low energy buildings design - reduction of building energy demand, increase of systems energy efficiency and maximization of renewable energy sources use - sets a trajectory that is completely coherent with the mission of a community living with a reduced need of carbon-based energies, down to zero.

How to keep high comfort and high indoor environmental quality levels by a new design and operational approach for buildings based on "de-carbonization": this is our ambitious target for the next future.

STEFANO P. CORGNATI
Prof., Ph. D.
President, Chair of the Awards Committee, REHVA
TEBE Research Group, Department of Energy, Politecnico di Torino, Italy
Email: stefano.corgnati@polito.it

To help us in this difficult path, the revised Energy Performance of Building Directive gives interesting messages to be interpreted in order to push the building performances towards a new era. There is now a clear focus on actual energy consumption and performances: we must work to reduce the so called "performance gap", that is the difference between calculated and actual energy performance. To do so, we have to better understand the influence of occupants' behaviour on building energy consumption, the way which occupants interact with the building to change comfort and/or consumption levels and how positive actions stimulated by an energy conscious approach may modify the building energy dynamics. If we want to increase the capability to interpret users and the "users & building" complex systems, we need data: the digitalization of the building, and specifically of the HVAC sector, is a fundamental step. Sensors are in buildings to measures quantities, to collect and elaborate data, to analyse and investigate indicators, to give information to the building manager, to give feedbacks to occupants. Data science is penetrating the building energy sector, and this is a unique opportunity to create new products and services. The development of the Smart Readiness Indicator, promoted by the new EPBD to help the interpretation of the metabolism of such complex organisms like buildings, is challenging and our HVAC community must take a leading position on this issue. Building monitoring and data analysis is useful not only to characterize the building in its individual behaviour, but also to open opportunities of interaction among buildings as parts of an energy communities. Day by day, we move our boundaries of energy investigations from single buildings to groups of connected building, where different energy vectors can be selected to feed the different energy equipment and to cover the different energy needs of the users. The transition to an all-electric, digitalized, connected and smart interacting buildings community is coming, as it is happening to the mobility sector. Be smart to take this opportunity to push new innovative solutions to our HVAC sector: the opportunity is there, we must be there too. ■

Addressing the identification of cost reductions in the design and construction process in new multi-family houses



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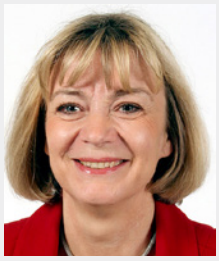
ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy



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Aalborg Universitet – SBi, Denmark

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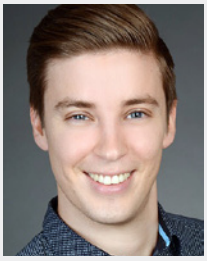

MARKO JACIMOVIC
Building and Civil Engineering Institute ZRMKGradbeni inštitut ZRMK, Slovenia

BENEDETTA MATTONI
ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy

OVE CHRISTEN MØRCK
Kuben Management A/S, Denmark

MARJANA ŠIJANEC-ZAVRL
Building and Civil Engineering Institute ZRMKGradbeni inštitut ZRMK, Slovenia

BERND UTESCH
ABG Frankfurt Holding, Germany

Introduction

The Project CoNZEBs (Solution sets for the cost reduction of new Nearly Zero-Energy Buildings) is funded by the European Commission in the framework of the Horizon 2020 Program to identify, asses life cycle cost and analysis, and disseminate technological solutions able to reduce the construction costs of new nearly zero energy multi-family houses. Among the different activi-

ties, a work package was bound to identify potential cost reduction in the design and construction process (hereafter D&CP). This article presents the main outcomes of the activities, which were structured in the following phases:

- Identification of the current D&CP in the EU member states, with obvious focus on the project participant countries (Denmark, Germany, Italy, Slovenia);
- Identification of common boundary conditions and areas for possible cost reductions;
- Involvement of stakeholders through questionnaires and interviews to identify most promising approaches, methods and tools for D&CP;
- Provide exemplary solutions able to optimise and reduce costs in the overall process.

The full report "D3.1 Assessment and exemplary solutions for cost reduction in the design and construction process" will be public on the project website (www.conzebs.eu), where all the results of the activity will be available in detail.

Current costs in the design and construction process

Current costs in the design process for minimum requirements and nearly zero energy multi-family houses were analysed in participant countries, while a wide literature review was carried out to assess such costs in other member states. Design fees can be determined in three main ways: percentage of the building cost, predefined fixed fees, time charge based on hourly rates, depending on: the country, the size of the project, and its complexity.

Results in the participant countries were significantly different, in fact the share of design fees in respect to the overall construction project costs was identified as follows:

- Denmark 8–15%
- Germany 13% (median value)
- Italy 7–9%
- Slovenia 3–4%

It has to be noted that only in Italy, the survey evidenced an increase of design costs for nearly zero-energy buildings in respect to the minimum requirements ones; while no differences were detected in the other countries.

Analysing the construction process, it was found out that the area for cost reduction could be focused on the preliminaries (or indirect costs), which are costs not explicitly related to the specific items of measured work but mainly related to the construction site "life cycle" (i.e. plants, accommodation, temporary services, rents, transport, scaffolding, and insurances). Few data were available among the participant countries, in Italy a small survey proved shares in the 5–10% range; more data were collected at EU level, proving that preliminary accounts for 10–15% of total construction project.

In the next phase common boundary conditions and topical issues were screened: the main actors involved in the process, specific issue for the social housing, the construction site organisation and the worker skill, the compliance of work execution, supporting instruments. It was found out that very few data from the field are available for what concerns the impact of several measures in reducing costs in the D&CP.

Potential for cost reduction: the stakeholders' view

In order to better understand the feeling and the expectations of the main actors involved in the D&CP, two questionnaires were developed and sent around to related categories. The questionnaire for the designers and planners addressed the following main issues:

- Awareness about and experience with the design and planning of NZEBs.
- Method of calculating the costs for design and planning.
- Solutions to reduce design and planning costs or to reduce costs during the whole construction process (to be tailored at national level).
- Experience and impact of the long-term maintenance costs.

The questionnaire for the designers and planners addressed the following main issues:

- Awareness and experience of NZEBs.
- Adopted process to execute the construction works.
- Magnitude and causes for cost variations in respect to the planned costs.
- Internal process to reduce construction costs.
- Solutions to reduce overall construction costs (to be tailored at national level).

Also, the housing companies were involved in the survey. Alternative to the questionnaire, interviews with targeted actors were carried out.

Designers and planners detect in the integrated planning the most profitable instrument to reduce overall costs for the design and construction process

on average in the four countries, see **Figure 1**. In Germany the most voted solution is avoiding underground spaces for cellars and parking. Average values are scored for the other proposed solutions. BIM is seen as a potential area for cost reduction, especially in Italy and in Slovenia, while the optimisation of common area in multi-family houses is not considered significantly. External staircases and more compact building forms are considered as profitable solutions to optimise the construction costs in Germany.

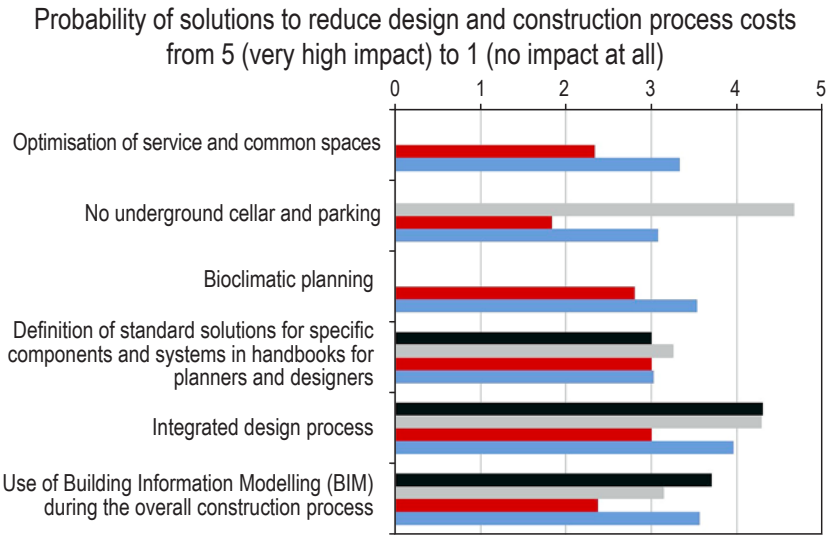

Figure 1. Answers of designers and planners about solutions to reduce D&CP costs. ■ Slovenia ■ Germany ■ Denmark ■ Italy

Concerning contractors and construction companies, the most profitable solution is the efficient quality control in each phase of the process to avoid extra cost for rework, the latter being a critical issue emerged from the questionnaire results, see **Figure 2**. Also, industrialisation in construction components reach a high score. Some solutions, as BIM and skilled workers, show a strong dependence on the specific country in terms of cost reduction expectations. It was observed that potential solutions for cost reduction are more positively evaluated in Italy and Slovenia than Germany and Denmark, a situation that might also depend on how the market has already implemented cost efficiency measures in the different countries.

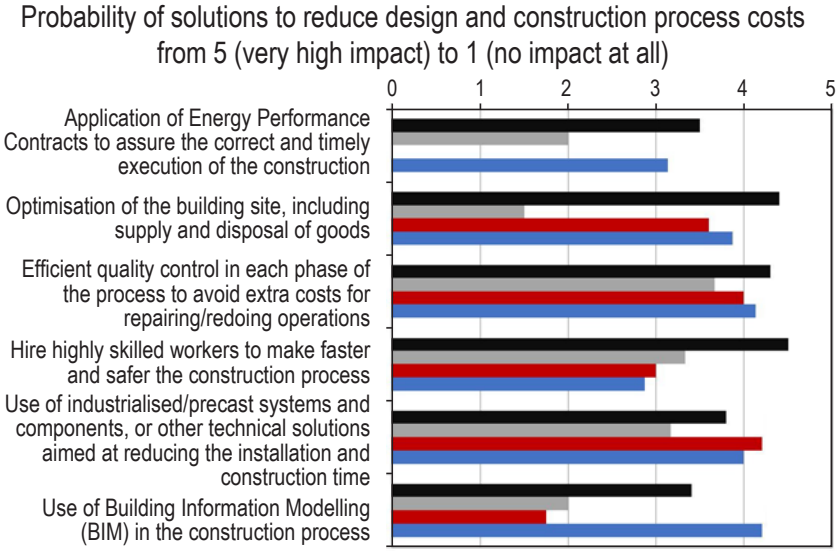

Figure 2. Answers of contractors and construction companies about solutions to reduce D&CP costs. ■ Slovenia ■ Germany ■ Denmark ■ Italy

Exemplary solutions for cost reduction in the design and construction process

Exemplary solutions were identified and analysed to show potential areas for cost reduction in the D&CP. It has to be underlined that they might not be of very general validity, since many factors can affect the final results; conversely, they show the potentialities for cost reduction, intrinsic in the overall process, which needs to be addressed by the involved actors in a holistic approach to the building construction project.

Impact of specific building envelope and energy system technologies

The investigated solutions demonstrate the cost effectiveness in terms of technology costs (material + labour), as well as the capacity of reducing the time for the execution of the works, with additional savings at construction site preliminaries.

The first example is the building facade made of large autoclaved aerated concrete (AAC) blocks, which allows completing the single layer facade in only one workflow with a thermal transmittance as low as to 0.15 W/m²K, instead of the two or three cycles needed with other envelope technologies. **Figure 3** shows construction works with AAC blocks. A comparison versus a reference clay brick layer plus an ETICS facade was carried out for an Italian multi-family house, showing 19% reduction costs and a significant 47% reduction of the construction time.

Another example, coming from Denmark, is the case for roof integrated PV systems: the underlying construction is the same as for other roof types, but the finishing layer is made of PV modules overlapping both by length and width the construction below, see **Figure 4**. This solar roof is easy and fast to mount in one

simple workflow; it is obviously more expensive than a conventional roof but compared to the situation in which a traditional PV system has to be added, it leads to about 28% cost savings. Moreover, the construction time is reduced by 50%.

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Figure 4. Exemplary application of PV integrated roof.

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Figure 5. Example of multi-family house with external staircases.

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Figure 3. Example of construction works using autoclaved aerated concrete blocks.

Impact of specific design solutions

These solutions proved that decisions taken during the design phase can positively affect the overall construction process cost, even though they may require small cost increase during the design and planning phase. A German study and application, as an example, proved the positive impact of external staircases in a multi-family house, with the concurrent reduction of the building external surface to heated volume ratio from 0.5 to 0.37 m^{-1}, and estimated 26% energy savings for space heating. Actualising the cost incurred at the construction time, the identified solution also leads to façade construction cost savings of 60 €/m^2 of living area. **Figure 5** shows a view of the building.

Impact of innovative project management systems

The focus was here on BIM (Building Information Modelling), generally defined as a digital planning and project monitoring method, based on a shared virtual dynamic building modelling, including a detailed database of continuously synchronised data. While this solution is still seen as not cost effective in relatively simple construction projects such as multi-family houses, a US study showed a high return of investments by BIM in a ten projects survey, with economic savings directly to the process in the 0–1.5% range (but one case with 14% savings). First data from the field in Europe were documented in two UK projects; here the economic benefit due to BIM were estimated to be 1.5 to 3%.

Conclusions

While most of the construction project costs are allocated for the construction phase (materials + labour) the performed activities evidenced areas for the cost reductions also in the design and construction process. Expectations and opinions of the involved actors differ from country to country depending on a specific priorities and maturity of the construction market. However, several strategies and solutions can be implemented with the general trend of moving the construction project from a traditional to an industry-like approach, where the accurately planning and management of all phases and the minimisation of the construction site lifetime will play a crucial role. ■

Acknowledgements

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MOBISTYLE

Introduction to the H2020 MOBISTYLE project

ANA TISOV
Huygen Engineers and Consultants,
Maastricht, The Netherlands
a.tisov@huygen.net

PETER OP 'T VELD
Huygen Engineers and Consultants,
Maastricht, The Netherlands
p.optveld@huygen.net

Motivating end-users behavioural change by combined ICT based tools and modular information services on energy use, indoor environment, health and lifestyle.

Keywords: Energy use, indoor environment, health, behaviour change, awareness campaign, people-centred approach.

The European Union (EU) introduced several measures to ensure better engagement of the citizens that are the key for a successful realization of the ambitious EU energy targets [1]. Among other initiatives, the European Commission (EC) funded several projects under Horizon 2020 programme aiming to achieve a behavioural change towards energy efficiency through ICT-based solutions.

In this context, 42-months European H2020 MOBISTYLE project was funded combining 10 organizations with different expertise. This paper presents project people-centric approach, highlights the main project objectives, describes the demonstration cases and presents the ICT solutions developed after 2 years working on the project.

The MOBISTYLE challenge and objectives

Despite the technological improvements of buildings and stricter policy measures, the latest assessments of the European energy strategy for 2030 targets show that these targets are not being met with a sufficient pace [1]. The studies show that the energy consumption has been increased in the recent years where the citizens are the ones consuming energy [2]. Energy efficiency has at the heart of the EU's transition to a resource-efficient economy and the EU 2020 strategy for sustainable growth. However, it seems it is not at the heart of its citizens.

This is one of the main drivers of MOBISTYLE since the MOBISTYLE attempts to alter a prevailing assumption that buildings use energy to an understanding that in fact, people use energy, for their everyday lifestyle and comfort. Therefore, to successfully accelerate the transition to a low-carbon society and economy, more emphasis should be on engaging people, motivating people and increasing their awareness, leading to an energy efficient building use on long term. Through a holistic approach, the multidisciplinary MOBISTYLE consortium aims to motivate behavioural change by raising user's awareness through the provision of attractive, personalized infor-

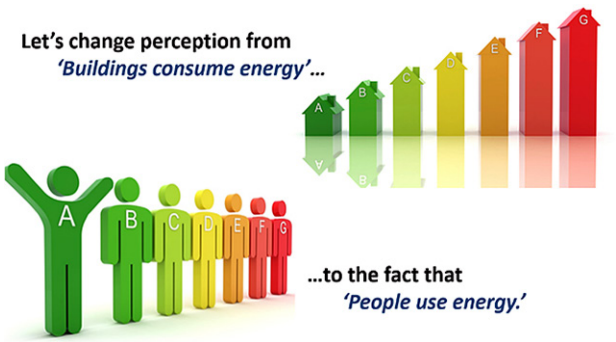


Figure 1. The H2020 MOBISTYLE project recognizes that people use energy, hence, most often this remains unnoticed. The MOBISTYLE aims to make the invisible relation between the building-user-energy visible to building users.

mation, both on user's energy use, indoor environment and health, all enabled by an integrated information and communication technology (ICT) service.

The overall aim of MOBISTYLE is to motivate behavioural change by raising citizens awareness by providing attractive personalized combined knowledge services on building's energy use, indoor environment, health and lifestyle, by ICT-based solutions. This awareness will support and motivate citizens to well informed pro-active behaviour towards energy use, energy efficiency and health, thus empowering users and providing confidence of making the right choices. The combination of awareness on both energy, health and lifestyle will offer citizens more and better incentives than only information on energy use.

In order to achieve this overall aim, MOBISTYLE is built on the following five qualitative objectives:

1. To present understandable information and indicators, related to energy use and energy efficiency, in an easy to handle and attractive way for users.
2. To provide understandable personalized information for users by combining energy monitoring with monitoring of indoor environmental quality, behaviour parameters and daily habits.
3. To motivate a prolonged change of users' habits and daily practices on energy use by combined modular personalized information on individual energy use, health and lifestyle.
4. To foster new business models and applications for future engagements of developers.

An important feature of the MOBISTYLE concept is the use of real environments to develop, deploy and validate the tools and solutions, developed in the project. The MOBISTYLE study and demonstration cases cover different building types (residential, non-residential), different scales (building, district), climatic zones and, most important, different types of building users:

- **Social housing apartments at Kildenparken, Aalborg, Denmark**
  18 residential apartments in 10 different two-story apartment blocks. Climatic zone: Northern.

- **University buildings at the University of Ljubljana, Slovenia**
  8 office rooms in 4 faculty buildings. Climatic zone: Continental Central.

- **Apartments at the Hotel Residence L'Orologio, Turin, Italy**
  4 hotel guest rooms/apartments and reception. Climatic zone: Mediterranean.

- **Office building Qeske, Kerkrade, The Netherlands**
  Open plan office in a five-story office building. Climatic zone: Western Central.

- **Residential houses as part of the Smart City Wroclaw, Poland**
  1000 residential units (detached & multi-family houses, apartment blocks). Climatic zone: Eastern.

Figure 2. MOBISTYLE approach is demonstrated in 5 European countries covering different building types, scales, climatic zones and different types of building users.

People-centred approach in design and development of ICT tools

In MOBISTYLE, users are put at the centre of the ICT tools development process as a necessary and knowledgeable stakeholder. **Figure 3** presents the developed MOBISTYLE people-centric approach; a four-step anthropological approach helping to develop user-friendly ICT tools.

Most often, the ICT design of solutions starts with Step 3 where designers and engineers forget for whom they are developing the solutions. In people-centric approach, a fundamental step is Step 1 Identification. In MOBISTYLE it was observed for each of the five demonstration cases who are actual building users and by looking into their daily behaviour and habits, their needs were identified.

The anthropological approach enables to access 'thick data', as an in-depth understanding of human behaviour, able to penetrate beyond the quantified behaviour of 'big data' collected via technological solutions. This understanding defines requirements for developing the ICT tools in order to provide user-friendly and attractive services.

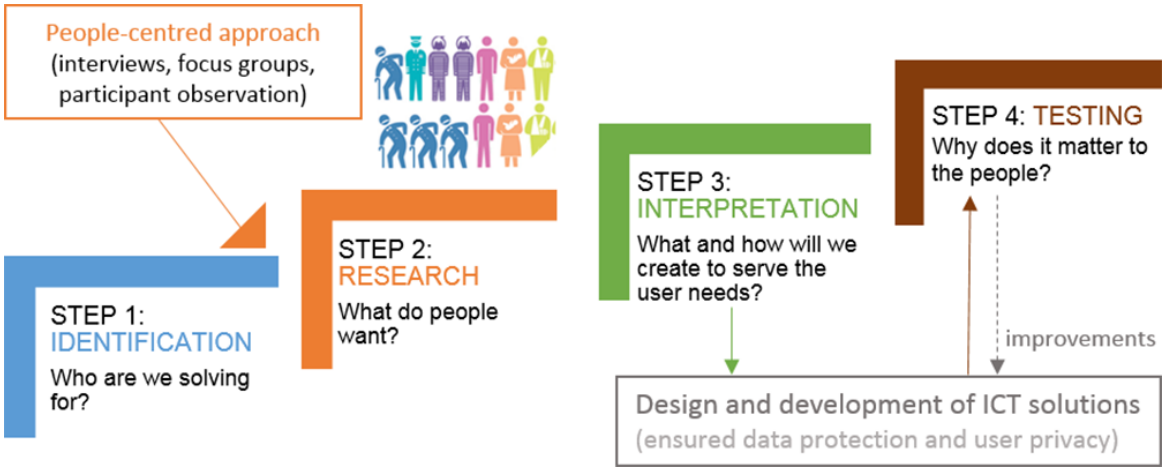


Figure 3. MOBISTYLE approach integrating social science aspects into occupant behaviour research.

Focus groups, supplemented by participant observation, have proven to be a useful research technique for studying users' habits, motivations, needs and expectations in the MOBISTYLE project since they allowed researchers to study people in a less structured conversation pattern than typically occurs in an ethnographic interview. The discussions were guided around MOBISTYLE related topics with open ended-questions where people were encouraged to talk to one another. They often commented each other's point of view or exchanged anecdotes. Some examples below:

- *"When we receive the bill at the end of the year, everyone gets really upset.''*
- *"You should do the things you like. I think that is the most important thing for being healthy"*
- *"My father used to say: if there is sun shining outside, turn off the lights!"*
- *"I changed my habits because of the electricity bills."*
- *"I would turn off the lights if the savings would be 5€ per month."*
- *"I no longer use the technology [a smart watch], since it makes me nervous."*
- *"My parents never told me to turn off the lights, because they lived in a block of flats."*

Figure 4. Focus groups are organized face-to-face in the natural environment of the people. People habits are investigated to discover their current practices, use of existing technologies, as well to investigate key factors that would trigger them to change their behaviour.

Behavioural action plan per demonstration case

In MOBISTYLE, the goal is to use existing technologies and make them more user-friendly and understandable in its operation. The goal is not so much the access into data but to get insight into data. Accordingly, based on the information made available from the focus groups (thick data), together with data coming from sensors, wearables and questionnaire responses (big data), scenarios of behavioural change intervention were developed for each demonstration case (**Figure 5**). Each developed MOBISTYLE Behavioural Action Plan includes a full description of:

- Optimization objective(s) of the Behavioural Change Campaign;
- Definition of Action(s) that can be taken (and influences) from the users;
- Definition of the variables that can be monitored, related to:
  - Actual energy usage (using indoor environment monitoring systems and smart meter data);
  - User's motivational drivers, attitudes, subjective norms and perceived behavioural control (using the questionnaire as a foundation of the app system architecture).

This implemented into the MOBISTYLE ICT solutions via which the information is disclosed to end users.

MOBISTYLE ICT architecture integrating user needs, recommendations and behavioural action plans

The main idea of personalized MOBISTYLE modular information services is to offer so called information/data acquisition bundles where end-users decide which services they want, how long and during what time, and which data they are willing to provide for these services. As seen in **Figure 6**, a modular structure is developed providing tailor-made information giving a possibility to add new modules later, e.g. desire to monitor additional IEQ parameters. Based on the project experiences blue prints will be made how to develop similar campaigns in other projects.

