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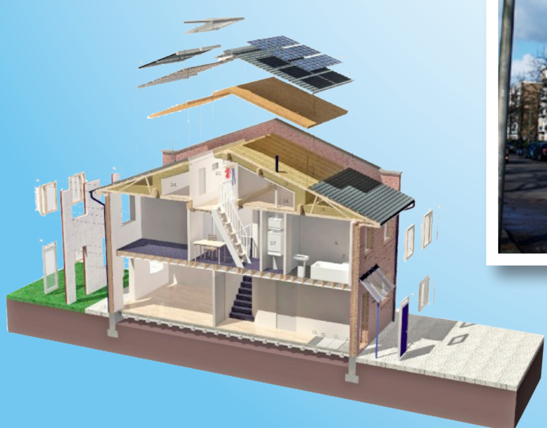
Building energy efficient renovations



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Specific focus required for building renovation

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The biggest challenge Europe has to deal with is the improvement of the existing building stock energy performance.

For this reason, directives and laws, which act in the framework of the existing buildings energy refurbishment, have to face this challenge with specific care related to the energy retrofit solutions.

The existing building stock is different not only in each Member State but also in regions of the same country; moreover, we can find old low efficiency buildings with no historical, but also situations when they have to be preserved.

Different scenarios to face need the development of diversified approaches for the improvement of the energy performance of existing buildings; these approaches must involve technical and economical/financial issues to be effective.

Today new buildings stock REIT (real estate investment trust) is very modest but at the same time a big market is potentially available for energy renovation of buildings: tax reductions and fiscal bonus can highly stimulate this market, as proved by same positive experiences in EU countries.

Nevertheless, energy targets must be fixed with care. Energy consumption reduction from 250 kWh/m^2y (typical of an existing building) to less than 30 kWh/m^2y (towards nZEB), ensuring at the same time cost optimality, is a very ambitious goal in existing buildings. Moreover, it is not always feasible due to technological issues and real estate criticalities.

German apartment block. (Source: "Refurbishment for the energy efficiency of historic buildings in member states in the Baltic Sea Region")

Polish historical building.

It is now important to define energy policies aimed at outlining minimum energy performance goals specifically addressed to existing buildings considering different types, design features and architectural value.

If on the one hand we should acknowledge legislative and prescriptive effort, aiming to raise existing building performances awareness, on the other hand we can feel a lack of laws and standards considering existing buildings as a peculiar target.

I truly believe Rehva community should take the lead of these necessities in order to encourage a specific and conscious development of building energy renovation. ■

Energy retrofit towards nZEB goals – Interview with JRC members




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Q1) According to EPBD recast, after 2020 all new buildings are expected to be nearly-zero energy buildings but, as known, the largest energy saving potential in the building sector is represented by existing buildings. Which are the most important actions taken by EU to incentivize retrofit actions oriented to nZEB goals?

Since the early 1990s the European policy framework for buildings has quickly evolved and Member States (MS) adopted a wide array of policy measures to transpose the general principles defined by the European Directives (EPBD, EPBD recast, RED, EED).

However, it is still valid the consideration made by the Commission in the 2010 proposal for revision of EPBD: *"the sector has significant untapped potential for cost-effective energy savings"*. In fact, the (few) estimations available assess the European renovation rates between 0.5% and 2.5% of the building stock per year, and a minor part of these is represented by deep and nZEB renovations.

The economic crisis of last years did not help to push toward the desired paradigmatic revolution, and on the contrary it accentuated the importance of financial barriers. Not surprisingly, then the policies designed by national and local authorities focused mostly on this aspect. Since 2008 almost all Member States introduced or strengthened their incentive measures, encouraging cost-effective energy renovations. Generally, the main target is the deep refurbishment of residential buildings, but also specific instruments for the tertiary and public sectors have been implemented.

We are telling successful stories since long time. The time needed to convince all cultures and stakeholders composing the European Union that a strong engagement on the energy efficiency of our buildings is crucial and necessary. The quick evolution of the national legislations towards nZEBs is a good and promising signal, but a wide diffusion and application will depend crucially on the involvement of all stakeholders from local government, industry, financial institutions and civil society.

Q2) Which are instead possible obstacles to a large-scale dissemination of retrofit interventions towards nZEBs?

We see different kinds of obstacles. We would mention here the main three:

1) Financial barriers: the cost of existing solutions is still high (considering the average age or the EU building stock reaching nZEB level it usually means deep, structural refurbishment) and building owners usually do not see sufficient returns on the investment (or not in a reasonable time). Based on these issues and on the value of collateral (the increase in the value of the property is not always linked to the energy renovation efforts) also banks are not currently providing adequate financial support at individual building owners.

2) Technical barriers: technical solutions to achieve nZEBs in existing buildings are not always feasible and cost-effective because limited by the existing building structure and by location. Normally specific interventions on individual cases and customized solutions are necessary, but new integrated design approaches and innovative building processes can reduce the investment costs and the renovation time.

3) Information barriers: still not all citizens in Europe are well informed about the availability of energy efficiency solutions and incentive programs available in their territory. Information, when available is still scattered and results into a wide range of options that are difficult to compare and understand for the final user. Key stakeholders (e.g. building administrators) and professionals should be regularly updated (importance of continuous professional education program) about innovative solutions and progresses in national and local policies.

Q3) What are, in your opinion, the most common goals for the effective widespread application of retrofit interventions towards nearly-zero energy projects?

Important progresses have been made during the last years but a series of goals remain to be achieved to reach a widespread application of nZEBs retrofit interventions.

One goal would be to stimulate R&D and competition in the building sector to find affordable, cost-effective and flexible solutions that can be applied to a large number of buildings in different regions.

Another key objective would be for public administrations to provide clear and unbiased information to all stakeholders and incentives to building owners, in all the situations where the market, alone, fails to deliver the desired outcome in terms of nZEB refurbishment (e.g. positive externalities, social benefits higher than private ones) or develop and support plans for large scale deep renovation of the building stock (e.g. phasing out of the most energy inefficient buildings etc.)

In addition, despite awareness of the importance of energy efficiency retrofit has significantly increased in the recent years, to further improve the diffusion of the specific concept of nZEB also outside the policy, academic and professional circles would possibly help in the widespread application of interventions towards nearly zero energy projects. To achieve this goal education programs are of key importance, from primary schools to specialized professional courses.

Q4) Which should be the desirable role of public administrations in the process towards a broader market transformation oriented to sustainability in the built environment?

Public administrations at all levels play various roles in this process.

On one side they should be responsible for the energy renovation of their building stock, in compliance with European Directives provisions (e.g. EED Art. 5). This would also be an important indirect effect on private owners as public administrations would thus play an exemplary role in the promotion of large-scale energy retrofit program.

On the other side, public administrations are called to support the adoption of market-oriented solutions: to provide a consistent and well defined legal framework, to adopt clear medium and long-term strategies, targets definitions and measures, to remove potential barriers to R&D, technological innovation, and competition in the construction sector and to foster a widespread energy efficiency education and specialized courses for professionals.

However, there would probably still be room to public interventions aimed at financially support energy retrofit projects or to assure adequate return expectations to investors, especially in specific areas and for medium and low-income population.

Q5) Nowadays good practices of realized high performing buildings - not nZEBs - are available, such as for example passive houses or green buildings. To what extent experiences of green buildings may be considered a precedent for the evolution of nZEBs?

All past and current experiences in the field of sustainable architecture are somehow related to the development and the evolution of the nZEB concept. They share the overall objective of contributing to save energy and reduce significantly the environmental footprint of buildings. However, even if in the same line, it is worth emphasizing that there is not a direct link between them nor nZEBs represent an evolution of earlier established concepts of high-efficient buildings. While some of the established solutions and principles (e.g. green building or eco-building) can be found also under the nZEB building generation, nZEB represent something different, which could be considered as more flexible, with a specific focus on the integration of strong energy efficiency measures and renewable energy generation.

Green labels and eco-certifications, such as LEED, BREEAM, Green-Building Programme, etc., demonstrated that they can be an important incentive in the diffusion and promotion of sustainable buildings. In light of these experiences, one could suggest that a nZEB "certification", based on the national definitions and standards, could be in principle equally important in the development of the market for nZEBs. The EPBD Directive (in article 11(9)) already requires the Commission to adopt, in consultation with the relevant sectors, a voluntary common European Union certification scheme for the energy performance of non-residential buildings.

Q6) The lack of a harmonized tool for collecting and sharing quantitative data from different case studies emerges nowadays; which would be instead the role and the influence of a common database in the process of nZEBs diffusion?

The realization of deep retrofit or nZEBs retrofit requires a wide range of technologies, systems and solutions with different degrees of complexity and sophistication, depending on the location and environment conditions, but also on local legislation and market conditions. A large-scale harmonized database would provide a complete overview of the state of the art in the different regions or MS, in order to compare and assess the most important information on the available solutions, but also on local conditions (legislation, market etc.), costs, benefits and financial support schemes. A EU database would have the potential to help all stakeholders; it would increase transparency and competition, it would reduce uncertainties for investors in calculating risks and payback times, it could serve as a kind of European *vademecum* of examples which designers, administrators and owners can consult for the most appropriate and effective solution to apply to specific cases.

A large-scale harmonized dataset on nZEBs refurbishment could also provide important quantitative information and indicators to monitor and evaluate the market, consumer choices and the impact of specific policy measures as well as to formulate specific targets for policy interventions.

Q7) Which information about nZEBs is more relevant to share?

The following information should be collected for each building where possible:

Location: the climatic condition of the building location is one of the most significant factors which can influence the nZEB design and its technical equipment, also regarding renewable sources available on site.

Year of construction: permits not only common classification in the timeframe but also the analysis of the time needed in the countries to implement EU or local policies.

Geometrical data: as area in m^2 and/or number of floors.

Envelope typology: information about the building envelope should be given as: U value W/m^2K for roof, basement, external walls and windows.

Technical equipment: type of technology should be specified for heating, cooling and ventilation system, as well as lighting and control system. Sub-categories for each sector could be detailed, in order to simplify statistical analysis. For example, sub-categories for heating could be: district heating, heat pumps, condensing boilers, etc.

Renewable sources technology and % of RES (energy level): as the EPBD defines a nearly Zero-Energy Building as "a building that has a very high energy performance… nearly zero or very low amount of energy required should to a very significant extent be covered by energy from renewable sources, including renewable energy produced on-site or nearby", knowing the %, the type of renewable sources (share of renewables in a quantitative or qualitative way) and the technology employed can give the measure of the understanding and implementing of the EU Directive in the different MS.

Energy demand [kWh/m²y]: energy is one of the main indicators. The value can be expressed through a model or referring to a building reference standard.

Investment costs, financial incentive and discounted payback time period (yr): economical and financial information should be given; investment costs can be given in euro or euro/m²**;** financial incentives are comprehensive of lease-back scheme, national and regional founds, loans and findings, etc.

Reference values or standards eventually established in the MS: if presents, labels, energy classes, standards, etc.

Socio-economic data: as type and number of occupants, age of the occupants, economic conditions, etc. These data can be very important to analyse the type of behaviour of the people living in the house and how they can influence the good functioning of the efficiency measures implemented.

For retrofit interventions the data collected should ideally allow a before and after comparison of the building energy performance.

Q8) Which is in your opinion the right approach to disseminate and to replicate retrofit actions on the building market?

The most common approach to replicate retrofit actions in the building market is to establish a number of successful representative projects across Europe, in a number of representative locations, in order to show how projects can succeed in very different climates and overcome other specific building related challenges.

These include:

- Different **construction techniques** for walls and other components.
- Different **heating systems** - for instance natural gas based systems in some locations against all -electric designs in others.
- The output of representative **photovoltaic systems** in different climates in EU locations and how these loads vary with building thermal and electrical loads.

Testimony from homeowners would certainly help to disseminate information on the success of the project. Finally, at least for high visibility initial projects, it would be important to have them monitored (e.g. with utility records compared before and after retrofit interventions) including also internal temperature and comfort conditions to help validate the nZEB retrofit approach. Also, to the extent possible, the real costs of refurbishment should be tracked (including also the often neglected "intangible" costs) and in this way the relative benefits from energy savings may be compared to the realistic costs of the remodelling effort.

However, to significantly improve the dissemination of successful retrofits two other factors are considered of key importance:

a) The development and use of **information tools**, in order to collect and share case studies data and experiences. An open data web-based platform together with social media and crowd-source datasets would have a great potential to spread good practices, technical solutions, experiences, information on costs and benefits, policies and incentives programmes, educational initiatives.
b) The development and diffusions of **large-scale education and information programs** targeted at all level from children to elderly, from professionals to non-professionals and policy makers.

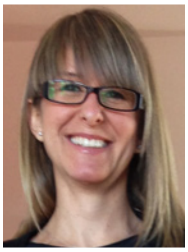
Q9) Which are the most important technologies to be developed to reach nZEB targets?

Technologies to reach nZEB include both the efficiency and renewable generation sides. Integrated and staged technologies to be implemented are challenging tools towards the nZEBs diffusion in Europe. Among the most important technologies are:

- Lower cost high-efficiency Heat Recovery Ventilators (**HRV**) and Energy Recovery Ventilators (**ERV**) for ventilation air. Analysis shows that air tightness is important in heating dominated climates; with air tightness comes a need to provide sufficient ventilation airflows with heat and/or enthalpy recovery.

- Advanced **smart window systems** with automated shutters or window coatings that allow adjustment to building interior conditions.
- More compact **high performance insulation** for piping. This may include low cost Aerogel type materials with very low thermal conductance which can substantially reduce thermal losses from piping either with radiators or otherwise with solar combisystems.
- Cooking and range **hood ventilation** represents a special challenge, not only because it is not often done in the most air tight building designs, but also for indoor air quality issues.
- Improved **heat pumps** for heating and cooling: this includes both air source heat pumps used for heating and cooling in mild climates and in geothermal systems for heating in colder locations where electricity is used for heating. Higher system COPs are desirable in both equipment classes. Electric heat pump water heaters in mild Mediterranean climates will be useful to obtain supply and exhaust air from the outdoors, or during the cooling season, to provide their supply air as a source of free cooling for the building interior.
- Continuation of progress on **appliance efficiency** and **lighting**.
- Diffusion of **precast elements** to be easily adapted to the building type with the support of specific innovative tools able to decrease the price of industrial processes.
- **Higher PV module efficiencies**. The current poly-crystalline silicon systems have efficiencies in the 14-16% range commonly. Performance in the 20%+ range is desirable as this will allow greater rooftop generation at lower installed costs. Currently, the available roof space often limits how much PV electricity can be generated onsite. Higher module efficiencies would increase the potential power production while reducing the cost of installation labour by reducing the size and numbers of PV modules necessary for greater solar electric production.
- **Electric storage**: producing power while improving the match with the utility grid will necessitate increasing onsite electrical storage to help flatten out the load curve and to smooth out the household electrical demand to be as close to zero as possible over the daily - and eventually - over the weekly cycle. Such needs will then require 10-20 kWh of electrical storage at the lowest possible cost. ■

A harmonized database to share nZEBs good practices



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A Rehva Task Force and an Italian Aicarr teamwork have developed a detailed database in order to share data of high performing buildings in Mediterranean climate. This database could be a fundamental tool to spread and engage the good practices to reach ZEB goals on a wide scale.

Keywords: database, nZEB, good practices, energy retrofit.

The European framework

Nowadays in the European framework the good practices of retrofitted high performing building, passive houses and energy efficient buildings are copious, but what emerges is the lack of information and data sharing about them. There are indeed no official sources for data deriving from this kind of building and, moreover, there is shortage of quantitative and comparable data. In a process oriented to a large-scale diffusion of nZEBs on the market, the existing good practices of retrofitted high performing buildings should be kept as market benchmarks and reveal to be precious sources of information. In the light of the above, the need of a harmonized database to collect and share data deriving from different case studies, building typologies and climate zones plays a fundamental role. Starting from the sharing of envelope technologies and system solutions, the creation of a database could reveal to be a crucial tool to spread and engage the good practices to reach ZEB goals on a wide scale. Up to now various practices attempting to collect data about nZEBs can be identified. Within this beginner development of databases, it is possible to identify two principal kinds of them related to two different levels of data collection. A first type database, which collects general information about a great number of buildings (requiring few and perfunctory information), reveals to be useful to provide statistical overviews at a large-scale. While a second type database collects data (regarding to the climate conditions, envelope, systems and operational parameters) of single building in a detailed way so that the energy modelling could be performed. However, due to the weakness of the existing databases and to the necessity of having practical guidelines to design nZEBs, at the European level, a current REHVA task force and, at the Italian level, an Aicarr teamwork are targeting the development of a design guide for nZEBs in Mediterranean region, based on different national experiences. In order to reach this target, they have created a second type database, useful to collect and share detailed information about single high performing buildings, with the aim of filling the lack of quantitative and comparable information, in a process towards nZEBs diffusion. The main purpose is to record nZEBs, which have been already built, with available monitored data and that represent concrete models for future designing. The present paper illustrates the structure of this database. Because of the still scarcity of monitored nZEBs, the shown database is suitable not only for realized monitored buildings but also for those that are still in a design phase.

The structure of the database

The database was developed as a MS Office Excel tool in order to be easily modified and implemented, covering most of the building typologies and features. Indeed, the format as it is allows collecting data both of new and existing buildings (monitored or not), belonging to different categories of end uses in order to be used for the whole building stock. As aforementioned, this database corresponds to the second type and requires many detailed information of the building; with this kind of data it is possible to develop an energy model of the building for a dynamic energy simulation.

The database is made of seventeen thematic sections, each one corresponding to a different spreadsheet, as shown in **Table 1**.

Table 1. Thematic sections of the database.

1	General information
2	Geometrical data
3	Building envelope
4	Building system
5	Space Heating System
6	Space Cooling System
7	DHW System
8	Storage
9	Ventilation
10	Lighting & Appliances
11	RESs
12	Energy Calculated Data
13	Energy Monitored Data
14	Conversion factors
15	Economic valuation
16	Sustainable and green features
17	References

Each section is structured in different consecutive columns (**Figure 1**). In the first column, the required information is reported; in the second one, the instructions detail precisely which kind of data is necessary to specify; in the third one, there is the space to fill in the data; in the fourth one, a space for notes is provided.

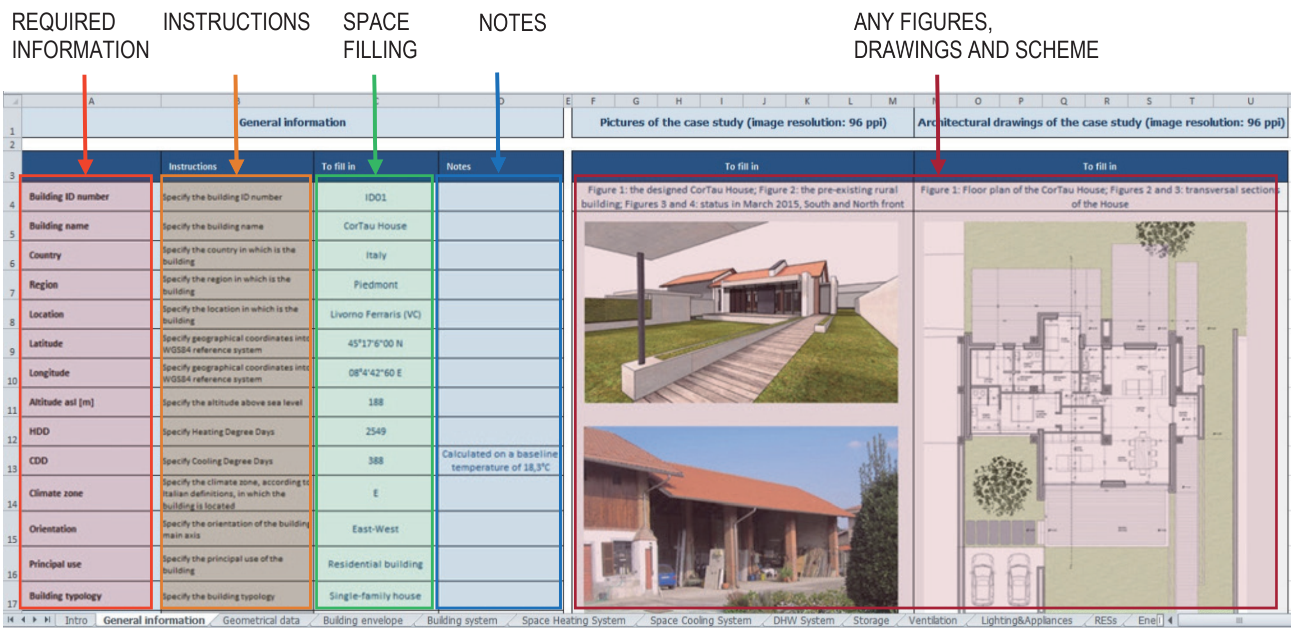

Figure 1. A screenshot of the database, section "General information".

In some specific sections, there are other columns dedicated to figures, drawings and schemes inclusion. Some of these data have to be filled, while others can be selected from drop-down menu.

In each section specific data about the analyzed case study are required; the first and the second sections are intended to provide an overview about the building. The first one collects general information concerning location, climate zone, period of construction, building typology and principal use of the building and whether it is a new construction or the result of a retrofit intervention on an existing building. Moreover, in this first section it is possible to indicate if the building is monitored and to specify operational parameters; pictures and architecture drawings of the case study are also required. The second section, containing geometrical data of the building (e.g. number of floors, floor surfaces and volumes), completes the introductory overview of the building.

The third spreadsheet contains data about opaque and transparent building envelope. For each kind of opaque building enclosure towards external and unheated spaces thermal transmittance, periodic thermal transmittance and surface mass are required; moreover, material layers should be described by indicating, if possible, thickness and features of each material. Each different kind of window should be also specified, by indicating thermal transmittance values and features of the glasses and frame. Moreover, information about solar shadings and thermal bridges are required.

Subsequently, sections from 4 to 11 are focused on the building systems. Specifically, the fourth section consists of a brief overview of the HVAC system configuration, including the presence of renewable energy sources (RESs). The fifth and sixth sections - referring to the space heating and cooling system – require several and different data, through schedules of system operating hours, set-point temperature and relative humidity, and features related to generation, distribution, control system, and terminal devices, to primary air system configuration. The section about the domestic hot water (DHW) is similar to the last listed. A section for the possible presence of a storage, and its related data, follows; the use to which the storage is dedicated, its volume, temperature have to be indicated. Then in the following section technical data are required in order to define the main features as type of ventilation system, air flow rate, the possible presence of heat recovery and its efficiency. The tenth section concerns instead the lighting system; here the typology, the total power and the operational schedule of each lighting system of the building are specified. The last section dedicated to the building system deals with RESs. Particularly, one portion is referred to the specification of the photovoltaic system, if existing; information about the technology, the panels' location and orientation, the dimensions and the system power, are requested. Another part is related to the features of the solar thermal system, if present; specific data about this system have to be filled, as technology type, panels location, orientation and dimensions, maximum temperature. Then, if other RESs are installed, there is the possibility to specify them.

