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ENERGY EFFICIENCY OF EUROPEAN BUILDINGS

ENERGY LABELS

PRODUCT CERTIFICATION

SEASONAL CHILLER PERFORMANCE

KITCHEN VENTILATION

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Energy – Water Nexus

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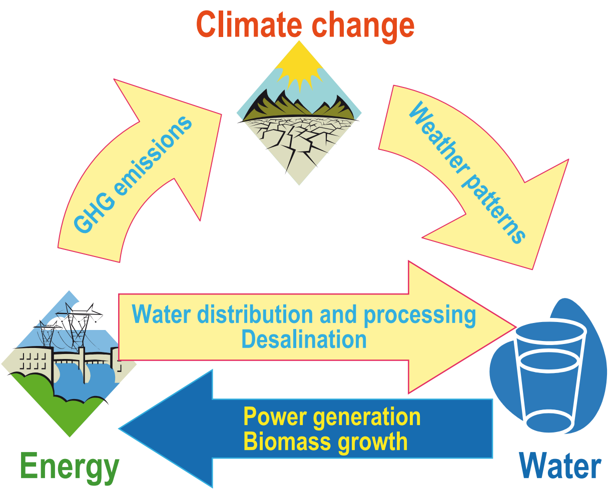
Energy and water are strongly interlinked. The energy-water "nexus" is more evident due to climate change increasing droughts, floods and different rainfalls. The interactions between water and energy is one of mutual dependency: the exploration of energy sources, biomass production and power generation need water; on the other hand, water distribution and processing needs energy.

15% of the global water withdrawals are used for the energy sector although the effective water consumption is smaller, as part of the withdrawal is led back to nature. Both withdrawals and consumption are projected to grow in the future, notably the consumption because of more biofuels.

Many energy sources, their extraction and fuel processing need water. These requirements depend on the fuel but also on the extraction site and technology. The power generation technologies differ significantly in their water needs. In general, the combined cycle gas turbine technologies need less water. Carbon capture and sequestration may remarkably increase the water use. Also, nuclear plants require more water than coal plants of the same capacity because they operate at reduced steam conditions. The renewable energy technologies differ: wind and photovoltaic technology barely consume water while water is important in concentrating solar systems. Hydropower is a story itself: run-of-river plants hardly lose water but evaporation from circulation plants with water storages may be significant.



Strong direct and indirect links between energy and water.

When it comes to energy end-use, water is not only consumed in kitchens and bathrooms but is also a medium of heat transfer. Luckily, saving both energy and water often leads to mutually useful measures. Pumping is at the heart of the nexus. Eco-design requirements and energy labels address also water consumption of washing machines and dish washers. Saving devices such as water saving toilets, shower heads, thermostatic water taps are appliances that save both energy and water.

European fresh water use in the past two decades has been slightly declining mainly because of efficient industrial use. However, the high water demand for irrigation in Southern Europe has not decreased although the irrigation technologies have much improved. The energy needs of the water sector have been growing as more water treatment and irrigation is needed, also because of desalination.

Worldwide more than one billion people in developing countries do not have a safe access to clean water and proper sanitation. Water collection is often a major workload for women who need to fetch the daily water sometimes kilometres away. New technologies to construct wells and operate these for instance by solar pumps, have improved the living conditions in many countries.

The water – energy nexus has recently gained more political visibility. In the future, water scarcity may increase the vulnerability of the energy sector. We need intelligent, sustainable energy to meet the global water requirements. A key answer to these challenges is efficiency at every step - notably in pumping, automation and metering but also in appliances. All these issues are most familiar to the readers of REHVA Journal. Your expertise is invited to meet the nexus!

Steps and policies towards better energy efficiency of European buildings

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Energy efficiency is at the heart of the European Union´s 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy. Energy efficiency is one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants. In many ways, energy efficiency can be seen as Europe's biggest energy resource. This is why the Union has set itself a target for 2020 of saving 20% of its primary energy consumption.

More than 40% of the EU's primary energy is used for buildings. Approximately 2/3 of this is used in residential buildings, and 1/3 in commercial (tertiary) buildings. The share of energy use for heating and ventilation from the energy delivered for buildings is roughly two thirds. The European commission has estimated that energy use of buildings can be reduced by approximately 30% in buildings using cost efficient measures.

Substantial steps have been taken towards this objective – notably in the appliances and buildings markets. Nonetheless, Commission estimates in 2011 suggest that the EU is on course to achieve only half of the 20% objective. Not content with achieving its 2012 targets and being on track to more than meet its 2020 goals, the EU is now aiming to cut total emissions by 80% by 2050. The European Commission has published a roadmap [**1**] in March 2011, which sets out key elements that should shape the EU's climate action helping the EU become a competitive low carbon economy by 2050. Although the continent is aiming to reduce emissions by 80%, the roadmap lays out plans to cut greenhouse gas emissions by up to 95% (**Figure 1**).

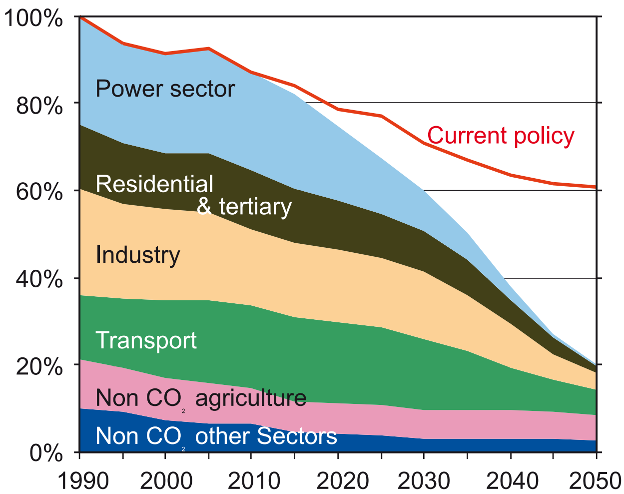

Figure 1. EU GHG emissions targets towards an 80% reduction (100%=1990). The target in the construction sector is even higher. [**1**]

At the same time the EC adopted the Communication "Energy Efficiency Plan 2011" [**2**] for saving more energy through concrete measures. The set of measures proposed aims at creating substantial benefits for households, businesses and public authorities: "it should transform our daily lives and generate financial savings of up to € 1 000 per household every year. It should improve the EU's industrial competitiveness with a potential for the creation of up to 2 million jobs".

The Energy efficiency plan focused on the following concrete measures:

- It promotes the exemplary role of the public sector.
- It accelerates the refurbishment rate of the public sector building stock with a specific goal.
- It requests public authorities to refurbish at least 3% of their buildings each year.
- It requires energy efficiency criteria to be included in public procurement.
- It aims to trigger the renovation process in private buildings and to improve the energy performance of appliances.

- It requests improvement of the efficiency in power and heat generation.
- It calls for energy efficiency requirements for industrial equipment.
- It calls for improved information provision for SMEs and energy audits and energy management systems for large companies.
- It encourages the use of smart grids and meters.

Legislative framework

Legislative framework in European Union is based on Directives which are prepared by the European Commission and accepted by the European Parliament and Council.

A directive requires Member States to achieve a particular result without dictating the means of achieving that result. It can be distinguished from regulations which are self-executing and do not require any implementing measures. Directives normally leave member states with a certain amount of leeway as to the exact rules to be adopted. Directives can be adopted by means of a variety of legislative procedures depending on their subject matter.

The following directives are most important in regulating the energy efficiency of buildings.

The Energy Performance of Buildings Directive (EPBD) [**3**], first adopted in 2002 and revised and adopted in 2010 [**4**], directly targets the energy efficiency of buildings. The main objective of the Directive is to ensure the establishment, at national level, of a comprehensive framework for improving the energy performance of residential and non-residential buildings through the setting of minimum energy performance requirements for new and existing buildings, for technical building systems and for building elements. The Directive ensures transparency by mandating energy performance certificates (EPCs) and their display in public buildings. The EPBD also looks at the future with requirements for nearly zero-energy buildings by the end of the decade.

The Directive on Ecodesign of Energy Using Products (ED) [**5**] was first adopted in 2005 when the focus was on the products which use energy; in 2009 its scope was expanded to all products which have an influence on energy use, **the Ecodesign Requirements for Energy-Related Products Directive** [**6**].

It is complemented **by the Energy Labelling Directive (ELD)** [7] which also covers product groups relevant for the energy performance of buildings including heating products, motors, fans and lighting.

While the EPBD requires Member States to set requirements at system level and does not prescribe the level of the requirements (except for the fact that they have to be cost-optimal) [**8**], the ED and the ELD address specific product groups and, in case of the ED, set specific minimum requirements. In the future, more Ecodesign requirements will be adopted for products that are part of technical building systems, and possibly also part of the building envelope (e.g. windows). The Commission services will therefore look closely at the interaction of these two pieces of legislation to ensure they are complementary.

Towards the end of 2012 a new **Energy Efficiency Directive (EED)** [**9**] was adopted. It is more general but contains several measures impacting on buildings. It is more of an administrative directive and requires the Member States to take actions to improve the energy efficiency with certain actions like inspections, renovation and improved efficiency of energy production with Combined Heat and Power (CHP).

The increase in the use of renewable energy is an essential part of the EU energy policy. The target is to have 20% of primary energy from renewable sources by 2020. The requirements for member states are given in the **Directive for the promotion of the use of energy from renewable sources** (RES-directive) [**10**].

EU energy policy is supported by several accompanying actions: **Intelligent Energy Europe** programme [**11**] for demonstration and dissemination, **BUILD UP portal** [**12**] for information exchange and **Skills programme** [**13**] to improve the skills of professionals for better energy efficiency.

In addition to the technical and administrative actions, the EU offers several opportunities for **financing** of feasible energy efficiency actions [**14**].

Energy performance buildings directive (EPBD)

The revised EPBD directive was adopted in 2010 [**4**]. It has to be implemented in all EU member countries by 2020. It is much more stringent than the EPBD 2002 version [**3**], and actually more stringent than the first proposal from the European Commission in 2008 due to influence of the European Parliament. The major contents in EPBD 2010 are summarized as follows:

- The Member States have to set national requirements **of energy efficiency on cost optimal level**. This allows the Member States to

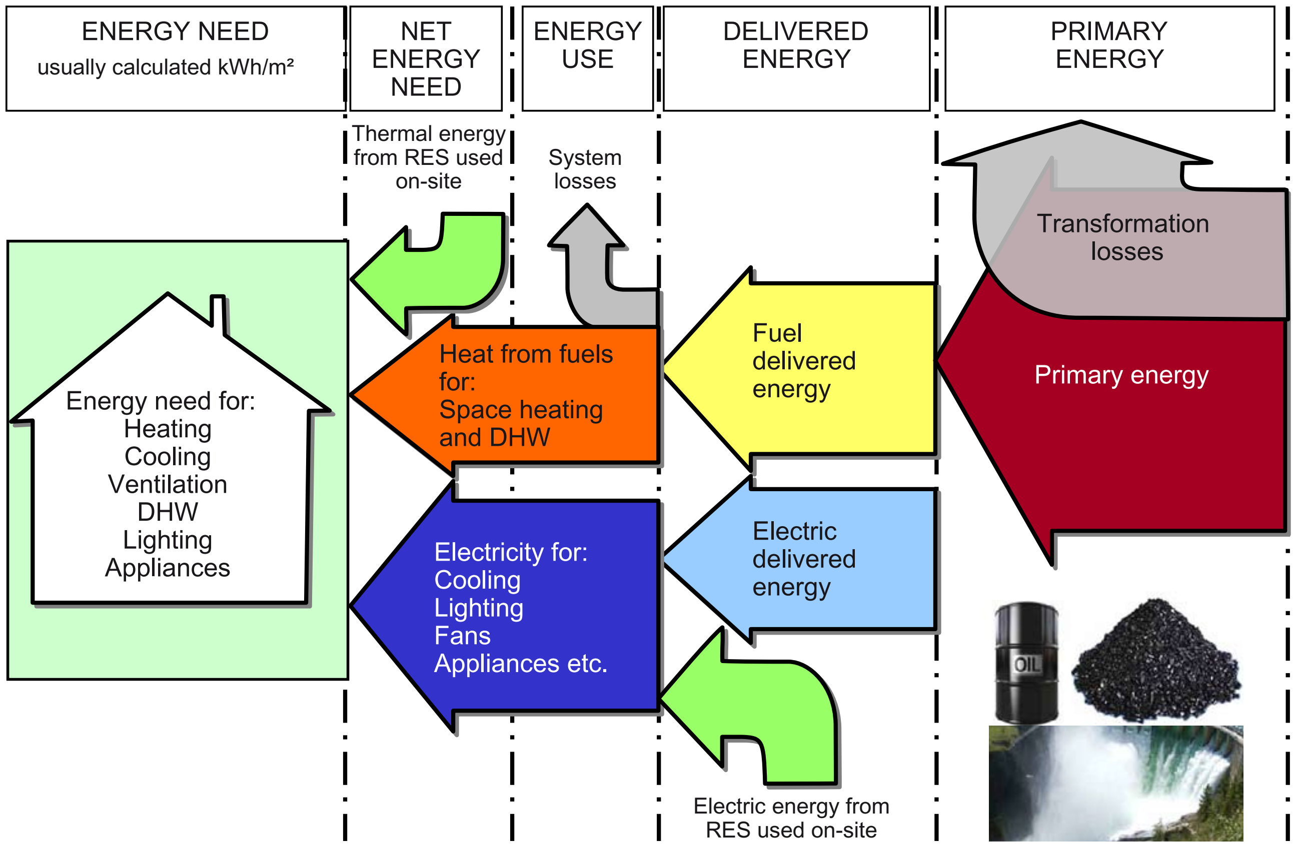

Figure 2. Primary energy use to satisfy the energy need of building is usually much higher than the energy need, due to the various losses in the transformation process.

integrate the national economical situation in the requirements. The guidelines for cost-optimal calculations were published in January 2012 [**15**].