The design of the MOBISTYLE sensors network architecture for each of the five demonstration buildings is based on building occupants needs and (existing) requirements of the building. For each demonstration case, relevant data about building and occupant performance (e.g. energy, indoor environment quality, health) is collected via sensors and then personalized information is presented to the users via different ICT based solutions: the MOBISTYLE Dashboard and the MOBISTYLE Game. The integrated methodology in the ICT tools incorporates behaviour nudging aspects for assessing what has the deepest impact on their behaviour.

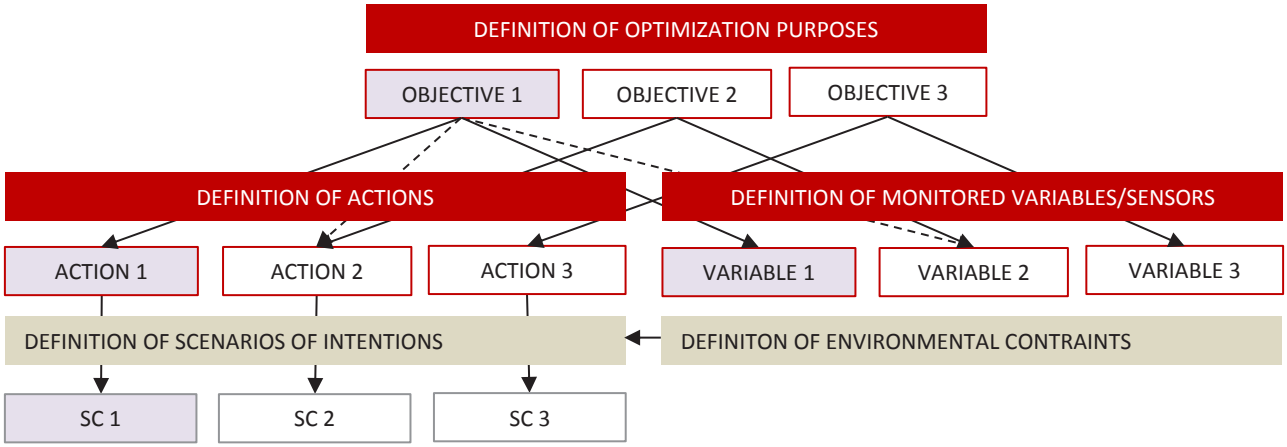


Figure 5. Structure of the Behavioural Change Intervention Action Plan, including optimization objectives, definition of actions and the data gathering from sensor, for the implementation of the scenarios of interventions and the feedback system architecture into the MOBISTYLE ICT solutions.

Table 1. MOBISTYLE ICT solutions.

	MOBISTYLE Dashboard	MOBISTYLE Game
What is it?	• Application for non-experts. • Data on energy use and IEQ based on measured parameters. • Visualisation can be customised for different roles (e.g. building occupant or building manager). • Objective is improving indoor environmental conditions and energy consumption through alerts/push messages recommendations.	• A mobile application, that based on defined objectives for preferable user practices. • Nudges user to change practices in a fun way. • It can track the effect of changed practices on energy use and indoor environment over time and compare with peers. • It provides scores to users for recommended practices and desirable changes.
For which purpose?	Monitoring & Raising awareness	Behavioural change & Raise awareness
For whom?	Building manager & Occupants (non-residential)	Residential users
Where it is validated?	Slovenian case & Italian case	Polish case & Danish case

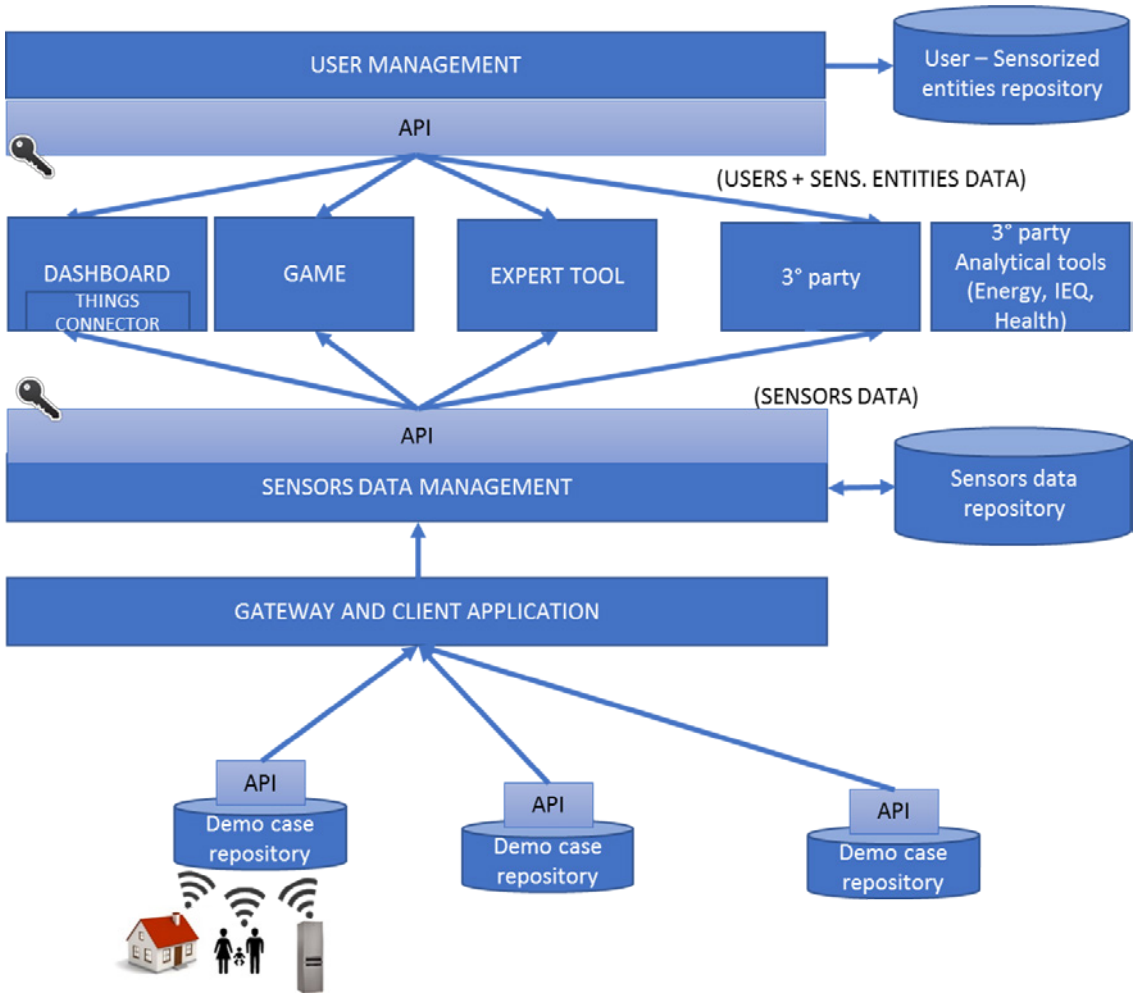


Figure 6. The MOBISTYLE ICT architecture.

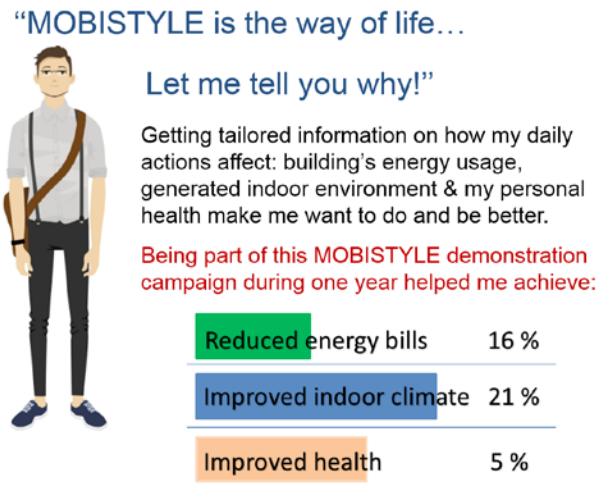
Involving commercial companies interested in MOBISTYLE approach

In order to ensure adequate exploitation of project results, activities are aimed at defining appropriate measures and methodologies for managing exploitation activities, including management of business models for different target groups, third parties and different countries.

The MOBISTYLE business strategy is based on a preliminary selection and definition of suitable business model(s) based on discussions with different organizations and companies taking part in in MOBISTYLE Consumers Advisory Board (MCAB). Different organizations and commercial companies around Europe have expressed their interest in the MOBISTYLE approach by signing a Letter of Support.

Do you want to be in style? Then join the MOBISTYLE Consumers Advisory Board and get more insights in this H2020 project.

The MOBISTYLE Consumers Advisory Board is open for all relevant stakeholders and interested organizations. If you are interested, contact the MOBISTYLE Ambassador: Andrei Vladimir Lițiu: litiu@kth.se. More information is available online at: https://www.mobistyle-project.eu/.



Conclusions

MOBISTYLE shows that improving building technologies and systems is not enough. In order to achieve ambitious goals of EU regarding energy savings a different approach is needed where users of the buildings are equally important part of the building ecosystem as building technologies. Therefore, the emphasis should be on educating users on how to behave in their buildings and increasing their awareness by combined information on their energy usage, generated IEQ and lifestyle. A long-term understanding can be stimulated where energy conscious healthy behaviour is a way of life and not only a one-time service (energy saving at the end of the month). ■

Partners

Acknowledgement

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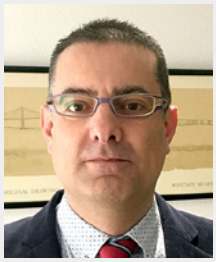
NZEB strategies – Mediterranean warm climate in housing buildings



M. J. ROMERO
Universidad Miguel Hernández de Elche, Elche, Spain
ETRES Consultores, Elche, Spain
Tel.: +34 965455129
mromero@etresconsultores.com

P. V. QUILES
Universidad Miguel Hernández de Elche, Elche, Spain
Tel.: +34 966658561
pedro.vicente@umh.es

In this article a detailed analysis of a real case of single-family homes is presented. As a starting point, the building complies with the Spanish regulation DB-HE 2013 and have an Energy Class "A" for the CO_2 emissions indicator and Class "B" for the non-renewable primary energy consumption indicator. Next, different strategies are analysed to convert the building into nZEB according to the ongoing Spanish regulation DB-HE 2018. The objective is to offer strategies that do not involve a significant increase in construction costs or a modification of the construction systems that are currently used.

Keywords: nZEB in single family homes, Mediterranean warm climate, Spanish DB-HE 2018

Introduction

The update of the Spanish building regulation "DB-HE", which must be finally approved during the year 2018, will be the second review of energy saving requirements that will occur since the first version was published in 2006. This new version of the DB-HE will incorporate the nZEB requirements into the Spanish regulation.

The new requirements are defined within a set of indicators that are based on the standard EN ISO 52000-1, the building that complies with the limits established for each of these indicators will be considered as nZEB.

The standard EN ISO 52000-1 indicators focus on four blocks:

- First indicator: The building envelope (energy needs or energy demand).
- Second indicator: The total primary energy use.
- Third indicator: Non-renewable primary energy use without compensation between energy carriers.
- Fourth indicator: Numerical indicator of non-renewable primary energy use with compensation.

The first three indicators are incorporated into the Spanish new DB-HE, leaving the fourth indicator for its development in future regulations.

In this article we analyse various alternatives applied to a real single-family dwelling, both in the envelope of the building and in its facilities (production of domestic hot water, heating and cooling).

The criterion that has been followed to determine energy improvement strategies follows the following principles:

- The strategies should not imply a significant increase in the construction cost.
- The strategies should not imply a significant modification of the constructive systems that are currently used.

In summary, we look for strategies that have an easy and fast implementation in the building sector in Spain, trying to create the feeling in the promoters of new buildings that nZEB is a feasible objective to achieve.

Description of the dwelling

This analysis is based on a single-family house that is currently on definition phase. The house is close to a group of similar houses which are currently on construction. They are located on the north coast of the province of Alicante (climatic zone B4), with 150.17 m² living space distributed over two floors, ground floor with 54.29 m² and first floor with 95.88 m².

The thermal envelope of the building consists of the elements presented in **Table 1**.

The windows have aluminum frames with thermal break, U = 3.20 W/(m²·K) and low emissive glasses, U = 1.80 W/(m²·K) (thermal transmission coefficient) and g = 64% (solar factor).

Regarding the definition of the encounters between the different enclosures that produce thermal bridges, and taking into account the constructive typology of the façade formed by double brick with an isolated air chamber, it has been considered:

- Slab penetrating a wall (façade) and encounter between wall and roof: thermal insulation not continuous.
- Pillar: there are no pillars (load bearing walls).
- Encounter between façade and external floor: thermal insulation above slab.
- Contour of the window: small separation between the thermal insulation of the façade and the window frames.
- Encounter between façade and floor above ground: thermal insulation not continuous.

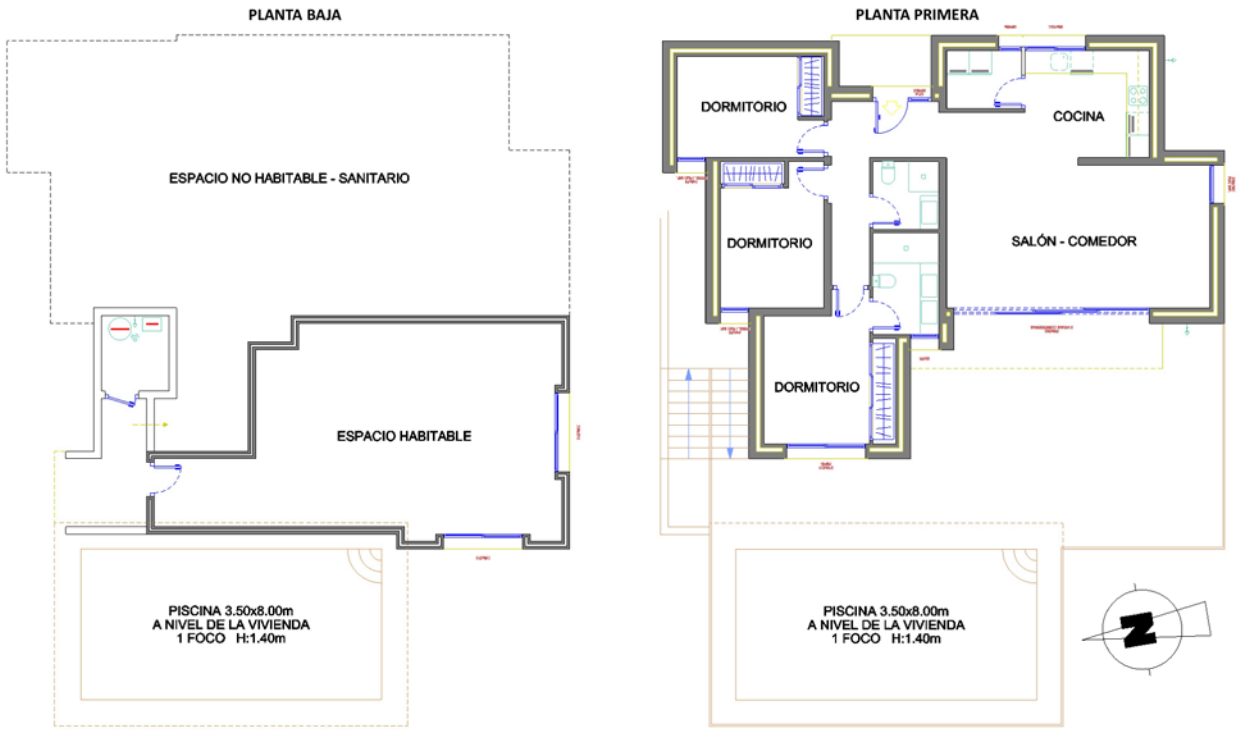


Figure 1. Drawings of the analysed dwelling.

Regarding the installations, the project has an air-water heat pump for the supply of both domestic hot water and heating (underfloor heating) and cooling (fan coils). At EUROVENT nominal conditions, the air-water heat pump has a nominal performance in heat mode COP of 4.29 and in cold mode the SEER seasonal average is 3.04. There is no solar thermal installation for domestic hot water. The ventilation is produced by an impulse / extraction system with a heat recovery of an efficiency of 77%.

Methodology followed

This study has been done using the software "Unified Tool LIDER – CALENER, HULC 2018 (Spanish acronym), version 1.5.1743.1155 of July 19, 2018. HULC is the Spanish official building energy certification tool used for the thermal energy demand assessment. This version of the HULC tool is included in the draft of the DB-HE 2018, which, as indicated above, includes the indicators for the nZEB buildings. It is important to highlight that the HULC tool follows a transitory calculation and hourly base assessment that has been validated through BESTEST and has been used in many recently published studies.

Figure 2. Exterior of similar homes to the analysed one built in the same development.

Table 1. Description of the thermal envelope of the building.

Façades (layers from outside to inside)		**U = 0.28 W/(m²·K)**
Cement mortar	1.5 cm	
Concrete block (load bearing walls)	20 cm	
Mineral wool – 0.034 W/m·K	5 + 5 cm	
Double air brick	7 cm	
Gypsum plaster	1.5 cm	
Roofs (layers from outside to inside)		**U = 0.20 W/(m²·K)**
Gravel + geotextile	5 cm	
Extruded polystyrene – 0.034 W/m·K	5 + 5 + 5 cm	
Geotextile + waterproofing	0.4 cm	
Light weight concrete	7 cm	
Unidirectional slab with concrete blocks	25 cm	
Gypsum plaster	1.5 cm	
Interior floor (layers from outside to inside)		**U = 0.96 W/(m²·K)**
Stoneware	1.5 cm	
Cement mortar	4 cm	
Expanded polystyrene (underfloor heating) – 0.039 W/m·K	2 cm	
Unidirectional slab with concrete blocks	25 cm	
Inside wall. Conditioning to not conditioning spaces		**U = 0.47 W/(m²·K)**
Concrete block (load bearing walls)	20 cm	
Mineral wool – 0.034 W/m·K	5 cm	
Double air brick	7 cm	
Gypsum plaster	1.5 cm	

For the analysis of the thermal bridges that arise in Case 2, the THERM Finite Element Simulator has been used in its latest version 7.6.01 (version date 17 November 2017). THERM is developed by Lawrence Berkeley National Laboratory (LBNL) to model two-dimensional heat transfer effects and is based on the finite element method and meets the requirements indicated in the UNE-EN ISO 10211 standard "Thermal bridges in buildings. Heat flows and surface temperatures".

In the analysis carried out, six cases are presented:

- Case 1: This is the starting situation in which the solutions described in the previous section are applied.
- Case 2: Starting from Case 1, it includes the necessary measures to comply with the parameter of the global heat transfer coefficient of the thermal envelope K.
- Case 3: From Case 2, the necessary measures are added to comply with the solar control parameter of the thermal envelope, q_{sol}; Cases 2 and 3 allow compliance with the energy demand indicator.
- Case 4: From Case 3, the necessary measures are included so that the building complies with both the total primary energy indicator and the non-renewable primary energy indicator.

From Case 4, the building complies with the Spanish nZEB requirements and, therefore, it is a Nearly Zero Energy Building.

To complement the research, two variations are made in the domestic hot water, heating and cooling installations according to the following:

- Case 5: Solar thermal solar installation and air/water heat pump for domestic hot water production and air/air heat pump for heating and cooling.
- Case 6: Photovoltaic solar installation and air /water heat pump for domestic hot water production and air/air heat pump for heating and cooling.

Results

The results obtained with each of the six cases analysed are shown below. In addition, the limit values established in the DB-HE 2018 draft form the indicators that define a NZEB are shown.

Case 1. Starting situation *(pls. see Table 2)*

Case 2. Comply with the parameter of the global coefficient of heat transmission through the thermal envelope K *(pls. see Table 3)*

The envelope global heat transfer coefficient, K depends on three main components: opaque parts (façades, roofs, outside floors and floors above the ground), windows and thermal bridges. The analysis of the contribution of each one of these three components on the total value will show us where to start the improvement process. The result is: 39% for opaque parts; 30% for windows and 31% for thermal bridges.

Given that the opaque part is already well insulated, with insulation thicknesses of 10 cm on façades and 15 cm on the roof, the analysis was focussed on thermal bridges: the reduction of the façade encounter with flat roofs is proposed, since in that encounter the highest energy losses are produced (54% of the total). It is proposed to replace the concrete blocks of the unidirectional slab by EPS expanded polystyrene blocks obtaining a linear thermal transmittance value, determined with THERM Software, of 0.18 W/m·K (much lower than the standard value of 0.92 W/m·K).

Case 3. Comply with the solar control parameter of the thermal envelope, q_{sol}, $q_{sol;jul}$ *(pls. see Table 4)*

The solar control of the thermal envelope depends on the solar gains, for July 15th, through all windows with the solar protections activated. Therefore, it is proposed to incorporate blinds to all windows (except those in the toilet rooms) and an awning in the window of the living - dining room. The standard EN ISO 52033-1 has been applied to determine the coefficient g_{gl}; s_h; w_i (total energy transmittance through a glass).

Table 2. Results obtained in Case 1.

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
12.80	19.80	5.30 - "A"	31.20 - "B"

First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.68 > 0.58 Fails	$q_{sol;jul}$ = 17.03 ≤ 2 Fails	51.20 ≤ 56 Comply	31.20 ≤ 28 Comply

Case 4. Comply with all nZEB indicators *(pls. see Table 5)*
Case 3 shows that the building is very close to comply all nZEB requirements. As it can be seen in the house drawings (**Figure 1**), the larger windows are oriented to the West, reducing the absorption of solar radiation in winter. It was proposed to change the orientation of the main bedroom room from West to South.

Case 5. Modification of the facilities: thermal solar installation and air/water heat pump for domestic hot water production and air/air heat pump for heating and cooling *(pls. see Table 6)*
Facilities are now modified: domestic hot water through solar thermal (annual solar coverage of 77.2%) and air-water heat pump (COP under EUROVENT conditions of 3.19); Air conditioning by autonomous air-to-air heat pump (EUROVENT COP 4.28 and EER 3.75). This case does not require the modification of the window orientation proposed in Case 4.

Case 6. Modification of the facilities: photovoltaic solar installation and air/water heat pump for domestic hot water production and air/air heat pump for heating and cooling *(pls. see Table 7)*
Facilities are modified: domestic hot water through photovoltaic solar installation (annual production of 432 kWh/year) and air to water heat pump (EUROVENT nominal COP = 3.19). Air conditioning by autonomous air to air heat pump (EUROVENT nominal COP = 4.28 and EER = 3.75). This case needs the modification of the window indicated in Case 4.

Table 3. Results obtained in Case 2.

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
9.8	19.4	4.9 - "A"	28.9 - "A"
First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.57 ≤ 0.58 Comply	q_{soljul} = 17.03 ≤ 2 Comply	47.6 ≤ 56 Comply	28.9 ≤ 28 Comply

Table 4. Results obtained in Case 3.

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
9.8	19.4	4.9 - "A"	28.9 - "A"
First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.57 ≤ 0.58 Comply	q_{soljul} = 2 ≤ 2 Comply	47.6 ≤ 56 Comply	28.9 ≤ 28 Comply

Table 5. Results obtained in Case 4.

