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REHVA

Federation of European Heating, Ventilation and Air Conditioning Associations

The REHVA European HVAC Journal

Volume: 50 Issue: 3 May 2013 www.rehva.eu

Special issue on Active House Alliance

Environmental specifications

Residential ventilation

Cost optimal methodology

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EU new boiler regulations

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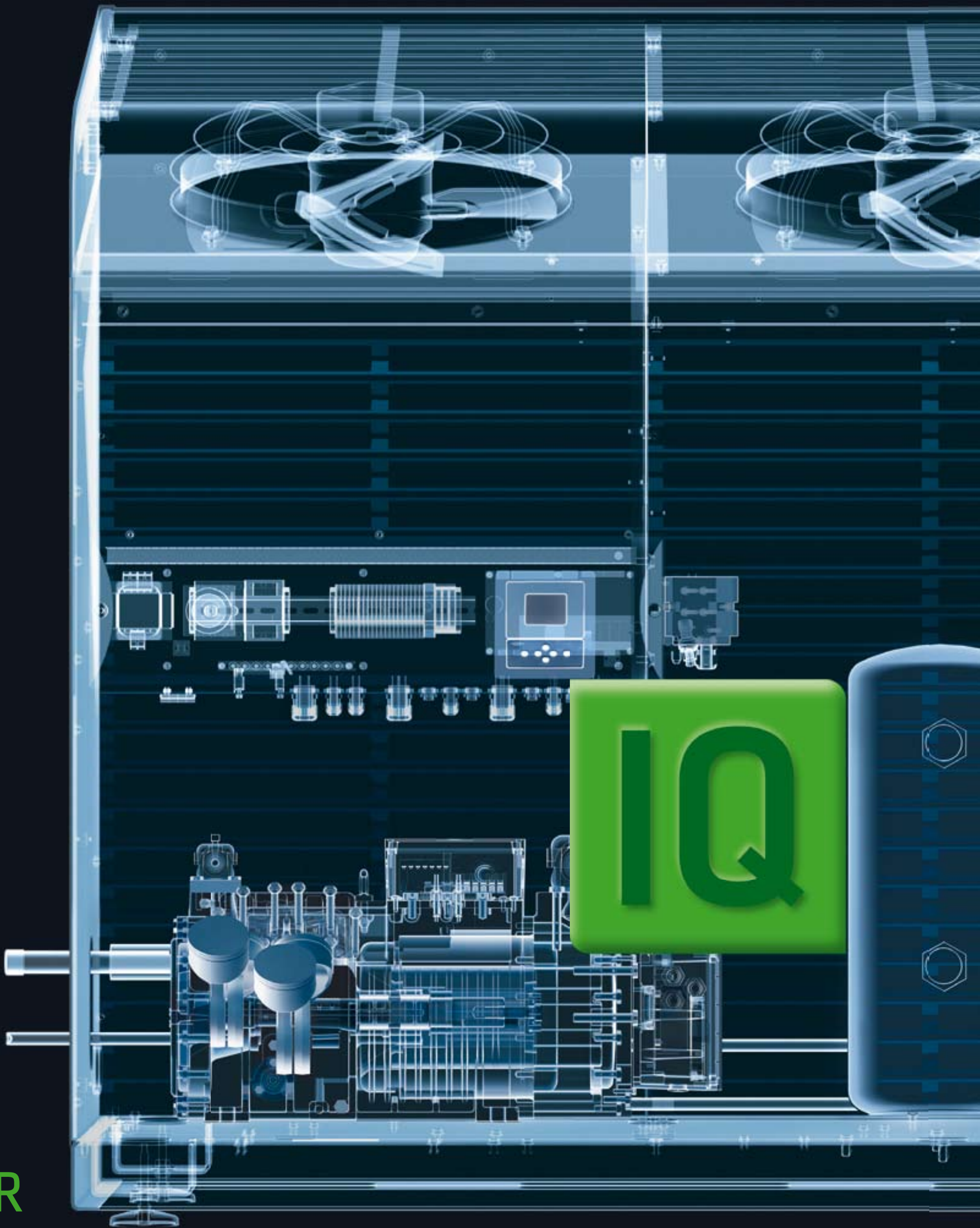

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Cover photo: Green Lighthouse, Denmark's first CO_2 neutral public building located at the Faculty of Science at the University of Copenhagen, Photo by Adam Mørk.

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Editorial

OLLI SEPPÄNEN
Professor,
Editor-in-chief

This is a special year for REHVA. The organisation celebrates its 50th anniversary, and holds its 11th World Conference Clima 2013. When founded, REHVA was more like a club where representatives of national member associations were able to meet and exchange news and learn from the experiences of each other. But the world is changing. Particularly during the last 10 years REHVA has changed its strategy and developed activities towards a strong influential technical organisation with close connections to the industry and European bodies and authorities. REHVA is now more than ever dedicated to the improvement of health, comfort and energy efficiency in all buildings and communities.

Clima 2013 is not any more European but more and more an international conference with hundreds of papers presented from all over the world. International exchange of information is important. The problems related to sustainable buildings are global, but though the solutions are local, there is a lot to be learnt from other continents.

The REHVA Word Conference offers a platform for industry and academicians for fruitful communication. REHVA has organised special workshops for this communication at Clima Conferences since Clima 2001 in Naples, Italy. The workshops have been successful and the participants have found them useful. The work in these workshops has resulted in many good ideas and topics for future development. The results of the workshop will be available soon after the conference from REHVA.

The REHVA Journal has found its role as a publication with technical articles with scientific background but focusing on practical applications. The readers are practitioners from the building and manufacturing industries, as well as academicians from education and research. A recent survey shows that 80 % of our readers rated the REHVA Journal and its technical coverage as excellent or good, and found the technical articles and case studies as the most interesting contents of the Journal. Last year, the Journal published articles from academicians and practitioners from more than 20 countries. The Journal also follows up what is going on in the area of the European legislation. The articles in this issue deal with the new boiler regulations based on eco-design directive, guidelines for cost-optimal methodology for building regulations and definition of nearly zero energy buildings.

The Journal is also available for readers at the REHVA website. All articles are available for download in html and pdf formats. The Journal website is getting more and more visitors. The number of visitors doubled from 2011 to 2012. Over 50 000 articles were downloaded in 2012. The survey also shows that subscribers use both the paper copy and the web version.

This issue focuses on an international network "Active House Alliance", which is a group of international companies who supports the development of buildings that create healthier and more comfortable lives for their residents without impacting negatively on the climate and environment. It is their ambition that Active House becomes the future principle for new buildings and renovation. The articles summarise the vision behind Active House and the specifications for Active House, and suggest them as one solution to nearly zero-energy buildings. Other articles reports some results of the Alliance members in developing buildings, systems and products to meet the established goals.

Cooperation is needed between research and practice. It is important that scientists focus on solutions to real problems so that the limited resources are used optimally. For the industry, it is important to base future development and investments on reliable research results. Articles in this issue show how fruitful the cooperation between industry and research organisations can be, especially when installing and monitoring buildings with innovative design and technical systems. The Active House Alliance has been successful in this cooperation between developers, industry and research. ■

Articles

Active House Alliance

– a network for development of sustainable buildings

The Active House Alliance has been established with an ambition to create a viable, independent and international influential alliance, which supports the vision of buildings that create healthier and more comfortable lives for their residents without impacting negatively on the climate and environment. The alliance includes the whole supply chain in the construction sector from manufacturers to architects, engineers, builders and investors, to research institutes, universities and branch organisations. The alliance has developed specifications and tools for active houses and the members are involved in demonstration projects, knowledge sharing, webinars, etc. The wish of the members is that Active House becomes the future principle for new buildings and renovation.

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Objectives of Active House Alliance

The background for the development of Active House and an Active House Alliance is the political focus on reduction of CO_2 emissions and the security of supply. The political focus forces the construction sector to build very low energy buildings throughout the world and to build Nearly Zero-Energy Buildings in EU member states by the end of 2020 (End of 2018 for public buildings).

The members of the alliance recognise this ambition for energy efficient and CO_2 neutral buildings and agree that it is possible to reach the ambition with the technology available today, it is a question of optimizing the design of the building as well as sharing knowledge and experience in the sector.

As people spend 90% of their time inside buildings, it is important to focus on human health and the need for ambitious requirements for comfort in buildings. Therefore the members agreed to develop a vision for buildings that focus on humans need and to build from there.

The global resources are limited and the amount of waste keeps increasing. Therefore the members also agree that an environmental focus is highly needed and it includes more than just traditional LCA analyses of products, it needs to move towards a view on the building and the use of, for example water. A topic that all agree will be a future challenges.

The above encouraged the alliance to develop the Active House Vision, which is based on a holistic view on Comfort, Energy and Environment. It is a vision of buildings that create healthier and more comfortable lives for their occupants without impacting negatively on the climate – moving us towards a cleaner, healthier and safer world (**Figure 1**).

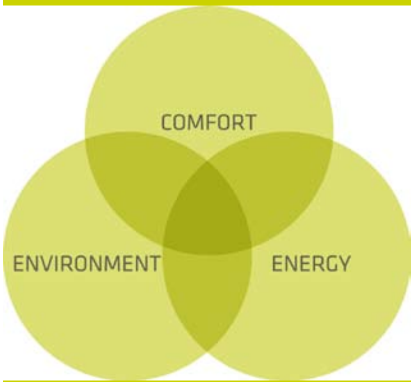
The Active House Alliance

The Active House Alliance is an alliance with representatives from the whole supply chain for the construction sector. The alliance has the ambition to create a viable, independent and international influential alliance, which supports the vision of buildings that create healthier and more comfortable lives for their residents without impacting negatively on the climate and environment.

The alliance focuses on the development of future sustainable buildings worldwide and it includes activities like demonstration projects, specifications and tools for evaluation of buildings, communication activities like organizing conferences, participating with posters and oral presentation at international fairs and conferences, and knowledge sharing activities like workgroups, workshops and webinars for members.

One of the main positions of the alliance is that sustainability has to be integrated into the design of the building already at the start of a project, from the first meeting between the investor, client and the architects. It is in this phase that one can optimize the building without much higher costs than for standard solutions. The design and construction process of buildings also includes involvement of engineers and builders and these sectors

ACTIVE HOUSE is a vision of buildings that create healthier and more comfortable lives for their occupants without negative impact on the climate – moving us towards a cleaner, healthier and safer world.



COMFORT
- Creates a healthier and more comfortable life for the occupants.
An Active House creates healthier and more comfortable indoor conditions for the occupants and the building ensures generous supply of daylight and fresh air. Materials used have a positive impact on comfort and indoor climate.

ENERGY
- Contributes positively to the energy balance of the building.
An Active House is energy efficient and all energy needed is supplied by renewable energy sources integrated in the building or from the nearby collective energy system and electricity grid.

ENVIRONMENT
- Has a positive impact on the environment.
An Active House interacts positively with the environment by means of an optimised relationship with the local context, focused use of resources, and on its overall environmental impact throughout its life cycle.

Figure 1. The Active House Vision.

are extremely important to include early in the process for the development of sustainable buildings. It is also important to involve manufactures into the process as early as possible as manufacturers have knowledge about use of their solutions and how to integrate these in a sustainable design process. Such knowledge includes a wide range of technologies from bricks, insulation materials, glass, to solutions based on use of natural ventilation, daylight, shading and renewable energy integrated in the design, and technical systems, including the management and intelligent control of the building.

Another position of the alliance is that the knowledge gained from the many demonstration projects throughout the world, from Active Houses as well as other visions, need to be gathered and shared within the construction sector. Several universities participated in the establishment of the alliance and therefore the alliance also focuses on development of the national and international network with and between institutes, universities and branch organizations.

Active House Alliance activities and work groups

The alliance develops its activities across the sectors, by engaging an open dialogue between partners, sharing knowledge and ensuring a close cross-sectoral collaboration to enhance visibility and development. The work is carried out within the alliance in three subgroups; knowledge sharing, specification and demonstration, communication (**Figure 2**).

The knowledge sharing group organises workshops for its members such as webinars regarding the development of the new specifications and tools to evaluate Active House projects. The workshops are announced on the active house homepage.

The ***specification and demonstration work group*** developed the new specifications and will in the future focus on development of tools as well as specifications for non-domestic buildings. The work with demonstration projects has among others included projects in USA, Canada, Austria, France, Germany, Netherland, Russia, Norway and Denmark.

The communication workgroup has developed the Active House website homepage and has organized several symposiums. The group also coordinates other activities like the participation at conferences with papers, posters, presentations and other promotional material.

Active House Specifications

The guideline to construct and evaluate domestic building as active houses is described in the Active House Specifications. The specifications were developed by members of the alliance, who have shared knowledge, experiences and feedback from demonstration projects and used it to develop the second edition, published April 2013 (**Figure 3**). The specifications are described in more details in the next article by Eriksen et al.

The specification were developed using an open source model, involving online debates and contributions as well as workshops with broad participation across the building industry globally. The new edition has been substantially improved, especially in terms of usability. The specifications are described in more in detail in a later article in this edition of the REHVA Journal.

Active House demonstration projects

Several projects have already proven the philosophy of Active House.

	Objectives	Activities and Deliverables
Knowledge Sharing	Leverage existing knowledge through strong alliance and facilitate cross-sector working groups.	• Annual general assembly • Topic based workshops for members • Training and webinars
Specification and demonstration	Create new knowledge, describe, illustrate and demonstrate the opportunities and attractiveness of Active Houses.	• Active House Specifications for residential and non-residential buildings • Simple evaluation scheme of buildings • Demonstration buildings • Catalogue of design patterns and cases • Design and Assessment Tools
Communication	Influence positively on the full supply chain in the construction sector, politicians and legislators.	• Communicate with building users and specifiers • External conferences and symposiums • Training and webinars for specifiers • Influence positively on codes and legislation

Figure 2. Workgroup activities.

The two latest projects were developed in the USA and the Netherlands.

Smith Residence is the project in USA (**Figure 4**). It is a newly built project which was developed with partners of the alliance and the family planning to live there. The project is situated in the center of the United States in a historic and bustling suburb located 15 minutes away from downtown St. Louis, MO. Because of its location in a mixed climate region, the home is designed to meet both warm and cold climate needs.

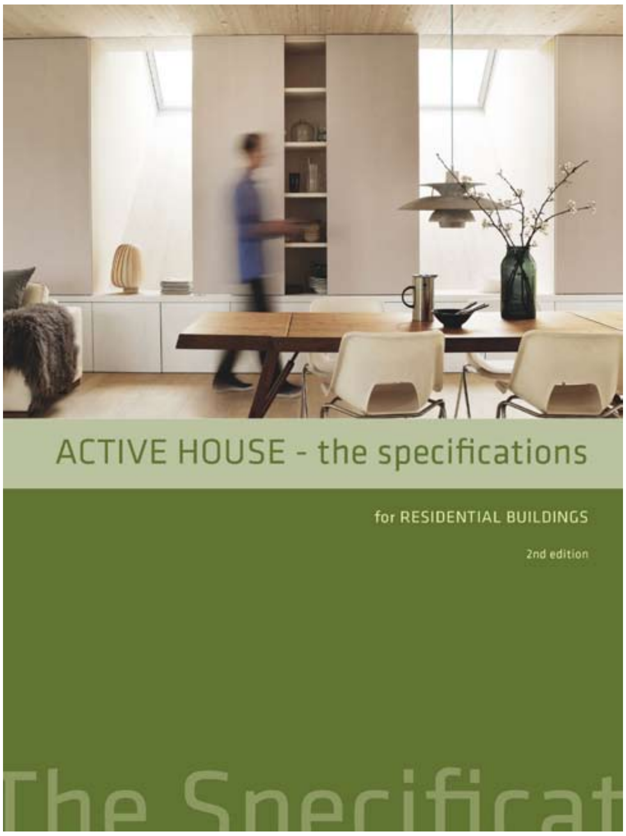


Figure 3. Cover of the booklet Active House Specification – see the contents in the next article by Eriksen at al.

Once the Smith family moves into the home, the University of Missouri Energy Efficiency Research Consortium and the Active House Alliance will monitor the project in order to provide anecdotal and statistical metrics to help assist with further research and development of green building standards in the US and abroad.

Montfoort Active House in Netherland (**Figure 5**) is a renovation of 10 row houses in Burghers Street, Montfoort, which all were upgraded to A++ in the Dutch energy label scheme for buildings.

By the use of a sustainable concept, based on the principles of Active House the homes have been renovated in a good balance between comfort, energy design and environment. Hereby the total energy demand and CO_2 emissions of the 40 year old houses have been reduced dramatically. In order to support the comfort and health of the residents in these homes, the interior design has been optimized with better access to daylight and fresh air.

Next steps

The alliance will continue developing the insights acquired in the first years and participate in relevant projects and create a platform for knowledge sharing for members and authorities.

The short term steps will focus on the further development on international and national level. It will include the establishment of national activities and where relevant, by engaging national ambassadors for the alliance.

Figure 4. "Smith Residence" - Active House project in USA.

Figure 5. Montfoort Active House in Netherland.

It will also include focus on the international activities and will, where possible, work towards integration of the Active House vision in strategies for sustainable buildings and implementation of nearly zero-energy buildings.

New partners are welcomed to contribute to the development and to get involved in the alliance. The development can be followed on the web page www.activehouse.info. ■

activehouse.INFO
NETWORK AND KNOWLEDGE SHARING

Active House Alliance

Members of the Active House Alliance includes architects, engineers manufacturers, builders, universities, research and branch organizations.

The ambition for the Active House Alliance is, in the common interest of its members, to create a viable, independent and international influential alliance.

Our wish is that Active House becomes the future principle for new buildings and renovation, worldwide.

www.activehouse.info.

Active House Specification

– evaluation of comfort, energy and environment in buildings

The article outlines the specifications for designing an Active House, a building that combines energy efficiency with specific attention to user comfort, indoor climate and the environment. The scope of the specifications is residential buildings. The specification outlines the vision behind Active House, lays down the key principles that have influenced the evolution of the Active House concept and outlines the technical specifications of an Active House. This definition and description of an Active House is intended as a guideline at an international level, and can be used as a tool for designing nearly zero energy buildings. It seeks innovative technical approaches whilst introducing goals of architectural quality and environmental design – at the same time as providing energy efficiency.

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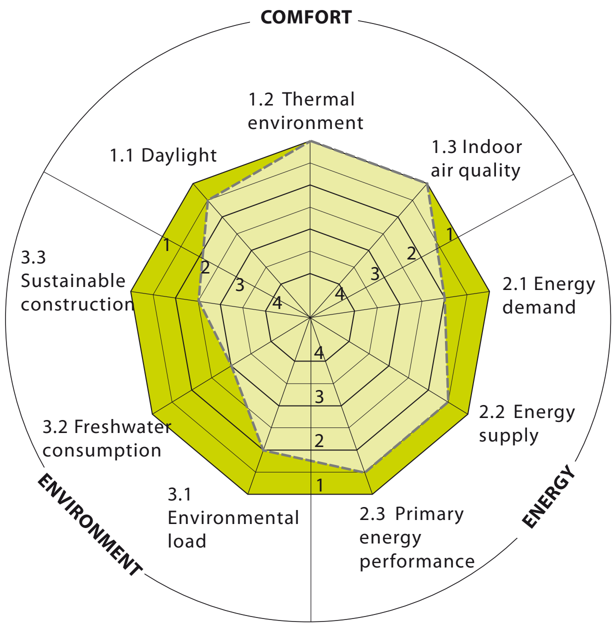

Figure 1 Active House Radar.

Active House Specifications

Members of the Active House Alliance and other experts have participated in the development of the Active House Specification. They have shared knowledge, experiences and feedback on their experience with development of energy efficient sustainable buildings, in order to develop this second edition. The new edition has been substantially improved, especially in terms of usability.

The specifications include the insight and knowledge needed to draw up the technical requirements and design concept for an Active House. The specifications include the important issues to consider when creating an Active House. These issues are often process oriented, some provide guidance on how to achieve the performance levels described in the technical specifications, and some describe the holistic approach of the design (biodiversity, local culture and location).

An Active House is finally evaluated on the integration the three main principles of Comfort, Energy and Environment. The performance can be described through the Active House Radar (**Figure 1**) showing the level of ambition of each of the three main Active House principles and their sub-parameters.

The integration of each parameter describes the level of ambition of how 'active' the building has become. For a building to be considered as an Active House, the level of ambition can be quantified into four levels where 1 is the highest level and 4 is the lowest. The ambitious requirement for Active House includes all nine parameters and recommends the best level for each of them. As long as the parameters are better than or equal to the lowest level of ambition, it is an Active House within the specific parameter.

Comfort

An Active House is a building that lets in an abundant amount of daylight and fresh air, thereby improving the quality of the indoor climate. Also the thermal indoor environment must be high quality.

As people spend 90% of their time indoors, the quality of the indoor climate has a considerable impact on their health and comfort. A good indoor climate is therefore a key quality of an Active House. Comfort must be an integrated part of the house design to ensure good daylight conditions, thermal environment and indoor air quality. To support this process, the parameters in the specifications must be considered.

Daylight

Adequate lighting and especially well-designed daylight penetration provide an array of health benefits to people in buildings. High levels of daylight and an optimal view out of the building positively influence people's mood and well-being. In an Active House it is thus important that the building allows for optimal daylight and attractive views to the outside.

Classification of daylight (classification is an average of the two requirements).

DAYLIGHT FACTOR: The amount of daylight in a room is evaluated through average daylight factor levels on a horizontal work plane:

1. DF > 5% on average
2. DF > 3% on average
3. DF > 2% on average
4. DF > 1% on average

Daylight factors are calculated using a Validated daylight simulation program.

DIRECT SUNLIGHT AVAILABILITY: For minimum one of the main habitable rooms, sunlight provision should be available between autumn and spring equinox:

1. At least 10% of probable sunlight hours
2. At least 7.5% of probable sunlight hours
3. At least 5% of probable sunlight hours
4. At least 2.5% of probable sunlight hours

The evaluation is made according to British Standard BS 8206-2:2008 "Lighting for buildings – Part 2: Code of practice for daylight".

Thermal environment

A pleasant thermal indoor environment is essential for a comfortable home. Adequate thermal comfort, both in summer and winter, enhaces the mood and increases the well-being. Active Houses should minimise overheating in summer and optimise indoor temperatures in winter without unnecessary energy use. Where possible, use simple, energy-efficient and easily maintained solutions.

Classification of thermal comfort (classification is an average of the two requirements).

THE MAXIMUM INDOOR TEMPERATURE limits apply in periods with an outside Trm of 12°C or more. For living rooms, kitchens, study rooms, bedrooms etc. in dwellings without mechanical air conditioning and with adequate opportunities for natural (cross or stack) ventilation, the maximum indoor operative temperatures are:

1. $T_{i,o} < 0.33 \times T_{rm} + 20.8$°C
2. $T_{i,o} < 0.33 \times T_{rm} + 21.8$°C
3. $T_{i,o} < 0.33 \times T_{rm} + 22.8$°C
4. $T_{i,o} < 0.33 \times T_{rm} + 23.8$°C

Trm is the Running Mean outdoor temperature as defined in Section 3.11 External temperature, running mean of EN 15251:2007'.

For living rooms etc. in residential buildings with air conditioning, the maximum operative temperatures are:

1. $T_{i,o} < 25.5$°C
2. $T_{i,o} < 26$°C
3. $T_{i,o} < 27$°C
4. $T_{i,o} < 28$°C

Reference: EN 15251:2007.

THE MINIMUM INDOOR TEMPERATURE limits apply in periods with an outside Trm of 12°C or less. For living rooms, kitchens, study rooms, bedrooms etc. in dwellings, the minimum operative temperatures are:

1. $T_{i,o} > 21$°C
2. $T_{i,o} > 20$°C
3. $T_{i,o} > 19$°C
4. $T_{i,o} > 18$°C

Indoor air quality

Active Houses should provide good air quality for the occupants while minimising energy use e.g. for ventilation. This means that natural ventilation should be used whenever possible, or hybrid systems (combination of natural and mechanical ventilation) as these systems provide the best energy performance. Active Houses should provide good indoor humidity levels for occupied spaces and set maximum requirements for indoor humidity. To avoid problems related to dampness and mould, it shall be guaranteed that there is sufficient exhaust ventilation in rooms with periodic high humidity loads (especially kitchens, bathrooms and toilets). The minimum exhaust air flow in these 'wet rooms' should be achievable as specified in national building codes or guidelines and the exhaust systems shall secure that the daily limit value for relative humidity in wet rooms such as bathrooms is below 80%.

Classification of indoor air quality

The fresh air supply shall be established according to the below limit values for indoor CO_2 concentration in living rooms, bedrooms, study rooms and other rooms with people as the dominant source and that are occupied for prolonged periods:

1. 500 ppm above outdoor CO_2 concentration
2. 750 ppm above outdoor CO_2 concentration
3. 1000 ppm above outdoor CO_2 concentration
4. 1200 ppm above outdoor CO_2 concentration

Energy

Globally, heating, cooling and electricity in buildings account for 40% of all energy consumption. Considering the total energy consumption throughout the whole lifecycle of a building, the energy performance and energy supply are important issues in the concern about climate changes, reliability of supply and reduced global energy consumption.

The design of an Active House has to be based on the Trias Energetica approach to sustainable design, focusing on the energy demand, integration of renewable energy and primary energy performance (**Figure 2**).

Energy demand

In an Active House the annual energy demand is minimized and the design phase must put focus on minimising the use of energy and heat loss from the building. This includes the transmission loss through constructions, thermal bridges etc. It is crucial to adopt a holistic approach to the use of energy. This means, for example, that an Active House should be optimised with maximum use of solutions that are not energy intensive. Such solutions could be solar gain, daylight, natural ventilation, ventilative cooling etc. This approach is also important in regards to the need for cooling of the building. Shading of exposed facades and windows shall be established either as permanent summer shading or dynamic shading, such as intelligent insulation of glazed facades.

Classification annual energy demand

An Active House is calculated by including all the energy demand for the building (including space and water heating, ventilation, air conditioning and cooling, technical installations and lighting).

1. ≤ 40 kWh/m²
2. ≤ 60 kWh/m²
3. ≤ 80 kWh/m²
4. ≤ 120 kWh/m²

The calculation methodology and definition of the heated floor area shall follow the national definition.

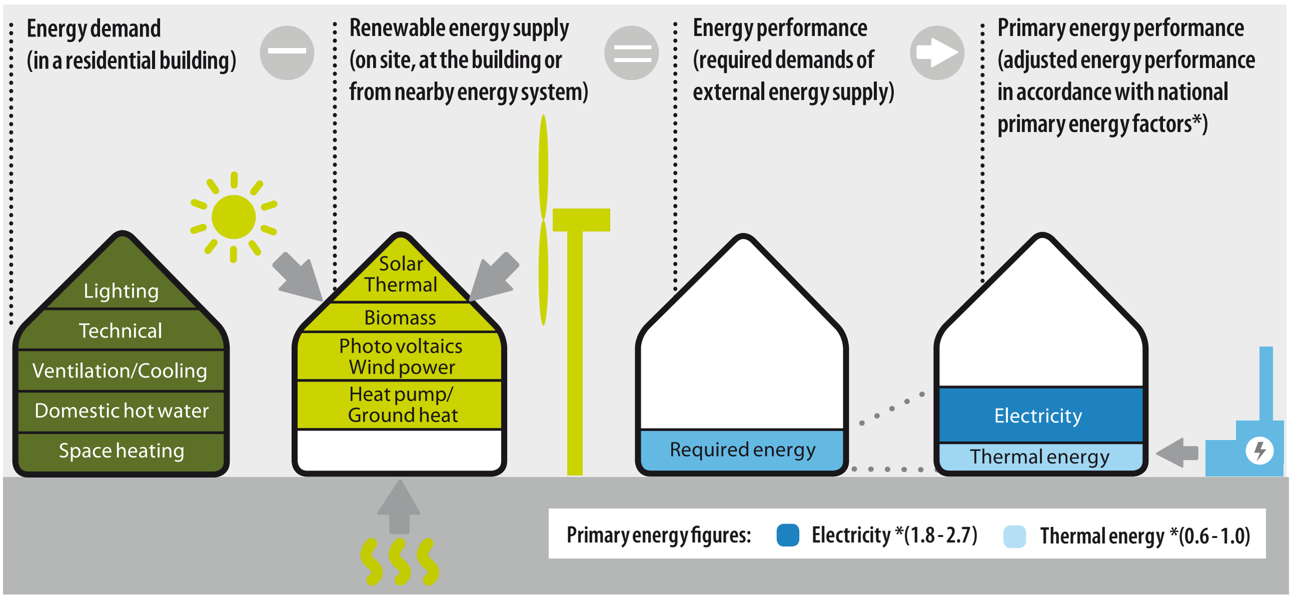

Figure 2. Energy principle for an Active House.

Energy supply

The goal is that the energy supply to an Active House shall be based on renewable and CO_2-neutral energy sources in accordance with the energy performance classification chosen. There are no specific requirements to where and how the renewable energy is produced. It can be on the building, the plot or the nearby system. It must, however, be documented that the energy comes from renewable energy in the energy system.

Classification of energy supply
The annual energy supply from renewable energy and CO_2-free energy sources shall be calculated and divided into the different sources (solar thermal, heat pumps, biomass, PV, wind etc). The energy produced on the building, on the plot or in a nearby system is:
1. 100% or more 2. ≥75% 3. ≥50% 4. ≥25%
The definition of renewable energy sources follows the EU Directive on the promotion of the use of energy from renewable sources (2009/28/EC of 23 April 2009).

Primary energy performance

The annual primary energy performance of an Active House shall be based on national figures on primary energy. The calculation shall include energy demand for the building as well as the energy supply from renewable energy.

Classification of annual primary energy performance
The primary energy performance is the "(energy used – renewable energy supply) multiplied with the national primary energy factors".
1. < 0 kWh/m² for the building 2. 0-15 kWh/m² for the building 3. 15-30 kWh/m² for the building 4. ≥ 30 kWh/ m² for the building
Calculation shall be based on the national calculation methodology and primary energy factors, as well as climate data.

Environment

Global environmental resources are under pressure from over-consumption and pollution. The pressure is felt at global, regional and a local level. When developing an Active House, it is important to ensure that such challenges are considered and that any harm to environment, soil, air and water are minimised

This is important in order to ensure a new generation of buildings and products that aim to have a positive impact on the environment. Consideration should be given in the design phase for how Active Houses use building materials and resources. It is also possible to consider the local building culture and behaviour in and around the local buildings as well as traditions, climate and ecology.

Environmental loads

The process of constructing a new building causes various emissions to air, soil and water, which have different impacts on the environment. When constructing an Active House and conducting a Life Cycle Assessment, it is important to know and consider the different impact categories of these emissions, which may have serious environmental effects. Active House sets requirement to evaluate 6 environmental loads, classified in the following table.

Classification of environmental loads (the classification is the average of all 6 criteria).
Building's primary energy consumption during entire life cycle 1. < -150 kWh/m² x a 2. < 15 kWh/m² x a 3. < 150 kWh/m² x a 4. < 200 kWh/m² x a
Global warming potential (GWP) during building's life cycle. 1. < -30 kg CO_2-eq./m² x a 2. < 10 kg CO_2-eq./m² x a 3. < 40 kg CO_2-eq./m² x a 4. < 50 kg CO_2-eq./m² x a
Ozone depletion potential (ODP) during building's life cycle. 1. < 2.25E-07 kg R_{11}-eq/m² x a 2. < 5.3E-07 kg R_{11}-eq/m² x a 3. < 3.7E-06 kg R_{11}-eq/m² x a 4. < 6.7E-06 kg R_{11}-eq/m² x a
Photochemical ozone creation potential (POCP) during building's life cycle. 1. < 0.0025 kg C_3H_4-eq./m² x a 2. < 0.0040 kg C_3H_4-eq./m² x a 3. < 0.0070 kg C_3H_4-eq./m² x a 4. < 0.0085 kg C_3H_4-eq./m² x a
Acidification potential (AP) during building's life cycle. 1. < 0.010 kg SO_2-eq./m² x a 2. < 0.075 kg SO_2-eq./m² x a 3. < 0.100 kg SO_2-eq./m² x a 4. < 0.125 kg SO_2-eq./m² x a
Eutrophication potential (EP) during building's life cycle. 1. < 0.0040 kg PO_4-eq./m² x a 2. < 0.0055 kg PO_4-eq./m² x a 3. < 0.0085 kg PO_4-eq./m² x a 4. < 0.0105 kg PO_4-eq./m² x a
When evaluating the above parameters the Life Cycle Assessment shall be made in accordance with the EN 15643 series on sustainable construction or with ISO 14040. In the above formular [a] is the number of years included in the estimated service life of the building.

Fresh water consumption

The depletion and scarcity of global freshwater resources are escalating and thus it is becoming increasingly important to consider water consumption – and treatment – during the life-time of a building. It is therefore also included in the Active House specifications. When freshwater is saved, it also results in wastewater savings as well. Freshwater consumption can be reduced by installation of water-saving faucets, use of grey or rain water for toilets and gardening, and the use of easy-to-clean surfaces.

Classification of fresh water consumption
MINIMISATION OF FRESHWATER CONSUMPTION DURING BUILDING'S USE: Calculation is based on the national average water consumption per building per year 1. Improvement ≥ 50% 2. Improvement ≥ 30% 3. Improvement ≥ 20% 4. Improvement ≥ 10% Percentages in the above is "(National average – building consumption x 100) / National average"

Sustainable construction

When designing an Active House, it is important to assess the amount of recycled material and its sourcing. The recycled content in an Active House is evaluated by weight and the evaluation shall take into consideration 80% of the weight of the building. It includes pre-consumer, internal and post-consumer recycling. Responsible sourcing includes the requirement to use certified sourcing either directly, like PEFC and FSC for sourcing of wood, and a supplier certification EMS for other materials.

Classification of sustainable construction (classification is an average of the two criteria).
RECYCLABLE CONTENT: By weight, the average of recycled content for all building materials (weighted by the proportion of the material in the building) should be: 1. ≥ 50% 2. ≥ 30% 3. ≥ 10% 4.≥ 5% 80% of the weight of the building should be accounted for. (In the recycled content, we take into account internal, pre-consumer and postconsumer recycling).
RESPONSIBLE SOURCING: The requirement include the amount of wood certified as FSC or PEFC and the amount of other new materials supplier certified by EMS 1. 100% of the wood and 80% of the new material 2. 80% of the wood and 50% of the new material 3. 65% of the wood and 40% of the new material 4. 50% of the wood and 25% of the new material

Calculation tools

The specification can be downloaded for free from the active house homepage www.activehouse.info

The Active House alliance has developed a tool for calculation of the performance of an Active House and it is available for free for members of the alliance.

During CLIMA2013, the Active House Alliance will organize a workshop where the specification will be presented and discussed. The workshop is planned to be organized on Monday 17. June in meeting room 3. Participants at CLIMA2013 are welcomed for free. ■

Active House Specification

Workshop at CLIMA 2013,
Monday 17 June 16.45-18.15 meeting room 3

Introduction to the Active House specification, including a detailed presentation of the calculation methodologies, evaluation methods and the use of the radar diagram, followed by a presentation and debate on specific Active House projects. The specification will be given for free to all participants.

activehouse.INFO
NETWORK AND KNOWLEDGE SHARING


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Implementing the cost-optimal methodology in EU countries – lessons learned from case studies

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The recast Energy Performance of Buildings Directive (EPBD, 2010/31/EU) requires Member States to introduce minimum energy performance requirements for buildings, building elements and technical building systems and set these requirements based on a cost-optimal methodology. However, the relevant regulation and guidelines developed by European Commission provide Member States with a very large degree of flexibility on how to implement the cost-optimal methodology at national level. The report presents the findings of the latest study (BPIE, 2013) carried out by Buildings Performance Institute Europe providing practical examples of cost-optimal calculations in EU countries. The study serves as additional guidance to Member States on the cost-optimality process and on how to use the methodology relating to nearly Zero-Energy Buildings (nZEB) requirement and long-term climate goals.

Introduction to EPBD Cost-Optimality

According to EPBD recast, Member States (MS) must set minimum energy performance requirements for buildings and building elements with a view to achieving cost-optimal levels. As "cost-optimal" level is defined the energy performance level which leads to the lowest cost during the estimated economic lifecycle. The cost-optimal methodology introduces - for the very first time - the prerequisite to consider the global lifetime costs of buildings to shape their future energy performance requirements. Thus, the evaluation of buildings' requirements will not anymore be related only to the investment costs, but will additionally take into account the operational, maintenance, disposal and energy saving costs of buildings.

The relevant legal document providing the frame is the EU Commission's *Cost-Optimal Delegated Regulation* (EC, 2012a). To support MS, this regulation is accompanied by *Guidelines* (EC, 2012b) outlining how to apply the framework to calculate the cost-optimal performance level. MS must report their level of energy requirements to the Commission at regular intervals of maximum five years, with the first report due by March 21, 2013, one year after Regulation's announcement.

Aims and methods of the study

Despite the general framework and guidelines provided by European Commission, a very large degree of flexibility has been given to MS regarding the selection of

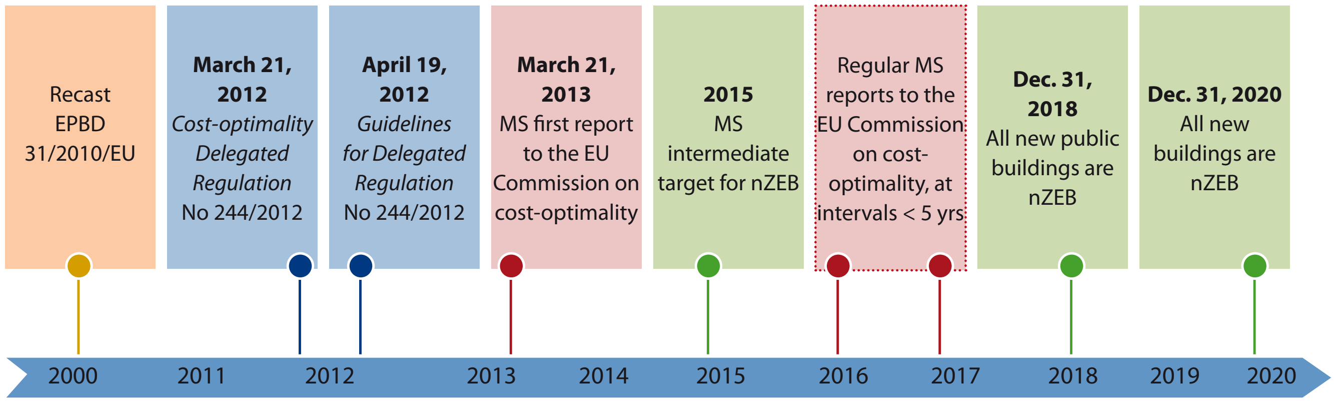

Figure 1. Implementation timeline for cost-optimality and nearly Zero-Energy Buildings' requirements of EPBD.

input data and the necessary assumptions for the cost-optimal calculation. Therefore, the BPIE study (BPIE, 2013) aims to provide additional guidance by delivering calculation examples for new residential buildings in Austria, Germany and Poland. Implications of using different values for key factors of the calculation (discount rates, simulation variants/packages, costs, energy prices) are also highlighted. Moreover, the study presents the advantage of considering ambitious packages of measures towards nearly zero-energy levels and to evaluate the carbon emissions in the light of long-term climate goals.