- Target values for energy efficiency have to be nationally based on the use of **primary energy in kWh/m²** or an alternative building performance indicator.
- Energy efficiency has to be improved in all **major renovations of existing buildings** and use of renewable energy has to be considered.
- Specific **regulations for energy efficiency are required for HVAC systems** (compulsory for existing buildings, optional for new buildings).
- All new buildings have to be "**nearly zero energy buildings**" in 2020 (public buildings two years earlier). Definition of nearly zero energy building is left to the Member States.
- National measures have to be developed to **overcome market barriers** for improving energy efficiency in each member state.
- All buildings have to have an **energy certificate**. The directive requires a stronger and more meaningful position for the energy certificates. The certificates shall also include a plan for improving energy efficiency of the building.
- Boiler inspections were already required in the 2002 directive. The 2010 directive expands the **inspections to cover the whole heating system**.
- **A/C inspections** were already required in the 2002 directive. The 2010 directive lays more emphasis **on reducing cooling loads** and low energy cooling.
- An independent **quality control system** has to be developed for all national inspections.
- The recast EPBD refers to the **CEN standards**. This will strengthen the role of the European standards in national legislations.

Primary energy factors

Primary energy for a building is the energy used to produce the energy delivered to the building. It is calculated from the delivered and exported amounts of energy carriers, using primary energy conversion factors. Primary energy includes non-renewable energy and renewable energy.

The EPBD requires the member states to define the maximum values for energy use in terms of primary energy, which is significantly higher than the energy need of a building, see **Figure 2**.

Table 1. An extract of the energy performance requirements set in the Danish energy frames for 2010, 2015 and 2020.

Characteristic values		Energy frame 2010	Energy frame 2015	Energy frame 2020
Maximum of delivered energy to	Residential buildings (houses, hotels, etc.)	52.5 + 1650/A in kWh/m²a	30 + 1000/A in kWh/m²a	20 kWh/m²a
	Non-residential buildings (offices, schools, institutions and other buildings)	71.3 + 1650/A in kWh/m²a	41 + 1000/A in kWh/m²a	25 kWh/m²a
Conversion factors	Electricity	2.5	2.5	1.8
	District heating	1.0	0.8	0.6

Primary energy factors vary significantly between countries, however, a primary energy factor = 1 for all fuels and 2.5 for electricity is quite common in Member States. For renewable sources the factor is less than one. Primary energy factors depend on the structure of the energy supply system of each Member State.

Cost optimality of regulations

EU Member States have to revise their regulations to be cost optimal. The Cost optimal level is the energy performance that leads to the lowest cost during the estimated economic lifecycle. EPBD 2010 requires the Member States to set the energy performance requirements on a cost optimal level, and gives instructions on how to do it [**8**]. The objective is to establish the cost optimal benchmark for every MS through calculation, and using this to assess the current requirements of that MS, and adjust the regulations if needed. This shall be done authorities in each Member State. An equivalent level of ambition is targeted in all MS but no harmonisation of requirements is needed.

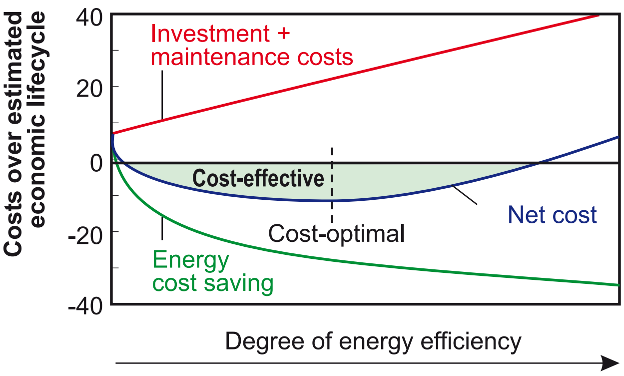

Figure 3. EU Member States have to revise their regulations to be cost optimal. The cost optimal level is the energy performance that leads to the lowest cost during the estimated economic lifecycle.

The methodology framework specifies rules for comparing energy efficiency measures, measures incorporating renewable energy sources and packages and variants of such measures, based on the primary energy performance and the cost attributed to their implementation. It also lays down how to apply these rules to selected reference buildings with the aim of identifying cost-optimal levels of minimum energy performance requirements.

Net zero energy buildings

The term "nearly zero-energy building" means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. According to EPBD (2010) the EU Member States shall ensure that by end of 2020, all new buildings are nearly zero energy buildings; and new buildings occupied and owned by public authorities two years earlier.

The EU regulation does not give minimum or maximum harmonized requirements. It will be up to the Member States to define what for them exactly constitutes a "very high energy performance". National roadmaps towards nearly zero energy buildings are needed for all member states. REHVA has developed a common definition for the nearly zero energy buildings [**15**].

In 2013 most of EU member countries are still developing the final roadmaps towards zero energy buildings; however, some have already published the goals. German policy is summarised in **Figure 4** and Danish targets in **Table 1**.

Eco-design of energy-related products

An important part of total energy efficiency in buildings is the efficiency of appliances and equipment. Apart

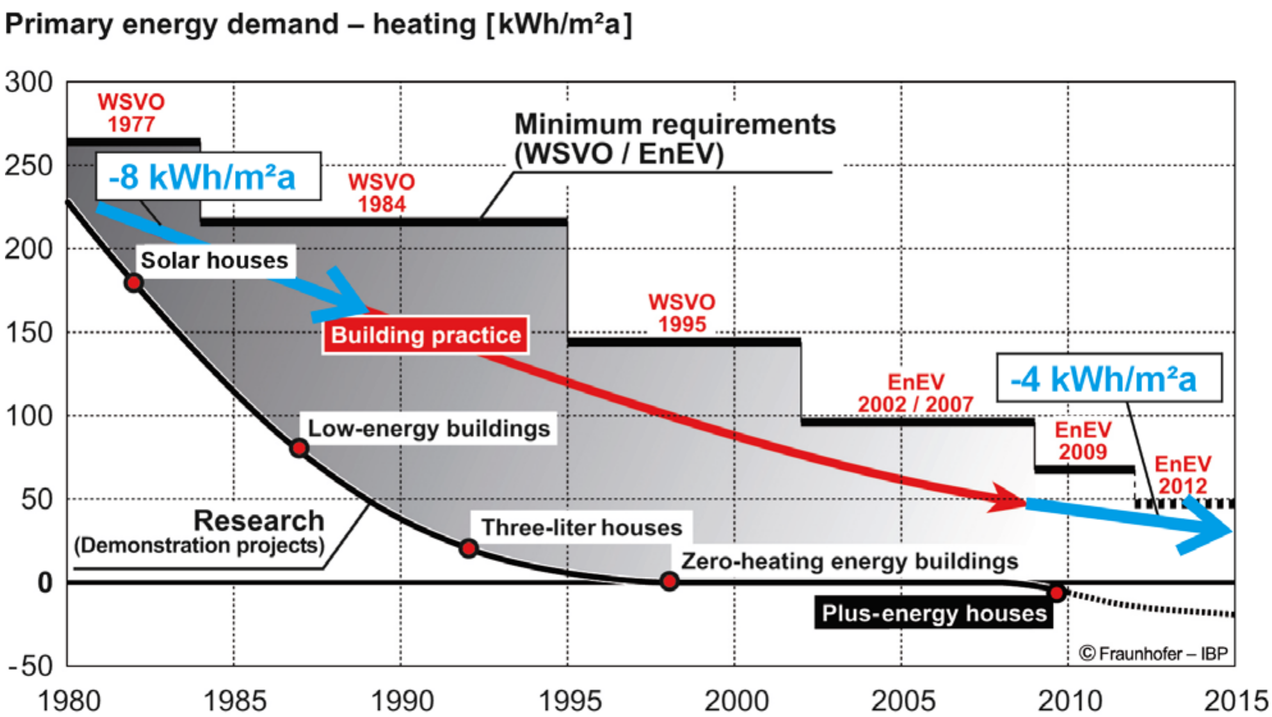

Figure 4. The development of the energy-saving construction in Germany showing the minimum energy performance requirements (upper line), the high performance pilot projects (lower line) and the innovative building practice (middle line) over the last 35 years.

from the user's behavior, there are two complementary ways of reducing the energy consumed by products:

- the energy efficiency requirements imposed on products in the design and manufacturing phase and
- labelling of the products for energy efficiency to raise consumer awareness and to guide consumers towards more energy efficient purchasing decisions

Ecodesign aims at reducing the environmental impact of products, including the energy consumption through their entire life cycle. It is estimated that over 80% of all product-related environmental impacts are determined during the design phase of a product. The eco-design regulations are developed following consultations with interested parties (industry, building owner, authorities etc).

Figure 5 illustrates the relationships between eco-design, energy label and eco-label for a certain product. Ecodesign will give minimum requirements for the environmental performance of the product – and products which do not fulfill these minimum requirements will not receive the obligatory CE marking and have no access to the market. The energy labelling includes a product classification A to G. Only products in the best class can receive the eco-label.

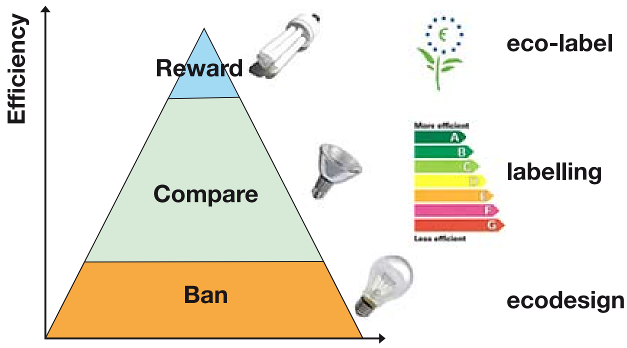

Figure 5. The relationships between ecodesign, energy label and eco-label. Ecodesign regulations set the minimum requirements, energy labels classify the products in the market and eco-label indicates the environmentally best product.

The regulations are based on the life cycle cost analysis, as illustrated in **Figure 6**. The objective is to specify the design solution which gives the lowest life cycle cost including the environmental impacts. When the currently adopted regulations are fully implemented the annual savings of electricity will be 377 TWh/a which is about 10% of the electricity use in EU and the same as total annual electricity production in United Kingdom. (**Table 2**).

Table 2. From the beginning of 2014, small air conditioners, sold in EU, shall meet the minimum requirements as indicated in the table. Other requirements described in details in [**18**].

	Air conditioners. except double and single duct air conditioners		Double duct air conditioners		Single duct air conditioners	
	SEER	SCOP (heating season average)	EER rated	COP rated	EER rated	COP rated
If GWP of refrigerant > 150 for < 6 kW	4.60	3.80	2.60	2.60	2.60	2.04
If GWP of refrigerant ≤ 150 for < 6 kW	4.14	3.42	2.34	12.34	2.34	1.84
If GWP of refrigerant > 150 for 6-12 kW	4.30	3.80	2.60	2.60	2.60	2.04
If GWP of refrigerant ≤ 150 for 6-12 kW	3.87	3.42	2.34	2.34	2.34	1.84

The EU Commission is currently working on regulations for several important building system related product groups. It is estimated that legislation will be adopted in 2013 for

- Air conditioning and ventilation systems
- Local room heating products and solid fuel boilers
- Central heating products using hot air

The ecodesign regulations are very specific. In the following, two small examples are given for fans and for small air conditioning units. The regulations also include the future, more stringent, criteria for the product so that the industry is aware of how the products have to be developed to meet the future criteria.

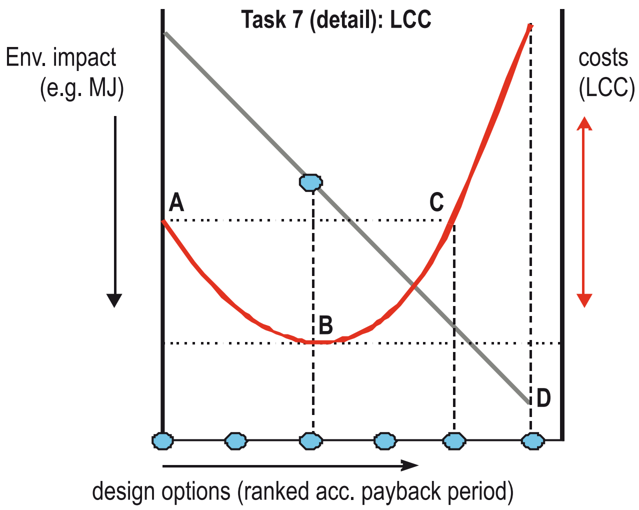

Figure 6. The ecodesign regulations are based on the life cycle cost analysis. The objective is to specify the design solution which gives the lowest life cycle cost including the environmental cost in the calculations.

Ecodesign criteria for fans

The fans have to generate pressure to overcome the pressure losses in air handling unit and duct system. Often the fans operate with low overall efficiency due to improper selection of fan or operating conditions which are not optimum. The fan efficiency can be improved with better electrical motors, better drives and better fans as well as their operating conditions.

The fans sold and used in Europe have to fulfill the minimum requirements for efficiency. These minimum values have been defined in fan regulations given on the basis of Ecodesign of Energy Using Product Directive 2009/125/EC [**6**]. Some examples of minimum requirements from the beginning of 2013 and 2015 are given in **Figure** 7.