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
8.5	19.1	4.6 - "A"	27.2 - "A"
First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.57 ≤ 0.58 Comply	q_{soljul} = 1.96 ≤ 2 Comply	44.90 ≤ 56 Comply	27.2 ≤ 28 Comply

Conclusions

It has been demonstrated that it is possible to achieve the requirements established in the latest version of the Spanish definition of nZEB, applying strategies that neither imply a significant increase in the construction costs nor a significant modification of the construction systems that are currently used.

Once the building is properly insulated according to current Spanish requirements, incorporating solutions to minimize thermal bridges, installing solar protection systems such as blinds and analysing the correct orientation of the windows, it will be possible to meet the nZEB requirements published in the last draft.

On the other hand, a comparison between different facilities is provided in **Table 8** (Cases 4, 5 and 6), which is interesting because there are significant differences in energy consumption. ■

Table 6. Results obtained in Case 5

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
9.8	19.4	4.3 - "A"	25.4 - "A"

First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.57 ≤ 0.58 Comply	$q_{sol;jul}$ = 2 ≤ 2 Comply	52.0 ≤ 56 Comply	25.4 ≤ 28 Comply

Table 7. Results obtained in Case 6.

Energy Demand		**Energy Class**	
Heating kWh/(m²·year)	Cooling kWh/(m²·year)	CO_2 emissions Kg CO_2/(m²·year)	Non-Renewable Primary Energy Consumption. kWh/(m²·year)
8.4	19.1	5.1 - "A"	24.5 - "A"

First indicator Energy Demand		**Second indicator** Total Primary Energy Consumption	**Third indicator** Non-Renewable Primary Energy Consumption
K = 0.57 ≤ 0.58 Comply	$q_{sol;jul}$ = 1.96 ≤ 2 Comply	49.6 ≤ 56 Comply	24.5 ≤ 28 Comply

Table 8. Comparison between Cases 4, 5 and 6.

Case	**Primary Energy Consumption [kWh/(m²·year)]**		
	Total	**Renewable**	**Non-Renewable**
Case 4. Air to water heat pump for domestic hot water production, heating and cooling	44.90	17.70	27.20
Case 5. Solar thermal installation and air to water heat pump for DHW production and air to air heat pump for heating and cooling	52.00	26.60	25.40
Case 6. Photovoltaic solar installation and air to water heat pump for DHW production and air to air heat pump for heating and cooling	49.60	25.10	24.50

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Quality Management and Digitalization for Building Performance

STEFAN PLESSER
Dr.-Ing. Head of Energy and Quality Management Group, Institute for Building Services and Energy Design (IGS), Technische Universität Braunschweig, Braunschweig, Germany and Synavision Owner and Managing Director, Bielefeld, Germany

OLE TEISEN
Chief Consultant, Project Manager at Sweco, Copenhagen, Denmark

Quality Management and digitalization are two equally booming terms when it comes to building performance. And since the EU has decided to further promote building automation as an essential part of buildings with EPBD from 2025* on, the importance of both will most likely further increase. And for a good reason: both are urgently needed if we want to improve the energy efficiency of our building stock.

A tale of sustainability: To achieve a Gold-level certification, a building owner integrates energy efficient supply systems in his building like a CHP, a heat pump, a solar thermal collector and an absorption chiller. The low calculated energy demand grants additional credits for certification. Shortly after handover, he notices that some of the systems don't seem to work the way they should. It turns out that the management of the different systems is quite a challenge and had never really been specified in the design phase. Some systems can't even communicate with each other. After months of claim management and frustrating attempts to find out how the *system-as-a-whole* should work, the operation staff decided to keep the heating and cooling valves in a large air handling unit constantly open to create constant energy demand. The systems now run smoothly due to the continuous consumption of heating and cooling energy at the same time. And the owner lived disillusioned ever after.

Building performance

The case on the left below could be a joke, but unfortunately it is not. Furthermore, it is representing a common scenario where a lot of participants with good intentions don't have the understanding of the technical complexity of a modern building. In this article we try to outline some of the tools we can use to support proactive quality management instead of reactive quality assurance or even worse need for improvement as a result of the construction that does not meet the requirements of the owner.

Europeans spend more than 90% of their lifetime in the buildings. Therefore, indoor environment should be a priority for a design and operation. Since buildings also cause 35% of all CO_2-emissions, energy efficiency is no less important either. As a consequence, Europe has taken important steps towards better buildings. Today, innovative technologies allow high performance and nearly zero energy buildings providing excellent IEQ. Moreover, over the last years, ambitious building codes have been continuously asking for higher standards and lower energy consumption. As a result, energy consumption in operation of the new buildings has decreased – at least in some types of building and systems. At the same time a phenomenon has become evident: those new buildings with their ventilation and automation systems turn out to be rather complicated technical systems apparently being a huge challenge to designers, engineers, construction companies and facilities manager – and even to owners and users. As a consequence, the performance gap appeared: buildings do not work as intended. They miss their initial performance targets in operation. This is doubly costly: first the design and construction cause additional cost and then, later, operation cost are also higher than expected. This is an economic and ecologic no-go.

Solutions to this problem can be found in other industries: quality management. The term "Quality" is a colloquially often used to refer do a characteristic of an object or generally something "good". In engineering, "quality" describes the degree, to which a set of inherent characteristics of an object fulfills requirements. Consequently, "quality management" is a process of supporting the fulfillment of requirements. Since today building suffers greatly from a performance gap, the bottom line is that we have a deficit in quality management for building performance.

* 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.

Quality Management and Digitalization for Building Performance

In 2012 a new 6,000 m² domicile was handed over from the design-build contractor to the owner. Various Danish media described the construction process as a success and all parties were satisfied with the result. The designers were particularly satisfied with the technical solutions:

- "Everything was tested before the building was put to service"
- The building achieved an architectural prize

Despite the fine words from all the dignitaries the employees working in the building kept complaining about the indoor climate. After the design professionals have tried to map the reason for the complains and after them the client advisor, a skilled Cx-team was invited to verify the indoor Climate. At this time, it is four years after hand-over.

The Cx team did the following observations and measurements:

- Unhealthy air
- Very varying air velocities in the working areas
- Too little supply of fresh air
- Poor distribution of the fresh air supplied from ventilation system
- Rapid rise of temperatures when the sun hits the facade

The ventilation system is designed as a Constant Air Volume system (CAV) despite meeting rooms operate with Variable Air Volume (VAV)

> Pressure oscillates in the air distribution ducts, the system can't obtain the values in the balancing report

No measuring points on hydronic systems

> Hydronic balancing is not possible

The story continues:
Ventilation system extracts air above ceiling without distribution ducts and Chill Beams are installed without following the requirements of the producer

> Draft

Architectural solution with windows in aluminum cassettes bolted to the outside of the facade

> Temperatures in the Cassettes up to 72°C, inner surface temperature measured on the glass 35–40°C

- Radiators are heating, also in the summer
- Solar screens operate after a control sequence that is not described
- The whole cooling system is running constantly – also in the winter – to keep IT-installations cold

Conclusion

- The owner's indoor climate requirements are not met
- Indoor conditions are so bad that it is not allowed to have employees working in the building
- 50% dissatisfied employees
- Energy consumption out of control
- Costly renewal of all technical installations and new cooling and ventilation concept necessitating new installations above ceilings and new ceiling system to be implemented while the building is in use

The Performance Gap

What is the performance gap that we aim to eliminate with quality management? It is often seen as energy consumption higher than budgeted. But energy is still cheap and for owners it is often much more serious if for example the indoor climate is negatively affecting the productivity of the employees. As you can read in the case above, the performance gap is a complex thing both to map and to handle. PhD student Helle Lohmann Rasmussen from Center for Facilities Management, DTU Management Engineering, Technical University of Denmark, has mapped various types of performance gap [1] in **Figure 1**.

Figure 1. Figure A Facilities Manager's typology of performance gaps.

The complexity of buildings and the variety of causes for the performance gap indicate the challenge to implement an effective quality management.

Quality Management

Somehow, quality management is of course a part of any building. Construction needs verifiable calculations for their statics that are engineered and cross-checked, concepts for fire protection need to be defined in early design stages and should be tested before handover and every elevator is frequently being inspected. Usually, these tests are being carried out by a third party along well-defined testing procedures usually by technical experts for the very field.

Building performance as a whole though is not covered by an effective quality management process. In fact, well-defined third-party testing is often only applied in the still very rare buildings undergoing a certification process for sustainability, e.g. DGNB, HQE, BREEAM or LEED. They give credits for the application of certain quality management procedures.

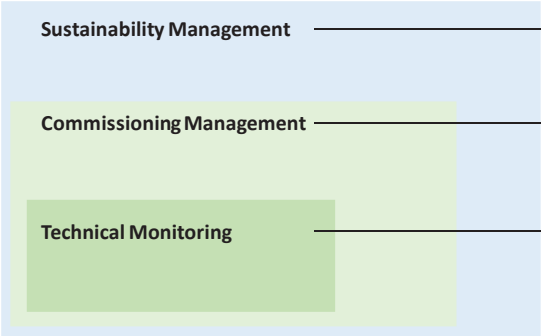


Figure 2. Quality management services as part of certification schemes.

Two of these procedures have evolved as particularly reliable and valuable services – even independently form certification schemes – and they are becoming increasingly popular: Technical Monitoring and Commissioning.

As a core aspect, both services have in common that they should be provided by an independent third-party that is explicitly not responsible for the design, construction and operation of the building. This independence is a prerequisite for the effective service and a transparent communication of any deficit detected by the quality management procedures.

Technical Monitoring (TMon)**

Technical Monitoring follows very closely the principal concept of quality by testing the fulfillment of requirements and thereby establishing a quality control loop for building performance. The service focusses on the precise definition of requirements as the basis for quality management and the application of testing procedures for those requirements.

The quality control loop as defined for technical monitoring consists of four essential elements listed in **Table 1**.

Table 1. Phases of the quality control loop for technical monitoring.

Target values define measurable requirements for buildings and its systems. This may include the maximum level of CO_2-concentration in a conference room, the coefficient of performance of a chiller plant or the set point of a supply air temperature of an air handling unit at a certain ambient air temperature.
Measured values are the values obtained from building or system operation. The building has to be technically able to provide this data, e.g. via its building management system or additional metering devices. They need to precisely correspond to the target values.
Evaluation procedures. To be able to check whether a building fulfills its requirements, TMon applies evaluation procedures to compare the measured values versus the target values. Here it becomes apparent that both need to be defined very carefully to allow a meaningful evaluation: If one uses for example the overall energy consumption of a building as a target value, this value will be very uncertain due to assumptions in design as well as through the actual use of the building that is affected by – among others – tenants moving in step by step, changes in use and user behavior.
Actions. To actually improve building performance, TMon needs to communicate its findings effectively into the project. Any evaluation therefore needs to provide reliable and transparent results that can be delivered to engineers, contractors and maintenance personnel in time to be recognized and to allow appropriate response.

** The service is described e.g. by AMEV 135, VDI 6041 and also within the LEED certification as monitoring-based commissioning.

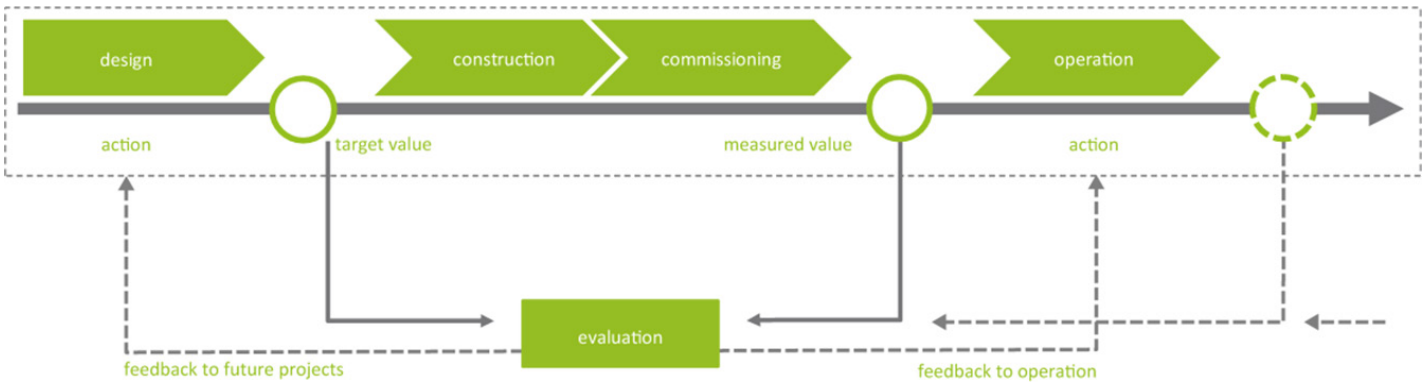


Figure 3. Quality Control loop.

If these four elements are implemented well into a building project, usually starting with the definition of "testable" requirements in the design phase, TMon can deliver a timely and very cost-effective support for any building project. In addition to the immediate control loop within a project, TMon also sets up a long tail loop: It allows to derive reliable experiences to learn for future projects.

Since TMon is based upon individual functional target values, it can be applied with an individually defined scope e.g. on individual systems and values. The option to choose an appropriate scope supports the cost effectiveness of the service.

Commissioning (Cx)

When we talk about Commissioning, we talk about a process. Commissioning is often misunderstood as "testing in the end". The direct translation of the English word has led to many misunderstandings. It is therefore essential that we distinguish between the "event of commissioning" which means "starting up" and the "Commissioning Process" that consists of a sequence of activities spread throughout the construction process, from the pre-design phase to at least one year into operation.

Many building owners are asking "Why do I have to pay for Commissioning, has it not been included since the beginning of time?" The simple answer to that is: "Yes, the event of Commissioning has always been included, and it might also have been sufficient before, but with the complexity of today's buildings, you have to do something extra".

In **Figure 4** it is illustrated that faults, misunderstandings and demand for clarifications occur through the whole construction project and not only in the construction phase.

The Commissioning process starts in the pre-design phase and formally ends one year after completion. It does not take over any of the activities, that the designers and the contractors are already hired to do; they still have to manage the quality of their own delivery and balance their own installations.

Commissioning (Cx) follows a broader scope than TMon. In addition to the "pure" specification and testing within Technical Monitoring, Cx includes a variety of additional services ranging from checking the of design documents, operationability, for example the accessibility of air handling units for maintenance services to functional testing of systems (Life-cycle cost calculations are good tools for that), O&M documentation and supervision of building maintenance personnel training.

The Commissioning Process can be illustrated in a simplified manner as shown in **Figure 5**.

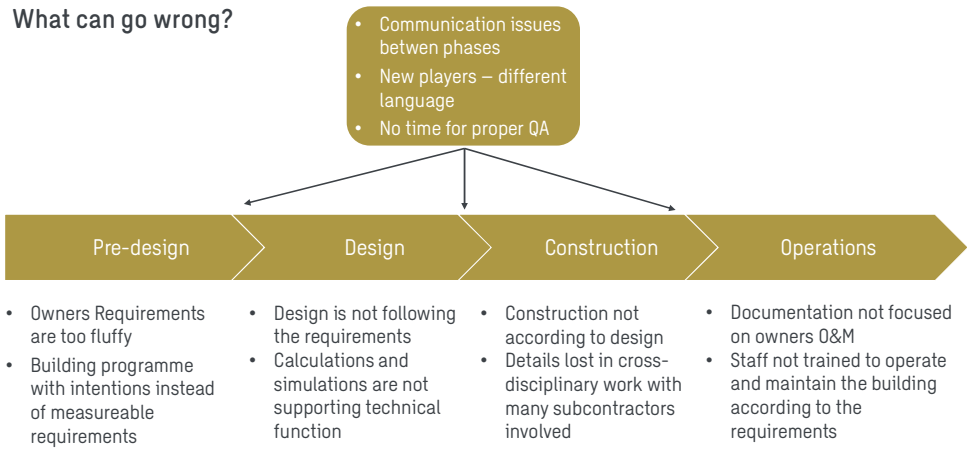


Figure 4. Possible causes of mistakes throughout the construction process.

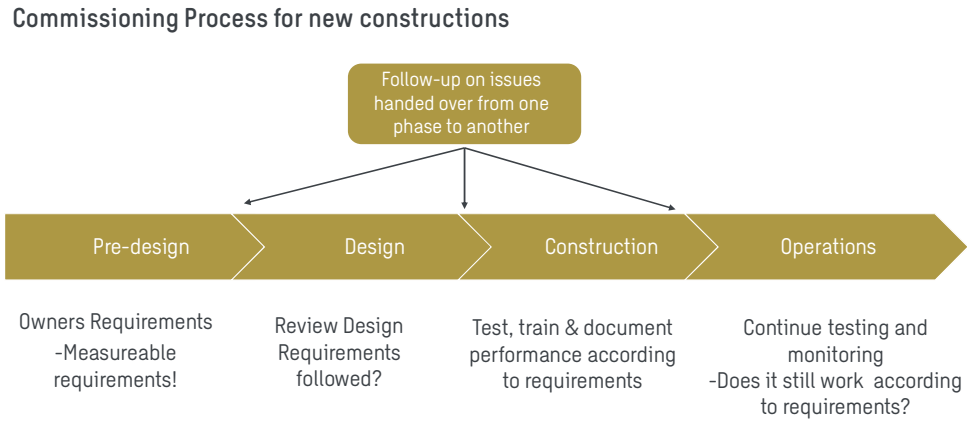
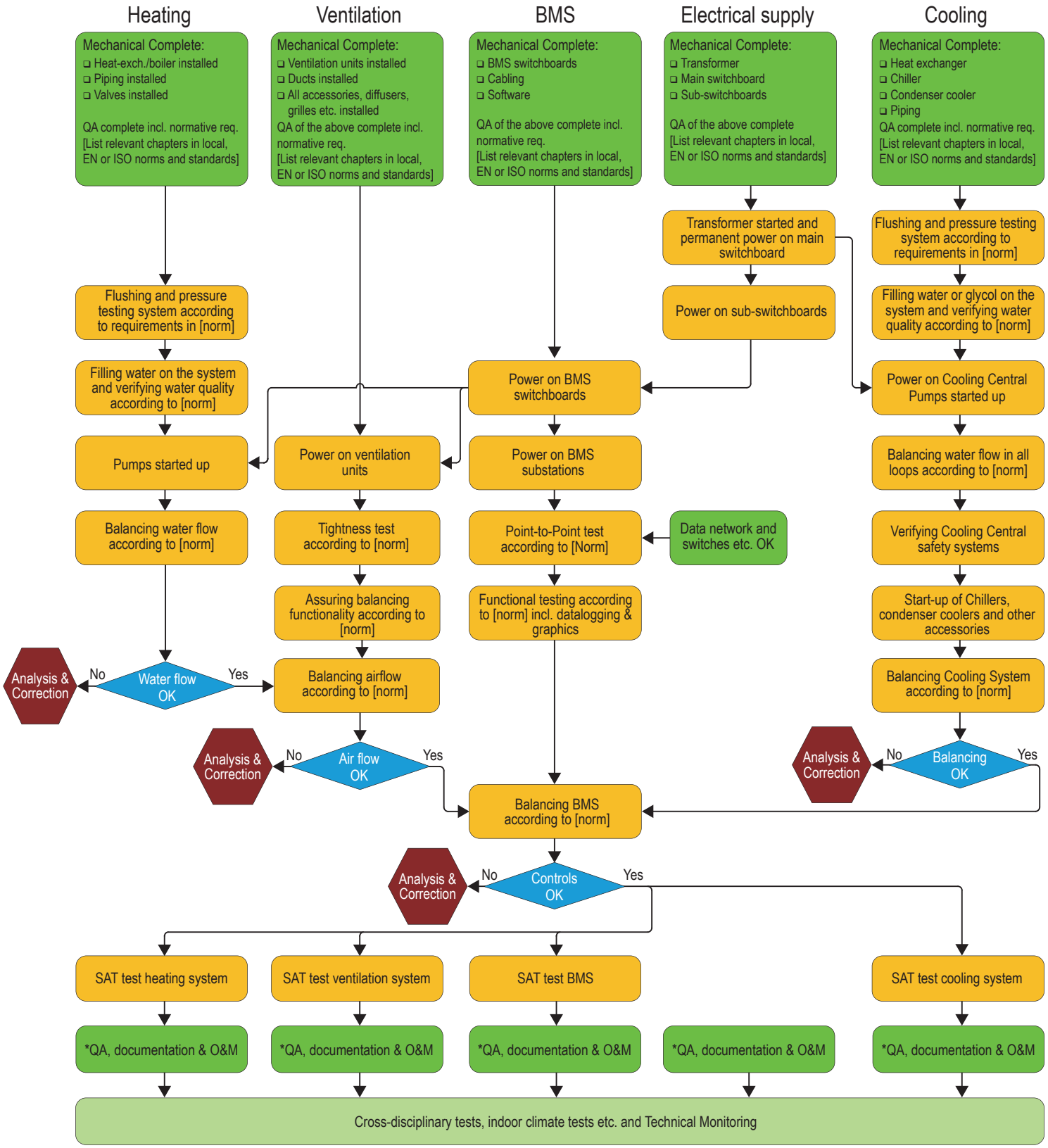


Figure 5. The Commissioning process made simple.

Flowchart interdependence between deliveries for typical HVAC start-up, balancing and verification



Prerequisite. Dark green boxes contains prerequisites. Documentation for fulfilled prerequisite must be shown.

Contractor Action. Yellow boxes are actions with an accompanying document reporting the action.

Acceptance. Blue diamonds show acceptance by the CxP.

Issue. Red hexagons for issues to solve.

Commissioning Action. Light green boxes are Cx or TM actions with an accompanying document reporting the action.

[Text in square brackets] refers to the corresponding norm. Local domestic norms must be activated, preferably related to EN, ISO or other international documents.

***QA, documentation & O&M**. All QA is completed. All issues solved and accepted by the commissioning provider. Documentation, drawings and descriptions exists. O&M exists.

Figure 6. Pre-required data for technical monitoring and commissioning. [© Ole Teisen 2018, Sweco A/S]

The complete Commissioning Process typically consists of a facilitation of the owner to set up measurable requirements for the process, minimum of two operations-focused cross-disciplinary design reviews, sample performance testing of systems and indoor climate, planning of digital hand-over of O&M and documentation and planning of user training. In the operations phase the Commissioning Process continues as "On-going Commissioning" or "Monitoring-Based Commissioning". Technical Monitoring should always be included as a core service of Commissioning.

In a popular way one could say that the Commissioning Process contains all quality management activities needed to facilitate and pass the tests of the Technical Monitoring.

To illustrate the complex relations and connections within modern buildings, **Figure 6** shows some of the prerequisites for TMon an Commissioning tests. It is very useful to include the tracking of all these QA documents listed here in the Commissioning Process to facilitate that systems are completed and quality assured before they participate in a cross-disciplinary test.

What is it worth?

The potential of a better quality as well as of TMon and Cx has been shown in numerous studies. For Technical Monitoring, that since 2017 in some German states is mandatory for public buildings, a study at Technische Universität Braunschweig [2] showed a return on invest of less than one year for Technical Monitoring. These numbers have been confirmed by about 250 TMon projects on more than 3,000 systems we did at synavision with our Digital Test Bench.

On commissioning, Evan Mills has analyzed 399 Commissioning projects, 322 on existing buildings and 22 on new constructions [3]. He found that the pay-back time for investment in a Commissioning Process that was 4.2 years for new constructions and 1.1 years for existing buildings. In the same study is found that the Commissioning Process costs ½–1% of construction costs. The study is renewed in the end of 2018. The own experience in Sweco is that pay-back time for new constructions are much lower than in the US. All the Commissioning projects the company has managed have paid back before hand-over in found deficiencies that would have been costly to redo later. Deficiencies are rooted in all stages of the construction process, and if they are found when testing and monitoring the completed construction, they usually are costly to fix. This can be illustrated by the curves in **Figure 7**.