After characterizing the envelope and systems, the database moves to focus on the case study energy data. The required information consist of energy needs and uses, delivered energy, RESs production, primary energy consumptions, CO_2 emissions and energy performance indexes (**Table 2**). Specifically, two sections, characterized by the same structure, are dedicated to energy performances; the former refers to calculated data, while the latter to monitored data. Regarding energy needs, the space heating and cooling energy need, and the electricity for lighting and appliances have to be specified, including the methodology used for the calculation in the case of presence of calculated data. With respect to energy uses, different end uses are reported: space heating and space cooling, DHW production, ventilation, auxiliary, lighting, appliances and others (if present). For each end use, it is necessary to specify the related energy carrier. Consequently, the total energy consumption for each energy carrier is automatically generated. Afterward there is a summary of the energy delivered to the building subdivided for the different energy carrier. The following part of the section refers to renewable energies. Precisely, five subdivisions are of interest to renewable energy produced on-site; percentage of renewable energy produced with heat pump; renewable energy consumed on-site; exported energy; renewable energy dissipation. Then, there is a part for the primary energy (delivered, produced from RESs on-site, produced from RESs and consumed on-site, exported, percentage of RESs contribution) and for CO_2 emissions, calculated with both national and European factors, which have to be specified in the fourteenth section called "Conversion factors". The last sub-section "Energy class and indexes" requires indexes for space heating and cooling, DHW production, and global energy performance, evaluated according to national certification; it is necessary also to specify the used methodology/software.

The fifteenth section is related to the economic valuation; it is required to specify the total investment cost for building realization, and separately the investment costs for the envelope, systems and other works, as for example excavation, foundations, etc. Furthermore, running costs are required in terms of energy, maintenance and replacement costs, after and before the renovation in the case of retrofit interventions. It is necessary to indicate if the investor benefits from incentives and tax credits. The last part presents some economic indexes as the payback period, the net present value (NPV) and the profitability index (PI).

The sixteenth section refers to sustainable and green features. It is made of eight subsections that focus on sustainability issues related to the examined case study. From the environmental quality of the site, through bioclimatic design elements, the use of natural materials, the water and waste management, the carbon reduction strategies, to the green transportation, this section deals with aspects - not emerging from the other sections – that underline the sustainability level of the building.

At the end, the last section is dedicated to bibliographic and web references related to the analyzed case study.

Table 2. Sub-sections for the energy data.

A	Energy needs
B	Energy uses
C	Energy delivered-to-building
D	Renewable energy
E	Primary energy
F	CO_2 emissions
G	National energy class

Conclusions and future developments

The main goal of the database is to provide as complete and detailed as possible an overview of the presence of high efficient buildings in different Mediterranean countries. The database aims to cover the variety of building typologies and features characterizing the European building stock and is, indeed, designed to be modified and implemented in future. The availability of a large number of comparable data from different case studies would surely help to draw on the lessons learnt from good practices in Mediterranean climate. Up to this moment, the database was tested on three Italian case studies (two of these described in subsequent papers) and on two Mediterranean ones. In order to serve as a guide for investors, designers and policy makers, it is necessary to collect inside the specified database as many as possible of the buildings in question. In a process oriented to a large-scale diffusion of nZEBs on the market, the main function of this tool is to collect and share quantitative and detailed data referred to good practices of energy efficient buildings in order to compare and assess the most important information on the available solutions, on the results obtained in terms of energy and monetary savings, and also on local market and legislation conditions. ■

Towards nZEB buildings: a historical building case study

The recast of EU Directive 2010/31 introduced the concept of (nearly) zero energy building (NZEB). In Italy this challenge is remarkable: existing buildings stock (mainly residential) is also historic, so it's subject to environmental constraints or architectural-artistic value. A case study of a radical refurbishment with NZEB as target is Ca' S. Orsola in Treviso.

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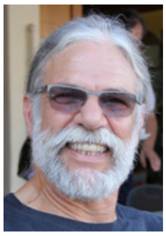

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Keywords: energy renovation, historical building, refurbishment, energy savings.

The case study

As it happens in several Italian cities, the downtown of Treviso, in North East of Italy, is characterized by the presence of historical buildings. Ca' S. Orsola building is a typical example: the building is located very close to the city Cathedral. Originally it was a convent: it was the old seat of Polish Institute of the Orsoline Sisters. Now it is a building listed by Historical and Architectural Heritage Superintendence of Veneto Region.

The building was inhabited until 2000 and during the time it keep intact the original structure and architectural distribution. Then it was bought in 2007 for acting a deeply renovation and converting it in a prestigious residential building; this renovation has been completed in 2012. The whole building (**Figure 1**) is a gross volume of 6 300 m³ and an area of 4 500 m².

At the beginning of construction phase the structure revealed a quite ruined state of conservation: walls are crooked and presented different solutions, moisture affected wooden elements in the floors and in the roof. There was a heritage architectural restriction about the external envelope. Specific goals of renovation project were:

- to achieve the A class energy classification according to Italian regulations;
- to consolidate and to reinforce the building structure;
- to improve the indoor thermal and acoustic quality;
- to transform it in a prestigious residence with all comforts.

The building refurbishment was developed with a particular regard on thermal insulation of the building envelope and special attention has been paid to the mechanical ventilation and the renewable energy utilization (both solar thermal and photovoltaic system).

The adopted requirements follow the legislative references as stated in national Italian laws before the 2012.

Before and after the renovation: the envelope and the technical systems

Building envelope before renovation presented a traditional construction system, based on bearing masonry with covered solid bricks. The floor had a wooden structure, while the ground floor leaned directly on soil. The roof is made of hollow tiles sheets with a wooden structure and a lightweight ceiling slab (**Figure 2**).

The windows frames were made of wood and the windows used to have a single glass. There is no insulation in the external walls, roof and floors (**Table 1**).

Table 1. Thermal characteristics of the building elements.

Element	Area (m^2)	U-value before renovation (W/m^2K)	U-value after renovation (W/m^2K)
Facade	1 300	0.90	0.18
Ceiling	508	1.65	0.788
Windows, doors	140	2.70	1.948 – 2.035
Roof	508	1.09	0.158

Figure 1. General view of the building before (left) and after the intervention (right).

Originally, no heating and cooling systems were installed. Heating was provided by a fireplace, also used for cooking, occasionally an electric heater or portable fan coils was placed in any room. The domestic hot water was supplied by electric heaters with storage tank; no ventilation system was present.

Energy renovation features

If we analyse this case study in terms of environmental sustainability, there are several challenges ahead. A first challenge was addressed at the level of structural consolidation then at the level of energy and indoor quality.

Technologies measures aimed to achieve an energy class as proposed by the Italian legislation before 2014; several design topics were adopted among which high insulated windows, high level of opaque walls insulation, mechanical ventilation system with heat recovery, solar thermal panels and PV systems, water to water heat pumps and chillers.

The first step has been taken the measures to consolidate the building structure. Subsequently a detailed study on thermal and acoustic bridges has been developed with the aim to improve the indoor thermal and acoustic quality.

In the external walls the insulation is placed on the inner part (**Figure 3**) and this solution meet the requirements of the Superintendence of Veneto Region, preserving the existing materials and the external architectural identity of the building. Specifically, two types of insulating are used: an expanded polystyrene (EPS) foam, placed directly on masonry, and a rigid mineral wool panel with a plasterboard cover. Roof was replaced with a new wooden structure and it was insulated with wood fibre and water tight covering. All existing windows are replaced with a low-energy double layer ones within wooden frames.

Figure 2. Building envelope before renovation: crooked walls (left), demolished partition walls left and used as a substrate (center), beam support in the perimeter wall (right).

Figure 3. Insulation on internal (left) and external walls (right).

Figure 4. Radiant system: collectors (left) and TNT underflooring above system (right).

Figure 5. Mechanical ventilation system: ducts and Heat Recovery.

About technical systems, the HVAC generation system is a water to water centralized heat pump/chiller. The underlying well is the hot/cold water source and internal comfort is achieved exploiting a radiant system (**Figure 4**) installed in the floor together with a dehumidification system for the summer period.

For heating and cooling the system adopted is a 32 kW heat pump with a distribution by radiant floor system; another heat pump (20 kW) is installed for domestic hot water requirement (DHW); mechanical ventilation (**Figure 5**) is provided by a system with heat recovery box (95% efficiency).

Table 2. Energy savings and CO_2 reduction.

Energy need		Before renovation	After renovation	Saving
Heating	kWh/m²y	342.7	42.3	88%
DHW	kWh/m²y	44.4	33.6	24%
Electricity	kWh/m²y	45.0	20.0	56%
Total	kWh/m²y	432.1	95.9	92.5%
Energy label		G	A+	
Carbon emissions	kg CO_{2Eq}/m²y	29.8	5.8	81%

Renewable energy systems have been installed after renovation: thermal solar panels for DHW production (20 m²) are located in vertical position and a photovoltaic power plant (18.85 m²) producing 3 300 kWh of total annual energy. These panels are installed on the roof and oriented to the south.

Achieved energy savings, CO_2 reductions and costs

Energy needs values before renovation have been evaluated by means of dynamic simulation: the results are showed for comparing thermal the different conditions after and before the retrofit measures. It should be stressed that values for DHW need already include the solar thermal contribution and the amount of renewable energy was zero before renovation (**Table 2**).

Construction costs of renovation (**Table 3**) exclude the costs for heating and DHW equipment, so the costs are related to the purchase of the area, charges, interest, taxes.

The contribution of renewable energy resources is given in 6.56 kWh/m²y: calculation and monitoring gives a production of about 3 300 kWh for photovoltaic system and 8 500 kWh for solar thermal.

Overall improvements

The major benefit given by renovation measures is obtained evaluating the energy saving: the energy need for heating was 432.1 kWh/m²y, including heating, DHW, ventilation systems. The interventions allowed to reduce the Energy need by 93%. The Energy class improves to G to A+.

At the same time, the indoor climate was improved due to the upgrade of the control of indoor temperature and humidity without relevant energy costs. The standard energy performance for new buildings in Italy has been achieved by several factors such as the reduction of losses through the walls insulation, roof and the installation of new window. The reduction

Table 3. Renovation costs.

Costs	EUR	EUR/m²
Craftsmen	2.94 million	1 463.41
Consultants	130 000.00	64.71
Electrical and Plumbing	700 000.00	348.43
Total construction	377 million	1 876.56
Thermal solar and PV system	32 000.00	15.92
NPV	13 Years	

of the thermal bridges allows to eliminate related condensation problems and also the mechanical ventilation is balanced with heat recovery and with a carefully adjusted supply temperature. From economic point of view, renovation of existing buildings, especially if listed, is too much expensive than standard, because it needs specialized operations and the preliminary count evaluation is upset during the construction phase. After intervention, however, market value increased for this property and also for the surrounding area: in this case study all apartments have been sold by the end of the construction phase (**Figure 6**).

About decision process during building phases, the investment costs were incurred by the contractor, that is also the owner: in this particular situation themes such as sustainability and energy retrofitting were understood and applied. The major overcome barriers were essentially related with the bureaucracy for obtaining the permission by Historical and Architectural Heritage Superintendence of Veneto.

After the retrofit intervention it's possible to underline also non-energy benefits, rather factors that can be brought back to social and economic aspects in the long term. For example, this radical renovation transformed this historic building in a prestigious

Figure 6. The residence after intervention: Courtyard from west perspective (left); Typical living room in a dwelling (right).

and comfortable residence. A better living conditions is enriched with more qualified living spaces and privacy to the occupants are ensured by a reached acoustic first class according to national standard UNI 11367. The improved structural conditions in an uninhabited and listed building implemented a seismic consolidation and an aesthetical improvement returned the identity of the original building and increased the market value.

Some remarks

The proposed renovation is aimed to redefine the indoor environmental quality with a particular attention to the energy and acoustic targets. Moreover, as requested by Italian laws, the building structures must be certified by seismic point of view.

The adopted measures for envelope and technical system, as low-e energy glasses, the high performance insulating layer, the installation of a mechanical ventilation system with heat recovery, the integration of solar panels for DHW, allowed to achieve that the apartments of the block have been certified in A Class.

Living environmental quality is assured by the use of indoor materials with low harmfulness and because of the installation of underfloor winter heating and summer cooling with humidity control. Renovation measures decreased global energy consumption, reducing up to 90%; the use of renewable (solar and photovoltaic systems) contributed to minimized energy consumption.

A prestigious location, a renovated historic building with the most innovative technical solutions made a safe and long-lasting investment. ■

Acknowledgements

Special thanks belong to:

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Build a solar model for an nZEB refurbishment

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VLS 500 is a building of social housing, built in 1974 and located in La Rochelle, France. With the envisioned integration of solar PV production, VLS 500 should be the first social housing building of France, retrofitted with the nZEB performance.

Keywords: Social housing – refurbishment – photovoltaic – solar collectors – district heating – prefabrication.

Site description and climatic relevant aspect

The building is located in the city of La Rochelle, on the French Atlantic Coast, with geographical coordinates: 46°09'07.09"N, 1°07'00.07"W and an altitude above sea level of 7 m. Under Köppen's climate classification, La Rochelle features an Oceanic climate. Seasonal weather is made of mild dry summer period and mild and humid winter periods. The characteristic values of the climate are summarized in **Table 1**.

Table 1. Climatic relevant aspect of La Rochelle.

ISO 877-1:2011 classification	Marine west coast climate
Physical information	La Rochelle (France)
HDD (Base 18°C) /CDD (Base 22°C)	2068/21
Average Annual Air Temperature	13.0°C
Average Annual Relative Humidity	80.6%
Rain amount (mm)	755 mm
Solar Irradiation	1 337 kWh/m²
Average Wind speed (m/s)	4.2 m/s

Fetch distance from the ocean is less than 4 km, with a yearly sunshine duration of 2200 hours per year, La Rochelle is the most isolated place of France's Atlantic coast.

Rupella-Reha Project

Supported by the Social Housing Agency of the urban area of La Rochelle (www.office-agglo-larochelle.fr) and managed by the University of La Rochelle (Tipee Plateform), Rupella-Reha is one of the award-winning projects launched by the French Environment and Energy Management Agency (ADEME) in 2011. This project involves retrofitting three buildings of the Social Housing Agency, located in three different districts of the city, with a global approach (indoor air quality, thermal, acoustical and visual comfort, solar energy systems). VLS 500 is one of these three buildings with an objective of 35 kWh/m².y (primary energy consumed on site). Its retrofit started in 2013 and the design phase ends at the beginning of 2016. Further to this period, the works will last eighteen months and will be completed by a monitoring period of two years. The design team is mainly composed of the architect "Cointet et associés", engineering companies "ITF" and "Atmosphère" and the University of La Rochelle. Cointet et Associés are the project manager for the Social Housing Agency, in charge of design and economic parts. ITF and Atmosphère are in charge of improving envelope and building systems. Eventually, the University of La Rochelle is the project manager for ADEME.

Figure 1. The district of Villeneuve-les-Salines.

VLS 500, from the seventies to a 21th century building

VLS 500 was built in 1974 displaying a cubic geometry (**Figure 1**). Because of its layout similar to the others buildings of Villeneuve-les-salines, VLS 500 is a distinctive architecture of this district.

The building is composed of four blocks (**Figure 2**) of flats with sixty-four residential units and less than one hundred occupants. Two blocks have six floors above the ground, while the two others are limited to four floors (**Figure 3**). The net conditioned floor area is 4 900 m² and the glazing percentage (overall window-to-wall ratio) is 20%.

Envelope thermal properties

In France, as most of buildings built in the seventies, the VLS 500 envelope was built out of prefabricated components. For the four blocks, each component of the building envelope (external walls, internal partitions, slabs and roofs) was developed with the same materials and according to a unique sequence of material layers. In spite of a detailed study about the building before retrofit, many physical characteristics or materials remain unknown.

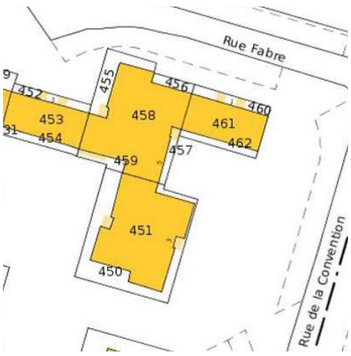

Figure 2. The four blocks of VLS 500.

To improve the thermal performance of the envelope, the design team proposed several retrofit actions. Reinforcing thermal insulation of external walls and windows was advocated using prefabricated externally insulated element to address the occupied site issues. This new layer is hitched to the current external wall, enlarging the total thickness from 25 cm to 40 cm (**Figure 4**).

Figure 3. A four and six floors block.

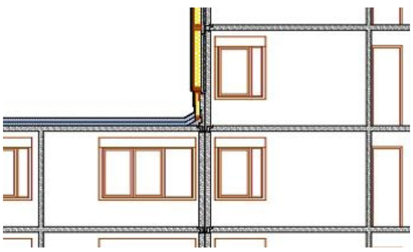

Figure 4. Prefabricated wall hitched to current external wall.

This prefabricated wall will include the new windows and will improve the airtightness because of this optimized assembly process. Moreover, because of retrofit intervention is done with the occupants inside, this technology permits a shorter intervention and a site less noisy.

Characteristics of the building components before and after retrofit are described in the following **Table 2.**

Building Systems

VLS 500's HVAC systems are not the usual systems employed for social housing buildings construction, for years in France. Only the ventilation system can be qualified as "standard" with natural ventilation strategy based on stack effect. From 1974, the heating and the DHW systems are connected to the district heating system of Villeneuve-les-Salines (distributing pressurized hot water

Table 2. Thermal characteristics before retrofit.

		Before retrofit	After retrofit
External wall	Construction	From exterior to interior: reinforced concrete (7 cm), polystyrene (4 cm) and reinforced concrete (14 cm).	From exterior to interior: 15 cm of insulation (fiberglass) in a wood frame, the current external wall (25 cm)
	Thickness [m]	0.25	0.40
	U-value [W/m²·K]	0.731 (estimation)	0.2
Flat roof	Construction	From exterior to interior: Gravel (5 cm), extruded polystyrene (5 cm), reinforced concrete (14 cm)	From exterior to interior: Gravel (5 cm), Polyurethane (20 cm), reinforced concrete (14 cm)
	Thickness [m]	0.25	0.39
	U-value [W/m²·K]	0.689 (estimation)	0.122
Ground floor slab	Construction	From exterior to interior: Reinforced concrete (14 cm)	From exterior to interior: Reinforced concrete (14 cm). insulation
	Thickness [m]	0.14	—
	U-value [W/m²·K]	3.692 (estimation)	0.256
Walls between the internal environment and unconditioned spaces	Construction	From exterior to interior: reinforced concrete (9 cm), insulation (5 cm), reinforced concrete (9 cm)	
	Thickness [m]	0.23	
Intermediate slabs	Construction	A unique layer of reinforced concrete (14 cm)	
	Thickness [m]	0.14	
	U-value [W/m²·K]	2.495 (estimation)	
Internal partitions	Construction	A unique layer of bricks (10 cm).	
	Thickness [m]	0.10	
Thermal bridges resolution	Specific features adopted in reducing thermal bridges through building envelope	A specific attention was given to balconies' thermal behaviour in order to reduce thermal bridges. A certain number of balconies will be destroyed.	
Airtightness	n50 [1/h]	Six residential units tested: results from 1.4 to 4.39	
Window 1	Typology	Single glazing with wood frame	Double glazing (argon) with PVC frame
	U-value windows [W/m²·K]	4.95 (estimation)	1.4
Window 2	Typology	Double glazing with PVC frame	
	U-value windows [W/m²·K]	2.9 (estimation)	
Shading	Type of solar shading	Louvered shutter	

to 2 136 flats). This district heating system is one of the first in France. Otherwise, a part of DHW is produced by solar collectors installed on the roof (flat plate collectors).

Because of VLS 500 is a pioneer building for using renewable energy technologies (RES) in the 70's, the design team highlighted pro-arguments to the Social Housing Agency in order to rise the amount of RES to aim a nZEB performance. This increase of RES has become possible for two reasons: a special wood frame is built on the current roof to support 465 m² of photovoltaic panels (65 kW_{peak}) and the ten years old solar collectors are replaced by evacuated tube collectors (thirty-five units).

Figure 5 displays the solar study to optimize productivity of photovoltaic panels and solar collectors.

During the period of time in which the heating system is switched on, the surplus of hot water produced by these new collectors shall be used to preheat water for heating system. During the switched off period, the surplus is injected in the district heating to avoid overheating (**Figure 6**). Except the solar thermal power

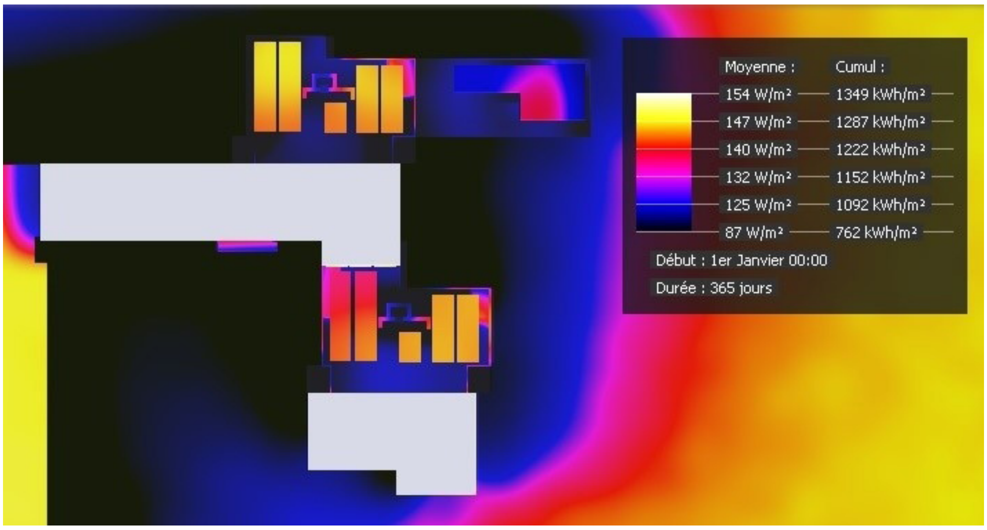

Figure 5. Improving RES by a solar study.

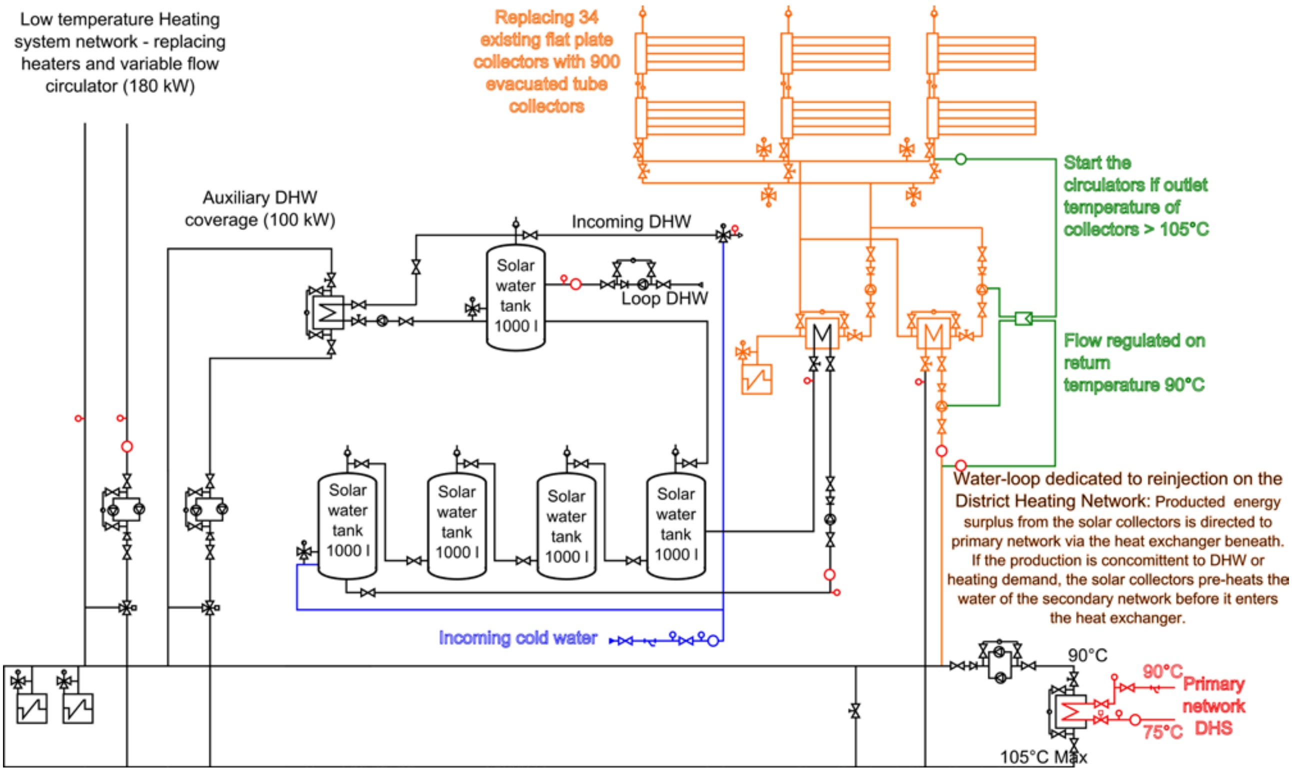

Figure 6. Schema of solar collectors.

stations, this combination was never used before in France on building retrofitting operations.