The cost-optimal calculations for the three countries considered in this study were elaborated by a group of local experts with a strong expertise in the field of energy efficiency and cost-optimality.

The calculations followed the steps indicated by the *Cost-Optimal Regulation* (EC, 2012a). Consequently, all three cost-optimal calculations were based on several common assumptions, while different national contexts and actual approaches were applied where relevant. The calculations were performed for both financial and societal/macro-economic perspectives, as required by the *Cost-Optimal Regulation* (EC, 2012a).

The cost-optimal evaluations were done only for new residential buildings, i.e. for single-family buildings (SFH) and/or multi-family buildings (MFH).

The calculations were implemented for packages of measures that comprise the actual buildings' standards as reference and several improved thermal performance and several heating & ventilation variants, including renewable energy options. Among the calculated packages of measures, there were some very ambitious ones towards nZEB levels.

Links with nearly-Zero Energy Buildings and long-term climate targets

According to EPBD, from 2020 onwards new buildings that will be constructed within EU have to be at 'nearly zero-energy' levels. At the same time, the *Cost-Optimal Regulation* (EC, 2012a) for adapting the energy performance requirements in the MS building codes will have to be applied from 2013. Therefore, it is recommended to use the cost-optimality methodology for new buildings, in order to identify and address the further implications of implementing requirements for nearly zero-energy buildings.

More specifically, the implementation of cost-optimality nowadays can offer an early evaluation of the existing gaps to be filled-in over the following years. By evaluating packages of insulation and heating variants leading towards nZEB levels, it will be possible to spot three types of potential gaps that have to be filled by 2020:

- Financial gap, i.e. the actual cost difference between cost-optimal and nZEB levels;
- Energy performance gap, i.e. the difference between primary energy at cost-optimal and nZEB levels;
- Environmental gap, i.e. the difference between associated CO_2 emissions to primary energy at cost-optimal and nZEB levels, the latter aiming also to nearly zero-carbon emissions (or < 3kg $CO_2/m^2/yr$), as it was suggested in a previous BPIE study (BPIE, 2011).

Cost-Optimal calculations for Austria and Germany

The cost-optimal calculations implemented under the scope of this study were focused on Austria, Germany and Poland. However, this paper presents indicatively only the results for Austria and Germany.

Table 1. Overview of parameters used for the sensitivity analysis for Austria.

Parameter	Value for basic calculation	Value for sensitivity analysis
Sens1: Cost of environmental damage	0 EUR/t CO_2	Carbon price according to recommended values by the C-O Regulation Annex II
Sens2: Energy price development	2.8 % p.a.	4 % p.a.
Sens3: Discount rate	3.0 % p.a.	1.0 % p.a.
Sens4: Discount rate and energy price development	3.0 % p.a. 2.8 % p.a.	1.0 % p.a. 4.0 % p.a.
Sens5: Investment cost		Reduction of difference costs between variants (due to regional cost differential)
Macro1: Macroeconomic-perspective 1	Discount rate 3.0% p.a. Energy price 2.8% p.a. VAT included No subsidies 0 EUR/t CO_2	Discount rate 1.0% p.a. Energy price 2.8% p.a. No tax No subsidies Carbon price according to recommended values by the C-O Regulation Annex II
Macro2: Macroeconomic-perspective 2	Discount rate 3.0% p.a. Energy price 2.8% p.a. VAT included No subsidies 0 EUR/t CO_2	Discount rate 1.0% p.a. Energy price 2.8% p.a. No tax No subsidies Carbon price according to recommended values by the C-O Regulation Annex II
Macro3: Macroeconomic-perspective 3	Discount rate 3.0% p.a. Energy price 2.8% p.a. VAT included No subsidies 0 EUR/t CO_2	Discount rate 1.0% p.a. Energy price 4.0% p.a. No tax No subsidies Carbon price according to recommended values by the C-O Regulation Annex II

The cost-optimal calculation for **Austria** was done for a newly constructed multi-family residential building. Altogether, 50 different technical variants were defined, with differentiations in thermal quality of the building envelope, window area, heat supply and ventilation systems. In addition, a series of sensitivity analyses was conducted in order to check the reliability and stability of the results of the baseline scenario. With the sensitivity analysis the impact of important framework conditions, such as the discount rate or the energy price development, was tested.

Table 1 summarises the variants considered in the sensitivity analysis for Austria.

Figure 2 shows an example of the results for the variants with district heating and ventilation systems.

The top diagram (**Figure 2**) presents the results regarding the private investor's perspective (financial calculation) (basic scenario compared to Sens1 to Sens5), while the figure on the bottom presents the results related to the macro-economic perspective (Macro1 to Macro3).

In short, the results showed that the influence of the tested input parameters was almost insignificant, mainly concerning the form of the cost curve and remarkable shifts of the cost optimum. It should be stressed that the cost curves are still very shallow. From the influence factors tested (and considering the assumptions taken), the most important factor seems to be the discount rate (Sens4); however, the assumed cost differences related to different qualities are also important (Sens5). The sensitivity analyses related to the macroeconomic perspective (Macro1 to Macro3), with a combination of low discount rate, exclusion of VAT and inclusion of CO_2-cost, show an improvement of the cost curve, mainly regarding the most efficient solutions – i.e. the variants with the lowest primary energy demand and lowest CO_2-emissions.

Overall, the implementation of the cost-optimal calculations for Austria -which are thoroughly presented on the relevant case study report (BPIE & e7, 2013) - proved that the actual building requirements are very close to the cost-optimal levels for new MFH. However, a tightening of the current building code of 15%-22% will be required when considering other heating methods (including solar heating) than district heating, which was considered in the reference case.

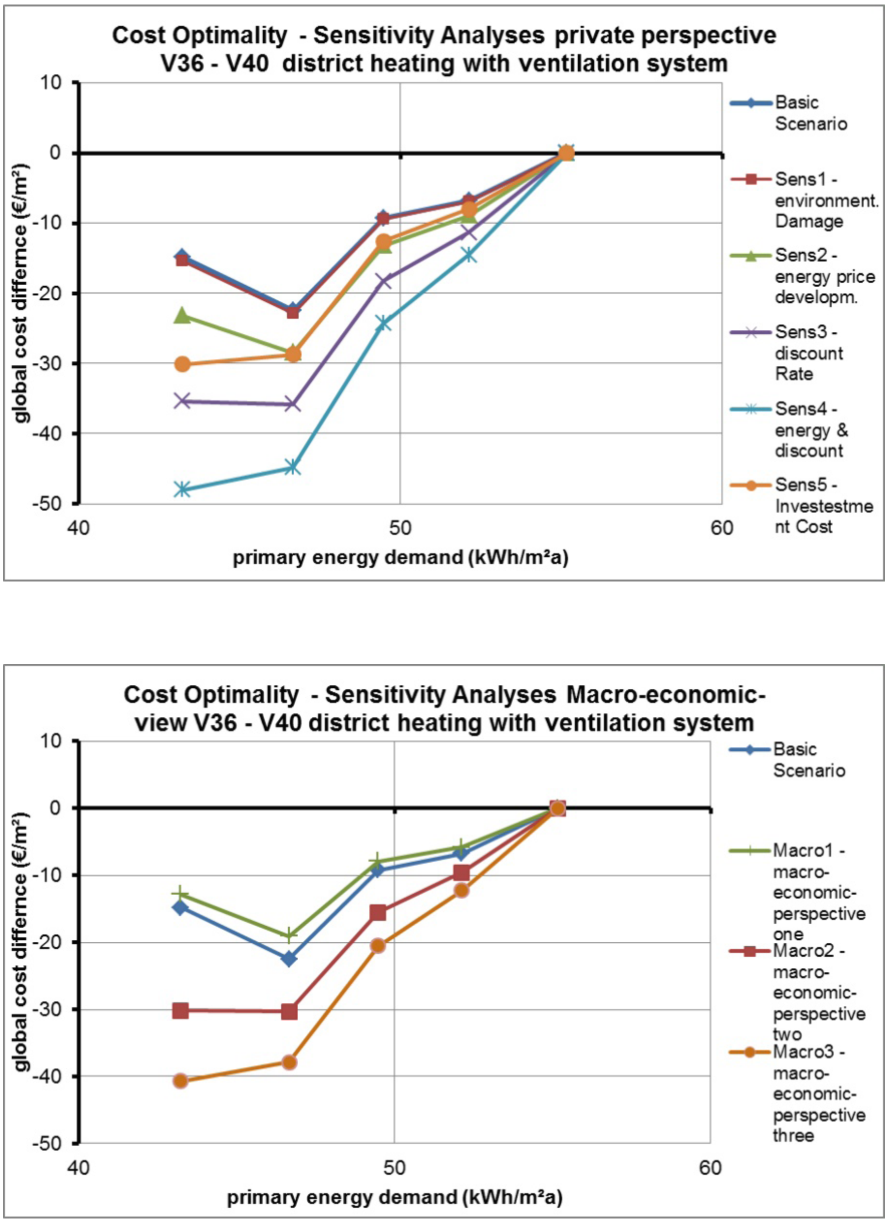

Figure 2. Results of the sensitivity analyses for the variants with district heating and ventilation system.

Moreover, the cost-optimal calculations for Austria included several packages of measures at very low-energy levels, with primary energy demand between 30-50 kWh/m²/yr. Compared to typical rent levels in multi-family houses (7-10 €/m² on average) and the levels of operating cost (0.50-1.50 €/m² except energy), the global cost differences between actual building requirement standards and those close to nZEB levels do not exceed 0.15 €/m² and many of the highly efficient variants are closer to the cost-optimum. Among the packages of measures at low-energy levels, some have significantly low CO_2 emissions or even negative CO_2 balance due to the overcapacity of renewable energy generation.

For **Germany**, cost-optimal calculations were done both for single-family and multi-family buildings. In total, 72 different packages of measures were used, including several thermal insulation and heat supply variants. A sensitivity analysis was performed on exemplary discount rates and energy price development scenarios.

Table 2. Important findings and recommendation for the cost-optimality calculation.

Reference Buildings	• Have to be **representative of the existing building stock** and **new buildings** in each country; • With simple geometries; • **Reproducible** in practice;
Selection of packages of measures	• Number of calculated packages have to be **at least 10** in addition to the reference case, which reflects actual regulations; • **Very ambitious packages** of measures should also be considered to provide an estimation of the financial and environmental implications of upcoming **nZEB** requirements;
Methodology and framework conditions	• Calculation based on **primary energy**; • Harmonized with the **European Standards**; • **Accurate conversion factors** and periodically updated;
Costs of materials, work and equipment	• Lack of accurate information of the costs in MS; • Scarce and not consistently collected data; • **Databases should be developed** and open to periodical scrutiny of main stakeholders;
Discount rates and energy prices development	• The energy prices development as well the relation with discount rate influence the global costs calculation and may slightly shift the cost-optimal point

A sample of the results of cost-optimal calculations at financial perspective is presented on **Figure 3**.

The calculation results are summarised in the followings:

- The cost-optimal level for both SFH and MFH is represented by a package composed by thermal insulation standard with U-values at 85% of the EnEV 2009 for reference building, combined with a condensing boiler and with solar heating system (4th data point of the curve – BWK+Sol / primary demand approx. 53-54 kWh/m²yr).
- Packages based on combinations of thermal insulation measures with wood pellet boilers (curves with green colour) or electric heat pumps (curves with brown colour) have nearly comparable global costs for both SFH and MFH. The global costs are nevertheless higher than those of packages including condensing boilers (curves with blue colour), but the primary energy demand values are lower, especially for heat supply systems with wood pellet boilers. The global cost differences are more significant for the SFH than in the MFH (due to lower investment costs per sq. meter for wood pellet boilers and electric heat pumps in the MFH).
- The current minimum energy performance requirements of EnEV 2009 for new buildings (vertical red line in the graph) do not yet achieve the cost-optimal levels. Compared to EnEV 2009, the cost-optimal levels lead to decreases of the global costs by about 12 €/m² (SFH) and 8 €/m² (MFH).
- On the whole, the extensive implementation of cost-optimal calculations in Germany -which can be found on the relevant case study report (BPIE & IWU, 2013) -proved that a tightening of current building requirements of approximately 25% is possible. German government has already adopted a plan to achieve this tightening in two steps, each by 12.5%.

Furthermore, for Germany, it has been assumed that the future nZEB definition will be close to the German national standard for energy in buildings, 'KfW Effizienzhaus 40'(kfW, 2012), which is the most ambitious level of the federal grant programme for new buildings. Compared to typical construction costs for new buildings in Germany (1300 €/m²), the additional global costs range between 2 and 8 % for the packages of measures towards nZEB. The CO_2 emissions associated to these packages of measures are in the range of 4.2 to 9.5 kg/m²/yr for both SFH and MFH.

Recommendations and conclusions

Finally, **Table 2** summarizes important findings and recommendations concerning the main implementation steps of the calculation and the selection of the most influential factors.

Overall, cost-optimal methodology causes a paradigm shift in building assessment methods: from considering only the investment costs to assessing the lifetime costs of a building. Cost-optimal methodology may be used as an opportunity to timely evaluate and facilitate the upcoming introduction of nZEB in EU as well as

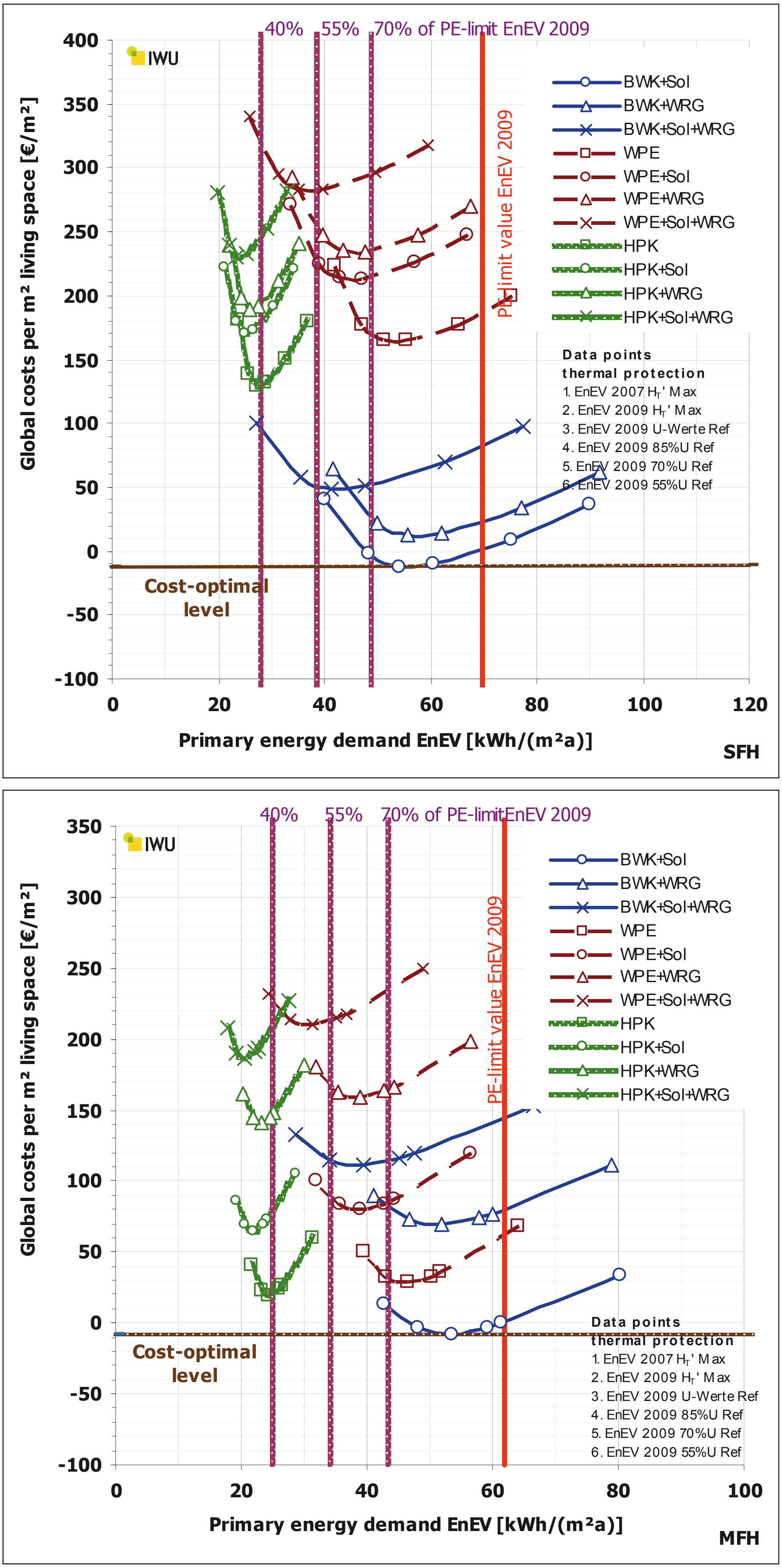

Figure 3. Global costs for SFH and MFH for all heat supply systems (baseline scenario, medium energy price development).

to increase consistency between buildings policies and long-term climate goals. However, all these potential benefits may be endangered by a poor implementation of cost-optimality among MS. To avoid this, there is a need for more guidance, best practices exchange between MS representatives and experts and awareness rising among stakeholders and citizens concerning the benefits of having ambitious buildings policies and regulations.

Acknowledgments

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References

See the complete list of references of the article in the html-version at **www.rehva.eu** -> REHVA Journal

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Technical definition for nearly zero energy buildings

REHVA launched 2013 version in cooperation with European standardization organization CEN for uniformed national implementation of EPBD recast.

REHVA has revised its nZEB technical definition, since now the only available methodology suitable for the implementation in national building codes for the primary energy indicator calculation. The 2013 version was prepared in cooperation with European standardization organization CEN and it replaces 2011 version with the intention to help the experts in the Member States to define the nearly zero energy buildings in a uniform way. 2013 version is complemented with specifications for nearby renewable energy and for the contribution of renewable energy use. A set of the system boundaries and equations are given for energy need, energy use, delivered and exported energy, primary energy and for renewable energy ratio calculation. With these definitions and energy calculation framework, primary energy indicator and renewable energy ratio can be calculated as required by the directive. Calculation principles are explained with worked examples in order to assure uniform understanding of the definitions. Full report is available at the REHVA website www.rehva.eu -> REHVA Journal.

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Background

EPBD recast (2010/31/EU) launched nearly zero energy (nZEB) target in 2010 with the need for the Member States to define what nZEB for them exactly constitutes. REHVA experts realized the problem that various definition of nZEB may cause in Europe and established a task force to prepare technical definitions and system boundaries for energy performance calculations.

Starting point for technical definitions is the requirement of nZEB in EPBD recast formulated as buildings with **a very high energy performance** and where energy need is covered to **a very significant extent by energy from renewable sources.** Since EPBD recast does not give minimum or maximum harmonized requirements as well as details of energy performance calculation framework, it will be up to the Member States to define what "a very high energy performance" and "to a very significant extent by energy from renewable sources" for them exactly constitute.

REHVA technical definition for nearly zero energy buildings

nZEB definition shall be based on delivered and exported energy according to EPBD recast and prEN 15603:2013. The basic energy balance of the delivered and exported energy and system boundaries for the primary and renewable energy calculations, are shown in **Figure 1** and **3** (for on site and for nearby assessment), and described with detailed system boundary definitions in **Figures 4** and **5**. According to EPBD recast, all components of the energy use are mandatory except the energy use of appliances (households, elevators/escalators and outlets) which may or may not be included. With the inclusion of appliances, energy use in the buildings includes energy used for heating, cooling, ventilation, hot water, lighting and appliances.

According to **Figure 1**, for delivered electricity and thermal energy it applies:

$$E_{us,el} = \left(E_{del,el} - E_{\exp,el}\right) + E_{ren,el} \qquad (1)$$

and

$$E_{us,T} = \left(E_{del,T} - E_{\exp,T}\right) + E_{ren,T} \qquad (2)$$

where
E_{us} is total energy use kWh/(a);
E_{del} is delivered energy on site (kWh/a);
E_{exp} is exported energy on site (kWh/a);
E_{ren} is on site renewable energy without fuels (kWh/a);

Subscript *el* refers to electricity and *T* to thermal energy.

An example in **Figure 2** explains the use of Equation 1. An all electrical building with energy use of 100 has a PV system generating 20, from which 10 is used in the building and 10 is exported. With these values, delivered energy on site becomes: $E_{del,el} = E_{us,el} + E_{\exp,el} - E_{ren,el} = 100 + 10 - 20 = 90$.

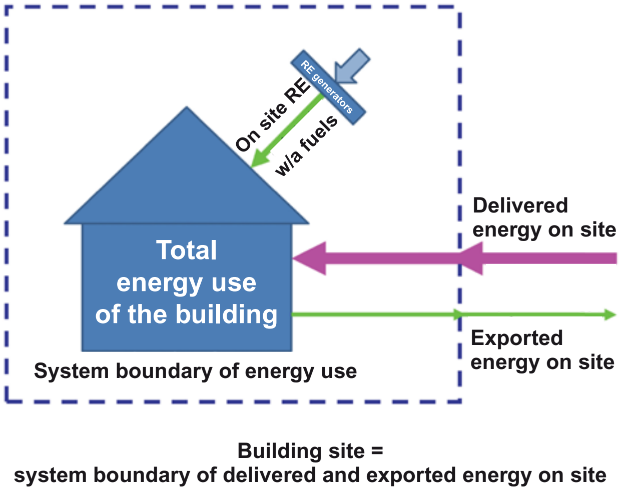


Figure 1. System boundaries for on site assessment (nearby production not linked to the building) connecting a building with on site renewable energy (RE) sources to energy networks. System boundary of energy use of building technical systems follows outer surface of the building in this simplified figure; system boundary of delivered and exported energy on site is shown with dashed line. In the case of nearby production, the nearby system boundary will be added, as shown in Figure 3.

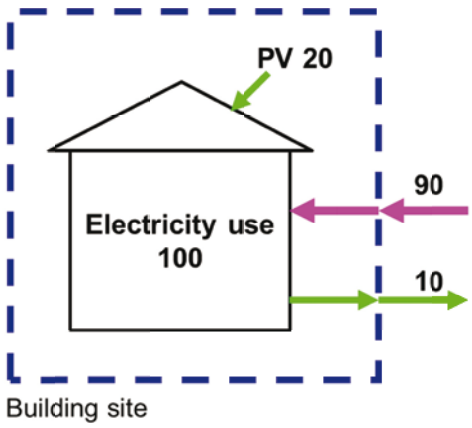


Figure 2. An example of an all electrical building explaining the use of Equations 1 and 2.

In order to be able to take into account a new nearby renewable energy production capacity contractually linked to the building and providing the real addition of the renewable capacity to the grid or district heating or cooling mix in connection with construction/development of the building(s), the system boundary of **Figure 1** has to be extended. (If not contractually linked to the building, nearby production is calculated with primary energy factors of the network mix as shown in **Figure 1**.) To calculate delivered and exported energy nearby, the energy flows of nearby production plant contractually linked to building are to be added/subtracted to the delivered and exported energy flows on site, **Figure 3**. Prerequisite to apply this nearby assessment, is the availability of national legislation allowing to allocate such new capacity to the building/development with a long term contract and assuring that the investment on that new capacity will lead to a real addition to the grid or district heating or cooling mix.

Primary energy indicator sums up all delivered and exported energy (electricity, district heat/cooling, fuels) into a single indicator. Primary energy and primary energy indicator are calculated from delivered and exported energy with national primary energy factors as:

$$E_{P,nren} = \sum_i \left(E_{del,i} f_{del,nren,i}\right) - \sum_i \left(E_{\exp,i} f_{\exp,nren,i}\right) \quad (3)$$

$$EP_P = \frac{E_{P,nren}}{A_{net}} \quad (4)$$

where

EP_P is the primary energy indicator (kWh/(m² a));
$E_{P,nren}$ is the non-renewable primary energy (kWh/a);
$E_{del,i}$ is the delivered energy on site or nearby (kWh/a) for energy carrier *i*;
$E_{exp,i}$ is the exported energy on site or nearby (kWh/a) for energy carrier *i*;
$f_{del,nren,i}$ is the non-renewable primary energy factor (-) for the delivered energy carrier *i*;
$f_{exp,nren,i}$ is the non-renewable primary energy factor (-) of the delivered energy compensated by the exported energy for energy carrier *i*, which is by default equal to the factor of the delivered energy, if not nationally defined in other way;
A_{net} useful floor area (m²) calculated according to national definition.

Net zero energy building definition has an exact performance level of 0 kWh/(m² a) non renewable primary energy. The performance level of "nearly" zero energy is a subject of national decision taking into account:

- technically reasonably achievable level of primary energy use;
- how many % of the primary energy is covered by renewable sources;
- available financial incentives for renewable energy or energy efficiency measures;
- cost implications and ambition level of the definition.

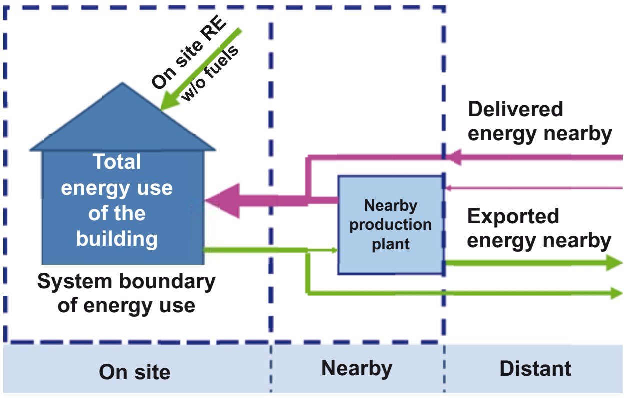


Figure 3. Nearby assessment boundary to be used in the case of nearby energy production linked contractually to the building. Compared to on site assessment boundary, delivered and exported energy flows on site are replaced by delivered and exported energy flows nearby.

The following definitions were prepared for uniformed EPBD recast implementation:[1]

net zero energy building (net ZEB)
Non-renewable primary energy of 0 kWh/(m² a).

nearly zero energy building (nZEB)
Technically and reasonably achievable national energy use of > 0 kWh/(m² a) but no more than a national limit value of non-renewable primary energy, achieved with a combination of best practice energy efficiency measures and renewable energy technologies[2] which may or may not be cost optimal[3].

Detailed system boundaries for delivered and exported energy calculation

The set of detailed system boundaries are extended from the assessment boundary of prEN 15603:2013. As stated in EPBD recast, the positive influence of renewable energy produced on site is taken into account so that it reduces the amount of delivered energy needed and may be exported if cannot used in the building (i.e. on site production is not considered as part of delivered energy on site), **Figure 4**.

1 'reasonably achievable' means by comparison with national energy use benchmarks appropriate to the activities served by the building, or any other metric that is deemed appropriate by each EU Member State.
2 Renewable energy technologies needed in nearly zero energy buildings may or may not be cost-effective, depending on available national financial incentives.
3 The Commission has established a comparative methodology framework for calculation of cost-optimal levels (Cost optimal).

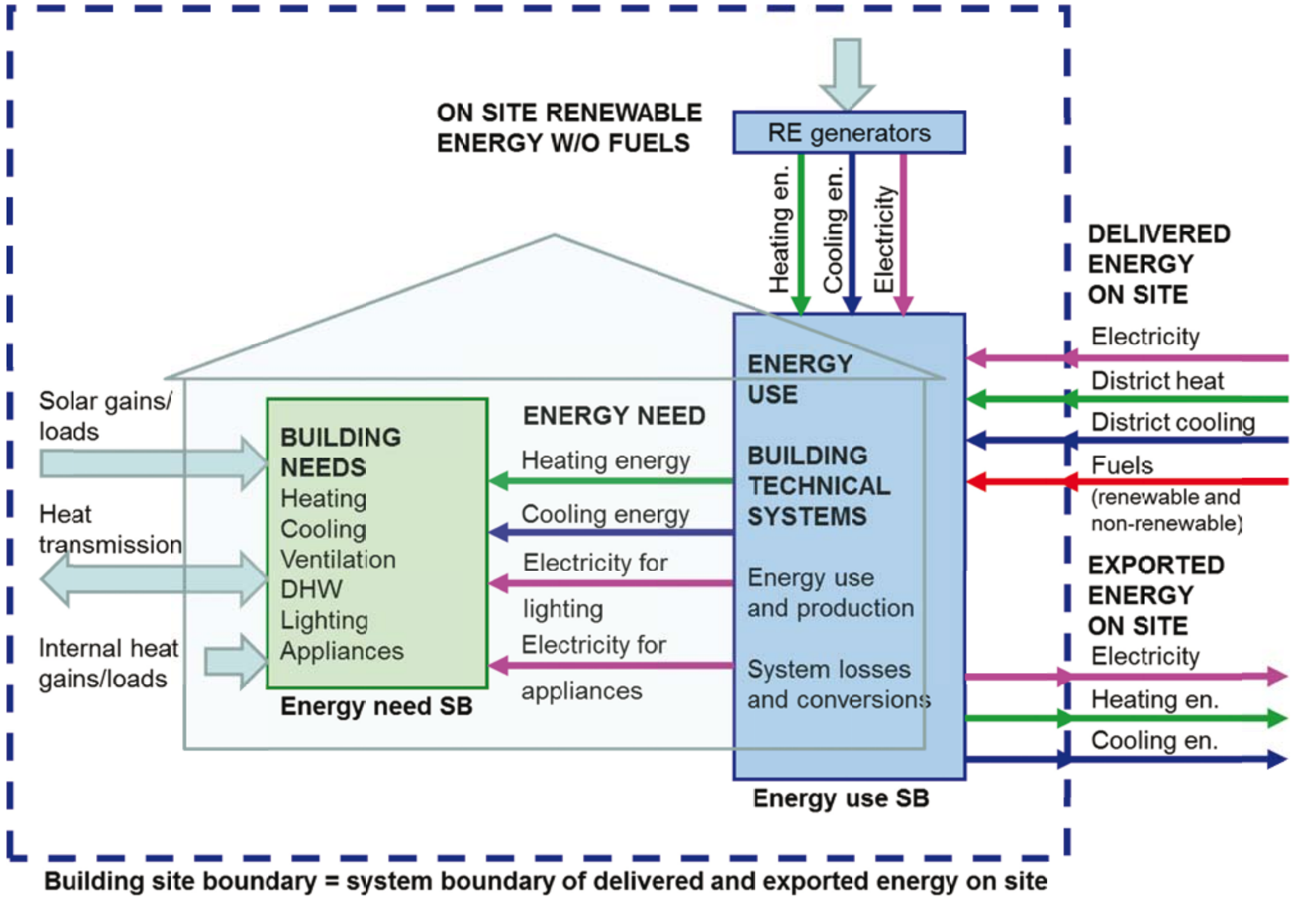


Figure 4. Three system boundaries (SB) for on site assessment (nearby production not linked to the building), for energy need, energy use and delivered and exported energy calculation. System boundary of energy use applies also for renewable energy ratio calculation with inclusion of RE from geo-, aero- and hydrothermal energy sources of heat pumps and free cooling as shown in Figure 5.

Renewable energy ratio (RER) calculation

In order to calculate the share of renewable energy use, renewable energy ratio RER, all renewable energy sources have to be accounted for. These include solar thermal, solar electricity, wind and hydro electricity, renewable energy captured from ambient heat sources by heat pumps and free cooling, renewable fuels and off site renewable energy. Ambient heat sources of heat pumps and free cooling are to be included to the renewable energy use system boundary, because in RER calculation, heat pumps and free cooling are not only taken into account with delivered energy calculation based on COP, but also by the extracted energy from ambient heat sources. Renewable energy use system boundary is shown in **Figure 5**.

The renewable energy ratio is calculated relative to all energy use in the building, in terms of total primary energy. It is taken into account that exported energy compensates delivered energy. By default, it is considered that the exported energy compensates the grid mix or in the case of thermal energy, the district heating or cooling network mix. For on-site and nearby renewable energy the total primary energy factor is 1.0 and the non-renewable primary energy factor is 0. Total primary energy based RER equation is the following:

$$RER_P = \frac{\sum_i E_{ren,i} + \sum_i \left(\left(f_{del,tot,i} - f_{del,nren,i}\right)E_{del,i}\right)}{\sum_i E_{ren,i} + \sum_i \left(E_{del,i} f_{del,tot,i}\right) - \sum_i \left(E_{\exp,i} f_{\exp,tot,i}\right)} \quad (5)$$

where

RER_P is the renewable energy ratio based on the total primary energy,

$E_{ren,i}$ is the renewable energy produced on site or nearby for energy carrier *i*, kWh/a;

$f_{del,tot,i}$ is the total primary energy factor (-) for the delivered energy carrier *i*;

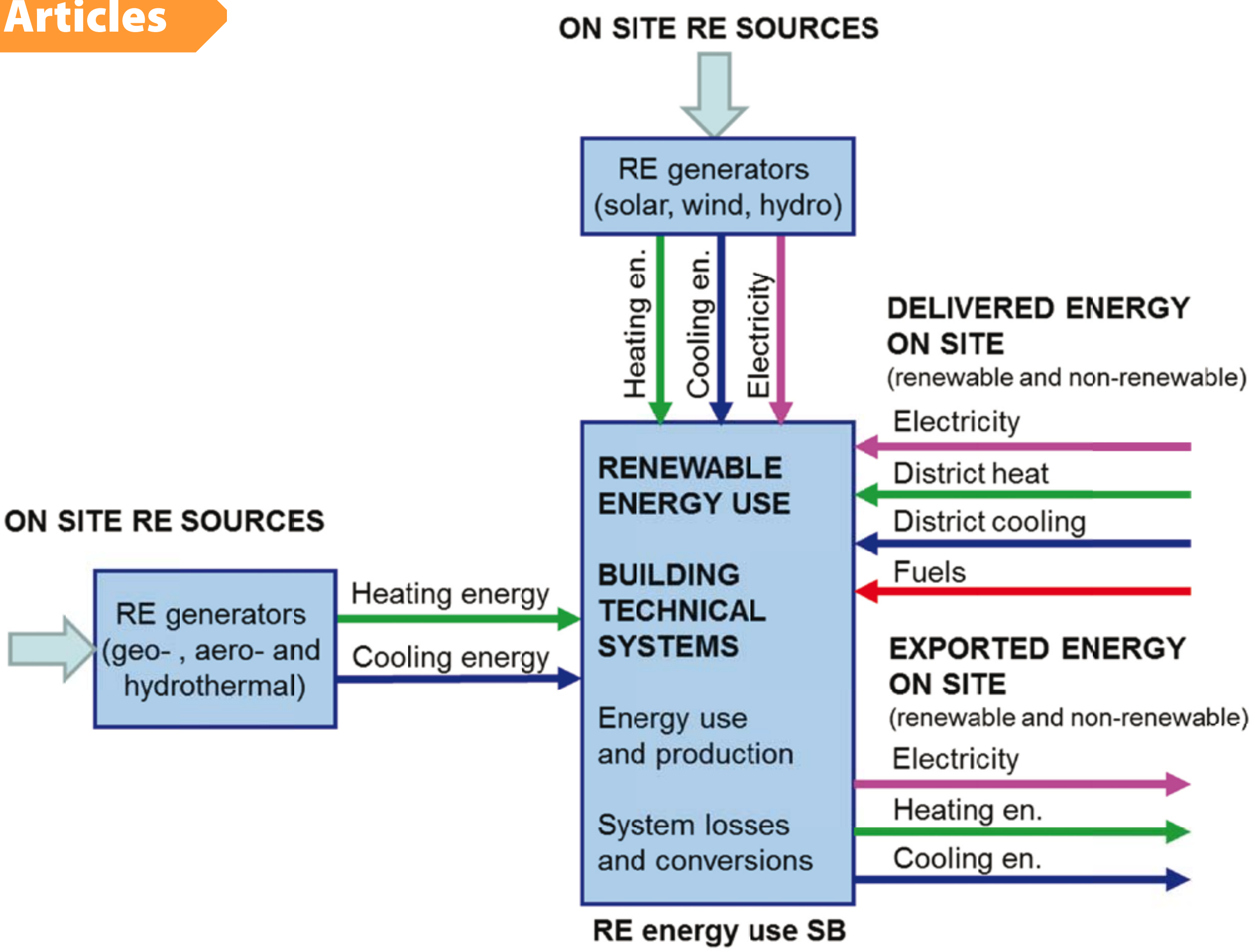


Figure 5. Renewable energy use system boundary for renewable energy ratio RER calculation. In addition to energy flows shown in Figure 4, renewable thermal energy from ambient heat pump and free cooling sources (heat exchangers) is accounted.

$f_{del,nren,i}$ is the non-renewable primary energy factor (-) for the delivered energy carrier *i*;

$f_{exp,tot,i}$ is the total primary energy factor (-)of the delivered energy compensated by the exported energy for energy carrier *i;*

$E_{del,i}$ is the delivered energy on site or nearby for energy carrier *i*, kWh/a;

$E_{exp,i}$ is the exported energy on site or nearby for energy carrier *i*, kWh/a.