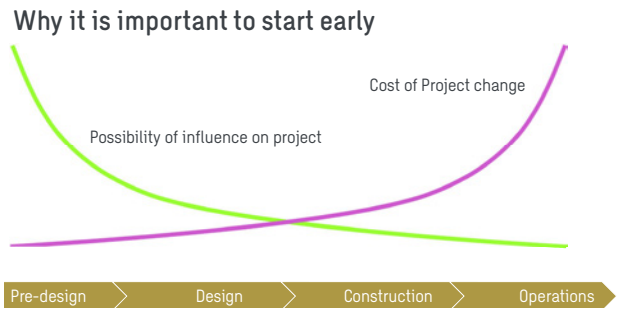


Figure 7. Deficiencies found when testing and monitoring the completed construction are usually costly to fix.

Digitalization

In the Commissioning Process, the hand-over of O&M documentation (and drawings calculations, descriptions etc.) is usually handled through a digital tool. The typical and well-proven option is to enter all data related to O&M, QM, Balancing Reports, documentation, design and drawings together with the documents of the Commissioning Process in the owners CMMS (Computerized Maintenance Management System) system that then serves as the "Systems Manual" hosting everv related documentation.

In Sweco we have now projects, where we link the Systems Manual (CMMS) and the building model. That opens up for help to find the precise location of a specific maintenance task generated in the system. You can also find the documentation for specific components and be guided into the building model to see in what locations the component is placed.

This linking between the Systems Manual and the Building Model is not very common yet, and we still need to see, if owners in the future will route sufficient resources to the FM staff to assure the maintaining and continuous update of the model and the link to the Systems Manual. But the digital approach is essential for quality management.

Although quality management services are principally available, there are barriers for their success. This became obvious through another quality management process: energy inspections for air conditioning system as required by EPBD. These inspections are mandatory in Germany since 2007 for every system with a cooling power of 12 kWth or more. The number of systems that have to be inspected is estimated to be about 250,000 [4]. So far not more than 10% of these systems actually have been inspected.

Buildings are becoming technically sophisticated systems. Therefore, as in other industries, **quality management** becomes an increasingly important part of the building process. Due to the complexity and uniqueness of buildings, **digitalization** – generally speaking the transformation of manual, human actions into data driven software-based processes – is a prerequisite to facility quality management. The first steps of this transformation started years ago when architects and engineers started to use computer aided design tools instead of pencils to create plans. Now the electronic design is to be further transformed into a digital building information model (BIM) containing information far beyond the physical shape of the construction like time of construction, product information and even ongoing metering data.

The reasons may be various: lack of owners' interest, lack of knowledge about the inspection duty, lack of control by authorities. But one reason is evident: The inspections usually require experienced experts to go on site and test the systems. These engineers simply do not exist! There is already a lack of engineers in the building industry so that additional services, if they are not exceptionally well paid, will have difficulties to succeed. Therefore, digitalization is an important opportunity for building performance. Not so much to cut cost but to enable quality management at all.

In this regard, TMon is of particular interest since the quality loop of defining target values, collecting measured data, evaluation it and communicating it to the project can be transformed completely into a digital service. One example is our Digital Test Bench at Synavision, which is currently proving its effectiveness within the EU funded Horizon 2020 project QUANTUM (www.quantum-project.eu). Our software as a service offers tools to digitally specify target values, import and evaluate data and produce a precise and transparent feedback. The software can be applied in new construction with a focus on the startup phase or in existing buildings e.g. for digital energy inspections. Due to the large extend of digitalization, the process does not require significant expert knowledge and in consequence can scale up massively and robustly.

Building performance needs to be improved in Europe. The technologies are already at hand. If we introduce quality management to ensure project success and if we use the new opportunities of digitalization, chances are good to turn the European building stock into a truly sustainable living environment.

Valuable sources of Commissioning Process knowledge

- IEA ECBCS Annex 47
- ASHRAE Guideline 0-2013
- ASHRAE standard 202
- BSRIA "Soft Landings"
- Danish Standard DS 3090
- LEED ver. 4
- DGNB Danish version Criterion 1.7 ■

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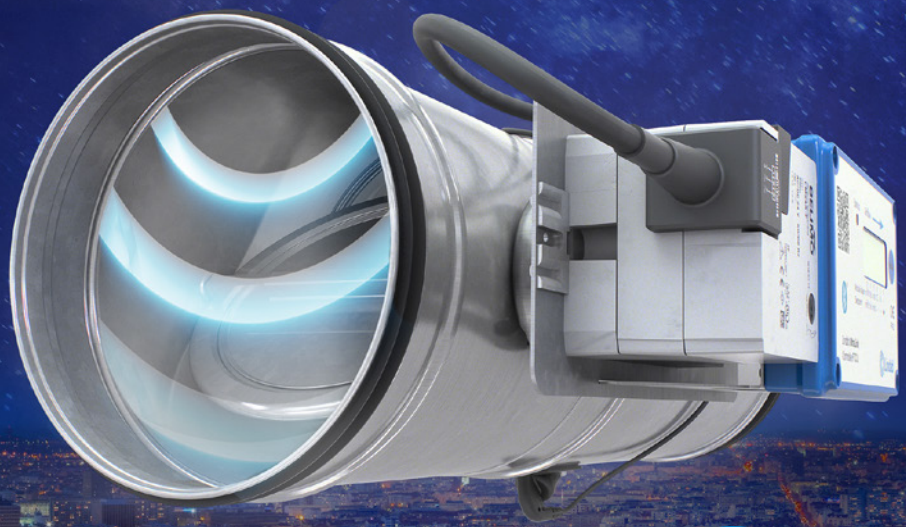
The only thing you cannot measure is its potential



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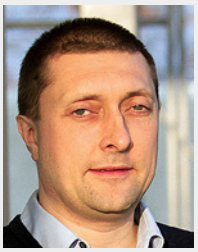
Annex 67 – Energy Flexible Buildings



BART BLEYS
Head of Laboratory
Water Technologies, ir.
Belgian Building Research Institute
bart.bleys@bbri.be

SØREN ØSTERGAARD JENSEN
Senior Project Manager
Energy and Climate Division
Danish Technological Institute
sdj@teknologisk.dk

ANNA MARSZAL-POMIANOWSKA
Associated Professor, PhD.
Department of Civil Engineering
Aalborg University
ajm@civil.aau.dk

Annex 67 is an ongoing research project of the Energy in Buildings and Communities programme (EBC) of the International Energy Agency (IEA) that aims at gaining knowledge on and demonstration of the energy flexibility buildings, and clusters of buildings, can provide to energy networks. This article gives a brief overview of the project and highlights some of its results.

Keywords: energy flexibility, demand side management, aggregated flexibility, grid requirements

Introduction

Large-scale integration of electricity production from renewable energy sources is often suggested as a key technology striving towards a sustainable energy system, mitigating fuel poverty and climate change. In many countries, the growing share of renewable energy sources (RES) goes in parallel with the extensive electrification of demand, e.g. replacement of traditional cars with electrical vehicles or displacement of fossil fuel heating systems, such as gas or oil boilers, with energy efficient heat pumps. At the same time, supporting the operation of (low temperature) district heating grids supplied by different renewable sources. These changes on both the demand and supply side impose new challenges to the management of energy systems, such as the variability and limited controllability of energy supply from renewables or increasing load variations over the day. Consequently, managing the energy transition following the traditional energy system viewpoint would lead to a grid operation closer to its limits, with a possible consequent increase of the energy use at peak periods, requiring more complex control problems with shorter decision times and smaller error margins.

As buildings account for approximately 40% of the annual energy use worldwide, they are likely to play a significant role in providing a safe and efficient operation of the future energy system. Buildings are able to deliver significant flexibility services to the system by intelligent control of their energy loads, both thermal and electric.

Buildings can supply flexibility services in different ways, e.g. utilization of thermal mass, adjustability of HVAC system use (e.g. heating/cooling/ventilation), charging of electric vehicles, and shifting of plug-loads. **Figure 1** illustrates a buildings capability to shift loads and thus using its flexibility.

Although various investigations of buildings in the Smart Grid/Smart Energy context have been carried out, research on the relationship between Energy Flexibility in buildings and future energy grids is still in its early stages. There is a need for increasing knowledge on and demonstration of the energy flexibility buildings can provide to future energy networks. At the same time, there is a need for identifying critical aspects and possible solutions to manage this energy flexibility, while maintaining the comfort of the occupants and minimizing the use of non-renewable energy. For these reasons, the research project Annex 67 [1] was launched in 2014.

PROJECT DURATION
2014 – 2019

OPERATING AGENT
Søren Østergaard Jensen, Danish Technological Institute, Denmark

PARTICIPATING COUNTRIES
Austria, Belgium, Canada, P.R. China, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Switzerland, UK

FURTHER INFORMATION
www.annex67.org

Objectives

The project objectives are:

- the development of a common terminology, a definition of 'energy flexibility in buildings' and a classification method,
- investigation of user comfort, motivation and acceptance associated with the introduction of energy flexibility in buildings,
- investigation of the energy flexibility potential in different buildings and contexts, and development of design examples, control strategies and algorithms,
- investigation of the aggregated energy flexibility of buildings and the potential effect on energy grids, and
- demonstration of energy flexibility through experimental and field studies.

Deliverables

The following project deliverables are planned:

- Principles of Energy Flexible Buildings,
- Characterization of Energy Flexibility in Buildings,
- Stakeholders' perspective on energy flexible buildings,
- Control strategies and algorithms for obtaining energy flexibility in buildings,
- Experimental facilities and methods for assessing energy flexibility in buildings,
- Examples of Energy Flexibility in buildings,
- Project Summary Report.

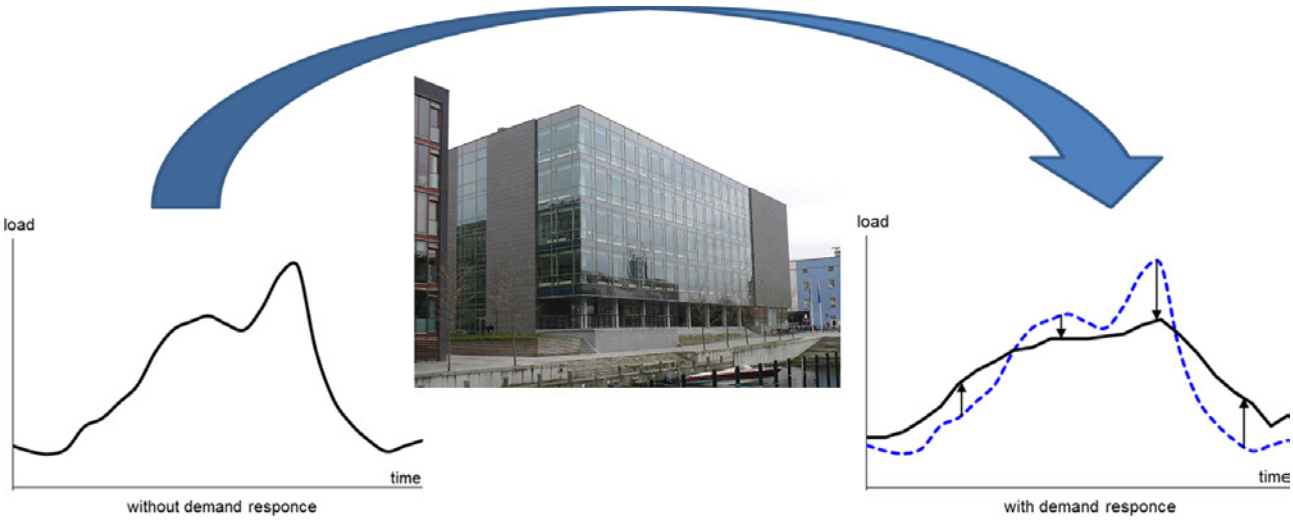


Figure 1. Load shifting and peak shaving using the flexibility available in a building.

Flexibility options

A large part of the energy demand of buildings – such as the energy for space heating/cooling or white-goods – may be shifted in time, and, thus, it may significantly contribute to increase the flexibility of the demand in the energy grids.

One option for generating flexibility is to make use of the thermal mass, which is embedded in all building structures. Depending on the thermal mass properties, such as the amount, the distribution, the speed of charging/discharging, etc. of the thermal mass it is possible to shift the heating or cooling demand in time for a certain period without jeopardizing the thermal comfort in the building. Typically, the time constant of buildings varies between a few hours to several days depending on the amount and exploitability of the thermal mass together with the heat loss, internal gains, user pattern and the actual climate conditions. In addition, many buildings use different types of distributed energy storages (e.g. water tanks, and electrical batteries), which may influence the Energy Flexibility of the buildings. One such typical storage is the domestic hot water tank, which might be excess pre-heated before a low energy level situation. The excess heat may be used for space heating but may also be used for white goods such as hot-fill dishwashers, washing machines and tumble dryers in order to decrease and shift their electricity need.

When referring to Energy Flexibility in terms of consumer demand, there are two main approaches, which meet the need to shift the energy demand: storage of electrical energy/heat and demand flexibility. Storage of heat (as mentioned above) is based on the utilization of the structural thermal mass (building inertia) or on water tanks, whereas storage of electrical energy relies on dedicated batteries or electric vehicles. The storage of heat can be done efficiently in a number of ways, most commonly used are the heat pump technology and hot water tanks. On the other hand, demand flexibility (response) is achieved when the electricity consumption of controllable devices (HVAC, washing machines, dishwashers, tumble dryers, electric vehicles, etc.) is shifted from its normal consumption patterns in response to changes in the price of electricity or to meet periods of high renewable generation.

Energy Flexibility definition

One of the first priorities of Annex 67 was to establish a clear definition of Energy Flexibility. After an intensive literature review, following definition was adopted [2]:

- The Energy Flexibility of a building is the ability to manage its demand and generation according to local climate conditions, user needs and grid requirements.
- Energy Flexibility of buildings will thus allow for demand side management/load control and thereby demand response based on the requirements of the surrounding grids.

Characterization methodology for Energy Flexibility

Another main deliverable from Annex 67 is to determine a methodology for characterization and labeling of Energy Flexibility in buildings.

Two approaches have been introduced to compute the flexibility characteristics: a data-driven approach whereby system identification techniques are used to identify the response function based on time series data of the system output (e.g. energy use) and the penalty signal; and a simulation-based approach whereby the flexibility characteristics are derived from simulating the system response to respectively a flat penalty and a step penalty.

The methodology [3] is based on the fact that the Energy Flexibility of a building is not a fixed value but varies with the daily and seasonal weather conditions, the use of the buildings, the requirements of the occupants e.g. comfort range, the requirements of the energy networks, etc.

Figure 2 shows an example of the aggregated response of buildings when receiving some sort of control signal – in the following called **penalty signal**.

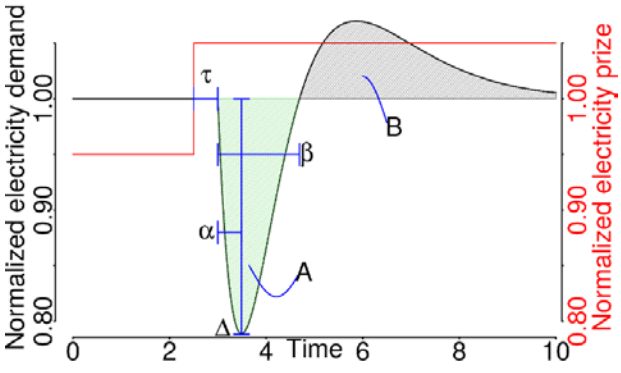


Figure 2. Example of aggregated response when some buildings receive a penalty signal – here a price [2]. The parameters in Figure are: τ is the time from the signal is submitted to an action starts, α is the period from start of the response to the max response, Δ is the max response, β is the duration of the response, A is the shifted amount of energy, and B is the rebound effect for returning the situation back to the "reference".

The penalty signal can be chosen according to specific conditions: often the penalty signal is a price signal, but can also be a signal based on the actual level CO_2 or actual level of energy from renewable energy sources (RES). For these signals the controller should minimize the price or CO_2 emission or maximize the utilization of RES.

The penalty signal can either be a step response (e.g. a sudden change of the price of energy) as in **Figure 2** in order to test different aspects of the available Energy Flexibility in a building or clusters of buildings, or it can be a temporal signal varying over the day and year (example see **Figure 3**) according to the requirements of the energy networks. A step response test may e.g. be utilized in simulations to test the capacity of e.g. a thermal storage. Temporal signals will typically be used when utilizing the energy flexibility in an area of an energy network and will concurrently feedback knowledge on the available energy flexibility in this area.

Due to the variation of the conditions for obtaining Energy Flexibility the focus is on a methodology rather than a number. However, using the methodology numbers may be obtained for the parameters mentioned **Figure 2** and for comparison with a reference case, where no flexibility is obtained. The latter refers to labelling, where buildings including their energy systems may be rated by their share of reduction on price/consumption/CO_2 -emissions etc. (depending on the target of the labelling) when using penalty-aware control instead of penalty-ignorant control.

Position paper on Smart Readiness Indicator (SRI)

Based on the above described methodology, Annex 67 has given input to the EU study on a Smart Readiness Indicator for implementation in EPBD [4]. Annex 67 has written a Position Paper explaining the view of Annex 67 regarding how to consider Energy Flexibility – also in the Smart Readiness Indicator. There is a need for an approach that takes in to account the dynamic behaviour of buildings rather than a static counting and rating of control devices. It is further important to minimize the CO_2 emission in the overall energy networks rather than optimize the energy efficiency of the single energy components in a building.

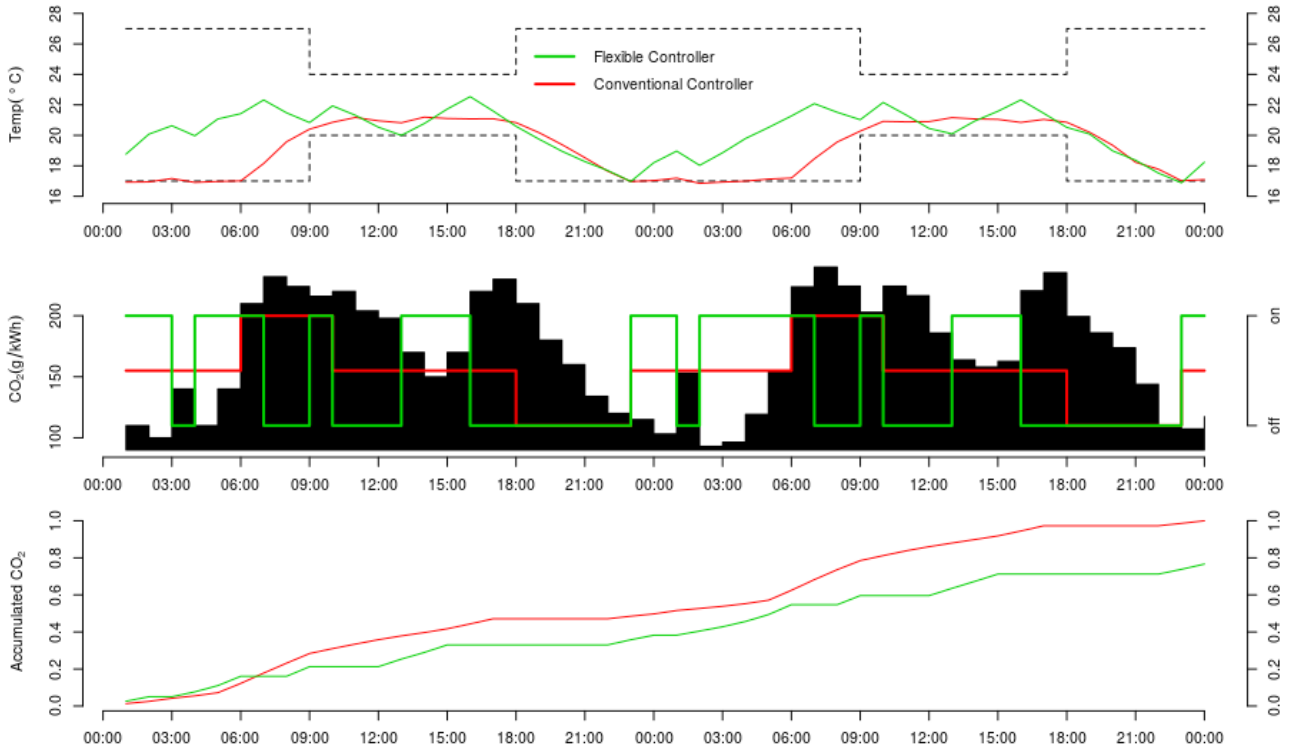


Figure 3. Top plot: the room temperature in a building is controlled by a penalty-aware controller (green line) or a conventional controller (red line). Both controllers are restricted to stay within the dashed lines. Middle plot: The black columns give the penalty, while the green and red lines show when the two controllers calls for heat. Bottom plot: the accumulated penalty for each of the controllers. The penalty-aware controller results for the considered period in 20 % less emission of CO_2 compared to the traditional controller [3].

The position paper can be downloaded from the Annex 67 website.

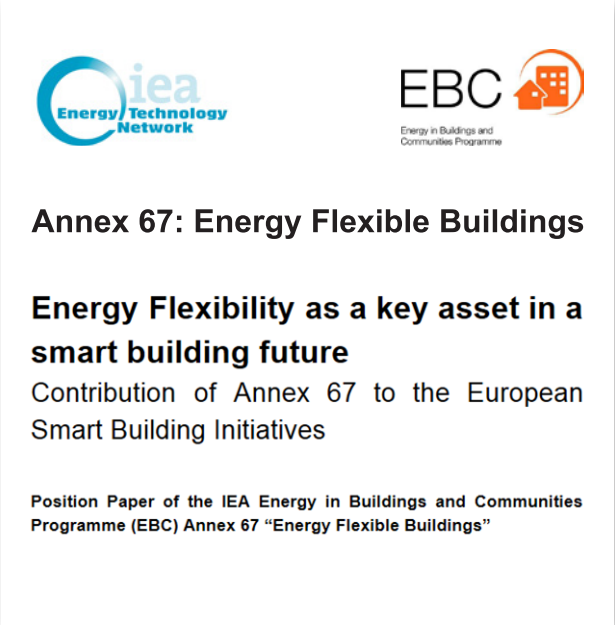


Figure 4. Position paper of Annex 67 on SRI.

Building stakeholders

When utilizing the Energy Flexibility in buildings the comfort and economy of the buildings are influenced. If the owner, caretaker and/or users of a building are not interested in delivering Energy Flexibility to the surrounding energy grids, it does not matter how energy flexible the building is as the building will not be an asset for the surrounding energy grids. It is, therefore, very important to investigate and understand which barriers exist for the stakeholders of buildings and how the stakeholders may be motivated to allow their buildings to contribute with Energy Flexibility to stabilize the future energy grids. Strategies to benefit both the total energy system and the customers are, therefore, investigated.