As the same time as these RES actions, the heating system is updated and the ventilation system is modified to a hybrid strategy powered by low-pressure mechanical ventilation systems.

Figure 7 displays an architectural view of VLS 500 after retrofit.

Figure 7. VLS 500 after retrofit.

Energy performances and economic aspects

In accordance with the French Thermal Regulations (RT 2012/RT-ex 2005), building energy performance after and before retrofit has to be calculated with a legal computation engine, specific to refurbishment operation. Also, the Effinergy association is the only French institute to deliver nZEB certification for new constructions. Therefore, the energy performances of VLS 500 are calculated with the legal computation engine and compared to French nZEB criteria (**Table 3**).

For this most ambitious project of the Social Housing Agency, 2 477 000 € are invested (excluding tax) for retrofit intervention, 108 000 € to replace solar collectors and 172 000 € for the PV installation (wood frame and panels). Apart from the income with selling kWh produced through PV system to the French Electricity Company (EDF), the cost for energy operation of the building will be about 15 k€ per year whereas it reached 43 k€ per year before retrofit intervention, corresponding to annual savings of 28 k€. ■

Acknowledgement

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Table 3. Energy uses before and after retrofit.

Energy uses & renewable energy before retrofit	
Total energy uses (Primary energy calculated with national conversion factors) (kWh/m².y)	135.11
Space heating (kWh/m².y)	109.27
Hot water (kWh/m².y)	14.63
Ventilation (kWh/m².y)	0
Lighting (kWh/m².y)	7.54
Auxiliary (kWh/m².y)	3.68
Renewable energy produced on-site: solar collectors (primary energy)	53 534 kWh
Energy uses & renewable energy after retrofit	
Total energy uses (Primary energy calculated with national conversion factors) (kWh/m².y)	44.04
Space heating (kWh/m².y)	23.41
Hot water (kWh/m².y)	10.01
Ventilation (kWh/m².y)	1.88
Lighting (kWh/m².y)	7.03
Auxiliary (kWh/m².y)	1.71
Renewable energy produced on-site: solar collectors (primary energy)	78 348 kWh
Renewable energy produced on-site: PV technology (primary energy)	157 160 kWh
Total energy uses nZEB Criteria (Primary energy) (kWh/m².y)	10.14

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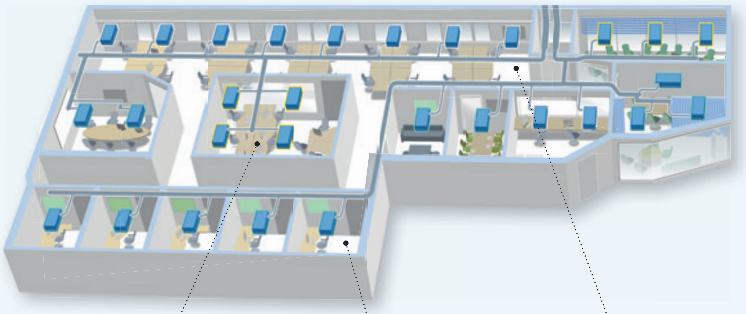

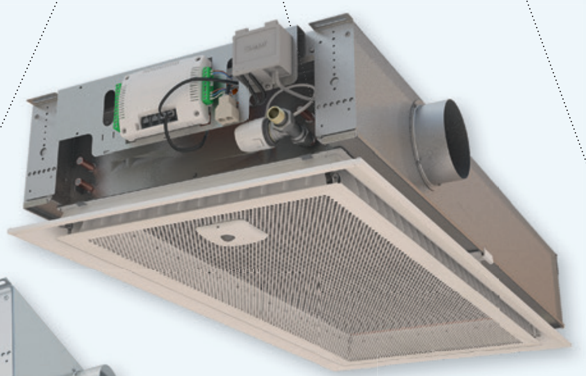

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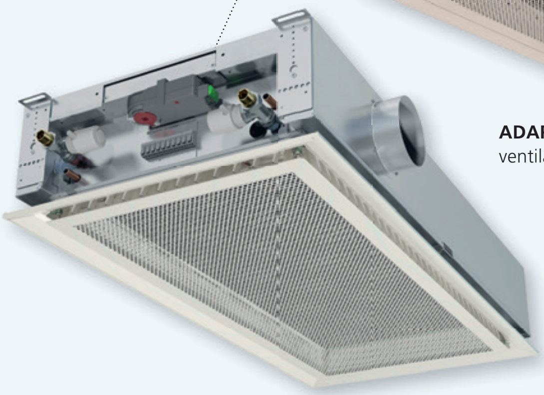

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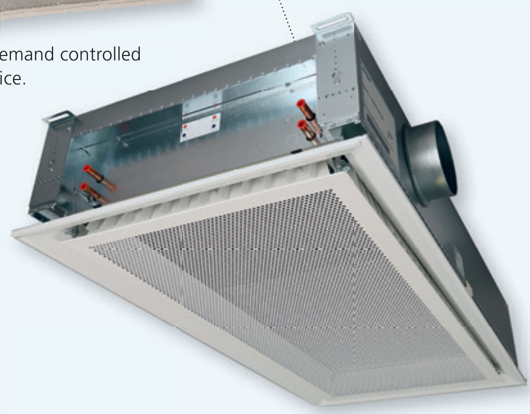

PARASOL. Constant air volume for open plan office.

A future nearly Zero Energy Hotel in Italy



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The paper presents the refurbishment project of one of the Italian pilot cases of the European neZEH project, the Residence L'Orologio in Turin. The provided information resulted from the energy audit and the feasibility study, currently in progress, aiming to guide the hotel owners in their choices.

Keywords: neZEH, nZEB, hotel, refurbishment project, energy efficiency measures.

Introduction

The case study proposed in this paper aims at demonstrating the feasibility and sustainability of a refurbishment project of a small-medium hotel. This is also one of the main goals of the IEE funded project neZEH[1] and, indeed, the presented hotel, the Italian Residence L'Orologio, is included in the long list of the thirteen European pilot projects that will run for the nearly Zero Energy goal in their businesses across seven countries.

The information derived from the energy audit of the Residence L'Orologio were used to structure this paper. Based on the current building features, the building model was implemented in an energy simulation software and retrofit interventions were simulated and evaluated by applying the cost-optimal methodology.

The Hotel and its context

The Residence L'Orologio is an urban hotel located in a central area of Turin, in Piedmont Region. The geographical location is representative of the Italian Middle Climatic Zone (HDD=2617), such as classified by Tabula project [1]. The specific location of the building, a densely built and historical part of the city, exemplifies the challenges of renovating the building stock in Italy.

This apartment building built at the beginning of 20th century was refurbished and converted into a hotel about ten years ago; the renovation process was started in 2003 by Talaia family, current owners and managers of the Residence. It is worth noting that, because of its historical features, the building is subjected to some constraints, to be considered during the renovation

1 Nearly Zero Energy Hotels (neZEH) is a three years long project supported by the Intelligent Energy Europe (IEE) program started in April 2013, involving a consortium of seven European Countries (Croatia, France, Greece, Italy, Romania, Spain, Sweden) and ten partners. The project aims at accelerating the refurbishment rate of existing buildings into nZEB in the hospitality sector and promoting the front-runners. Focusing particularly on the SME hotels. www.nezeh.eu

process. Particularly, the main façade cannot be insulated neither from the outside, because of aesthetical reasons, nor from the inside, because of standard minimum guestroom dimension to be maintained.

The building has a rectangular plan, developing in six floors above ground and in a half-basement area (**Figure 1**). Not the whole building area is occupied by the hotel: the top-floor hosts two private apartments, independent from it. Residence L'Orologio offers twenty guestrooms, each of them fully supplied with appliances such as fridge, dishwasher, electric oven, microwave, electric stove, washing machine and TV. Indeed, this business mainly relies on guests' long-term stays, which requires the guestrooms to be very similar to small apartments in terms of internal layout and equipment. The extra facilities offered by the Residence are a small gym, a kitchen for the staff and a children playroom, all located at the half-basement. The main data about the hotel are displayed in **Table 1**.

Original building envelope and energy system

Residence L'Orologio presents a very traditional structure with load bearing masonry walls. During the first refurbishment of the building, ten years ago, no further insulation was added because their thermal properties were good enough according to the national minimum requirements in effect at that time [2]. Nonetheless, the walls transmittance ($U_{wall,hotel}$ = 1.12 W/m²K) is far below the limit U-value currently in force in Piedmont ($U_{wall,standard}$ = 0.33 W/m²K [3]). On the contrary, all the windows were substituted with the most up-to-date solution in 2005: windows with double-pane and wooden frame ($U_{window,hotel}$ = 2.5 W/m²K). Again, the thermal performance of windows are below the current standards expectations ($U_{window,standard}$ = 2.00 W/m²K [3]).

Dealing with plants, the building is now heated by two condensing boilers powered by natural gas (rated output 84 kW), also used for Domestic Hot Water (DHW) production. The DHW loop also includes an accumulation tank of 300 litres, where water is maintained at the temperature of 46°C. A chiller (cooling capacity 97 kW) is installed for the cooling system. Two-pipes fan coil units, placed in the false ceiling, are the terminals of the heating and cooling system. At present, the building does not have a mechanical ventilation system (except for exhaust air systems in bathrooms and kitchens) and it does not use any on-site renewable energy source.

Figure 1. Typical floor.

Table 1. Hotel's main information.

Name Residence L'Orologio
Location Corso Alcide De Gasperi 41, Turin
Type of hotel Urban
Owner Talaia family
Manager Stefania Talaia
Floor area 1 138 m² *(heated area)*
Floors 6 (one half-basement area)
Guest rooms area 874m²
Guest rooms 20
Guest beds 78
Offered facilities Gym, kitchen for the staff, (children playroom)

In terms of energy use management, a number of energy saving measures are installed. All rooms are supplied with key-card and windows' opening sensors communicating with the cooling system.

Current energy consumptions

The energy audit performed within the neZEH project allowed to obtain and compare real and simulated energy uses for Residence L'Orologio. On one side, the actual energy use of the hotel, derived from energy bills, were extrapolated for the past two full years (2013, 2014). On the other side, the information collected about the building physical (envelope, plants, etc.) and operational (occupancy, equipment schedules, etc.) features enabled the authors to model the building in SEAS[2] energy simulation software. In case of unknown operational details, reference was made to Italian standards (e.g. minimum ventilation rates, derived from Italian standard UNI 10339 [4]). The simulated delivered energy uses are in line with the actual energy uses, as shown in **Table 2.** Primary energy consumption was calculated by applying to the annual delivered energy results the Italian primary energy factors for natural gas and electricity (1 kWh_{gas} = 1 kWh_{PE} [5]; 1 kWh_{el} = 2.174 kWh_{PE} [5])[3].

Considering that different hotels may offer different facilities, the neZEH Project approaches to the problenm by dealing only with the hotels' energy use for the "hosting functions" (guests' rooms, reception hall, offices, bar and restaurant, meeting rooms), as defined in [6]. Therefore, in addition to the primary energy consumptions for the whole building, energy uses for the hosting functions are displayed. They will be the focus for the next steps of the study.

Toward the energy retrofit: defining Energy Efficiency Measures

The above information was the starting point to draft building energy retrofit hypothesis for the hotel. The existing building was taken as the baseline model to which technically feasible Energy Efficiency Measures (EEMs) were applied via simulations. Bespoke options were considered by taking into account energy audit results, context, building typology and, of course, owners' point of view. Blending EEMs, packages of retrofit interventions (summarized in **Table 3**) were proposed.

Table 2. Energy consumptions of the building.

		REAL		CALCULATED			
		DELIVERED ENERGY		DELIVERED ENERGY		PRIMARY ENERGY	
SOURCE		2013	2014	Whole building	Hosting functions	Whole building	Hosting functions
Natural gas	kWh_{th}	160 694	142 715	152 035	152 035	152 035	152 035
	kWh_{th}/m^2	141	125	134	134	134	134
Electricity grid	kWh_{el}	96 324	80 443	81 703	69 279	177 622	150 612
	kWh_{el}/m^2	85	71	72	61	156	132

Table 3. List and description of the packages of retrofit interventions.

EEM	Interventions													
	1	2	3A	4A	3B	4B	5B	6B	1C	2C	1D	2D	3D	4D
Water saving devices	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
District heating					✓	✓	✓	✓		✓				
Solar thermal system			✓	✓					✓					
Wall insulation - 10 cm				✓		✓								
Wall insulation - 23 cm								✓						
Windows substitution				✓		✓		✓						
Stand-by reduction	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Induction cookers		✓	✓	✓	✓	✓	✓	✓				✓	✓	✓
LED lights		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Photovoltaic system							✓	✓					✓	✓

2 Simulation and energy diagnosis software developed by the Department of Energy Engineering, Systems, Land and Construction (DESTEC) at the Pisa University in collaboration with ENEA.

3 The Italian primary energy factor used in this paper were modified by D.M. 26.06.2015, valid from 1st October 2015. Since the study was carried on before this date, the new factors were not used.

Energy and Economic evaluation of the retrofit options

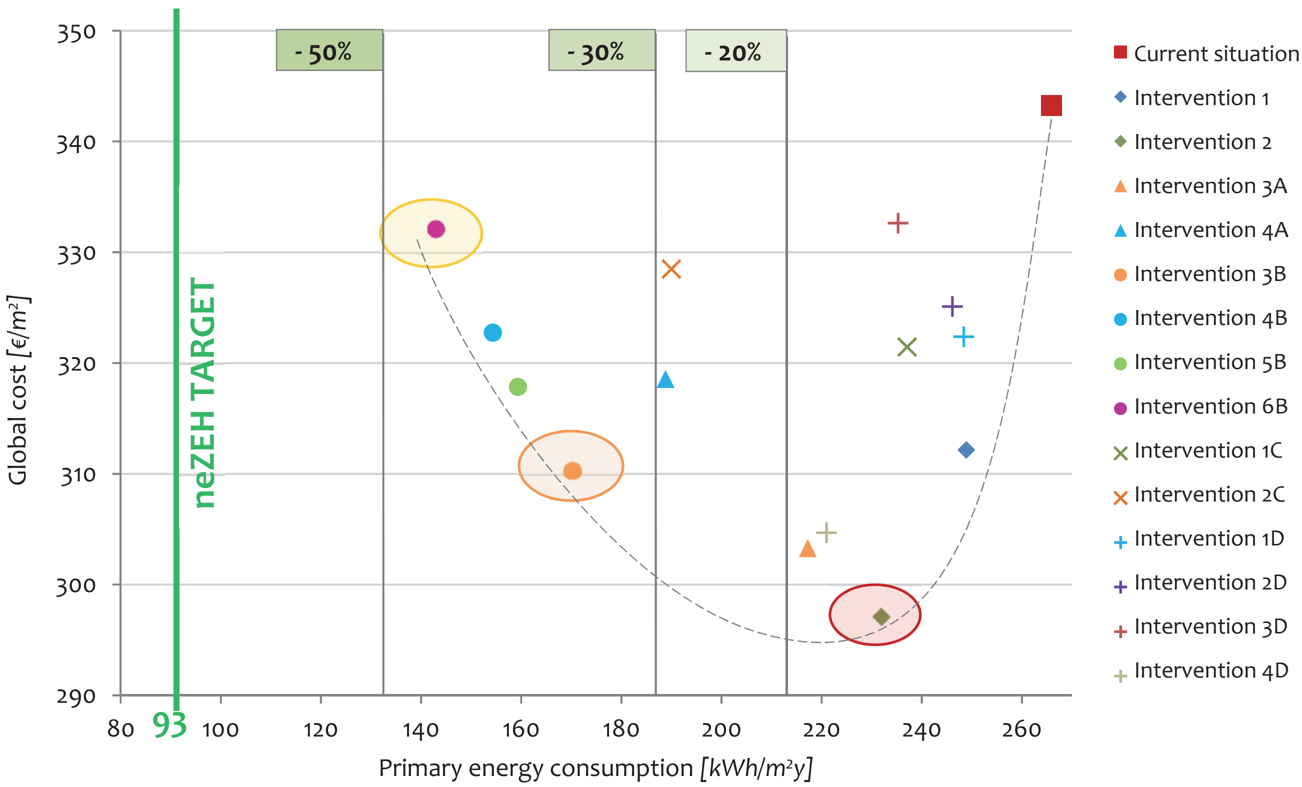
The energy and economic convenience of the proposed retrofit interventions was evaluated by applying the EU-suggested cost-optimal analysis [7], aiming to define the amount of typical primary energy use (i.e. energy use associated with a typical use of the building) leading to the minimum life cycle cost. The cost-optimal framework methodology builds on a comparative methodology framework that is based on the global cost (C_G) method [8], therefore for the baseline model and for each model implementing EEMs all the required input were defined and the C_G was calculated. The calculation period was set as twenty years; 3% discount rate was used; investment costs were taken from Piedmont Price List 2015 or derived from market estimations; replacement and maintenance costs were derived from EN 15459:2007 Appendix A [7]; energy costs were calculated by applying to SEAS simulation results the following energy tariffs: natural gas cost = 0.063 €/kWh; electricity cost = 0.190 €/kWh.

Graph 2 shows the results of the cost-optimal analysis. Primary energy results for retrofit interventions are plotted versus the calculated global cost and vertical lines points out different reduction targets up to the most ambitious one, the Italian benchmark for nearly Zero Energy Hotels defined by neZEH project [5].

The study shows intervention 2 as the cost-optimal retrofit option. However, despite the higher global cost, intervention 3B is a valuable proposal as well, able to reach much higher primary energy savings (- 36% with respect to the baseline model).

Moreover, thinking of an on-going retrofit process, the building could implement EEMs during the years by starting from intervention 2 and going up to the intervention 6B (nearly 50% of primary energy savings). The **intervention 2** would allow the building to save more than 4 000 € per year by implementing simple EEMs. They could be the first improvements for the Residence. By connecting the hotel to the district heating system (**int. 3B**) cost savings are similar, but the higher initial cost is balanced by primary energy savings: 36% of reduction due to the high percentage of RES used to produce this thermal energy. Thus, owners could decide to proceed with the refurbishment by installing photovoltaic panels (**int. 5B**) reducing primary energy to 40%. The last intervention (**int. 6B**) was calculated with the aim to investigate on the best performances of the building by mixing all compatible EEMs.

With regard to the neZEH benchmark, none of the feasible retrofit intervention was able to reduce the primary energy use to the desired target. However, it



Graph 2. Cost optimal analysis.

must be noted that the high electricity consumptions of the building are mainly due to the fact each guestroom is fully supplied with appliances, which is not the case of a standard hotel. By excluding these "extra-consumptions", the best achievable primary energy index (int. 6B) decreases from 143 kWh/m²y to 112 kWh/m²y, getting closer to the benchmark. Major interventions, usually related to an overall building reinvestment and remodelling, would allow making the benchmark reachable.

Moreover, the peculiarities of the structure make neZEH target too ambitious. The most evident "real life" constraints for the implementation of retrofit measures are related to the building envelope. The façade insulation is not a suitable measure because of the high cost and the possibility to operate only in the south one and the windows substitution is considered just a theoretically feasible EEM (the potential energy performance improvement achieved does not justify the high investment cost).

Lessons learned

Simulation results pointed out that none of the technically feasible and admissible retrofit intervention is able to reach the target, even if they could lead to halve the current primary energy consumption. These findings are at first sight disappointing for the purpose of the project. Nonetheless on one side they might be the starting point for a review of the proposed benchmarks based on "on-field" experience. On the other side, is must be noted that all interventions were proposed based on the hotelier's needs and plans, which did not include a major renovation. In case of overall building reinvestment, more invasive interventions could have been proposed, making the neZEH target easier to meet.

The economic evaluation of the retrofit interventions, compared in terms of global cost, pointed out that the cost-optimal level of energy performance for Residence L'Orologio is very far from the higher achievable energy performance indicating that financial support by renovation grants or some other incentives would be required in order to realize the energy saving potential. Nonetheless, programming a process of implementation of retrofit measures can be a solution to reach the highest energy performance by distributing the economical efforts year by year. ■

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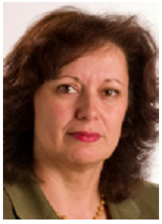
See the complete list of references of the article in the html-version at www.rehva.eu -> REHVA Journal.

CO_2 zero schools

School building renovation towards emissions neutrality



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Vila Nova de Gaia, a 300 000 inhabitants' municipality in Portugal, has established the goal of transforming their schools into carbon emissions free buildings. The first pilot project shows a combination of cost effective energy efficiency measures with renewable energy harvesting allowing reducing nearly 90% final energy use and carbon emissions.

Keywords: School buildings renovation; Energy efficiency; Renewable energy; Nearly-zero emissions.

In Europe, the urban areas are responsible for 70% of the final energy consumption [1]. In an attempt to reduce these numbers, many initiatives have been developed, mainly within the scope of the Climate Change Package, where the main targets are the reduction of the carbon emissions, the increase of the production of energy based on renewable energy sources and increase the energy efficiency, with the well-known goal of 20% for each [2].

In Portugal, the energy efficiency goals include the renovation of public buildings, such as schools, in order to promote a more efficient management and better serve the local community, [3] while improving the comfort conditions and the energy performance and reducing the operation costs. The basic school buildings are owned and managed by the municipalities, which assume the responsibility for all the costs related to their use, maintenance and renovation.

Having joined the Covenant of Mayors initiative, a European movement involving local and regional authorities, voluntarily committing to increase energy efficiency and use of renewable energy sources in their territories, the municipality of Vila Nova de Gaia developed an Action Plan for Energy Sustainability aiming to exceed the European Union 20% CO_2 reduction objective by 2020.

Within this Plan, the municipality included an action, called School Buildings CO_2 Zero, where all school buildings under the municipality management, must present zero carbon emissions until 2020 [4].

Vila de Nova the Gaia municipality has 110 schools under their supervision, which, according to 2013 data, resulted in an energy consumption of 2.8 GWh and 1239 Ton of carbon emissions [5].

In Portugal, many school buildings were built between 1940 and 1970 and are still being used, with a significant number of these schools based on a model, known as P3, which was inspired in a Scandinavian design. These buildings present pathologies related to thermal discomfort, indoor air quality and signs of degradation.

The average indoor temperature varies between 15°C and 18°C during winter and 26°C and 29°C during summer and the CO_2 concentration is frequently above the regulation limit, overcoming 4000ppm several times during the day. These problems have been noticed in similar buildings placed in different locations, which mean that this is a common pathology in school buildings [5, 6, 7].

Figure 1 shows the general plan of a P3 school, with U shape. In the figure, number 6 refers to classrooms and number 5 is a multipurpose area.