Ecodesign criteria for small air conditioners

From the beginning of 2014, air conditioners shall meet the requirements as indicated in the **Table 2** [**18**]. The requirements on energy efficiency for air conditioners, excluding single and double duct air conditioners, shall relate to the reference design conditions. In addition to the performance criteria in operation the regulations gives requirements for maximum stand by electricity use, product information and operating instructions etc.

Renewable Energy Sources (RES)

Most countries have a specific quota for RES to achieve the goals set in the Directive for the use of Renewable Energy Sources (RES Directive) [**10**]. On average this directive requires the member states to increase the share of RES by 10% within the total primary energy use. See **Table 3** for some country specific targets.

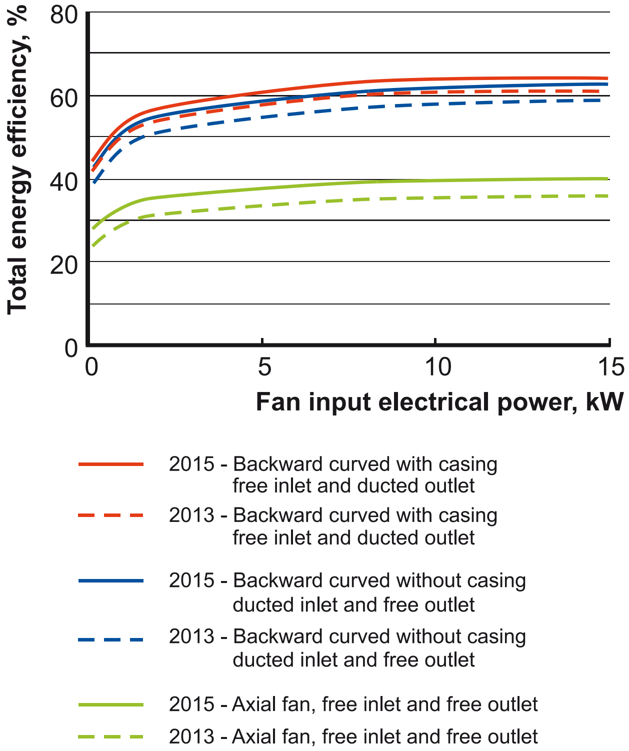

Figure 7. Some examples of minimum requirements for efficiency for fans [**17**] sold in Europe from the beginning of 2013 and 2015 in Fan regulations based on Ecodesign of energy related products EU Directive 2009/125/EC [**6**].

Table 3. Some specific requirements set in RES directive for EU member states regarding how much the use of renewable energy shall be increased from the 2005 level by 2020.

	2005	2020
Sweden	39.8%	49%
Latvia	32.6%	40%
Finland	28.5%	38%
Austria	23.3%	34%
Portugal	20.5%	31%
Denmark	17.0%	30%
Estonia	18.0%	25%
Slovenia	16.0%	25%
Romania	17.8%	24%
France	10.3%	23%
Lithuania	15.0%	23%
Spain	8.7%	20%
Germany	5.8%	18%
Greece	6.9%	18%
Italy	5.2%	17%
Bulgaria	9.4%	16%
Ireland	3.1%	16%
Poland	7.2%	15%
United Kingdom	1.3%	15%
Netherlands	2.4%	14%
Belgium	2.2%	13%

The numbers in **Table 3** are over all targets in the national energy balance. Buildings can contribute to a certain extent in achieving the targets by using solar energy for electricity, heating and cooling. Also, use of biomass for heating is included in the quota of renewable energy as well as a part of the heat supplied by heat pumps for heating. In the building regulations the requirement for the share of RES in buildings varies between countries with respect to the magnitude and also from which energy flow the share is calculated. In Germany, the share of RES is calculated from heating energy. Depending on the type of RES and building, the requirement varies from 15 to 50%. In Slovenia the requirement is set at 25 to 70% depending on the source. In Norway the requirement of 40% is calculated from the net energy demand. The UK already required a 10% share of RES in non-domestic buildings before the adoption of RES directive. In Italy 50% of the heating of domestic hot water has to come from renewable sources.

Energy efficiency directive

Technical regulations are needed for developing common energy efficient technology but technical regulations are not enough. There is a need to speed up the implementation of various activities for better energy efficiency to achieve the goal of 20% reduction by the year 2020. For this several actions were developed to improve the energy efficiency in practice; these were collated in the Energy Efficiency Directive 2012/27/EU [**9**] which was adopted in October 2012. This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 headline target of 20% on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020.

The key elements in the directive are quoted below:

Building renovation

Member States should renovate 3% of the total floor surface of heated and/ or cooled buildings belonging to the central government and occupied by it.

Systems energy efficiency for utilities

Energy companies covered by the Directive should achieve "cumulated energy savings in the final stage" by 2020. For further savings each year, this should be at least 1.5% by volume of their annual energy from 2014 to 2020, and be calculated on the basis of the year 2009.

Energy Audits

All major companies have to be energy audited. These audits should begin within three years after the coming into force of the Directive (2012) and must be conducted every four years by qualified and approved energy auditors.

Promote efficiency in heating and cooling

By December 2015, European countries should complete and provide the Commission with a "full assessment" of the scope of cogeneration systems and effective heating and cooling.

Funding Mechanisms

Deputies also proposed to establish financing facilities for energy efficiency measures. Member States should facilitate the establishment of these mechanisms or use existing mechanisms.

European and National Goals

The directive defines common measures to ensure that the EU is moving towards its main goal to use 20% less energy by 2020. Each Member State shall establish its own goals and present an action plan for energy efficiency every three years - in 2014, 2017 and 2020.

Summary

Reducing energy consumption and eliminating energy wastage are among the main goals of the European Union. EU support for improving energy efficiency will prove decisive for competitiveness, security of supply and for meeting the commitments on climate change made under the Kyoto Protocol. There is significant potential for reducing consumption, especially in energy-intensive sectors such as buildings. At the end of 2006, the EU pledged to cut its annual consumption of primary energy by 20% by 2020. Follow up studies in 2011 showed that the goal cannot be reached if no further actions are taken. To achieve the original goal several actions have been take both in EU and national levels. The EU and its Member States have been successful during the last two years to mobilise public opinion, decision-makers and market operators and to set minimum energy efficiency standards and rules on labelling for products, services and infrastructure. Some of the most important legislative actions were described in this paper.

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Energy Labelling

- State of play and conceptions for future

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It is no novelty that the EU is aiming for a 20% cut in Europe's annual primary energy consumption by 2020, but how we get there, seems to be a regularly reappearing novelty. Ecodesign and energy labelling have been key instruments in boosting the energy efficiency of appliances. While ecodesign cuts the least efficient appliances off the market, energy labels help consumers choosing products which save energy and thus money. They also provide incentives for the industry to develop and invest in energy efficient product design. However, the energy labelling landscape is changing. First, the introduction of new labels will guide, apart from consumers, also professionals such as system designers and installers. This is in particular the case with the new energy labels on air-conditioners, heaters, and water heaters. Second, many consumer products will reach the maximum energy efficiency classes during the coming years. Therefore, the future review of the Energy Labelling Directive will have to face the challenge of addressing these issues. This article sheds light on some of the key issues related to the future of energy label building on the first inputs available from stakeholders.

Background in Brief

The European Community scheme on energy labelling of 1979 presented in Council Directive 79/530/EEC was the first approach on presenting energy efficiency to consumers on a European level. It gave Member States discretion to require labelling of some household appliances sold within their jurisdiction providing a common EU label format was used. This early label was of an information-only type, which presented technical details including energy consumption under standard test conditions, but not information about the appliance's relative energy performance or efficiency compared to similar models. Being text only, it was therefore quite different to modern labels and not very successful. In practice, this label was only briefly applied in few Member States (Denmark and Italy) for one appliance (household ovens) and hence had a negligible impact.

Following this first approach, Council Directive 92/75/EC was the first 'modern' piece of legislation in the EU to establish a common energy consumption labelling scheme. The directive was supplemented by further, implementing Commission Directives [**1**] on household washing machines, washer-dryers, lamps, cold appliances, electric ovens and air-conditioners during the period 1995-2002.

Household appliances offered for sale, hire, or hire-purchase had to be accompanied by a fiche and a label providing information relating to their consumption of energy and of other essential resources. The supplier had to establish technical documentation sufficient to enable the accuracy of the information contained in the label and the fiche to be assessed (including the description of the product, results of design calculations and where necessary, test reports).

The first labels were provided in eleven different languages with the Belgian label in two languages (see **Figure 1** for English language version). Suppliers provided a free label to retailers and include the fiche in the packaging of the product, and retailers attached the label to the appliance.

In 2005, Directive 2005/32/EC on ecodesign for energy-using products was introduced. It utilised a life-cycle approach, allowing the setting of minimum performance requirements on energy-using products. A result was the phasing out of the most environmentally-harmful products from the market, with a *de facto* removal of appliances from the lower energy labelling classes.

The Energy Labelling Directive 92/75/EC was finally replaced by the recast Directive 2010/30/EU. Its main features were the introduction of A+, A++, and A+++ classes on top of the A-G scale, an almost language free label used across the whole internal market, and distance and internet sales added into the scope. **Figure 2** presents an example of such a new label.

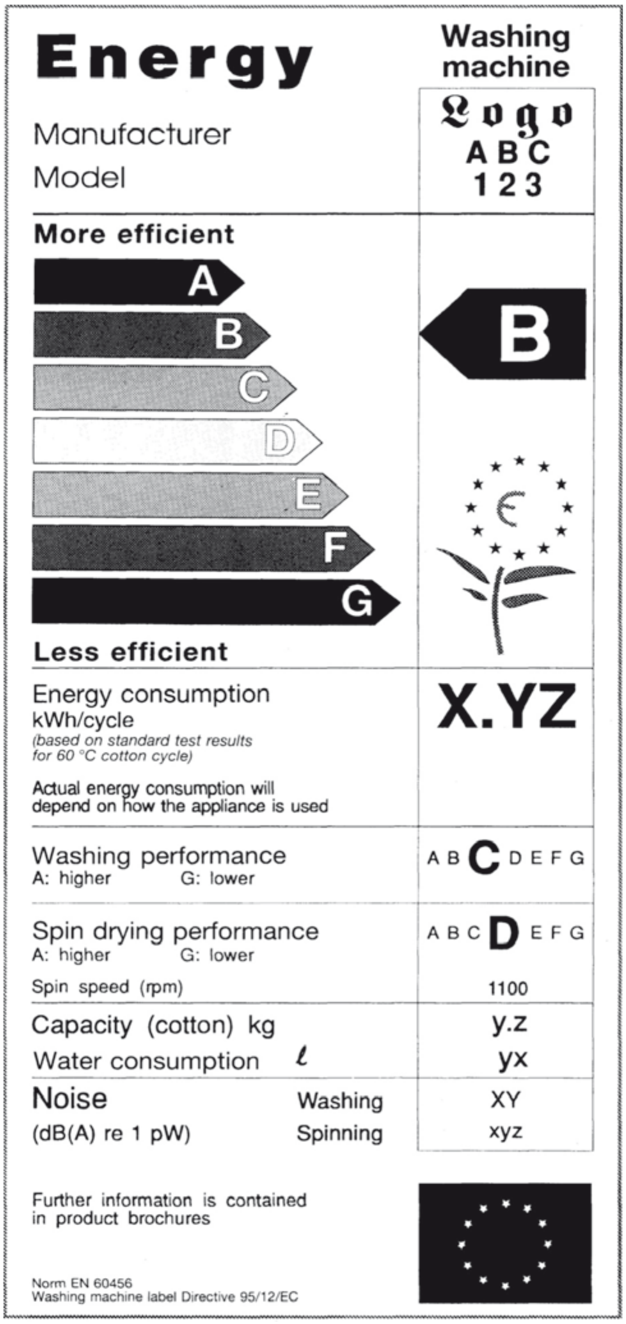

Figure 1.
First mandatory EU energy label in black and white.

Figure 2. Modern EU energy label for a fridge in colour and with additional information.

To date, seven energy labelling regulations [**2**] are in place and six new regulations [**3**] are planned to be adopted in 2013, including the regulations on heaters and water heaters.

Impact of the Energy Label

Since its introduction, the energy label has been a story of success. It is well known (80% of citizens recognise the label), and has helped create offspring labels for buildings, cars, and tyres. European consumers trust the energy label and usually take it into account when they buy electrical household appliances with the undeniable effect of transforming the market towards more energy efficient products [**4**].

Much of the credit must be attributed to its design, which also helped in exporting the idea of the label to numerous countries abroad (see **Figures 3-6**). Today, over 70 countries have an energy label, allowing some 500 million people to make an energy efficient choice in buying products [**5**]. It has achieved this by being:

- Easy to understand: comparative information is presented without the need for technical knowledge, and it touches the heart of consumers: money (85% of consumers pay attention to cost while only 15% pay attention to environmental aspects)[2];
- Language neutral, which is a prerequisite for an EU label with over 20 language zones within the internal market. Pictograms, however, limit the complexity of the message that can be passed and today's/tomorrow's products will be more and more complex.

Result of the Success of the Label and Ecodesign

The success of the European Union's energy efficiency legislation created a fundamental issue hard to resolve. Energy labelling and ecodesign measures have removed products with low energy efficiency from the market. More and more products end up in the highest class with empty lower classes, and rapidly diminishing possibility to differentiate anymore between the efficiency of products.