Concluding Remarks

Annex 67 is tackling the very challenging topic of Energy Flexibility in buildings. This topic will become ever more important with the growing share of RES in sustainable energy systems. So far, the project has been very productive. For all available articles, conference papers, reports and other results, see www.annex67.org. ■

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The Digitalization of Residential Building Services:

Comfort, Convenience and Control - a Romanian Case Study

ANDREI VLADIMIR LIȚIU *[1,2] **CARMEN LUMINIȚA CUC** [2] **IVO MARTINAC** [1]

[1] KTH Royal Institute of Technology, Division of Building Services and Energy Systems, Stockholm, Sweden
[2] S.C. PRODAO-ING S.R.L., Timişoara, România
*Corresponding email: litiu@kth.se, andreilitiu@gmail.com

Note
This case study article further builds on an online article published in iMagazin.ro [1] and the same title presentation delivered during the 10th "Romanian Conference on Energy Performance of Buildings" (RCEPB-X), 7–8 June 2018, Bucharest, Romania [2].

This case study (duplex, Timișoara, România) illustrates the out-of-the-box capabilities of smart home accessories, available today on the market, installed for controlling (also remotely), automating and monitoring the operation of the heating, cooling, ventilation and garden lighting systems, Indoor Environmental Quality (IEQ) too, through a mobile app providing an integrated user-building interaction interface.

Keywords: residential, building services, digitalization, smart home, building automation, case study, user-building interaction interface

By the year 2020, an entire generation, Generation C (for "connected"), will have grown up in a primarily digital world. Computers, the Internet, mobile phones, social networking — all are second nature to members of this group. The phenomenon of digitization is reaching an inflection point. The effects of an increasingly digitized world are now reaching into every corner of our lives and residential building services make no exception. The futuristic perceived concept of smart home is already a reality today in many buildings across the globe.

The global building automation industry is reacting as recent research shows that growth in software and the Internet of Things (IoT) are the key drivers of growth. The global building automation market is increasingly focused on the three "I"s: information technology, integration of systems and IP connectivity. [3] Moreover,

technology companies are entering the building automation market, either partnering (or being purchased) by established building automation manufacturers or as new players and are apparently having a disruptive effect in terms of technology being installed especially in dwellings and the way the products are being purchased via online shopping sites.

This case study illustrates the out-of-the-box capabilities of devices, manufactured by new home automation market players and available today for purchase in national level online shopping sites across Europe, that enable and facilitate swift control (also remote), automation and monitoring the operation of building services. The presented building is a duplex house located in a residential suburb of Timișoara (România). Smart home accessories have been installed for controlling, automating and monitoring the operation of the heating, cooling, ventilation and garden lighting systems (monitoring of Indoor Environmental Quality too). Furthermore, a mobile app provides an integrated user-building interaction interface through which the users can visualize the current state of building services operation and indoor climate conditions as well as historical information, manually control (also remotely) the building services and automate their operation based on different predefined scenes and activation criteria e.g. timers, rules (triggers, conditions, actions).

If we are to consider the difference between digitization, digitalization and digital transformation [4] (digitization – the process of making information available and accessible in a digital format; digitalization – the process of considering how best to apply digitized information to simplify specific operations; digital transformation – the process of devising new business applications that integrate all the digitized data and digitalized applications) this case study article mainly focuses on the digitalization aspects still incorporates parts of the digitization conversion and several enabled features of digital transformation.

User needs and existing building services

The users (a couple over 50s) desired to know what is happening, have easy control (also remote) and easy automation of the building services, providing thermal comfort and indoor air quality, as well as their inherent energy costs. All this is based on their strong conviction that high IEQ has a positive impact on health, well-being and comfort and the fact that they're spending on average more than 12 hours per day at home (sleeping included) and are often travelling.

When the discussion started (summer time 2017) the duplex (commissioned autumn time 2013) was equipped with the following building services:

- Thermal comfort:
  - Radiant floor heating controlled with 2 chrono-thermostats (1 per floor) – gas condensing boiler;
  - Bathroom decorative radiators (towel drying purpose) and convector in the atrium (all on a separate heating circuit than the radiant floor heating)
  - Cooling/heating coil of the double flow mechanical ventilation unit with heat recovery controlled by an on/off analog timer switch for the circulation pump – reversible heat pump & storage tank;
  - Domestic hot water recirculation pump (aiming at minimizing waiting time and water waste) in continuous operation – same gas condensing boiler.

- IEQ: Double flow mechanical ventilation unit with heat recovery and air filtration controlled by an on/off analog timer switch for the supply and exhaust fans.

The operational energy performance of the house for 2017 was:

- Delivered energy: 113 kWh/(m²·a) – 80% natural gas, 20% electricity;
- Primary energy: 147 kWh/(m²·a) – 62% natural gas, 38% electricity.

Although the building services are state-of-the-art for the residential sector in Romania, the control and automation side had minimum functions and resulted in difficulties during day-to-day usage, especially in the case of the ventilation system. In general, there was no possibility to "see" real-time or historical information about IEQ and equipment operation which left the users often wondering if everything is as it should be. Furthermore, remote access was missing altogether. Lastly, the users had the suspicion that certain components of the building services might operate sub-optimally leading to reduced IEQ or additional unnecessary energy costs. The users identified all these shortcomings and additional needs only after having occupied the house and acquired inconvenient experiences. They admit if they would start over the construction process they would take different decisions during the design and installation phases and have a stronger focus on the operation phase.

Adopted improvements

The following smart home devices (Bluetooth 4.0 smart) were installed for meeting user needs:

- 1 pc … communication module with cloud services (via Wi-Fi bridge) for the gas condensing boiler;
- 2 pcs … controllers connected to the cloud via Wi-Fi bridge;
- 1 pc … tablet (user-building interaction interface);
- 1 pc … wireless outdoor air sensor (temperature, relative humidity and air pressure – placed on the terrace);
- 4 pcs … wireless IEQ sensors (temperature, relative humidity, volatile organic compounds – placed in master bedroom, master bathroom, living room, kitchen);
- 11 pcs … smart plug (on/off switch, energy meter – pumps, fans and garden lighting).

The cost of these smart home devices was 9 EUR/m².

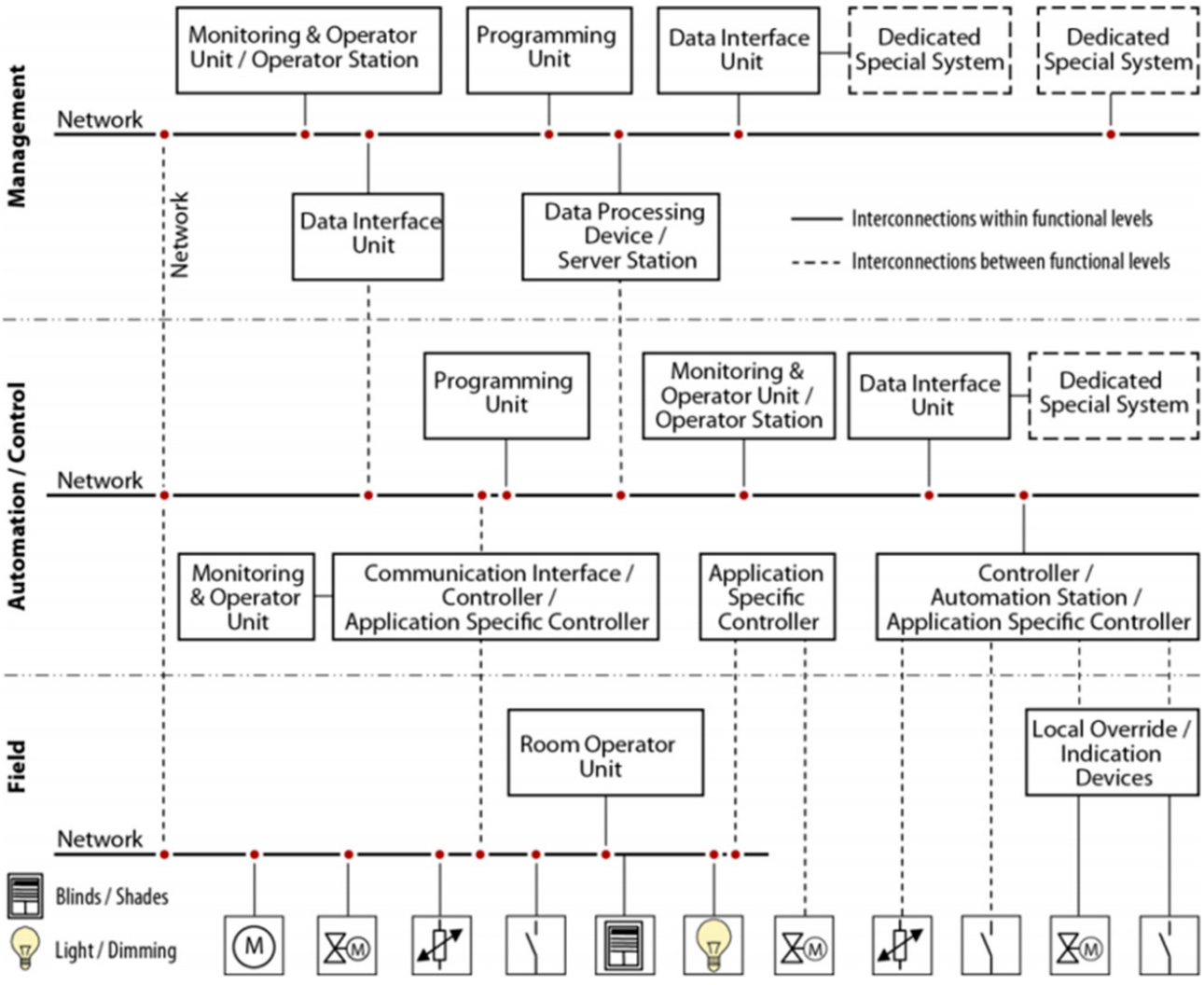


Figure 1. A generic architecture model for the building automation and control network and its different levels according to EN ISO 16484.

The installation took place in 3 steps for minimising the risk of negative impact on IEQ and day-to-day activities:

- December 2017: IEQ sensors and several smart plugs (pumps, fans) for monitoring purposes only;
- April 2018: Additional smart plugs for demand-based control of the ventilation system and garden lighting system (including the definition of scenes, timers and rules);
- September 2018: Last smart plugs for the heating system (including the definition of scenes, timers and rules).

Each step required adjustments to the existing building services for accommodating the installation of the smart home devices.

The users reported that it was very valuable having a first only monitoring step. It enabled them to gain insights and understanding about the operation of their building services and the relation to IEQ and to obtain confirmation regarding their suspicions of sub-optimal operation of components e.g. the ventilation system was sometimes running more than necessary and sometimes not enough (based on correlations with data from IEQ sensors). Moreover, after visualising the accumulating and annual predicted costs of the domestic hot water circulation pump they couldn't wait any longer and defined timers for scheduling its operation.

If before the adoption of the improvements the building automation system was mostly at field level and slightly at automation/control level now after the adopted improvements it covers all 3 levels as shown in **Figure 1** on page 39.

Benefits

The digitalized building services are accessible through mobile apps:

- Mobile app for the gas condensing boiler (generation side heating and domestic hot water) having all functions normally available on the boiler's physical automation panel (see **Figure 2**);
- Mobile app heating, cooling, ventilation, domestic hot water recirculation (distribution and emission side) and garden lighting:
  - Remote access;
  - Data visualization (real-time and historical) – IEQ, energy use, operation status;
  - Control and automation – scenes, timers and rules.

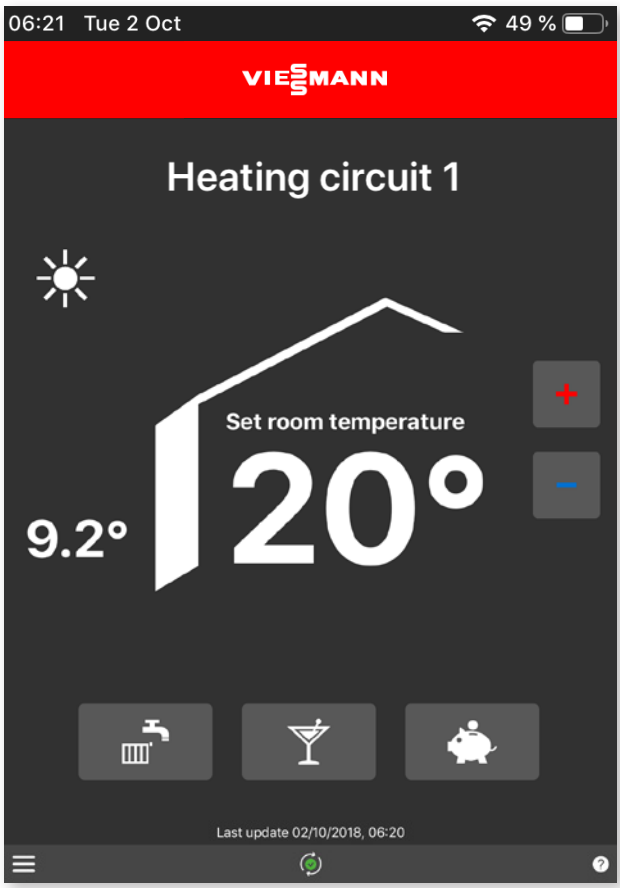


Figure 2. Screenshot from the mobile app for the boiler.

In addition to the mobile app screenshots on page 41 and **Figure 2**, please see more in the HTML-version of this article at the REHVA Journal homepage**.

The key added value of such smart home devices is that it enables automated operation of the building services based on desired indoor environmental quality parameters (e.g. volatile organic compound, relative humidity, temperature – with likely positive impact on health, well-being and comfort) and remote access.

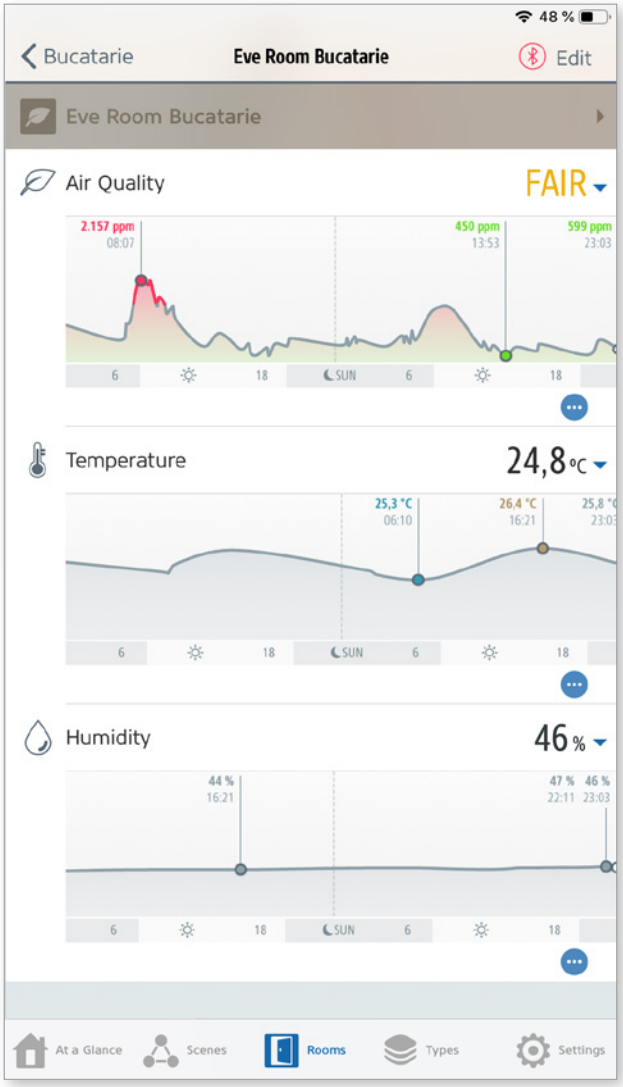
Considering the users and their satisfaction, comfort, health and well-being such smart home enable and facilitate empowerment, education and continuous adjustment and improvement leading to an enriched/new life experience at home.

Digitalizing building services shall take the offering of designers and installers to a digital transformation that will ultimately lead to better user focused services resulting from the created continuous quality feedback loop. One could easily imagine several enabled services e.g. ongoing commissioning, remote operational improvement, remote service and maintenance, guaranteed quality of services.

** https://www.rehva.eu/publications-and-resources/rehva-journal.html

Although, there are new aspects that require attention (e.g. data protection and privacy, cyber security), in general terms the digitalization of building services brings many opportunities for the sector and most importantly can help create more satisfactory, comfortable and healthy living conditions in our homes. ■

Outdoor air parameters in the mobile app for the smart home devices.



Indoor air parameters in the mobile app for the smart home devices.

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DAIKIN anniversary interview with Frans Hoorelbeke, Chairman and Member of the Board of Directors

Interviewer: **ANITA DERJANECZ**, REHVA Managing Director

DAIKIN Europe celebrates its 45th anniversary in 2018, and the company has been a true REHVA supporter for a decade this very year. On the occasion of the double anniversary, REHVA President Stefano Corgnati offered a special award to Frans Hoorelbeke Chairman, and Member of the Board of Directors, who sat down with REHVA Managing Director Anita Derjanecz for an inspiring interview to discuss the history and future priorities of the company.

Anita Derjanecz: Congratulations to the 45th anniversary of DAIKIN Europe. How would you summarize the history of the company in Belgium? What do you see as the key factors of being successful and growing over the past 45 years?

Frans Hoorelbeke: The story of DAIKIN in Europe started with an interesting twist. In 1966, there was a British distributor based in Malta that sold Hitachi equipment and got in conflict with the company, so they split. And it was this gentleman who went to the competitor DAIKIN and convinced them to start selling their products in Europe. It was not DAIKIN who came to Europe, back then it was a very domestic company, they only had a small affiliated company in Singapore. So, this was the first time ever they started to sell beyond Asia. But soon they saw that things go very well in Europe, so DAIKIN was surprised and started to analyse the market situation and decided to create a subsidy on the continent. They didn't find Malta as the best location. They choose Belgium, because 25% of the turnover back then was sales in the UK, but they made a very wise decision to stay on the continent. Belgium was selected because of the very good infrastructure, airports, seaport and highways. Besides that, the skilled

Frans Hoorelbeke

- Born in 1946, Belgium
- Master's in Business Administration
- Whole career has been in DAIKIN, starting in financial administration in 1976
- In 1988 he became the Director in Finance and Administration and in 1998 he progresses to Executive Vice-President of DAIKIN Europe
- Between 2011-2016 he was a member of the Board of DAIKIN Industries Ltd. Japan
- Chairman, member of the Board of Directors of DAIKIN Europe NV, since 2005

and hardworking labour force, and some very attractive conditions for foreign investors, for instance 5-years exemption of paying real estate tax and very cheap land. DAIKIN Europe was established on 29 March 1972, and the factory in Oostende was inaugurated in 1973.

DAIKIN Europe had hard times at the beginning of its history. The first ten years from 1973 to 1983 were very difficult for two reasons. The Japanese have always long-term thinking and planning. They analysed the market in the 2nd half of the 1960's and saw that the market in Europe was mostly composed of water cooled monobloc systems. So, we started to produce these products. For the Japanese it was hard to understand that in Europe they don't have one single market, and that they can't simply copy the product sold in Japan. They had to realise that the European market is not at all united, they must cope and comply with 20 different national markets and regulations. Also, from the beginning of 1970's the market started to change to air-cooled monobloc and split systems became more and more popular. These two points from changing the product range and not having the experience to adjust yourself to the market requirements made the first ten years very difficult. We were making losses, had overstock, and had to let go employees.

In the second period, 1985-1995 two important developments happened. First, DAIKIN introduced VRF systems in Europe, which was a market revolution. DAIKIN organised a lot of trainings, seminars and promotion actions, sent consultants to Japan where the technology was used already since the early 1980's, to show the system its flexibility and easy installation to Europeans specialists. This was an extremely successful product and DAIKIN could provide it without competitors and had for years 100% market share in Europe. The second important development was the increase of the manufacturing capacity of the company. We expanded drastically, from 5K m^2 to 25K m^2 production surface. It was very important for the later reaction to the fluctuation of the market demand. Now, 80% of the production in Europe is sold in the European market.

In the third period between 1995 and 2005 DAIKIN Europe started with the systematic acquisition of its distributors. This was very important, because it allowed us to know from first-hand information how the market is existing and developing, so we didn't have to rely on the information filtered by the distributors according their own interest. This allowed DAIKIN also to take more direct action towards market development. We were able to capture the real market, which I think, is a key success factor in the history of DAIKIN.

And then we have the fourth period from 2005 till 2015 when we had expansion in both territory and technology, because DAIKIN Europe became responsible for Middle-East and Africa and we entered in other business domains, such as refrigeration and heating, and strengthened our position in the market of chillers.

This period also thought an important lesson to DAIKIN, after the Lehmann crisis. In this period DAIKIN was extremely successful, we achieved 15-20% annual growth factor. And DAIKIN became, let's say, arrogant, thinking that people may be happy that they can buy products from us. We were not listening to the market anymore, we didn't explain the advantages of our products. And when the Lehman crisis happened, the others who were working hard on competing with us and were doing efforts in gaining new customers, they were attacking us. This thought us to never be arrogant again, go back to basics, and do not forget our basic principles. It took us three years here to achieve change in the minds of people at the company. It was a very good lesson.

Finally, in our latest period from 2015, we see new rising becoming important, such as refrigerants, environment, renewable energy and health, IoT and digitalization. For us ventilation will become also more and more important. We work in 5-years plans, and our current plan 2015-2020 has the very ambitious target to increase our turnover from 2,1Bn to 3.4Bn. Now, after 3 nearly years, I can say, we are still on track. Regarding the technologies, for us the most important at the moment is definitely heating with renewable energy and also environmentally friendly R32 products. I think here we have excellent product already and it will be developed also for residential market.

AD: Would you share with us your personal history at DAIKIN? When did you join the company? What are the most important DAIKIN values for you?

FH: I have joined the company on the 11th February 1976 during my studies, before even graduating as economist. I am typical example of what a Japanese call a "freshman" who started and worked at one company for his whole life. The company was very small back then, we were only 68 people worked and the turnover was around 5M euros. And today we are 7500 people and the turnover for this year budgeted is 2.8Bn euros. I

was lucky to grow together with the company. I started as an accountant and administration supervisor for 1,5 years. This gave me the advantage of the small company that I had to deal with everything from budgeting to HR and customs. I have been able to grow through all the management steps up to Vice-President. At a certain moment I was asked to become member of the associated Board in Japan and until 2017 I've been also member of the DAIKIN Group's Board.

How is it, working in a Japanese company? We have 3 basic principles followed throughout the whole company. First: absolute credibility. If you make a promise, you have to do it whatever happens. This is very important in everything we do, suppliers' goods, quality, service, and so on. You must be credible. The second principle is cherishing entrepreneurial management spirit. This means that people have to work in the company, as if it would be their own. They should take real initiative and be creative, coming up with ideas. The third one is the harmonious personal relationship within the company. People are the most important in a company and it is crucial that they have a very good relationship, and the company provides them coaching and a long-term carrier development. It is important for DAIKIN that its employees believe in the company and we make sure that people can grow and are passionate about their work.

Many people ask me, are you a Japanese or a Belgian company? And I always say, we are a little bit of both sides. What we learned from the Japanese is the long-term vision, the sense for detail, and the thrive for consensus in the decision making involving every level. This decision-making model may take some time in the planning phase, but if everybody agrees in the decisions, then the execution is very quickly. This is a completely different to the Americans for instance, where the management decides, maybe many people don't agree, and when things don't work, they change.

What we have from Belgium is the hard working and skilled workforce, the language skills, as - unlike Japan - speaking many languages is a traditional value in our country. Then a sense of diplomacy, we know how to deal with other cultures. I think, the combination of these skills works very well and are key in the expansion of the company.

AD: What do you see as the most important market trends that influences DAIKIN and the HVAC manufacturing sector in the next decade?