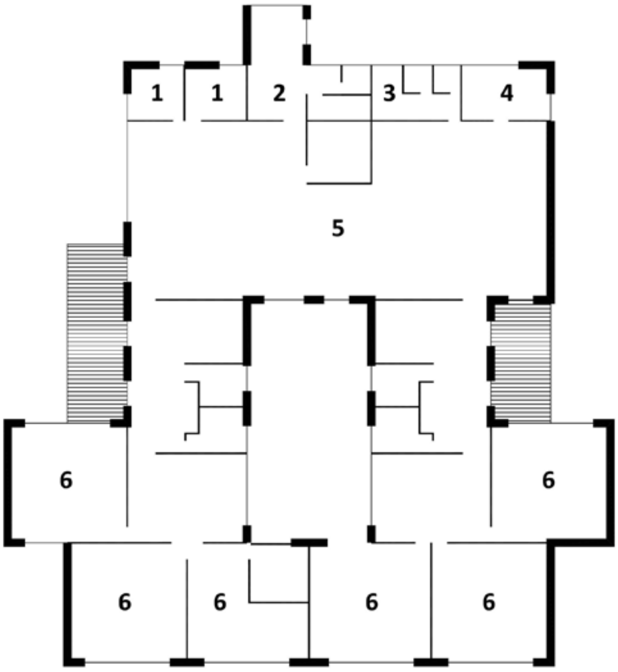

Figure 1. P3 School general plan of ground floor.

The renovation is currently in the project phase, where it has been important to analyse different solutions and choose the most cost effective way of reaching the goal of zero carbon emissions.

Objective

The main purpose, from the technical perspective of energy and emissions reduction, is to pave the way for the elimination of the CO_2 emissions and improve the overall energy performance of the building. This reduction will allow savings on the energy bills supported by the municipality and will cooperate in the implementation of the Action Plan for Energy Sustainability. Besides, it is intended to improve the comfort conditions and the indoor air quality to assure the users' health conditions and the optimization of the environmental conditions for the students.

For the present intervention, there is a constraint regarding the building integrated technical systems (BITS) for heating and cooling. As these systems have been recently replaced, they will be kept as they are in this first phase of the renovation process and their replacement by systems based on renewable energy sources will only occur in a later intervention, closer to the end of the systems lifetime.

Methods

The most cost effective way to reduce significantly the emissions, resulting from the use of buildings is very often improving the buildings envelope to a certain level and using efficient technical systems based on renewable energy sources [8].

The selection of the most cost effective package of measures has been done with a life cycle costs approach based on the cost optimal method, introduced by EC Delegated Regulation (EU) No 244/2012 of 16 January 2012, supplementing Directive 2010/31/EU of the European Parliament and of Council on the Energy Performance of Buildings.

The method requires the calculation of the energy performance of the building with each one of the considered renovation packages. The energy calculations were based on the Portuguese thermal regulation that is based on ISO-13790. Then, the global costs were calculated using the net present value (including investment costs, energy costs, maintenance costs and replacement costs).

The comparison of the results can be made comparing the primary energy and the global cost of each renovation package. **Figure 2** shows a generic representation of a cost-energy curve where the cost optimal solution is identified.

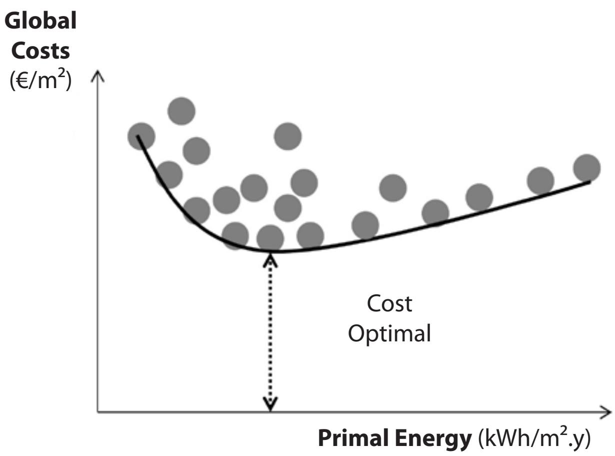

Figure 2. Generic results of the cost optimal calculations.

Building general characterization

The school was built in 1970 and it can be divided in two different zones, considering its occupation and energy use patterns: the classrooms zone and the multipurpose area, which is used as refectory and indoor playground.

The classrooms are distributed in two floors, with 6 classrooms in each floor, with a total acclimatized area of 733 m² and a floor to ceiling height of 2.7 m. The multipurpose area has only one floor with a floor to ceiling height of 5.2 m and an acclimatized floor area of 317 m². The total acclimatized area is 1 050 m².

Concerning construction solutions, the building has cavity walls without insulation, fibre cement tiles on the roof and simple glazing with aluminium frame windows. The glazing area corresponds to 41% of the vertical opaque area, which is very significant and with a great impact on the building thermal performance.

For heating the classrooms, electric storage heaters (with 2.4 kW/each and an efficiency of 1.0) that absorb energy during the night and release it during the day were recently installed, taking advantage of the reduced price of the electricity with the night tariff (when Portugal has a surplus of production). For DHW, in the toilets, there are electric heaters with 50 l storage tank (with nominal capacity of 1.5 kW).

In the multipurpose area there is an HVAC system for heating and cooling (COP=3.00/EER=3.50, nominal capacity of 6.50 kW) and in the kitchen, for DHW, there is a gas heater with 23.6 kW and an efficiency of 80%.

The classrooms do not have a cooling system or mechanical ventilation.

The internal lighting is mainly based on fluorescent lamps with an average capacity of 58 W each.

Energy renovation features

Data collected from energy monitoring before renovation allowed identifying the distribution of the energy use and the main physical pathologies. Regarding the energy use, main consumers are lighting, appliances and heating. Regarding the indoor air quality, the monitoring has shown that the concentration of CO_2 is above the adequate values most of the time.

In order to solve these problems in a cost effective way, several measures have been analysed individually, as well as several packages of those renovation measures, due to the trade-offs and synergies that can result from their combination.

In accordance with this methodology, the solution chosen for the renovation of this school resulted from the combination of each cost optimal measure that is associated to each building element.

Following, a description of the intervention on each of the main building elements is presented.

Exterior Walls

For the exterior walls, the solution includes placement of external insulation over the existing facades, consisting of EPS (expanded polystyrene) with 6cm of thickness, covered by Viroc® boards (compressed and dry mixture of pine wood particle and cement). This solution, besides significantly reducing the thermal losses and consequently the heating energy needs, improves the comfort conditions, solves the thermal bridges problems eliminating building pathologies and creates a façade with low maintenance costs.

Roof

For the roof, the chosen solution includes removing the existing tiles and the introduction of rock wool with 10cm, covered by new steel sheets. The inclusion of insulation reduces the heat losses optimizing the heating systems behaviour and preventing summer overheating.

Windows

As the glazing area is a very significant part of the building envelope in this building, the replacement of the existing windows is not only necessary, because of their state of degradation, but also an important measure due to its impact on the energy performance of the building. Therefore, new PVC windows with double-glazing (6 mm+16 mm+6 mm) will be installed. The cavity between the layers of glass is filled with argon. This solution leads to a U-value of 0.7 W/m²°C. Besides the thermal characteristics of the glass and frames, in the classrooms, shading devices will be placed outside above the windows, consisting on horizontal plats to control shading and to drive natural lighting into the interior ceiling.

Ventilation

To assure the interior air quality, a hybrid ventilation system has been designed and will be installed. The air intake is promoted by the adoption of ventilation grids under the windows and the air exhaust is done on the opposite side of the rooms, through the roof. Mechanical extraction in the exhaust area will allow the increase of the air renovation rate whenever the CO_2 sensors detect a concentration above the desired values.

In the multipurpose area, the air quality is already controlled due to the installed HVAC system.

Heating and cooling systems

The existing systems have been recently installed so, their replacement is not an option at the moment. Closer to the end of their lifetime, in a 2nd phase, it is planned that the heating systems can be replaced by systems fully based on renewable energy, namely a biomass boiler.

Lighting and appliances

LED lamps with 20 W each will replace the lighting. This solution allows reducing the energy consumption and producing less heat, reducing internal gains that are a problem during summer.

There are also appliances in the classrooms and in the kitchen that are not intended to be replaced within the current renovation process, but only when their replacement moment arrives. Appliances with the highest efficiency level should replace these.

These actions allow reducing very significantly the energy use, but the final energy values are yet far from the zero energy level. To fill this gap and get closer to the zero emissions goal, photovoltaic panels will be installed to produce electricity from renewable sources. These panels will produce energy for the school, mainly for lighting and appliances.

In brief, the adopted energy renovation features are the following:

- External insulation on the walls and roof;
- PVC framed double glass windows;
- Hybrid ventilation with natural crossed ventilation through ventilation grids and mechanical exhaustion controlled by CO_2 sensors;
- LED based lighting;
- Photovoltaic panels.

Table 1 presents the U-values for the elements of the building before and after the renovation. The ground floor solution is kept as it is, with a U-value of 1.89W/m^{2}y.

Comparing the results achieved with the several renovation measures, the energy efficiency measure with the highest impact is the replacement of the windows (due to their large area and substantial reduction of the U-value), followed by the replacement of lighting. Besides these measures, only photovoltaic panels allow higher reductions of the non-renewable primary energy use as well as the future replacement of the heating system by a wood pellets based system.

Impact of renovation

The chosen renovation solution allows improving the comfort conditions, assuring the indoor air quality, saving energy and significantly reducing the carbon emissions. With the contribution of the photovoltaic panels, the electricity use is not far from zero but the high conversion factor for electricity in Portugal (2.5 kWh_{EP}/ kWh) still leads to a primary energy use of 39.73 kWh_{EP}/m^2y. **Table 2** presents the energy use, primary energy and carbon emissions before the renovation and the estimated use after the renovation (phase 1) and also after replacing the heating system (phase 2).

After the global renovation, 72% of the energy needs will be fulfilled based on renewable energy and the energy use for appliances and lighting will be reduced in 84%, when compared to the values before renovation. Concerning the primary energy

Table 1. Buildings thermal characterization before and after renovation.

Element	**U-Value** [W/m^2.y]	
	Before	**After**
Walls	1.19	0.40
Roof	1.40	0.38
Windows	5.20	0.70

Table 2. Summary of the renovation impact.

Energy use [kWh/m^{2}y]	**Before**	**After** (Phase 1)	**After** (Phase 2)
Appliances (Electricity)	16.6	2.6	2.6
Lighting (Electricity)	20.2	3.2	3.2
Heating (Electricity)	47.6	4.8	0.0
Cooling (Electricity)	0.5	1.0	1.0
Ventilation (Electricity)	0.0	1.4	1.4
Cooking & DHW (Nat. Gas)	7.3	7.3	7.3
Primary energy [kWh/m^{2}y]	219.4	39.7	27.7
Emissions [kgCO_2eq/y]	1 4127	3 260	2 535

and emissions, the reductions to be achieved are presented in **Table 3**.

Regarding costs, the chosen renovation solution has high investment costs but in a life cycle perspective, it has lower global costs than the base scenario (restoring the building functionality without improving the energy performance).

Figure 3 shows the costs for the thirty years' life cycle. Analysing the figure, it is noticed that the investment costs are clearly higher in the chosen renovation but the operating costs are lower.

Conclusions

It is expected that the users' comfort will improve significantly and the problems related to the quality of the air will disappear without the need of complex HVAC systems that have been widely used in this type of buildings during recent years.

The Portuguese thermal regulation has energy reference requirements for the buildings' envelope, thus the chosen renovation presents solutions for the walls, roof and windows that are in accordance with the reference U-values. It is noteworthy that the U-value of the windows is quite low when compared to the reference value.

According to the calculations, this intervention will also allow significantly reducing the energy consumptions and the carbon emissions in a cost effective way during the building's life cycle. The energy bills of public buildings under the municipality´s supervision are quite heavy, and the reduction of these numbers, through investment on energy efficiency improvement, is an added value for the municipality, that can use those savings for other purposes.

Further energy efficiency measures are possible, but reduced improvements are achieved with high investments costs and more photovoltaic panels will decrease the efficiency of the system due to the lack of synchronism between the electricity generation and its use.

Although the zero emissions level has not yet been achieved, the full planned renovation is considered a good compromise between this goal and the cost-effectiveness of the intervention. The renovation procedures analysed and presented in this paper do not constitute a single pilot project as the municipality intends to replicate these measures in the many similar schools in need of renovation in the country. ■

Table 3. Summary of total reduction of non-renewable primary energy and emissions.

	Reduction
Non-renewable primary energy	87%
CO_{2eq} emissions	88%

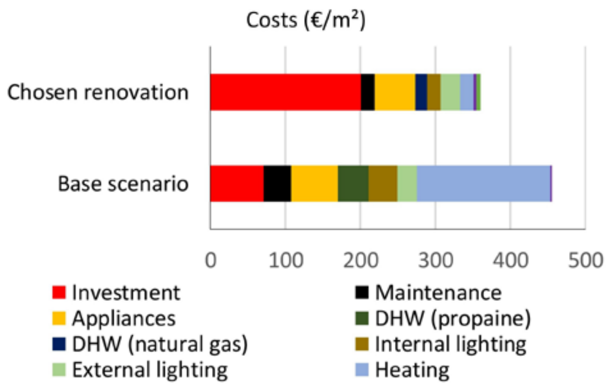

Figure 3. Distribution of the global costs during thirty years.

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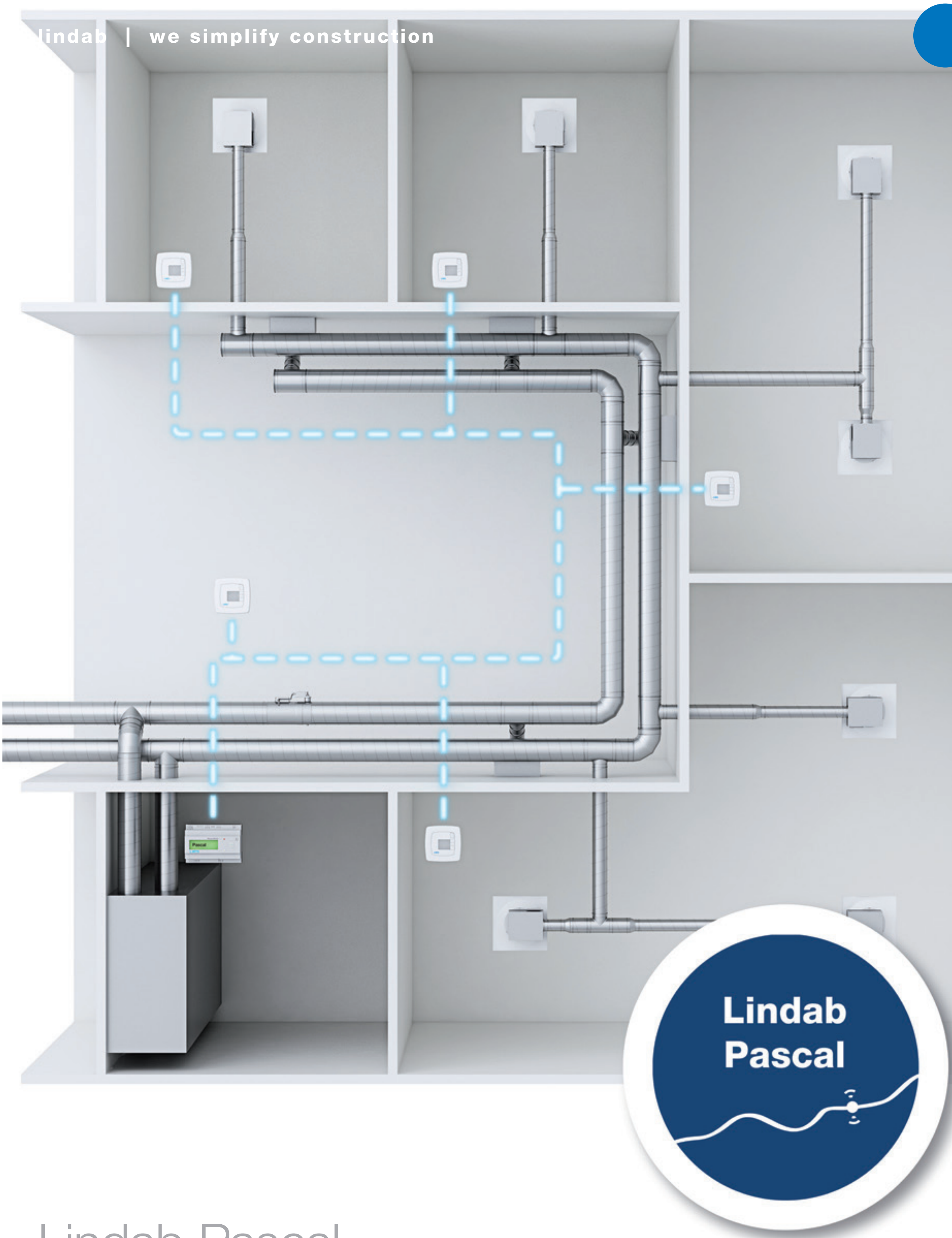

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Renewables and HVAC retrofit on an existing building in Spain

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This article describes a project carried out to retrofit the HVAC facilities and to install renewable energies on a university building located in eastern Spain. The main objective of the proposal is to minimize the consumption of non-Renewable Primary Energy of the building at an affordable cost.

Keywords: nZEB, Energy Efficiency, Building Retrofit, Renewable Energies, HVAC Replacement.

The present paper describes a project carried out to retrofit the HVAC facilities and to install renewable energy facilities in a university building located in Orihuela (Alicante) Spain.

The building in question is fourty-five years old and experiences grave malfunction within its equipment. Thus, the university proposes replacing the building's facilities, with the additional aim of improving efficiency. The concept is:

- To replace the HVAC facilities as the current ones are defective or do not work properly.
- The university is ready to assume additional costs in order to make the building energy efficient.
- The building envelope is not considered for reformation: windows and insulation will remain unchanged.

Spanish legislation does not yet define "Nearly Zero Energy Buildings". However, regulations involving Energy Performance Certificates are well established and used regularly. It is required that new public buildings attain, at the very least, an Energy Rating Letter 'B', but nothing is said concerning refurbishment of existing buildings.

This being said, there are very promising financial support schemes in place that encourage rehabilitation projects that entail an enhanced energy performance level.

If the energy performance ratings reach levels 'A' or 'B', the financial incentives are even greater. Therefore, an approach to obtain an energy performance rating 'A' is proposed, considering that this will be similar to having a Nearly Zero Energy Building.

Site description and climatic relevant aspects

The building is located on the outskirts of agricultural fields, 4 km away from the nearest town (Orihuela with 90 000 inhabitants). It is very close to the river Segura and is thus a very humid area. It is located about 20 km from the sea and at only 20 m above sea level.

Climatic data of the capital (Alicante), situated 40 km away are available. However, experience corroborated by measurements, confirms that in summer the temperature on campus is 3–4°C higher than in the capital yet in winter it is 3–4°C lower.

The Orihuela campus (**Figure 1**) is home to the School of Agricultural Engineers with its own cultivation land that generates a significant amount of biomass. Furthermore, it has a pelletizer, thus making biomass an attractive solution.

Figure 1. Site Location.

Description of building geometrical features and envelope thermal properties before and after retrofit

The building in question (**Figure 2**) is completely detached, but the south facing façade receives shade from a nearby building. Also, the windows have overhangs that perform as awnings very effectively in summer.

Figure 2. Photo of Building.

The constructed surface area is 5 800 m², 4 640 m² being air-conditioned. The building is used 8:00–22:00, Monday through Friday and 8:00–15:00 on Saturdays. It closes in August, making up a total of 3 696 hours per year 'of use'.

The windows are old and single glazed with 6mm glass and an aluminium frame without thermal breaks.

Description of systems features before and after retrofit

Before retrofit

The facilities are found mostly on the roof of the building: there are two reversible heat pump units and a cooling unit. All of them are included in **Figure 3.**

Figure 3. View from Top. HVAC Installations.

Table I shows the energy performance simulation of the building before retrofit, where Final Energy Consumption, Non-Renewable Primary Energy Consumption and CO_2 Emissions are included. The non-Renewable Primary Energy conversion factor for delivered electricity in Spain is 1.954 kWh_{nRPE}/ kWh_E.

Figure 4 shows the results from the simulation about the monthly final energy consumption before retrofit.

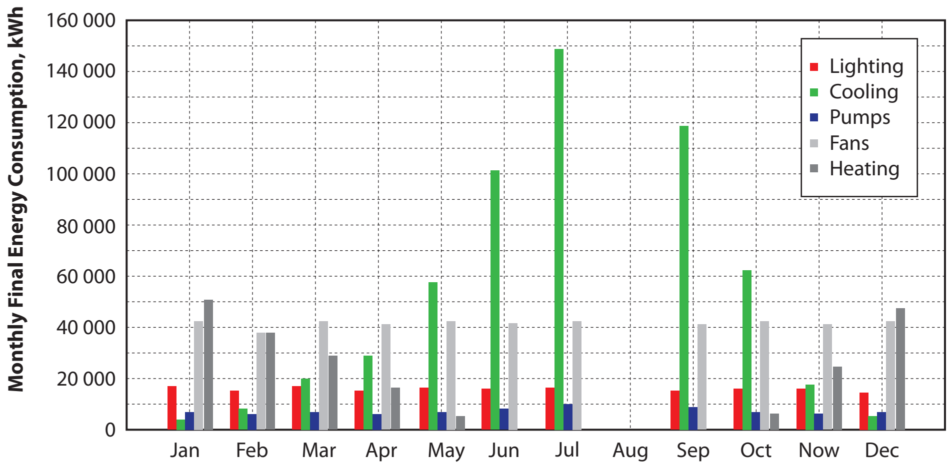

Figure 4. Monthly Final Energy Consumption by Each System before retrofit.

Currently the units are fitted with fixed speed reciprocating compressors and the water flow both in the primary circuit and the distribution system are constant. The building works on a cooling or heating only basis. The lecture rooms, hallways and canteen are conditioned with the building's fourteen AHUs (twelve on the roof and two indoor). The building also has thirty-four offices and one fan-coil unit per office.

After retrofit

Tables II and **III** show the simulation results after retrofit.

The heat pump's user experience has been unsatisfactory. The units have proved to be unreliable and their performance at low temperatures has been poor, in part due to the area's high humidity on cold mornings.

Therefore, a biomass boiler is installed with a power rating of 500 kW, thus covering for 100% of the required heating demand and 100% of energy demand. An additional propane boiler will be fitted as a redundant system to guarantee adequate service in case the biomass boiler becomes defective, thus will not be taken into account in this study.

To cover for cooling demands, two Daikin EWAD TZPS 345 cooling units are chosen. Enclosing inverter screw compressors and with a nominal power of 339 kW, said units are highly efficient with an EER=3.34 and an ESEER=5.46 (according to EN14511-3-2011).

The building's renovation must conform to current Spanish legislation that requires the installation of heat recovery systems. Thus the existing AHUs are modified and a heat recovery system is added to them. In addition, the control systems are improved to take advantage of free cooling through enthalpy controllers, as well as perform night cooling when convenient. Similarly, VFDs are incorporated to both the return and supply fans.

Table I. Energy Performance Certificate before retrofit.