This problem was first addressed in 2010 with the introduction of A+/++/+++ classes. However, the introduction of 'plus-classes' better than A was only seen as an intermediate step, because a further drive towards better products will lead to the same problem again. Furthermore, research [**2**, **6**] has shown that consumers are liable to misinterpret the difference between the new classes (i.e. A+++ to A class) more than the difference between the old classes (i.e. A class to D class), which leaves adding further 'plus-classes' as an inferior option. Other important aspects are:

- Many classes in the label are empty, which gives misleading information to consumers on the relative energy efficiency;
- It will be practically impossible to populate seven classes in the future, because there will be not enough difference in terms of energy efficiency between the worst and best appliance given the impact of tolerances and/or insignificant difference in consumer savings between models;
- Any attempt to 're-launch' an A-G scale replacing the current A+++ scale will require the downgrading of existing appliances, which will receive industry opposition when faced with a situation without return to investment (e.g. A appliances to be downgraded to e.g. class D);
- Due to increasing complexity of products and aspects labelled, more complex information is entering into the label making it more difficult for consumers to understand. Several labels will also include information for new target groups such as installers. However, a positive aspect is that some of this new information triggers useful questions from consumers to installers;
- Thus far only products have been labelled but the situation is changing. The current system does not allow for the labelling of important products and systems such as most modes of transport (aircraft…), services (holidays…), systems (other than buildings), or energy producers (nuclear, renewables…). The question is if we should be aiming towards savings through labelling within these new areas or are there other more suitable tools for this objective.

Starting a Discussion on the Future Energy Label Review

The Energy Labelling Directive is foreseen for 2014 with a review study launched early 2013. The study will be open for participation to all stakeholders and interested parties of the society. The first contributions to the future of the energy labelling have already been launched by stakeholders. Consumers, environmental organisations, academia, Member States and the EU institutions are well aware of the key issue with the current label, each of them from their own view point. These views are still to be expressed and shared in a systematic review process.

To avoid a conflicting and stalling discussion between stakeholders, green NGOs (EEB and ECOS) and household appliance manufacturers (CECED) have initiated an informal discussion platform in view of the 2014 review. They have identified a set of shared general principles to take into account when exploring future options for revising the energy label.

Following these principles, the label should be based on a reasonable number of indicators, usually three or four, with the main focus on energy. Balance between energy, other resources, and performance shall be ensured, especially when they are correlated.

All the necessary information should be displayed within the same label in order to allow the consumer easy access to comparison between models. The energy information should be available both in absolute value and relative value. The level of prominence of display should be determined on a product-by-product basis to ensure best consumer understanding. The absolute value informs about the actual impact of the product, while the relative value informs about the efficiency of the product in its category.

As previously, the calculation methodologies behind the parameters should be clear, credible, and sufficiently close to real life use of the products, provided that uncertainty and complexity remain acceptable. When energy use is substantially influenced by regional variations in the EU (e.g. for heat pumps and air-conditioners), the label should help consumers evaluate the performance for their geographical situation.

Future layouts should follow current examples and be as uniform as possible across product groups; visual simplicity should be a priority. The main parameter(s) should be displayed in a way that allows clear differen-

Figure 3. Example of two Chinese energy labels following the European class system.

Figure 4. Example of an energy label from Singapore using a slightly different approach.

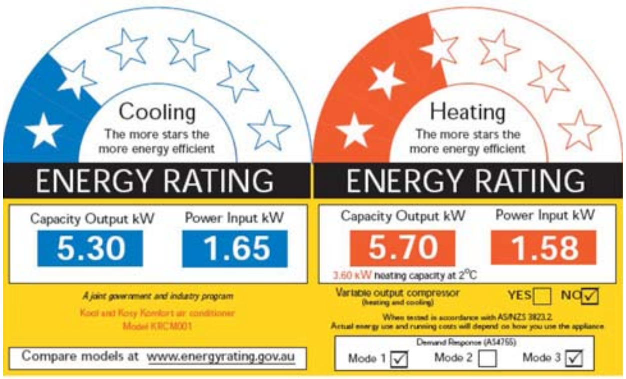

Figure 5.
Example of an energy label from Australia.

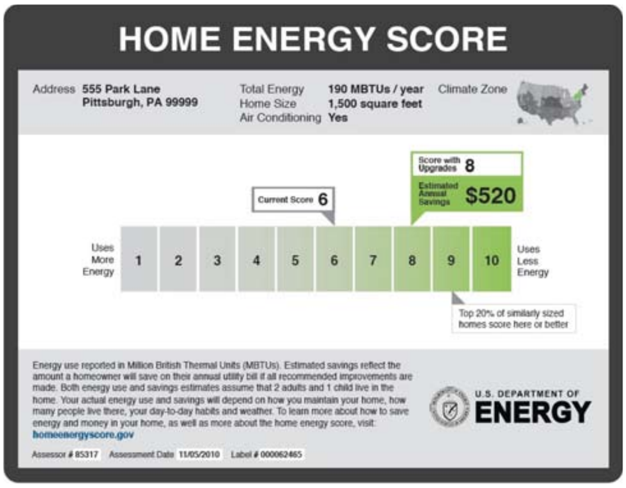

Figure 6. Example of an US energy label with estimated savings in US Dollars.

tiation and comparability between products, and encourages innovating towards the top. However, the scale and reference should be designed in a way that ensures that consumers are not encouraged to buy products with high absolute impact even if they are efficient in their category. Furthermore, continuous or class scales should be used in a way that minimises the need for complicated reclassifications or scale modifications such as experienced in the moment. Colour codes are a fundamental component of the layout. They should be used in a simple and understandable way that helps identifying the top performing products on the market.

Following these principles would allow very different label designs ranging from keeping the existing structure, using further classes and removing unused, old ones up to using a continuous scale with a numerical value without fixed classes including any mixture in-between (i.e. using classes with numerical values), which is in-line with ECOS, EEB, and CECED intention to investigate as many different designs as possible. In addition, the information provided on the paper label displayed in shops should be systematically complemented by more refined information available through internet and smart phone tools.

The overall expectations for the new label are to transform the market with a drive towards best appliances while being transparent to the consumer and conducive for innovation.

Insights from Research

Research provides useful information on the impact and acceptance of the energy labelling policies, and should therefore be seen as a valuable resource in the review process.

In contradiction to some proposals, research has shown that the colour coding should be consistent, but is much less important than the numerical or alphabetical value presented (such as A class) [**7**]. Furthermore, the coding with a specific value should be clear and follow concepts familiar to consumers (i.e. the difference between an A and a D is much faster for consumers to process than A+++ to A) [**2**].

Another important insight is that the main criterion for a label should be the actual money saved by the consumer, or a value in a direct and easy-to-understand relation to it [**2**, **5**]. For most consumers, saving money is the number one reason for choosing energy efficient products, and the energy label is seen as valuable information to achieve this task.

Conclusion

Overall, it is vital to base the review process on research findings to ensure a successful energy label, which is accepted by all stakeholders while achieving its goals towards greater energy efficiency. Consumers are at the centre of these considerations. Only an energy label which can easily be understood by consumers, gives reliable and accurate information, and offers preferably information on direct financial benefits to consumers will be able to increase the energy efficiency of products.

While this article aimed at shedding light on some of the key issues and the energy labelling issue to be addressed in the coming years, it reads from the nature and level of challenges that that success in tackling the challenges ahead can only be ensured with broad and transparent cooperation involving the relevant actors, industry, consumer and environmental organisations, academia, Member States and the European institutions alike.

References

[1] 95/12/EC household washing machines and 95/13/EC household electric tumble dryers, 96/60/EC household combined washer-dryers, 98/11/EC household lamps, 1999/9/EC household dishwashers, 2003/66/EC household electric refrigerators, freezers and their combinations, 2002/40/EC household electric ovens, 2002/31/EC household air-conditioners.

[2] List of adopted regulations: http://ec.europa.eu/energy/efficiency/labelling/labelling_en.htm

[3] Ecodesign Working Plan 2012-2014: http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/product-groups/index_en.htm

[4] AEA (2012). Consumer research on EU product label options. Final report for the European Commission.

[5] Amann, JT (2007). The effectiveness of energy labelling. ACEE Conference presentation

[6] Heinzle, SL, and Wüstenhagen, R (2012). Dynamic adjustment of eco-labeling schemes and consumer choice – the revision of the EU energy label as a missed opportunity? Bus Strat Env, 21(60-70).

[7] Heinzle, S (2012). Consumer response to energy labels - insights from choice experiments. Doctoral dissertation at Uni St. Gallen. 3E

Eco design of energy related products directive sets requirements also to products imported to EU

The scope of Energy using product directive was expanded to all energy related products in 2009. The Eco-design directive allows the Commission to develop regulation – with minimum requirements and mandatory CE marking - for practically any product used in buildings.

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The Eco-design directive does not set binding requirements on products by itself: it provides a framework for setting such requirements through implementing measures. The Commission prepares implementing measures only for products which have significant sales and trade in the EU – generally over 200 000 pieces per year - and a significant environmental impact and potential for improvement. The preparation of implementing measures includes several stages ending up in publishing the final regulation – meaning also that the requirements for products defined in the regulation are exactly the same in all EU Member States.

Industry and other stakeholders may follow the progress in all stages, and during the preparatory studies stakeholder meetings are arranged, in principle open to all. However, generally speaking, industry is not really well prepared - only a few companies put enough effort today to follow up, and very few forerunners (typically large international companies) influence actively. All others (SMEs, branch organizations, other stakeholders…) are either totally asleep, or struggle with lack of resources (expertise, money, language skill, patience…)

Process of preparation of regulations

Figure 1 shows the main phases of the preparations.

Figure 2 shows the phases in more detail, including also some features of the minimum duration of phases. The whole process takes 55 months as a minimum, but in practice the whole process can take up to 10 years.

Figure 1. Preparation of Eco-design regulations – the main phases. **1.** Working plan, **2.** Preparatory study – Stakeholder meetings, **3.** Draft regulation – Consultation forum, **4.** Regulatory Committee, **5.** Final regulation.

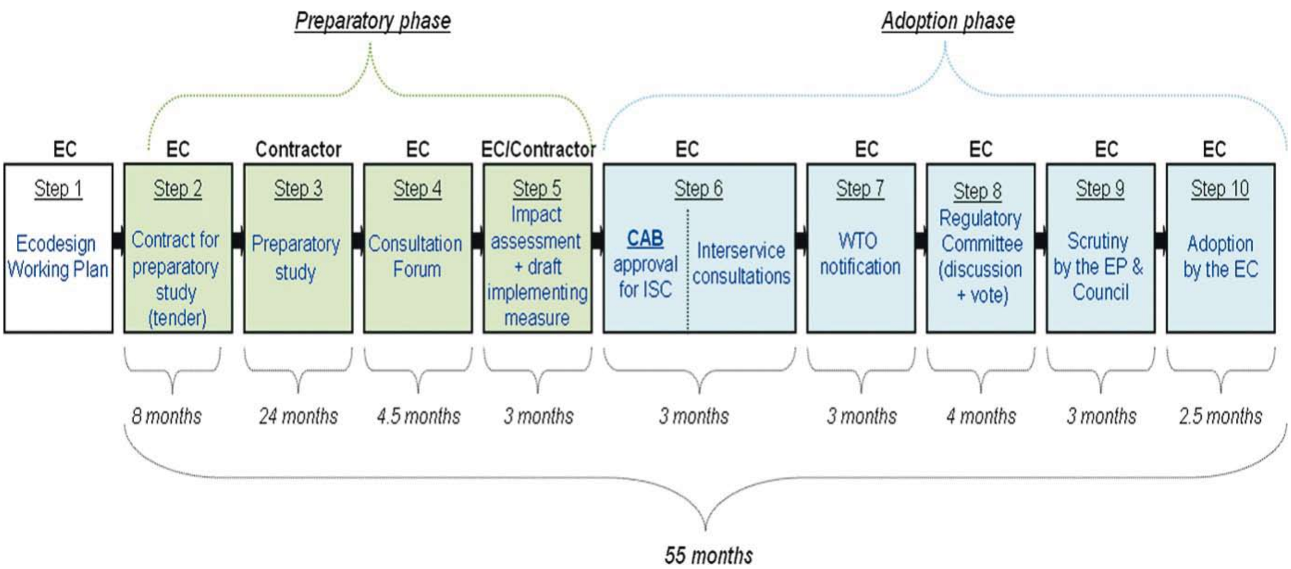

Figure 2. Minimum duration of different phases and steps of Eco-design process.

HVAC-related Eco-design regulations

Adopted HVAC related regulations

Implementing measures have been published and regulations have entered into force for several product groups, including (Regulations can be obtained from Ecodesign website -> Product groups page / Table at the bottom gives links to the regulations in all EU languages)

- Electrical motors - Commission Regulation (EC) No 640/2009
- Circulators - Commission Regulation (EC) No 641/2009
- Fans (125 W to 500 kW power input) - Commission Regulation (EU) No 327/2011
- Air conditioners and comfort fans - Commission Regulation (EU) No 206/2012

Regulations in preparation relevant to HVAC (studies completed)

ENER Lot 1 **Boilers** - The scope of this lot includes self-standing boilers. Technologies covered are fossil-fuel boilers, heat pumps and micro cogeneration up to electrical capacity of 50 W. This includes combination boilers providing heat for heating sanitary water.

The draft ecodesign requirements would be introduced gradually two and four years after entry into force of the regulation. Annex II of the proposal includes information requirements and minimum performance standards for seasonal space heating energy efficiency, water heating energy efficiency, sound power level and nitrogen oxide emissions.