Calculation example

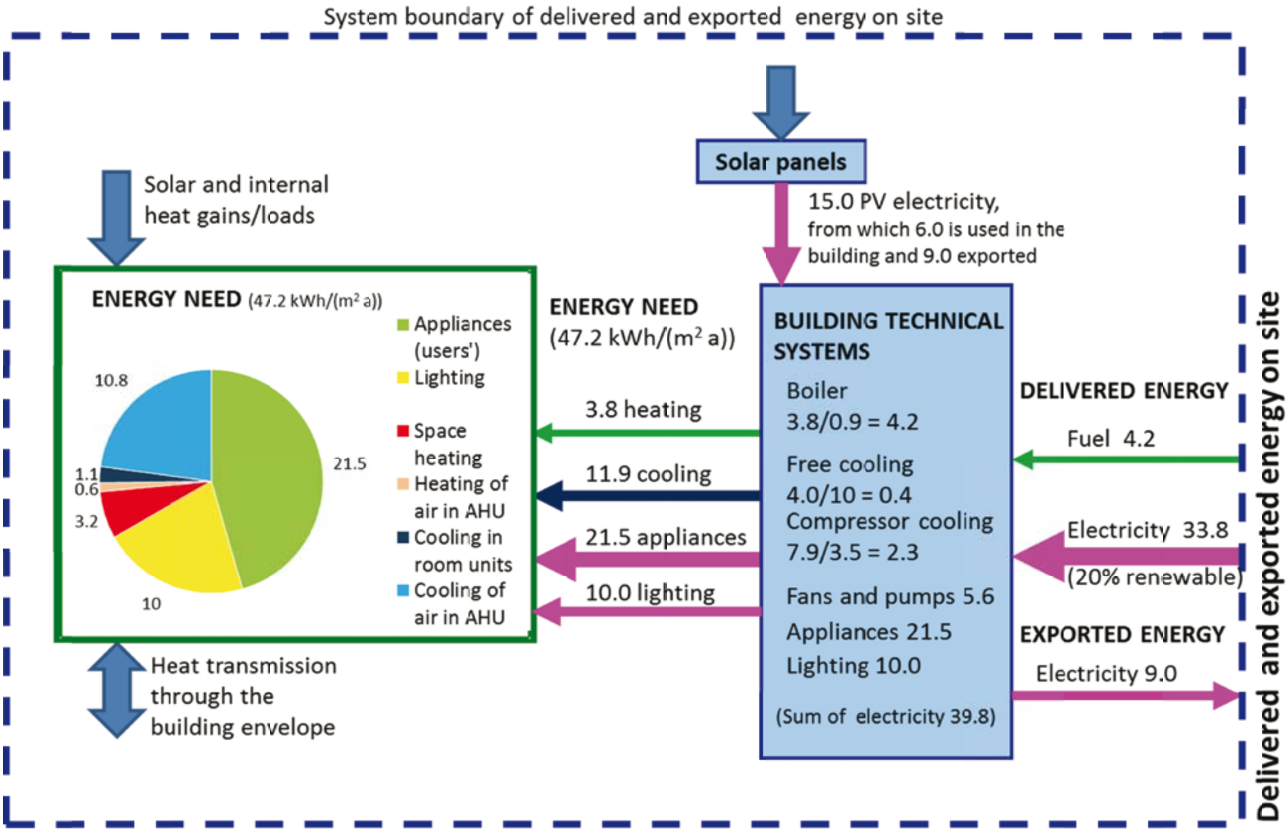
Consider an office building located in Paris with following annual energy needs (all values are specific values in kWh/(m² a)):

- 3.8 kWh/(m² a) energy need for heating (space heating, supply air heating and DHW)
- 11.9 kWh/(m² a) energy need for cooling
- 21.5 kWh/(m² a) electricity for appliances
- 10.0 kWh/(m² a) electricity for lighting

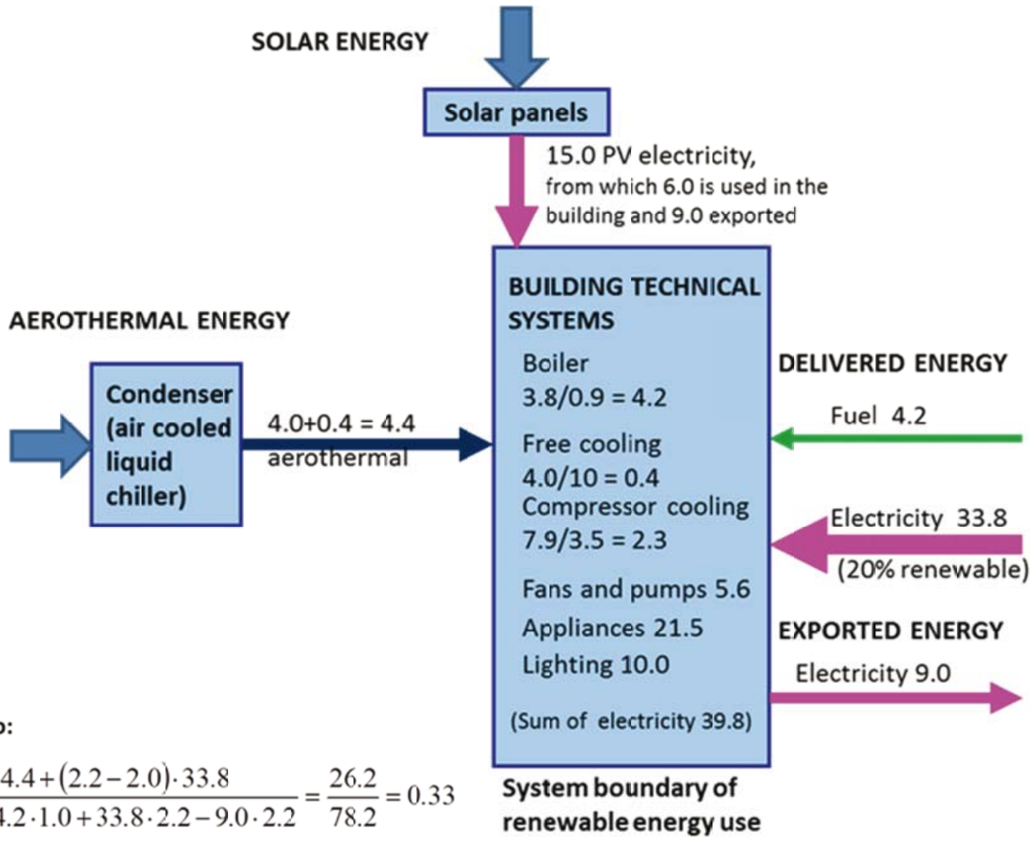
Breakdown of the energy need is shown in **Figure 6**.

The building has a gas boiler for heating with seasonal efficiency of 90%. For the cooling, free cooling from boreholes (about 1/3 of the need) is used and the rest is covered with mechanical cooling. For borehole cooling, seasonal energy efficiency ratio of 10 is used and for mechanical cooling 3.5. To simplify the calculation, emission and distribution losses of the heating and cooling systems are neglected in this example. Ventilation system with specific fan power of 1.2 kW/(m³/s) and the circulation pump of the heating system will use 5.6 kWh/(m² a) electricity. There is installed a solar PV system providing 15.0 kWh/(m² a), from which 6.0 is utilized in the building and 9.0 is exported to the grid.

Energy calculation results are shown in **Figure 6**, in the building technical systems box. Gas boiler with 90% efficiency results in 4.2 kWh/(m² a) fuel energy. Electricity use of the cooling system is calculated with seasonal energy efficiency ratios 10 and 3.5 respectively. Electricity use



Primary energy: $EP_P = 4.2 \cdot 1.0 + 33.8 \cdot 2.0 - 9.0 \cdot 2.0 = 53.8 \frac{kWh}{m^2 a}$



Renewable energy ratio:

$$RER_P = \frac{15.0 + 4.4 + (2.2 - 2.0) \cdot 33.8}{15.0 + 4.4 + 4.2 \cdot 1.0 + 33.8 \cdot 2.2 - 9.0 \cdot 2.2} = \frac{26.2}{78.2} = 0.33$$

Figure 6. Calculation example of the energy flows in nZEB office building.

Figure 7. Some nZEB office buildings are calculated and reported according to REHVA definition that makes it possible to compare the results. See in Journal 3/2011, 2/2012 and 5/2012 for these buildings from France, the Netherlands, Switzerland, Finland.

of free cooling, mechanical cooling, ventilation, lighting and appliances is 39.8 kWh/(m² a). Solar electricity of 6.0 kWh/(m² a) used in the building reduces the delivered electricity to 33.8 kWh/(m² a). The rest of PV electricity, 9.0 kWh/(m² a) is exported. The delivered fuel energy (caloric value of delivered natural gas) is 4.2 kWh/(m² a).

In this example, it is considered that 20% of the grid electricity is from renewable sources with the non-renewable primary energy factor of 0 and the total primary energy factor of 1.0. For the rest of 80% of the grid electricity the total and non-renewable primary energy factor of 2.5 is used. Therefore, the non-renewable primary energy factor of the grid mix is $0 \cdot 0.2 + 2.5 \cdot 0.8 = 2.0$ and the total primary energy factor is $1.0 \cdot 0.2 + 2.5 \cdot 0.8 = 2.2$. It is assumed that exported electricity compensates the grid mix.

Acknowledgment

REHVA nZEB Task Force and CEN EPBD project group members are greatly acknowledged for this work: Francis Allard, Derrick Braham, Dick van Dijk, Jacquelyn Fox, Jonas Gräslund, Per Heiselberg, Frank Hovorka, Risto Kosonen, Jean Lebrun, Zoltán Magyar, Livio Mazzarella, Ivo Martinac, Vojislav Novakovic, Jorma Railio, Olli Seppänen, Igor Sartori, Johann Zirngibl, Michael Schmidt, Maija Virta, Karsten Voss, Åsa Wahlström. ■

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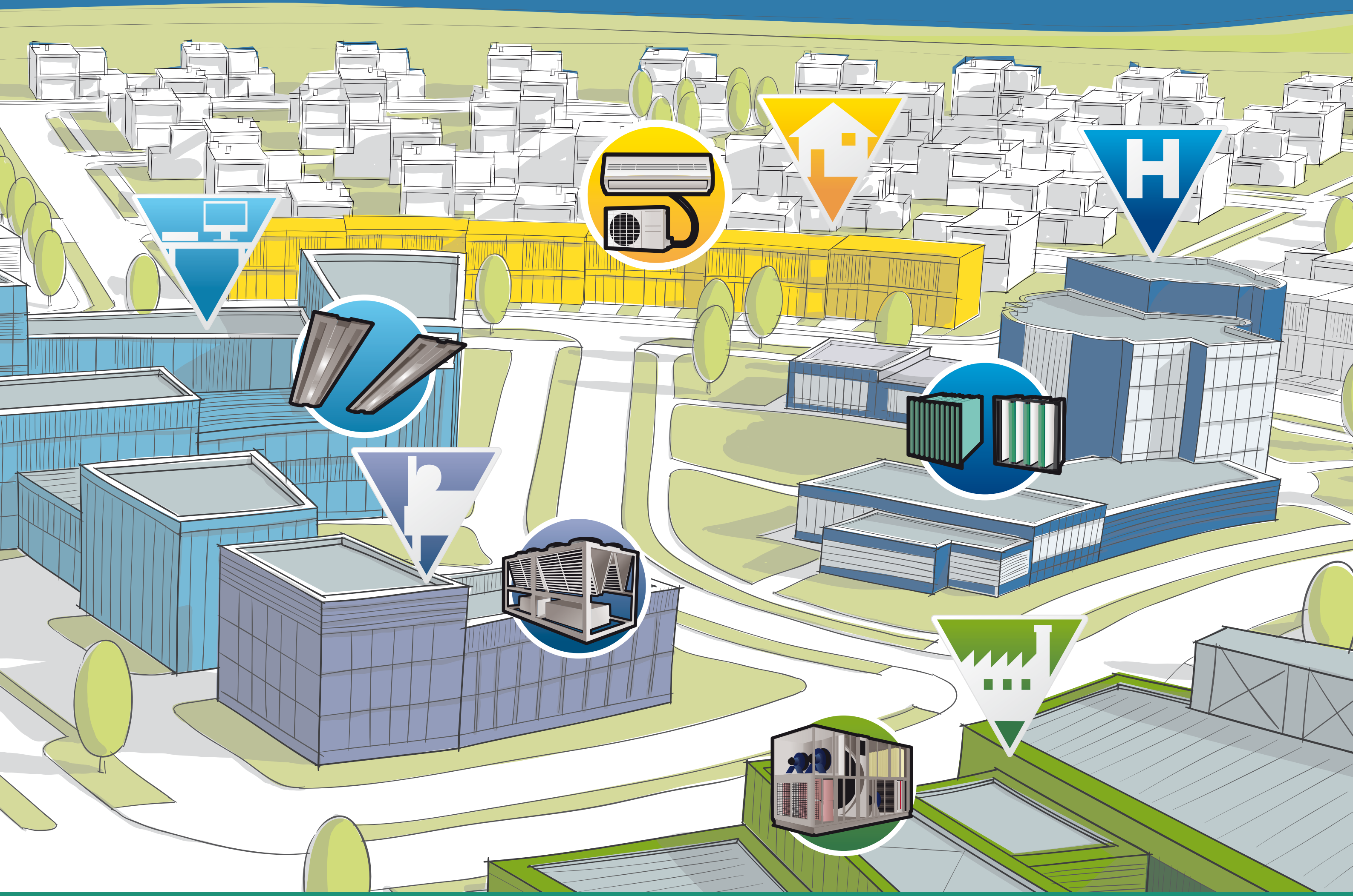

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New Regulation sets demanding Ecodesign requirements for boilers

Ecodesign of Energy Using Products Directive (ED) and Energy Labelling Directive (ELD) are recent legal instruments in European Union aiming to improve the energy efficiency of appliances. While energy labels assist consumers in choosing products which save energy, and thus money, ecodesign is aimed to eliminate the least efficient appliances from the market by establishing specific minimum requirements for specific product groups. The aim is that the ecodesign and the energy labelling requirements be introduced at the same time to facilitate implementation of the two measures and to guarantee the longest possible validity for the energy label. Energy labelling was addressed in REHVA Journal – March 2013 issue. In this article the new Regulation on ecodesign of heaters is presented.

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Background

The Ecodesign Framework Directive (ED) 2009/125/EC establishes a framework for setting *ecodesign requirements* for energy-related products [**2**]. It is a key instrument of EU policy for improving the energy efficiency and other aspects of the environmental performance of products in the internal market. The Directive addresses products identified by the Council and the European Parliament as priorities for the Commission for implementation, including heating equipment. Heaters are therefore priority product groups considered for implementing measures under the Ecodesign Directive. Energy Labeling Directive (ELD) establishes a framework for the Commission to develop Delegated Regulations for the *labelling* of energy-related products. [**1**].

The ED is an important instrument for achieving the objective of 20% energy savings compared with baseline projections for 2020, and its implementation is one of the priorities in the Commission's Communication on Energy 2020 and Energy Efficiency Plan 2011. [**3, 4**]

Directives are brought into practice by Commission issuing implementing measures in the form of Regulations, Delegated Regulations, Communications, etc.

Contents of the regulation

The Commission Regulation [**5**] implementing Ecodesign Directive [**2**] was adopted by voting in the meeting of the Regulatory Committee on Heaters on 13th March 2013. In this regulation energy efficiency requirements for space heaters and for the space heating function of combination heaters are set on the basis of **seasonal space heating efficiency**, which considers the energy inputs to satisfy the space heating demand for a designated heating season under defined conditions.

Energy efficiency requirements for the domestic hot water heating function of combination heaters are set on the basis of load profiles, namely a certain sequence of water draw-offs representing the function of water heating, in accordance with the separate proposed regulation introducing ecodesign requirements for water heaters.

Apart from energy efficiency, the sound power levels and nitrogen oxides emissions are identified as significant environmental aspects for certain heaters. Accordingly, maximum sound power level requirements are proposed for heat pumps. For heaters using fuels, the Regulation sets maximum nitrogen oxides emission levels.

Requirements on minimum seasonal space heating energy efficiency, minimum water heating energy efficiency, maximum sound power level, maximum nitrogen oxides emissions and information to be provided by manufacturers are scheduled as follows:

After 2 years since this Regulation has entered into force:

- minimum seasonal space heating energy efficiency
- minimum useful efficiency at full load and part load of heaters and of combination heaters
- minimum water heating energy efficiency of combination heaters
- maximum sound power level for heat pumps
- new technical information on the product to be provided by manufacturers

After 4 years:

- tougher minimum water heating energy efficiency of combination heaters
- tougher minimum seasonal space heating energy efficiency requirements for heat pumps and electric boilers

After 5 years:

- maximum nitrogen oxides emissions for heaters and combination heaters
- maximum emission values for CHP-units and heat pumps

Measurements and calculations of the relevant product parameters should be performed using generally recognised state-of-the-art calculation and measurement methods. In this context, manufacturers may apply reliable, accurate and reproducible measurement and calculation methods and harmonised standards.

As required in Article 8(2) of Directive [**2**], the new Regulation [**5**] specifies the applicable **conformity assessment** procedures, which should be either internal design control as set out in Annex IV to that Directive or the management system set out in Annex V to the Directive, without prejudice to Articles 7(2) and 8 of and Annexes III to V to Council Directive 92/42/EEC [**6**]. Commission means here that the old boiler efficiency Directive [**6**] should be repealed, **except for** articles and Annexes mentioned in the previous sentence, and new provisions are laid down in this Regulation to ensure that the scope is extended to heaters other than boilers.

In order to facilitate compliance checks, manufacturers are required to provide **information in the technical documentation** referred to in the conformity assessment procedures. Further standard product information to the end-user is set out in the separate Delegated Regulation on energy labelling. [**7, 8**]

Technical requirements for boilers

The following definitions are introduced in the Regualation.

'Space heater' means a device that a) provides heat to a water-based central heating system in order to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room; and b) is equipped with one or more heat generators.

'Combination heater' means a space heater that is designed to also provide heat to deliver hot drinking or sanitary water at a given temperature levels, quantities and flow rates during given intervals, and is connected to an external supply of drinking sanitary water.

The technical requirements for space heaters and combination heaters are described in the following.

Requirements for seasonal space heating energy efficiency

Two years after this Regulation has entered into force the seasonal space heating energy efficiency and useful efficiencies of heaters shall not fall below the following values:

Fuel boiler space heaters with rated heat output ≤ 70 kW and fuel boiler combination heaters with rated heat output ≤ 70 kW, with the exception of type B11 boilers with rated heat output ≤ 10 kW and type B11*) combination boilers with rated heat output ≤ 30 kW:
The seasonal space heating energy efficiency) shall not fall below 86%.**
Type B11 boilers with rated heat output ≤ 10 kW and type B11 combination boilers with rated heat output ≤ 30 kW:
The seasonal space heating energy efficiency shall not fall below 75%.
Fuel boiler space heaters with rated heat output > 70 kW and ≤ 400 kW and fuel boiler combination heaters with rated heat output > 70 kW and ≤ 400 kW:
The useful efficiency at 100% of the rated heat output shall not fall below 86%, and the useful efficiency at 30% of the rated heat output shall not fall below 94%.

*) type B11 combination boiler means a natural draught fuel boiler combination heater incorporating a draught diverter, intended to be connected to a flue that evacuates the residues of combustion to the outside of the room containing the fuel boiler combination heater, and drawing the combustion air directly from the room; a type B11 combination boiler is marketed as type B11 combination boiler only.

**) See the separate box for calculation of the seasonal space heating energy efficiency.

Requirements for water heating energy efficiency

Two years after this Regulation has entered into force the water heating energy efficiency of combination heaters shall not fall below the following values:

Declared load profile	3XS	XXS	XS	S	M	L	XL	XXL	3XL	4XL
Water heating energy efficiency	22%	23%	26%	30%	30%	30%	30%	32%	32%	32%

Four years after this Regulation has entered into force the water heating energy efficiency of combination heaters shall not fall below the following values:

Declared load profile	3XS	XXS	XS	S	M	L	XL	XXL	3XL	4XL
Water heating energy efficiency	32%	32%	32%	32%	36%	37%	38%	60%	64%	64%

Declared load profile means the load profile applied for conformity assessment. The load profiles are defined in the Annex III of the Regulation.

Requirements for emissions of nitrogen oxides

Five years after this Regulation has entered into force emissions of nitrogen oxides, expressed in nitrogen dioxide, of boiler space heaters and boiler combination heaters shall not exceed the following values:

- fuel boiler space heaters and fuel boiler combination heaters using gaseous fuels: 56 mg/kWh fuel input in terms of GCV;
- fuel boiler space heaters and fuel boiler combination heaters using liquid fuels: 120 mg/kWh fuel input in terms of GCV;

Requirements on technical information

In addition to basic product information presented so far, the new technical information requirements for boiler space heaters and boiler combination heaters now include:

- at 30% part load: useful heat output and the corresponding efficiency
- auxiliary electricity consumption at full load, at part load and in standby mode
- standby heat loss
- ignition burner power consumption
- NOx emissions
- daily electricity consumption at the declared load profile
- energy efficiency and daily fuel consumption for domestic hot water.

These require background documentation, which is available only through testing. ■

References

See the complete list of references of the article in the html-version at **www.rehva.eu** -> REHVA Journal

“Seasonal space heating energy efficiency” – a base for setting ecodesign requirements under ED and for energy labelling classification under ELD

All efficiencies are related to gross calorific value (GCV) of the fuel.

The key role in the Regulation plays the *seasonal space heating energy efficiency* η_s, defined as the ratio between the space heating demand for a designated heating season, supplied by a heater and the annual energy consumption required to meet this demand, expressed in %. The computer calculation spreadsheet first introduced in the preparation phase [**9**] to calculate this figure, and subsequently modified, has finally been replaced by a single formula applicable for all kinds of heaters covered by ED. The formula is not provided in the Regulation itself but in an accompanying draft document [**10**]. The formula is:

$$\eta_s = 0.85\eta_1 + 0.15\eta_4 - \sum F(i)$$

where for fuel boiler space heaters and fuel boiler combination heaters:

- η_1 is useful efficiency at 30% of the rated heat output, expressed in %;
- η_4 is useful efficiency at rated heat output, expressed in %.

The corrections F(i) for fuel boiler space heaters and fuel boiler combination heaters are:

F(1) accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls. The correction is F(1) = 3%.

F(2) accounts for a negative contribution to the seasonal space heating energy efficiency by auxiliary electricity consumption, expressed in %, and is given as follows:
$F(2) = 2.5 \cdot (0.15 \cdot elmax + 0.85 \cdot elmin + 1.3 \cdot P_{SB}) / (0.15 \cdot P_4 + 0.85 \cdot P_1)$
OR a default value as set out in EN 15316-4-1 may be applied.

F(3) accounts for a negative contribution to the seasonal space heating energy efficiency by standby heat loss and is given as follows:
$F(3) = 0.5 \cdot P_{stby} / P_4$
OR a default value as set out in EN 15316-4-1 may be applied.

F(4) accounts for a negative contribution to the seasonal space heating energy efficiency by ignition burner power consumption and is given as follows:
$F(4) = 0.5 \cdot P_{ign} / P_4$

Where the notations are:

- P_1 is useful heat output at 30% of rated heat output, expressed in kW
- P_4 is useful heat output at rated heat output, expressed in kW
- P_{stby} is the heat loss of a boiler in operating modes without heat demand, expressed in kW
- P_{ign} is the power consumption of a burner intended to ignite the main burner, expressed in W in terms of GCV
- *elmax* is electric power consumption of a boiler operating at full load, expressed in kW
- *elmin* is electric power consumption of a boiler operating at part load, expressed in kW
- P_{SB} is electric power consumption of a boiler in operating modes without heat demand, expressed in kW

“Useful efficiency” means the ratio of the useful heat output and the total energy input of a boiler space heater, or boiler combination heater, expressed in %, whereby the total energy input is expressed in terms of gross calorific value (GCV) of the fuel.

The full length version of this article with references is available at the journal website: **http://www.rehva.eu/** -> REHVA Journal

Indoor environmental criteria for older adults: ageing means business

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Introduction

Europeans are living longer than ever in history, because of the economic growth and advances in hygiene and health care. Today, average life expectancy is over 80, and by 2020 around 25% of the population will be over 65. The increasing group of older people poses great challenges in terms of creating suitable living environments and appropriate housing facilities. The physical indoor environment plays an important role in creating fitting, comfortable and healthy domestic spaces. Our senses are the primary interface with the built environment. With biological ageing, a number of sensory changes occur as a result of the intrinsic ageing process in sensory organs and their association with the nervous system. These changes can in turn change the way we perceive the environment around us. It is important to understand these changes when designing for older occupants, for instance, care homes, hospitals and private homes, as well as office spaces given the developments in the domain of staying active at work until older age.

Within the domain of building sciences, the indoor environment is the realm of building physicists, environmental engineers and building services engineers. The indoor environment can be influenced or altered by building services: lighting systems can increase indoor light levels; and heating, ventilation and air-conditioning (HVAC) systems are used to control temperature and humidity. Therefore, it is the engineers who can help achieve fitting indoor environments for the ageing population. Many standards and models relating to indoor environmental quality focus on office situations, which are mainly populated by people roughly aged between 20 and 65 years old. It is, therefore, of the utmost importance to have a closer look at the effects of biological ageing on the perception of the indoor environment. The goal of this article is to present an overview of the effects of biological ageing on the perception of the indoor environment, in particular (1) the thermal environment, (2) air and odours, (3) light and lighting, and (4) the acoustical environment. Thereafter, we discuss the importance of these changes for design practice.

Ageing-related changes in thermal perception

Until recently, scholars supported the hypothesis that in relation to thermal comfort, older adults did not perceive thermal comfort differently from younger college-age adults. The effects of gender and age were accounted for by PMV-model parameters, such as activity and clothing level. The ability to regulate body temperature tends to decrease with age, and these changes vary widely among individuals and are related more to general health than age. Moreover, basal metabolism declines with advancing age leading to lower body temperatures. In recent studies by Schellen et al. (2010) and Schellen (2012) on moderate temperature drifts, it was found that the thermal sensation of older adults is in general 0.5 scale units on the 7-point ASHRAE scale of thermal sensation lower in comparison to younger adults under the same thermal conditions. According to Schellen (2012), older adults, thus, prefer higher ambient temperatures. In her words, mild thermal challenges can cause significant physiological responses. For instance, cold temperature exposures can results in increased systolic blood pressure levels. Older adults, should, therefore, be protected from even mild thermal disturbances.

Ageing-related changes in the perception of odours

There is strong evidence that smell perception declines markedly with age. Age-related losses of smell normally begin after the age of sixty. Age-related sensory changes to smell include a decrease in the number of olfactory cells. These changes may lead to decreased appetite and poor nutrition, as well as a decreased protection from noxious odours. The loss of cells in the olfactory bulb in the human forebrain can lead to changes in smell. In addition, a history of upper respiratory infections, exposure to tobacco smoke and other toxic agents, and changing levels of hormones negatively influence olfactory function (van Hoof et al., 2010a).

Ageing-related changes in vision and effects of light

Ageing negatively affects vision. In general, the performance of the human eye deteriorates at early age. Many people aged 45 and over wear glasses to compensate for impaired vision due to presbyopia, the significant loss of focusing power. Older people are known to have vision impairments stemming from the normal ageing process, which include an impaired ability to adapt to changes in light levels, extreme sensitivity to glare, reduced visual acuity, restricted field of vision and depth perception, reduced contrast sensitivity, and restricted colour recognition. Changes in vision do not happen overnight, and depend on the progress of age. After the age of 50, glare and low levels of light become increasingly problematic. People require more contrast for proper vision and have difficulty perceiving patterns. After the age of 70, fine details become harder to see, and colour and depth perception may be affected. Apart from the influence of ageing, there are pathological changes leading to low vision and eventual blindness, such as cataract, macular degeneration, glaucoma, and diabetic retinopathy (van Hoof et al., 2010a, Sinoo et al., 2012).

Apart from being indispensable for proper vision, light exposure is the most important stimulus for synchronising our day and night rhythm. Research by Aarts and Westerlaken (2005) in The Netherlands has shown that light levels that older adults are exposed to (due to their mainly indoor lives in general), even during daytime, are too low to allow for proper vision and biological effects. Nowadays, older people are being exposed to so-called ambient bright light from ceiling-mounted luminaires. This encompasses an increase of the general illuminance in rooms. There are several short-term and long-term effects such as lessened nocturnal unrest, a more stable sleep-wake cycle, possible improvement to restless and agitated behaviour as well as sleep, increased amplitude of the circadian body temperature cycle, and a lessening of cognitive decline (van Hoof et al., 2012).

Noise and room acoustics

In addition to sight, one of the first senses to be affected by age is hearing, and this begins to occur by the age of 40. High-frequency pitches are the first to become less audible, with a lesser sensitivity to lower frequency pitches. The ability to understand normal conversation is usually not disturbed at first, but when combined with the presence of background noise comprehension may be affected. A laboratory study by Sato (2005) involving 20 younger and 20 older subjects using various speech tests showed that speech recognition (intelligibility) scores of the older listeners were 25% lower than those of young adults for any kind of speech test. The effect of this difference is equal to the 5 dB increase of ambient noise.

Implication for design and practice

Given the demographic changes in our societies, it is very important to be aware that biological ageing may go together with different needs and preferences concerning the indoor environment. For designers, these criteria may be extra important when designing health care facilities or buildings that facilitate activities for older adults, such as day care centres or activity halls. For designers of work places it might be wise to have a second look at the controllability of the indoor environment given the trend that people have to work longer in relation to a postponed retirement. Being conscious of differences between younger adults, on whom most standards are based, and older adults, is the first step in improving your design.

At the same time, we need to be critical. There is still a lot we do not know. Of all the indoor environmental parameters treated above, light is the best understood, and even in that domain, gaps in our knowledge are plentiful. Novel lighting applications are developed by the industry and applied to improve cognition, mood and behaviour, sleep and vision, such as dynamic lighting systems. To date, we do not know if such expensive systems have better outcomes than static lighting systems, and how such systems interact with available daylight. Vision can be improved by raising general illuminance levels and glare control. When integrated in the building, light therapy solutions challenge the designer to come up with a design that on the one hand yields the right lighting to procure non visual effects and on the other hand does not hamper (through glare as a result of the high illuminances needed) the occupant while performing visual tasks.

The supply of fresh air, elimination of bad odours, reduction of background noise and other aspects of the acoustical environment are recognised as being important, but are not as well-studied as light and lighting. The economic benefits of accounting for these parameters are not yet clear. In terms of the acoustical environment, it is not possible to provide specific data and values of the ideal sound pressure levels and reverberation times for older persons. Recent findings in the realm of thermal comfort research suggest that older adults may have a need for slightly higher indoor temperatures. As long as there are many uncertainties, we suggest to allow for a maximum of user control in buildings. Apart from designing indoor environments that meet the needs of older adults, the accessibility of spaces and other human factors approaches should be considered to optimize a building for use by older occupants. ■

Using ventilative cooling and solar shading to achieve good thermal environment in a Danish Active House

Figure 1. "Home for Life". South and east facades.

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The thermal comfort of the residential building Home for Life is presented with a particular focus on the strategies used to achieve good thermal comfort, and the role of solar shading and ventilative cooling with natural ventilation. Home for Life was completed in 2009 as one of six buildings in the Model Home 2020 project. It has generous daylight conditions, and is designed to be energy neutral with a good indoor environment.

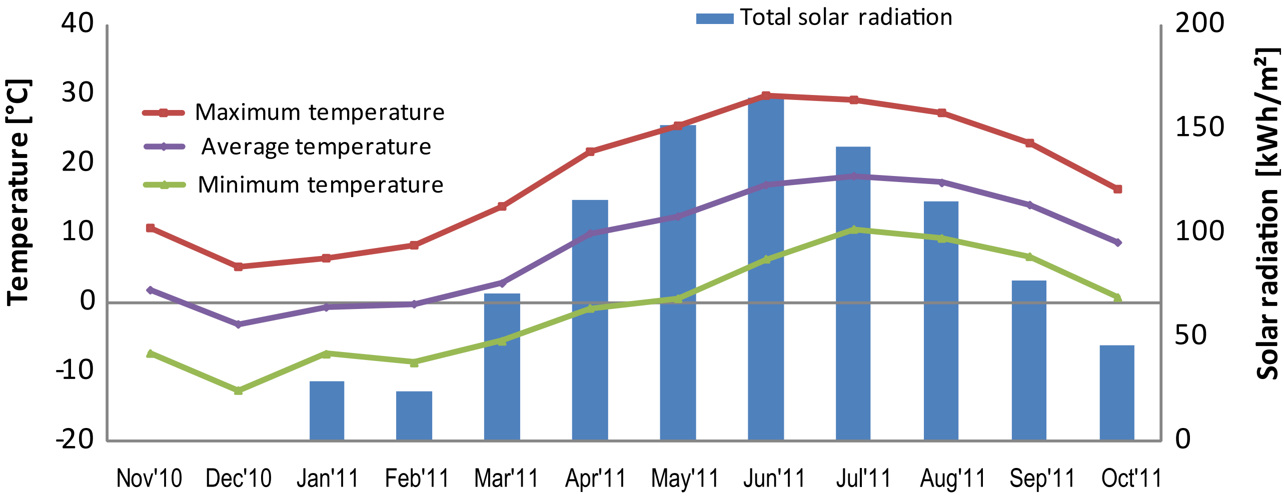

Figure 2. Outdoor conditions during the measurement period. The pyranometer was installed in January 2011, and therefore data is not available for November and December.

The thermal environment is evaluated according to the Active House specification (see article by Eriksen, Rode and Gillet in this issue of REHVA Journal), and it is found that the house reaches level 1 for the summer situation. Some undercooling occurs during winter, which is due to the occupants' preferred balance between indoor temperatures and heating consumption.

It is found that ventilative cooling through window openings play a particularly important role in maintaining thermal comfort.

Introduction

Five single-family houses in five European countries were built between 2009 to 2011 as a result of the Model Home 2020 project. The first house (Home for Life, Denmark), was completed in spring 2009 and has been occupied by two different families, of which the last family has bought the house. Measurements were performed for two years during the occupancy of two families. Home for Life is a 1½-storey house with a total floor area of 190 m². Basic climatic data are presented in **Figure 2**.

The six houses follow the Active House (www.activehouse.info) principles which mean that a balanced priority of energy use, indoor environment and connection to the external environment must be made. In practice this means that the houses should have both an excellent indoor environment and a very low use of energy. There is a particular focus on good daylight conditions and fresh air from natural ventilation. Most main rooms have daylight factors above 5%.

The ventilation system is hybrid, i.e. natural ventilation is used during the summertime and mechanical ventilation with heat recovery during the wintertime, while hybrid ventilation is used spring and fall. The switch between mechanical and natural ventilation is controlled based on the outdoor temperature. The setpoint is 12.5°C with a 0.5°C hysteresis. Below the setpoint the ventilation is in mechanical mode, above the setpoint the ventilation is in natural mode. In both natural and mechanical mode, the ventilation rate is demand-controlled. CO_2 is used as indicator for the Indoor Air Quality, and a setpoint of 850 ppm CO_2 is used. Besides that, relative humidity is also used as indicator. When RH is 60% or higher, ventilation is increased step-wise to maximum ventilation, which is used when RH is 80% or higher.

There is external automatic solar shading on all windows towards South, and overhangs are used where appropriate.

Results

Figure 4 shows that five rooms achieve Active House level 2, while six rooms achieve level 4. It is clear from the figure that the majority of the hours in level 2, 3 and 4 are caused by low temperatures, i.e. undercooling rather than overheating. When undercooling is disregarded, all rooms except bedroom and scullery achieve level 1.

The focus of this article is on the performance related to ventilative cooling and potential overheating. The further analyses will focus on the performance of the kitchen, which is a combined kitchen and dining room with a large south-facing window section, **Figure 1**.

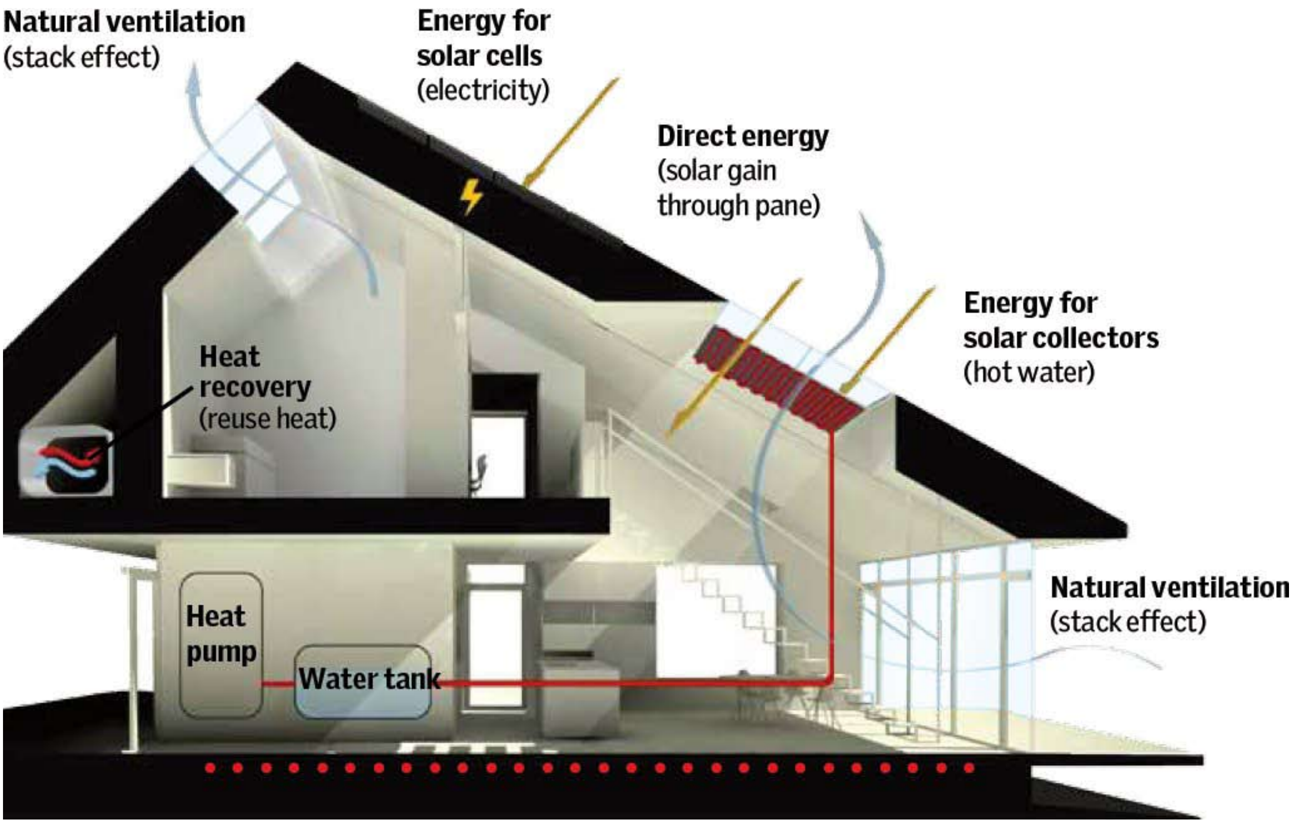

Figure 3. "Home for Life". Concept for daylight, ventilation and energy.

The distribution of categoeries between months are seen at **Figure 5**. As expected from **Figure 4**, the undercooling is an issue in 4 winter months from November to February. From April to October, level 1 is achieved.

Figure 6 shows the indoor temperature at each hour of the year plotted against the running mean outdoor temperature as defined in EN 15251. It is seen that temperatures below the level 1 limit (21°C) occur both in winter and in the transition periods, but only with a few hours below the level 2 limit (20°C). It is suspected that the episodes with temperatures below 21°C are caused by either manual or automatic airings, or more simply by user preference. The occupants have not reported discomfort due to undercooling in their diaries.