Concept	Studied Building	Reference Building
Final Energy (kWh/year)	1 511 983.0	1 547 290.0
Final Energy (kWh/ m^{2}year)	275.8	282.3
Primary Energy (kWh/year)	3 935 691.8	2 634 266.3
Primary Energy (kWh/ m^{2}year)	718.0	480.6
Emissions (kg CO_2/year)	**981 276.9**	**672 794.8**
Emissions (kg CO_2/ m^{2}year)	**179.0**	**122.7**

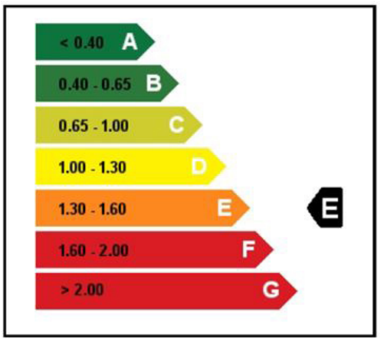

Table III. Energy Performance Certificate after retrofit.

Concept	Studied Building	Reference Building
Final Energy (kWh/year)	452 677.4	106 439.1
Final Energy (kWh/ m^{2}year)	82.6	194.2
Primary Energy (kWh/year)	862 678.0	2 075 804.1
Primary Energy (kWh/ m^{2}year)	157.4	378.7
Emissions (kg CO_2/year)	**186 134.1**	**525 533.8**
Emissions (kg CO_2/ m^{2}year)	**34.0**	**95.9**

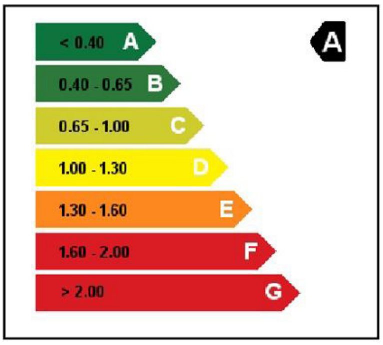

Table II. Monthly final energy consumption by each system after retrofit.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lighting	5 945.8	5 437.9	5 997.20	5 437.9	5 971.5	5 730.4	5 971.5	0.0	5 463.6	5 971.5	5 704.7	5 171.2	62 803.1
Cooling	256.8	199.1	969.50	2 013.4	3 389.8	4 186.8	8 083.3	0.0	6 062.8	4 459.8	883.7	383.4	30 888.5
Pumps	2 551.3	2 029.4	1 666.80	11 35.3	1 709.8	2 684.1	3 587.4	0.0	2 975.9	1 822.2	1 529.3	2 275.4	23 966.9
Fans	23 147.5	18 503.9	17 935.50	19 446.0	20 235.7	18 301.3	19 256.2	39.4	1 9067.1	1 9692.9	18 289.1	24 293.8	218208.5
Heating	157.5	121.4	76.60	29.8	1.3	0.0	0.0	0.0	1.8	14.7	84.5	147.3	635.0
TOTAL	32 058.9	26 291.7	26 645.5	28 062.4	31 308.1	30 902.6	5 971.5	0.0	5 463.6	5 971.5	5 704.7	5 171.2	62 803.1

Table IV. Table of components before and after.

COMPONENTS	BEFORE RETROFIT		Power	Effi or η	AFTER RETROFIT		Power	Effi or η
	Uts.		Σ kW	EER / COP	Uts		Σ kW	EN14511-3:2011
Cooling Plant	3	2 Heat Pump +1 Chiller, R_22 Reciprocating Comp	690	2.19	2	Chillers, R-134a, Inverter Screw	678	EER / ESEER 3.34 / 5.46
Heating Plant	2	Heat Pump, R-22, Reciprocating Comp	460	2.60	1	Biomass Boiler	250	90%
Renewable Energy Systems	0				1	Photovoltaic system, Instant self-consumption (60 kWp)	50	85%
1º Pump System	3	Constant Water Flow	9	49%	3	Constant Water Flow	7.5	60%
2º Pump System	6	Constant Water Flow	11	49%	6	Variable Water Flow	9	60%
AHU'S	14	Constant Air Flow, Constant Water Flow, Thermal Free Cooling, No Heat Recovery, No_CO_2 Detection	34,5		14	Variable Air Flow, Variable Water Flow, Enthalphy Free Cooling, CO_2 Detection, 65%_Heat_Recovery	34.5	
Fan Coils	34	Constant Air and Water Flow	6,3		34	Constant Air and Water Flow	6.3	
Control		Centralized Analogical Control of AHU's. No Monitoring				Centralized Digital Control of AHUS's, Chillers and Boiler. WebServer Monitoring		

Table V. Demand and emissions comparison.

Demand and emissions	Before	After	Savings
Heating Demand (kWh/ m^2)	22.60	18.40	4.20
Cooling Demand (kWh/ m^2)	153.00	134.80	18.20
Primary Energy (kWh/ m^2)	718.00	157.40	560.60
Cooling Emissions (kg CO_2/ m^2)	157.90	27.60	130.30
DHW Emissions (kg CO_2/ m^2)	0.00	0.00	0.00
Lighting Emissions (kg CO_2/ m^2)	**21.20**	**6.30**	**14.90**
Total Emissions (kg CO_2/ m^2)	**179.10**	**33.90**	**145.20**

Seeing as the secondary pumping system will now be fed via a hydraulic variable displacement pump, the current three-way valves within each AHU are replaced by two-way valves.

All analogous control systems are replaced to ensure optimal performance within the pumping-production-distribution loop, guaranteeing therefore that demand and production are as close as possible at all times.

The building's lighting makes up 14% of the total energy demand and is henceforth an aspect of the building to be considered. Thus a light controlled LED lighting system is proposed, to replace all existing and out-dated systems.

As there are no domestic hot water systems in this building, except for a small electric boiler in the canteen, the DHW systems and its calculations are not taken into account in this study.

Description of utilized res

Under Spanish legislation an efficient building (Class 'A') is defined as a building with a non-renewable primary energy consumption; due to air conditioning, lighting and hot water systems, 40% lower compared to its own "reference building".

The debate about what constitutes as renewable energy and what does not, has no effect over certification, it can therefore be understood that it will not affect future Class A buildings.

Renewable energies used are:

1. **Biomass:** Biomass produced on campus; consisting of the campus's and nearby farm's agricultural crop residues, as well as forest and garden waste and any other material found on the river slopes is used. The chosen boiler is poly-combustible, though it is primed for the use pellets; it will also be capable of working with chips and biomass with a humidity of up to 30%.

2. **Photovoltaics.** A 60 kWp PV system is installed in order to supply energy to the air conditioning equipment. The system has been dimensioned to accommodate for the demand produced by the AC pumps and fans. Therefore the primary energy savings due to the use of the PV system is only justified through its use in the HVAC facilities. PV energy sale to the grid is not considered, neither is its consumption in any other facility within the building.

Table VI. Energy and emissions by each system before and after.

	Before			After		
SYSTEM	Final Energy (kWh/year)	Primary Energy (kWh/year)	Emissions (kg CO_2/year)	Final Energy (kWh/year)	Primary Energy (kWh/year)	Emissions (kg CO_2/year)
Heating	220 358.10	573 592.20	143 012.40	116 810.50	117 587.80	362.40
Cooling	574 003.70	1 494 131.50	372 528.30	30 888.50	68 523.30	17 084.70
Pumps	83 332.30	216 914.00	54 082.70	23 966.90	53 168.50	13 256.40
Fans	455 483.90	1 185 624.20	295 609.00	218 208.50	484 076.00	120 693.50
Lighting	178 805.40	465 430.30	116 044.70	62 803.10	139 323.00	34 737.10
TOTAL	**1 511 983.40**	**3 935 692.20**	**981 277.10**	**452 677.50**	**862 678.60**	**186 134.10**

Table VII. Economic ratios and return periods by system.

	Energy and Emission Savings			Money Saving and Repayment Period			
SYSTEM	Final Energy (kWh/year)	Primary Energy (kWh/year)	Emissions (kg CO_2/year)	Costs of investment (€)	Cost of final kWh Before	Annual Savings (€)	Years to repayment
Heating	103 547.60	456 004.40	142 650.00	119 348.00	0.05	5 476.08	21.79
Cooling	543 115.20	1 425 608.20	355 443.60	279 653.00	0.06	34 099.70	10.43
Pumps	59 365.40	163 745.50	40 826.30	34 568.00	0.11	6 530.19	6.73
Fans	237 275.40	701 548.20	174 915.50	43 359.00	0.11	26 100.29	2.11
Lighting	116 002.30	326 107.30	81 307.60	68 456.00	0.11	12 760.25	6.82
PV60 kWp				115 624.00			9.58
TOTAL	**1 059 305.90**	**2 617 009.20**	**652 493.00**	**661 008.00**		**84 966.51**	**7.78**

Energy performance indexes

As mentioned above, Spanish certification practice is based upon a comparison with a reference building. Not only is this paper concerned with comparing the university building with a reference building, but also and more importantly, with its former self.

The improved indexes are produced via: the upgraded air conditioning units, the utilization of biomass, the improvement in lighting and the introduction of VFDs to the facilities' pumps and fans. Ratios by system are shown in **Table VI**.

Economic indexes

Investment in equipment is necessary as existing equipment was obsolete. The proprietor (the university) is uniquely concerned primary energy savings and the use of renewable energies. Furthermore, the use of biomass is fully justified given the campus's characteristics.

The building's Energy Performance Certificate has been upgraded from 'E' to 'A'.

The investment budget is € 690 906. The economic savings will be analysed through subsystems.

The average simple payback period of investment is 7.78 years (**Table VII**). Which is more than satisfactory given that the life expectancy of the facilities is at least fifteen years.

The price of the heat recovery systems has been included in the cooling system's price. The cost implications of the automatic regulation and control system have been shared out proportionately amongst all systems.

Lessons learned

The use of biomass fuel entails significant savings in terms of the use of non-renewable, primary energy and eases the procurement of the Energy Performance Certificate 'A'.

The improved LED lighting system improves the building's efficiency, having such a fast return on investment.

ESEERs of above 5 are achieved using cooling systems with inverter screw compressors, this dramatically improves the building's efficiency.

Though clearly not as remarkable as it could have been in a colder climate, the energy recovery systems clearly contribute towards the improvement in the building's cooling and heating demand. Moreover, in cases like these, they are a requirement under Spanish regulations.

Not only do the fans, pumps and VFDs prove to contribute actively towards the improved energy consumption and emission ratings, but they also prove to be one of the more interesting ventures, due to their fast return on investment.

The use of solar PV energy for instant self-consumption within the HVAC system has proven to be the best method to increase efficiency on these types of systems.

The annual consumption consequences of running fans and pumps are very clear. During the building's operating hours, said systems are permanently on and in this particular case, account for approximately 50% of final energy consumption. This can be effectively offset through the utilization of renewable energy sources such as solar PV (in Spain, only self-consumed PV electricity can be considered). ■


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A non-residential NZEB in Naples


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The feasibility of several new technologies for energy efficiency in buildings is investigated by means of a novel in-house developed Building Energy Performance Simulation (BEPS) code (called DETECt). A novel case study referred to a non-residential NZEB to be built up in Naples is presented.

Keywords: net zero energy building, passive design strategies, energy optimization procedure, building integrated solar thermal systems, phase change materials.

Buildings energy efficiency targets have led the research interest toward new energy saving strategies to be integrated into the design, construction, and operation of new and retrofitted existing buildings. Particularly for sizing and optimising purposes (especially for NZEBs), advanced energy analysis tools should be adopted to analyse the potential effects of crucial design and operating variables on the building energy performances. Aim of this work is to present the results of a comprehensive energy analysis, carried out through an in-house validated dynamic simulation code written in MatLab (called DETECt 2.2 [1]), and referred to a non-residential multi-zone NZEB to be located in Naples, Southern Italy [2]. In such building, electricity is produced through a BIPV/T system, while heat is obtained by innovative integrated solar collectors (also driving a double stage absorption chiller for solar cooling). Different novel building integrated energy saving techniques are taken into account: PCM, sunspace, smart daylighting, etc. A suitable parametric analysis is carried out in order to identify the optimal set of design and operating parameters that minimizes the building heating and cooling energy consumptions. Details about the simulation results and the economic feasibility of all the considered energy efficiency techniques are provided. According to the authors' knowledge the presented non-residential NZEB is the first one conceived for Mediterranean climates.

Site and climate

The building will be built up in Naples (Southern Italy, 40°20'N – 14°15'E), which features a Mediterranean temperate climate with rather hot and humid summers (CDD = 185 Kd, design temperature and humidity: 32°C and 60%) and quite mild winters (HDD = 1 163 Kd, design and average temperature: 2 and 10°C).

Building envelope

The project initiative stems from the action ED6 of the Sustainable Energy Action Plan (SEAP, Covenant of Majors of the European Community, August 3rd 2012) and from an explicit Resolution (n. 517 on April 21st 2011) of the Municipality of Naples. The NZEB will be built up on three floors, two of them above the ground level (**Figure 1**). It will host offices (at the ground floor) and conference and exposition spaces (at the first floor). Equipment rooms and stories will be located at the basement.

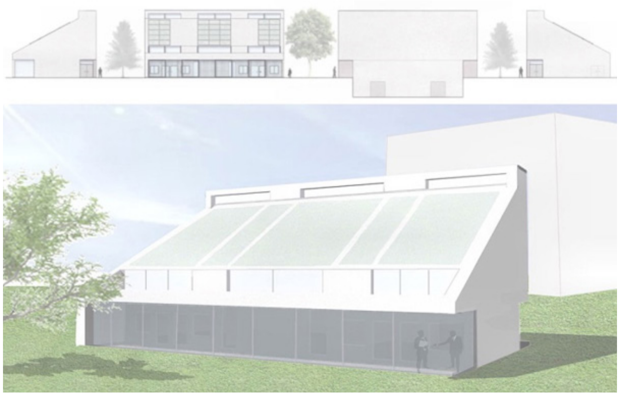

Figure 1. Non-residential NZEB to be built up in Naples, southern view.

In order to fulfil the criteria for passive heating and cooling techniques, the building is subdivided in ten thermal zones and it is conceived with a rectangular shape (15.0 × 24.5 m, East-West oriented longitudinal axis) with a S/V ratio equal to 0.38. In order to minimize the primary energy demand, several design parameters have been optimized through a validated simulation code, DETECt 2.2, which easily enables the automatic comparison of multiple building scenarios by a single simulation run [1, 3]. Several obtained building features are reported in **Table 1**.

For optimizing the winter heat loss and the yearly solar heat gains and radiation loads, windows are designed only on the southern façades (**Figure 1**). Thus, the low building window to wall surface area ratio (about 15%) reaches 70% if referred to the southern façade only. Here, first floor terrace windows are equipped by external variable tilt solar shadings. At the southern side of the ground floor, a sunspace is designed to maximize the winter passive heating. Such space becomes (by opening the external sliding windows) a shaded open porch during summer. The porch ceiling width and height are optimised to prevent indoor space superheating (**Figure 2**). More details are reported in [2].

Building plants and RES

The roof surface is 70% (135 m²) covered by mono-crystalline BIPV/T panels (16.5 kW$_p$). The remaining roof area (58 m²) is equipped by innovative building integrated flat-plate evacuated solar thermal collectors (37 kW$_p$), providing space solar heating and cooling and DHW preparation. For both such technologies, energy performance and passive effects on the thermal building behaviour were dynamically assessed through DETECt. The roof integrated PV/T system is cooled by an air stream of 0.5 kg/s, which provides free space heating during the middle seasons. For enhancing the system energy performance, the BIPV/T system is suitably coupled to PCM panels. In summer, the hot fluid obtained by the solar thermal panels (up to 250°C) is exploited for space cooling (HVAC system supported by a 26 kW double stage absorption chiller). The passive effect of such innovative solar thermal collectors is low due to their high thermal insulation (deep vacuum up to 10^{-9} mbar). The HVAC system backup is obtained through a 38 kW geothermal heat pump/chiller. Heating and cooling is provided to the indoor spaces through a fan coil and primary air system (AHU of 2 500 m³/h) supported by ground-to-air and air-to-air heat exchangers (with summer evaporative cooling unit).

Energy performance analysis

The dynamic energy performance analysis is carried out through DETECt 2.2 [1-3]. Weather conditions are simulated according to the IWEC hourly data of Naples. The simulation starts on January 1st and ends at December 31st. Heating is activated from November 15th to March 31st and cooling from June 1st to September 30th (August excluded), both from 9:00 to 18:00. The winter indoor air set-point is 20°C (sensible

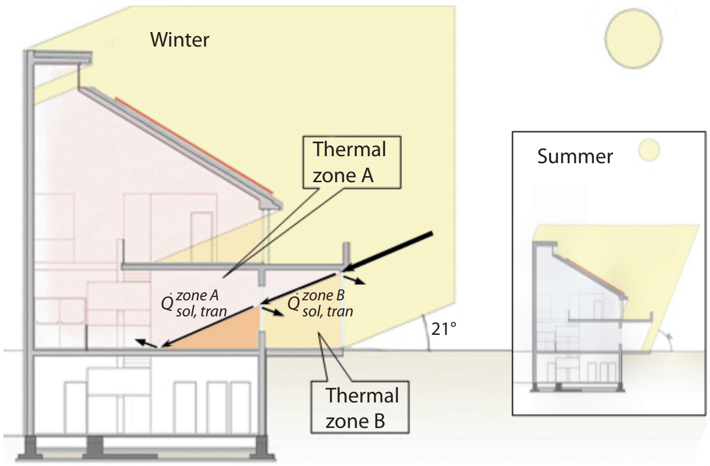

Figure 2. Winter sunspace, summer porch and solar radiation optimization.

Table 1. Building envelope features.

Building element	Density [kg/m³]	Transmittance U [W/m²K]	Embedded PCM layer	Note
Vertical walls	800 (brick layer)	0.23	Yes (3 cm)	
Tilted roof	1 050 (concrete slab)	0.23	Yes (3 cm)	
Sunspace (exterior), East office, conference room windows	—	1.6	No	Emissivity = 0.10. 6/13/6 glazing filled by Argon. SHGC = 0.58
Other windows	—	0.9	No	Emissivity = 0.10. 6/8/6/8/6 glazing filled by Krypton. SHGC = 0.46

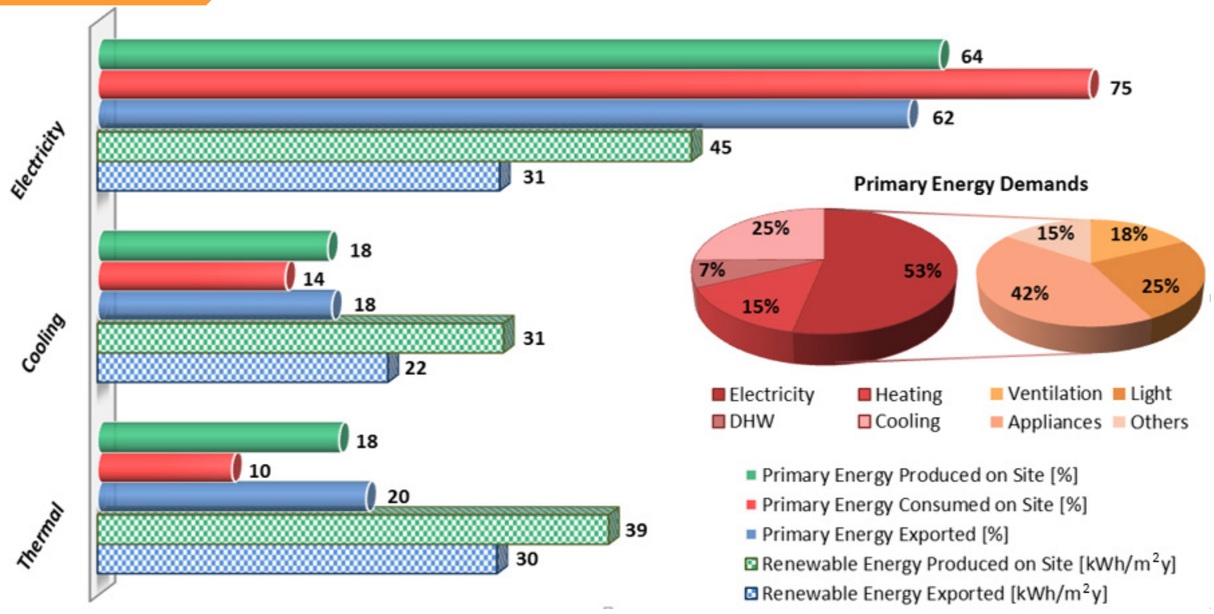

Figure 3. Annual energy analysis results.

heating only). The summer set-points for temperature and humidity are 26°C and 60% (sensible cooling and dehumidification). Occupancy rates are: offices 9 h/day, 5 d/week; expo spaces 9 h/day, 3 d/week; conference room 9 h/day, 1 d/week. Ventilation rates and internal loads are set as the standard ones for the simulated building uses.

The results of the energy analysis are shown in **Figure 3**. Here, the reported percentages are referred to the produced, consumed and exported primary energy for electricity, cooling and thermal uses, respectively. Primary energy produced and consumed on site and exported surplus are equal to 153.7, 40.9 and 108.1 kWh/m^{2}y, respectively. The heating and cooling energy demands are very low resulting almost entirely covered by solar energy production (about 90 and 93% of the energy demands for heating and cooling are balanced by renewable energy). The electricity demand (about 53% of the overall building energy one) is mainly due to ventilation, lighting (optimized by modulating the windows shadings according to the optimal visual comfort) and appliances (rather high, about 42% of the demand, according to the considered building uses). The contribution on the overall balance of renewable energies is equal to 235% (remarkably high because of the large solar field designed to supply energy also to an adjacent public building) while the imported primary energy requirement is equal to 32.0 kWh/m^{2}y. Note that according to the Italian rules (UNI TS 11300 - Italian release of EN 13790), the NZEB heating primary energy and cooling energy (not primary) demands result 1.92 kWh/m^{3}y and 9.39 kWh/m^{2}y, respectively (corresponding to the best energy efficiency classes: A+ and I).

A simplified economic analysis, referred only to the extra-costs to be considered vs. a standard NZEB configuration (fulfilling the requirements of the Italian rules for the buildings energy efficiency) was also carried out. Such overall extra-cost reaches 48.2 k€ and decreases to 1.6 k€ without PCM adoption. In this case (no PCM) the SPB period (selling the exported electricity at 0.08 €/kWh) is of about 14 years without national funding. With PCM the resulting SPB period is currently too long. ■

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Energy efficient renovation approach in Turkey: targets, barriers and practice

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Building stock in Turkey is estimated around 8.8 million buildings and this stock represents a great energy saving potential.

Considering this saving potential and the requirements of European Union (EU) directives, future targets were established in Turkey with regard to energy efficiency in buildings [1]. However, in practice, there are barriers that prevent to achieve these targets. Therefore, there is an effort on researches aimed to remove the barriers and to develop convenient strategies for energy efficient renovations in Turkey. This article summarizes the strategical targets, the barriers and practices with regard to building energy renovation.

Targets on Energy Efficient Renovations

The main related legislative tools in Turkey are Energy Efficiency Law and Building Energy Performance Regulation [2, 3]. These are enacted respectively in 2007 and 2008 in compliance with the Energy Performance of Buildings Directive (EPBD) of EU [1]. In order to guide new legislation, the recent Energy Efficiency Strategy Paper prepared by "Higher Planning Council of Turkey" was published in the Official Gazette on February 2012 [4]. This Strategy Paper involves situation analyses and strategical targets up to year 2023. It is planned to be revised in the future according to the political decisions, EU policy and encountered problems in practice. The key targets specified in Strategy Paper about energy performance requirements for buildings are summarized below.