FH: An important trend we will consider when planning our next 5-year strategy is the change in the service business. I think that a similar change we can see now in the mobility sector, that people are subscribing to car-sharing services and pay only when they use the service, will happen also in the air conditioning industry. In the future, we will sell energy and comfort, and the end user will pay a monthly fee for that. Our responsibility will be to create the enabling environment and the products that guarantee comfort and wellbeing in terms of indoor humidity, temperature and ventilation. I think this will come with a lot of challenges and uncertain factors, and we have to see how we can manage that. This is one of the biggest challenges.

Safety of our products is well established, although it was not always considered when making choices. The recent fires in buildings are an example of it. Today there are relaxations proposed for the safety requirements in view of better balancing with climate impact. We need to balance these contradictory aspects.

Health is another key aspect. Our know-how about the parameters related to health, comfort and well-being and the relation with indoor and outdoor air quality is constantly increasing. This will push the market to new solutions, driving towards air-pollution free and CO_2 emission free technologies, and I think heat pumps are the key in this field. Another important requirement is to reduce the noise pollution related to HVAC equipment. There are many studies on the negative impact of noise in urban environment. The building sector together with HVAC-sector will develop new technics to cover these needs.

Climate change and resource efficiency is the third important trend. I am convinced that the future is in renewable energy HVAC products. We should further improve demand management and the related technologies, like storage, to ensure the comfort of the end-user. Resource efficiency requirement influence all materials that we use in our products, together with the production process. We aim to integrate the circular economy approach in our production process by recycling our equipment as much as possible.

Digitalisation and automatization will also reshape our industry. We expect that future users will tell manufacturers directly that they want using interactive applications and smart devices. Daikin already has service related software for customers that permanently monitor the systems and enable preventive

maintenance. In the future, we expect increasing direct contact with our customers, which will take over more and more the direct contact with installers. Automatization is also an important technology in the production facilities. DAIKIN Europe's factory in Oostende won the Belgian Factory of the Future Award in 2017 for the its ability to incorporate world-class technologies to developing smart and sustainable production with a focus on technology, and for upholding a human-centric approach, viewing employees as a significant asset for the future development of a company.

AD: At the anniversary festivities in Oostende in September, both President Masatsugu Minaka and Flemish energy minister Bart Tommelein talked about DAIKIN's increased investment in research facilities and activities in Belgium in the past 5 years. How big is this research capacity and what are DAIKIN's research and development priorities in Belgium and Europe?

FH: The basic research is done in Japan. We have there a big research centre, the Technical Innovation Center (TIC) in Japan, where more than thousands of researchers from around the word are working. This basic research is linked to our research activities in Belgium also with a help of the 48 Japanese colleagues who work in Oostende and fulfil also a bridge function. The TIC brings together all relevant disciplines: mechanical, chemical and electrical engineering.

In Belgium, 250 engineers are currently working and 25% of them are non-Belgian. The aim of the research centre is to promote out of the box thinking as well as interdisciplinary and intercultural cooperation. The number of test facilities in Europe increased from 25 to 40 in the past decade. We can test now our equipment in all possible climate and operation conditions. We are proud to say that the development of all heating and commercial refrigeration products, also for the whole global group, is concentrated in Europe. Also, the design of products sold on the continent is made more and more in Europe for Europe, beside manufacturing.

AD: REHVA is proud that DAIKIN is a Diamond Sponsor of CLIMA2019 with a special DAIKIN AWARD competition. Can you tell us more about the initiative? Who are your target group and what do you expect from the applicants?

We decided to become a Diamond Sponsor, because we are convinced of the importance of the CLIMA2019 congress. It is an important event where you bring together participants form industry, and academic sector, including university professors and PhD students. So, we see this as a good opportunity to make students aware of DAIKIN as a possible partner or even a career possibility by launching our DAIKIN AWARD competition for students. The competition will target PhD students who can apply with research and development projects.

During the recent months the abstracts could be submitted to the CLIMA2019 review committee. When submitting, the author(s) could apply for the Daikin Award as well.

During the CLIMA2019, the nominated poster presentations will be able to present their contribution to an international jury who will finally decide on the winner. The winner will receive a full Daikin Academy course which will be free of charge including travelling cost to Belgium.

AD: DAIKIN has been a true supporter of REHVA for 10 years and is pro-actively participating in our activities. What values do you see in being part of the REHVA "family"? What do you expect form REHVA in the future?

FH: Being a REHVA supporter was a well-considered choice for DAIKIN, because REHVA is advocating the importance of IAQ and our sector. We see as added value that REHVA represents academics EU wide, and disseminates knowledge, which is helpful for our business analysis. REHVA should keep up this work and take leadership in unifying European engineers and convince policy makers about the importance of our sector. The key mission of REHVA should remain to focus on how to keep high IEQ while being energy efficient at the same time. I think that REHVA shall develop a harmonised energy performance calculation methodology and support harmonization in all relevant regulatory fields for our sector. Regarding the technical issues, I think REHVA should have more articles about the conversion of heating, cooling and air-conditioning technologies, which is already happening and will be more important in the future. One suggestion to REHVA in political advocacy is to be aware that when you talk to EU politicians you can't talk too much scientific language. Finally, I think that we need better cooperation among the different HVAC related associations. It is very important to work together with other industry associations and convey the same message to policy makers. ■

The European Smart Readiness Indicator (SRI) for Buildings – in the making, get involved!





ANDREI VLADIMIR LIȚIU*[1,2] ANITA DERJANECZ [2] JAREK KURNITSKI[3] RISTO KOSONEN [4,5] IVO MARTINAC[1]

[1] KTH Royal Institute of Technology, Division of Building Services and Energy Systems, Stockholm, Sweden
[2] REHVA Federation of European Heating, Ventilation and Air Conditioning Associations, Brussels, Belgium
[3] TALTECH Tallin University of Technology, Nearly Zero Energy Buildings Research Group, Tallin, Estonia
[4] AALTO University, Department of Mechanical Engineering, Espoo, Finland
[5] Nanjing Technical University, Nanjing, China

* Corresponding email: litiu@kth.se, avl@rehva.eu
Authors emails: ad@rehva.eu, jarek.kurnitski@taltech.ee, risto.kosonen@aalto.fi, im@kth.se

The revised Energy Performance of Buildings Directive (EPBD)[1], published on 19 June 2018, has introduced the game-changing concept of Smart Readiness Indicator (SRI). The European Commission aims to adopt, by 31 December 2019, a delegated act, supplementing the EPBD by establishing a voluntary European scheme for rating the smart readiness of buildings, intended to have a complementary relation to the mandatory scheme of the energy performance certificates (EPCs).

Keywords: smart buildings, smart technology, occupants' needs, maintenance and efficient operation, demand response, smart meters, building automation and control systems, smart appliances, energy storage.

The SRI promise

According to the revised EPBD [1], the Smart Readiness Indicator (SRI) should be used to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and the grid and to improve the energy efficiency and overall performance of buildings. Furthermore, the SRI should raise awareness amongst building owners and occupants of the value behind the services offered

by building automation and electronic monitoring of technical building systems and should give confidence to occupants about the actual benefits of those new enhanced-functionalities. The **SRI for buildings should be optional for Member States.**

The SRI rating shall be based on an assessment of the capabilities of a building or building unit to adapt its operation to the **needs of the occupant** and **the energy systems** and to **improve its energy efficiency and overall performance**. The smart readiness indicator shall cover features for enhanced energy and cost savings, benchmarking and flexibility, enhanced functionalities and capabilities resulting from more interconnected and intelligent devices.

The methodology shall take into account features such as smart meters, building automation and control systems, self-regulating devices for the regulation of indoor air temperature, built-in home appliances, recharging points for electric vehicles, energy storage and detailed functionalities and the interoperability of those features, as well as benefits for the indoor climate condition, energy efficiency, performance levels and enabled flexibility.

The methodology shall rely on three key functionalities relating to the building and its technical building systems:

- The ability to maintain energy performance and operation of the building through the adaptation of energy consumption for example through use of energy from renewable sources;
- The ability to adapt its operation mode in response to the needs of the occupant (e.g. perceived IEQ) while paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and the ability to report on energy use; and
- The flexibility of a building's overall electricity demand, including its ability to enable participation in active and passive as well as implicit and explicit demand response, in relation to the grid, for example through flexibility and load shifting capacities.

The methodology may further take into account interoperability issues.

The methodology shall not negatively affect the existing national energy performance certification schemes and shall build on related initiatives at national level, while taking into account the principle of occupant ownership, data protection, privacy and security, in compliance with relevant Union data protection and privacy law as well as best available techniques for cyber security.

The methodology shall set out the **most appropriate format of the smart readiness indicator parameter** and shall be **simple**, **transparent**, and **easily understandable** for consumers/prosumers, owners, investors and demand-response market participants.

1st Technical study commissioned and supervised by DG ENERGY

Intermediary results of this 1st study have been previously covered in REHVA Journal [2,3].

The **1st study (1.5-year) providing technical support** to the Directorate-General for Energy of the European Commission in order to feed the discussions on the establishment of a 'Smart Readiness Indicator' for buildings as part of the revision of the Energy Performance of Buildings Directive has come to an **end in August 2018**. This technical study has investigated the **definition and scope of the SRI**, has proposed a **draft framework for the SRI**, and has led a **first evaluation of the potential impacts of the SRI**.

The final results of the study can be consulted in the final report [4] and the executive summary [5], which are available on the study website [6].

Throughout this study, a number of consultations were organized to discuss progress and give stakeholders, including REHVA, the opportunity to express their

Three key functionalities of smart readiness in buildings.

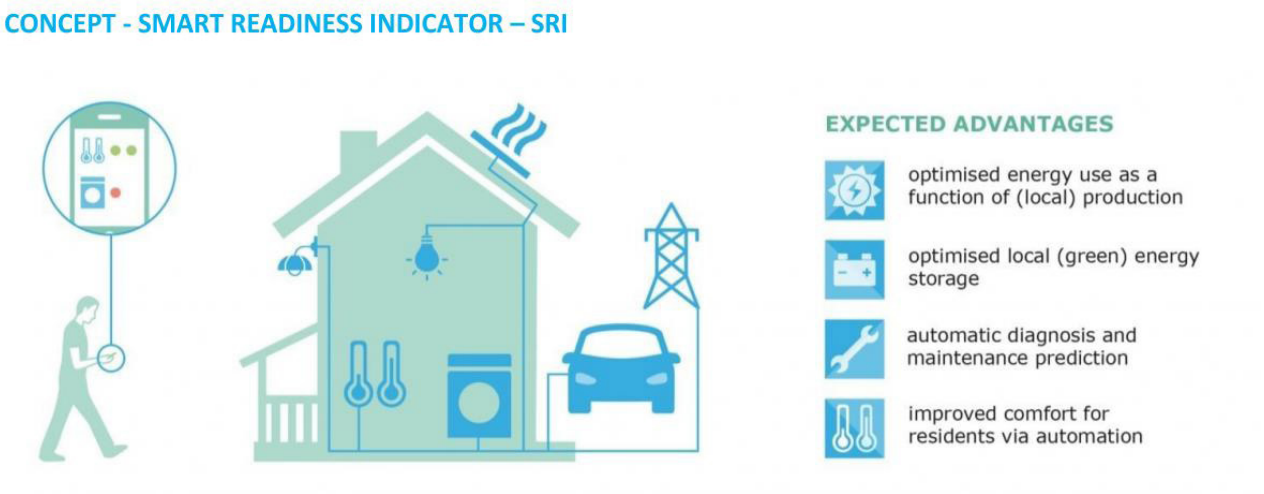
views and provide input for creating a transparent and open process. Furthermore, 3 stakeholder meetings were organized for the same purpose:

- 7 June 2017, more than 65 representatives;
- 21 December 2017, close to 100 representatives;
- 28 May 2018, more than 70 representatives.

According to the final report [4] the SRI is expected to become a cost-effective measure which can effectively assist in creating **more healthy and comfortable buildings with a lower energy use and carbon impact** and can facilitate the integration of Renewable Energy Sources.

The proposed SRI assessment procedure is based on an **inventory of the smart ready services (52 services)** which are present in a building and an evaluation of the functionalities they can offer. A potential implementation path is that of an **SRI assessor** who performs the assessment by indicating the implemented functionality levels for the relevant smart ready services using a **simple check-list approach**.

The services present in a building cover **multiple domains** (e.g. heating, cooling, ventilation, lighting, electric vehicle charging, etc.) and can also bring about **various impacts** (energy savings, comfort improvements, flexibility towards the energy grid, etc.).



Expected advantages of smart technologies in buildings.

Graphical representation of linkages of the SRI to other policy initiatives.

Target audience for the SRI.

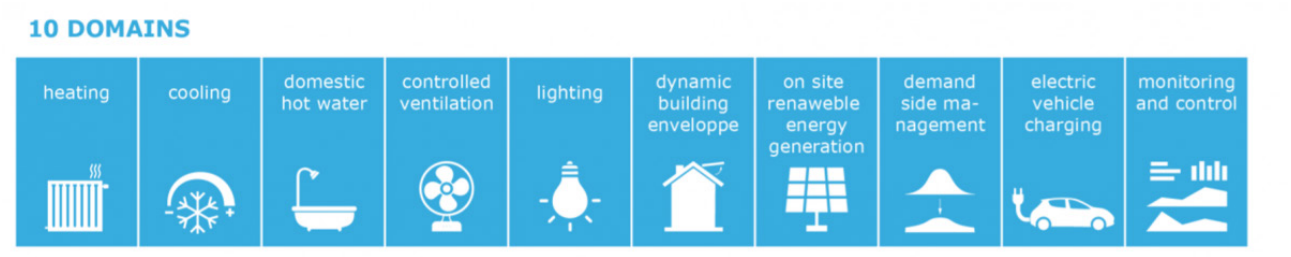
In order to cope with this multitude of domains and impact categories, **a multi-criteria assessment method** is proposed as the underlying methodology for calculating the smart readiness indicator. In this multi-criteria assessment, **weightings** can be attributed to domains and impact criteria to reflect their relative contributions to an aggregated overall impact score. The methodology has the flexibility to be practically implemented in various ways, e.g. **through on site- inspections by external SRI assessors**, self-assessment by building owners, a blend of check-lists and self- reporting by intelligent equipment, etc. A working assumption is made that a likely implementation process will involve an **inspection carried out by a competent third-party assessor**.

The study team defined for each of the 52 services, structured within 10 domains, and **several functionality levels**. A higher functionality level reflects a "smarter" implementation of the service, which generally provides more added value to building users or to the grid compared to services implemented at a lower functionality level. The number of functionality levels varies from service to service, the maximum level can be as low as 2 or as high as 5. The functionality levels are expressed as ordinal numbers, implying that ranks cannot be readily compared quantitatively from one service to another.

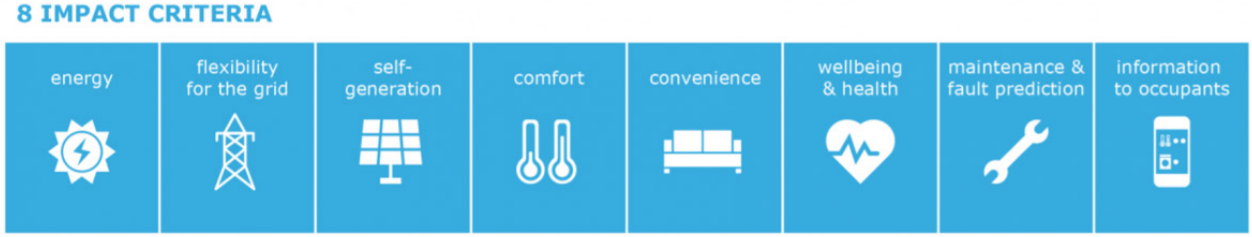
The provisional impacts in the catalogue, developed during the 1st technical study, are based on expert assessment and, where possible, on applicable standards. At this stage, the impacts are not fully quantified and are solely used to support the development of the methodology. For some of the impact categories, it can be envisioned that it will be possible to move towards direct quantification (e.g. through dedicated simulations, or even on-site measurements) whereas for other impact categories (e.g. 'convenience') impacts should be defined based on a broad consensus. In any case, deriving scores for the more subjective impact categories should not be based on interpretation by individual SRI assessors, but be defined in the method to ensure a fully replicable SRI assessment.

The SRI assessment and proposed check-list of smart ready services would be fast and straightforward especially in old and "simple" buildings, i.e. quite minimal effort is needed to provide SRI rating for existing building stock. On the other hand, for the design process of new complex nearly zero energy buildings the method needs to be further developed. Hopefully, this issue shall be properly addressed during the 2nd technical study.

For more detailed information about the 1st technical study we recommend checking the **executive summary** [5] and the **final report** [4].



Ten domains structuring the SRI catalogue.



Eight impact criteria defined in the study.

2nd Technical study commissioned and supervised by DG ENERGY

The conclusions of the 1st study are only a starting basis. Further investigation and discussions are needed to ensure a wide consensus on the SRI. The approach has generally been welcomed by the community, with some caveats, e.g. towards a more quantitative (performance-based) approach, questions of scoring and weighting consolidation.

Closer to the end of the 1st technical study, the European Commission Services announced all involved stakeholders that they are planning to launch a **2nd technical study** on the SRI in the **last quarter of 2018**. This additional study (estimated total value of 355.000 EUR, excluding VAT [7]) will **review and consolidate the draft SRI** framework proposed by the 1st study, investigate the **implementation of the indicator**, and take further the **evaluation of potential impacts**. All stakeholders will have the opportunity to further contribute to the shaping of the SRI in this next phase. In principle, all contacts registered on the mailing list of the 1st technical study will be informed in due course of the start of the 2nd study.

At the time of writing this article it is expected that the contract signing procedure for the 2nd technical study shall take place in the course of December 2018; the kick-off will take place early January 2019 and therefore the 1st stakeholder meeting around March 2019. Moreover, in contrast to the 1st technical study, the 2nd technical study shall involve Member States in the stakeholder consultation process.

In the **technical specifications** [8] of the 2nd technical study's **call for tenders** [7] the following **main tasks** are listed:

- Task 1: Technical support for the consolidation of the definition and the calculation methodology of the SRI;
- Task 2: Investigation of SRI implementation pathways and of the format of the SRI;
- Task 3: Guidance for effective SRI implementation;
- Task 4: Quantitative modelling and analysis of the impact of the SRI at EU level;
- Task 5: Stakeholder consultation and study website;
- Task 6: Support to the policy making process.

According to the revised EPBD [1], the European Commission Services supposedly need to align this work with the adoption, by 31 December 2019, of the SRI delegated act, supplementing the EPBD or possibly delay the adoption process.

SRI 2nd technical study timeline outlined according to the technical specifications [8] and the expected kick-off in January 2019.

REHVA's commitment

REHVA is committed to engage as key stakeholder during the further development of the SRI and actively get involved in the SRI development process managed by DG Energy and the 2nd study team. REHVA will set up a **special SRI technical advocacy working group** as the key forum to elaborate input. Aggregating a broad range of inputs from REHVA network shall ensure a meaningful and useful REHVA input to the 2nd technical study and ultimately facilitate the shaping of a more effective and better tailored to the building sector's needs Smart Readiness Indicator.

In parallel, to the technical advocacy work on the SRI, **REHVA's Technology and Research Committee** has recently approved a dedicated **Smart Buildings Task Force**. The main aim of REHVA's Smart Buildings Task Force is to develop a **REHVA Guidebook** endeavouring to ensure clarity about the 'Smart Building' service platform, gather existing resources and commercial practices, and tackle in more depth the aspects most relevant in the near future for the buildings sector. REHVA's Smart Buildings Task Force has a broader scope and although it shall provide input to the technical advocacy work on the SRI, it shall not be limited to the shaping of this emerging EU level political instrument. ■

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REDay2018: The Key Tools to Boost Energy Renovation

AUTHOR: REBEKA MARŠNJAK, REHVA EU Public Affairs and Publication Assistant

REDay initiative is a leading force of Renovate Europe, gathering 41 partners taking the lead in political communications campaign with the ambition to reduce energy demand of the EU buildings stock by 80% by 2050 compared to 2005 levels via legislation and ambitious renovation programmes. The main aim is to bring the energy performance of the entire building stock in the EU to the nZEB performance level.

This year's Renovate Europe Day was held in the European Parliament in Brussels on 9 October 2018 hosted by **Bendt Bendtsen** (MEP, EPP Group), the Parliaments' rapporteur on the Energy Performance of Building Directive (EBPD) review. Bendtsen pointed out the challenges that the amended EPBD is bringing and highlighted opportunities for the national policy makers. Thus, the next steps in the implementing

REDay2018 panellists at the European Parliament (from left to right): Adrian Joyce (Renovate Europe Campaign Director), Craig Egner (Scottish Government representative), Marjolaine Meynier-Millefert (Member of the French National Assembly), Bendt Bendtsen (MEP, EPP Group), Stephanie Sfakianos (Global Head of Sustainable Capital Markets, BNPP) and Stephen Richardson (World Green Building Council).

EPBD directive presenting the Long-Term Renovation Strategies (LTRS) that all member states must introduce by 19 March 2020 including public consultation and action plans. Additionally, member states must ensure that subsidies lead to energy savings with a new financial instrument established and stipulating the holistic governance approach to provide coordination and mutual support across European, national, sub-national and city governance levels.

The moderator of the panel was **Adrian Joyce**, campaign Director or Renovate Europe, who introduced the campaign and highlighted some of the energy renovation challenges such as the fact that 200 million existing buildings need to be renovated before 2050 and we need to strive for the deep energy renovation target for up to 3% per year (today, the rate of deep energy renovation is only 0.15% per year). Joyce stressed that all new renovations could contribute to a new 2 million direct local jobs, which leads to over 6 million total new jobs; health and welfare improvements; boasting EU GDP up to 0.77% per year.

Marjolaine Meynier-Millefert, Member of the French National Assembly followed by presenting the progress in a buildings related energy policy in France, where the building sector represents about 45% of energy consumption and it causes about 25% of the greenhouse emission. The main progresses in France are the inputs on the Energy Transition Tax Credit for the residential sector; Energy Saving Obligation Scheme (called White Certificates) for both residential and non-residential sector, using the same principles as the European Union's Emissions Trading Scheme; Global brand called FAIRE, which is a call to a common action and also recognises that energy savings and cost reduction are not the only triggers for renovation, but also the comfort matters. Due to this, the national plan in France is focusing on making building renovation as the national priority (planned budget for this is 14 billion euros over 5 years).

Side visit to the Cosmopolitan building renovation project.

Key plans are also to intensify housing renovation with a special focus on reducing fuel poverty; to boost the energy renovation in the tertiary sector and to reinforce skills and innovations towards the professionals.

Craig Egner from the Scottish Government highlighted the Scottish climate change plan trajectory to 2032 that requires 35% of domestic and 70% of non-domestic buildings heat to be supplied by the low carbon technologies. **Joyca Leplae** representing the city of Ghent, presented an excellent policy practice implemented in the city since years to tackle challenges and plans in city renovation strategy for existing buildings. The city provides free consultancy services to residents on how to renovate their homes, raising awareness via an online tool, where citizens can check the energy performance, as well as health and indoor environment quality related indicators in their homes. The city of Ghent is granting energy incentives (8,300), expert advises (around 16,000) and 2,000 renovations support, with a special focus on the low-income families and landlords, renting out for the low-income families.

Regarding the financing of renovation, two speakers brought up interesting points on financial solutions to foster renovations across Europe. Stephen Richardson from the World Green Building Council presented the importance of developing a market of financial products that stimulate energy renovations, such as green mortgages that can establish new market standard and foster the coordination of the banks, industry and governments. **Stephanie Sfakianos**, Global Head of Sustainable Capital Markets, BNPP presented an overview on launching a green mortgage pilot in the UK. Both speakers highlighted the Energy Efficiency Mortgage Action Plan (EeMAP) initiative that can ensure banks and investors loans based on lower risk and could qualify for a better capital treatment.