Some episodes with temperatures above 26°C are also seen during winter and in the transition periods, auggesting large variations in temperature during short periods of time. This is suspected to be due to solar gains. The automatic control of window openings and solar shading is setup to prevent overheating, but especially

Table 1. Thermal comfort scores as defined in the Active House specification, section 1.2 for naturally ventilated buildings.

The maximum indoor temperature limits apply in periods with an outside T_{rm} of 12°C or more. T_{rm} is the Running Mean outdoor temperature as defined in 'chapter 3.11 External temperature, running mean of EN 15251:2007'. The limits apply to living rooms, kitchens, study rooms, bedrooms etc. in dwellings without mechanical air conditioning and with adequate opportunities for natural (cross or stack) ventilation.

The maximum indoor operative temperatures are:
1. $T_{i,o} < 0.33 \times T_{rm} + 20.8$°C, for T_{rm} of 12°C or more
2. $T_{i,o} < 0.33 \times T_{rm} + 21.8$°C, for T_{rm} of 12°C or more
3. $T_{i,o} < 0.33 \times T_{rm} + 22.8$°C, for T_{rm} of 12°C or more
4. $T_{i,o} < 0.33 \times T_{rm} + 23.8$°C, for T_{rm} of 12°C or more

"Too high" used in this paper applies to $T_{i,o} > 0.33 \times T_{rm} + 23.8$°C, for T_{rm} of 12°C or more

The minimum operative temperatures are:
1. $T_{i,o} > 21$°C, for T_{rm} of 12°C or less
2. $T_{i,o} > 20$°C, for T_{rm} of 12°C or less
3. $T_{i,o} > 19$°C, for T_{rm} of 12°C or less
4. $T_{i,o} > 18$°C, for T_{rm} of 12°C or less

"Too low" used in this paper applies to $T_{i,o} < 18$°C, for T_{rm} of 12°C or less

Further information can be found in the specification at www.activehouse.info.

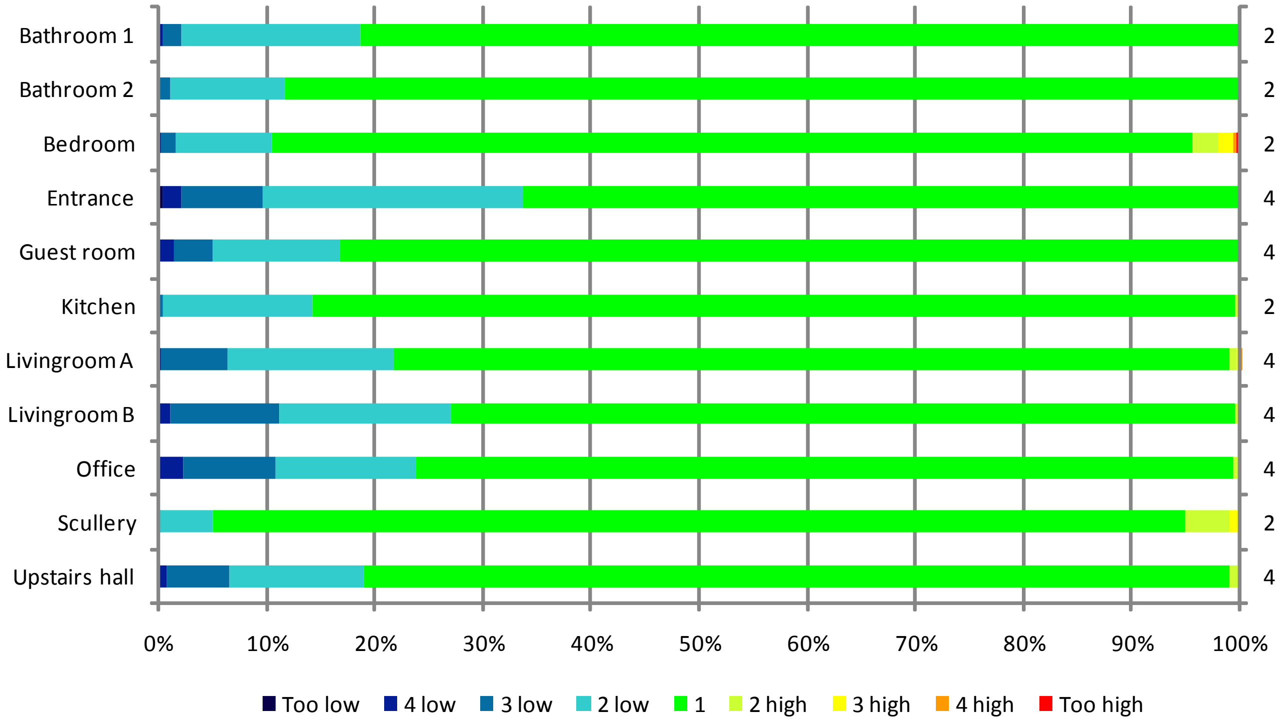

Figure 4. Thermal comfort for each of the rooms evaluated according to Active House specification section 1.2 (see Table 1 for explanation). The levels are differentiated between high and low temperatures. The number at the right side of the diagram indicates the level for each room (1 to 4). To achieve a score of e.g. "2", at least 95% of the time must be at that level or better, as defined in EN 15251.

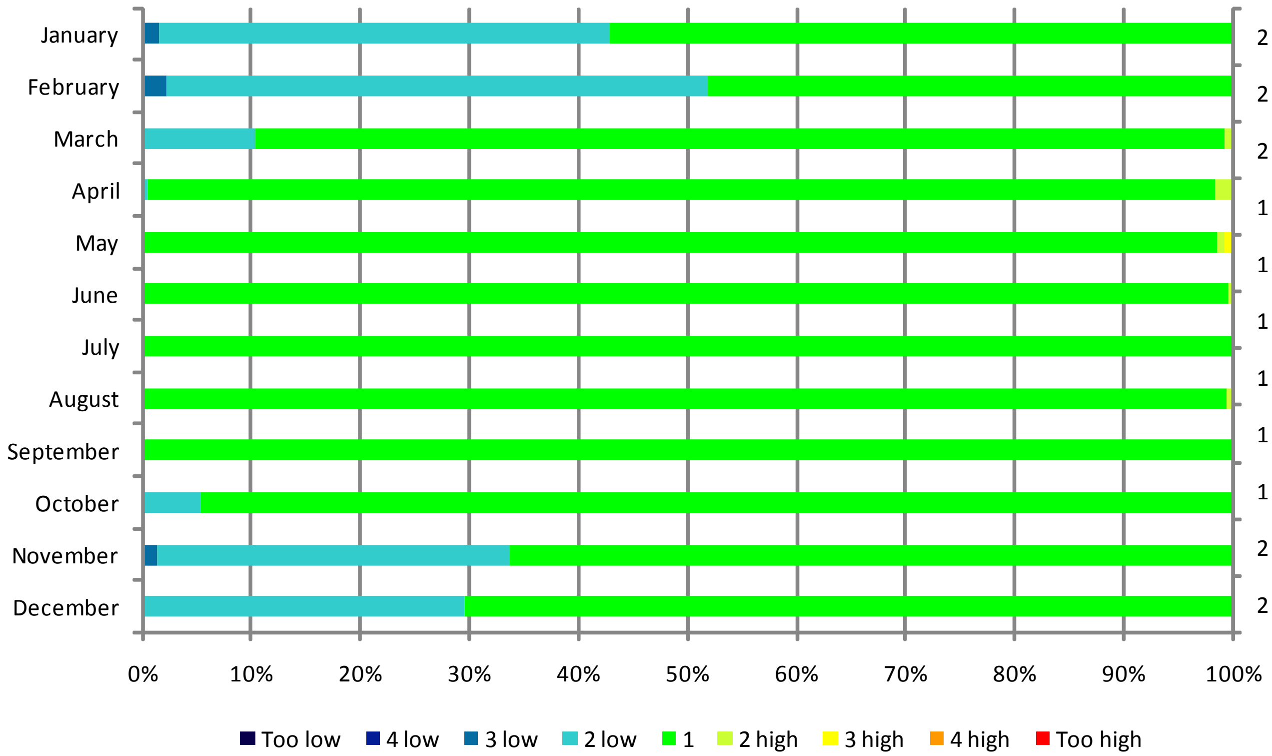

Figure 5. Thermal comfort categories for each month of the year for the kitchen and dining room. The number at the right side of the diagram indicates the score for each month (1 to 4). To achieve a score of e.g. "2", at least 95% of the time must be at that level or better, as defined in EN 15251. (see Table 1 for explanations)

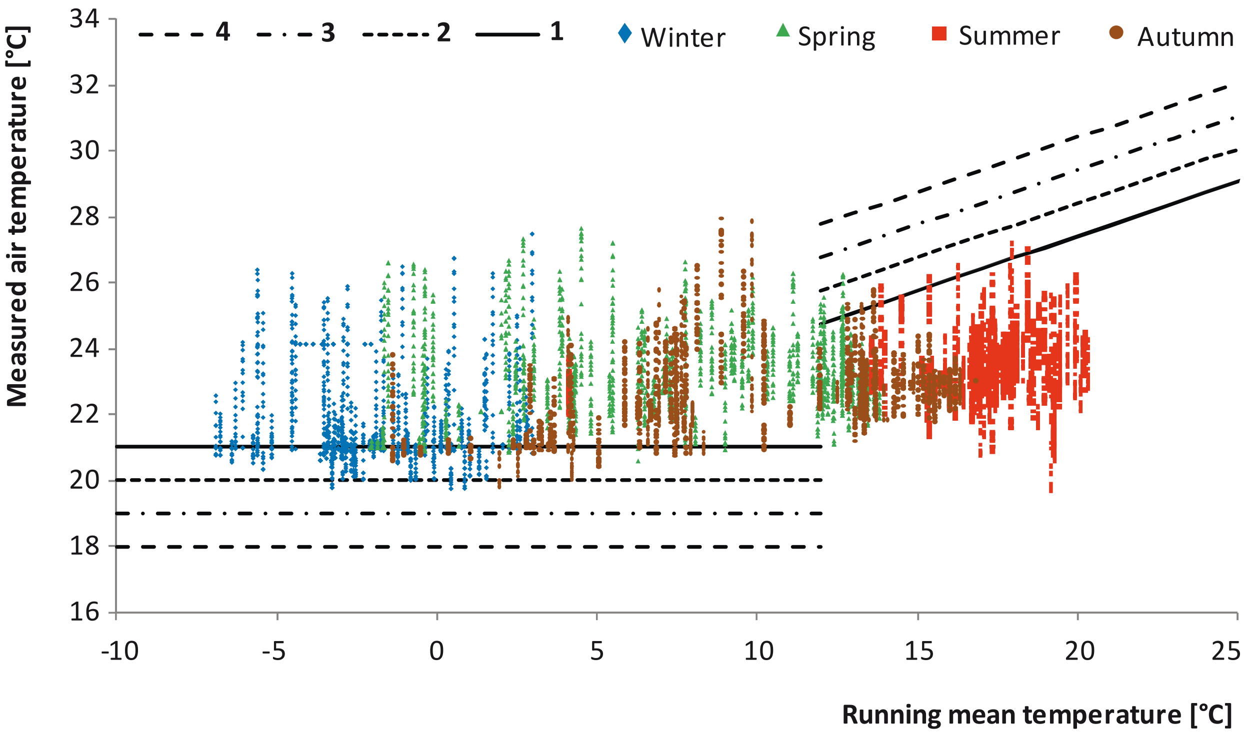

Figure 6. Indoor temperatures in the kitchen plotted against running mean temperature for each hour of the year including the Active House limits. The dots are coloured to represent a season.

during winter the system will accept high solar gains to reduce the heating demand.

During summer the system prioritizes to maintain thermal comfort, and **Figure 6** shows very limited overheating during summer, with only a few episodes with temperatures above level 1. Relatively low temperatures are observed during summer, with episodes with temperature drops below 21°C. This is suspected to be caused by night cooling, where the temperature decreases during the night to reduce overheating the following day, which in some situations lead to temperatures in the morning between 20°C and 21°C.

The variation over time-of-day and time-of-year is further investigated in **Figure 7**. It is seen that the episodes during winter with temperatures below level 1 can last for several days during the winter, but that in many of the episodes, the temperature reaches level 1 between 12:00 and 20:00, possibly due to solar gains.

During summer, only few episodes with temperatures beyond level 1 are observed.

To investigate the role of window openings in maintaining comfort, **Figure 8** is used. A rather strict comfort definition is imposed for the sake of the analysis (level 2 was the design target), where only level 1 is considered comfort. The figure also shows if windows where active during each hour.

Figure 8 shows that windows were not open during the winter episodes with temperatures below level 1 (orange), indicating that these episodes were not caused by airings. The heating system during winter is controlled in such a way that the supply temperature for the floor heating system is set at the heat pump control. The lower the supply temperature, the better the system efficiency. The occupants have reported that they set the supply temperature so that the room temperature would reach 20-21°C to reduce heating consumption. The episodes with winter temperatures below level 1 can thus be attributed to user preferences.

A few episodes with red colour are seen during summer in the late afternoon, indicating that overheating occurred and that windows were opened, but that this was not sufficient to maintain level 1.

Figure 8 further shows that during the summer, windows are almost permanently open between 9:00 and 22:00 and that level 1 is maintained during these hours

Figure 7. The comfort level of each hour of the year is plotted as a temporal map (kitchen and dining room).

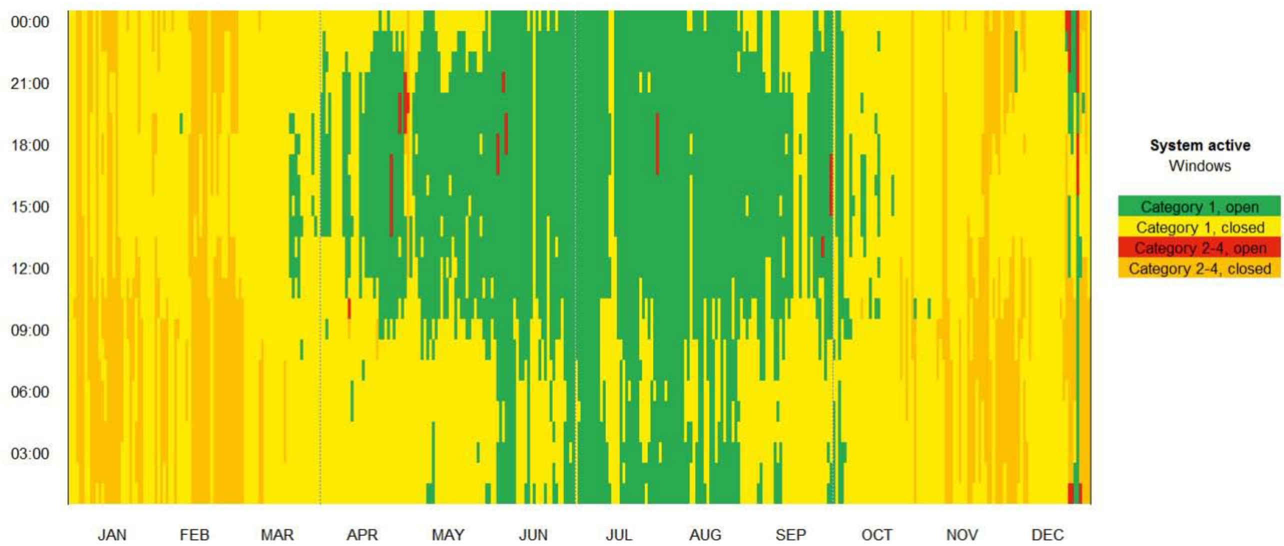

Figure 8. Temporal map showing comfort or discomfort (discomfort is here temperatures in level 2, 3 or 4) and if windows were open or closed (active or not active). Figure shows the combined kitchen and dining room.

(green). The figure shows many episodes with open windows between 22:00 and 9:00 (green), which can be assumed to be caused by automatic window opening for night cooling. Also in the transition periods (March to May and September to October) windows are used to a large extent, with openings between 12:00 and 18:00 as a typical episode (green).

The occurrence of windows in relation to outdoor temperature is further investigated at **Figure 9**. It is seen that windows are generally closed (red dots) when the running mean temperature is below 10°C. When the running mean temperature is above 12°C, windows are generally opened when the indoor temperature exceeds 22 -23°C, which is in accordance with the control strategy.

Discussion

For the rooms in Home for Life, half fall in level 2 and the other half in level 4 with regards to thermal conditions,

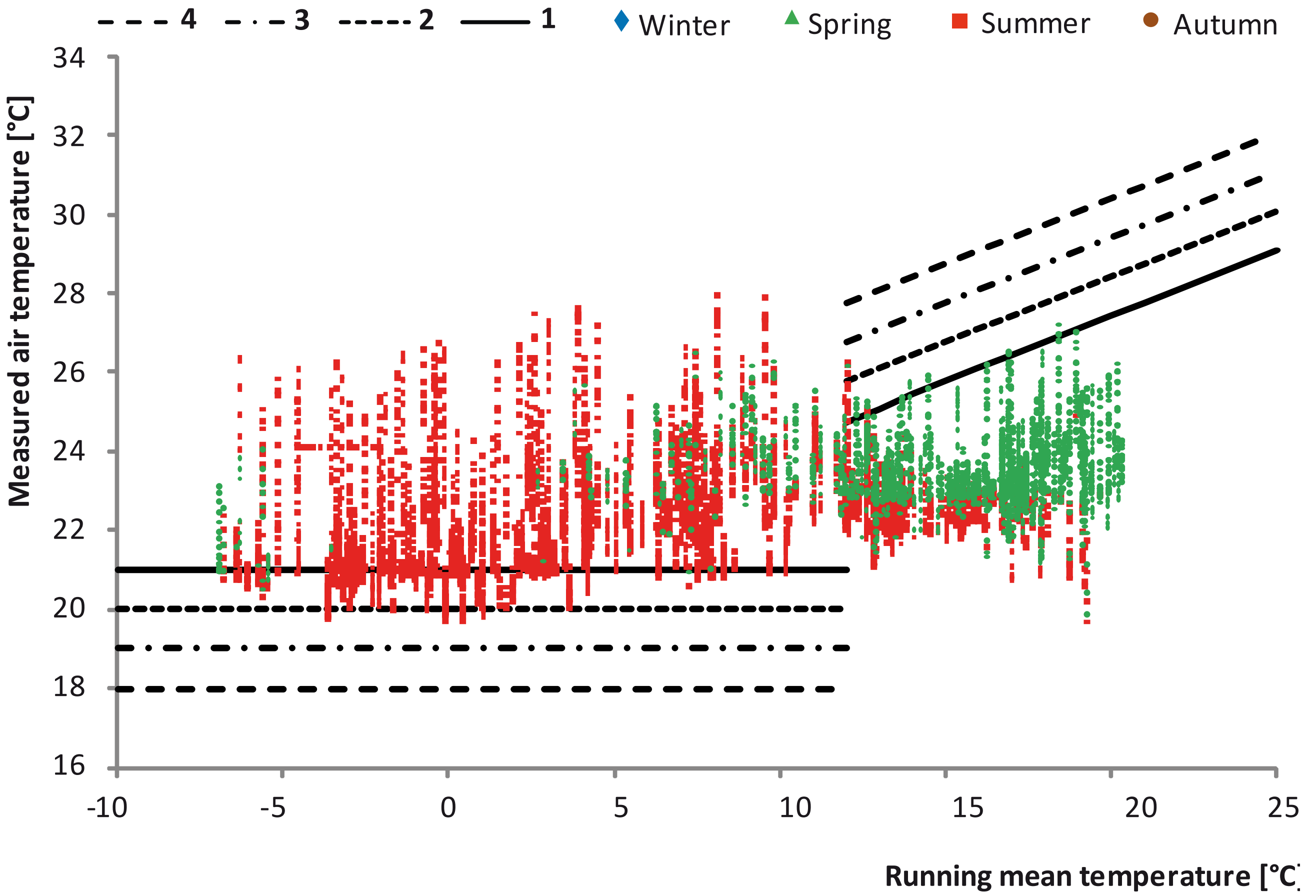

Figure 9. Indoor temperature vs. running mean outdoor temperature. The colour indicates if windows were open (green) or closed (red) for each hour (kitchen and dining room).

when evaluated according to the Active House specification, which uses the same methodology and criteria as EN 15251 with regards to thermal comfort. The hours not in level 1 are mainly hours with undercooling, while overheating is rare. If undercooling is disregarded, the primary rooms of the house achieve level 1. For low energy houses, overheating should be prevented by the building design, as overheating may require substantial measures if handled after completion. Home for Life thus meets the level 1 with regards to overheating, which is very satisfactory, given the generous daylight conditions.

The episodes with undercooling could be caused by insufficient heating capacity, window airings, poor building airtightness or occupant preferences. It was found that there was no correlation between window openings and undercooling. The airtightness has been verified by a blowerdoor test. The heating system is known to have a sufficient capacity, but the supply temperature was actively reduced by the occupants to reduce the heating consumption. Undercooling in Home for Life is therefore explained by occupant preferences.

In the kitchen/dining room, a correlation between window openings and the combination of high indoor and outdoor temperatures was found. Further, a clear correlation between window openings and acceptable thermal comfort was found. This indicates that window openings have contributed to achieving and maintaining good thermal conditions.

No clear correlation between use of external solar shading and temperature. Users may often have used the override function to deactivate the automatic control of solar shading, which could explain the missing correlation between use of shading and the combination of high indoor and outdoor temperatures.

In conclusion, Home for Life achieves a good thermal performance in real use, which should be seen in connection to the high daylight levels of the building. The good performance is achieved with automatic control of window openings and solar shading, where especially the ventilative cooling from open windows was important. ■

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Performance of automated demand controlled mechanical extract ventilation systems for dwellings in Europe

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Introduction and methodology

On continent Europe, demand controlled ventilation (DCV) is considered today as a particularly relevant alternative to other mechanical extract ventilation systems (MEV) and especially for mechanical ventilation systems with heat recovery (MVHR). For the moderate climate zone of Western Europe, with about 2500–3000 heating degree days, the payback time for investments in heat recovery ventilation is long, especially in buildings with relatively low air change rates such as dwellings. Due to its competitive price setting as well as due to reports in popular media and scientific literature about possible health risks associated with heat recovery systems, simple central MEV dominates the residential ventilation market in this region. The great variability of a dwelling occupancy in time and place, enhances the potential of DCV. By applying DCV, heating energy related to ventilation is reduced by 20 to 50%, while electricity consumption is similarly reduced.

In Belgium an equivalence approach based on a Contam model[1] is used to rate the performance of demand controlled ventilation systems. Average cumulative CO_2-concentration (kppm.h) above Δ600 ppm is used as IAQ indicator, next to the risk on condensation and the exposure to odours.

In France the assessment of DCV systems is done by CSTB based on the Siren model[1] resulting in a so-called "Avis Technique". In the calculation also IAQ restrictions must be fulfilled.

In Germany the energy performance of a DCV system was investigated by the Fraunhofer institute based on the WUFI-Plus model[2]. In contrast to Belgium and France, however, this methodology is not officially accepted by authorities, to take into account in the German energy performance calculation (EnEv). Using DCV only leads to a fixed 10% reduction compared to MEV systems.

In the UK, there is no recognition of advanced systems either under Part F of the Building Regulation or under Appendix Q of the Standard Assessment Procedure (SAP). Therefore the Belgian approach is used to calculate the impact on IAQ and energy consumption of demand controlled systems.

The aim of this article is to assess theoretically the energy saving potential of DCV and the indoor air quality (IAQ) to which the occupants of the dwelling are exposed, compared to normative (design flow rates according to national standard) ventilation systems. Two different demand controlled mechanical extract ventilation (DCV) systems (DCV1 and DCV2) in comparison with passive stack ventilation PSV, MEV and MVHR were investigated.

Characteristics demand controlled systems

In this study, two automated demand controlled mechanical extract ventilation systems of Renson based on natural supply via trickle vents in the habitable rooms and mechanical extraction in the wet rooms (such as kitchen, bathroom, sanitary accommodation (toilet) and laundry (utility)) (DCV1) or even the bedrooms (DCV2) were analysed (**Figure 1**).

1 Savin, J-L., Laverge, J. (2011). Demand-controlled Ventilation: an outline of assessment methods and simulations tools. AIVC-tightvent conference 32.

2 Lengsfeld, K., Holm, A. Entwicklung und Validierung einer hygrothermischen Raumklima-Simulationssoftware WUFI-Plus. Bauphysik 29 (2007), Heft 3, Seite 178-186. Ernst & Sohn Verlag Berlin.

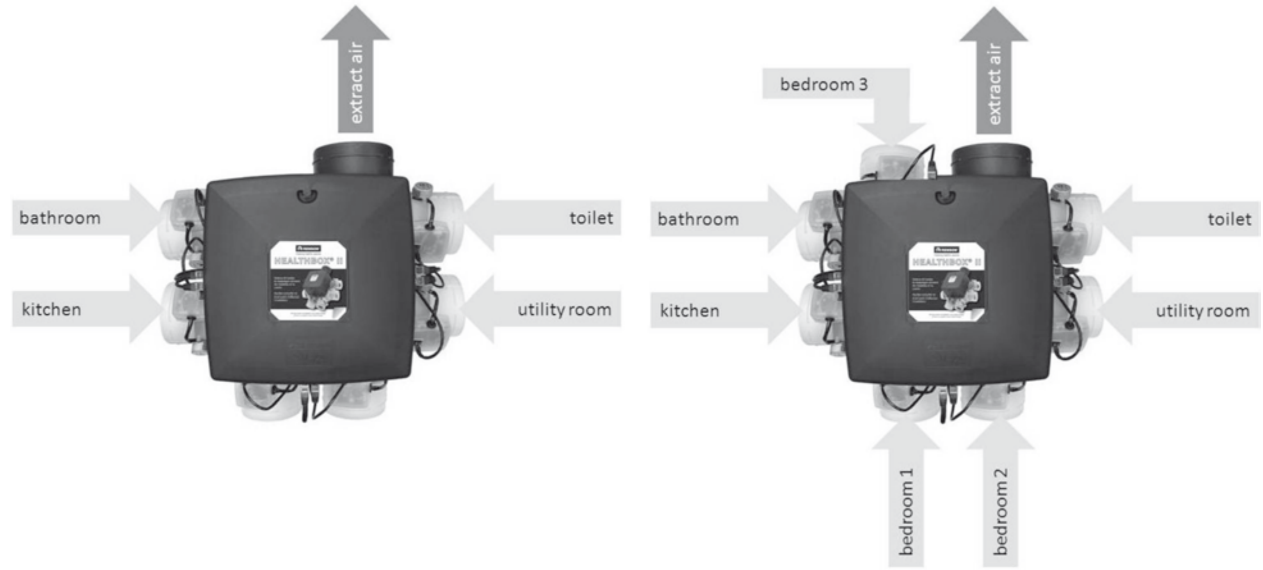

Figure 1. Configuration of DCV 1 (left side) and DCV 2 (right side). The fan is situated in the central box, the valves which contain the IAQ sensors (RH, CO_2, VOC) are connected to the central box.

The basis of the DCV system constitutes a constant pressure fan which has self-regulating extract valves connected to the fan at the end of the extract ducts. In that way, the air flow rate is controlled on pollutant concentration at room level (multi-zone-control). An automatic calibration procedure is integrated in the system to make sure that in each extract duct the design air flow rate can be effectively reached.

Each self-regulating extract valve can contain up to two sensors, to control and monitor the extract air flow rate. A relative humidity sensor (RH), an odour (VOC) sensor and/or a CO_2 sensor can be applied. Based on the measured values of the sensors, the flow rate through the duct is adjusted between a minimum (15% of the design flow rate) and the design flow rate. The minimal room air flow rate is never lower than 0.1 l/s/m² as specified in EN 15251.

Results

Belgium

For DCV1 and DCV2 the ventilation heat losses and cumulative CO_2-concentration are shown in **Figure 2** compared to the reference systems which are indicated by the red line. As can be seen in **Figure 2**, the IAQ of PSV and MEV is always worse with respect to that of MVHR. Due to variable wind and thermal forces on the building, air flow rates are less controlled and cross ventilation can occur, especially in case of PSV, which causes higher CO_2-concentrations especially in the bedrooms.

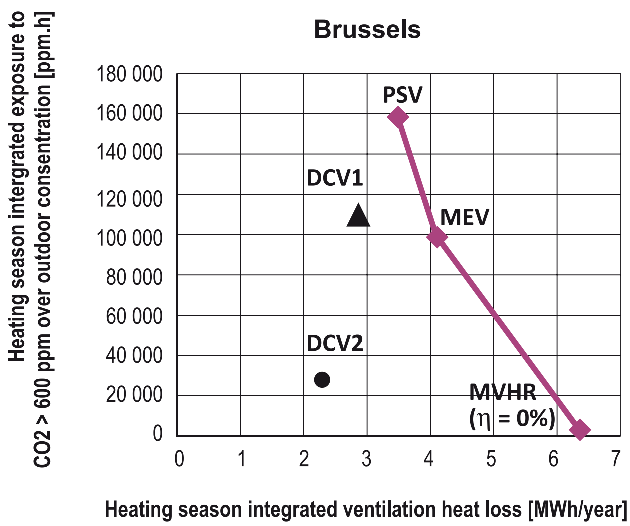

Figure 2. Average cumulative CO_2-concentrations (kppm.h) above Δ600 ppm against ventilation heat loss (MWh/year) for the reference (red line) and the DCV1 and DCV2 ventilation systems according to current Belgian standard.

DCV1 realises a similar IAQ compared to MEV, while the CO_2-concentration exceeds of DCV2 are very small. This means that DCV2 approaches closely the IAQ of MVHR. DCV1 and DCV2 reduces the ventilation heating energy with approximately 35 and 50%, respectively, compared to MEV. When expressed compared to MVHR (no heat recovery, $\eta = 0\%$), a heating energy reduction of about 55 to 65%, respectively, is found. Common residential MVHR realise a heat recovery efficiency of 70 to 85%, if well designed and maintained.

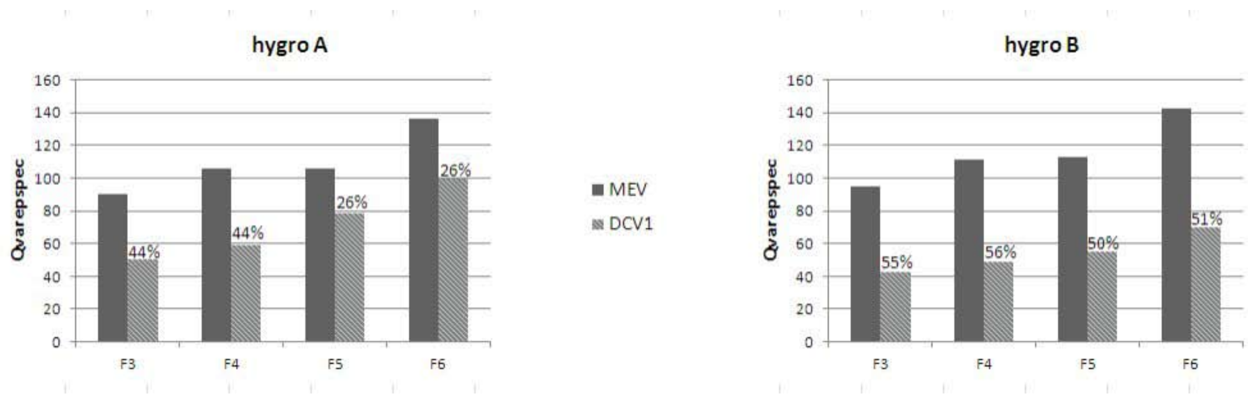

Figure 3. Average reduction for the reference and DCV1 ventilation systems according to current French law and "Avis Technique" for hygro A (left) and hygro B (right) systems.

France

In the French calculation procedure DCV systems are only compered to MEV systems. When IAQ criteria are fulfilled, a so-called air flow rate reduction factor "$Q_{varepspec}$" is calculated. Since extract from bedrooms is not allowed according to the law of 24 march 1982, there are no results for DCV2. The mean results for classic DCV1 systems now available on the French market are shown on **Figure 3** for the most current building types (F3 – F6) and for both hygro A and hygro B systems. Hygro B meaning not only the extract is adapted according to RH in the room but also supply is controlled on RH in the dry room. **Figure 3** shows how for the hygro A systems DCV1 results in a reduction from 26 to 44% in comparison with MEV systems without demand control. In combination with a RH controlled supply, an even greater reduction can be achieved with a DCV1 system of approximately 53%.

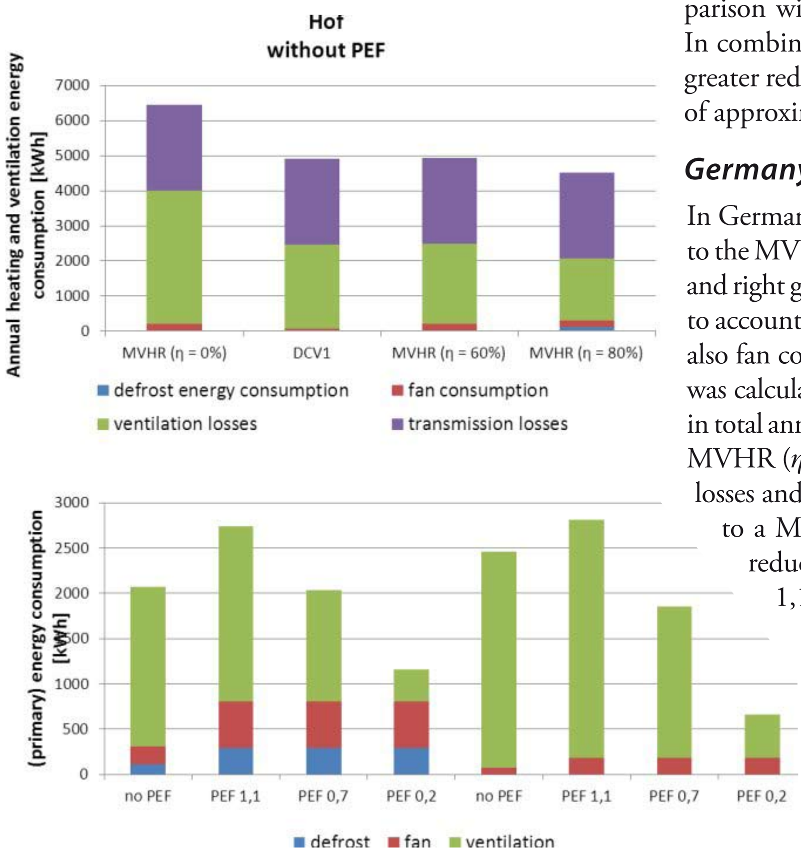

Figure 4. Energy loss (kWh) for the reference and DCV1 ventilation systems according to current German standard not taking into account primary energy factors (top) and taking into account primary energy factors for heating energy (bottom).

Germany

In Germany only DCV1 was calculated and compared to the MVHR systems as shown in **Figure 4**. On the left and right graph, respectively without and with taking into account different primary energy factors (PEF). Here also fan consumption and defrost energy consumption was calculated for the different systems. The difference in total annual energy consumption between DCV1 and MVHR (η = 80%) is only 633 kWh due to ventilation losses and 241 kWh less fan consumption. Compared to a MVHR (η = 60%) system, DCV1 achieves a reduction of 27 kWh. Furthermore, for PEF = 1,1 (a classic heating system with gas) DCV1 performs equal as MVHR (η = 80%). The smaller the PEF, the better DCV1 performs since the electrical part becomes more important. Thanks to the minimal electrical consumption of DCV1 it performs better than MVHR (η = 80%).

Looking at IAQ DCV1 performs well, only in the bedroom the threshold of 1200 ppmv was exceeded. With DCV2, extracting direct from the bedrooms, this would definitely not be the case.

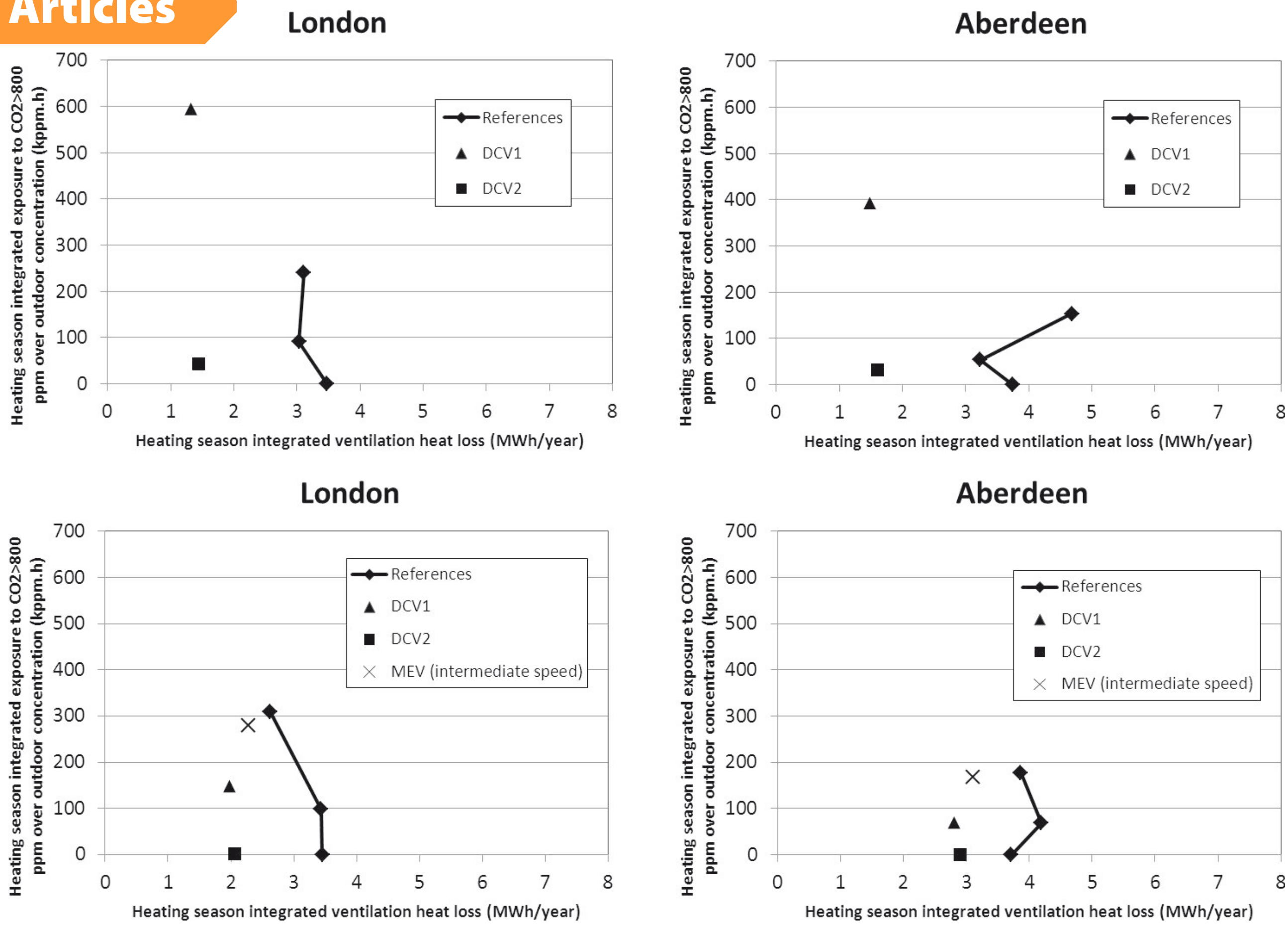

Figure 5. Average cumulative CO_2-concentrations (kppm.h) above 800 ppm over outdoor CO_2-concentration against ventilation heat loss (MWh/year) for the reference (red line) and the DCV1 and DCV2 ventilation systems with supply air flow rates according to current British standard (top) or equal to MVHR (bottom) for London and Aberdeen.