- **"SP-02: To decrease energy demand and carbon emissions of the buildings and to promote sustainable, environment friendly buildings using renewable energy sources"**
  This strategic purpose involves, limiting the maximum energy demand and maximum CO_2 emission in buildings by revising the legislation in line with EU applications, regarding different building types and different climatic regions. By the year 2017, it is planned to apply administrative sanction for the buildings which exceed the limits of carbon dioxide emissions. Afterwards, by year 2023, the aim is to provide at least one fourth of the building stock in 2010 consists of sustainable buildings.
  Another action of this target is to encourage the use of renewable energy sources, cogeneration and micro generation, district and regional heating and cooling systems and heat pump systems in public housing projects.
- **"SP-06: To use energy effectively and efficiently in the public sector"**
  Under this strategic purpose, decreasing annual energy consumption at the rate of 10% by 2015 and 20% by 2023 is targeted for public buildings. Renovation budget of the public buildings are decided to be primarily used for the energy efficiency projects that are developed according to energy audits.

In addition, the existing legislation is planned to be revised in order to prevent public rental of the buildings that exceed the maximum allowed energy consumption level.

Another important target under this title is, to carry out energy efficient renovations by performance guaranteed Energy Performance Agreements and to give priority to the allowance proposals for this purpose.

- **"SP-07: To strengthen institutional structures, capacities and collaboration; to increase use of state of the art technology and awareness activities and to develop financial mechanisms except public"**

  In order to increase the capacities, the target is to train the related staff in both public and private sectors about the correct applications of Building Energy Performance Regulation. This strategic purpose also includes the increase in the total number of:
  - energy managers
  - energy efficiency consultancy companies
  - unique designs/products on energy efficiency and renewable energy systems based on R&D.

  Collaborating public sector, private sector and NGOs within the frame of an organized communication plan is another important action that is planned under this title in order to provide dissemination.

Setting these targets is a positive progress since a holistic approach is adopted by including limits for energy consumption, requirements for efficiency in public buildings as promotive samples and activities for raising awareness and dissemination in Turkey. However, in order to achieve these targets, new legislation arrangements and revisions for the existing legislation are required. In addition, remarkable concrete steps are needed to be taken in overcoming the barriers against the energy efficient renovations.

Barriers and Practices

In Turkey, there are several barriers against energy efficient renovation of the building stock such as; technological barriers, barriers based on insufficient funding, barriers related to climatic conditions, sociological barriers and legislative barriers. Samples of the important barriers in Turkey are explained below.

One of the important barriers is directly related to the existing policy and climate. The mandatory heat insulation standard, TS825, involves four different heating degree day regions as shown in **Figure 1** and defines the maximum limits of overall heat transfer coefficients according to these regions [5]. However, as a consequence of being a Mediterranean country, in Turkey there are five climatic regions as shown in **Figure 2**: tempered humid, tempered dry, hot-humid, hot-dry and cold climatic regions. Differently from the cold regions, buildings in hot climatic regions need specific measures mainly for

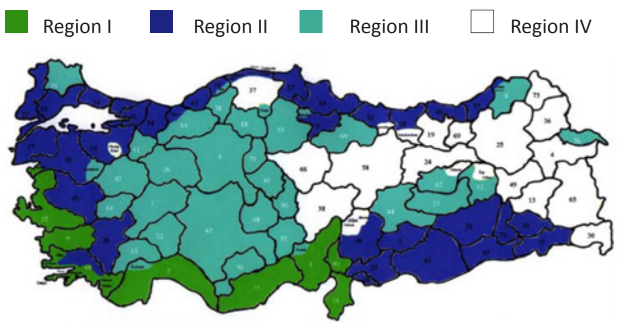

Figure 1. Heating degree day regions of Turkey.

Figure 2. Climatic regions of Turkey.

decreasing high cooling energy demand in order to provide reduction in total annual energy demand. Therefore, the national heat insulation standard based on heating degree days is not able to accurately represent the specific requirements of these climatic regions.

The climatic diversity is a challenge that is faced in Mediterranean countries and requires different strategies for each climatic region. The national legislation has to consider and reflect these strategies as well. Therefore, developing energy efficiency strategies in Turkey is more complicated than northern countries and this procedure requires more consideration than application of the heat insulation standard. For example, **Figure 3** displays the energy simulation results of the same residential building assumed as constructed in different climatic regions of Turkey. In each case, it is assumed that, overall heat transfer coefficients of the building envelope components are equal to the maximum limits allowed by the heat insulation standard for the related city. All other parameters are same for three cases. As seen from the graph, in hot-humid climate (Antalya) cooling energy consumption is the dominant while in cold climate heating energy consumption is extremely high.

Another important barrier in Turkey is the uniformity of the legal boundary climatic design conditions for the buildings with different functions. The different building types require different design strategies since their behaviors are significantly affected by the internal heat gains. In example, considering the mild climatic region of Turkey, energy needs for cooling and lighting are dominant in commercial buildings while heating energy needs are remarkable in residential buildings.

There are also some barriers related to financial issues. The recent EU Directive, EPBD Recast, is one of the main binding legislation forcing energy efficient renovations in buildings and this directive requires to set energy performance requirements for buildings "with a view to achieving cost-optimal levels". In accordance with the cost optimal methodology framework provided by EPBD Recast and related EU Regulation, global costs of the energy efficiency measures/packages have to be calculated for long term periods [1, 6]. The measures which result with benefits in both energy performances and global costs represent the cost optimal level. However, the investment costs of these measures are not always affordable for the investors because of their expensiveness and long payback periods. In order to overcome this

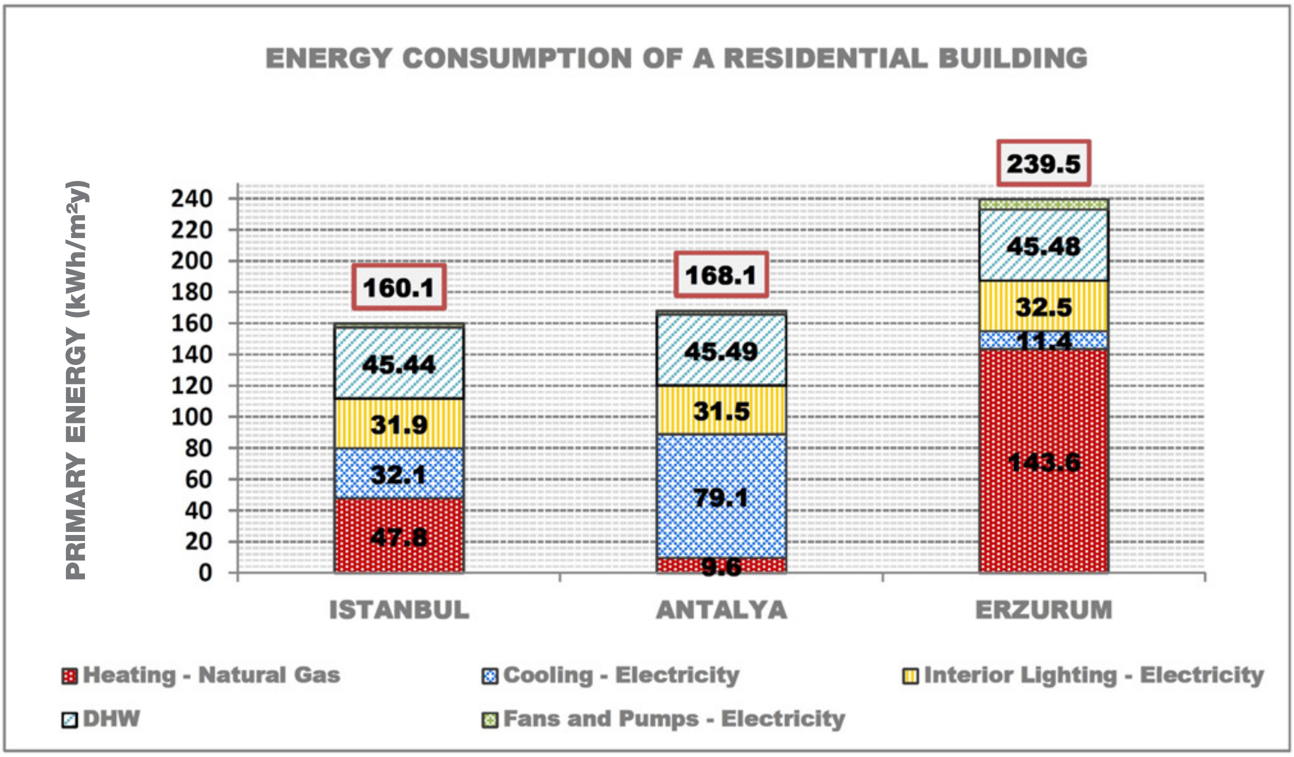

Figure 3. Sample calculation results for the same building in different climatic regions of Turkey.

barrier, subsidies and incentives are required for the cost optimal solutions.

In fact, there are some loan opportunities for the heat insulation, windows, efficient heating system, efficient appliances, efficient lighting and solar water heaters in residential buildings. These loans are provided by TuREEFF (Turkish Residential Energy Efficiency Financing Facility), with support of the EBRD (European Bank of Reconstruction and Development) and CTF (Clean Technology Fund) [7]. This loan program involves $350 million for energy efficiency investments in residential buildings. It is expected to support also future strategical targets by this funding program in the following years. However, today still the common practice in residential building renovations is limited with heat insulation and individual window changes. In addition, the urban transformation projects in Turkey are mainly focused on demolishing and reconstructing instead of renovation.

In Turkey, a legal basis requiring energy efficient renovations is not yet brought in. However, there are researches focusing on national applications of cost optimal methodology framework of EPBD Recast, and on specific deep energy renovation strategies and also on developing the ecological standards for the urban transformation [8, 9]. Although one of the researches on ecological standards for the urban transformation is conducted under the Ministry of Environment and Urbanization; mostly, these researches are conducted with individual efforts and not connected with each other or not coordinated by legal authorities in order to guide laws and regulations. But the outcomes of these researches are needed to be linked with legal arrangements to make the effort valuable.

Conclusion

In Turkey, there is an intension in energy efficient renovation of existing buildings. The actions are mostly individual attempts and are mainly limited with heat insulation applications on the facade. However, in order to manage the whole energy saving potential with a holistic approach, a new legal basis is required. While existing regulation and standards are being revised, barriers also have to be considered.

Academic studies are also focused on existing building renovations. But, a high level coordination is required between these studies in order to provide corporation and coherence and to benefit from their common results. ■

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ISH CHINA CIHE

30 May – 1 June 2016, Beijing, China

ISH China & CIHE, Asia's largest exhibition for HVAC, plumbing and home comfort system, will be held at the New China International Exhibition Center in Beijing from 30 May – 1 June 2016. Organised by Messe Frankfurt (Shanghai) Co Ltd and Beijing B&D Tiger Exhibition Co Ltd, the three-day event spans over 95,000 m^2 across 8 halls. The 2015 edition gathered 1,119 exhibitors from 21 countries and regions, and attracted 46,836 visitors from 50 countries and regions, a 13.6% growth over the previous year. With the support of government and industry associations, country and regional pavilions that participated in 2015 were from Germany, Italy, Turkey and the Zhejiang province of China. Celebrating its 20th anniversary, the 2016 show will feature a series of concurrent events including "China International HVAC Congress", focusing on renewable energies, intelligent HVAC technologies, ventilation and heat pump technologies.

For more information: www.ishc-cihe.com

light+building

13-18 March 2016, Germany

The world's leading trade fair for lighting and building services technology

About 2,500 exhibitors take part in Light + Building at Frankfurt Fair and Exhibition Centre and almost one in two of the over 210,000 visitors come from outside Germany. The most important visitor target groups are architects, interior architects, designers, planners, engineers, artisans, the distributive trades and industry.

Every two years, the industry presents its latest innovations for the fields of lighting, electrical engineering, house and building automation and software for the construction industry at the world's leading trade fair for architecture and technology. The main theme at Light + Building is energy efficiency.

Light + Building is the world's biggest trade fair for lighting and building-services technology and presents solutions that cut the energy consumption of a building at the same time as increasing the level of comfort. At the fair, everything is represented, from LED technology, via photovoltaic and electromobility, to intelligent electricity usages with smart metering and smart grids. Thanks to the combination of lighting and networked building-services technology, the companies can present an integrated spectrum of products and services that make a decisive contribution to exploiting the energy-saving potential of buildings to the full.

Light + Building product segments

As the world's only trade fair to combine the fields of architecture and technology, Light + Building presents the key sectors for integrated building planning at the same time and place:

- Lighting
- Electrical engineering
- Home and building automation

For more information:
http://light-building.messefrankfurt.com/frankfurt/en/besucher/willkommen.html

Conference programme now available!

24 – 26 February 2016, Austria

World Sustainable Energy Days

Sustainable buildings on focus

As one of Europe's largest annual conferences on energy efficiency and renewable energy, the WORLD SUSTAINABLE ENERGY DAYS (WSED) have grown over the past 20 years into a global meeting place for the sustainable buildings community. Each year, the unique combination of events attracts experts from all over the world to Wels.

6 specialised conferences offer the opportunity to learn about current trends in sustainable buildings. Interactive events provide valuable networking possibilities. In 2015, 750 energy experts from 65 countries took part in the World Sustainable Energy Days. The next edition will be held from 24 – 26 February 2016 in Wels/Austria.

6 specialised conferences:

- European Pellet Conference
- European Nearly Zero Energy Buildings Conference
- Young Researchers Conference: Biomass + Energy Efficiency
- European Energy Efficiency Watch Conference
- Energy Efficiency Services Conference
- Smart Facade Materials Conference

3 hands-on events:

- Major energy tradeshow
- Technical site visits
- Cooperation platform

The **European Nearly Zero Energy Building Conference** is dedicated to very high efficiency buildings supplied to a large extent by renewable energy. Europe will see a strong increase in the number of NZEBs in the coming years: according to EU directives, all new buildings must reach NZEB standard by 2020.

Experts from all over the world come together at the European NZEB Conference to discuss innovative concepts and present solutions for efficient building technologies and renewable energy. The conference provides information on technologies and strategies, focuses on costs and innovative financing and operational models and presents flagship projects in the areas of new construction and retrofitting.

The **European Pellet Conference**, with more than 600 participants every year, has become the largest annual pellet event in the world. The conference is the meeting place for the global pellet community and delivers the latest news about markets, technologies and policies.

Mark your calendars for 24-26 February 2016 and join experts in Wels/Upper Austria at the **World Sustainable Energy Days**. For more information, visit the conference website www.wsed.at.

Registration & more information: Conference-website www.wsed.at and OÖ Energiesparverband, Landstrasse 45, 4020 3Linz, T: +43-732-7720-14386, office@esv.or.at, www.esv.or.at

LAND OBERÖSTERREICH

World Sustainable Energy Days 2016

OÖENERGIESPARVERBAND


Seminar participants.

Highlights from REHVA Supporters' Seminar 2015

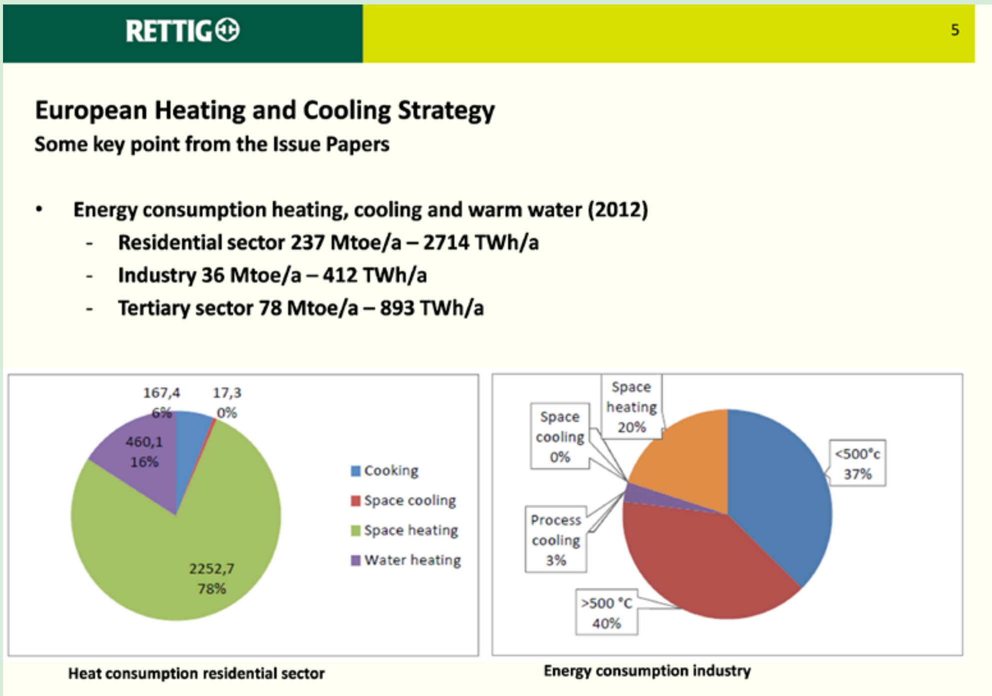
This year, REHVA Supporters Seminar was hold in Brussels in October 6, 2015. The seminar focused on EPBD and Ecodesign driven regulation. The first main theme was dedicated to EPBD review and its public consultation – the seminar discussed REHVA and EVIA positions on EPBD review as the EPBD public consultation closed at the end of October.

Summarized by JAREK KURNITSKI, REHVA Vice-President

The second main theme discussed was Ecodesign product groups' regulation status, and more specifically brought the attention to the situation of requirements related measurement and calculation methods, which form a complicated mix of Ecodesign regulations, European product and system standards and third party certification test methods represented by Eurovent. In the following, some highlights of the seminar are reported.

Panelists: Mikko Ivonen, Lars Nielsen, Stefano Corgnati, Jarek Kurnitski & Jaap Hogeling.

Mikko Iivonen from Rettig, representing also European Heating Industry EHI inform us about EU heating and cooling strategy role in the EPBD review. It is important that heating and cooling of buildings is recognized as an own sector. This allows understanding that the volumes are actually huge and making relevant comparisons with other sectors when looking for energy performance improvements.



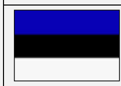
Jarek Kurnitski, REHVA Vice-President discussed an open nZEB issues and problems in national applications which could be solved through the EPBD review process. To make national applications more comparable MS should account the same energy uses. System boundaries and RES inclusion also need harmonization to be transparent, and building categories should follow EPBD Annex I list instead of residential and non-residential division to be meaningful for design choices.

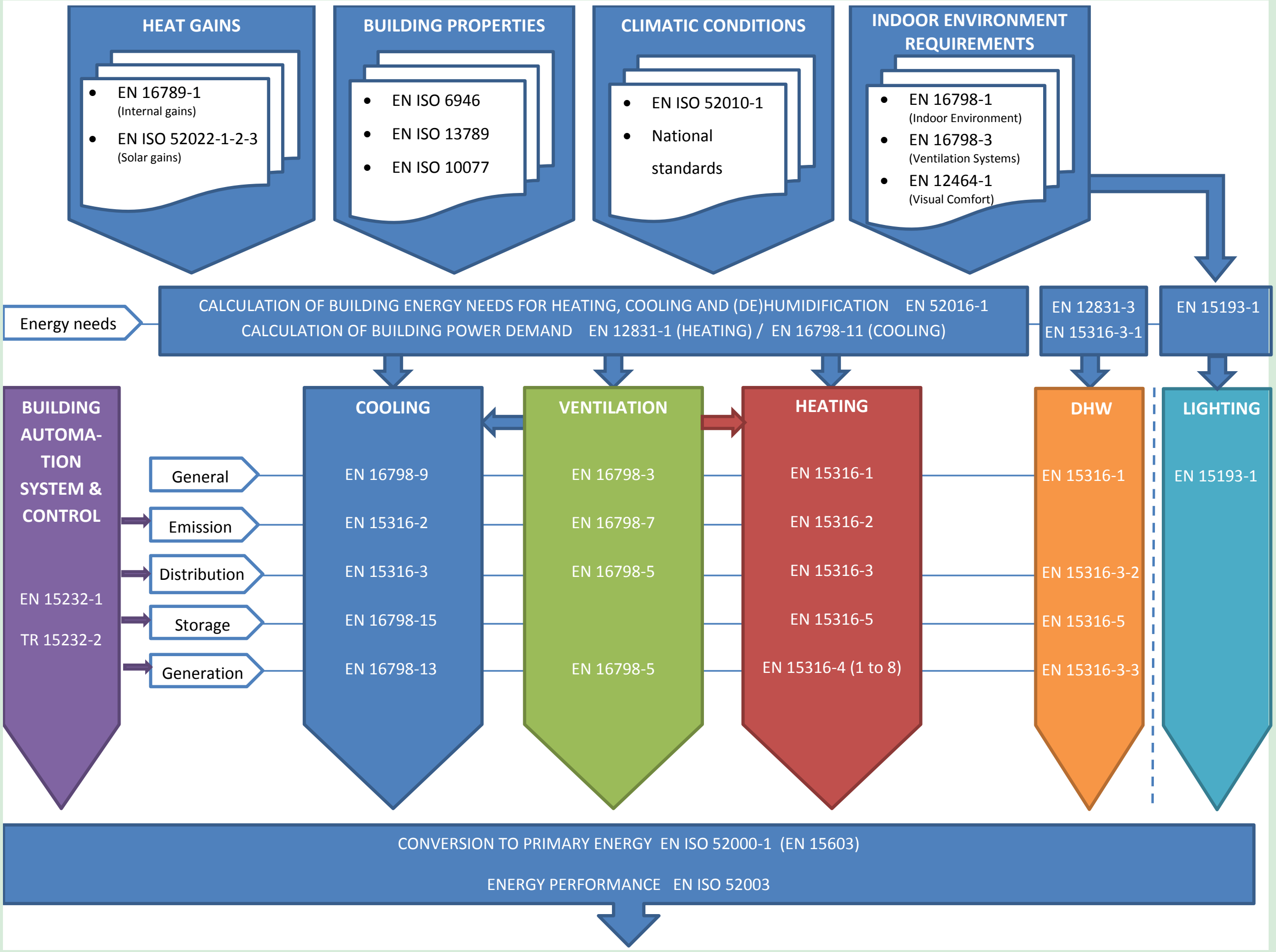
nZEB Task Force latest buildings (5-8 in the Table)

DSK-II school, Haarlem, the Netherlands	
 Construction year 2014 3 900 m² Extra nZEB cost 250 €/m² estimated	
General description	Primary school with zero energy consumption, meaning the total amount of energy used for the building itself on an annual basis is roughly equal to the amount of renewable energy produced on site.
Energy performance	**Net-zero energy building** without accounting small power equipment loads, achieved with large on-site PV, heat pumps and energy wells.

Väla Gård office building, Sweden	
 Construction year 2013 1 750 m² Extra nZEB cost 230 €/m² estimated	
General description	Skanska office in Helsingborg. A nZEB office building, energy consumption is nearly zero or plus including tenant power over the year. LEED certified Platinum.
Energy performance	**Net zero energy building** (small power equipment loads accounted) or **plus energy building** w/o small power, achieved with extensive on-site PV, ground source heat pump and boreholes.