In the afternoon, REDay2018 organised two side visits for participants showcasing two renovation projects in Brussel. One of them the Cosmopolitan building renovation project, which is transforming a high-rise office building in the centre of Brussels into mixed-use housing. The second site was Rue Royale 89, a project of a "building brought to life". The objective of this high-performance renovation is to achieve a very low energy level and profitable techniques like the installation of a double flow ventilation system with heat recovery, a condensing gas boiler and the reuse of rainwater. ■

Have your say on EPB standards' roll-out and join the practitioner's community!

AUTHORS: JAAP HOGELING, DICK VAN DIJK, EPB Center, Rotterdam, The Netherlands & **ANITA DERJANECZ**, REHVA, Belgium

How the EPB Center supports the dissemination and roll-out of the new Energy Performance of Building standards

Introduction

The set of CEN and CEN ISO Energy Performance of Buildings standards, developed under EC Mandate M/480 and published in 2017, provide EU Member States (MS) with a toolbox to help the implementation of the EPBD and aim also at higher transparency regarding the energy performance calculation methodologies. Each EPB standard has a template for a National Annex* that enables Member States to tailor the methodology to the national situation.

On September 21, 2018 a Service Contract was signed between DG ENER and a consortium led by ISSO to support the uptake of this set of EPB standards.

This 3-years' Service Contract will serve its purpose by:

- Providing support to Member States and National Standardization bodies as needed when preparing the National Annexes or National data sheets of the overarching EPB standards;
- Supporting the wide dissemination of the overarching EPB standards and their use by Member States (including as part of the obligations in Annex I of the revised EPBD);
- Setting up and running a public frequently asked questions database on developing National Annexes or data sheets, practical application of the standards, etc.
- Preparing practical case studies to support the use of EPB standards (e.g. use by industry stakeholders, researchers, international fora, financial institutions, etc.);
- Developing and disseminating calculation tools for individual EPB standards;
- Setting up a large network of current and future practitioners (i.e. building physics and HVAC students) and support the uptake of standards by organising regular hands-on workshops, webinars, online courses, etc.

The core part of the communication and dissemination is the **EPB Center** website (www.epb.center) acting as interface to and from the target groups, as well as a dedicated LinkedIn group.

* See www.epb.center/implementation/national-annexes

The consortium

The consortium consists of a team of EPB experts and involved organizations, grouped around the EPB Center:

- Project leader: **Jaap Hogeling** (ISSO / EPB Center)
- REHVA: **Anita Derjanecz**: Workshops, webinars, communication
- NEN: **Annet van der Horn** (secr. of CEN/TC 371)

EPB experts:

- **Dick van Dijk**, The Netherlands (CEN/TC 89+371 & ISO/TC 163+205+TC 163/SC 2/WG15)
- **Dirk Van Orshoven**, Belgium (CEN/TC 371 + ISO/TC 163+TC 163/SC 2/WG15)
- **Laurent Socal**, Italy (CEN/TC 228 + 371)
- **Gerhard Zweifel**, Switzerland (CEN/TC 156 +371 + ISO/TC 163+205)
- **Johann Zirngibl**, France (CEN/TC 228+371 + ISO/TC 205)
- **Jean Daniel Napar**, France (CEN/TC 247+371 + ISO/TC 205)

Activities in the first 6 months

To quick-start the exchange process, the prime concerns of the EU MS's will be identified and MSs will be engaged in the early stage of the project so that the project team can offer the best possible support that will help MSs in overcoming barriers, like questions raised on the National Annex approach or regarding the interpretation of particular EPB standards.

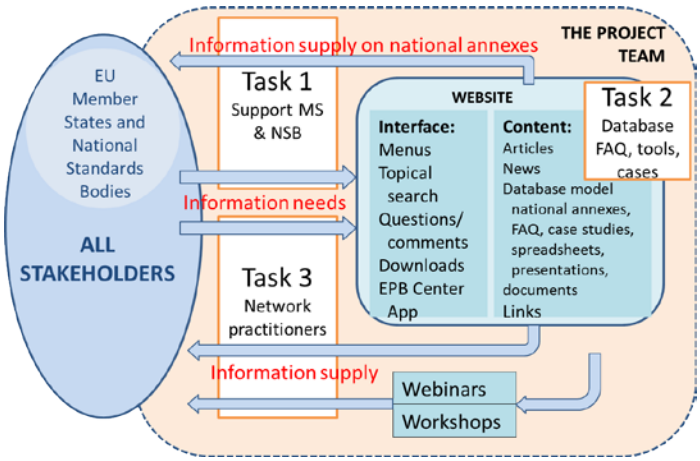

Figure 1. Illustration of the relation between the different activities in the project.

Some outcomes of the first 6 months are:

- An informative report, a presentation and a brochure describing the state of play for the energy performance of buildings standards;
- A first version of FAQs and examples for filling the National Annexes and examples where EPB standards are applied or could be used (e.g. by industry stakeholders, researchers, financial institutions, etc.);
- A first draft for calculation tools for selected individual EPB standards including user guide, a presentation and examples of first case studies;

Description of the tasks

In line with the revised EPBD (2018), priority is given to the following 'overarching' standards: EN ISO 52000-1, EN ISO 52003-1, EN ISO 52010-1, EN ISO 52016-1 and EN ISO 52018-1.

These five 'overarching' EPB standards have in common that each of these describes an important step in the assessment of the energy performance of building:

Based on early feedback from the stakeholders, additional priorities are proposed by the project team. These deal with specific areas in the domain of the EPB standards describing the performance of the technical building systems that require special attention, because of their importance and complexity (see Figure 2).

Task 1: Support to Member States and National Standardization Bodies

Task 1 aims to reach out to Member States and National Standardization Bodies and support them in using the Energy Performance of Buildings standards. The main activity is to monitor and support the preparation and (intended) use of National Annexes or National datasheets to the EPB standards.

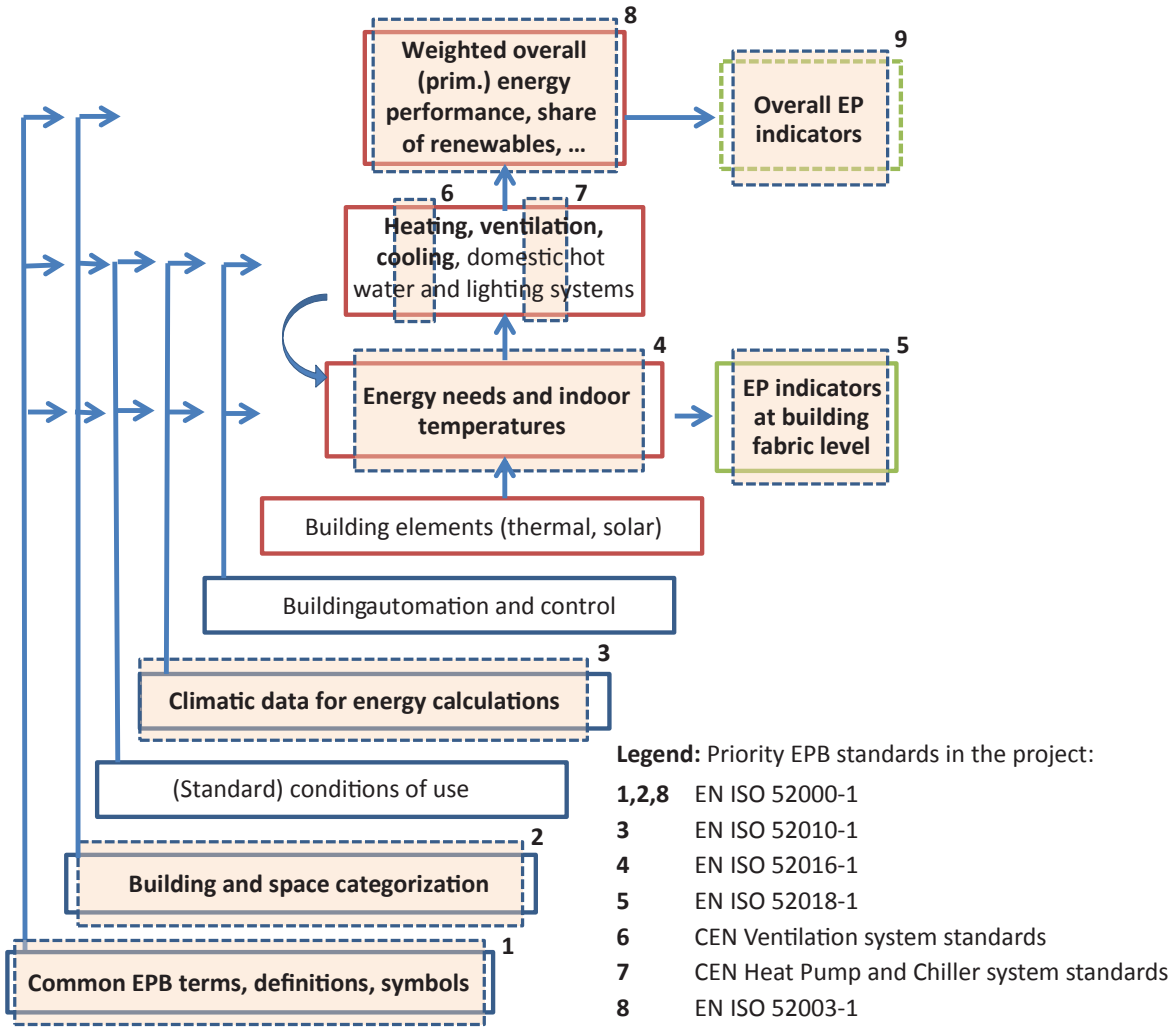

Figure 2. Flow chart in energy performance assessment and selected priority standards.

The EPB Center facilitates a platform of experts on the set of EPB standards with the aim of supporting member states in completing the National Annexes or National datasheets for the set of EPB standards.

Task 2: Setting up a database of FAQs, calculation spreadsheets and case studies

Database of Frequently Asked Questions

The main scope of the FAQs will be:

- the rationale behind and the rules for the National Annexes / National Datasheets,
- the completion of National Annexes / National Datasheets,
- the application of Annex I of the revised EPBD (2018): description of the national calculation methodology following the national annexes of the overarching standards,
- other issues related to national implementation,
- the technical content of the EPB standards,
- support tools (e.g. spreadsheets) and the case studies.

Calculation tools (e.g. spreadsheets)

In the M/480 mandate project (development of the set of EPB-standards), one of the tools to safeguard the necessary overall consistency and coherence for the set of EPB-standards, was the preparation of a spreadsheet for each EPB standard containing calculation procedures.in this Task 2 the spreadsheets of the earlier indicated priority standards will be updated.

Case studies

Partial Case studies:

- A few typical example buildings and climate data sets will be chosen as basis for the case studies.
- The example buildings and climatic datasets will be selected in such a way that they ensure a wide European climatic coverage. As a minimum, examples will cover:
  - Cold, mild and warm climate
  - Residential and non-residential buildings
- For each case, parameter variations will be prepared, to reveal the impact of the choice in input variables or in national choices on the output.
- As a rule, the (updated) spreadsheets will be used to prepare the case studies.

Simplified whole building cases studies:

In addition to these partial case studies, a few whole building case studies will be performed to demonstrate the overall usability of the set of EPB standards, e.g. with respect to the cost optimality calculations.

The envisaged case studies comprise:

- One single family house, new and existing
- One apartment building, new and existing
- One office building, new and existing

Because output data need to be transferred manually from one EPB standard as input to another EPB standard, a monthly method and other simplifications will be applied.

The main difference between the case for the new and the existing building is the availability of reliable input data.

Task 3: Creating a network of practitioners

Task 3 will include at least the following activities:

- Identification and targeted engagement of practitioner and stakeholder types.
- Cooperation with global and international organizations and networks.
- Set up of the network of practitioners (including organization of workshops, webinars and other events).
- **EPB Standards Academy:** information pool and capacity building platform with the following modules:
  - **Webinars and online courses** tailored to different types of stakeholders, including MS level regulatory bodies and public administrators
  - **Models and examples of National Annexes / National Datasheets:** to collect, compare and present National Annexes and National Datasheets that (are being / have been) prepared by MS's.
  - Information materials and fact sheets about the EPB standards:
  - EPB Case Study Database:

Concluding and asking feedback from EPB practitioners

The purpose of this article is not just to inform the REHVA Journal readers about this project: for the effectiveness of the project it is important to obtain early feedback from professionals involved or interested in the assessment of Energy Performance of Buildings and in the implementation of the related articles of the recently revised EPBD.

This feedback will help to adjust and tailor the planned activities in the project to the needs of the stakeholders.

The EPB Center activities are to plan, coordinate and guide the process of promoting the implementation and use, maintenance and further development of the set of EPB standards and safeguard the coherence of their technical content.

Other activities which are foreseen if sufficient interest can be organized are, for instance: improving the links between the EPB standards and ECODESIGN and further embedding of the EPB standards in the EN ISO set of EPB standards (ISO 52000 family of EPB standards).

All these activities aim to contribute to achieving uniformity, flexibility and sustainability as well as cost and risk reductions in the built environment. ■

REHVA Brussels Summit highlights

AUTHORS: TIZIANA BUSO, Ph.D., REHVA Project Officer & **REBEKA MARŠNJAK**, REHVA EU Public Affairs and Publication Assistant

Monday 12 and Tuesday 13 November, REHVA confirmed the successful format of its Brussels Summit, that for the second edition brought together over one hundred HVAC stakeholders in the REHVA network. The first day was devoted to REHVA Committees meetings and to strategic EU project workshops, while on the 13th the REHVA Brussels Summit Conference was held.

ALDREN and CEN-CE workshops

On day one, two project-related workshops were organized in the framework of the Brussels Summit to exploit synergies between REHVA stakeholders' activities and REHVA's European projects goals.

The first workshop showcased **CEN-CE**, a H2020 project running until May 2020. CEN-CE is developing a European training and qualification scheme based on the **new set of EPB standards**. The workshop interactively involved participants in the critical evaluation of the training material, towards an active involvement in the deployment of such scheme.

ALDREN workshop, instead, proposed to an audience of REHVA experts and EU level stakeholders the project strategy to **consolidate, extend and implement the 'European Voluntary Certification Scheme'** policy instrument (EPBD Art. 11(9)) along the deep renovation process. The ultimate goal of the meeting REHVA networks was to understand to which extent energy efficiency stakeholders are interested and willing to endorse the certification scheme proposed by this H2020 project and how its contents are relevant for training building professionals.

The first workshop showcased CEN-CE, a H2020 project running until May 2020.

In both workshops over 50 participants were entertained and directly involved in the conversation through live polling sessions, open discussion and direct access to the speakers' presentations on their own devices. The same material is now available online in the corresponding projects websites.

REHVA committees

The first day of the REHVA Brussels Summit was also the meeting day for the REHVA Board, the REHVA Cooperation group (COP) and the REHVA standing committees on Education and Training (EC), Publishing and Marketing (PMC), Supporters (SC) and Technology and Research (TRC).

In these meetings many proposals were made, and decisions taken to increase REHVA visibility and the support to its network. Among others, REHVA is planning modifications to its **dictionary app** for providing additional tools such as EPBD table of standards, link to REHVA member's websites, unit converter tool. To increase visibility of the REHVA knowledge platform and the knowledge of REHVA members, REHVA will soon launch a **book repository tool**, which aims to collect all the publications of REHVA members that represent technical topics of a common interest at the European level. These changes will come along with a revamped REHVA website.

In terms of REHVA publications, **four new guidebooks** to be launched at CLIMA 2019 were officially announced during the TRC and PMC meetings:

- Guidebook 9 update - Hygiene requirements for ventilation and air-conditioning systems
- NZEB design strategies for residential buildings in Mediterranean regions
- Quality Management for Buildings
- The REHVA-ISHARE Building Commissioning guidelines

Bedside the confirmed ones, other guidebooks are in the pipeline for 2019 and a new Task Force on smart buildings was officially approved.

REHVA dinner celebrating DAIKIN Europe

After a day dense of the meetings, Monday night was closed by the traditional informal REHVA dinner, that welcomed over 50 guests in the pentahotel Brussels City Center. During the evening event REHAV President **Stefano Paolo Corgnati** handed over a special award to **Frans Hoorelbeke**, chairman of Daikin Europe to celebrate the joint 45th anniversary of the company and commemorating that DAIKIN Europe has been a true REHVA supporter company for a decade the same year.

REHVA conference on "Smart buildings for smart users - implementing the new EPBD"

The second day of the REHVA Brussels Summit was dedicated to the traditional REHVA Conference. The topic of the event, "Smart buildings for smart users - implementing the new EPBD", gathered around a hundred participants among EU stakeholders, experts and HVAC industry representatives, in the conference room of the pentahotel Brussels City Center. The conference was organized in a morning and an afternoon session: the former more policy oriented, the latter more technology oriented. All presentations are available on the REHVA website.

The morning session was chaired by the REHVA President Stefano Paolo Corgnati and REHVA Vice-President and Chair of the Technology and Research Committee **Jarek Kurnitski**, who introduced speakers dealing with building smartness from different points of view.

The first speaker was **Pau Garcia-Audi**, Policy Officer at DG Energy and, in this speech, spokesperson for his colleague **Sylvain Robert**. Mr. Garcia-Audi introduced the ongoing activities of the European Commission with respect to the **Smart Readiness Indicator (SRI)**,

REHVA special award for DAIKIN Europe.

Panelists (from left to the right): Pau Garcia-Audi (Policy Officer at DG Energy), Bart Bleys (Quality Manager at BBRI), Ivo Martinac (Professor at KTH), Simona d'Oca (PhD and project coordinator at Huygens Engineers and Consultants), Stefan Plesser (CEO at Synavision).

which should assess the capability of a building "to adapt its operation to the needs of the occupant and the grid and to improve its energy efficiency and overall performance" [Article 8(10) revised EPBD]. The speaker went through the key outcomes of the first study, ended in August 2018, which proposed an SRI calculation framework, and reported SRI stakeholders' reactions, who are asking for a performance-based evaluation and a sound scoring and weighting system. The same remarks raised from the Conference audience: SRI Indicator should make sure that smart technologies are not only installed in buildings, but that they are also optimally used. The second SRI study will start in December 2018 and will address these comments in its proposal for a calculation methodology.

Participants at REHVA conference.

In the second presentation, **Bart Bleys**, Quality Manager at BBRI and Co-Subtask Leader of IEA Annex 67 "**Energy Flexible Buildings**", went into details for one of the key features of smart buildings: energy flexibility. This is defined by Annex 67 as the ability of a building to manage its energy demand and generation according to local climate conditions, user needs and grid requirements, thus allowing for demand side management/load control. Most of the building have the ability to become energy flexible, but the challenge is to quantify this flexibility. The speaker also offered examples of the energy saving potential enabled by energy flexible demand response controls.

The speech of the third presenter, **Ivo Martinac**, professor at KTH, stated the importance of a smart features in buildings as powerful means to maximize occupants' comfort. He stressed the fact that while we have knowledge and tools to confirm the **role of Indoor Environmental Quality in people's well-being**, a robust valuation framework is missing. Clear-cut metrics, quality assured-measured data, tailored KPIs have to be defined to get a better understanding of the overall building performances (energy, financial, comfort) and to translate it into marketable indicators that seize the human perspective. To connect the dots towards and integrated and user-centric approach to building performance management, Prof. Martinac presented a number of ongoing initiatives, including the REHVA Task Force on Smart Buildings.

The presentation by **Simona d'Oca**, PhD and project coordinator at Huygens Engineers and Consultants, was a perfect follow up in the direction of user-centric design approach. Dr. d'Oca introduced the research approach and application of the H2020 project **Mobistyle**, a 42 months project ending in April 2020. The project, as well as her speech, stressed the crucial **role of users in smart buildings**. Indeed, the building ecosystem is made up of the interaction of occupants with systems, and both elements need to be smart in order to achieve an overall efficiency. Mobistyle project has identified user's needs and has put them into relation with systems by exploiting ICT solutions.

After the coffee break, **Pau Audi-Garcia** (DG Energy), returned on the stage with a presentation focusing on the **role of inspections in the revised EPBD.** By highlighting the changes with respect to the EPBD recast, he raised one of the most debated points among REHVA experts: can Building Automation and Control Systems (BACS) replace inspections, as stated in the directive? REHVA experts even expressed their concerns regarding this option in a REHVA position paper. According to Mr. Audi-Garcia, the main issue in this statement lies in the different understanding of BACS functionalities from EPBD and market points of views. According to the revised EPBD, BACS key functionalities are to analyze, benchmark, detect and inform with respect to energy use and efficiency of the technical building systems, while allowing communication and interoperability with them. However, in real installations BACS are nowadays often far from enabling these functions. The revised EPBD is meant to improve the situation. In this perspective, understanding the role of BACS in triggering building renovation will be the turning point for supporting the market uptake of more complex systems.

The last presentation of the morning was given by **Stefan Plesser**, CEO at synavision, professor at TU-Braunschweig and **QUANTUM** project coordinator. He shared his vision of the **role of quality management in technical monitoring** and how this quality control can by digitalized. Indeed, with the building technical systems becoming more and more complex and the regulatory framework continuously evolving, building professionals need support in the correct management of the overall construction process in order to meet owners' projects requirements. The solution proposed by the speaker is a digitalized technical monitoring process to engineer, analyse and supervise the technical building systems. The German AMEV Technical Monitoring Guidelines (available in English on QUANTUM website) are a good example of established procedure for carrying up these tasks and a forthcoming (May 2019) REHVA-QUANTUM guidebook will further clarify the role of Technical Monitoring and Building Commissioning from the investors' perspective.

REHVA President Stefano Corgnati, together with (from left to right) Atze Boerstra (REHVA Vice-president and Chair of the REHVA Supporters Committee), Filip Jorissen (PhD and Post-Doc at KU Leuven), Henk Kranenberg (Senior Manager at Daikin Europe)

The speakers were then involved in an interesting panel discussion with the audience, that lasted until lunch time.

Atze Boerstra, REHVA Vice-President and chair of the REHVA Supporters committee, chaired the afternoon session of the conference, which shed lights on the market analysis of specific technologies.

The first speaker was **Filip Jorissen**, PhD and Post-Doc at KU Leuven, key member of hybridGEOTABS project consortium, with a presentation on **Model Predictive Control (MPC) algorithms applied to hybridGEOTABS buildings**. MPC can answers to the control challenges posed by smart buildings, where technical building systems have to interact and integrate towards an optimal management of energy use and comfort conditions. Specifically, the speaker presented the potential of a white box approach to MPC: the MPC toolchain currently being developed at KU Leuven will allow a user-friendly set up of MPC algorithms based on building schematics information. Dr. Jorissen then presented the application of these strategy to a case study building, where simulation results showed an energy saving potential of MPC of 0ver 50% with respect to traditional rule-based control.

The floor was then given to **Leonardo Prendin**, Marketing Group Manager at Rhoss, who gave to the audience an overview of the **technology and market trends for heat pumps and chillers**. The key points of his presentation were the effect of EU directives and regulations on these technologies, that will have to rethink to their design features in order to be compliant and financially sustainable. One major aspect to be considered is the evolution of refrigerants where a trade-off between Global Warming Power and flammability is the upcoming challenge.