UK

Following approved document F and the Belgian assessment procedure, DCV1 and DCV2 were compared to the reference systems in **Figure 5** for the location of London and Aberdeen. The smaller air supply rates of all UK designed ventilation systems and the smaller extract rates of MVHR, explain the lower heat losses and the worse IAQ of UK designed systems when compared with **Figure 2**.

When looking to DCV1 and DCV2 in **Figure 5** for a given location, it is clear that both DCV systems have a similar impact on the ventilation heat losses, but huge differences are observed concerning exposed IAQ. Since DCV1 has an IAQ worse than the reference it is unacceptable according to the procedure. Increasing the design air flow rates for MEV to a similar level as those for MVHR, improves significantly the IAQ of DCV1 (**Figure 5**). For DCV2 the IAQ is acceptable and situated in the middle between that of MEV and MVHR. The heating energy reduction of DCV1 and DCV2 for the two locations is in the range of 50 to 60% when compared to MEV and MVHR (η = 0%).

With respect to ventilation heat losses for the location of London, the energy losses of DCV1 and DCV2 with higher air supply rates increase by about half. This means that heating energy reduction for DCV1 and DCV2 becomes about 35% compared to MEV and about 40% when compared to MVHR (η = 0%).

Conclusions

By means of different European equivalence procedures the significant effect of demand control on the performance of a MEV system was illustrated and discussed. Ventilation heat losses were reduced by 30 to 50% due to automated demand controlled systems. Fan consumption of demand controlled MEV systems is remarkably lower than MVHR systems. In that way, under Western European climate conditions, demand control can bring a standard MEV system to a similar level as MVHR when considering primary energy consumption. Besides, due to the automatic detection of the IAQ in the different rooms, the guarantee on good IAQ is higher when compared with a manually operated mechanical system without sensors, leading to similar IAQ levels as those obtained with MVHR. ■

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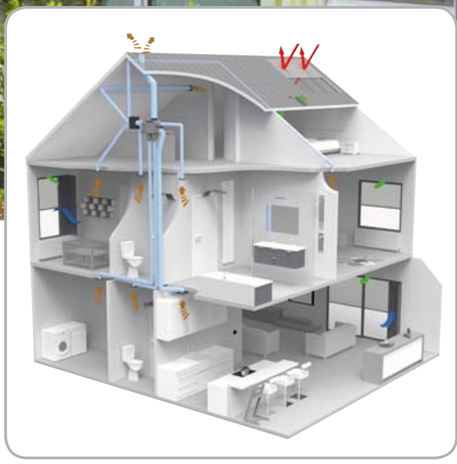

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Green Building Market in Russia

Russia is catching up quickly with the mature green building markets. The number of buildings certified to LEED and BREEAM is growing weekly. National Green Building Standards have been developed and are coming into force. DGNB, the German standard is also known on the market. A Localised Passive House Standard is being implemented.

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Russian National Green Building Standards

GOST R 54964–2012 «Environmental requirements for real estate» is a conformity assessment method, environmental requirements to a property. It was approved in 2012 as a voluntary state standard. It is based on the Russian building regulations (GOST and SNiP) with a strong influence by the BREEAM and LEED benchmarking tools.

The standard **STO NOSTROY 2.35.4 2011** «Green building. Buildings and civil construction. Rating system for evaluation sustainability of residential and public buildings» complies with international ISO standards, taking into account the national construction and sanitary norms, regulations and guidance documents. The standard is influenced by LEED, BREEAM, DGNB and HQE (France). It defines the principles, categories, evaluation criteria, sustainability indicators of habitat, as well as weighting for ratings for buildings; provide a framework of basic indicators, which, when necessary are corrected or supplemented by coefficient parameters to reflect regional or local climate, energy, economic, social and even bespoke features; establishes classes of sustainability for the built environment, including renovated residential and public buildings, for both the building and project documentation. The benchmarking system for «sustainable habitat» includes basic values of the criteria and their equivalents, roughly corresponding to the conditions of the Moscow region. As Russian regions significantly differ by climate, resources (water and energy) and the potential for generating renewable power, there is an obvious need for a regional perspective in any rating tool. For such a regional perspective, categories and criteria of «sustainable habitat» are dealt with in the **STO NOSTROY 2.35.69–2012** «Green building. Buildings and civil construction. Consideration of regional characteristics in the rating estimation of sustainability in building construction».

The documents are jointly developed by «ABOK» (Association of Engineers for Heating Ventilation and Air Conditioning), «Centre for Environmental Certifications – green standards» (supported by the Ministry of Nature Resource of Russia), «National Association of Builders – NOSTROY and TERMEK.

BREEAM in Russia

BREEAM in the most commonly used rating system in Russia. More than 10 buildings are certified including a business centre Ducat Place III in Moscow – the first commercial real estate in Russia-certified by BREEAM. The building was awarded with a «Very Good» level by BREEAM Europe Offices scheme. Due to environmental initiatives energy consumption of the building has decreased by almost 35 % in 2010 compared with 2008, with savings for tenants to more than 188,000 USD a year.

12 Olympic facilities of various types (indoor and outdoor sports arenas, cottage village, university, office buildings, hotels and spa resorts as well as a railway station) in Sochi are being certified on individual criteria, developed in accordance with the logic BREEAM Bespoke International 2008–2011 standards.

An important result of certification of the Olympic facilities will be the development and approval of the so-called «checklist A10» – incorporation of European regulations used in the BREEAM system and Russian building regulations. When the developed checklist A10 system is approved by BRE Global (BREEAM operator), a number of Russian norms are deemed admissible as evidence for the BREEAM certification which will simplify the certification process.

Other green buildings in Russia

In addition to the buildings that are certified by green standards there are a number of objectively green and innovative buildings that deserve special attention and recognition because they demonstrate innovation in terms of ecology, economy, energy and resource efficiency as well as other aspects of the green construction.

More information at zvt.abok.ru

«Bolshoy» (Big) Ice Palace in Sochi

The «Adler» passenger railway station in Sochi

Passive house in South Butovo

Business centre «Japan House»
(first building in Russia by BREEAM In-Use).

Innovative modern technology in Sochi

As part of the certification process in Sochi there are some innovative technologies and solutions applied – important for Russia's green building industry development:

- The broad and extensive use of photovoltaic cells (PV panels) to generate electricity.
- The broad and extensive use of solar hot water systems (SHW).
- The use of high quality energy-efficient materials in construction (fit-out, glass and external surfaces).
- The use of high-quality and efficient engineering equipment for buildings.
- Implementing of innovative construction technologies that save time, money and reduce the overall impact on the environment.
- The conservation and restoration of biodiversity in areas of construction.
- The creation of bicycle parking, paths and infrastructure.
- Charging stands for electric vehicles (EV) some from renewable energy sources.
- The partial use of both vertical and horizontal landscaping on buildings (green roofs and walls).
- The widespread use of LED lighting.
- Energy modelling at project design stage to calculate efficiency of design and to help finding optimal solutions and implementation methods.
- The use of FSC-certified wood. ■

Solar Shading in Active House

Daylight is a central element in the Active House vision. In this article we show that solar shading is an essential building block that enables the Active House daylighting ambition. In a lot of practical cases, the daylighting requirements will necessitate substantial window size. Combined with the high thermal insulation needed to achieve a sufficiently low energy demand for heating, solar heat gain needs to be harnessed in order to meet the summer thermal comfort criteria of Active House.

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Daylight and view out

Daylight is a central element in Active House. Today, there is ample evidence for the importance of daylight for our health and well-being. Besides that, it is a freely available source of high quality light of high luminous efficacy (visible flux as a proportion of radiant flux, lm/W).

There are two objective metrics for the quality of daylight in the Active House specification. The first is the well known daylight factor, DF. The daylight factor measures the ratio between the interior horizontal illuminance and the unobstructed exterior horizontal illuminance under overcast sky conditions. An adequate daylight factor ensures that under worst case conditions (overcast sky) there still is adequate daylight. The specifications require a DF > 5% for the highest rating on this aspect or a DF > 3% for the second highest rating (averaged over the area of the space). It is clear that a high DF is directly related to large window size and is further influenced by obstacles in the immediate environment of the building. **Figure 1** shows a living room with an area averaged DF > 5.

The second metric applies to at least one of the main habitable rooms and requires that between the fall and spring equinox this room receives at least 10% of the probable sunlight hours for the highest rating on this aspect and at least 7.5% for the second highest rating. This second metric is clearly related to orientation – favoring south orientations – and takes obstructions in the environment into account. The specifications recommend that a shading device should allow for direct sunlight to be excluded if desired.

Energy Demand

At a ventilation regime of 0.2 ACH during the night and 2 ACH during occupancy (conforming to the Active House specifications), the annual energy requirement of the model living room for heating is only 3 kWh/m².a when heat recovery with an efficiency of 76% is used. The materialization of the living room is medium heavy and consists of R = 5.0 m²K/W external walls and triple glazing with U = 0.74 W/m²K, g = 0.51 and a visual transmittance of 0.69. The house is assumed to be located in Amsterdam and the glazed façade is facing south. Our living room is occupied between 7 and 22 h.

Thermal comfort

The daylight requirements above clearly have their consequences when it comes to thermal comfort. From the specifications: "Buildings should minimize overheating in summer and optimize indoor temperatures in winter without unnecessary energy use. Where possible use good building physics and clever solar shading instead of overcomplicated and energy intensive mechanical systems." The Active House specifications look at the operative temperature at room level and give requirements for the maximum in summer and the minimum in winter. In summer, the maximum operative temperature is related to a running mean outdoor temperature T_{rm} as defined in EN 15251. Summer is defined as the time of year when T_{rm} > 12°C. In the climate data used in our simulations there were 150 summer days according to this definition. The summer requirement for the operative temperature reads: $T_{op} < 0.33 \times T_{rm} + T_c$, with T_c = 20.8°C for the highest category (Class 1) and 21.8°C for the second highest category (Class 2). These requirements are to be met during 95% of the occupied time, which in our case translates to a maximum of 113 h during which the requirement may be exceeded. **Figure 2** shows the operative temperature for our south oriented living room. From **Figure 2** it is clear that a DF > 5 and good thermal comfort are conflicting requirements without any further measures.

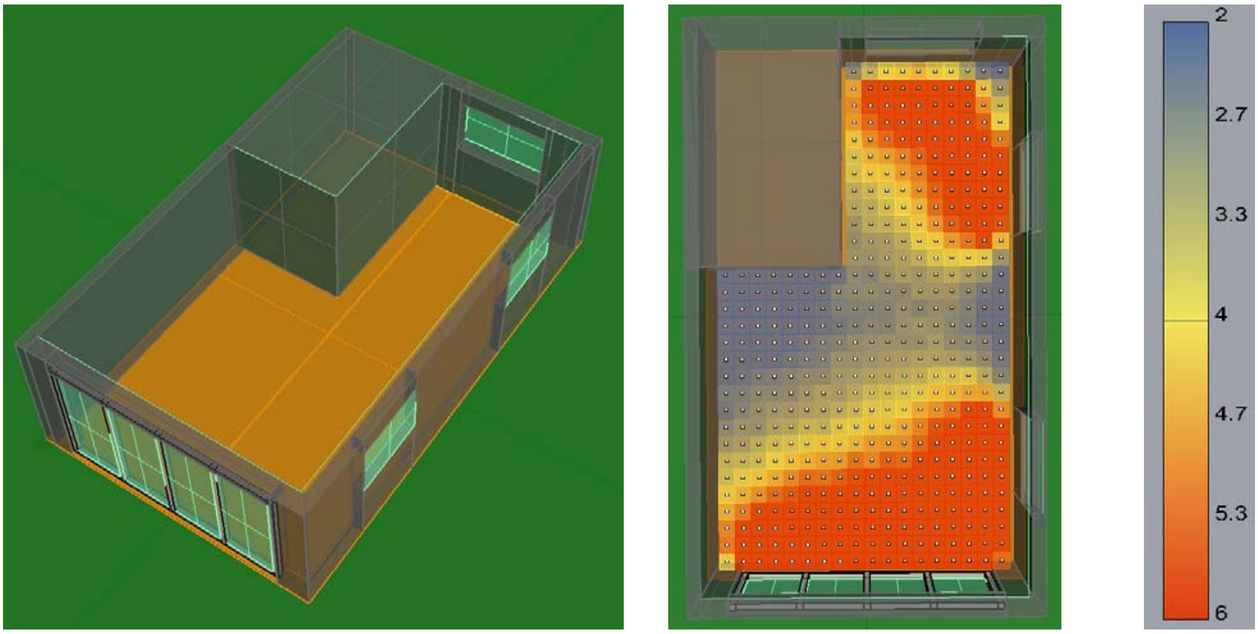


Figure 1. Model living room having an average daylight factor DF of 5.3% at a height of 0.85 m above the floor. From the model it is clear that a daylight factor > 5% requires a fair amount of glazing. The window to wall ratio in this case is 17%. It is also clear that there is quite some variation over the surface of the room: 49% of the area has 2% < DF < 5%, 42% of the area has DF > 6% and 9% of the area has DF < 2%. Without the two windows at the right, the DF drops to 3.7%.

Since our living room is thermally well insulated, accumulated heat will not easily escape. That is desirable in winter, but not so in summer. Ventilation obviously helps to cool the building mass when ambient temperatures are lower than the operative temperature. Therefore, we increase the ventilation rate to 2 ACH at all times during the summer season.

Exterior shading is the passive solution that can reconcile the daylight and thermal requirements. **Figure 3** shows the operative temperature of the living room fitted with external Venetian blinds. These blinds are lowered whenever the vertical irradiance on the façade exceeds 140 W. When deployed, the slat angle of this blind is continuously kept in block beam solar mode. This means that the slat angle is such that just prevents direct sunlight to pass between slats. Whereas this mode of operation may not be the one keeping out the maximum amount of heat, it does allow daylight to enter as much as possible, both as diffuse radiation from the environment and as reflected radiation from the sun. In this respect it is interesting to look at the slat angle over the year. On a south façade, there are a lot of hours that the blind will prevent the entrance of direct solar radiation when fully open. Under these circumstances the view of the outdoors is unimpeded. **Figure 4** shows the block beam slat angle for the south facing window. Here, the slat angle is defined as the angle between the normal of the glazing and the normal vector of the slat, i.e. 90 is fully open, 0 is fully closed.

Besides preventing unwanted solar heat gain, the shading also has a significant effect on the temperature of the window pane. Without shading surface temperatures get as high as 43.5°C. The same window fitted with an external Venetian blind has substantially lower surface temperatures, down to 32.5°C. This is of course reflected in the operative temperature of the room.

Active controls

If one considers the variability of solar radiation during the day and over the year, the challenge of using sunlight and daylight is control.

Active House encourages the application of active and integrated controls: "Through an easy and user friendly interface, a building management system (BMS) may control an Active House." For the blind described in the previous section to function, the basic controls or actors are readily available. Further integration of these controls has advantages and is in fact needed. **Figure 4** shows when the blind is deployed according to an irradiance set point of 140 W/m^2. It is quite clear that such a static set point is not desirable in winter because the blind will block valuable solar energy useful for passive heating. A more advanced strategy to deploy the blind is needed.

It was already stated that block beam solar is not necessarily the most effective mode to control solar heat gain. When coupled to a BMS, it is easy to detect temperature

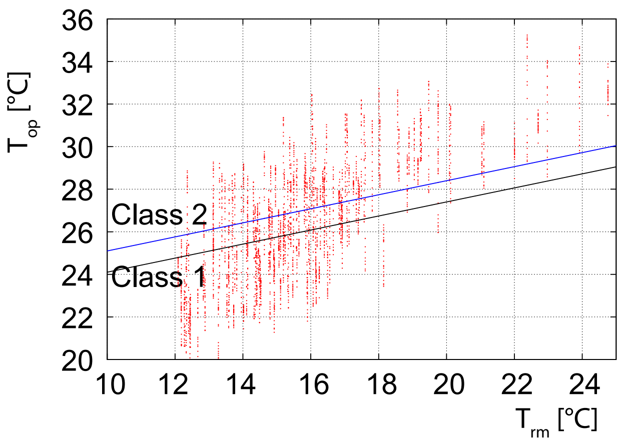


Figure 2. Operative temperature in the living room without solar shading. The Class 1 requirement is exceeded during 2067 h (57% of time), for Class 2 this is 1544 h (43% of time).

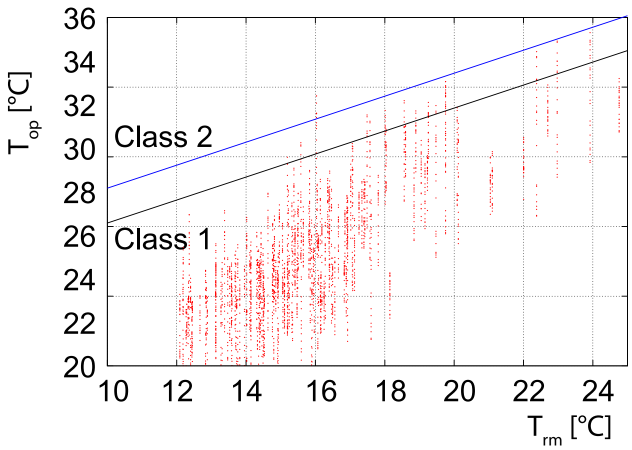
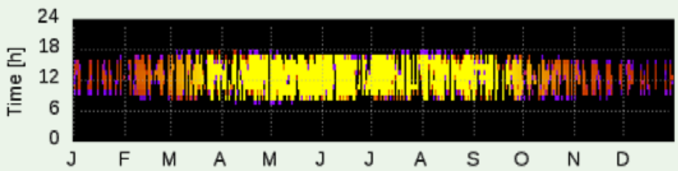


Figure 3. Operative temperature in the living room fitted with external Venetian blinds. The Class 1 requirement is exceeded during 76 h (2.1% of time), for Class 2 this is 7 h (0.2% of time).

exceedance in the space and override the standard slat angle control to a more closed state of the blind, thus further reducing solar heat gain. Likewise, it is possible to use the signal of an occupancy sensor. If there's no one in the room, daylight is not an issue and fully closing the blind will maximally keep out solar heat and keep the room cooler. Whenever the user enters the space, the management system sends a message to the blind controller to revert to daylighting mode. Active and integrated control of a blind clearly has both comfort and energy benefits. Individual control – the ability of the occupants to directly influence their environment from a comfort perspective – is an important requirement within Active House. This translates to the BMS and underlying controllers. Firstly, they should facilitate such interventions. Secondly, the logic should be robust and be able to deal with them. Thirdly, there should be a mechanism that returns the system to its energy-comfort optimal routine after a predefined time or user action.

There are numerous other possibilities to use an active blind. Reducing thermal heat loss during winter by closing a blind at night is a possibility. This will also reduce condensation at the exterior pane of triple pane glazing during cold nights. Although not really an energy or comfort aspect, it is nonetheless valued by home owners.



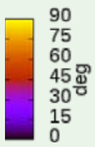


Figure 4. Annual map of the blind slat angle. The x-axis gives the months of the year, the y-axis the hours of the day. The blind is deployed during some 2000 h. Half of that time the blind is fully open (90°, see text), indicated by the brightest yellow part of the annual map.

Hunter Douglas and Active House

Hunter Douglas has been a contributor to the Active House Alliance since its inception. Our philosophy of Sustainable Comfort seamlessly integrates with the Active House vision.

We are currently working on the practical application of solar shading and the control strategies touched upon in the previous sections in a research project called Active Reuse House. Participants in this project are amongst others the Rotterdam University of Applied Sciences, the city of Rotterdam and the housing cooperative Woonbron. In this project a consortium aims to design, construct and evaluate an Active House in a reuse context for building materials.

The Hunter Douglas Energy Tool

Hunter Douglas developed a tool can be used to make analyses similar to the one presented in this article. This tool is available for download at: tools.hde.nl/energytool2/index.html. It contains the characteristics of our shading solutions and allows the comparative evaluation of different designs and shading strategies.

Conclusion

In this article we've explored the role of solar shading in Active House. In practice, the daylighting requirements will often necessitate substantial window size. High thermal insulation and air tightness are needed to achieve a sufficiently low energy demand for heating. In order to meet the summer thermal comfort criteria of Active House, an active shading strategy is essential if mechanical cooling is to be avoided. Building physical simulation is an essential tool for engineering an Active House. Integration of the shading and ventilation strategy in the context of a building management system appears to be essential. ■

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Project : Residential Gloucester Merchant Quay
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Thermal storage eliminates energy waste in existing district heating network

Minimising energy consumption of buildings is of major importance on the way to zero impact buildings. However, a more holistic approach to the actual energy system may prove to have an even greater effect.

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The Energy Central is the result of a cooperation between Grundfos and the local district heating company. [Photo: Anders Nielsen]

Earlier this year, Grundfos headquarters and the local district heating company inaugurated a joint system to store the surplus heat from the Grundfos factories in obsolete groundwater boreholes, and use it in the district heating network when needed.

The synergy between the cooling demand in Grundfos' production plants and the heat demand of Bjerringbro district heating company has virtually eliminated energy waste. The remarkable reduction of energy consumption, CO_2 emission and operational costs now benefit both companies and the district heating customers in the area.

As part of the agreement, a new energy central with state-of-the-art cooling compressors and heating pumps has been established.

The new setup is based on three elements:

1. Exploitation of surplus heat from cooling in the factories.
2. Indirect storage of heat in an underground aquifer.
3. Heat pumps supply additional heat, when required

Central and efficient cooling function

Using small, individual refrigeration compressors to cool down machines in production facilities is a very inefficient, but nevertheless very common method. To make matters worse, the heat energy developed in the process is virtually always wasted.

With the new shared Energy Central, Grundfos productions facilities are cooled by cold water from the District heating network. And when the cold water needs to be colder, three large cooling compressors with a total cooling capacity of 2.85 MW and thermal power of 3.65 MW handle the job from a central facility.

Cooling compressors.

During the heating season, the cold water used to cool the machines at Grundfos, becomes hot in the process, and along with the excess heat from the cooling compressors in the energy central, the heat is recycled and sent directly to the district heating network.

Storing surplus heat under ground

During summer, when the heating demand is minimal, the surplus heat is stored in underground energy storage - a so-called ATES-stock (Aquifer Thermal Energy Storage) located 80 metres underground.

During the four summer months, a total cooling output of 3 500 MWh is accumulated. And more than 80% of the stored energy during summer will be supplied to the district heating network during the heating season. In fact, the energy central covers more than 15% of the town's annual heat requirement, of which 1/3 comes from the hot water storage.

The system

Frequency controlled

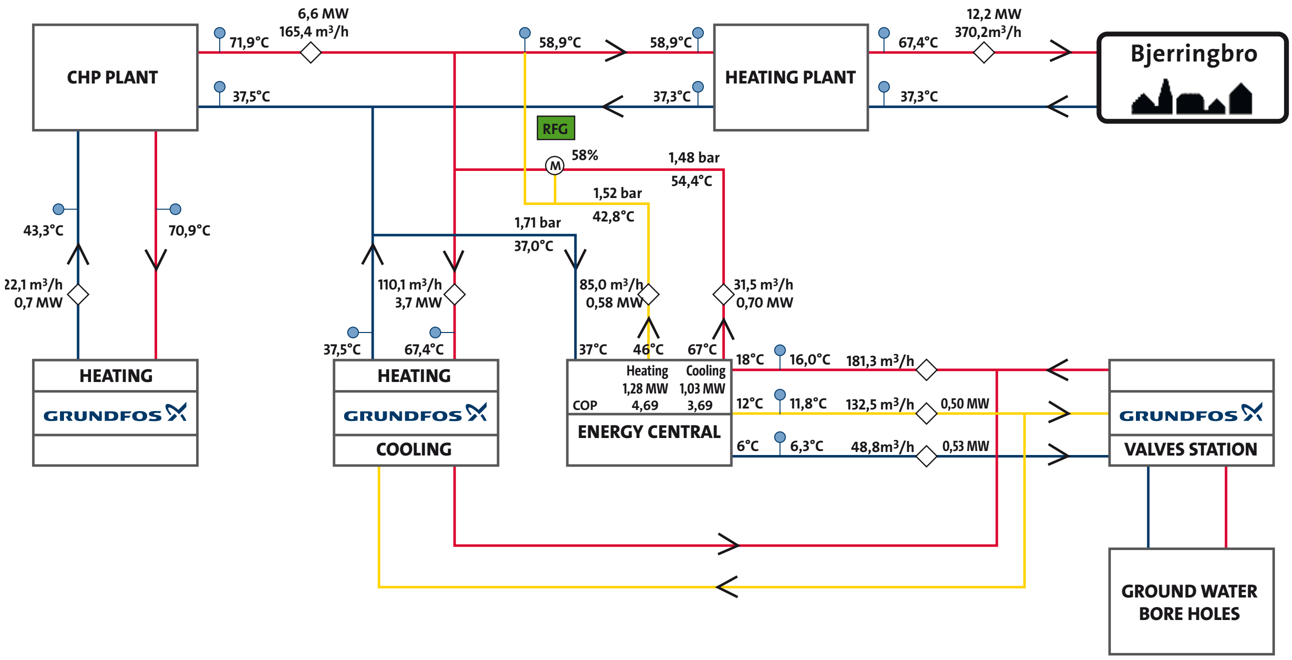
Pressure drops across valves in a heating system are costly and waste energy. This system however, is frequency controlled and designed for completely open valves. Accordingly, all thermal adjustments are carried out, by speed controlled pumps. As a result, pressure drop across the valves have been completely eliminated and replaced by massive energy savings.

Savings of up to 90%

The ATES system will reduce Grundfos' energy consumption for cooling by up to 90%. Combined with significantly reduced heating costs, the result is cheaper

Technical and performance data for the system

Number of bore holes	5
Amount of circulated water in groundwater systems (max)	160 m^3/h
Amount of circulated water per year	1.5 mill. m^3/year
Groundwater temperature	9°C
Aquifer cooling capacity before exchange	1.5 MW
Average COP for cooling (aquifer)	46
Average COP for heating (energy central)	4.6
Average COP for cooling (energy central)	3.6



Flow chart of Bjerringbro district heating and cooling network which supplies Grundfos production plants with ground water thermal storage, district heating network and heat pumps (in the energy central in the figure) for additional heating and cooling (compressors in the figure next page). The water used for cooling in the Grundfos factories is 6-12°C and 18°C when returned to the central. The temperature of the water is raised to 46/67°C with heat pumps and supplied to the district heating network. COP for heat pumps for heating is 4.60.

Cooling compressors.

heating for the citizens and massive energy savings for Grundfos and the district heating plant.

In fact, the carbon emission will be reduced by some 3,700 tonnes a year, equivalent to 1.5 tonnes per household connected to the heating plant.

Payback time

In total, Grundfos and Bjerringbro district heating company have invested 4.5 mill. euro in the new system. Without this joint investment, two separate systems would have been the solution. Compared to these reference systems, annual savings of 400 000 euro was initially expected, but because the system seems to be more efficient than estimated, the payback time will most likely be shorter than the projected 11.25 years.

With the new setup Bjerringbro district heating company seizes the opportunity to store energy and become less dependent on natural gas. As a result, the plant will emit less CO_2 and be able to offer more sustainable heating supply even lower price.

A model for future heating and cooling

Many European countries aim to be free from the use of fossil fuels in the near future, and this type of system is a big step in that direction. The system is able to store solar heat and thus, in principle, low fossil heat as it runs only on electricity. In the future, this may be supplied by wind turbines or any other renewable source.

According to Lars Hummelmose of the Danish Board of District Heating, this solution will hopefully inspire others to explore local environmental friendly energy opportunities. He sees many elements of the project that can be used globally, especially in countries that already have district heating, but also in countries that are facing a transition away from nuclear power. ■

Economics of the investment

Annual cooling output of groundwater cooling – 4 summer months (*Groundwater cooling covers cooling of all factories*).	3 500 MWh
Annual heat production of the cooling machines	13 400 MWh
Annual cooling output of cooling machines – 8 months	10 500 MWh
Total investment	4.5 mill. Euro
Estimated annual savings	400 000 Euro
Total annual reduction in carbon emissions	3 700 ton

DEMAND MAGNA3

MAGNA3 is more than a pump. It's a circulator, a pump throttling valve and a heat energy meter, all in one – reducing the need for separate pump throttling valves in the system. Offering over 150 different single and twin circulators for heating, cooling, GSHP systems and domestic hot water applications, MAGNA3 is a truly full range of the world's most efficient and installer-friendly circulators. Packed with innovations including our tried-and-tested Grundfos AUTOADAPT intelligent control mode, wireless communication, improved hydraulics and Grundfos Blueflux® motor technology, everything in the MAGNA3 is designed to improve reliability, make installation simpler and reduce your customers' energy consumption and electricity bills.

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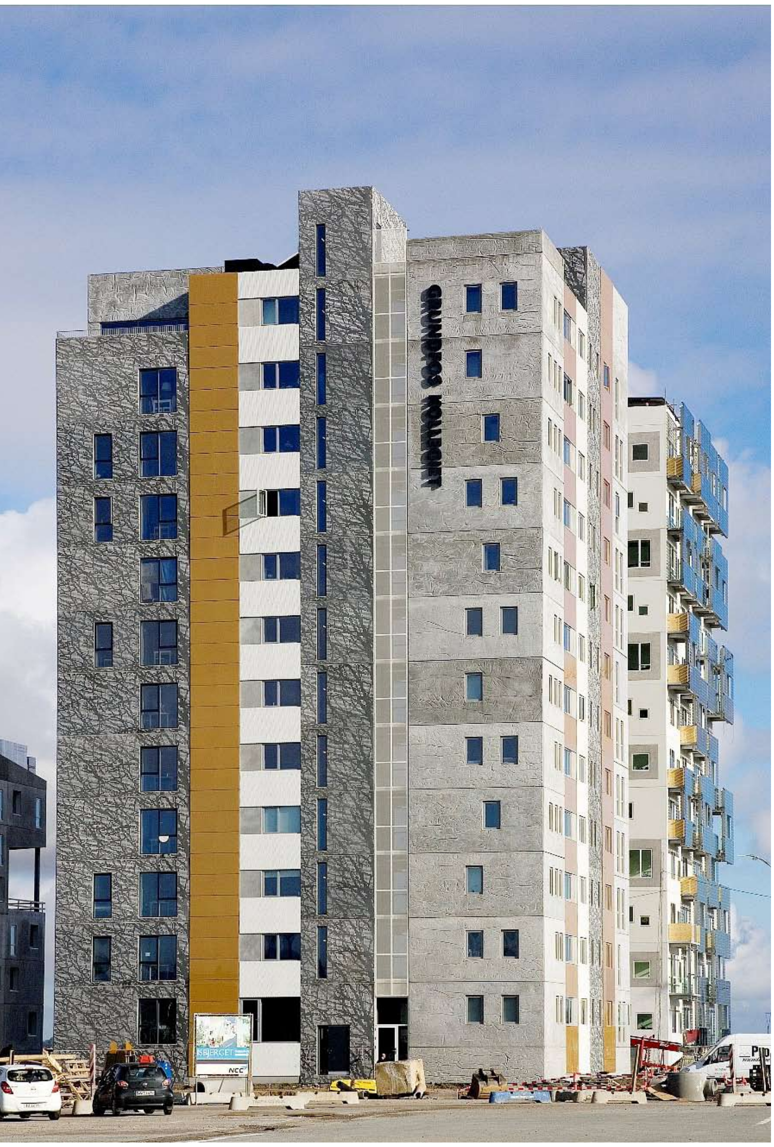
GRUNDFOS

Grundfos dormitory – a living laboratory



Grundfos dormitory – Student hall of residence in Aarhus a living laboratory:
- 12 floors
- 159 apartments - 7 different designs
- Basement: pump systems & laundry
- Roof: Ventilation & Solar panels

A new dormitory in the Danish city of Aarhus is not just the residence of more than 200 students it is also a living laboratory. More than 1,800 sensors throughout the building allow Grundfos and partners to test new energy-saving technologies in a real environment – and gain valuable knowhow on how to minimise the water and energy consumption in the 12-storey building.

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Over the next years, Grundfos and other external partners will continue to test different solutions in an effort to further optimise operations in the building. The access to valid data in the building is a unique chance to learn more about consumption patterns and test alternative solutions and thereby becoming able to develop new solutions to support even more sustainable building in the future.

Green building

The Grundfos dormitory already has a green profile. It has been built according to the Danish standard of low-energy, class 1 (2015) that provides very low consumption of primary energy – more precisely 52.5 kWh/a per m^2 including heating, cooling, ventilation and domestic hot water.

Reality vs. Theory

A key motivation behind the project is the paradigm of understanding between theory and reality. Years of data collection, simulations and extensive test facilities have offered valuable information, but not the precise and unpredictable environment that a living laboratory does. Today, most systems are modelled based on how things are supposed to work in theory. The truth is; most component and system builders do not have valid, detailed data that document how systems perform in real life, and why.

To serve the purpose as a learning environment, the dormitory has been equipped with state-of-the-art pumping systems for heating, ventilation and wastewater, and in addition sensors throughout the building to monitor "everything".

1,800 Sensors installed for monitoring

To acquire the necessary level of information from the building, it has been fitted with close to 1,800 sensor points. In addition to sensors on all main energy and water meters, each apartment has 12 sensor points that measure:

- Indoor climate - temperature, CO_2 level and relative humidity
- Electricity consumption
- Flow and temperature in the cold domestic water and flow
- Flow, pressure and Delta T on the hot water.
- Flow and Delta T on the heating system.

Partners make it possible

To ensure that the Dormitory is Smart Grid ready and actually reap the full potential of the living lab Grundfos has teamed up with Aarhus University and the technical Alexandra Institute. These specific studies and experiments are a part of the strategic research council project EcoSense and the ForskEl project VPP4SGR both anchored at Aarhus University.[1]

1 http://www.alexandra.dk/dk/projekter/sider/ecosense.aspx
https://www.forskel.dk/Pages/default.aspx

The cooperation offers thorough analyses of relevant data in the right context and in-depth behaviour studies, on the large group of residents.

Data analysis

To succeed in developing high-tech solutions that use less energy and provide flexibility for future intelligent electricity and water systems in buildings, it is essential first to understand how residents use the building and enable them to interact with the control system.

With the advanced sensor setup it is possible to measure changes in any parameters down to 250 milliseconds. The analysis of the data is expected to reveal differences in consumptions based on where in the building the apartment is located, dependent on weather conditions, time of day, time of week, general load of the building, etc.

Sensors reveal consumption patterns

The massive time-series of sensor data from 159 apartments allow for detailed investigation of how various control strategies for the mechanical systems impact the consumption or waste of water and energy, e.g.:

Domestic Hot Water recirculation

What are the true costs and benefits of recirculating hot water? By varying the control strategy across different well-known approaches and monitoring the results, data will reveal exactly how much energy is spent on hot water recirculation and how much water is saved. It will even be possible to analyse the time spent on waiting for hot water at all instances of hot water use. Combined with occupant surveys, the perceived impact on comfort and convenience may be included as well.

Pressure Boosting

A state of the art intelligent boosting system ensures that the needed water pressure is available at all time at the minimal energy consumption. But how close are we in fact to the optimal boosting strategy? By mapping the static pressure levels and actual water consumption across all apartments in the building it is possible to determine the true water delivery efficiency at system level and assess potential areas for optimisation.

Space Heating

By analysing the detailed dynamics of the radiators, the loads and the building itself, it is possible to determine and implement the optimal strategy for controlling the heating system. Combined with historic and predictive weather data from the on-site weather station and meteorological internet sources, it is possible to assess and compensate for the true passive performance of the building. Data will also allow a solid investigation of the thermal effect of the hot water recirculation system on the space heating load.

These are merely examples – the abundance of data enables a wide range of research that aims to dramatically improve our understanding of the complex nature of buildings.

Resident behaviour

Gaining an understanding of WHY the residents do what they do is crucial, in the effort to change this behaviour into a more sustainable behaviour. The assumption is that two demographically similar tenants might exhibit very different usage patterns. The key to bringing down the consumption is to understand this difference and learn from it.

Right now a baseline study including technical data from all the different sensors and meters is being carried out. This is followed by a more qualitative baseline, where the important values and norms of the residents will identify what is important for the residents in their daily lives.

Un-hiding consumption

One of the challenges with energy consumption today is that it's "hidden". Energy is something we all consume more or less subconsciously, even though many of us would like to do 'the right thing' as responsible world citizens. However, the innovative sensors allow each resident to follow the development of his or her own consumption measured against the average consumption for the entire building.

It is assumed that un-hiding the energy consumption and the potential gains will create a cognitive relation between daily practice and energy consumption and eventually influence the behaviour. ■

Links for websites:

http://www.alexandra.dk/dk/projekter/sider/ecosense.aspx

https://www.forskel.dk/Pages/default.aspx

A low cost plus energy building in Istanbul


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Introduction

Building industry is certainly one of the most important industrial and economic sectors that affect the life quality and environmental issues, since it has a strong effect on user comfort and energy consumption. It is known that 1/3 of greenhouse emissions in the world is from buildings due to their high energy consumption. All because of those, in every country in the world, regulations came into force to decrease the emissions from the buildings. Energy Performance Directive for Buildings (EPBD) has described the rules to increase energy performance of existing and new buildings. In the framework of EPBD, in Turkey "Building Energy Performance Regulation" has been published in 2008 and the rules for emission reduction from buildings have been described in this regulation. In the meantime, EPBD recast has been prepared to consider cost optimality together with energy efficiency. Recast EPBD directs to define cost optimal level of energy efficiency considering investment, maintenance and energy cost of buildings. However, in Turkey there is a prejudice that the energy efficient building is expensive building considering investment cost. In fact, if the required studies have been carried out during the design stage to improve energy efficiency through energy modeling and feasibility studies, it is possible not to increase the initial cost of building for higher energy performance. In this study, a PlusEnergy building in Istanbul is introduced. This building has been designed to decrease the energy need to the possible minimum level and this need has been met by solar thermal and solar power systems integrated to its roof. Monitoring results of the past year showed that the building has only used the 40% of this self-produced energy.