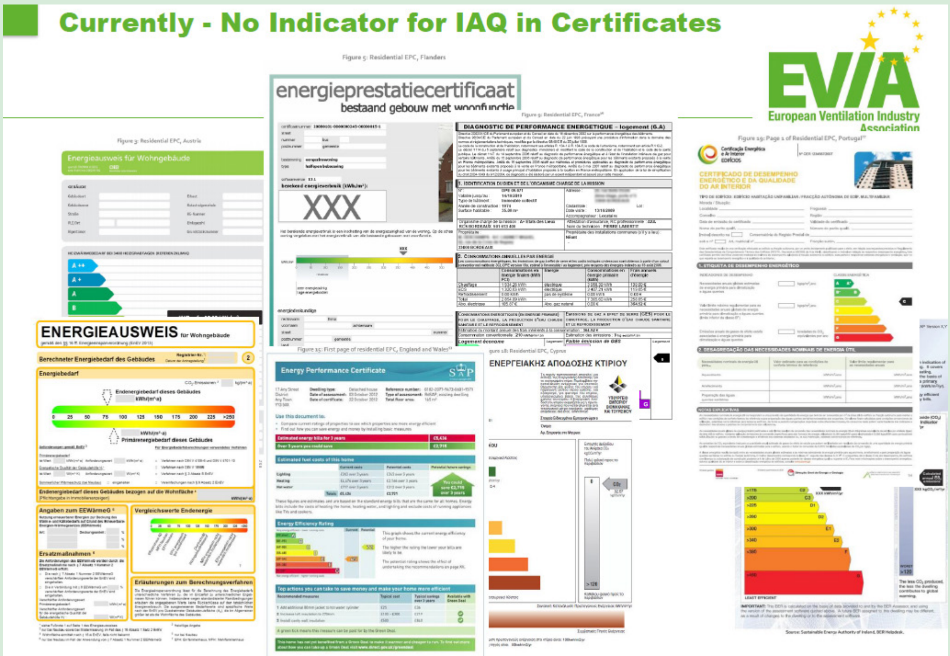
Entré Lindhagen office building, Sweden	
 Construction year 2014 65 000 m² Extra nZEB cost 55 €/m² estimated (w/o wind farm investment)	
General description	Skanska head office, Nordea office nZEB building, energy consumption 55 % less than code requirement, building demonstrates low speed ventilation and Skanska Deep Green Cooling, a ground cooling system without heat pump or chiller. Triple Leed Platinum. For core and shell, for Skanska interior design, for Nordea interior design.
Energy performance	**Net-zero energy building** (small power equipment loads accounted) without accounting district heat, achieved with nearby wind farm, district heating and boreholes. **Nearly zero energy building** if the share of wind farm is not accounted.

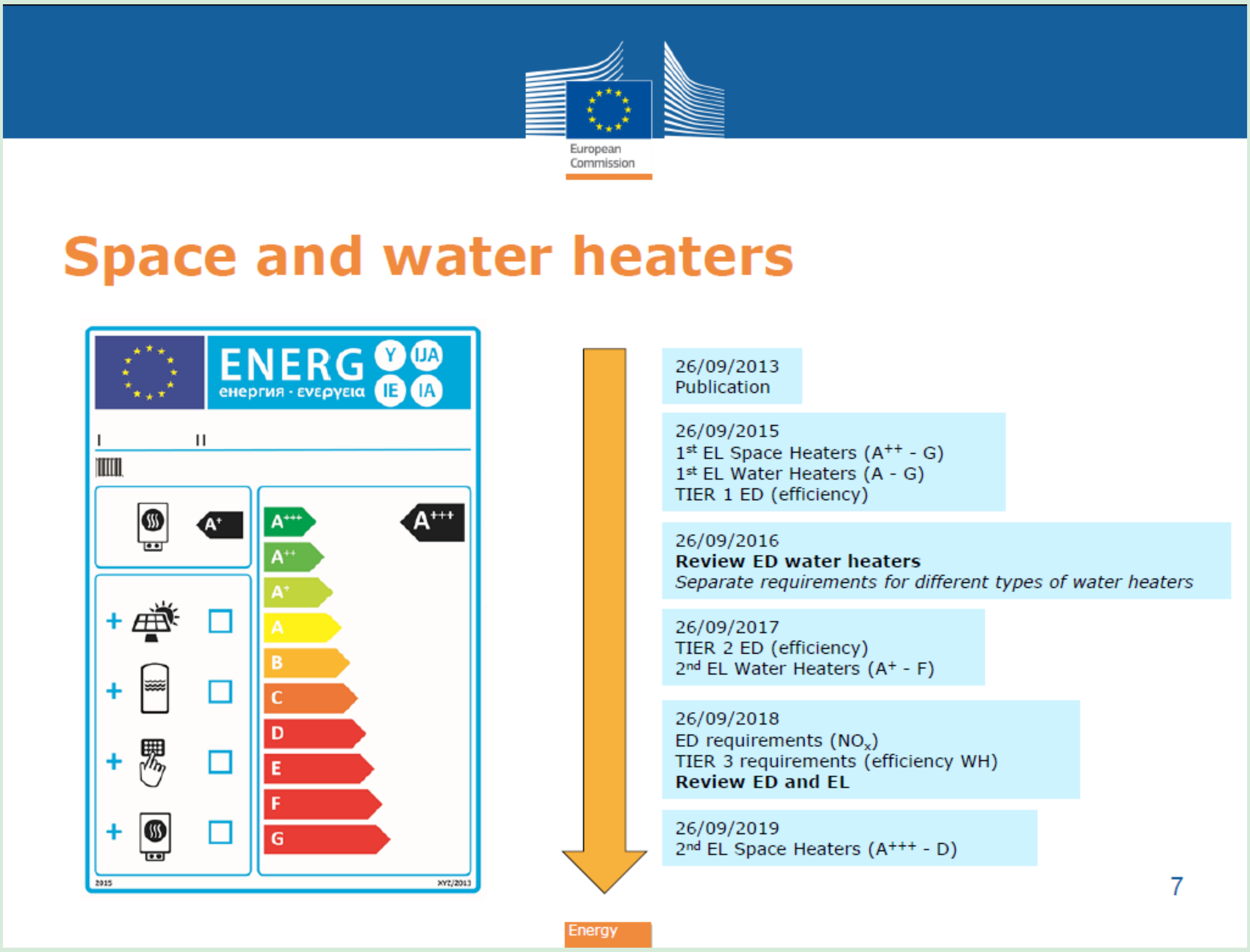
Rakvere Smart Building Competence Centre office building, Estonia	
 Construction year 2014-2015 2 170 m² Extra nZEB cost 200-300 €/m² estimated	
General description	Estonian first nZEB office building, primary energy consumption 60 % less than code requirement, building demonstrates smart building automation systems.
Energy performance	**Nearly zero energy building** (small power equipment loads accounted), achieved with on-site PV, district heating and energy wells.



Jaap Hogeling, Chair CENTC 371 Program Committee on EPBD reported the status of EPB-standards, including the framework of the revised Overarching Standard. During 2015, the enquiries for most of the draft EPB-standards should be closed and by the end of 2016 all EPB-standards are expected to be published as EN or EN-ISO standards.

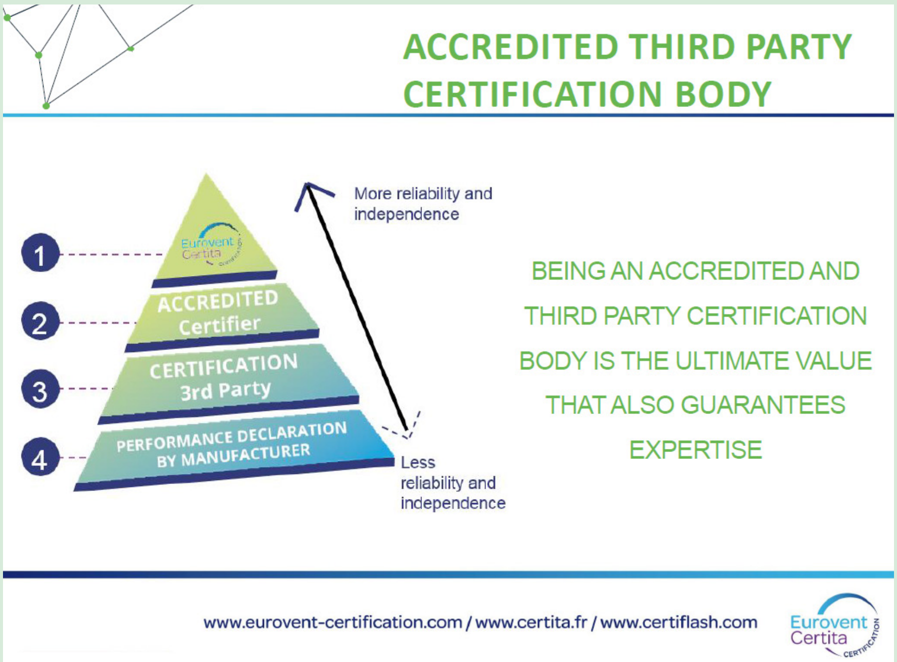
Claus Händel, EVIA Technical Secretary pointed out that currently any EPC certificate has no indicator for IAQ and proposed that new article of minimum indoor air quality requirements has to be set up. Evidently, nZEB as well as deeply renovated buildings will need dedicated ventilation systems, otherwise air change will stop because of well-sealed envelopes.





Robert Nuij, Head of sector, DG Energy provided an overview of Ecodesign: 2015-2017 Work Plan and latest developments concerning HVAC products. Measures under development and new measures under study consider for instance air heating products, commercial refrigeration, compressors, heating and lighting controls etc.

Erick Melquiond from Eurovent Certification discussed the compatibility of Ecodesign regulation with CEN standards and EUROVENT testing. Because of parallel development of the regulation and EPBD standards there exists some conflicts, and Ecodesign rating conditions do not always represent common operational conditions which are better addressed by EPBD standards. However, it takes time for testing methods to follow the development of standards, third party certification provides the best available benchmarks.



Conference participants.

ABOK 25th anniversary

On 29 October 2015, ABOK celebrated their 25th anniversary in the JAR Theater in Moscow.

It was a remarkable evening with congratulations of many good friends, industrial members and other organizations. Jan Aufderheijde, Secretary General, represented REHVA, the European Federation of National HVAC Societies. In his small speech he informed the audience, that it is a milestone in two ways. We not only celebrate 25 years of ABOK, but 25 years of REHVA membership as well. At that time prof. Branko Todorovic was REHVA's president. He and his wife Marija attended this evening also.

Jan Aufderheijde congratulated on behalf of REHVA, ABOK's president prof. Yuri Tabunschikov and vice president prof. Marianna Brodach with ABOK's anniversary.

In particular, he thanked Marianna for all the work she did for REHVA. He stressed Marianna's never weakened activities for REHVA, her contributions to REHVA journal, her translation work of 12 000 English terms into Russian in the REHVA Dictionary, the translation of REHVA Guidebook on Displacement Ventilation and her networking for REHVA. All these contributions are impressive he said. As many other representatives did, Jan Aufderheijde handed over to Yuri and Marianna, a Certificate of Merit, to stress the good relation between ABOK and REHVA, but he did more. He also handed over a tray (a replica of the famous Dutch painter Johannes Vermeer, 'The girl with a pearl earring') with 2 espresso cups and a tin with Dutch 'stroopwafels', and wishes Marianna in near future a moment of reflection to enjoy a cup of coffee with a stroopwafel together with Yuri to remember this wonderful night and REHVA. ■

Jan Aufderheijde (l), REHVA Secretary General , Marianna Brodatch, Abok Vice President Prof. Yuri Tabunschikov , Abok President, Marija Todorovic and Branko Todorovic (r), SMEITS President.

Prof. Yuri Tabunschikov (l), Abok President, Jan Aufderheijde, REHVA Secretary General and Marianna Brodatch(r), Abok Vice President.

15 – 18 March 2016, Milano, Italy

Let the countdown for MCE – MOSTRA CONVEGNO EXPOCOMFORT begin

The international benchmark exhibition for all professionals in the sector to be held from 15th to 18th March 2016 at Fiera Milano.

Milan – November 2015 – Preparations are in full swing for MCE, the world's leading biennial exhibition dedicated to residential and industrial installations, air-conditioning and renewable energy scheduled for 15th – 18th March 2016 at Fiera Milano, that will once again act as an international platform to bring together even more visitors and exhibitors from around the world. The strength of MCE – MOSTRA CONVEGNO EXPOCOMFORT is in its consolidated international outlook supported by the outstanding results achieved at MCE 2014: 2,039 exhibiting companies, 871 of whom were from abroad, 155,987 trade professionals, 36,311 of whom made their way to the show from 146 countries, who filled the aisles of Fiera Milano throughout the four-day exhibition.

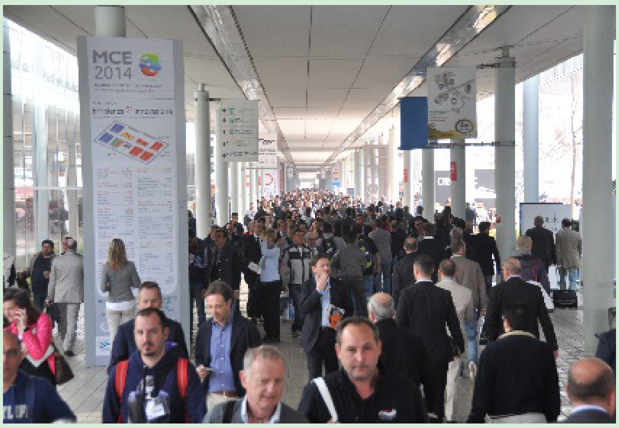
In this context, with four months to go before MCE 2016 takes place, the exhibition grounds dedicated to air-conditioning, refrigeration, hardware are almost fully booked, as well as the display areas dedicated to heating, water treatment, sanitary technology, tools and renewable energy have recorded high numbers.

The major industry sector represented on MCE floor is one of the most dynamic in the world and increasingly strategic in the International and European economic scenarios, characterised over the last years by investments in innovative integrated technologies offering ground-breaking products, systems, and solutions to better improve energy performance of buildings, as well as thermal comfort to facilitate comfortable interior living conditions. Buildings construction today is not just about optimizing energy performance by reducing energy consumption, but also using technologies with integrated functionality, control and management tools. A high integration between building envelope and installation-technology, and buildings and cities is required to create a new vision of building and living. Energy efficiency to protect and preserve the environment, and natural resource wealth at our disposal.

MCE 2016, as usual, will offer a busy programme of conferences, workshops and special events that will integrate synergistically with a wide exhibition area. A unique opportunity for skills training and updating aimed at professionals involved in the designing and management of residential, commercial and industrial buildings such as: engineers, architects, designers, planners, maintenance technicians, and energy managers.

At MCE 2016 THAT'S SMART is back, an event featuring the latest ground breaking systems and products dedicated to Home & Building Automation, Smart metering, Electric Mobility and Renewable electricity, all essential elements to highlight the importance of high grade integration between building envelope and installation-technology and optimise the global energy performance providing interconnection between neighbourhood, city and territory.

All the latest updates on MCE – MOSTRA CONVEGNO EXPOCOMFORT 2016 are available on-line at: www.mcexpocomfort.it, a new and restyled website, constantly providing visitors and exhibitors with a full panorama of news about MCE, as well as industry's latest breaking news, exhibiting company's products, full conference programme, and the new features in store for this year's edition.



FINVAC seminar on energy efficiency of buildings

FINVAC* seminar on energy efficiency of buildings in last October attracted over 500 top experts in Finland.

– OLLI SEPPÄNEN, FINVAC president

The audience was a combination of business and public sector people. The focus of the seminar was not only in technology but also in business: how to make business with energy efficiency. The seminar was organised in cooperation with several Finnish professional organisations and building owners association.

The main speech in the seminar was delivered by the Finnish Minister of the Environment (in charge also of housing and building construction). He stressed the importance of the construction sector in the Finnish environmental policy, and predicted increase in the energy related activities.

FINVAC had also invited two speakers from middle Europe, Ms Heike Erhorn from Fraunhofer Institute of Building Physics, Germany and Professor Francis Allard, from University of LaRochelle, France. Ms Erhorn made an excellent overview on Energy renovations in Germany, focusing especially on the question "what Finland can learn from German experiences". Professor Allard focused in the seminar on the "Innovative methods to encourage energy efficiency in France". Both presentations were extremely useful to the Finnish audience. They helped the participants open their minds to new ideas and way of thinking.

Interesting technical presentations were made by the Professors Kai Siren, Matti Lehtonen and Raimo Lovio from Aalto University, discussing with optimisation of energy efficiency measures, balancing the supply and demand of electricity and opportunities of local energy systems with use of heat pumps, biomass and generation of electricity. Successful business cases were presented by contracting company Are, consulting company Granlund Oy, computer software company Equa Simulation Finland, Helsinki Energy Company, steel construction manufacturer Ruukki, and heating system supplier Uponor.

FINVAC Building energy seminar attracted over 500 participants in October.

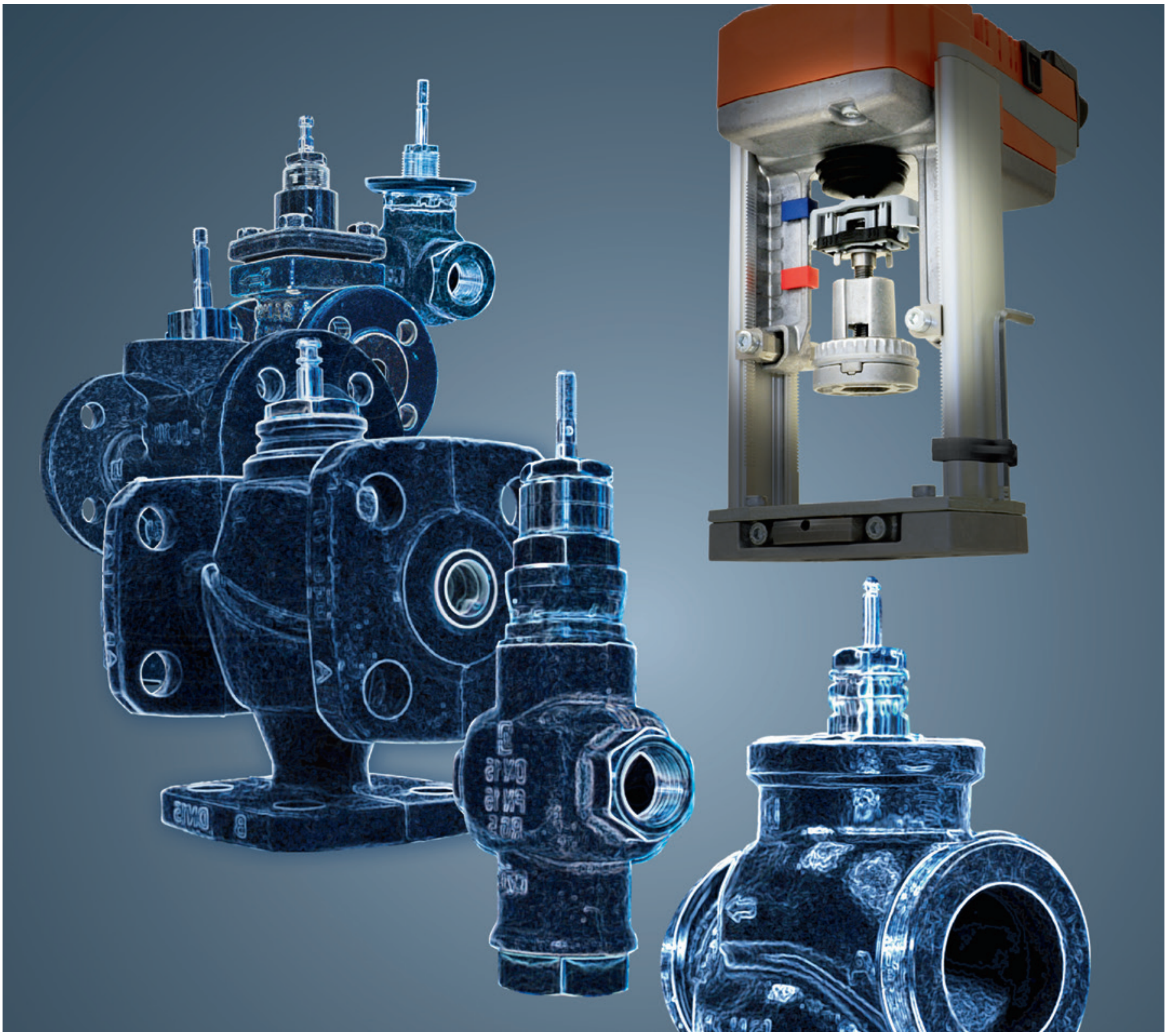
An exhibition with close to fifty companies was organised in connection of the seminar. Several REHVA supporters participated like Belimo, FläktWoods, Granlund, Grundfos, Halton, Rettig, Somfy, Swegon, Systemair, Uponor.

The seminar was very well received by the participants. Due to great success of the seminar the board of FINVAC decided to organize the next seminar on **September 20th, 2016** in the Finlandia Hall (the same hall where Clima 2007 opening ceremony took place). Over 1 000 experts are expected to participate.

Ms Heike Erhorn made a presentation on "What Finland can learn from German experiences in energy renovations".

Professor Francis Allard (former president of REHVA) made a presentation on "Innovative methods to encourage energy efficiency in France".

*FINVAC is the Finnish member of REHVA, representing over 5 000 HVAC professionals in Finland. Its president is Professor Olli Seppänen and secretary general Ms Siru Lönnqvist.



BELIMO

Product news

Smart universal retrofit concept from Belimo

The perfect choice for almost any globe valve

Replacing actuators on globe valves has just become as a whole lot easier, quicker and more efficient. And it's all thanks to the new retrofit globe valve actuators from Belimo. Featuring customisable parameters and equipped with a universal valve neck and stem adapter, they can be installed quickly and easily on virtually all the valves currently available from manufacturers worldwide.

As HVAC units start to age, installers and maintenance service companies see the prospect of more and more business developing in the form of replacing and retrofitting older globe valves. Sourcing the right actuators, however – and the adapters and brackets that go with them – is often a laborious, time-consuming process. Keeping equipment and accessories in stock for every valve brand and model range is virtually impossible, not to mention costly, and the result is that many jobs can be subject to significant delays – a frustrating situation for the customer and the service provider alike.

Lower costs, faster service

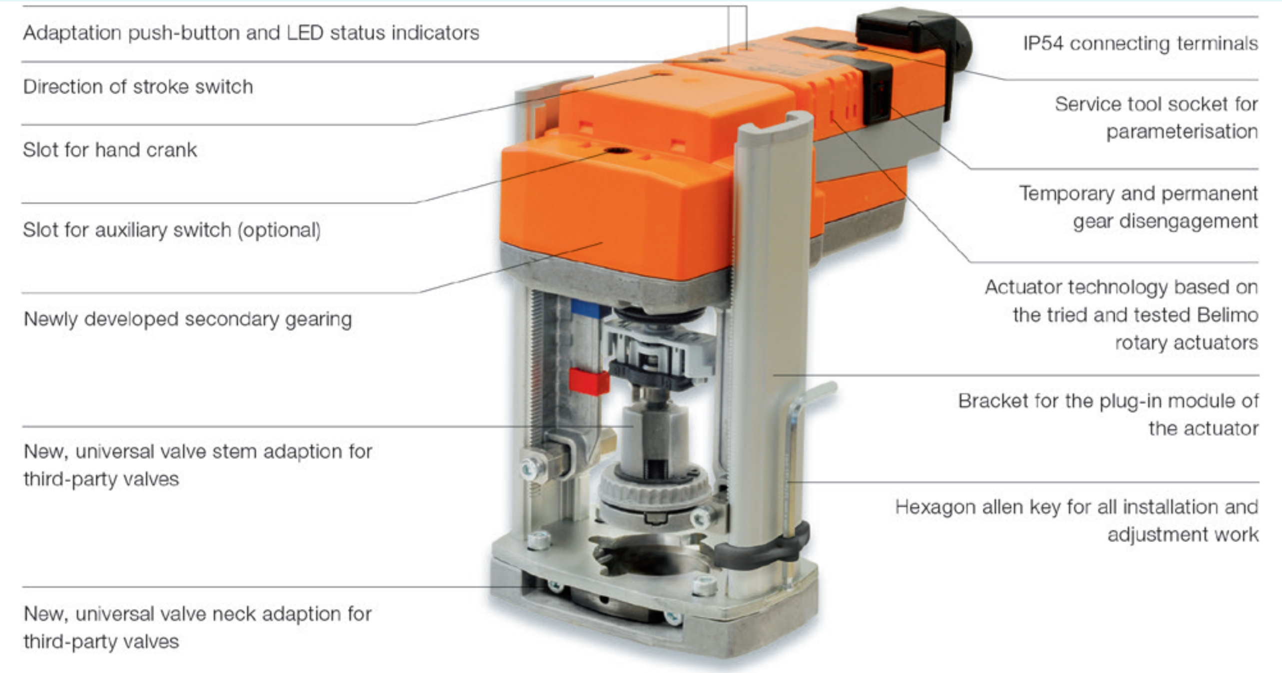
Now, the new generation of Belimo retrofit globe valve actuators has made this problem a thing of the past in virtually every scenario. The MP and MF types can be adjusted to suit the valves in question using the practical PC-Tool or the handy ZTH EU service tool, working in your own workshop or at the unit location itself. As a result, you only need a few basic types to ensure that your service staff always have the right equipment type on hand when they need it.