> In the December issue of the journal, page 22, in Mr Saikkala- Grönroos interview it was estimated that the boiler regulations will be published in early 2014 – it should have been **early 2013**.

ENER Lot 2 **Water Heaters**. - The proposed requirements for water heaters, storage tanks, space and combination heaters include provisions for energy efficiency, storage volume, sound power level, nitrogen oxide emissions and product information.

ENER Lot 15 **Solid fuel boilers and fireplace**. - The scope of the proposed ecodesign requirements include solid fuel boiler space heaters and solid fuel boiler combination heaters ('boilers') ≤ 500 kW. Boiler combination heaters can be defined as boilers for space heating in combination with supply of heat to deliver hot drinking and sanitary water. They were not included in the preparatory study of lot 15, but have been included in the working document since no specific other lot covers this product type.

"ENTR Lot 6 – Air Conditioning and Ventilation Systems" –project was closed in July 2012. The "Document" page of the project*, now contains links to the complete final outcome of both "Ventilation" and "Air conditioning" parts of the study. **Ecodesign – Lot 20 and 21 for heating products** final reports are now available online for local heating (Lot 20)**, and for central heating products (Lot 21)***.

So, several product groups for heating, ventilation and air conditioning are subject to preparation of regulations. The difficulty is that a product with several functions can be subject to several regulations, e.g. one for heating, another or cooling, and a third one for ventilation.

For Ventilation units, a Working Document containing a draft regulation of ecodesign and labeling, was sent to the Member States in October 2012. The document is based on the "Ventilation" parts of **ENER Lot 10 and ENTR Lot 6**. One key issue there is that the borderline between "residential ventilation units" and "non-residential ventilation units" has now been defined. Units with fans of less than 125 W power input are regarded as "residential", and larger ones as "non-residential". The proposed regulation, however, gives the manufacturer the possibility to decide the category of the unit independently of the size. Labelling requirements are prepared for "residential ventilation" only, because energy labelling is primarily for consumer products.

2012 - 2014 working programme – other activities for the future

The Working Plan sets out an indicative list of product groups which are considered priorities for the adoption of implementing measures under the Ecodesign Directive.

List of "next" products subject to preparatory studies

European Commission, Directorate-General for Energy, launched in August 2012 a call for tenders with subject **framework contracts for the provision of preparatory studies, review studies and technical assistance**. This framework contract is divided into three lots. The first one deals with preparatory studies and related technical assistance on specific product groups listed in the ecodesign working plans adopted under the Ecodesign Directive. The products mentioned in the call, as priority product groups listed in the second and subsequent ecodesign working plans, include **steam boilers (<50 MW), smart appliances/meters, positive displacement pumps, heating controls and lighting controls/systems.** 3E

* http://www.ecohvac.eu/documents.htm

** http://www.ecoheater.org/lot20/documents.php

*** http://www.ecoheater.org/lot21/documents.php

Evolving landscape of sustainable habitats in India

– TERI's role in constructing change

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The rapid increase in Indian population and growth of Gross Domestic Product (GDP) has given rise to an enormous demand for buildings with a subsequent pressure on availability of resources. With an anticipated 500 million people living in urban India by 2020 (when the present world population is about 7 000 million), the challenges of greenhouse gas emissions from electricity use in new and existing buildings, and building material manufacturing are likely to spike up significantly. Another key challenge for the built-environment of Indian cities is the diminishing availability of water for urban areas.

In order to be sustainable, the environmental pressures of increased demand for resources coupled with a rapidly changing climate are being addressed by policy makers at various levels. Several policy and regulatory mechanisms to address the urban challenges, implemented through national plans and programmes have been devised. The Ministries and agencies at the Centre have designed frameworks such as the Environmental Clearance to ensure efficiency in resource use for large projects (i.e. more than 20 000 m² built up area), the Energy Conservation Building Code (ECBC) applicable to air conditioned commercial buildings with connected load more than 100 kW and the Solar Buildings Programme for Energy Efficient Buildings, for implementation by the designated State agencies and municipal bodies.

However as in most countries, there is a huge scope to optimize the effectiveness of policy by encouraging a more holistic life-cycle approach to building. Lack of disincentives for non-compliance, agencies and systems working in factions (i.e. various departments at Centre and State looking at issues related to energy efficiency, renewable energy, water resources, waste management independently; as opposed to a holistic approach that would address the building sector encompassing water, energy etc. as a whole); and implementation of codes and standards *prior* to verification on site, leading to implementation challenges on site are some of the difficulties faced during implementation of policies on sustainable habitats.

A perceived notion of high costs of green buildings, coupled with flawed and old interpretation, lack of clarity on application domain (such as the ECBC does not address energy efficiency in residential buildings), and lack on integration and uniformity of various codes and standards, has added to impediments in implementation of sustainable habitats.

In view of the above, and with an overall objective to reduce resource consumption, reduce greenhouse gas emissions and enhance the use of renewable and recycled resources by the building sector, TERI has played a crucial role in convergence of various initiatives, essential for effective implementation and mainstreaming of sustainable habitats in India. With over two decades of experience on green and energy efficient buildings, TERI has developed GRIHA (Green Rating for Integrated Habitat Assessment), which was adopted as the national rating system for green buildings by the Government of India in 2007 (refer **Figure 1**).

GRIHA is a tool to facilitate design, construction and operation of green buildings in India, which in turn measures "greenness" of a building. With approximately 7.5 million-m² built up space registered to be

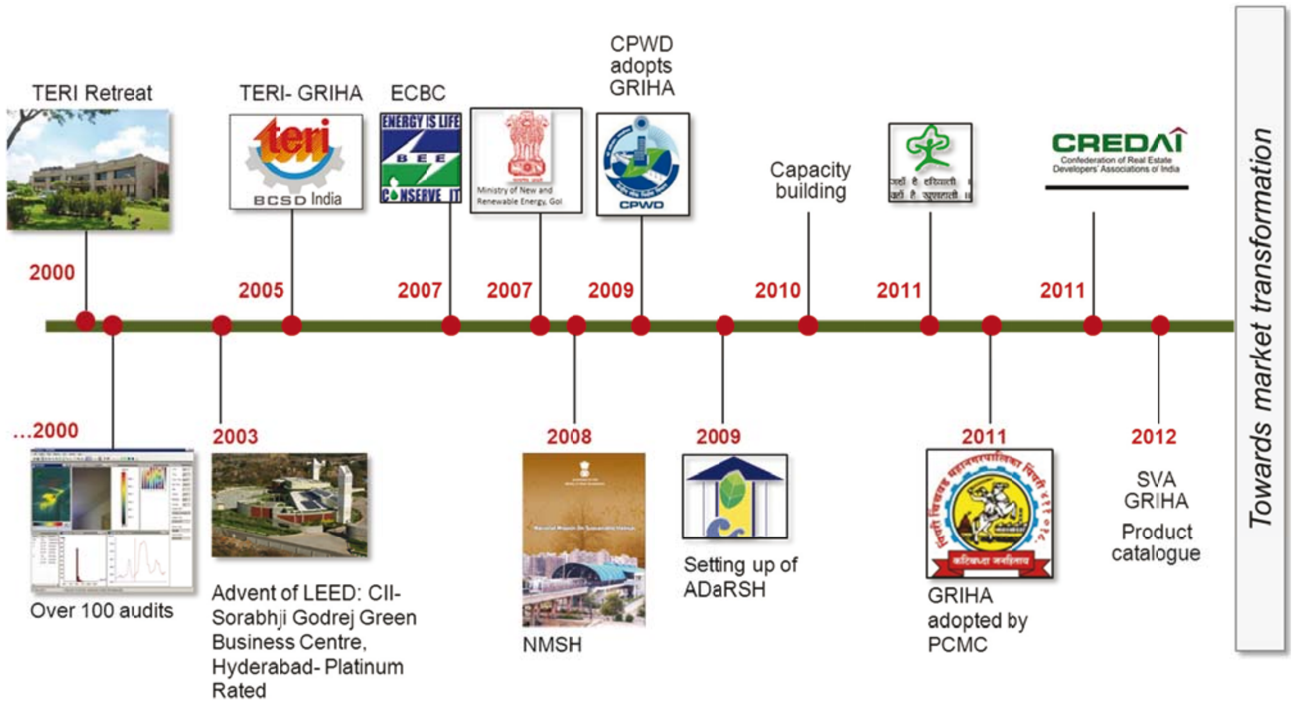

Figure 1. Evolving landscape of sustainable habitats in India: genesis of GRIHA.

GRIHA complaint by the end of 11th Five Year Plan (i.e. March 2012), it is estimated that installation of 5.1 MW of renewable energy through solar photovoltaic cells, solar water heating systems for 1 500 m³ of hot water and full compliance with ECBC shall be executed on completion of the projects. GRIHA compliance for a typical office building used for 8 hours shall result in 30–50% reduction in energy consumption compared to GRIHA benchmarks, 40–65% reduction in building water consumption compared to GRIHA base case and implementation of good practices on site at no/negligible incremental cost. Further, experience from GRIHA implementation on site also contributes to influencing and implementing policy at various levels at the Centre and State.

TERI, together with the Ministry of New and Renewable Energy Government of India and other prominent stakeholders of the industry has set up an independent society called ADaRSH (Association for Development and Research for Sustainable Habitats) for effective implementation and promotion of GRIHA across the country. ADaRSH has trained over 10 000 green building professionals and generated a pool of over 450 GRIHA trainers and evaluators for training and independent evaluation of GRIHA registered projects.

The demonstrated impact of GRIHA projects includes quantification of resource use optimization, implementation of environmental commitments and enhanced transparency through a web based portal. GRIHA also serves as an integrated platform for implementation of various government strategies for environmental sustainability.

In the last one year, the adoption and implementation of the GRIHA standard have grown exponentially across the country as members of the construction sector recognize the value added that GRIHA brings to construction projects across the country. This standard offers proof of the sound environmental performance of buildings, notably of their carbon emissions, and as such helps to increase demand for GRIHA-certified constructions. Companies and others whose constructions comply with the standard therefore gain a competitive advantage over other non-GRIHA compliant institutions.

The success of GRIHA and its endorsement by the government have encouraged companies from the private sector to adopt it and many are now adapting their business models and practices to make them compliant with the standard.

Eurovent chiller certification key stones and future challenges

In 1995 Eurovent launched the first European chiller certification program with the announced goals to provide a common playing field to manufacturer, promote energy efficiency and educate end user. The continuous effort of the industry and independent laboratories helped over the years to shape a strong well recognize program and to lead the way for upcoming legislation.

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Energy Labeling since 2005

Eurovent chiller program introduced the first energy label for chiller based on energy efficiency restricted until that moment to household appliances in the regulation. The classification scheme follows the A to G approach used in the European Energy Labeling regulations for household appliances while the class's thresholds were defined and revised by the participants to promote energy efficient products, phase out non- efficient products and incentivize development.

Development of a European Seasonal Energy Efficiency Ratio

The seasonal efficiency ratio presents another effort from Eurovent and the chiller certification program participant's to provide simple and representative selection criteria to help the purchaser choose more efficient products. Efficiency at standard conditions and energy labeling are great tools to select efficient products but they only reflect the efficiency of the product under standard conditions at full load which is practically insignificant over the real operating conditions of the product. The European Seasonal Energy Efficiency Ratio (ESEER) is a weighed formula enabling to take into account the variation of EER (Energy Efficiency Ratio) with the load rate and the variation of air or water inlet condenser temperature as follows

$$ESEER = A \times EER_A + B \times EER_B + C \times EER_C + D \times EER_D$$

Where

Conditions	Load Ratio %	Weighing coefficient	Air temperature at condenser inlet (air cooled chillers)	Water temperature at condenser inlet (water cooled chillers)
A	100	0.03	35	30
B	75	0.33	30	26
C	50	0.41	25	22
D	25	0.23	20	18

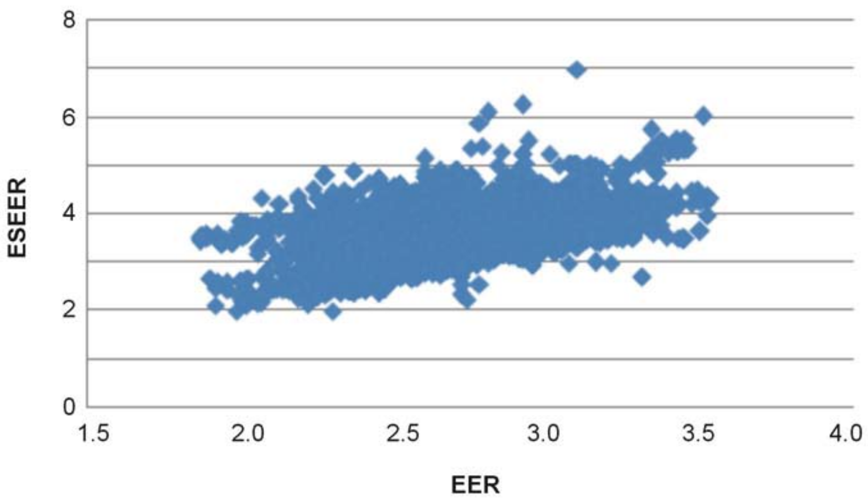

Figure 1. ESEER vs. EER Eurovent 2012 certified data for air cooled chillers

Although the ESEER methodology is inspired by ARI IPLV[**1**], the conditions and the weighing coefficient were determined after a study for European climate and European buildings.