The last presentation of the conference was by **Henk Kranenberg**, senior manager at Daikin Europe, who talked about **ventilation and climate control in terms of market and product development trends**. There are a number of key take away for REHVA network from his speech: a) the plethora of the local regulations dampen the ventilation and heat recovery technologies market uptake, b) European standards have a big role to play in market standardization, c) until now energy efficiency has been the core aim of regulations, market strategy and political agreement, but in the near future every aspect the performance of a building will be considered and interconnected. Thus, the next challenge for the ventilation industry is to include Indoor Air Quality control as a standard feature in its products; d) integration of ventilation and IAQ requires to control and monitor the related parameters, therefore new ventilation products should include already now these options in their standard applications.

The conclusive open discussion was led by Atze Boerstra, who then invited REHVA President Stefano Corgnati for the closing remarks. ■

REHVA and CCHVAC organised the HVAC World Student Competition 2018 in China

HVAC World Student Competition was held in Sanmenxia, the province of Henan, in China, on 25th of October 2018, during the 21st Academic Conference of the Chinese Committee for HVAC (CCHVAC2018). It followed the REHVA World Student competition, held in 2016, during the CLIMA 2016 Conference in the city of Aalborg in Denmark.

The first competition was organized by REHVA together with ASHRAE, SHASE, CCHVAC, SAREK and ISHRAE. Initially, it was planned that the competition would be held each three years, following the organization cycle of the CLIMA conference. However, due to the will of the partners to have it organized each year, after negotiations with EUROVENT, the competition sponsor, it was decided to rename the competition and organize it every year. In Sanmenxia, not all the partners were represented, since two of them had no time to organize the internal competitions and nominate their representatives. Thus, the competition run with students representing China (CCHVAC), Europe (REHVA), India (ISHRAE) and Korea (SAREK). The names of the participating students, as well as the titles of their respective works are shown in the table below.

The jury was chaired by Prof. **Manuel Gameiro da Silva**, representing REHVA, together with **Prof. Xianting Li**, representing CCHVAC, Prof. **C. Subramanian**, representing ISHRAE and Prof. **Hwataik Han**, representing SAREK.

Kristian Martin (left) represented Europe at the HVAC World Student Competition 2018 in China in October.

	First Name	Family Name	Title of Work	Supervisor / Institution	Partner / Zone
1	Xingru	Liu	Developing New Vapor Injection Technologies for Single Cylinder Rotary Compressor	Dr. Baolong Wang, Tsinghua University, Beijing	CCHVAC / China
2	Kristian	Martin	Demand Response of Heating and Ventilation within Educational Office Buildings	Dr. Risto Kosonen, Aalto University, Espoo	REHVA / Europe
3	Rana Veer	Pratap Singh	Performance Analysis of Solar Adsorption Chiller for Radiant Cooling Applications	Dr. Jyotirmay Mathur, Malaviya National Institute of Technology, Jaipur	ISHRAE / India
4	Ju-young Hye-im	Yun Lee	Study on personal air-conditioning system using model predict control and wearable device	Dr. Yujin Nam, Pusan National University	SAREK / South Korea

The students have previously submitted a 6 pages scientific paper about their work and delivered a 15 minutes oral presentation and a poster during the evaluation session. The grading process is based upon the following criteria: relevance and technical feasibility, clear statement of the objectives, used method(s), validity and reliability of the results, graphical quality of the paper, the presentation and the poster; ability to argument during the discussion. The result of the competition was according to the podium of next figure.

The Awards have been delivered on the 26th of October, during the Closing Ceremony of the CCHVAC 2018 Conference in session chaired by Prof. Manuel Gameiro da Silva and Mr. Erick Melquiond, the CEO of Eurovent.

The next HVAC World Student Competition will be held during CLIMA 2019, from 26 to 29 May in Bucharest. It is expected the presence of representatives of the associations that took a part at the competition in Sanmenxia, together with ASHRAE and SHASE. An invitation was also sent to FAIAR., who signed recently an MoU with REHVA. ■

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VDI

ÉTE Építéstudományi Egyesület

AiCARR Cultura e Tecnica per Energia Uomo e Ambiente

Latvijas Siltuma, Gāzes un Ūdens Tehnologijas Inženieru Savienība

LIŠTIA

AIIRM Asociația Inginerilor de Instalații din Republica Moldova

VVS-foreningen

PZITS

ORDEM DOS ENGENHEIROS

AFCR Asociația Frigotehniștilor și Criogeniștilor din România

AGFR www.agfro.ro The Romanian General Association of Refrigeration

AIIR Asociația Inginerilor de Instalații din Romania

ABOK

kgh

STP

SITHOK

Atecyr Asociación Técnica Española de Climatización y Refrigeración

ENERGI & MILJÖ Tekniska Föreningen

SWKI SICC SITC

TVVL Platform voor mens en techniek

Turkish Society of HVAC & Sanitary Engineers TTMD 1982 Turkey

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Send information of your event to Ms Chiara Girardi cg@rehva.eu

Events & fairs in 2019

Exhibitions 2019

14-16 January	AHR Expo	Atlanta, USA	www.ahrexpo.com
12-15 February	Aquatherm Moscow	Moscow, Russia	https://www.aquatherm-moscow.ru/en/
February 27 - March 1	WSED 2019	Wels, Austria	www.wsed.at/en
February 28 - March 2	ACREX 2019	Mumbai, India	www.acrex.in
5-7 March	Futurebuild	London, UK	www.futurebuild.co.uk
11-15 March	ISH 2019	Frankfurt, Germany,	www.ish.messefrankfurt.com
1-5 April	BET - Building Energy Technologies 2019	Berlin, Germany	
17-20 April	teskon+SODEX 2019	Izmir, Turkey	http://www.teskonsodex.com/en
6-8 May	ISH China & CIHE	Beijing, China	https://ishc-cihe.hk.messefrankfurt.com/beijing/en.html
3-5 September	ISH Shanghai & CIHE	Shanghai, China	https://www.hk.messefrankfurt.com/content/ishs_cihe/shanghai/en/visitors/welcome.html
2-5 October	ISK-SODEX 2019	Istanbul, Turkey	www.sodex.com.tr/en

Conferences and seminars 2019

1-2 February	ACIEQ - Asian Conference of Indoor Environmental Quality	New Delhi, India	www.acieq2019.org
13 February	Indoor Air Quality, Ventilation and Energy Conservation in Buildings AirVent. Conference	Moscow, Russia	
20-22 February	AiCARR 51st International Conference "The human dimension of building energy performance"	Venice, Italy	
27 February - 1 March	WSED 2019 - European Energy Efficiency Conference	Wels, Austria	www.wsed.at/en/programme/european-energy-efficiency-conference.html
27-28 March	AIVC workshop	Dublin, Ireland	
26-29 May	CLIMA 2019	Bucharest, Romania	www.clima2019.org/congress/
12-15 July	ISHVAC 2019 - 11th International Symposium of Heating, Ventilation and Air-Conditioning	Harbin, China	
2-4 September	Building Simulation 2019	Rome, Italy	www.buildingsimulation2019.org
5-7 September	IAQVEC 2019	Bari, Italy	www.iaqvec2019.org
26-28 September	Annual Meeting of VDI-Society for Civil Engineering and Building Services	Dresden, Germany	
15-16 October	AIVC 2019 Conference - From energy crisis to sustainable indoor climate	Ghent, Belgium	https://www.aivc2019conference.org/

Annex 71
SYMPOSIUM

The Building as the Cornerstone of our Future Energy Infrastructure
The importance of dynamic and real data for reliable assessment

10–11 April 2019, Bilbao, Spain

Invited speakers are international experts on seven selected topics:

1. *Measurement for validation (in-situ and real data)* – speaker TBC
2. *Building simulation for future urban energy systems (IBPSA)* – Nick Kelly – ESRU, UK
3. *Energy related standards – CEN/ISO* – Jaap Hogeling – EPB Centre, NL
4. *Renovation projects for buildings and cities (EPBD, EED and the building stock)*– César Valmaseda – CARTIF, ES
5. *Renewable Energy integration (CITIES)* – Henrik Madsen – DTU, DK
6. *Electric Vehicles integration (electrical storage)* – speaker TBC
7. *Urban dimension (from building to city modelling; CityGML)* – Volker Coors – HfT Stuttgart, DE

During a final panel discussion, these topics will be discussed with IEA–EBC Annex71.
These seven topics are introduced in a separate article that can be downloaded from www.dynastee.info

In the transition towards a new energy system, based on minimal carbon use and circular economy principles, the building is the cornerstone of the future energy infrastructure. Energy use in European buildings is still around 40 % of the total final energy use. Decarbonisation of power and heat are high on the agenda of EU Member States. Present initiatives by governments for a proper energy transition are based on reducing energy use, increased use of renewable energy resources and making the energy infrastructure more intelligent (SRI as mentioned in the EPBD). The citizen should become at the centre of the energy system; from passive consumers to engaged energy customers. For that purpose, digitisation is essential, enabling monitoring and control of optimised energy use for a comfortable living and working environment. The level of balancing between the building end-user and the climate is not often carefully considered. Also, the energy flow between buildings and the energy networks will become more and more multi-directional. Buildings will produce energy: electricity that is partly delivered to the grid, and heat that is stored in the building or underground. The near future may see more self-consumption in buildings, including the electricity stored in electric cars. One may conclude that buildings in which presently 40% of final energy is used, will take a more prominent position in the energy infrastructure. Seven invited experts will present the challenges and innovation aspects that may facilitate the energy transition.

The symposium runs from Wednesday noon till Thursday noon. It is organised in the frame of the IEA-EBC Annex71 6th Expert meeting Spring 2019 in Bilbao.

Registration form and practical information can be downloaded from www.dynastee.info

CLIMA 2019
Built environment facing climate change
REHVA 13th HVAC World Congress
26 - 29 May, Bucharest, Romania

The first set of CLIMA 2019 Workshops announced!

CLIMA 2019 continues with the longstanding tradition to offer several practical, interactive workshops beside the plenary paper sessions. The workshops are organised by REHVA and its international sister associations, European research and innovation projects, as well as REHVA supporter companies representing leading HVAC manufactures and service providers. We are happy to announce the first set of interesting workshops awaiting our CLIMA 2019 participants.

Title: NZEB concepts in Europe and Japan

Organisers: REHVA & SHASE

Chairs: Jarek Kurnitski, REHVA; Gyuyoung Yoon, SHASE

Speakers: Jarek Kurnitski, REHVA and Gyuyoung Yoon, SHASE (Chairs); Hideharu Niwa, SHASE

Short description: Recent developments of nearly zero and zero energy requirements in EU and Japan are discussed and possibilities to benchmark NZEB performance levels in different climates and countries will be analysed in more general. The aim is to show how energy performance requirements are set and how these can be compared so that climatic differences, national input data and calculation rules are taken into account.

Title: Evidence-based ventilation needs and development process of future standards

Organiser: REHVA & ISIAQ

Chairs: Jarek Kurnitski, REHVA; Pawel Wargocki, ISIAQ

Speakers: Jarek Kurnitski, REHVA and Pawel Wargocki, ISIAQ; Bjarne Olesen, William Bahnfleth

Short description: Recent research findings, their interpretation and meaning for ventilation system sizing is discussed with the aim to establish evidence-based design criteria of ventilation rates for residential and non-residential buildings. The workshop attempts to summarize existing evidence, possible knowledge gaps and to specify further actions what are needed to implement evidence-based ventilation rate values into future indoor climate standards such as EN 16798-1:2019 and possibly some other ventilation standards.

Title: Dissemination and roll-out of the set of EPB standards. Asking feedback from practitioners

Organiser: REHVA & EPB Center

Chairs: Jaap Hogeling, Dick van Dijk

Short description: The EPB Center (www.epb.center) has been set up to support the uptake of the (CEN and CEN ISO) Energy Performance of Buildings standards developed under EC Mandate M/480, by providing tailored information, technical assistance and capacity building services for involved stakeholders. The purpose of this workshop is to inform the participants about the ongoing activities, more importantly to interact and obtain feedback from professionals involved or interested in the EPB assessment and in the implementation of the related articles of the recently revised EPBD.

Title: From regular inspection to BACS supported HVAC system technical monitoring, commissioning and certification

Organiser: REHVA & eu.bac

Chairs: Atze Boerstra, REHVA; Peter Hug, eu.bac

Speakers: DG ENERGY (tbc); Bonnie Brooks - Siemens/eu.bac; Stefan Plesser, synavision; Cormac Ryan, CoPilot

Short description: This workshop will present the wide spectrum of tools supported by BACS to improve and optimize HVAC systems' performance and make it transparent to building owners and operators. Speakers will present requirements of the revised EPBD, discuss the role of BACS in ongoing commissioning with outlook to the future, present BACS supported technical monitoring tools and introduce the COPILOT commissioning certification scheme developed with contribution of REHVA Member Associations and other partners.

Title: Towards optimized performance, design, and comfort in hybridGEOTABS buildings

Organiser: hybridGEOTABS

Chair: Lieve Helsen, KULeuven

Speakers: Lieve Helsen, KULeuven; Eline Himpe, UGent; Ongun Berk Kazanci, DTU; Qian Wang, Uponor/KTH; Wim Boydens, Boydens Engineering.

Short description: HybridGEOTABS refers to the integration of GEOTABS (Geothermal heat pumps in combination with Thermally Activated Building Systems) with secondary heating and cooling systems. This technology offers huge potential to meet heating and cooling needs throughout Europe in a sustainable way, while providing a very comfortable conditioning of the indoor space. This workshop, organized by hybridGEOTABS H2020 project, will discuss the effects of radiant heating and cooling systems on IEQ, as well as the proper design of hybridGEOTABS buildings.

Title: Building commissioning in Europe

Organiser: QUANTUM

Chairs: Stefan Plesser, Ole Teisen

Speakers: Stefan Plesser, IGS TU Braunschweig; Jan Mehnert, IGS; Ole Teisen, Sweco; Margot Grim, E7; Cormac Ryan, CoPilot

Short description: New buildings and deep retrofits with their sophisticated systems for heating, cooling and air conditioning are rather complicated technical systems. Especially, building automation and control systems have added complexity to building projects. As a consequence, the performance gap appeared. Quality management, a process of supporting the fulfilment of requirements, can solve this problem. The workshop will present the current stage of quality management for building performance. This workshop is part of the H2020 project '*QUANTUM - Quality management for building performance*'.

Title: Why people matter? Exploitation strategies for people-centred design

Organiser: TripleA-reno & MOBISTYLE projects

Chair: Dr. Simona D'Oca, Huygen Engineers & Consultants

Speakers: Dr. Simona D'Oca, Huygen Engineers & Consultants; Dr. Dan Podjed, Institute for Innovation and Development of the University of Ljubljana; Ana Tisov, Huygen Engineers & Consultants

Short description: the workshop is organised by the H2020 projects TripleA-reno and MOBISTYLE, which both adopted a people-centred approach to improve the performance of the European building stock reaching beyond the focus on technology-driven solutions. The workshop will introduce the TripleA-reno and MOBISTYLE open ICT solutions, followed by a dynamic interactive brainstorm session around the following questions: What problems can the gamified platforms and ICT solutions solve for the engineering branch? Why these open platforms are better than the existing ones? What results these projects offer for engineers and manufacturers? Who are the users of these innovative solutions and how can we better deliver the tools to them?

Title: The Power of the Cloud

Organiser: Belimo Automation AG

Chairs: Dr. Marc Thuillard

Speakers: Dr. Marc Thuillard, Dipl. Ing. Marc Steiner, Dipl. Ing. Forest Reider

Short description: This workshop presents how the power of the cloud can benefit the HVAC industry, by facilitating the exchange of information between stakeholders, it can affect the entire lifecycle of a building. The design, commissioning, operation and maintenance can leverage the cloud as a medium to store and share information, configure and monitor devices, and provide a gateway to integrate technologies. It provides a medium for transparency, intelligent monitoring, and optimization.

Title: The Value of Good Performance - How High-Performance Buildings Protect the Asset value and Increase your Bottom Line

Organiser: BRE- Building Research Establishment (BRE) UK Ltd.

Sponsor: BRE Global

Speakers: Dr. Andy Lewry and James Fisher, presenters of case studies (TBC)

Short description: The discussion would address questions such as: we have the ability to design good buildings and the knowledge to operate them in an effective and efficient manner – so why doesn't it happen? Why doesn't the design feed through to performance-in-use? "The performance gap", with increased energy usage of between 200-450%: what are causes and how can this be remedied? What is the effect on the asset and its value from poor performance? The second session will be a showcase for high performance buildings in Romania – Where 4 cases where presented and then the discussion on how the sustainable performance and certification was achieved.

CLIMA 2019 - Important dates and deadlines

Registration opening	December 1st 2018
Deadline for full paper submission	December 31st 2018
Deadline for early registration	February 1st 2019
REHVA Annual Meeting	May 24-26 2019
REHVA World Congress CLIMA 2019 & Exhibition	May 26-29 2019
Additional social programme	May 29-31 2019

You can find more details on the event website www.clima2019.org or ask for more information at our e-desk: info@clima2019.org.

International Conference

World Sustainable Energy Days **2019**

27 February - 1 March 2019
WELS, AUSTRIA

CONFERENCES:

- European Energy Efficiency Conference
- European Pellet Conference
- Young Energy Researchers Conference
- Energy Efficiency Policy Conference
- Innovation Workshops Energy and Buildings
- Smart E-Mobility Conference
- Industrial Energy Efficiency Conference
- Energy Efficiency Economy Workshop
- Tradeshow "Energiesparmesse"
- Technical Site Visits
- Poster Presentation

WWW.WSED.AT

Energy efficiency and renewable energy are at the core of Europe's commitment to a clean energy transition that serves the needs of citizens, economic development and the environment.

Achieving a smart, socially fair and sustainable energy system requires strong policies, competitive businesses and technology innovation. Mastering the digital transformation of energy and buildings will be crucial for creating a thriving economy and for the success of the global clean energy transition.

The World Sustainable Energy Days 2019, one of Europe's largest annual conferences in its field, connect people and empower them to embrace the necessary change according to the motto: **Clean. Competitive. Connected.**

The conference brings together more than 650 delegates from over 50 countries from business, the research community and the public sector.

The next edition will be held from **27 February – 1 March 2019 in Wels/Austria.** The event will feature policies, technologies, innovation and market development.

The conference is held in parallel with the Energiesparmesse, a major tradeshow on energy efficiency and renewable energy, with more than 1,600 exhibitors and 100,000 visitors annually.

Mark your calendars and come join us at the **World Sustainable Energy Days!**

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World Sustainable Energy Days 2019

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EUROPEAN GUIDEBOOKS

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No.01: DISPLACEMENT VENTILATION IN NON-INDUSTRIAL PREMISES

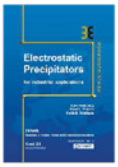
Håkon Skistad (ed.)

Elisabeth Mundt, Peter V. Nielsen, Kim Hagström, Jorma Railio

No.02: VENTILATION EFFECTIVENESS

Elisabeth Mundt (ed.)

Hans Martin Mathisen, Peter V. Nielsen, Alfred Moser



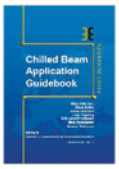
No.03: ELECTROSTATIC PRECIPITATORS FOR INDUSTRIAL APPLICATIONS

Kjell Porle (ed.)

Steve L. Francis, Keith M. Bradburn

No.04: VENTILATION AND SMOKING

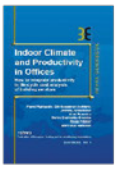
Håkon Skistad, Ben Bronsema (eds.)



No.05: CHILLED BEAM APPLICATION GUIDEBOOK

Majia Virta (ed.)

David Butler, Jonas Gräslund, Jaap Hogeling, Erik Lund Kristiansen, Mika Reinikainen, Gunnar Svensson



No.06: INDOOR CLIMATE AND PRODUCTIVITY IN OFFICES

Pawel Wargocki, Olli Seppänen (eds.)

Johnny Andersson, Atze Boerstra, Derek Clements-Croome, Klaus Fitzner, Sten Olaf Hanssen

No.07: LOW TEMPERATURE HEATING AND HIGH TEMPERATURE COOLING

Jan Babiak, Bjarne W. Olesen, Dušan Petráš

No.08: CLEANLINESS OF VENTILATION SYSTEM

Pertti Pasanen (ed.)

Birgit Müller, Rauno Holopainen, Jorma Railio, Harry Ripatti, Olle Berglund, Kimmo Haapalainen

No.09: HYGIENE REQUIREMENT FOR VENTILATION AND AIR CONDITIONING

Based on VDI 6022

No.10: COMPUTATIONAL FLUID DYNAMICS IN VENTILATION DESIGN

Peter V. Nielsen (ed.)

Francis Allard, Hazim B. Awbi, Lars Davidson, Alois Schälin

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Jan Gustavsson (ed.)

Alain Ginestet, Paolo Tronville, Marko Hyttinen

No.12: SOLAR SHADING

Wouter Beck (ed.)

Dick Dolmans, Gonzague Dutoo, Anders Hall, Olli Seppänen

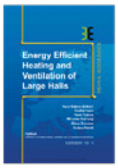
No.13: INDOOR ENVIRONMENT AND ENERGY EFFICIENCY IN SCHOOLS - PART 1 PRINCIPLES

Francesca R. d'Ambrosio Alfano (ed.)

Laura Bellia, Atze Boerstra, Froukje van Dijken, Elvira Ianniello, Gino Lopardo, Francesco Minichiello, Piercarlo Romagnoni, Manuel C. Gameiro da Silva

No.14: INDOOR CLIMATE QUALITY ASSESSMENT

Stefano P. Corgnati, Manuel C. Gameiro da Silva (eds.)



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

Karel Kabele (ed.)

Ondřej Hojer, Miroslav Kotrbatý, Klaus Sommer, Dušan Petráš

No.16: HVAC IN SUSTAINABLE OFFICE BUILDINGS

Majia Virta (ed.)

Frank Hovorka, Andrei Litiu, Jarek Kurnitski

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

Nejc Brelih (ed.)

Olli Seppänen, Thore Bertilsson, Mari-Lii Maripuu, Hervé Lamy, Alex Vanden Borre

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

Sergio La Mura, Cesare M. Joppolo, Luca A. Piterà (eds.)

Jean Pierre Angermann, Mark Izard

No.19: MIXING VENTILATION

Dirk Müller (ed.)

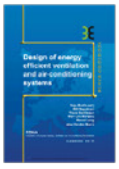
Claudia Kandzia, Risto Kosonen, Arsen K. Melikov, Peter V. Nielsen

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

Franziska Bockelmann, Stefan Plesser, Hanna Soldaty

No.21: ACTIVE AND PASSIVE BEAM APPLICATION DESIGN GUIDE

REHVA-ASHRAE joint publication



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

Andrei Litiu (ed.)

Bonnie Brook, Stefano P. Corgnati, Simona D'Oca, Valentina Fabi, Markus Keel, Hans Kranz, Jarek Kurnitski, Peter Schoenenberger, Roland Ullman

No.23: DISPLACEMENT VENTILATION

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Arsen K. Melikov, Elisabeth Mundt, Panu Mustakallio, Peter V. Nielsen

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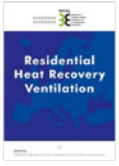

No.25: RESIDENTIAL HEAT RECOVERY VENTILATION

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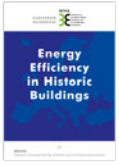

No.26: ENERGY EFFICIENCY IN HISTORIC BUILDINGS

Francesca R. d'Ambrosio Alfano, Livio Mazzarella (eds.)

REHVA Office 40 Rue Washington 1050 Brussels - Belgium |
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