Thanks to the pre-assembled universal valve neck and stem adapters, the days of hunting for the right adapter are gone. Not only that, but the smart concept also makes installation a breeze. Installing the new Belimo actuators on an existing globe valve takes no time at all, and all you need is a hexagon socket screw key: simply fix the adapter plate on the valve neck, align the valve stem adapter and fasten it, and screw on the universal bracket. Then push the actuator into the bracket, tighten the screws and attach the valve stem. The self-adjusting function will then do all the other commissioning work for you.

Better performance, outstanding quality

The Belimo retrofit globe valve actuators are available in performance classes from 1 000 to 4 500 N and with stroke lengths of 20, 32 and 50 mm. In addition to the standard types, there are also bus-compatible (MP) models available for easy integration into higher-level systems. The technology and operating concept are of the same standard as those found in the rotary actuators produced by this world-leading manufacturer, which have proven themselves millions of times over. This ensures the equipment can deliver the very best performance, as well as outstanding quality that comes with a 5-year warranty.

More information: www.belimo.eu

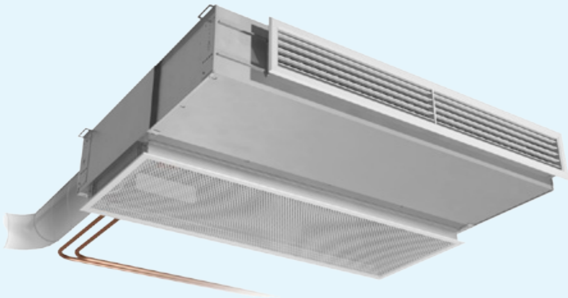


The smart universal concept for replacing and retrofitting older globe valves.

Product news

Great savings with the new generation PARAGON

Besides friendly staff and great location, one of the top priorities of hotel guests is a comfortable room climate – requiring perfect supply of fresh air, the right air temperature and low noise level. As a solution to all these requirements, Swegon has created the PARAGON comfort module, providing the perfect indoor climate in a highly energy efficient way. The solution has proven itself in hotel rooms, as well as nursing homes and hospital rooms, since year 2009 with over 13 000 units installed.



The secret behind the PARAGON is to use the air pressure from a centrally placed air handling unit, together with small nozzles inside PARAGON, to create an induction effect, distributing the air along the ceiling. This results in a highly efficient mix of fresh air and room air, which together with a waterborne heat exchanger make sure the room is well ventilated at the right temperature, by adding heating or cooling according to demand. With the PARAGON solution, there are no noisy fans, condensation problems or cold draught in the room.

Now the new generation of PARAGON is here, with a unique Compact Change Over-valve integrated in the unit, increasing each unit's cooling capacity about 20%, and the heating capacity about 60%.

Product Manager Jonas Åkesson sees a great potential in the new product generation; "The gain in capacity can be used in several ways, one is to adjust the cooling and heating water temperatures, allowing for a more economical operating mode of the heat pump or chiller. For a typical heat pump, this may convert into an electrical energy saving of about 25%."

Jonas Åkesson also points out the advantages from a building process perspective; "PARAGON's increased capacity makes product dimensioning easier and provides a more robust system design, without any compromises concerning the indoor climate. In the end this makes PARAGON a crucial factor for hotel guest satisfaction and retention."

Zehnder ComfoSpot 50 – new decentralised domestic ventilation unit with enthalpy exchanger

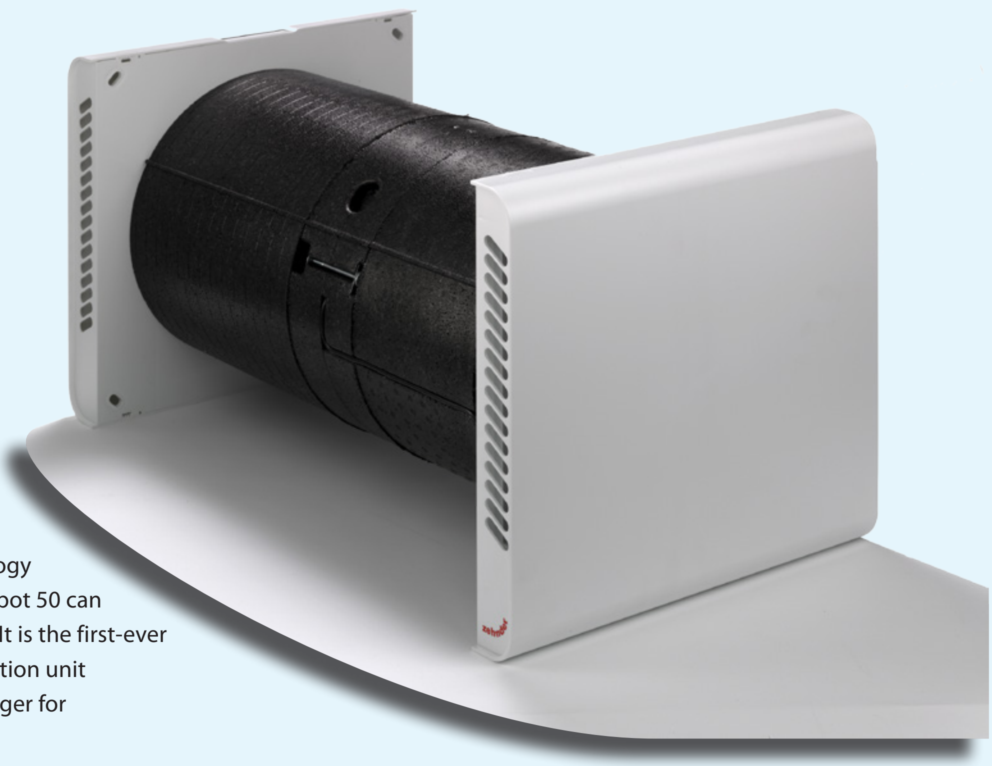
Indoor climate specialist Zehnder launched ComfoSpot 50, a new decentralised comfort ventilation unit that can be fitted with minimal installation work, even in small living spaces, and allows the customer to benefit from comfortable indoor ventilation with humidity recovery. Zehnder ComfoSpot 50 is therefore a one-of-a-kind innovation in its field. Thanks to its compact dimensions, the ventilation unit is not only a highly practical solution for refurbishments, but can also be easily incorporated into plans for new construction projects.

The powerful enthalpy exchanger is unique for this type of unit and allows up to 82% heat recovery and 78% humidity recovery. It is extremely efficient at preventing the air in the room from getting too dry and also prevents condensate from forming. There is absolutely no accumulation of condensate which could drip on the façade, and that there is no need to remove condensate from the unit. The unit can therefore be mounted outwards without an incline, which makes installation much easier. Fully operational up to -5°C, Zehnder ComfoSpot is operated with frost protection in temperature ranges between -5°C and -15°C, which prevents it from freezing over.

The decentralised ventilation unit Zehnder ComfoSpot 50 can move air at volumes of up to 55 m^3/h and works extremely quietly as well: at a distance of three metres, the noise generated by the unit with a transported air volume of 30 m^3/h is only approx. 25 dB (A), which means a sound pressure level below an audible level.

The new decentralised ventilation unit Zehnder ComfoSpot 50 provides the ideal solution for a price-sensitive, energy-efficient supply of fresh air for small living spaces, highly practical for refurbishments, and is the first of its kind to include humidity recovery.

More information: www.zehnder-systems.com



Apart from the two discreet wall panels (which can be painted over), all the technology required by Zehnder ComfoSpot 50 can simply be hidden in the wall. It is the first-ever decentralised comfort ventilation unit with built-in enthalpy exchanger for heat and humidity recovery.

VPF solution by RHOSS: the new plant engineering breakthrough

Refrigeration systems with variable flow hydronic circuit (VPF: Variable Primary Flow), ideal for medium to large cooling capacities, represent an interesting alternative to the more traditional systems with a constant flow.

The solutions designed by Rhoss, in fact offer benefits, such as reduced energy consumption of the pumping units with a consequent saving in costs, combined with reliability and simplified control of the system.

Using these systems contributes significantly to achieving greater credits in the LEED certification of buildings.

The Rhoss VPF solution can be summarised as follows:

The primary/secondary variable system is introduced. The pump or double pump of the primary circuit is inverter-controlled for the flow to be adjusted and thereby reduce the pumping power [P= f (Q3)].

The inverter pump/pumps to control the secondary one are provided by the customer. In this case, RHOSS will control them therefore; there will be no limitations in their use.

The tests of the VPF solution in the Rhoss Research & Development R&D Lab, whichever the solution may be, have proven that the amount of water is important in order to stabilise the operation and reduce the ON/OFF functions of the cooling unit. A primary side external tank (TANK) is recommended, connected to the unit, with a minimum volume of 5 l/kW or less if the Tank&Pump inside the unit is used.

The probe for measuring the ΔP (information required to adjust the inverter pumps) is provided and positioned by the user in the hydraulic circuit.

It is recommended to use 2-way "V2" valves for the terminals and a minimum number of 3-way "V3" valves to guarantee a 20% minimum flow when the terminals are closed.

Advantages of the RHOSS VPF solution:

1) A stable and functioning solution to adjust the system
2) Energetically convenient solution with actual pumping energy savings
3) Safe solution for the chiller
4) Validated solution even with multiple chillers connected in parallel

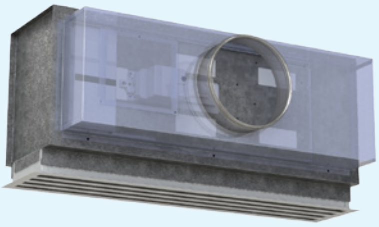
More information: http://www.rhoss.com/

VPF solution by RHOSS: the value of the energy savings.

Vario E System Halton

Requirements imposed on buildings are getting more and more restrictive. Buildings have to be cheaper (investment- and maintenance-wise), more energy efficient, more flexible, allow the tenant to arrange the interior in any way he wishes, and his office to be prepared as fast as possible. Needless to say, tenants will chose the best option they can find.

BuroHaphold, with its office in Warsaw, offers HALTON Vario E System. It allows for saving energy by cutting off fresh air supply in places where it is not needed, and channeling it to where the system deems it should be. This is done with the help of sensors that measure the concentration of carbon dioxide. This indicates where the people are. Thus the system can distribute fresh air accordingly. This is achieved thanks to Halton slot diffusers armed with Vario E plenums with a constant pressure duct system. This system was designed with the help of HALTON Hit Balance program, which simulates constant pressure system in the ducts.



By maintaining constant pressure in the air system, the points of fresh air discharge can be adjusted freely - closed to reduce energy consumption, or opened to better fit the needs of the client. If the interior design changes, and more people are assigned to the space, the air system does not need to be TVario E diffusers, which can be fitted into the existing duct system. These factors contribute to cost efficiency and reduction of time required to prepare an arrangement for a tenant.

More information: Aleksandra Słonecka, Sales and Service Engineer, Halton

Fan coil unit for suspended ceiling and hygienic operations with high comfort from DencoHappel

The HyCassette-Geko with SWIRL® outlet is a fan coil unit from DencoHappel (former GEA Air Treatment) which is installed in a suspended ceiling and designed for hygienic operations with a maximum comfort. It provides a cooling capacity up to 4.5 kW and a heating capacity up to 8.6 kW.

EC motors allow continuous regulation of the fan speed in accordance with demand. The air flow is discharged in a swirl pattern out of the unit through the patented, round SWIRL® outlet, with outstanding air distribution throughout the room. In addition, the DencoHappel MATRIX control system regulates cross-section of the air outlet and angular setting in accordance with load conditions and operating mode. In cooling mode and at low fan speed, for example, the control system reduces cross section of the outlet and sets a very flat angle, in order that the air is discharged throughout the room along the ceiling (Coandă effect). The result: the cool air falls slowly and uniformly over a large area toward the floor. To prevent significant differences of temperatures between the outlet air flow and the surrounding room temperature, room air is drawn into the unit adjacent to the outlet nozzles and is mixed with air cooled by the fan coil unit. These solutions minimize draft effects of air throughout the room.

The use of high-quality closed-pore materials means that the HyCassette-Geko with SWIRL® outlet also conforms to strict hygiene requirements. Well-shaped geometry as well as generously rounded edges prevent adherence of dirt and debris and simplify cleaning of the unit. Condensate is effectively drained. All relevant interior components are made of synthetic materials

DencoHappel®

resistant to disinfectants, and are microbiologically non-metabolizable. HyCassette-Geko with SWIRL® outlet satisfies the requirements of VDI 6022 and DIN 1946 T4 class II (certified by the Ruhr District Institute of Hygiene HY, Germany). Accordingly this fan coil is effectively suited not only for comfortable air conditioning, but also for climate control in hospitals, nursing homes, and other facilities with strict requirements for hygiene. For this reason, HyCassette-Geko with SWIRL® outlet won the innovation award at the trade fair Hôpitech 2015 (October 7-9, 2015, in Pau/France).

VDI-Standards published in November and December 2015

November

VDI 3807 part 3 (2015-11). Characteristic consumption values for buildings; Characteristic water consumption values

This standard applies, in addition to VDI 3807 Part 2, to the use of characteristic water consumption values for buildings, especially where values for individual buildings and individual periods of consumption are required. The standard also helps property owners to identify the sources of irregularities and disturbances in water consumption. German/ English language.

VDI 3819 part 1 draft (2015-11). Fire protection in building services; Fundamentals; Terminology, acts, ordinances, technical rules

The standard provides an overview of laws, regulations and technical rules to be followed in connection with the fire protection in the various provinces and trades of building services. The standard explains the terms used in the application of the series of standards VDI 3819 and VDI 6010. Available only in German.

Correction of VDI 4700 part 1 (2015-11). Terminology of civil engineering and building services

The standard defines terms from the fields of architecture, civil engineering, building services and facilities management, listed in alphabetical order and written according to the rules applicable to international terminology standards. The standard is intended as a source of information for all persons who are required to consider technical rules in the planning, execution, evaluation and operation of the technical building services or its scientific debate. The standard facilitates the understanding of contents of technical rules for users such as consulting engineers, planners, exporting companies, operators and possibly lawyers. German/ English language.

VDI 6012 part 2.1 (2015-11). Integration of distributed and renewables-based energy systems in buildings; Thermic systems; Biomass firing systems

This standard covers the use of renewable, thermal energy systems in buildings, including the delivery and storage of fuels and the disposal of combustion residues. Systems are considered, which serve both the heat generation in close proximity to consumers in residential and non-residential buildings where the following wooden fuels are used: (a) solid pieces of wood, including attached bark, especially in the form of logs and wood chips, and twigs and cones; (b) compacts made of untreated wood in the form of briquettes according to DIN EN ISO 17225-3 or in the form of pellets according to DIN EN ISO 17225-2 as well as other wood briquettes or wood pellets made of natural wood with equivalent quality. The maximum rated output of the considered fuels in this standard is limited to 500 kW. The standard is targeted at: system manufacturers; architects; planners; builders; investors; operators; service providers, such as energy consultants and chimney sweeper; approval and building authorities; component and system manufacturers. German/ English language.

VDI 6014 draft (2015-11). Energy conservation by application of variable speed drives (VSD) in building services

This standard constitutes the basic for the selection of variable-speed drives. It allows for a holistic view on the system drive motor, work machine and speed control. With respect to building services this standard is limited to fans and pumps. The existing energy-efficiency requirements for electric motors, pumps and fans are covered by this standard as well as the potential for saving energy in specific applications and the improvement of effectiveness. Available only in German.

December

VDI 6022 part 5 draft (2015-12). Ventilation and indoor-air quality; Avoidance of allergenic exposure; Requirements regarding the testing and evaluation of technical products and components affecting the indoor air

The standard provides a basis for the prevention of allergic potential of devices and products and makes it measurable. The standard describes existing instrumentation, testing and evaluation methods respecting the interest of consumers. It describes the methods of pollutant and allergen avoidance, largely protecting people from the contact and the inhalation of pollutants of various origins. Available only in German.

VDI 6201 part 1 (2015-12). Software-based structural analysis; Fundamentals, requirements, modelling

Development and the use of software for structural engineering are not regulated in Germany. For quality assurance, there are no specific guidelines or general rules for the user or manufacturer side. Poor quality of software solutions as well as the trend towards more complex structures not only produce unnecessary discussions between the designer, test engineer and contractor on the relevance of the results of a structural software, but can also lead to damages to the buildings, in limiting cases up to structural failure. The application of the standard helps to minimize shortcomings in the software-based detection of the bearing capacity and serviceability, to meet higher quality standards and thereby allowing for a higher level of acceptance of the software-based safety testing in international competition. German/ English language.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Events in 2015 - 2016

Conferences and seminars 2016

Jan 23-27	ASHRAE Winter Conference	Orlando, Florida, USA	www.ashrae.org/orlando
Feb 24-26	World Sustainable Energy Days	Wels, Austria	www.wsed.at/en/world-sustainable-energy-days/
March 8-11	Sustainable Built Environment - SBE 2016	Hamburg, Germany	www.sbe16hamburg.org
March 16-18	9th International Conference Improving Energy Efficiency in Commercial Buildings and Smart Communities (IEECB&SC'16)	Frankfurt, Germany	http://iet.jrc.ec.europa.eu/energyefficiency/node/9096
March 31-April 2	12th International HVAC+R Technology Symposium	Istanbul, Turkey	www.ttmd.org.tr/sempozyum2016/eng/
May 22-25	12th REHVA World Conference - CLIMA 2016	Aalborg, Denmark	www.clima2016.org
May 30-June 3	CIB World Building Congress 2016 Intelligent built environment for life	Tampere, Finland	http://wbc16.com
June 22-24	Central Europe towards Sustainable Building Prague 2016	Prague, Czech Republic	www.cesb.cz
July 3-8	Indoor Air 2016	Ghent, Belgium	www.indoorair2016.org
August 21-24	12th IIR Natural Working Fluids Conference	Edinburgh, United Kingdom	www.ior.org.uk
September 21-23	International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access	Bad Hersfeld, Metropolitan area Frankfurt, Germany	www.energy-access.eu
October 23-26	IAQVEC 2016: international conference on indoor air quality, ventilation & energy conservation in buildings	Seoul, South Korea	www.iaqvec2016.org

Exhibitions 2016

January 25-27	2016 AHR Expo	Orlando, Florida, USA	www.ahrexpo.com
February 2-5	Aqua-Therm Moscow	Moscow, Russia	www.aquatherm-moscow.ru/en
February 24-26	Aqua-Therm Novosibirsk	Novosibirsk, Russia	http://www.aquatherm-novosibirsk.ru/en
March 1-4	AQUATHERM Prague	Prague, Czech Republic	www.aquatherm-praha.com/en/
March 13-18	Light and Building	Frankfurt, Germany	http://ish.messefrankfurt.com
March 15-18	Mostra Convegno Expocomfort	Milan, Italy	www.mcexpocomfort.it/
April 5-8	Nordbygg	Stockholm, Sweden	www.nordbygg.se
April 20-22	Aqua-Therm St-Petersburg	St-Petersburg, Russia	www.aquatherm-spb.com/en
May 4-7	ISK-SODEX 2016	Istanbul, Turkey	www.sodex.com.tr/
October 12-14	FinnBuild	Helsinki, Finland	www.messukeskus.com/Sites1/FinnBuild/

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As of January 2015, there is a new private area in the website. REHVA has decided to develop this section progressively. On the first phase, the **REHVA Journal** has been made available to download and read online. All the issues (full articles) are now available in this private section. REHVA is now ready to add new services in this section.

These services are now added in the private area!

⇒ EU policy tracking – **new**

⇒ HVAC terminology – **new**

⇒ eBooks - **4 new books are available online!**
GB1/Displacement ventilation in non-industrial premises
GB4/Ventilation and smoking
GB5/Chilled Beam Applications
GB6/Indoor Climate and Productivity in Offices

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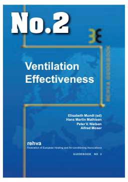
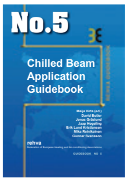
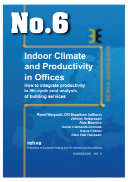


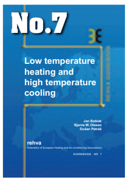
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook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



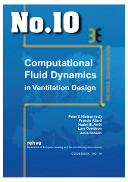
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature 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.



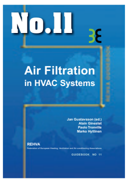
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available.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



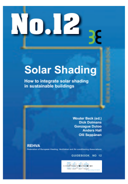
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in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



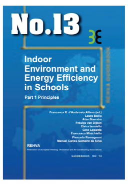
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary 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.



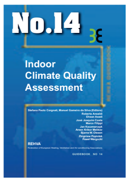
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on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



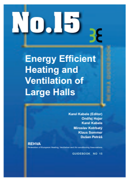
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy 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.



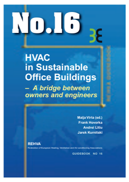
Indoor Environment and Energy Efficiency in Schools – *Part 1 Principles.* School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly on energy efficient systems for a healthy indoor environment.



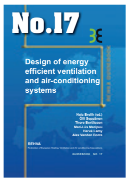
Indoor Climate Quality Assessment. This Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring have allowed enlarging significantly number of possible applications, especially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



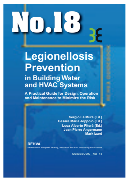
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating,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



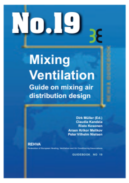
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be asked in various phrases of building's life time. Different case studies of sustainable office buildings are presented.



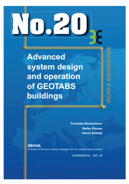
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked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



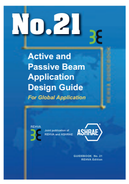
Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification), Production of hot water for washing (fundamentally but not only hot water for washing) and Evaporative cooling tower.



Mixing Ventilation. In this Guidebook most of the known and used in practice methods for achieving mixing air distribution are discussed. Mixing ventilation has been applied to many different spaces providing fresh air and thermal comfort to the occupants. Today, a design engineer can choose from large selection of air diffusers and exhaust openings.



Advanced system design and operation of GEOTABS buildings. This Guidebook provides comprehensive information on GEOTABS systems. It is intended to support building owners, architects and engineers in an early design stage showing how GEOTABS can be integrated into their building concepts. It also gives many helpful advices from experienced engineers that have designed, built and run GEOTABS systems.



Active and Passive Beam Application Design Guide is the result of collaboration by worldwide experts. It provides energy-efficient methods of cooling, heating, and ventilating indoor areas, especially spaces that require individual zone control and where internal moisture loads are moderate. The systems are simple to operate and maintain. This new guide provides up-to-date tools and advice for designing, commissioning, and operating chilled-beam systems to achieve a determined indoor climate and includes examples of active and passive beam calculations and selections.

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