Figure 1. Steelife-EcoHouse South Façade.

Plus energy building in Istanbul

The name of the Building is Steelife-EcoHouse and it is the first sample and prototype in Turkey which aims to produce energy from building integrated renewables to achieve zero carbon objectives during operation period.

Architectural Design

All design decisions have been made according to the detailed dynamic simulation results, to achieve low energy consumption and zero carbon emission through renewables. As a result of this design process, Steelife-EcoHouse has exceeded its first aim and it has become a PlusEnergy house that provides more energy than it requires. Steelife-EcoHouse offers healthy life conditions to its occupants. Energy efficiency has been considered in three headlines;

- to reduce energy demands in heating, cooling and lighting
- to meet the energy need through efficient systems
- to provide energy through clean energy sources

The South facade of the house is shown in **Figure 1**.

In the design process of this prototype, detailed dynamic simulations have been performed to ensure thermal, visual, and acoustical comfort of the building occupants at the maximum level and to minimize the heating, cooling, ventilation and lighting energy demand to provide these comfort conditions. All design details including insulation thicknesses and thermal bridge insulations are determined according to these simulation results. The windows have been predicted to have three glass layers and the size of the overhang shading has been defined through detailed simulations. Moreover, to determine the position of the building, shading analyzes of the surrounding buildings have been performed during the design process. **Figure 2** shows examples for simulation model and shading analyzes.

The energy performance level of the building has been compared with National Reference Building which is described in Turkish National Building Energy Performance Calculation Method (BEP-TR). The annual heating and cooling energy demands of the reference building for Steelife-EcoHouse are shown in **Figure 3**. As it mentioned before insulation, window type, daylight and natural ventilation strategies, etc. have been determined in accordance with detailed dynamic simulations and the annual heating and cooling energy demand results of the proposed design is also shown in **Figure 3**. The simulation results in **Figure 3** shows that the energy demands of the proposed design have been reduced 70% and almost 50% in comparison to the reference building, respectively for cooling and heating, and the total energy demand from 84 to 44 kWh/m². In all of the energy efficiency strategies also maximum benefit from daylight has been aimed and therefore, lighting energy demand has been reduced as much as possible. Window frames have been selected as PVC having three glass layers with Passive House certificate and the U-value of the window is 0.9 W/m²K.

Roof slope was desired to be only in one direction by architect and it has been planned with the optimum angle to get maximum benefit from solar radiation for solar power (PV) and thermal solar systems. As shown in **Figure 1**, PV panels for electricity production and solar collectors for domestic hot water production have been located on the roof. To be able to provide enough daylight and minimize the heating and cooling energy demands at the same time, the dimension of the roof overhang has been determined by making shading and energy analyzes. **Figure 5** shows the interior of Steelife-EcoHouse.

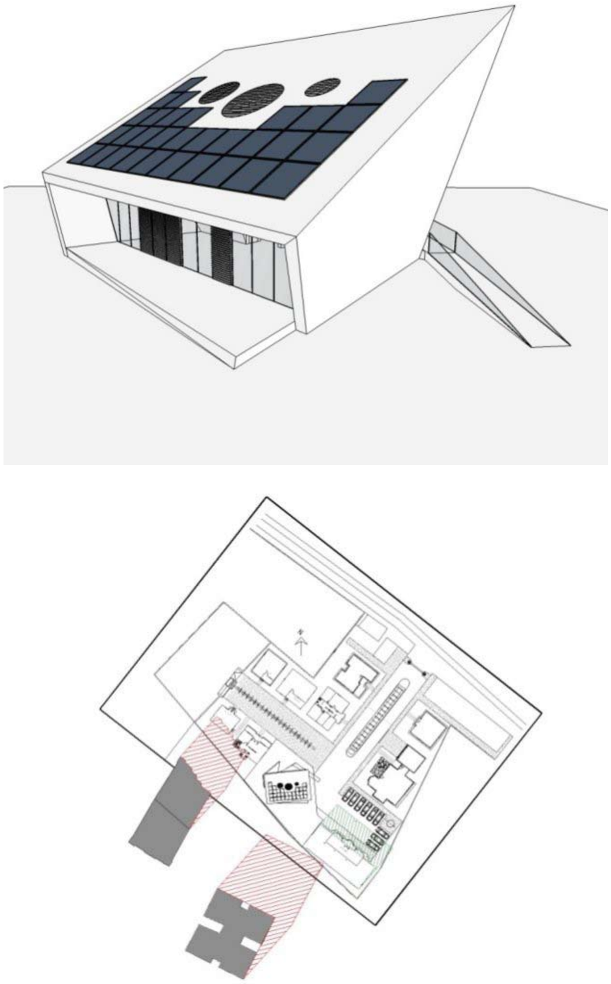

Figure 2. Examples for the Simulation Model and Shading Effect Analyzes of Surrounding Buildings.

Technical Equipment

The technical systems that have been used to provide clean energy and energy efficiency in the house are as below:

- PV Panels and Solar Collectors
- Air Source Heat Pump
- Under-floor Heating/Cooling System
- Controlled Ventilation System/Heat Recovery Unit
- Rain Water Storage System
- Gray Water Treatment System
- Waste Water System
- Water Efficient Fixtures
- Central Vacuum System
- Led Lighting
- Control Panel

Air source heat pump with COP of 3.5 - 4 has been used in order to supply the under-floor heating system to meet the minimized heating and cooling energy demands of the Steelife-EcoHouse. Moreover, since the system has been applied to a wider surface, it can work with low water temperature. The minimum water temperature that is used in under-floor heating system is around 42°C in a standard insulated building in Istanbul weather conditions. However, it should be remarked that the water temperature for under-floor heating system in Steelife-EcoHouse is around 33°C since the heating energy demand is minimized through architectural design. Therefore it requires less energy in comparison to other heating/cooling terminal units. The electricity that is required by the heat pump has been easily provided from the PV panels located on the roof, therefore no fossil fuels has been used for heating and cooling. The building is self-sufficient without any need from natural gas or others.

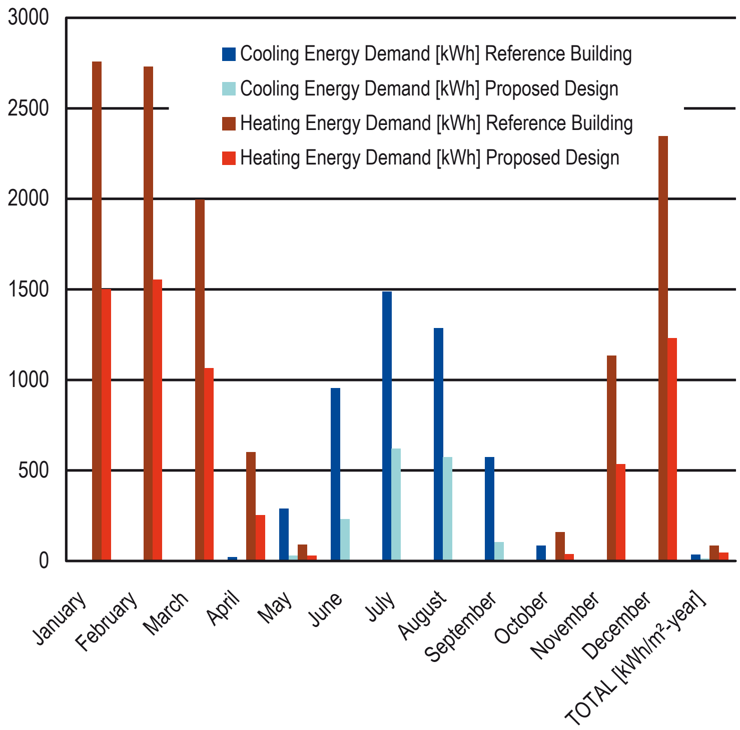

Figure 3. Monthly cooling and heating energy demand of the reference building and proposed design in kWh/month. Annual heating energy demand was reduced from 34 to 11 kWh/m^2 and cooling energy from 84 to 44 kWh/m^2.

Whenever the outdoor air quality is appropriate for comfort conditions, fresh air is provided from roof and façade windows through natural ventilation. When the outdoor air temperature and humidity are not appropriate, controlled ventilation system starts to operate.

Rain water storage system and gray water treatment system are used for garden irrigation and/or in reservoirs. The reservoir that is used in the building has dual functions with the 2.5- 4 liters or 3- 6 liters options, therefore it provides almost 70%water saving. In addition, water consumption is reduced using the efficient fixtures in lavatory and bath.

Figure 5. Steelife-EcoHouse Interior and System Control Panels.

Led luminaires have been used for all lighting systems in the building. These luminaries can work until 100,000 hours and have 10 W Led lamps instead of 75 W lamps. These lamps produce 25 times less heat than the standard lamps and therefore prevent the loss of energy as heat and therefore they have positive effect on cooling loads.

The control panel which is located in the living area as it is shown in **Figure 4** to control all of the technical systems. The production of PV panels has also been continuously monitored.

It has been defined that only 40% of the electricity produced by 28 unit of PV panels located on the roof can meet the total electricity required by all technical systems of Steelife-EcoHouse. The excess electricity production is providing electricity demand of the neighborhood buildings.

Thus, Steelife-EcoHouse is PlusEnergy building operating with zero carbon emission and providing comfortable indoor environment to the occupants without any energy bill. ■

Model-Monitoring for maximum livability with minimal footprint

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Introduction

How to maximise well-being and living comfort of the inhabitants, whilst minimising the environmental impact? A unique interdisciplinary research carried out on a climate renovation of a typical 1950s Settler House in Hamburg aims to verify the theoretical planning and calculations in terms of quantitative and qualitative measures, and to map how the two are closely intertwined.

LichtAktiv Haus

LichtAktiv Haus is the German contribution to the European VELUX Model Home 2020 project, situated in Wilhelmsburg within the framework of the IBA Hamburg international building exhibition 2013. The design of the half double house was the winning scheme in a student competition at Technical University of Darmstadt, which suggested a design true to the original expression of this house type, however modernized and restructured substantially inside, and supplemented with an extension – **Figure 1** The extension is built in full length in the demonstration house, yet it can be left out or resized depending on demand for renewable energy, space and finance. The neighbour occupying the other half of the double house has modernised the climate envelope in the same design, and utilised the top attic as a living room.

Interdisciplinary monitoring team

The Family Oldendorf has in 2012 moved from their apartment in Hamburg into the climate renovated LichtAktiv Haus in Hamburg, to test it for 24 months.

The family of four is closely followed by a research team, developing methodologies and learnings as a model for monitoring and learnings to pass on to practice and theory to further qualify other climate renovation projects. Following the residential living experiment is an interdisciplinary team of comprehensive scientific monitor-

Figure 1. Katenweg 41 before and as LichtAktiv Haus after climate renovation.

Figure 2. The Lichtlanterne, the core of the old house.

ing in cooperation between the Technical Universities (TU) of Braunschweig and Darmstadt, and Humboldt University in Berlin. The monitoring team set off on common ground together with the client VELUX, and developed a mutual point of departure for the interdisciplinary investigations, in short: How can we achieve maximum livability with a minimal footprint?

The quantitative aspects are monitored in a subgroup led by Dipl.-Ing. Thomas Wilken from Technical University of Braunschweig; the leading motive is: *what is the correlation between the theoretical assumptions on energy consumption and production?*

The qualitative monitoring is led by M.A. Soz. Percy Scheller from Humboldt University in Berlin with a leading motive of: *how well are the inhabitants feeling?*

The monitoring concept brings together quantitative and qualitative diagnostic techniques, making the methodology a model on its own included in the investigations on this particularly project.

Outdoor climate and corresponding indoor values are quantitatively recorded and documented, alongside input from the test family Oldendorf by means of qualitative research regarding their experiences of living and well-being in the house. The results of the quantitative and qualitative monitoring is presented and discussed regularly in the entire team, where evaluations and possible counter-measures are taken up and pursued.

Natural ventilation as key principle for modular and feasible adaptation

The LichtAktiv Haus is designed to be carbon-neutral in operations, with renewable energy production from windows, solar collectors and photovoltaic panels, controlled by a solar based heat pump with an outdoor unit. The house is based on automated natural ventilation as key principle for air exchange throughout the year. The Settler House type is widely spread in Germany; there is around 13 million of this house type. The modular design of the LichtAktiv Haus is suggesting a number of modular solutions which can be adapted on idea basis into other similar existing houses, due for climate renovation. The natural ventilation as key principle was chosen based on the assumption, that a modular model for climate renovation would not feasibly suppose mechanical ventilation to be installed in existing housing in general.

Methodological approach of the qualitative monitoring

The team from Humboldt University working with the well-being of the family base their work on a three-dimensional structure of attitudes. The tripartite model distinguishes between three categories of reactions to attitudes: cognitive, affective and conative reactions, which can manifest themselves verbally and non-verbally and can be measured:

- Affective attitude components (feeling)
    - Feeling, evaluation, reactions of the autonomic nervous system
- Cognitive attitude components (thinking)
    - Evaluation, conviction, opinion, knowledge, notion, judgement
- Conative attitude components (acting)
    - Behavioural tendency, behavioural intention, willingness to act

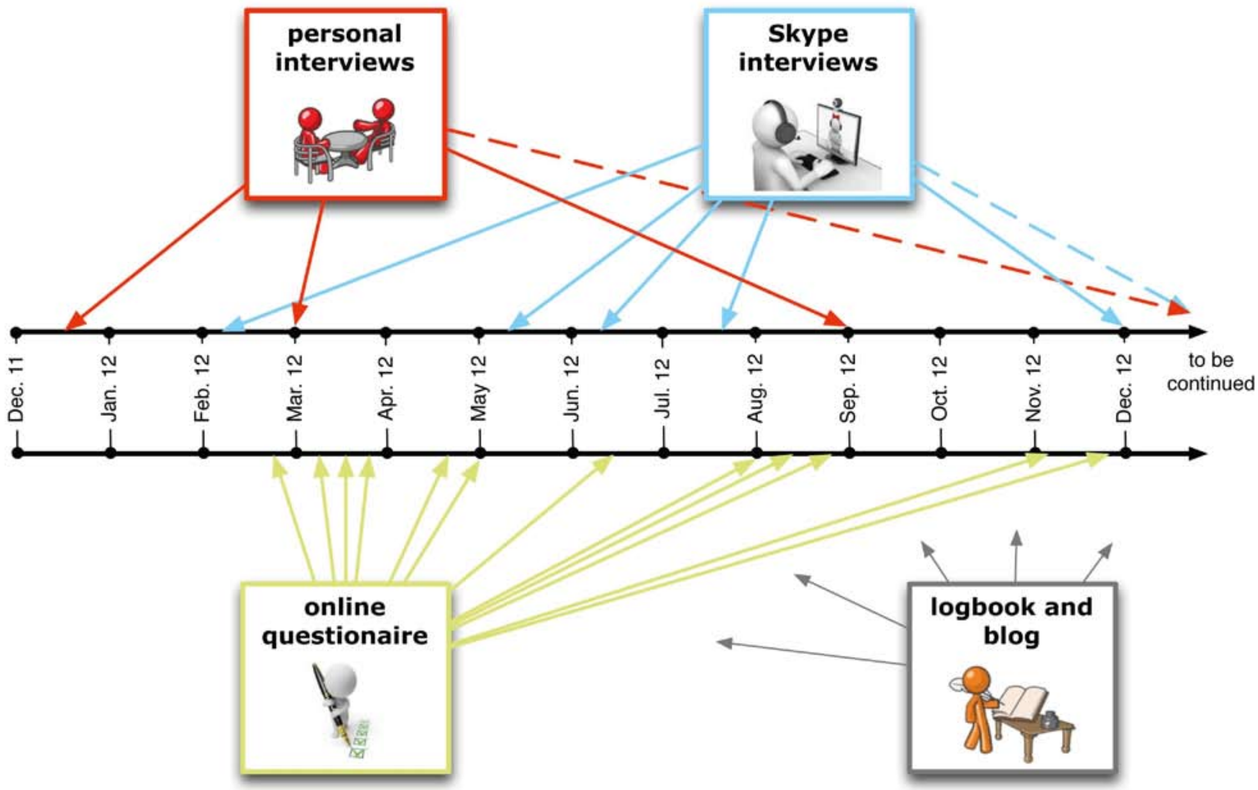


Figure 3. Overview of the qualitative study design.

The team is monitoring via different investigative methods, **Figure 3**:

- Diary format in a digital logbook and a public blog, both maintained by the family, recording their living conditions.
- Approx. every 4 weeks the respondents complete an online questionnaire including both open and closed questions about the various dimensions of well-being.
- Approx. every 4 to 8 weeks, more in-depth structured interviews are conducted with the parents in the form of video calls.
- Longer structured interviews are conducted in the house at the end of each season.

This allows statements to be recorded in detail, and to be set into context with the respective evaluations (evaluation problem).

Interim results of the quantitative monitoring

The LichtAktiv Haus is designed according to the Active House principles[1], and the indicators for comfort, energy and environment can be read in **Figure 4**. The indicator levels express the designed levels, which are monitored in practice. Differences between design and measure, from factory to field, are subject to examination and evaluation in the monitoring team. The measured levels will be communicated as an overlay onto the design radar later in the monitoring phase.

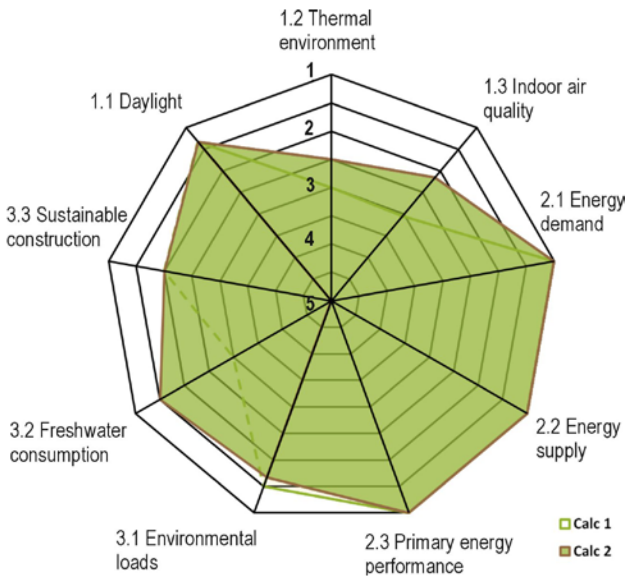


Figure 4. The Active House radar diagram - designed indicators

1 Activehouse.info. See also the article on Active House Specification by Eriksen at al. in this issue.

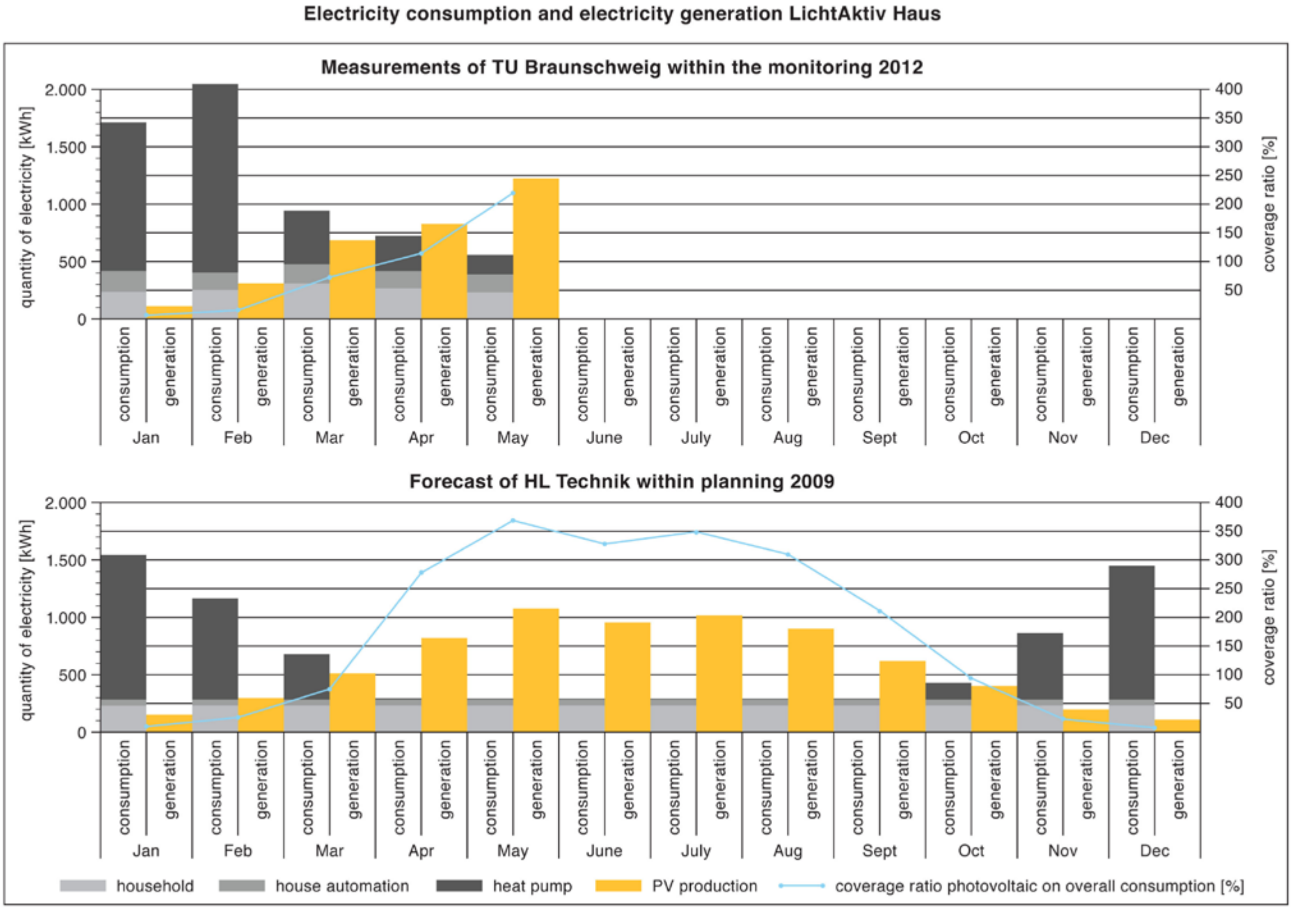


Figure 5. Designed vs. measured energy consumption and production.

The interim results from the first months of test living in the house show some interesting indications, some of which are the following:

Energy *(indicators 2.1 + 2.2 in Figure 2)*

The heating energy consumption in the LichtAktiv Haus first test period corresponds to the forecasts – despite the fact that the average indoor temperature of 22-23°C is around two degrees above the standard calculated values. LichtAktiv Haus does not achieve an electricity surplus before April; although the power consumption corresponds to the predicted data and the photovoltaic yields are above the calculated values (**Figure 5**). The reason is the heat pump´s electricity consumption which still is higher than calculated owning to the fact that it has still to be adjusted. [1] The family has rated the functionality of the heating as working perfectly. [3]

Thermal Comfort *(1.2) – quantitative indicator*

No overheating was seen in winter, but three episodes of spring overheating (light green dots are seen – **Figure 6**). This happens when the outdoor temperature is below 26°C, and the most likely cause is that the control system is in "spring" mode where it maximizes solar gains and not in "summer" mode where it is set to minimize overheating. Some summertime overheating is observed with episodes where category 3 is exceeded. Relatively low temperatures are observed during summer, with episodes with temperature drops below 21°C. This can be caused by night cooling, where the temperature decreases during the night to reduce overheating the following day, which in some situations lead to temperatures in the morning between 20°C and 21°C. [2]

Thermal Aspect *(1.2) - qualitative indicator*

This aspect reflects the perception of temperature, air draught and humidity. A certain difference between the two grown-ups perception is detected during the studies, in general the occupants the room temperature as satisfactory over the entire year – **Figure 7**.

High satisfaction and living comfort

The first investigations show that the LichtAktiv Haus offers the test family a high level of living comfort and, apart from a few minor criticisms, the family is very

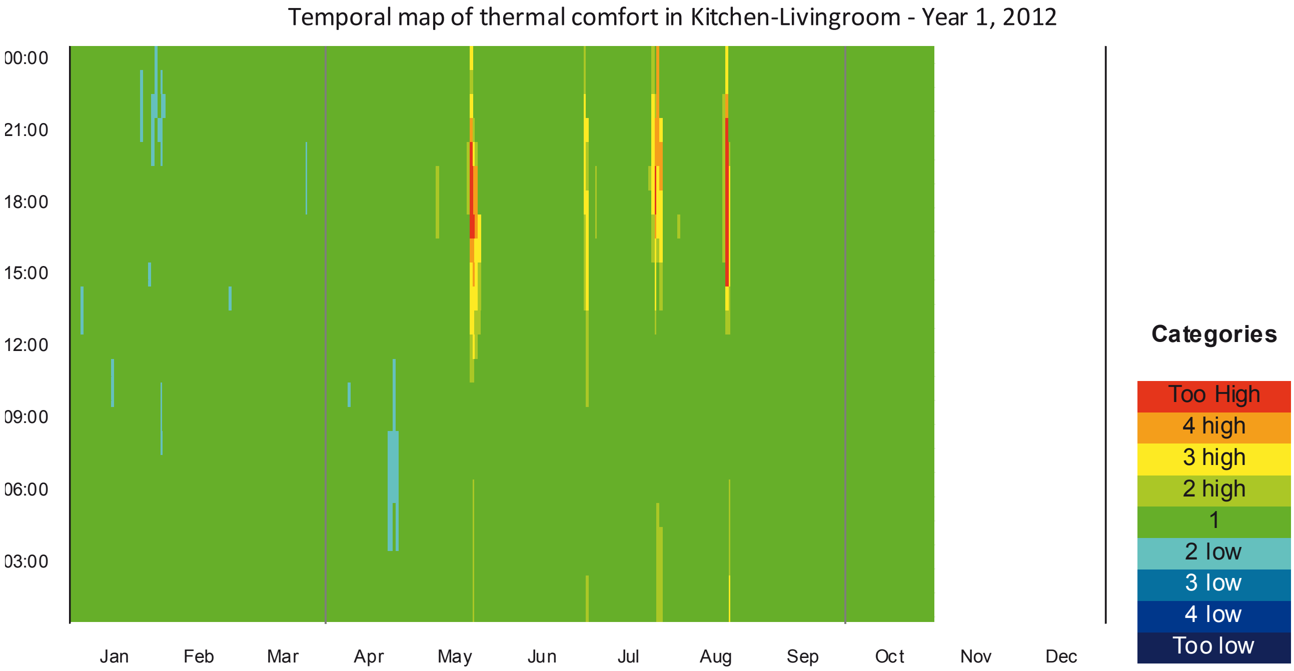


Figure 6. Living room in LichtAktiv Haus. The comfort category of each hour of the year is plotted as a temporal map colors. See Table 1 in the article by Peter Foldbjerg and Thorbjørn Asmussen on this issue for the explanation of the categories.

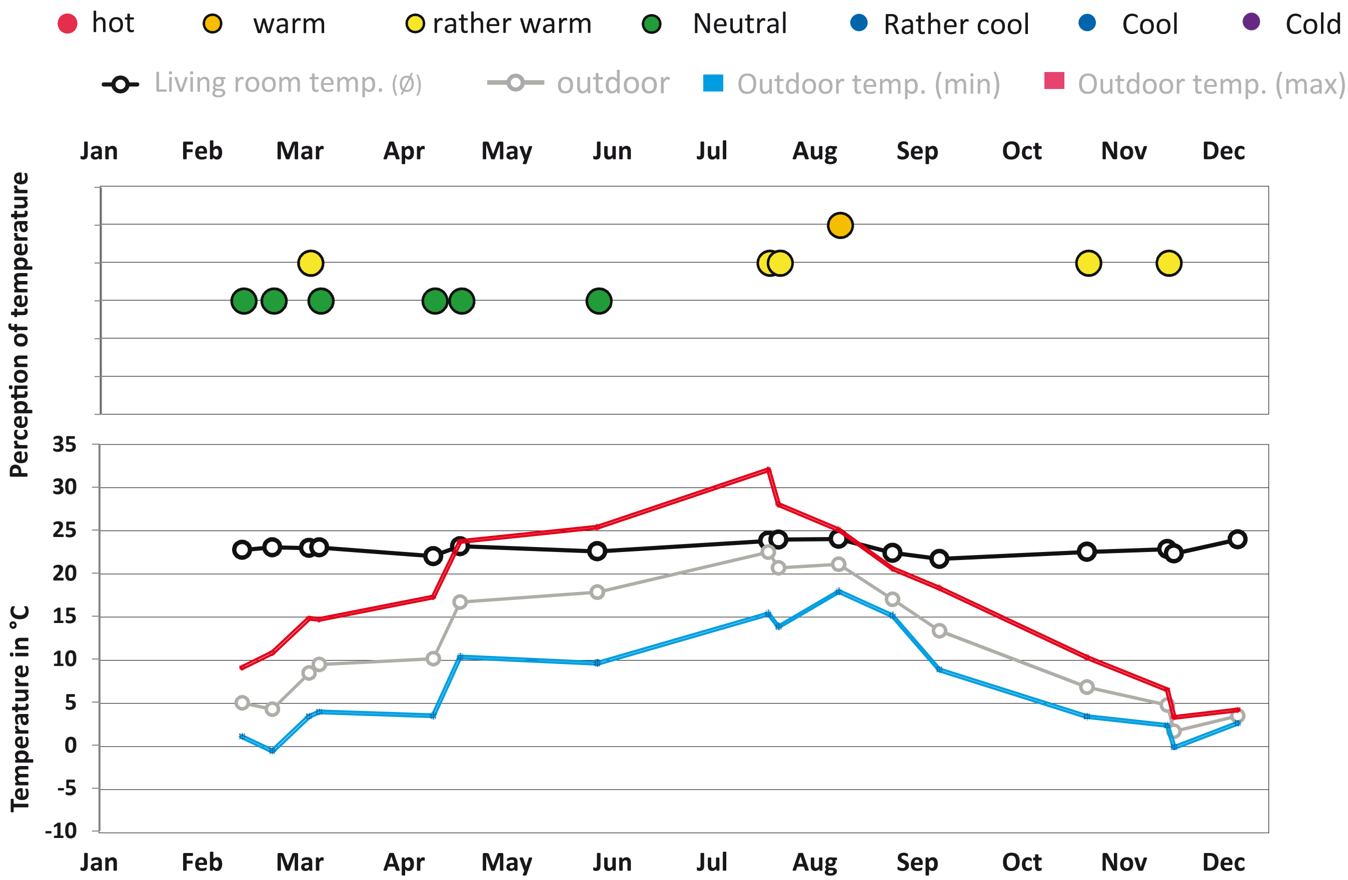


Figure 7. Temperature perception overview.

Figure 8. Irina Oldendorf making observations in the top attic.

The LichtAktiv Haus

is Germany's contribution to the Europe-wide VELUX Model Home 2020 project. The LichtAktiv Haus is a project of the IBA Hamburg international building exhibition and part of the Renewable Wilhelmsburg climate action concept. The family is blogging on lichtaktivhaus.de, giving their experiences and everyday findings their own words.

The house was developed by:

Design planning: TU Darmstadt FG ee, Prof. Manfred Hegger, Design: Katharina Fey (TU Darmstadt), Architects: Ostermann Architekten, Energy concept: HL Technik, Prof. Klaus Daniels, Lighting design: Prof. Peter Andres PLDA, Structural: TSB-Ingenieure, Prof. Karsten Tichelmann, VKR Group partners: Sonnenkraft, VELFAC, WindowMaster

Cooperation partners: Eternit, Gira, Grohe, Keramag, Knauf, Knauf Insulation, Metten, Nolte Küchen, Somfy Find out more at www.velux.de/lichtaktivhaus

satisfied with living in the house (affective dimension). The primary motivation for the positive effects is the abundance of daylight. The automation of the indoor environment is not unconditionally a positive experience, e.g. the systems opening windows at night has proved to be disturbing. However the technical setup does result in increased living comfort, as it optimizes the indoor climate and automates certain processes for the family [3]. ■

References

[1] Wilken et al (2012); Positive interim report for residential experiment in the LichtAktiv Haus.

[2] Asmussen, Foldbjerg, Rasmussen (2013); Thermal Comfort in two European Active Houses, analysis of the effect of Solar Shading and Ventilative Cooling , Clima 2013 Conference, Prague June 2013.

[3] Fedkenheuer, Scheller, Wegener (2013): Residential well-being as a multi-dimensional construct. Interim report on the psycho-social monitoring of the VELUX LichtAktiv Haus during 2012, Berlin.

New REHVA website !

On Monday March 18th 2013, REHVA launched a new revised website. The new website has been designed to provide the ultimate user-friendly experience with improved navigation and functionality throughout, allowing visitors to access more technical information.

The site includes extensive technical data to disseminate information in the field of building services. Technical reports, publications, brochures and seminar presentations provide a detailed overview of the latest HVAC technologies.

Created with the user experience firmly in mind, the website has been designed using the latest technology so the site is compatible with today's browsers.

One of the special features of our new website is the possibility to purchase and download **Guidebooks in a PDF format** at new reduced prices!

The new website will give you **direct access to the REHVA Dictionary**. REHVA members can now benefit from the online content that is easier to navigate.

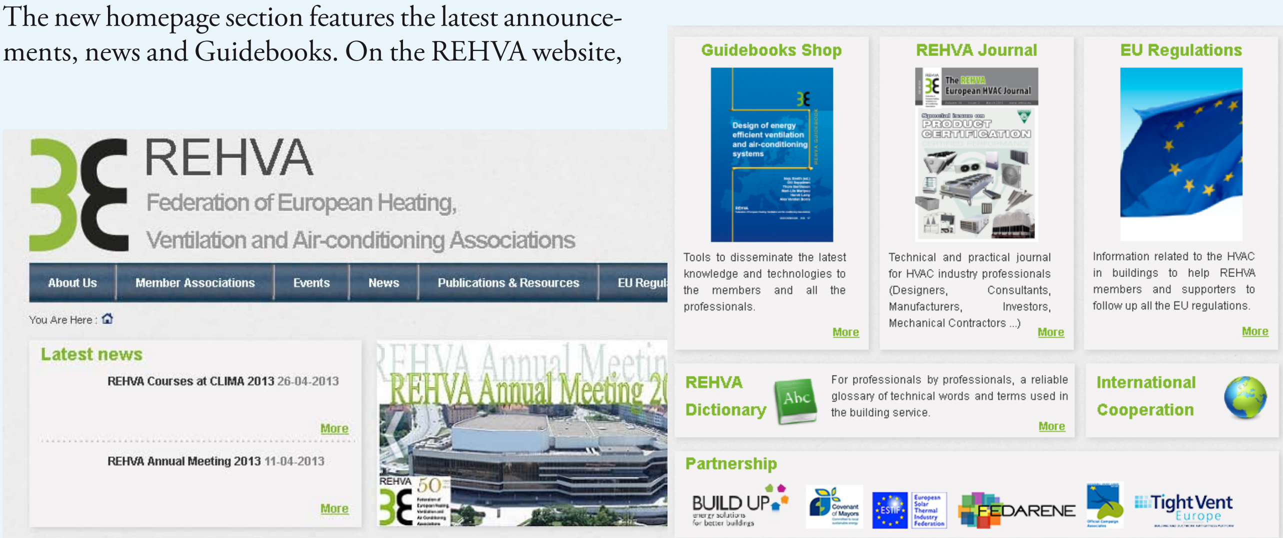
REHVA Journal and its articles in pdf and html format are available at the website. The journal pages have also articles which are not published in the paper copy.

The new homepage section features the latest announcements, news and Guidebooks. On the REHVA website, visitors can also stay informed with the latest news of the company, and the heating, ventilation and air conditioning industry. On REHVA website, visitors can also stay informed with the latest news in the heating, ventilation and air conditioning industry.

REHVA Website team in the REHVA Office.

Furthermore, the new website allows users to share products and pages that interest them with others across Facebook and LinkedIn.

Visit the new REHVA website and why not give us your feedback on the new website by posting a comment on our Facebook page. ■



www.rehva.eu.

www.facebook.com/pages/Rehva/146683652052290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Growing International Participation at AQUATHERM Almaty, Kazakhstan

As the leading HVAC exhibition in Kazakhstan, AQUATHERM Almaty is now fast approaching, and this year, the organisers are delighted to welcome an increase in international companies confirming their participation at the event.

AQUATHERM Almaty annually welcomes over 140 HVAC industry players, who showcase their latest products, services and technologies to over 7,000 specialist visitors.

Amongst confirmed exhibitors are leading global brands, such as Comfort Heat, Immergas, Polidoro, Grundfos, Viessman, Valliant, Danfoss, as well as many others.

Exhibitors at AQUATHERM Almaty showcase a ray of equipment and technologies for heating, water supply and air conditioning market. This year, the exhibition is divided into four key industry sectors:

- **CoolClima** – a new sector dedicated to technologies and equipment for climate control. This sector presents innovative cooling, air conditioning and ventilation technology for residential, commercial and industrial premises.
- **Basseyn Pool** – a specialised sector dedicated to swimming pool and pool equipment industry.
- **Eco Energy** – a sector supporting the growing culture of ecology and the development of energy-efficient technologies.
- **WaterTech** – a section dedicated to the water technologies and services sector.

Furthermore, AQUATHERM Almaty is more than an exhibition. The show annually features a number of specialised seminars, round table discussions and conferences. This year, a new Forum will take place, entitled *'Energy Efficient Design & Construction of Residential Building'*. The Forum is co-organised together with the Government of Kazakhstan, the United Nations Development Project and the Global Environment Facility project.