As shown in **Figure 1** the discrepancy between Energy Efficiency ratio at nominal condition and the ESEER, and the fact those units with the similar EER have different values of ESEER summarize the added value of this approach. The ESEER should be the primary criteria to select a unit with better performances at operating temperature conditions and part load.

The ESEER is largely embraced by the market and become recognized as a major selection criterion. The ESEER certification also constituted experience that helped during the study for Ecodesign[**2**] regulation Lot 6 especially for determination of minimum energy efficiency requirement and possible threshold for labeling.

Energy use of pumps and fans impact on chiller performances

A revision of EN14511 was ratified on the 19th of July 2011 and published beginning of 2012. The new version of EN 14511-2011 advocates that the efficiency of the pump whether it is an integral part of the unit or not is a function of its hydraulic power instead of the default value.

Historically chiller performances were certified as "gross" values measured when the pump is not running for units with integral pumps. This choice was made as the previous methodology (using a default value) was unrealistic and penalizing especially large units.

As this method is more realistic, the chillers program participants decided to fully apply this new version starting from the 2012 certification campaign. The new performances declared based on this new version of the standard were published on the ECC website by March 2012.

As shown in **Figure 2** a significant difference between thermal performances (Cooling/Heating capacities, EER/COP and ESEER) published according to EN 14511:3-2011 and those certified during the previous campaigns (calculated according to EN 14511:3-2007 with exception of heat exchanger pressure drop & water pump efficiency) can be observed.

Eurovent also advocates for the adoption of the same mythology for Fan's as minimum efficiency are already defined in the regulation 327 for lot 11. This approach will guarantee harmonization between the different EupLots[**3**] and to have a better transcription of the real performance of the unit.

Ecodesign

Under Ecodesign Directive chillers are affected by 3 studies which are Lot 1 Boilers and combiboilers, ENTR Lot 1 Refrigerating and freezing equipment and ENTR[**4**] Lot 6 Air-conditioning and ventilation systems. The Eurovent product group for chillers heavily participated in the work done for these lots through position papers, meeting with the consultants in charge of the preparatory study and participation in the stakeholders meeting. Eurovent help bringing accurate data and information about the state of the art of chiller industries and the forecasted technological developments in this field. The work done by Eurovent certification on the development of a seasonal energy efficiency ratio in cooling and later on in heating (ESCOP[**5**] project) helped pinpoint the dif-

1 ARI IPLV" : Integrated Part Load Value by AHRI [reference : AHRI Standard 550/590 (I-P), see http://www.ahrinet.org/App_Content/ahri/files/standards%20pdfs/AHRI%20standards%20pdfs/AHRI%20Standard%20550-590%20%28I-P%29-2011.pdf]

2 Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast).

3 "Eup Lots": Lots for "Energy using Products directive", previous name of "Energy related Products directive" [reference : http://ec.europa.eu/energy/efficiency/studies/ecodesign_en.htm] where scope has been splitted per families of products, grouped in so called Lots.

4 Directorate-General for Enterprise and Industry at the European Commission.

5 "ESCOP": European Seasonal Coefficient of Performance.

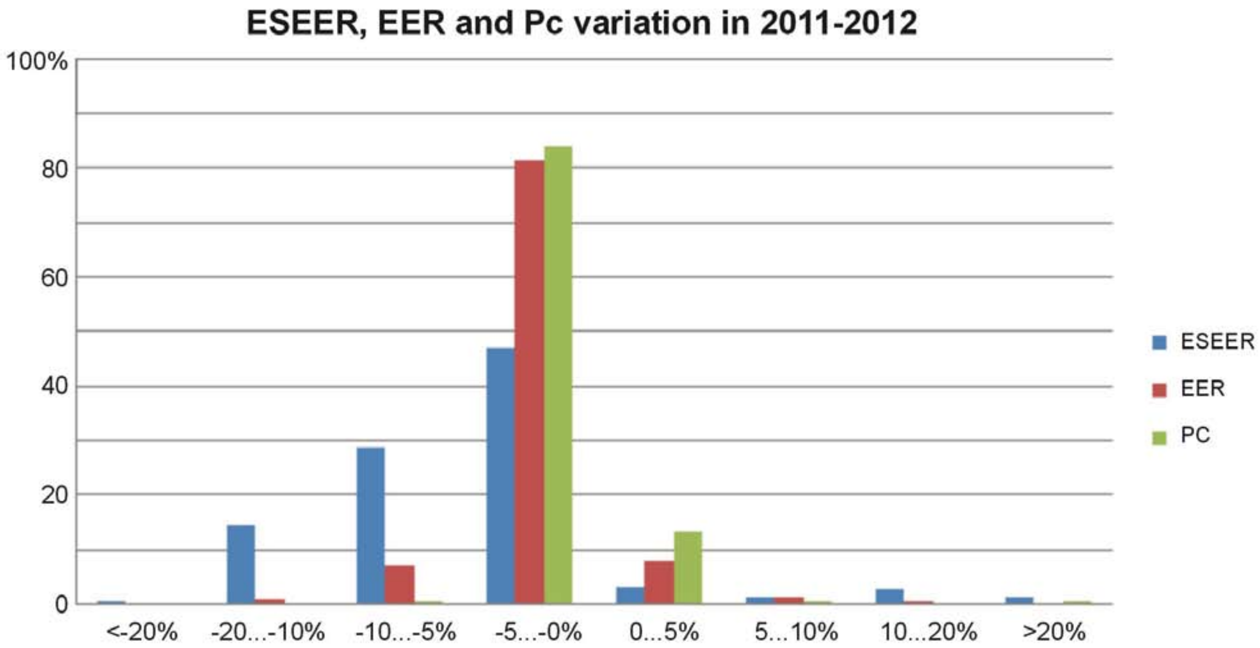

Figure 2. Distribution of the difference between 2012 net data and 2011 gross data in percentage (in horizontal axis). ESEER = European Seasonal Energy Efficiency Ration, EER =Energy Efficiency Ratio, Pc = Cooling.

ferent challenges for the instituting such factors. The certification committee for chiller also started working by creating a technical committee in order to tackle the different issue for starting the certification of performances required by the regulation that will emerge from the lots sited above.

Data publication

Making the certified data easy available for consumer and consultant was always a priority for Eurovent. Our interactive web site, created since the launching of the company helps bring reliable data. In addition to the certified data a dedicated description page for each certification program containing the outlet of the program, definitions and rating conditions is made accessible and constantly updated to help visitors understand the value and the consistency of the certified data.

In 2009 Eurovent launched a widget called Certiflash designed as a service bringing added value to the community of consultants, design engineers, specifiers, architects, buyers, contractors, developers looking for quick and real-time access to HVAC products data and to get individual certificate for HVAC products.

Available on the three popular web browsers and on iPhone, Blackberry and Android mobile phones, Certiflash is the guarantee to have a permanent access to certified data and to generate individual certificate that can be used to complete applications for local incentive scheme or to obtain a building energy performance rating.

Eurovent is also part of a project called CLE@[**6**] that aims to feed on a regular basis numerous building thermal/energy simulation software. By doing so, Eurovent certified products and associated performance data are imbedded and directly used in building calculation engines which is very helpful to consultant at the stage of product selection. This project comes as a response for the implementation of EPBD directive in different EU countries (RT 2012 in France) that requires the declaration of an important amount of performances. 3Ɛ

The article was originally written by Ahmed Fatteh, Project Engineer at Eurovent Certification

6 "CLE@": Association managing databases (issued from Promodul and Edibatec associations): [ref: http://www.promodul.fr/sites/default/files/Juin_2012-Lettre%20Information%20CLEA.pdf]

How to improve energy efficiency of fans for air handling units

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Introduction

Fans use approximately 40% of all electricity in HVAC systems. Despite all the textbooks and handbooks, which describe the proper procedure for selection of fans, practice shows that fans in existing HVAC systems have very low total efficiency. In Sweden, ECiS AB (Energy Concept in Sweden) performed performance measurements of 767 fans in existing HVAC systems between the years 2005 and 2009. The average total efficiency[1] of all the fans was only 33% (**Figure 1**). Only a minor share of the fans had the efficiency in the range 50–60%, which is below the requirements of the EU regulation on efficiency of fans. It is most likely that the data from Sweden represent better than average practice in EU countries. It is evident that on average, fans have a huge energy improvement potential. Up to 50% of electricity for fans could be saved just by designing and installing more energy efficient fans and introducing better control strategies.

Best technology products

Today's best fans include an electric motor in brushless direct current (DC) technology, also known as electronically commutated motors (EC motor), with an integrated frequency converter for step-less load control and an impeller with low aerodynamic losses. Fans should be direct-driven, i.e. the fan impeller is directly mounted on the electric motor shaft. In the range of higher flows and pressures, the EC motors are not yet available. In that range the best available technology of motor is an AC electric motor of the efficiency rating IE3 with a variable frequency drive.

1 Total efficiency is measured by comparing the electric power consumption to the mechanical power of the fan.

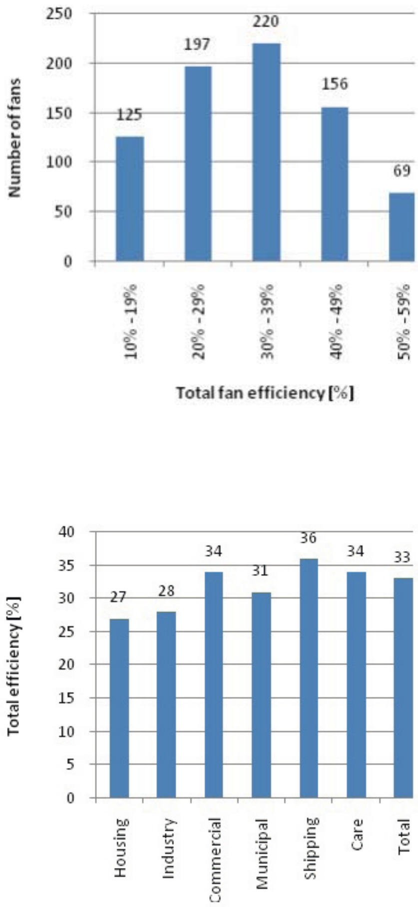


Figure 1. Results of total efficiency measurements of 779 fans in Sweden. Most of the fans had total efficiency between 30–39%. Efficiency is comparable in different building sectors (top), but the lowest in residential sector (bottom).

Requirements for the minimum energy efficiency of fans are presented in the mandatory European regulation on fans based on Ecodesign directive (EC, 2011). The fan regulation (**Figure 2**) only set limits for the lowest fan efficiency of the products sold or manufactured in EU. Already today in 2012, the products with better efficiencies than those required by the directive are available in the market.

According to the regulation on fans, the efficiency of fans must be always given as a total efficiency of the fan assembly, i.e. including losses of all the components of

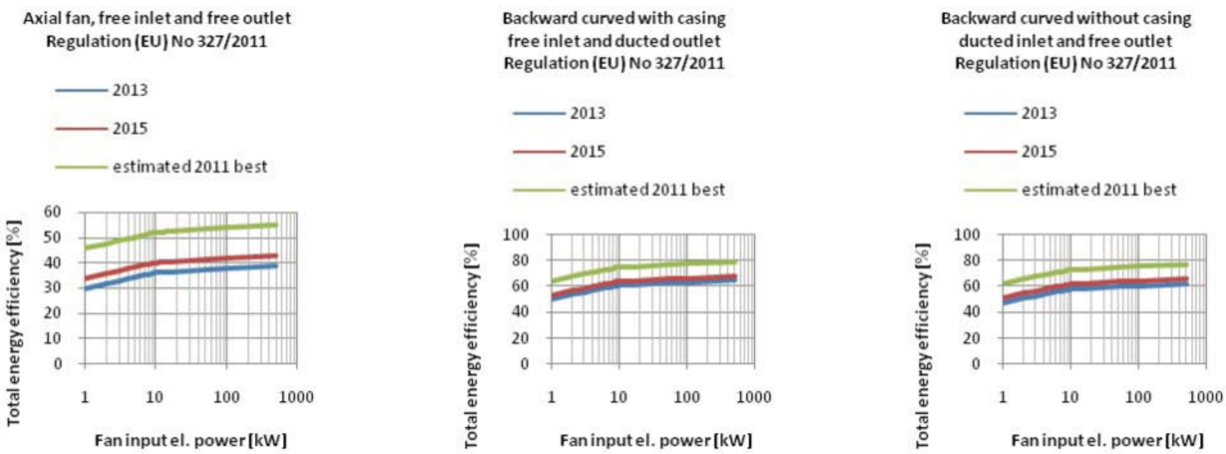
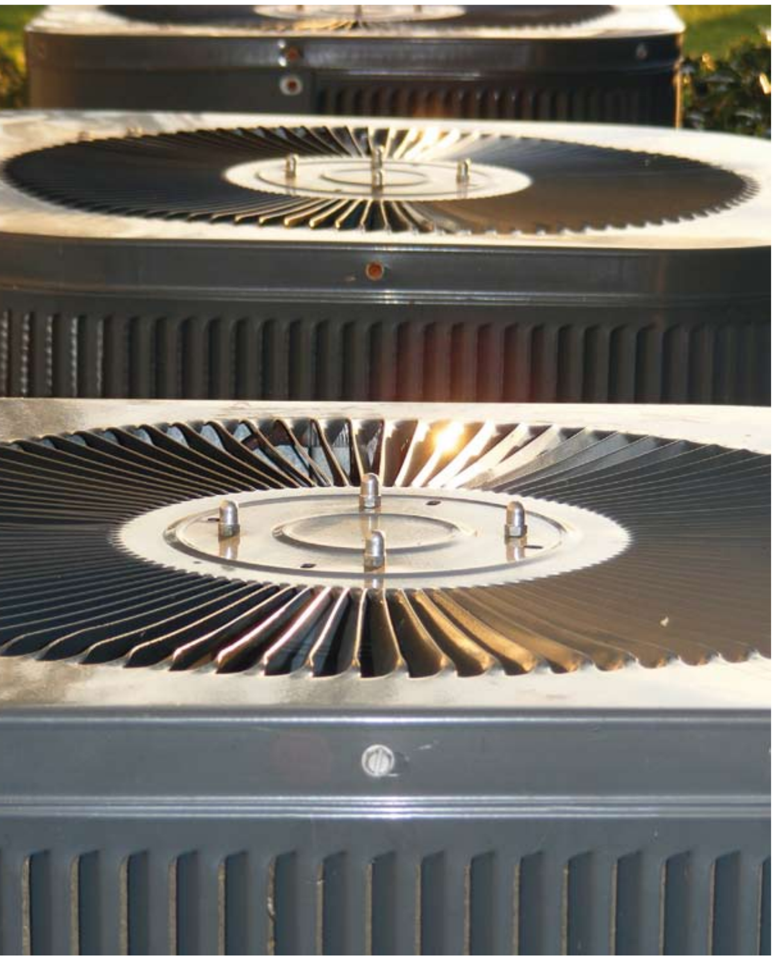


Figure 2. Target total efficiency of fans according to requirements of EU fan regulation. The charts indicate that the requirements for 2015 are stricter that the requirements for 2013.