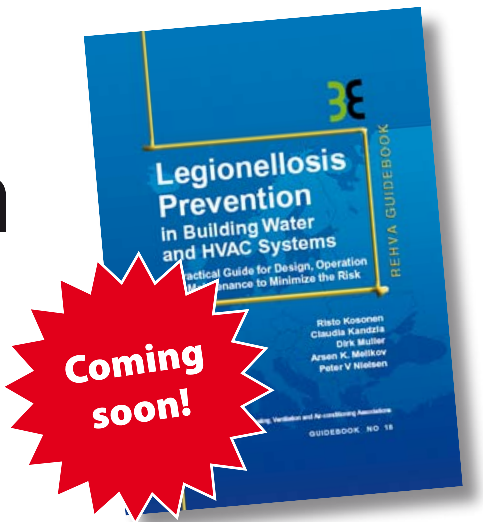
AQUATHERM Almaty will take place on **3-6 September 2013, at the Atakent Exhibition Centre, in Almaty, Kazakhstan.** ■

NEW **REHVA Guidebook on**

Legionellosis prevention

Legionellosis Prevention in Building Water and HVAC Systems

A Practical Guide for Design, Operation and Maintenance to Minimize the Risk



REHVA - Federation of European Heating, Ventilation and Air Conditioning Associations

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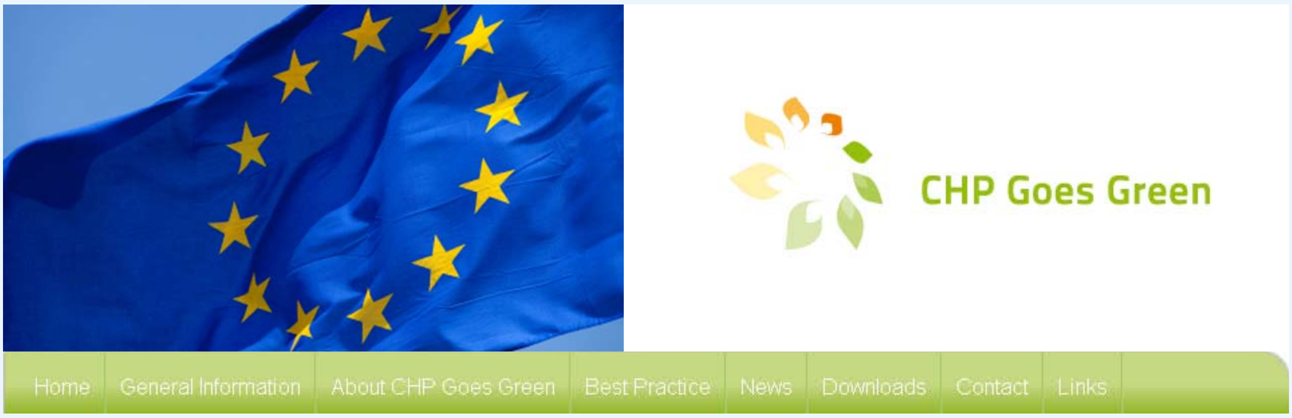
REHVA Guidebooks are available at www.rehva.eu

EU project: *The CHP Goes Green project*

– EU energy and climate policy drives bio-energy CHP in European cities



The CHP Goes Green project is co-funded by Intelligent Energy Europe (IEE) and promotes the use of RES in combination with CHP, allowing the highest efficiency combined with an increase of renewables' share. This combination can contribute to reaching the ambitious EU climate and energy goals, but is not yet widely spread and implemented.

EU policy is the single strongest driver for local actions towards more bio-energy CHP according to the CHP Goes Green project team who will present their final results in Brussels on 19th April. Despite facing the challenge of a product which is poorly understood and deployed, the project has developed a strategy to move the sector forward. The project will present its strategy for the wider implementation of green CHP based on the replicable, widely deployable successes of the model cities. Key success factors such as linked market actors, a successful business case for the investor and a local public body with responsibility for implementing energy efficiency/CO_2 reduction improvements, will be elaborated at the Final Conference in Brussels. The components of a successful fuel supply chain, which remains a particular challenge for significant take-up of bio-energy related solutions will also be explored. European project proposes strategy and recommendations for the implementation of bio-energy CHP projects at local and regional level. The following cities are represented in the project: Berlin, Frankfurt, Hannover, Graz, Paris, Lyon, Prague and Riga.

For more information visit: **www.chp-goes-green.info**

NEW REHVA Guidebook on Mixing ventilation

Mixing ventilation is the most common ventilation strategy in commercial and residential buildings. Introduced will be the new design guide that gives overview of nature of mixing ventilation, design methods and evaluation of the indoor conditions. The Guidebook shows practical examples of the case-studies.

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2013 CLIMA CZ

REHVA Workshops at CLIMA 2013 congress

in Prague – June 16-19, 2013

The REHVA workshops will take place parallel to other sessions at CLIMA 2013 conference. Each workshop will focus on a specific question(s). The result of the workshop could be an international action plan, a list of research needs, outline for a guideline, a policy statement, etc. The results will be presented to the Conference participants in a summary report that will be sent to all participants after the conference and published at the REHVA website (www.rehva.eu).

REHVA 50 1963 2013 Federation of European Heating, Ventilation and Air Conditioning Associations

	Meeting room 2	Meeting room 3	Meeting room 4	Meeting room 5
MONDAY – June 17				
11.00-12.30		**WS 1** Could ventilation rates be reduced due to effective air cleaning? *CAMFIL*	**WS 4** Cross-disciplinary education on NZEB *IDES-EDU EU-project*	**WS 7** Shading Solutions for Comfort and Energy Efficiency in Buildings *European Solar Shading Organisation*
13.00-14.30		**WS 2** The Value of Product Certification - The First Best Practice - Chillers and VRF Systems *AHRI*	**WS 5** The Practical Benchmarking of HVAC Systems Energy Efficiency in Use *iSERV EU-project*	**WS 8** Personal control over heating, cooling and ventilation *REHVA Task Force +ISIAQ*
15.00-16.30		**WS 3** HVAC Benefits Translated to Real-estate Valuation *UPONOR+ RHOSS + CAISSE DES DEPOTS*	**WS 6** Special HVAC Solutions for The Refurbishment of Historic Buildings *3ENCULT EU project*	**WS 9** New EP Standards for Direct Transposition of EPBD – Towards a Common European Method *REHVA Task Force + CEN*
TUESDAY – June 18				
11.00-12.30		**WS 10** Could ventilation rates be reduced due to effective air cleaning? *CAMFIL*	**WS 13** Superior energy performance, enabled by newest pump technology *GRUNDFOS*	**WS 16** nZEB Nearly Zero Energy Buildings - System Boundaries and Implementation in National Codes *REHVA Task Force*
13.00-14.30		**WS 11** Demand Control Ventilation (DCV) *SWEGON*	**WS 14** REHVA-ASHRAE Cold Climate HVAC Design Guide *REHVA Task Force+ASHRAE*	**WS 17** Cutting-edge Japanese Technologies for HVAC: Our Vision and SHASE-awarded Buildings *SHASE (Japan)*
15.00-16.30		**WS 12** Green Lease: Launchpad for green techs and energy efficiency *CAISSE DES DÉPÔTS + ICADE*	**WS 15** Outcomes and future research in Energy Use related to Occupant's behaviour *REHVA Task Force*	**WS 18** BELIMO Experience with Energy Efficiency *BELIMO*
WEDNESDAY – June 19				
11.00-12.30	**WS 25** Energy efficiency with certified products *Eurovent Certification Company*	**WS 19** Deep Energy Refurbishment for Zero CO_2 Emission Buildings and nZEB *REHVA Task Force*	**WS 21** Reference Buildings for Energy and Cost Optimal Analysis *REHVA Task Force*	**WS 23** Mixing Ventilation in a Nutshell – a New REHVA Guide Book *REHVA Task Force*
13.00-14.30		**WS 20** Energy Efficiency with Cogeneration (CHP) on Building Level *REHVA Task Force*	**WS 22** Environmental-friendly Refrigerants in HVAC Applications *REHVA Task Force*	**WS 24** China Forum - Energy Efficient Ventilation Solutions in China *China committee of HVAC*

Energy roadmap 2050 puts pressure on building sector

"The Parliament recognised the benefits that Member States derive from working together for an energy system transformation; endorses, therefore, the Commission's Energy Roadmap 2050 as a basis for proposing legislative and other initiatives on energy policy with a view to developing a policy framework for 2030, including milestones and targets on greenhouse gas emissions, renewable energy and energy efficiency, with the aim of establishing an ambitious and stable legal and regulatory framework; notes that defining energy targets for 2050 and the intervening period assumes pan-European governance; proposes the adoption, within the spirit of solidarity, of a strategy that allows Member States to cooperate under the Roadmap in a spirit of solidarity – the creation of a European Energy Community; encourages work to define the 2030 policy framework within a timeframe that is appropriate for providing investor security"

The Committee on Industry, Research and Energy (ITRE) stressed in its report to the Parliament the importance of the EU's energy policy amidst the economic and financial crisis, and the role that energy plays in spurring growth and economic competitiveness and creating jobs in the EU. The Commission is asked to propose post-2020 strategies and a policy framework for 2030, including milestones and targets on greenhouse gas emissions, renewable energy and energy efficiency, with the aim of establishing an ambitious and stable legal and regulatory framework.

In its report to the Parliament ITRE invites the Commission further to:

- explore a combined "**high renewables and high energy efficiency**" scenario, noting that a choice made about which path to take would help increase investment certainty;
- take **decentralised generation** explicitly into account in future estimates of renewable energy in the EU energy mix, and map financial, technical and infrastructural obstacles that hamper the growth of decentralised generation in Member States.

In the area of energy efficiency ITRE stresses that the EU's long-term energy-efficiency policy should take the **reduction of energy use in buildings** as a central element, calling on Member States to adopt ambitious, long-term building renovation strategies as required by the **Energy Efficiency Directive.** The current quality of building renovation needs to be substantially scaled up in order to **significant reduction of energy consumption of the existing building stock by 80 %, relative to 2010 levels, by 2050.**

The ITRE report calls, furthermore, for greater attention to be paid to **the heat and cooling sectors** in the transformation of the energy system, noting that this sector represents about 45 % of the final energy consumption in Europe.

The Energy Roadmap 2015 final version is available at the webpage of the European Parliament **www.europarl.europa.eu**

The proposal of the Energy Roadmap 2015 by the Commission was summarised in the REHVA Journal 3/2011 pp 83–85

New report from world green building council

The new report, "The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants," from WGBC examines whether or not it's possible to attach a financial value to the cost and benefits of green buildings. Today, green buildings can be delivered at a price comparable to conventional buildings and investments can be recouped through operational cost savings and, with the right design features, create a more productive workplace. **http://www.worldgbc.org/activities/business-case/**

The SINPHONIE project focused on IAQ in schools

The SINPHONIE project was a complex research project covering the areas of health, environment, transport and climate change, aiming at the improvement of air quality in schools and kindergartens. The project was initiated by the European Parliament and implemented under a service contract with the European Commission (Directorate-General for Health and Consumers, DG SANCO). The project consortium of the 25 European countries wishes to address the outcomes of the SINPHONIE project as a contribution to the revision of the European Air Quality Policy and actions.

The SINPHONIE project reports on children's health and indoor air quality, and discuss the recommendations on the European guidelines for healthy environments within European schools – in the light of the European Year of Air.

More information at **http://www.sinphonie.eu/**

News

Commission has declared 2013 the year of air

The EU has been tackling air pollution since the 1970s. Steps like controlling emissions of harmful substances into the atmosphere and improving fuel quality have contributed to progress in this area, but the problem still remains. This is mainly as a result of human activities: the burning of fossil fuels and the dramatic rise in traffic on the roads, for instance. As a consequence, air pollution is cited as the main cause of lung conditions such as asthma (there are twice as many sufferers today compared to 30 years ago), and as the cause of over 350 000 premature deaths in the EU every year. Now, the European Commission is adopting a new strategy and has declared 2013 as the year of air, with new proposals on improving air quality across Europe.

The plan is to highlight the importance of clean air for all and to focus on actions to improve air quality across the EU. Already the European Commission has formed a collaboration with the World Health Organization (WHO) Regional Office for Europe. They will review the latest health science on major air pollutants such as particulate matter, ground-level ozone, and nitrogen dioxide. Their findings will be presented at an event this month titled 'Understanding the health effects of air pollution: recent advances to inform EU policies'.

The 2013 edition of Green Week, the biggest annual conference on European environment policy, will take place from 4 to 7 June at a new venue, The Egg Conference Centre in Brussels. This year's theme is Air quality.

For more information, please visit:
European Commission - Environment - Air **http://ec.europa.eu/environment/air/index_en.htm**
World Health Organization (WHO) - Air pollution **http://www.who.int/topics/air_pollution/en/**
European Environment Agency - Air pollution **http://www.eea.europa.eu/themes/air**

BUILD UP energy solutions for better buildings

In the framework of the **BUILD UP Skills** initiative, 30 EU countries are working on national roadmaps to qualifying the building workforce for the 2020 challenges. Already about 20 national teams have completed their analyses of the status quo. During the recent BUILD UP Skills EU Exchange Meeting, over 100 representatives shared information on the development of training roadmaps. Material and presentations have been posted in the recently launched BUILD UP Skills website.

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The **BUILD UP Country Facts** page, provided in collaboration with the Concerted Action EPBD, is regularly upgraded with key information on national policies, regulations, registries, software, financing mechanisms, contacts and more.

NEW in Eco-design

According to Article 16(1) of the Eco-design Directive, the Commission adopted in December 2012 a Working Plan for the period 2012-2014, setting out an indicative list of energy-using products which will be considered in priority for the adoption of implementing measures.

The full text can be downloaded at EC home page*:

- Window products
- Steam boilers (< 50 MW)
- Power cables
- Enterprises' servers, data storage and ancillary equipment
- Smart appliances/meters
- Wine storage appliances (c.f. Ecodesign regulation 643/2009)
- Water-related products

Wine storage appliances have been added to the priority list, as there is a legal obligation under Ecodesign regulation 643/20099 to assess the need to adopt ecodesign requirements for this product group. It has been estimated that the combined energy savings potential of the priority product groups covered by this working plan would amount to just under 3 000 PJ per year by 2030. The list of conditional product groups, where launching a preparatory study is dependent on the outcome of on-going regulatory processes and/or reviews, comprises the following groups:

- Positive displacement pumps
- Fractional horse power motors under 200 W
- Heating controls
- Lighting controls/systems
- Thermal insulation products for buildings

The Commission has also published its report on the revision of the Eco-design Directive. The main conclusion is that there is not an immediate need to review the Directive and that the scope needs no extension to non-energy-related products

* http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/working-plan/index_en.htm

ASHRAE IAQ 2013 Conference

Environmental Health in Low Energy Buildings – IAQ 2013 October 15 - 18, 2013, Vancouver, British Columbia, Canada

IAQ 2013 will review the state of knowledge of the balance of environmental health and energy efficiency in buildings and help define future education, policy and research directions. With an increasing emphasis on energy conservation, there is a tendency to ignore the purpose of the use of much of that energy, the maintenance of good indoor environmental quality. The roles of building, HVAC and passive system design and operation for achieving good environmental health in low energy buildings are the core themes of this conference.

The conference program will include internationally acclaimed keynote speakers, original peer reviewed conference papers and extended abstract presentations. Abstracts are invited in the following subject areas:

- Environmental Health in Low Energy Buildings
- Moisture and Health
- Sources and Chemistry
- IEQ Factor Interactions
- Residential Buildings
- Commercial and Institutional Buildings
- Air Cleaning and Filtration
- Microorganisms and Infection
- Tools (models, measurements and more)

ACREX REHVA seminars in Mumbai

REHVA actively present at ACREX exhibition and conference in Mumbai, March 2013

REHVA and ISHRAE *(Indian Society of Heating, Refrigerating and Air Conditioning Engineers)* signed a Memorandum of Understanding in early 2012 and since that there have been several shared activities. As part of cooperation REHVA and ISHRAE visited 2012 together both the European Commission DG Energy in Brussels and Indian Bureau of Energy Efficiency (BEE) in Delhi. During these visits it became clear that there is a need and also an opportunity for closer cooperation between India and Europe in the area of energy efficient buildings and especially in Heating, Ventilation and Air-conditioning (HVAC). HVAC represents 55% of energy use of buildings in India and therefore it is one of the key areas when improving the energy efficiency.

REHVA organised with ISHRAE during the ACREX Exhibition two seminars, five training sessions (workshops), prepared a special issue of REHVA journal with 5 000 copies distributed to visitors, sold REHVA guidebooks. In addition REHVA representatives were international experts in the Bry-Air HVAC competition.

Indo-European Seminar for Policies & Technologies for a Better Energy Future in India

REHVA and ISHRAE (Indian Society of Heating, Refrigerating and Air Conditioning Engineers) organized together a seminar "Policies & Technologies for a Better Energy Future in India: Indo-European Cooperation" during ACREX exhibition on 7th of March 2013 in Mumbai. In this seminar we introduced the building related energy efficiency legislation both in India and in Europe as well as we had two real estate industry representatives, one from Europe and one from India, to talk about why energy efficiency is important in their business. This seminar and a round table discussion after that was a beginning of REHVA-ISHRAE cooperation with BEE and DG Energy for knowledge sharing, education, and development. A follow up group under leadership of Ms Maija Virta was established. The presentations of the seminar are available at www.rehva.eu, and summarised below.

ALEXANDRA SOMBSTHAY from European Commission DG Energy presented the European legislation for energy efficient buildings and products. European Union has been pioneering in energy efficient building legislation and published the Energy Performance of Buildings Directive already 2002 and a recast 2010. This directive sets the energy performance requirements for buildings. There is also a requirement to meet the nearly zero energy level in national building legislation by 2020. In parallel European Union has published Ecodesign Directive 2009 to set the minimum performance criteria for energy related products promoted and sold in Europe and Energy Labelling Directive 2010 to promote the most energy efficient products. The Energy Efficiency Directive (2013) also focuses on existing buildings and their energy efficiency. If Europe is able to achieve its 20% energy efficiency target, it means 2.6 billion barrels of oil import saved or 1000 coal power plants less or money saved equal to the GDP of Portugal.

S KUMAR DEEPA was presenting the corresponding Indian legislation behalf of Indian Bureau of Energy Efficiency. BEE launched the Energy Conservation Building Code (ECBC) already 2007 as a voluntary scheme. The impact of ECBC is already proven as the national benchmark for energy use of building is 180 kWh/m²,a but the ECPC compliant building uses only 110 kWh/m²,a. Energy efficiency of existing buildings is addressed through energy auditing and accredited energy service companies (ESCOs) schemes. The Star Rating Program for buildings is based on the actual performance of the building in terms of specific energy usage (kWh/m² per year).

FRANK HOVORKA, head of real estate sustainability policy in Caisse des Dépôts, France, was talking about how to measure the energy efficiency of building and how it impacts the value. It is important to consider not only the operational energy use but also the embodied energy of building structures as well as the energy used for transportation. The green value of a building is the net additional value that it is possible to reach on the market for efficiency (resources, energy, but also indoor environment quality and comfort). Discounted cash flow method highlights the future performance of building and is therefore a good tool for future building valuation. The main benefit from energy efficiency lies in its impact on long term value and therefore the long term investors are in a key role when promoting the energy efficiency of buildings.

ROHAN PARIKH, head of green initiatives in Infosys, India presented that the Green is a new gold as there are so many benefits in green, energy efficient buildings for its owner and user. In Infosys they have managed to develop new buildings that are 50% more efficient at no extra capital costs. There is 35% reduction per capita in electricity consumption of existing buildings and 25% reduction per capita in water consumption in existing campuses due to implemented improvements. This result € 35 million and saved in operation costs and € 43 million saved by frugal engineering. Another strong message was that building owners and designers have to set unrealistic goals for themselves. The integrated design process and especially when the design fees are linked to the project targets are key issues when implementing the energy efficiency in construction projects.

REHVA Training sessions

REHVA also organised with ISHRAE five technical half day training sessions during on the topics selected by ISHRAE experts.

- Ventilation of commercial kitchen, Risto Kosonen, Halton and Aalto University
- Energy efficient and environmentally friendly cooling for HVAC+R systems, Attila Zoltan, UNEP consultant in environmental issues
- Design of effective and draft less air distribution for air conditioning systems, Risto Kosonen, Halton and Aalto University
- Solar Shading – how to integrate solar shading in sustainable buildings, Wouter Beck, Greentech Hunter Douglas
- Design of surface cooling, Maija Virta, Santrupti Engineers

Bry Air Awards competition jury members and the organisers of the competition.

Bry-Air Awards of Excellence in HVAC&R

Bry-Air has instituted the Awards to motivate, promote and award excellence in innovative thinking that will enhance India's competitiveness in the HVAC&R industry worldwide to encourage HVAC&R Engineers and Designers to design commercially successful products, processes and services, which are "Indian sub-continent centric" and give India a sustainable competitive advantage.

During the ACREX exhibition the Bry-Air Awards, now in their eighth year, were presented to individuals and/or corporates who have made outstanding contribution to the HVAC&R industry in terms of innovations in HVAC&R Systems Design or Product Design.

The awards were presented to the winners of the competition in three categories.

- Innovative System Design
- Innovative Product Design
- Student: For Innovative Project

An independent and eminent Jury Panel will review the nominations and select the most outstanding work through a transparent system, under the Chairmanship of Mr. A.K. Joshi, President – Electro-Mechanical Projects & Services, Voltas Ltd. Ms Maija Virta and prof Olli Seppänen represented REHVA in the Awards Jury. ■

Awardees are described in detail at **www.bryairawards.com**

REHVA - ISHRAE Technical seminar in Mumbai: Energy Efficient Buildings

HVAC technology for low energy buildings: European experience

This seminar introduces some European Technology and regulations to the Indian experts and visitors of the exhibition with following programme. The presentations are available at **www.rehva.eu** > Publications & Resources > Event presentations.

- Steps and tools towards better energy efficiency of European buildings, Olli Seppänen, REHVA Journal
- Energy efficient and good indoor environment in buildings, Dr Risto Kosonen, Adjunct professor, Aalto University and Halton
- Performance testing and certification air handling units (DOAS) and cooling towers, Mr Ian Butler, Eurovent Certification Company
- Portfolio scale energy refurbishments, Mr Frank Hovorka, Head of real estate sustainability policy, Caisse des Dépôts, France
- Modern HVAC-systems for nearly zero energy buildings, Mr Maija Virta, M.Sc. REHVA Fellow

Historical and existing building: designing the retrofit – an overview from energy performances to indoor air quality

49th AiCARR International Conference

Roma 2014 February 26th – 28th

The 49th Edition of AiCARR International Conference of 2014 will take place in Roma. The Conference is devoted to providing a deep overview on the retrofit design of the historical and existing buildings; the themes related to the energy performances, to the indoor air quality, to the energy sustainability and to the innovations on buildings and their systems will be proposed.

The necessity of reducing energy consumptions in existing buildings is an important goal for all Countries that seek a rational use of resources and the reduction of CO_2 emissions. Interventions in existing and especially historical buildings must be carefully designed and defined both for the existence of static and/or historical constraints, both for use requirements, operational, maintenance and cost.

The energy performance of buildings shall be defined on the basis of methodologies, which include, in addition to thermal characteristics, other factors that play an increasingly important role such as heating and air-conditioning installations, application of energy from renewable sources, passive heating and cooling elements, shading, indoor air quality, adequate natural light and satisfactory indoor noise level.

The conference aims to analyse the main technologies in plants and equipments applicable today in existing buildings to improve energy performance, indoor environmental quality and sustainability.

Proposal for free papers: abstract (4000 characters including spaces) should be submitted to AiCARR web site within July 1st, 2013

Rules of the Conference for the Authors are published on AiCARR website at: **www.aicarr.org** > Convegni > Author Area > Rules ■

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KazBuild

The CLIMA 2013 – 11th REHVA world congress

The CLIMA 2013 – 11th REHVA world congress is in full swing. Together with 25 high quality REHVA workshops for professionals, REHVA and ASHRAE intensive courses held just before the congress. CLIMA 2013 is aiming to be the greatest professional meeting in the field of "Energy efficient, smart and healthy buildings" this year.

Besides the high valuated scientific meeting, you will be able to explore also the "Jewel in the Crown" of Central Europe! Many social events and sightseeing tours have been organised. You will visit historical places such as Konopiště Castle, Pilsner Brewery and Koněprusy.

You can find more detailed information in the conference programme or just visit the event registration desk. The event organisers' will be happy to assist you with your requests.

Join us at the Congress Farewell Party on June 18, 2013 at the Municipal House - the European pearl of Art Nouveau where you will have fantastic opportunity to dance in its representative halls which will be exclusively opened for this evening – see congress web pages **www.clima2013.org**. During this evening, you will also have the opportunity to make your own photo in the period photo studio.

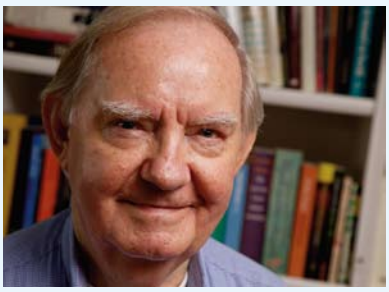
The Prague Municipal House also offers during your stay in Prague a very unique and high-valuated exhibition of Alfons Mucha´s art nouveau period posters from the private collection of famous Czech tennis player Ivan Lendl. Tickets are available directly at the cash desk in the Municipal House.

Special exhibitions will be offered to the spouses. The world-famous fashion designer, Blanka Matragi, is coming to the Prague Municipal House with a new exhibition. This exhibition held in the Gaming Parlours will present primarily dresses and accessories but also glass, porcelain, sculptures, chandeliers and graphic art among others. Tickets are available directly at the cash desk of the Municipal House.

Wishing you many successful experiences and fun during the CLIMA 2013! ■

Ben Bronsema defended publicly his thesis on Earth, Wind & Fire - Natural Air conditioning

Ben Bronsema, REHVA Honorary Fellow, spent a lifetime experimenting with and perfecting traditional air conditioning systems. But while in his second career as guest tutor in the Faculty of Architecture, the students search for a simpler solution towards climate design inspired him to take a different approach. He developed the Earth, Wind & Fire, a natural air conditioning system consisting of architectural elements, while in his third incarnation as a 76 year old PhD Student. In order to obtain the degree of doctor at the Delft University of technology, Ben Bronsema defended publicly on June 7, 2013, at 10: 00 am his thesis on Earth, Wind & Fire - Natural Air conditioning on the authority of the Rector Magnificus Prof. ir. K. Ch. A.M. Luyben, President of the doctorate Board. A week later, he will present the results of his research at CLIMA 2013. An article related to the work Ben Bronseman´s research was published in the REHVA Journal 4/2012 pp 25-32. ■



Master and Post-graduate Education and Training in Cross-disciplinary Teams Implementing EPBD and Beyond – IDES-EDU project

IDES-EDU

The need for skills and knowledge that exceed the requirements of the EPBD has increased significantly over the past years in Europe mainly as a result of the adoption of the Energy Performance of Buildings Directive and the 20-20-20 targets set by the EU.

IDES-EDU is a project co-funded by the Intelligent Energy - Europe program in which 15 European universities work together to fulfill this need through the development of curricula and training programs on Integrated Sustainable Energy Design for MSc students and Professionals. Architects and specialists like mechanical, civil, HVAC engineers and energy experts that graduate from an IDES-EDU course will be capable of working with the integrated design process and in cross-disciplinary teams, and as a result deliver optimum performing buildings.

Major outcomes and results of IDES-EDU

- Development of curricula and training programs (master courses and post graduate courses) on nZEB design principles and on cross-disciplinary teamwork. The developed educational material includes 13 modules with 102 lectures and 10 seminars on a Master level for students and a Post-graduate level for professionals working in the buildign sector.
- Implementation of these courses in the 15 participating universities.
- Exchange and collaboration workshops between students and professionals.
- Internal students exchange program.
- A general framework for the training and education building objects to be used by students and post graduate participants in the practical design cases.
- Elaborated designs and terms of references for building objects by each university and business plans for realization of the building objects by the participating universities and the members of the collaborating national consortia.
- Realised training and education buildings by Hogeschool Zuyd, Heerlen and by the University of Ljubljana.
- An intelligent dynamical and adaptive multimedia teaching portal.
- Dissemination of the action in all EU member states by exchange programme with other EU universities.
- Recommendations to relevant stakeholders and policy makers on the potential of integrated sustainable energy building design, capacity and potential of the trained experts.
- Increasing European awareness, promoting implementation and commitment on Integrated Sustainable Energy Design in the Built Environment.

IDES-EDU and CLIMA 2013

The completion of the IDES-EDU project in June 2013 is marked with the workshop "Towards NZEB's and renovation: the role of education" at the CLIMA 2013 conference. More information about the workshop can be found at the CLIMA 2013 official website. ■

More information about the project and it's outcomes can be found at **http://www.ides-edu.eu/**

Disclaimer
This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Supported by INTELLIGENT ENERGY EUROPE

HealthVent project completed

The project "HealthVent - Health-Based Ventilation Guidelines for Europe" was funded in the framework of the Second Programme of Community Action in the Field of Health (2008 - 2013), European Commission - Directorate General for Health and Consumers. The project team was composed of a multidisciplinary group of experts from medicine, engineering, indoor air sciences, exposure and risk assessment, energy for thermal comfort, ventilation practices as well as patient groups. Project was coordinated by Dr Pawel Wargocki from Technical University of Denmark.

REHVA participated in project as partner and leader of the Work Package 5 "Existing buildings, building codes, ventilation standards and ventilation in Europe". The final report of WP 5 is available at **www.rehva.eu** > EU Projects > Current Projects>HealthVent.

The project was built on the experience, findings and recommendations of the previous projects funded by the European Commission in the field of indoor air quality and health (e.g. EnVie, EuroVen, IAIAQ): of the ongoing development of Indoor Air Quality Guidelines by the World Health Organization (WHO); and of all other projects relevant to the topic. The scientific literature has been reviewed in the context of ventilation and its impact on health and on exposures affecting health, examining whether it provides information on the association between health and ventilation, and documenting ventilation design requirements, operation and maintenance.

The group developed guidelines for setting health-based ventilation for public and residential buildings in Europe, and discussed the consequences of implementing the guidelines for health, bearing also in mind future trends in the built environments, including the related energy use.

HealthVent project proposed policy actions and identified needs for research

Policy

The health-based ventilation rate in a specific building is defined when the WHO guidelines are met through an integrated preventive approach combining source control measures and health-based ventilation practices that guarantee the protection of health. A holistic approach is needed, defining the building and urban and indoor air quality role for the global sustainability. This approach requires integrated strategies and policy recommendations, some of which are described in the following:

- Development of a common regulation in Europe on ventilation rates, which would harmonize calculation practice among countries and take care that required ventilation rates are health based and are implemented in connection with appropriate source control strategies to guarantee health protection while rationalizing economic and energy expenditure. Such a document would serve as a base document for legislators in EU countries and/or in the European Commission. Inclusion of requirements for indoor air quality in the national regulations of all European countries, including a harmonized minimum number of pollutants and associated limit levels according to the WHO guidelines.

- Development of a harmonized product labelling criteria to be used as a part of ventilation rate design specification aligned with the harmonization framework for indoor products emissions testing, health-based evaluation and labelling which was developed by the EC's Joint Research Centre (ECA Report 29, 2013).

- Inclusion of indoor air quality and its auditing in the future recast of Energy Performance Buildings Directive (EPBD) and in the revision of ventilation regulations. This can be facilitated by and can take advantage of the harmonization framework for indoor air monitoring recently developed by the European Commission (DG JRC and DG SANCO) in the context of the PILOT INDOOR AIR MONIT project.

- Integration of indoor air quality issues and accounting for the associated environmental, health, social and economic impacts in the potential review of Ambient Air Directive by DG ENV.

- Development of a new European guideline providing guidance on proper scope, design, construction, maintenance and inspections of ventilation systems. It can bee and inspection of ventilation systems. It

To present project results, an event was organised at the European Parliament in Brussels on February 20th, 2013. The event was hosted by Mrs Catherine Stihler, Member of the European Parliament (MEP), and was coordinated by EFA's EU Policy Officer, Ms Roberta Savli, a partner in HealthVent project along with active contributions from the other members of the HealthVent consortium.

can be considered to enforce the maintenance and inspection of ventilation systems if possible in parallel with inspections of air-conditioning systems and energy auditing under EPBD.

- Developing cross-cutting criteria for energy requirements decoupling ventilation and indoor air quality objectives and thermal comfort aligned across various legislative instruments such as DG ENV's Eco-label criteria for various products, Ecodesign Directive Lot 6 on ventilation, CEN/TC 350/WG 5 prEN 16309 "Sustainability of construction works".

- Development of new EU policies allowing the sustainable houses that adapt to variations in indoor and outdoor sources and featuring passive/active control for moisture/dampness and avoidance of particles.

Future research

The gaps in knowledge and needs for future research were also identified in the HealthVent project. They included:

- Population representative measurement campaigns on indoor exposures in all major types of building; these exposure measurements should include quantification of ventilation rates and analysis of the role of indoor and outdoor sources.

- A better characterization of exposures is needed and there is also a need to define acceptable indoor levels for more pollutants.

- Studies are needed to provide information on potential pollutants transported from outdoors, their infiltration parameters and decay rates.

- Emissions from indoor sources in addition to carbon dioxide need to be incorporated in future projects and lowest concentrations of interest have to be defined.

Further information

Details about HealthVent project can be found on the website: **www.healthvent.eu**

REHVA report available at **www.rehva.eu** > EU Projects > Current Projects>HealthVent.

REHVA Journal has published several articles on the result s of WP 5

- **Andrei Litiu**: Ventilation system type in some EU countries RJ 1/2012 page 18
- **Nejc Brelih**: Ventilation rates and IAQ in national regulations RJ 1/2012 page 24
- **Olli Seppänen**: Effect of EPBD in future ventilation systems RJ 2/2012 page 34
- **Nejc Brelih**: Thermal and acoustic comfort requirements in European Standards and National 2/2013, pp 16

For further information on HealthVent Project, please contact: **healthvent@healthvent.eu** or **info@efanet.org** ■

Solutions & tools for conservation compatible energy retrofit of historic buildings

Historic buildings are the trademark of many European cities, towns and villages and are a living symbol of Europe's rich cultural heritage. On the other hand, they are also substantial contributors to CO_2 emissions and rising energy bills, and often do not offer the comfort needed – comfort for users and "comfort" for heritage collections. Can these buildings be made more energy efficient while conserving their heritage value and guaranteeing their long-term structural health and preservation?

The research project 3ENCULT proposes that it is possible, if all stakeholder are included in the design process of the energy retrofit[1]. This base principal is also reflected in the consortium of the multidisciplinary project itself: it has gathered together scientists along with stakeholders from architecture, conservation, building physics and other specific technologies.

The multidisciplinary exchange begins with a comprehensive **diagnosis**, supports the **design** process, and continues to the **implementation** of an integrated **monitoring & control** system (figure at left). It looks at **all the components of a building**, identifying solutions which best fit a specific building (See **figure** attached) In doing so, 3ENCULT demonstrates that a consistent reduction of energy demand up to factor 4 or even factor 10 is also feasible in historic buildings, all the while respecting their heritage value.

The team develops passive and active solutions, proposing existing products as well as developing new ones. Eight case studies demonstrate solutions that are applicable to the majority of European heritage buildings in urban areas.

One year before the end of the project, several prototypes have already been prepared – from a conservation compatible phA window with enhanced internal insulation, to optimised LED lighting solutions, to low impact ventilation – as well as application and solution guidelines, and diagnosis and planning tools.

Case Study: Monumental School, Innsbruck (Austria)

- high efficient passive house windows with integrated shading
- internal/external insulation of walls and roof
- ventilation system with heat recovery

To give a specific example in HVAC: To minimise the impact (and maximise the reversibility) on architecture and building structure, 3ENCULT partner University of Innsbruck designed and tested a new ventilation system for the Höttinger school in Innsbruck ("Early Modernism") – taking advantage of the building's intrinsic potential: the large corridors serve as "fresh air reservoirs" for the classrooms which are ventilated from the corridor with an active overflow system. This reduces the ductwork within the building to a minimum, since a central heat recovery system has only to ventilate the staircase and the corridors with preheated fresh air.

In conclusion, 3ENCULT does not propose "standard solutions", but rather provides a pool of possible measures and tools, along with guidelines for how to incorporate those into a building[2]. ■

ALEXANDRA TROI
EURAC research, 3ENCULT coordinator

3encult
EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

1 Efficient Energy for EU Cultural Heritage, funded within FP7, GA n° 260162, www.3encult.eu

2 Results will be disseminated via the project website, but also via BUILD UP and in a handbook.

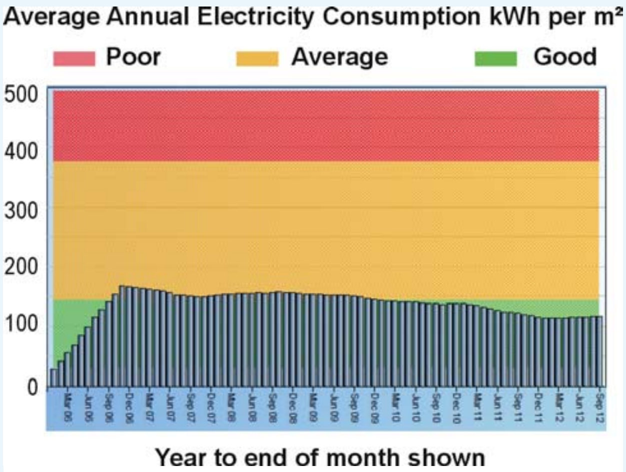
Automatic monitoring targeting real energy savings & benchmarks

While it is becoming common to analyse the energy consumption in a building and invest in energy efficient technologies, HVAC systems are lagging behind. Their energy consumption disappears in the general electricity bill with separate meters seldom installed. The iSERVcmb Project is designed to shed more light onto this subject, as well as to encourage monitoring and establish energy benchmarks for HVAC systems.

"Cardiff University's involvement with both the IEE HARMONAC and iSERVcmb projects has meant we now can pay much closer attention to the detailed operation, maintenance and control of the University's HVAC systems than we would have done in the past. The savings achieved in McKenzie House over the time span of these two projects has demonstrated to us that there are significant energy and cost savings to be had in many of our buildings. This makes the initial time spent in understanding our systems, through describing the buildings physical assets using the iSERVcmb spreadsheet, a worthwhile and cost effective investment."
Keith Sims - Maintenance Engineer at Cardiff University

The iSERVcmb project has been discussed in previous REHVA Journals (August '11, January '12). This update on the project's progress shows the level of electrical energy savings being achieved at a whole building level from implementation of the iSERV process in a UK building over a period of 5 years. This is therefore the first building to be demonstrating results within the project period.

These first results show that the savings being achieved are significant: a reduction of 25% of the total build-



Currently, 89 buildings, 351 HVAC systems and 1,653 HVAC components have been loaded into HERO. Interested end users are invited to contact the iSERVcmb project partners for more information on benefits. Go to the project website to join the 130 companies and buildings already providing data to iSERV, and see how much money and energy you could save in your building services.

ing electrical energy consumption, worth around EUR 66,000 per year, has been realised in the case study building as a result of using the iSERV methodology. This has been achieved at a total cost of less than EUR 7,000 invested to understand the HVAC systems fully through cataloguing via plant visits and resetting controls via the BEMS. The savings therefore pay back the costs of achieving them nearly 10 times over every year.

The case study building, McKenzie House, is an office block of 8,435 m^2 conditioned gross internal area arranged over 11 stories, in Cardiff, UK. Floors 4 to 11 of the building are served by a VAV system with heating, cooling, and filtration. The Ground to 3rd floors, stairwells, toilets and landings are served by other HVAC systems. Cooling is provided by two packaged chillers, with a total Nominal Cooling Capacity of 740 kW. The boiler plant consists of three gas fired cast iron sectional boilers with a total heating capacity of 1.4 MW. The building systems are controlled by a BMS, and the HVAC systems generally operate on optimized stop and start control algorithms.