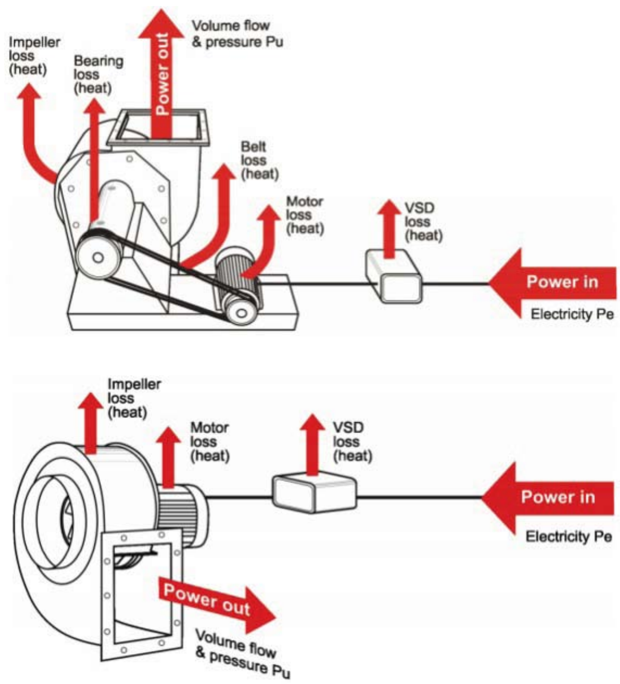


Figure 3. Breakdown of efficiency losses in fans. Belt-driven centrifugal fan (top). Direct-driven centrifugal fan (bottom). There are less steps of energy conversion in direct-driven fans, which makes them more efficient.

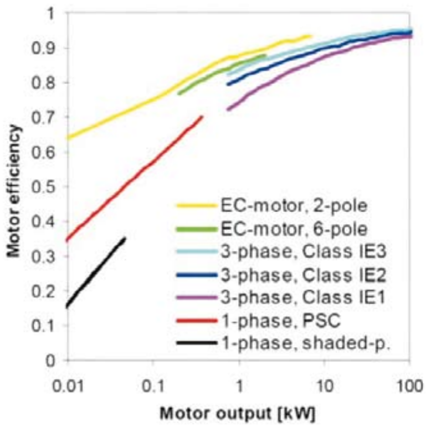


Figure 4. Efficiency of different motor types. EC motors have the highest efficiency, especially in the range of low motor output.

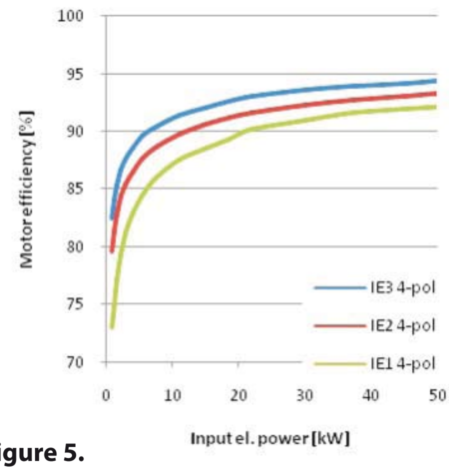


Figure 5. Efficiency classes of AC motors. IE3 class is the most stringent.

the assembly: the electric motor, the frequency converter, the belt drive (if given), the aerodynamic design, and the efficiency of the fan wheel.

The total efficiency is measured by comparing the electric power consumption to the mechanical power of the fan. The total efficiency of a fan is given as a product of all the partial efficiencies of the fan assembly:

$$\eta_{total} = \eta_{motor} \times \eta_{frequency\ converter} \times \eta_{belt\ gear} \times \eta_{dynamic\ loss} \times \eta_{fan\ wheel}$$

It is evident from the equation that in order to have a high total efficiency, all the efficiency of each component should be as high as possible. One weak link in the system can considerably reduce the efficiency of the entire fan assembly.

Motors (η_{motor}) are a crucial link in the efficiency chain of every fan. The best electric motors are brushless DC motors, otherwise known also as the EC motors because they are electronically commutated. The commutation is the application of current to motor phases for production of an optimum motor torque. With an electronic commutation, a motor can operate with e.g. 1.4 poles to find the right speed. The EC motors are currently available in the low power ranges but they are slowly penetrating into the market of the higher motor powers. The advantage of EC motors in comparison to an AC squirrel-cage induction motors is not as outstanding in the high power ranges, but it is the part-load efficiency that gives advantage the EC motor technology (**Figure 4**). The AC motors are classified into the three efficiency classes (**Figure 5**). As from 16th June 2011, motors of the class IE1 should not be sold on the market. Class IE4 (Super-Premium Efficiency) is expected to be officially defined in the future and will take into account also non-AC motors, like EC motors. The IE3 motors are already available on the market today, and some EC motors already fulfil the requirements of the proposed IE4 class.

Variable frequency drive – VFD ($\eta_{frequency\ converter}$) adjusts the speed of the electric motor according to the load, which results in a lower motor speed and an energy saving. The frequency drive itself has an efficiency rating that needs to be taken into account, because it depends on the nominal output and the partial load. The VFD losses are typically 2…5% at the nominal torque and speed, and 10…30% at 25% torque and speed.

Belt drive ($\eta_{belt\ gear}$) imposes considerable efficiency loss. The efficiency depends on the calculation of the belt gear, type of the belt, and the complete gear adjustment. Normally an expected efficiency of a belt drive is 90% at medium power (3–15 kW), but it can easily slip to 60–70% if the gear adjustment is incorrect. The newly designed AHUs must avoid belt-driven fans and should always use direct driven fans, whose transmission efficiency is 100%.

Aerodynamic design ($\eta_{dynamic\ loss}$). There is always a dynamic pressure loss in a fan. The size of the loss is dictated by the aerodynamics of the fan hood (or the AHU chamber in the case when a hood is not used). A well designed fan hood always gives less dynamic pressure loss than a chamber does.

Fan wheel ($\eta_{fan\ wheel}$). Depending on the type and design of the blades of the wheel, the efficiency will be different. The highest efficiency of up to 85% is achieved with backward curved blades (wheel type B). The forward type wheel is often used because it delivers greater airflow at smaller sizes of the wheel but at a cost of lower efficiency. In practice, fan wheels with backward curved blades should be used in AHUs.

Selection of a fan type and size

In selecting a fan for HVAC applications it is often found that several fans of different types and sizes provide the required performance. Considering that an engineer already defined the required performance of the fan (airflow requirement, pressure, size restrictions, ambient temperature and other special requirements), the first step in a selection process is to select fan type. If that the fan is to be installed into an AHU, the most common question is whether to select a centrifugal fan in casing or without casing. Centrifugal fan in casing usually has slightly higher efficiency than a fan without casing, but in an AHU it is more vulnerable to the installation effect, which reduces its efficiency. Therefore, for AHUs, a backward curved centrifugal fan without casing is the preferred option for majority of AHUs.

The next step is to select a fan motor. Because of the high efficiency, EC motors should be used whenever possible. Asynchronous AC motors with variable frequency drives as are the second option. When selecting the fan size, several sizes are usually able to provide the required airflow and pressure in the operating point. The size, where the operating point is closest to the best efficiency point and motor electrical input is the lowest, should be selected.

However, if the fan is going to operate in a variable flow system, and it is selected using “worst case” (design) operating point near the point of highest efficiency, such fan may operate at lower efficiency in the part load. Knowing that in variable flow systems fans operate most of the time with less than the “worst case” flow, such a fan will not have the lowest LCC. For variable flow cases, a selection should also consider efficiency and operating time in part-load range. The best efficiency point is by no means close to the 70% of maximum airflow, like suggested in EN 13779, but considerably varies with flow rate and pressure.

Another problem that will probably appear in fans, operating in variable flow but selected for the “worst case” flow is the low frequency noise problem (rumbling), which appears in part load range. This noise is difficult and costly to attenuate. It is better to select a fan size such that peak efficiency is achieved at the most common flow rate, but fan should still be able to deliver the “worst case” flow. During the short periods of maximum flow demand, the increased fan noise will have a higher frequency, which is easier to attenuate, using less expensive silencers.

Importance of good specification

Specification of a fan is an equally important step in a HVAC system design as the selection process. In many EU countries, designers only specify the needed airflow and pressure of a fan in an AHU assembly. The contractor, responsible for ventilation installations, orders equipment on the base of criteria, which is given in the project specification. If total fan efficiency or motor input power is not given in the specification, the contractor can choose any fan that fulfils the basic requirements which are given, i.e. usually airflow and external pressure. In such situation, the contractors select the fan with lowest first cost, which still fulfils the specified requirements. Due to the fact that one fan can cover a wide range of airflows and pressure, especially in combination with a variable frequency drive, it is relatively easy to choose a smaller (and cheaper) fan instead of a larger (and more expensive) fan. **Figure 6** shows how two different fans can operate at the same operating point but one fan has more than 20% lower total efficiency. The fan with the lower efficiency is two nominal sizes smaller and thus less expensive to install than the fan operating with the higher efficiency. The current EU fan regulation does not prevent such situation

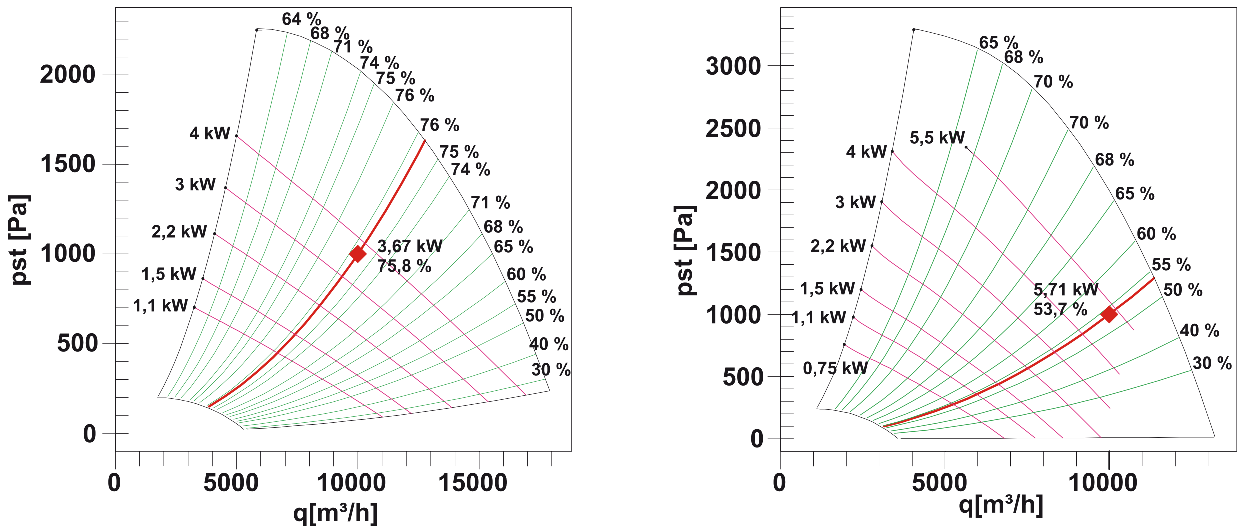


Figure 6. Comparison of two fans of different sizes operating at the same operating point but with different efficiency. The left diagram is nominal size 500 mm and the right one for a fan of nominal size 400 mm.

because it only limits the minimum total fan efficiency at the best efficiency point, which can be in practice far away from the real operating point, where efficiency is considerably lower.

If a contractor installs the fan from the **Figure 6** (right) into a system that operates 4000 hours per year, it will use 22 840 kWh of electricity. The electricity cost per year at a price of 0.10 €/kWh will be 2 284 €. If a contractor would install the more efficient fan (**Figure 6** left) it would use 14 680 kWh of electricity at a cost of 1 460 € per year. A specification of the more efficient fan would save the building owner or tenant 816 € per year or 12 240 € in 15 years. It is evident, that the installation of a ca. 500 € cheaper fan will cause considerably higher electricity use and costs to the owner or tenant.