The consumption data presented in this report starts in June 2003 and includes energy consumption of gas and electricity. From December 2006 onwards the rolling annual electricity use of the whole building starts to reduce. The initial reduction from a peak of 184 kWh/m^2a in August 2005 to around 169 kWh/m^2a in October 2008 is primarily due to the implementation of an Eco-champions network at Cardiff University. The prior project to iSERVcmb, HARMONAC (2007 to 2010), started to make an impact from December 2008 onwards achieving a reduction in the HVAC systems' electrical energy use. The continued steep reduction after this date to a current consumption of 124 kWh/m^2a is due to the improved control being exerted on the building's HVAC system arising from better understanding. These electricity savings represent a total reduction of 33% from the initial electricity use peak. The annual electrical savings achieved in the building are currently 528,000 kWh, with approximately 395,000 kWh/ annum arising from better understanding and control of the HVAC plant.

Regarding replicability, it's likely that these savings will be at the upper end of what is possible to achieve in commercial buildings without major design changes, as some of the measures undertaken, such as changing setpoints for the HVAC system components, have led to increased complaints from occupants which are likely to require additional energy to rectify in the longer term. However, with electrical energy savings of 50% to 70% in the HVAC components alone, there is room to trade off energy savings for increased comfort while still making substantial energy savings. The achieved savings are in line with the upper end of savings predictions from HARMONAC.

The information coming back from HERO, iSERVcmb's online application, indicates that there are also further savings to be made, but these will require further investment. HERO's capabilities are currently being extended by introducing targeted ECOs (Energy Conservation Opportunities) in the reports sent back to the HVAC system owners. Specific to the energy performance of an HVAC system or its components, users will be informed via these ECO's about quantified potential energy and cost savings they could realise by implementing various energy efficiency measures.

The project hopes to identify further McKenzie House savings once the iSERVcmb ECO's are all fully integrated into the HERO analysis and reporting system. It is clear from the project that the availability of end user HVAC data, presented in an easy to understand fashion, encourages owners to take action while at the same time helping to make legally required inspections more efficient. In order to test and deliver high-quality reports for end-users, the project is still looking for system owners, facilities managers and HVAC manufacturers who would like to contribute to the project. Appropriate systems should already have monitoring equipment in place – or their owners should be willing to install monitoring equipment– and be able to contribute monitoring data to the project. In return they will be able to use HERO to learn more about possible improvements to their system(s) and contribute to the development of benchmarks relevant to their systems. ■

COLLECT & CONNECT : www.iservcmb.info

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Wide variation in how parameters are regarded in environmental certification systems

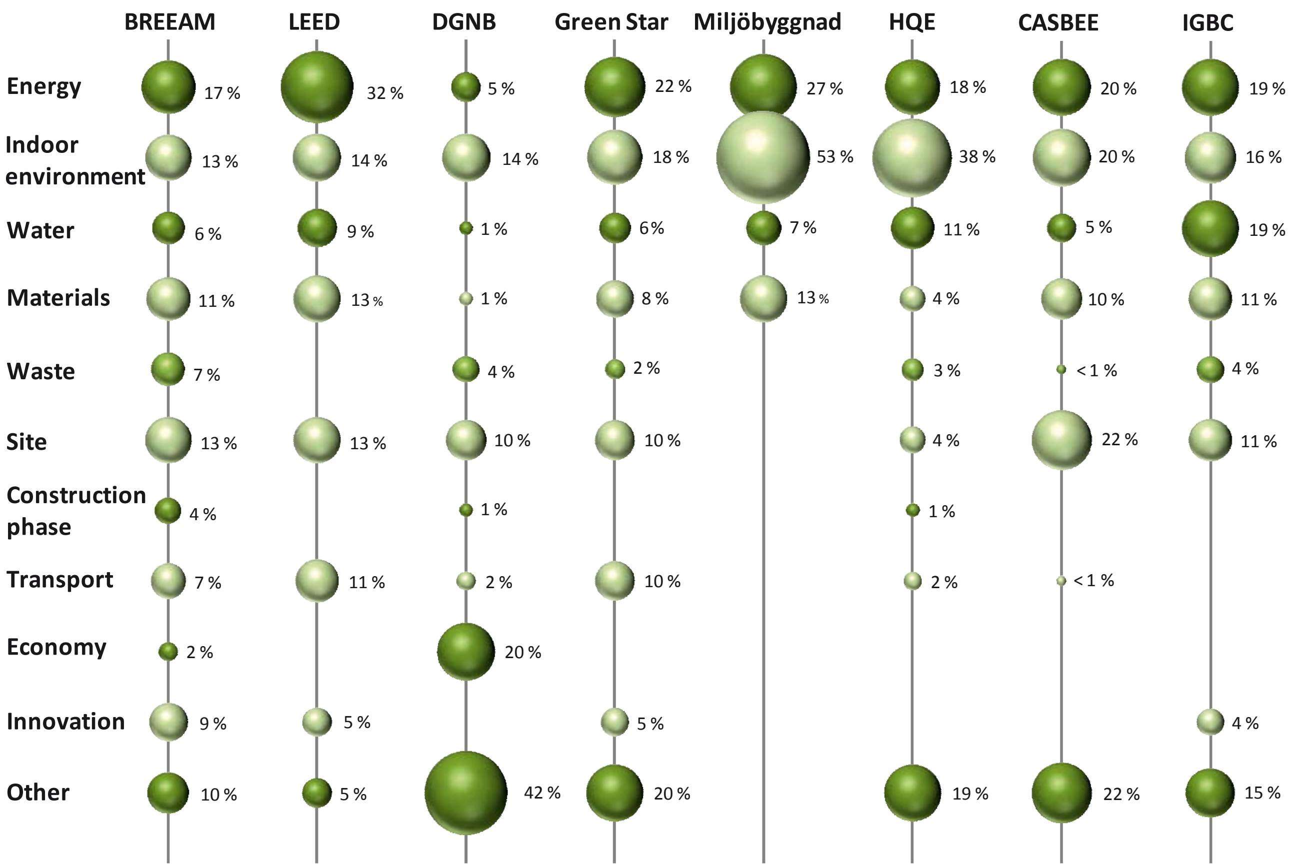
DANIEL OLSSON
CIT Energy Management AB,
Gothenburg, Sweden

For anyone wishing to certify a building there is an enormous choice of certification systems to choose between, each one offering its own distinctive approach to the subject. In order to clarify the differences and likenesses between the best known systems, Swegon Air Academy has published the book SIMPLY GREEN A quick guide to environmental and energy certification systems for sustainable buildings.

Certification systems for buildings can be divided into two main types, depending on which perspective they are based: the *holistic* perspective or the *specific* perspective.

The first type embraces environmental certification systems which, consequently, often consider a large number of aspects, from the choice of building materials and the disposal of waste products to the distance to the nearest stop for public transport. These systems can be said to quantify a building's total environmental footprint, which can, of course, be commendable. However, individual aspects, such as energy performance, can risk being partly overshadowed by all the other aspects and this is a disadvantage. This would not happen to the energy performance aspect in an energy certification system, as this would have a specific perspective. On the other hand, it would be the *only* question to be addressed

The proportions of the different categories in each environmental certification system.



(though often together with certain indoor environmental criteria). Energy certification systems are therefore often regarded as 'single issue systems'.

It is not possible to give a general answer to the question about which type of certification system, or which specific system, is best: this will, of course, depend on both the perspective chosen by the property owner as well as a number of other factors, for example, the benefits to be gained from the certification itself, in which country the building is located, the cost of the certification process, etc.

A quick look at the environmental certification systems described in the book will reveal certain common approaches, for instance, with respect to the choices of what has an affect on the environment. However, a closer look will show that a number of the systems are significantly different, for instance, when it comes to how different parameters are assessed and weighted, i.e. how the significance of a particular parameter is judged in respect to other parameters. Weighting can be carried out in two different ways: by applying a weighting factor to an individual parameter or to a whole category of parameters, depending on the scoring method used in a particular system, or by assessing a larger number of parameters within the categories on which the system developers want to put the greatest focus. Some systems have a clearer focus on certain issues than others and it is interesting to note how these are reflected both geographically and culturally. For example, the Indian IGBC system is strongly biased towards the precarious fresh water situations found around a number of major Indian cities. The Japanese CASBEE system, on the other hand, is more specific than other systems when it comes to requirements and measures to minimize damage caused by earthquakes. This system also places great importance on so-called light pollution, which is most likely due to prevailing problems in Tokyo and other major cities. A European example that illustrates local and cultural aspects is Minergie, the Swiss energy certification system, which, perhaps not unexpectedly, is primarily marketed as a quality 'Swiss Made' brand.

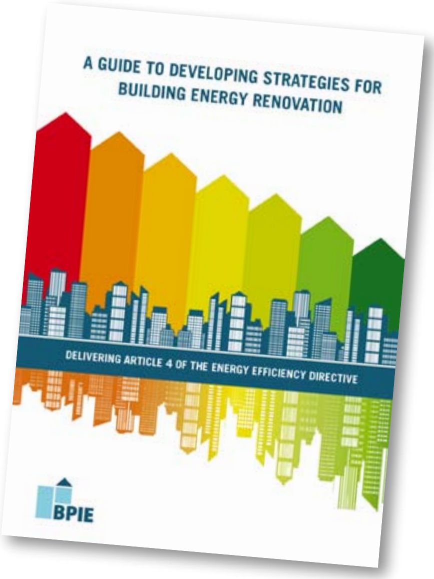
One way in which similarities and differences between systems can be illustrated is by setting them out in a table with corresponding explanations of the parameters that each system takes into account. Unfortunately, it would be virtually impossible to comprehend such a table without first actually dictating under which category headings the systems and their environmental parameters were to be sorted. In the table below, an attempt has been made along these lines in order to visualize the differences between the different systems. Note, that no single environmental certification system shown here is actually summarized according to the headings in the table. Subsequently, as there is no universal way of organizing environmental parameters, these headings will have to suffice. However, four points must be noted:

1) Even if a system actually assesses categories using the same headings as in the table, it is not necessarily true that the headings always include the same parameters. This can be illustrated by the environmental parameter Legionella, which in some systems is found under the category *Indoor Environment* while in others it is found under the category *Water*. In the table below it is categorized under *Water*.
2) In the German DGNB system there is a large 'sphere' representing the category *Other* and this is because the system places great importance on issues related to planning and the building process. These parameters have not been given an individual assessment category here because they are not clearly distinguished in the other systems.
3) Systems with a large proportion of mandatory parameters (which are not awarded points) are, to some degree, misrepresented. This is especially true in the case of LEED, which takes into consideration the categories *Waste Management* and *Construction Phase* but regards them as mandatory measures. This means that these parameters are not apportioned points in the table, which can be interpreted as them being of less importance in LEED, which, in fact, is not the case.
4) A number of the certification systems in the table below are divided into sub-systems, for example, for dwellings and commercial buildings, for which the assessed parameters and requirements can vary. The sub-systems chosen for inclusion in the table have been regarded as being representative of their respective certification systems. Common to all is that each system is applicable to new buildings, though not neighbourhoods. The sub-systems are:
   - BREEAM Europe Commercial 2009 Office
   - LEED 2009 for New Constructions and Major Renovations Commercial
   - Green Star Office
   - HQE International
   - CASBEE for New Constructions
   - IGBC Green Home

For more information about SIMPLY GREEN visit **www.swegonairacademy.com** ■

BPIE provides guidance for EU Member States

A guide to develop strategies for building energy renovation

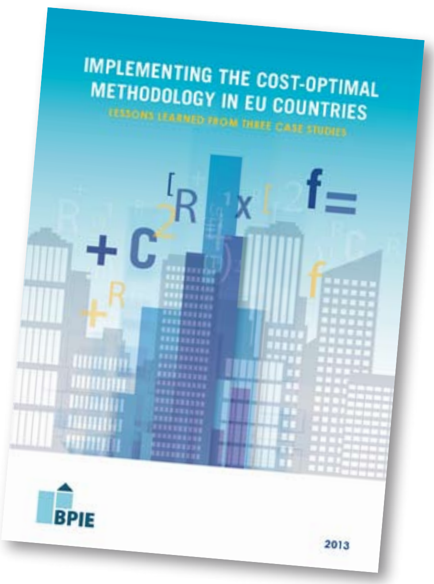


BPIE has produced a guide to develop renovation strategies which will help the EU Member States develop the first version of their renovation strategies to be published by April 30th 2014.

Deep renovations are specifically encouraged by the Energy Efficiency Directive (EED, 2012/27/EU) through the requirement for Member States to establish long term strategies for the renovation of national building stocks covering all building types, including residential and non-residential buildings, whether in private, public or mixed ownership. The adoption of the EED in October 2012, developed in order to help deliver the EU's 20% headline target on energy efficiency by 2020, as well as to pave the way for further improvements thereafter, provides the regulatory drive around which to define a body of support to achieve this long-term ambition. (EED, article 4 requirements on building renovation).

More info at: **http://www.bpie.eu/**

The cost-optimal methodology at national level

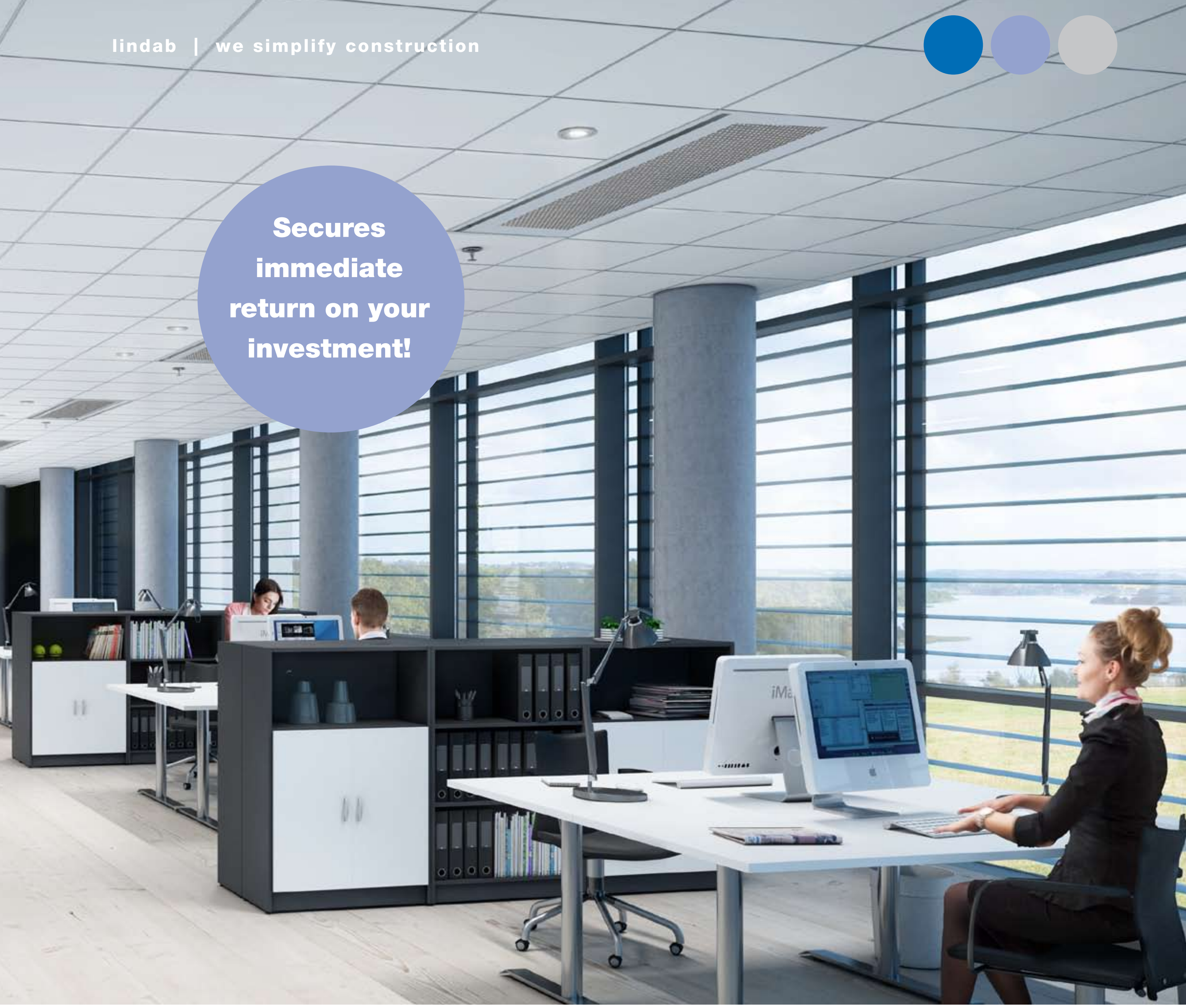


Convinced that MS would benefit from additional guidance on the cost-optimality process, BPIE intends to provide with this report additional practical examples on how to effectively implement the cost-optimal methodology at national level. The main goal is to evaluate the implications of different critical parameters, as well as to share the good practices across EU countries.

Three case studies are delivered with the support of consultants from Austria (e-sieben), Germany (IWU) and Poland (BuildDesk).

See also the article in this issue on page 16.

More info at: **http://www.bpie.eu/**



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When using renewable energy sources you are able to gain very high energy savings compared to conventional cooling systems.

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New VDI- Guidelines published March – June 2013

D VDI 2035/3 "Prevention of damage in water heating installations; Corrosion by fuel gases"

This guideline deals with the exhaust-side corrosion of metallic materials in directly heated hot-water systems in hot-water heating systems and the associated exhaust systems with the aim to minimize the probability of component failure or malfunction through proper planning, design and operation.

VDI 2067/30 "Economic efficiency of building installations; Energy effort for distribution"

This guideline specifies the calculation of the energy effort for the distribution of heating energy between a central heat generator or chiller and distributed points of use. Water is predominantly used as heat-carrying medium. The guideline considers centralised and distributed pump systems. The method is to be used by way of analogy for chilling systems.

VDI 2077/3.2 "Energy consumption accounting for the building services; Heat and hot-water supply installations; Cost allocation in connected installations"

This guideline applies to the distribution of costs in heat supply systems. The cost for the energy used by, and for the operation of, heat supply systems must be distributed both independent on consumption and consumption-dependent.

VDI 2070 "Service water management for buildings and estates"

The guideline supports the planning, operation and maintenance of service water installations. It deals in particular with the use of grey water, rainwater, surface water and process water. The following applications are considered in particular: watering of greenery, cleaning, toilet flushing, commercial use, cooling water, firefighting installations.

VDI 2083/17 "Cleanroom technology; Compatibility of materials with the required cleanliness"

The guideline deals with particulate and chemical (molecular) contaminations and electrostatic characteristics of materials and the cleanability of surfaces. The guideline defines the cleanliness compatibility and cleanroom compatibility for materials.

VDI 2262/1 "Workplace air; Reduction of exposure to air pollutants; Legal principles, terms and definitions, basic organizational measures for industrial safety and environmental protection"

This guideline presents an overview of the legal bases and terms and definitions as well as fundamental organizational measures. Furthermore, the guideline points out the prerequisites to be taken into account.

D = **Draft Guideline**

VDI 3803/5 "Air-conditioning, system requirements; Heat recovery systems (VDI Ventilation Code of Practice)"

The guideline applies to air-conditioning systems. The recovery of heat from exhaust air is an important step towards reducing the primary-energy demand for heating. The guideline specifies the basic terminology for heat recovery systems and describes the required equipment, systems, techniques and their operation.

D VDI 3805/99 "Product data exchange in the Building Services; General components"

The guideline describes the rules for the exchange of product data in the computer-aided process of planning technical building services for general components. It is based on the guideline VDI 3805 Part 1.

VDI 3807/1 "Characteristic consumption values for buildings; Fundamentals"

This guideline describes the method for determining characteristic consumption values for buildings. The method is applicable to thermal and electrical energy and water. The characteristic values are determined from measured consumptions. They aim, in particular, at identifying potential savings.

D VDI 4704 "Water heating installations; Water quality, pressure maintenance, deaeration; Trainings"

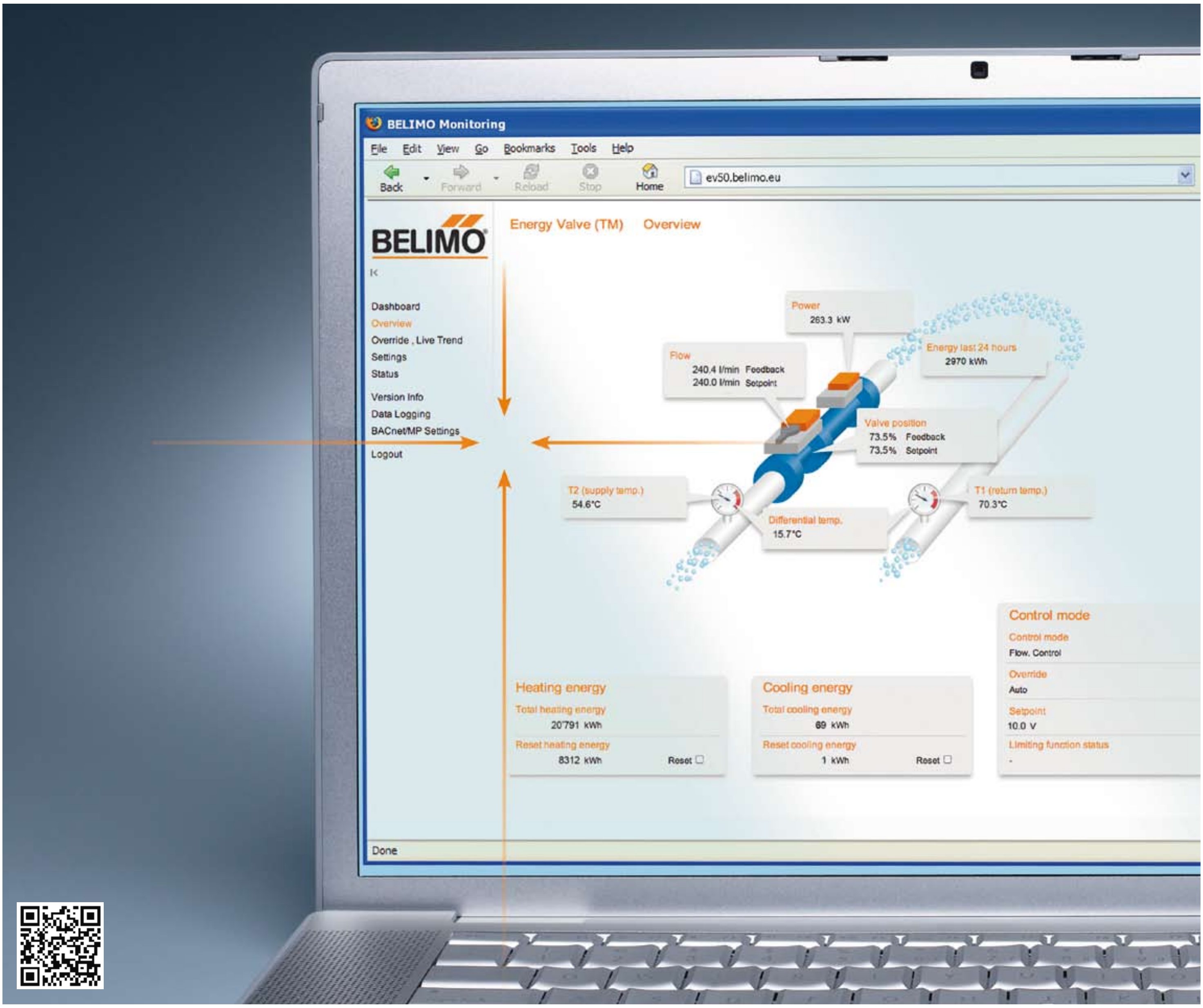
Owing to the increasing complexity of modern hot-water heating installations, the specifications given in the series of guideline VDI 2035 and VDI 4708 must be observed for function, energy efficiency and service life to meet the requirements. The guideline provides the concept for a training intended for all technical personnel involved in planning, erecting, operating and maintaining hot-water heating installations.

VDI 4710/1 "Meteorological data for building-services purposes; Non-European climatic data"

The dimensioning of building services by the planner requires reliable data describing the meteorological conditions at the site. This guideline supplies long-term meteorological data for 20 stations distributed fairly evenly over longitude and latitude. The data are supplied as tables on CD ROM for use in simulation software and the like. The data are provided and prepared for the guideline by the DWD.

VDI/DVGW 6023 "Hygiene in drinking-water installations; Requirements for planning, execution, operation and maintenance"

The guideline applies to all drinking-water installations on premises and in buildings. Its application to all other drinking-water installations is intended, especially to mobile installations, e.g. on ships. It contains guidance for planning, erecting, commissioning, use, operation and maintenance of any drinking-water installation.



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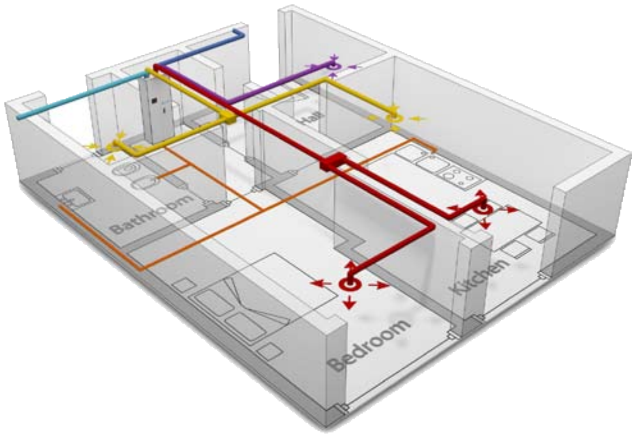
Events in 2013 - 2014

Conferences and seminars 2013			
June 3 - 8	eceee 2013 Summer Study on energy efficiency	Toulon/Hyere, France	www.eceee.org/summerstudy
June 7 - 8	The Latest Technology in Air Conditioning and Refrigeration Industry	Milan, Italy	http://tinyurl.com/bn9tbqz
June 16 - 19	11th REHVA world congress Clima 2013	Prague, Czech Republic	www.clima2013.org
June 17-19	Fourth IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants	Delft, The Netherlands	www.tptpr2013.nl
June 19 - 21	Intersolar Europe 2013: Innovative Technologies and New Markets	Munich, Germany	www.intersolar.de
June 22 - 26	2013 ASHRAE Annual Conference	Denver, Colorado	http://tinyurl.com/czznath
June 24 - 28	EU Sustainable Energy Week 2013 in Brussels	Brussels, Belgium	www.eusew.eu
June 26 - 28	Central Europe towards Sustainable Building Prague 2013	Prague, Czech Republic	www.cesb.cz/en
September 22 - 27	8th Conference on Sustainable Development of Energy, Water and Environment Systems	Dubrovnik, Croatia	www.dubrovnik2013.sdewes.org
September 25 - 26	34th AIVC- 3rd TightVent- 2nd Cool Roofs' - 1st Venticool	Athens, Greece	www.AIVC2013Conference.org
September 25 - 27	5th International Conference Solar Air-Conditioning	Germany	www.otti.eu
September 25 - 29	International Conference on Sustainable Building Restoration and Revitalisation	Shanghai, China	www.wta-conferences.org/conference/1869
October 3 - 4	CLIMAMED - VII Mediterranean Congress of Climatizacion	Istanbul, Turkey	www.climamed.org
October 15 - 16	European Heat Pump Summit	Nürnberg, Germany	www.hp-summit.de
October 15 - 18	IAQ 2013 - Environmental Health in Low Energy Buildings	Vancouver, Canada	http://tinyurl.com/dxkkf9z
October 16 - 18	Building Services for the Third Millenium	Sinaia, Romania	www.aiiro.ro
October 18 - 19	COGEN Europe Annual Conference & Dinner	Brussels, Belgium	www.cogeneurope.eu
October 19 - 21	ISHVAC	Xi'an, China	www.ishvac2013.org
October 20 - 21	Energy Efficiency & Behaviour	Helsinki, Finland	www.behave2012.info
November 5 - 6	8th ENERGY FORUM on Solar Building Skins	Bressanone, Italy	www.energy-forum.com
December 4 - 6	44 International Congress of HVAC&R	Belgrade, Serbia	www.kgh-kongres.org
Conferences and seminars 2014			
January 18 - 22	ASHRAE 2014 Winter Conference	New York, NY, USA	www.ashrae.org/membership--conferences/conferences
February 24 - 26	1st International Conference on Energy and Indoor Environment for Hot Climates	Doha, Qatar	www.ashrae.org/HotClimates
February 26 - 28	49th AiCARR International Conference	Rome, Italy	www.aicarr.org
April 28-30	REHVA Annual meeting	Dusseldorf, Germany	www.rehva.eu
May 13 - 15	11th IEA Heat Pump Conference 2014	Montreal, Canada	http://tinyurl.com/bujgfem
August 31 - Sep 2	11th IIR-Gustav Lorentzen Conference on Natural Refrigerants - GL2014	Hangzhou, China	
October 18 - 19	CCHVAC Congress	China	
Exhibitions 2013			
September 3 - 6	Aqua-Therm Almaty	Almaty, Kazakhstan	www.aquatherm-almaty.com
October 23 - 26	Aqua-Therm Baku	Baku, Kazakhstan	www.aquatherm-baku.com
November 4 - 8	Interclima+Elec	Paris, France	www.interclimaelec.com
Exhibitions 2014			
January 21 - 23	AHR Expo	New York, NY, USA	www.ahrexpo.com
February 4 - 7	Aqua-Therm Moscow	Moscow, Russia	www.aquatherm-moscow.ru/en/
March 1 - 3	ACREX 2014	New Delhi, India	
March 4 - 7	Aqua-Therm Prague	Prague, Czech Republic	www.aquatherm-praha.com/en/
April 1 - 4	NORDBYGG 2014	Stockholm, Sweden	www.nordbygg.se
March 18 - 21	MCE - Mostra Convegno Expocomfort 2014	Fiera Milano, Italy	www.mcexpocomfort.it
March 30 - Apr 4	Light + Building	Frankfurt, Germany	www.light-building.messefrankfurt.com
May 7 - 10	ISK - SODEX 2014	Istanbul, Turkey	www.hmsf.com
October 14 - 16	Chillventa 2014	Nuremberg, Germany	www.chillventa.de/en/
Sep 30 - Oct 3	Finnbuild 2014	Helsinki, Finland	www.finnbuild.fi

Elfosystem housing by Clivet: New air for social housing

Dedicated to **multifamily residential houses with decentralized system**, ELFOSystem Housing is based on an **"all in one" air-source heat pump unit, ELFOPack**, which covers the needs of **heating, cooling, hot water, mechanical ventilation with thermodynamic heat recovery and electronic filtration**, revolutionising the market of comfort solutions for independent plant.



The main features of ELFOPack are:

- **Ambient comfort** through a compact full fresh, outdoor air unit, which uses heat pump technology to supply air into the house at the ideal temperature and at the right humidity condition.

Thanks to its low thermal inertia, the system allows to quickly meet the required heat load.

- **Domestic hot water production,** simultaneously to heating and cooling, with very low energy consumption in winter, and free in summer.
- **Continuous air purification**, using electronic filters, with efficiency higher than 99.9 %, and extracting exhausted air from areas where humidity and foul odours predominate.
- **High efficiency** thanks to the active recovery of the energy contained in the exhaust air, to the free-cooling and free-heating, where adequate ambient conditions are present, and to the exploitation of renewable energy.
- **Decentralized solution** which guarantees the end user a reduction in charges by eliminating all the waste of energy of a traditional centralised system, such as distribution losses and pipeline pumping power, thereby achieving reliable utility metering without using a thermal energy monitoring system (EMS).

By integrating all the functions required for a system in an "all in one" unit that uses the ducts of the controlled mechanical ventilation for maintaining ambient comfort, ELFOPack **reduces the capital cost**, the **management** cost and simplifies installation, drastically reducing time to implementation since it does not require central thermal plant, distribution piping nor thermal energy accounting system.

Even the **design** is **simplified**, providing architects and designers the opportunity to foresee at design phase the plant for comfort and energy saving, guaranteeing perfect building-system integration.

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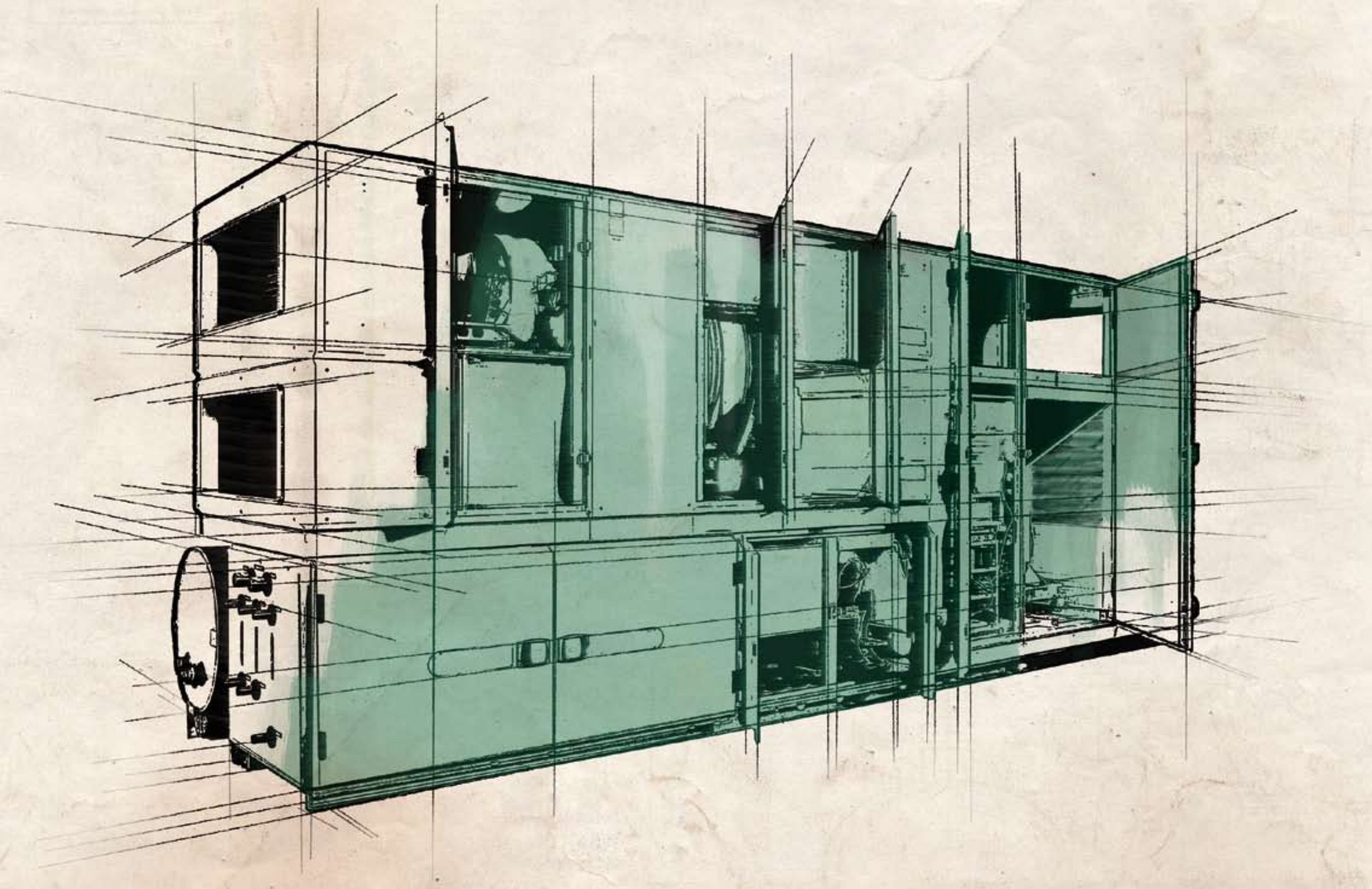

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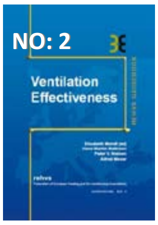
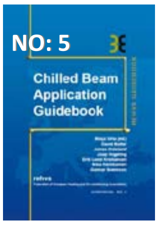
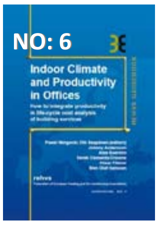


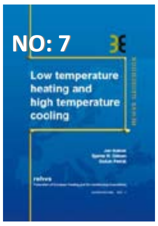
Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook provides easy-to-understand descriptions of the indices used to mesure the performance of a ventilation system and which indices to use in different cases.



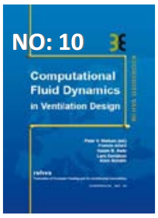
Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system. Primary air supply induces room air to be recirculated through the heat exchanger of the chilled beam. In order to cool or heat the room either cold or warm water is cycled through the heat exchanger.



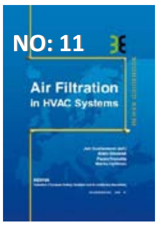
Indoor Climate and Productivity in Offices Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The quantitative relationships presented in this Guidebook can be used to calculate the costs and benefits of running and operating the building.



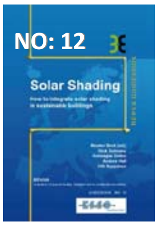
This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at low temperatures for heating and relatively high temperature for cooling.



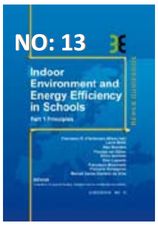
CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) – in Ventilation Design models is written by a working group of highly qualified international experts representing research, consulting and design.



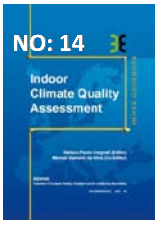
Air filtration Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such as levels of existing pollutants, indoor air quality and energy efficiency requirements.



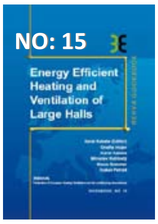
Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for selection, installation and operation of solar shading as well as future trends in integration of HVAC-systems with solar control.



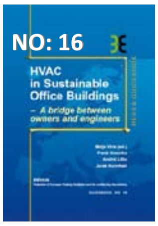
School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly on energy efficient systems for a healthy indoor environment.



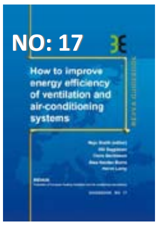
This new REHVA Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring has allowed enlarging significantly number of possible applications, especially in existing buildings. The Guidebook illustrates with several cases the instrumentation for the monitoring and assessment of indoor climate.



This guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, floor heating and industrial air heating systems. Various heating systems are illustrated with case studies. Design principles, methods and modeling tools are presented for various systems.



This guidebook talks about the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be asked in various phrases of building's life time. Different case studies of sustainable office buildings are also presented.



This guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked in the daily design practice, resulting in poor performance of high quality products once they are installed in the building system.

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