In order to prevent such situation from occurring in practice, an engineer should always specify at least the following data; airflow, external pressure, total fan efficiency, grid power, air temperature rise. Besides that, voltage and type of motor should also be specified in order to eliminate the problem of compatibility between the fan end the electric network.

Control strategies

Control allows a fan to adapt airflow and/or pressure to the needs of a system. If we consider that the suggested SFP for new building is 2.0 kW/(m³/s) or 2.0 W/(l/s), for every litre of air per second that is moved around without purpose, 2 W of energy is wasted just for the transport its transport. The energy wasting can be several times higher if heating and cooling of the air are also considered.

Traditionally fans were usually not equipped with any of the control strategies and run at constant speed. Some belt driven fans have relied on gear mechanisms to change the fan speed and thus control air flow in steps. Other control types included pressure dampers, vane angle and bypass to control volume flow in the system. However, these systems are not energy efficient because the fan speed is not reduced.

According to the fan affinity laws, fan power is proportional to the third power of the ratio of fan speed:

$$P_{r2} = P_{r1} \times (n_2 / n_2)^3 \qquad \textbf{(Equation 1)}$$

where P_r is the mechanical input to the impeller and n is the fan rotational speed. That means, if fan rotation speed is reduced by 10%, the fan power will reduce 27%. The most efficient way to reduce fan energy use in variable flow is to reduce fan rotation speed, which can be most efficiently achieved with frequency controlled electric motors.

The biggest advantage of using speed-controlled fans is when they are used in variable air volume flow systems (VAV). Fan power can be considerably reduced in the part-load range if air volume flow is reduced:

$$P_{input} = \frac{p_{tot} \cdot \dot{V}}{\eta_{tot}} \qquad \textbf{(Equation 2)}$$

where P_{input} is electrical power absorbed by the motor from the grid (W), ptot is total pressure across fan (Pa), $\dot{V}$ is air volume flow (m³/s) and η_{tot} is total fan efficiency (%).

The relation in **Equation 2** between fan input power and air volume flow is linear if total pressure and efficiency are constant. In practice, total fan efficiency and pressure vary if volume flow is changing. For a fixed system, it may be said that the system resistance (equal to the pressure required to pass a given volume of air through the system) will vary as the square of the volume flow rate, i.e. $p_f \propto q_v^2$. Therefore, to double the airflow, a pressure four times greater is required from the fan. This is only true for a static system and constant air density. If the resistance of the system can be altered, e.g. by closure of a damper, then the above laws do not apply and the relation between pressure and flow is much more complicated. The efficiency in **Equation 2** is also reduced by decreasing airflow due to the part-load losses in electric motor and variable speed drive (**Figure 7**). The decrease in efficiency is greater in the case of AC motor controlled by a VFD because they have lower part load efficiencies than EC motors. This Figure also suggests that fan should not be sized with a reserve on air volume flow side. In contrast to reserve on the pressure side, reducing volume flow does considerably affect efficiency of a fan.

All new fans are suggested to be speed controlled by using EC motors, which have integrated VFD, or AC motors with an external VFD. On the first sight it may seem that a VFD in addition to an AC motor is useless or even unfavourable due to its losses in constant air volume flow systems (CAV). However, pressure conditions vary in every ventilation system which is equipped with filters, because filter pressure drop changes through time as filters get soiled. Buildings are rarely static systems. There may be significant alterations in the function or capacity of ventilation systems, which often require reset of fan operation point. Another advantage of variable frequency drives is that they allow for small pressure reserve on the fan size during the design phase. If pressure reserve is used when selecting single speed fan but the resistance of a real system is lower, a fan will operate at a higher flow rate and thus waste energy. If a variable EC motor or VFD is used in such situation, it will allow for changes of the fan speed and thus pressure of fan – air volume flow can easily be adapted to the designed air flow and energy waste is avoided. An example in **Figure 8** shows that the efficiency does not decrease dramatically when the static pressure of an EC fan is decreased (in case when a fan was selected with some pressure reserve).

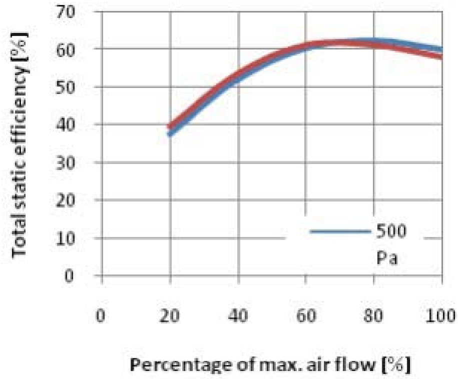


Figure 7. Total static fan efficiency of a backward curved EC fan without casing (100% = 10 000 m³/h). By reducing the airflow, efficiency first increases because the 100% operating point was selected on the right side of the best efficiency point. (Calculated with Ziehl-Abbeg fan selector)

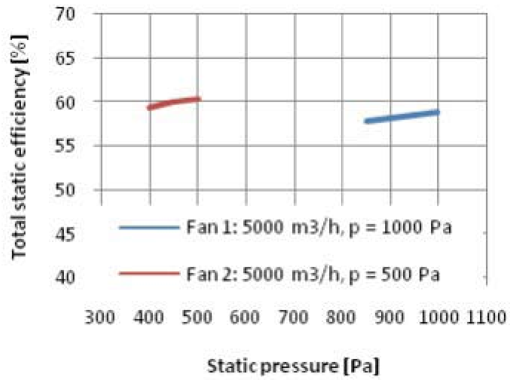


Figure 8. Total static efficiency decrease of the same fan as on the left chart due to the lower operational static pressure (Calculated with Ziehl-Abbeg fan selector).

Conclusion

Fans are one of the major electricity users in HVAC systems. In order to achieve good efficiency of fans once they are installed, it is not enough just to select best products on the market, but also to change design and and selection procedure to fit such technology. With increased number of variable air volume systems entering the market, old principles of design that are embeded in minds of engineers have to be changed and alligned with the development of technology.

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Influence of the dry cooler capacity on the efficiency of chillers

- increased energy efficiency through certification

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Energy efficiency is currently one of the most important subjects in the HVAC&R industry. When using a certified chiller with a separately installed condenser or recooler, it is very advisable also to use a certified product in order to reach the maximum energy efficiency.

Eurovent Certification Company (ECC) started the Certification Programme for Liquid Chilling Packages (Chillers) in 1996. The programme applies to standard chillers used for air conditioning and refrigeration. In 2006 the ESEER -European Seasonal Energy Efficiency Ratio - was implemented. By the publication of the certified data on the ECC website www.eurovent-certification.com the average chiller efficiency is comparable.

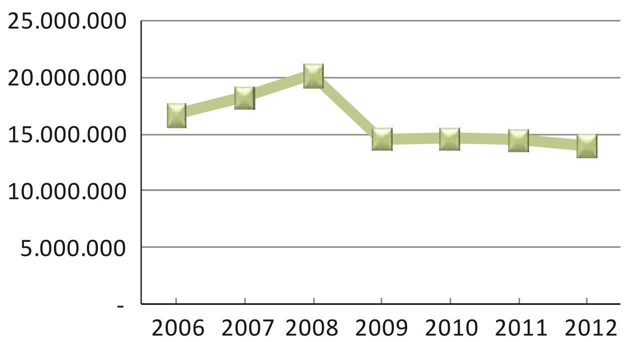

Figure 1. Chillers' sales evolution in cooling capacity, EU.

Chiller Construction Types

Water cooled chillers are built with plate and tube bundle heat exchangers as condensers. Hereby the heat is being dissipated into the ambient air by a recooler in the secondary cycle. If the heat is being dissipated directly into the ambient air by a condenser, the system is called air cooled chiller. These are classified as either compact chiller for outdoor use with integrated air cooled condenser or chiller split system with an air cooled condenser for outdoor installation. Today, in most cases compact air cooled chillers are used.

Chiller Market

Most chillers are certified by Eurovent Certification Company. Currently 33 chiller manufacturers participate in the Certification Programme. The chillers' sales evolution in the EU in the past seven years is shown in **Figure 1**.

The EU sales proportion according to construction type and size is shown in **Figure 2** and **Figure 3** [**1**].

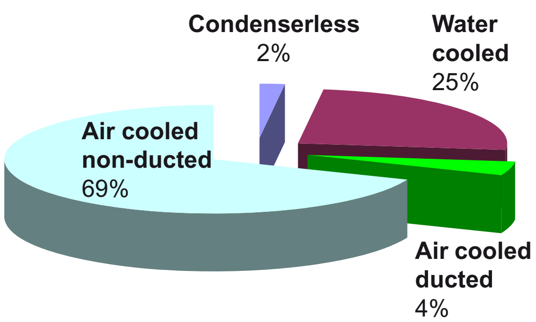

Figure 2. Chillers' sales by construction type (shares in cooling capacity, kW), EU 2011.

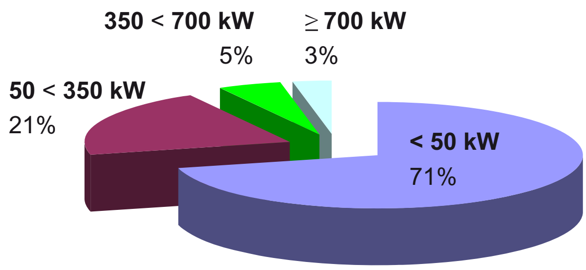

Figure 3. Chillers' sales by cooling capacity (shares in number), EU 2011.

In the following the energy consumption of the complete system water cooled chiller plus dry cooler is considered. Thereby the influence of the dry cooler's capacity on the energy efficiency of the complete system is shown.

On the initiative of the Eurovent certified heat exchanger manufacturers the performance of nine heat exchangers manufactured by seven European companies not participation in the Eurovent Certification Programme was tested in an independent test facility between 2004 and 2008. A comparison of the performance data tested with the values published in the manufacturers' product literature resulted in a capacity reduction up to 37% [**2**].

Calculation Model

A Eurovent certified water cooled chiller of Eurovent energy efficiency class B used for air conditioning (cooling only) is considered. The cooling capacity of 1 000 kW at full load and ambient temperature 35°Cis provided by two screw compressors using refrigerant R134a. The evaporator is cooling down water from 12°Cto 7°C. In the simplified model it is assumed that the temperature difference between condensing temperature and ambient temperature is fixed 12 K. The condenser is heating up the secondary fluid which is recooled by a dry cooler. In the dry cooler the secondary fluid is cooled down by 5 K to a temperature which is 5 K above the ambient temperature. The pump power of the secondary fluid is not considered. The study is comparing the efficiency of the chiller plus certified dry cooler with the chiller plus a non-certified dry cooler having a capacity gap of 25%. At full load the non-certified dry cooler is causing a 2.5 K higher condensing temperature of the chiller. At 75%, 50% and 25% part load operation the AC fans' speed of the non-certified dry cooler is raised to achieve the same condensing temperature as when using the certified dry cooler. By the calculation of the ESEER value of the complete system the energy efficiency is compared.

Results

The dry cooler fan power consumption is within the range of 10% and 20% of the total system's power consumption at the different load conditions (**Figure 4**).

Figure 5 shows the EER of the total system with the two different dry coolers. The ESEER value of the system using a dry cooler with capacity gap is 4.6% lower due to the higher power consumption of the chiller at full load and the higher power consumption of the fans of the dry cooler at part load operation.

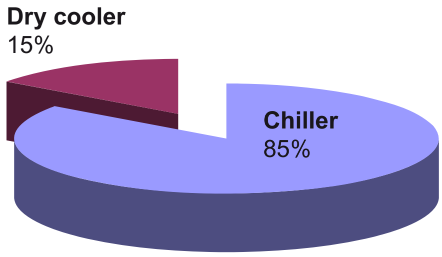

Figure 4. Power consumption of the total system chiller plus dry cooler (kW).

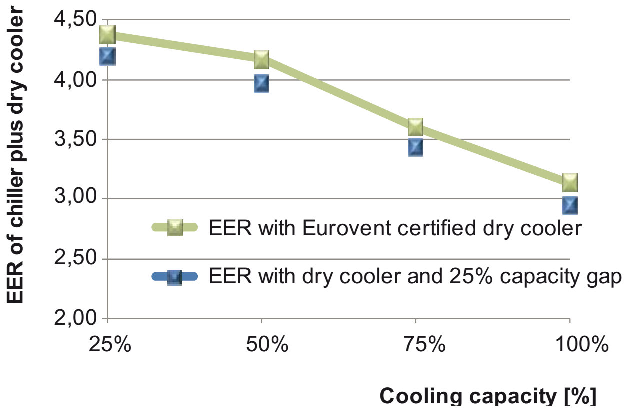

Figure 5. EER of system chiller plus dry cooler at different load.

For the City of Milan the annual energy saving of the chiller system using a dry cooler obtaining the designed capacity is around 20 000 kWh at calculated 3 542 operating hours. At energy costs of 0.15 €/kWh the saving in energy costs will be around 3 000 € per year. Assuming that a non certified dry cooler may be 10% cheaper the payback time is less than 1.7 years and every year annual savings in operating costs will be achieved. Additionally capacity gains or benefits when for example operating with free cooling are possible. For chillers with longer operating hours or chillers designed for process cooling the payback time will be even shorter.

Conclusions

The paper showed how important it is to use certified components and systems. Correct performance data for heat exchangers are absolutely essential, because they influence the energy efficiency of the entire system. In the study a water cooled chiller recooled by a dry cooler with a capacity gap of 25% was causing 4.6% higher energy costs.

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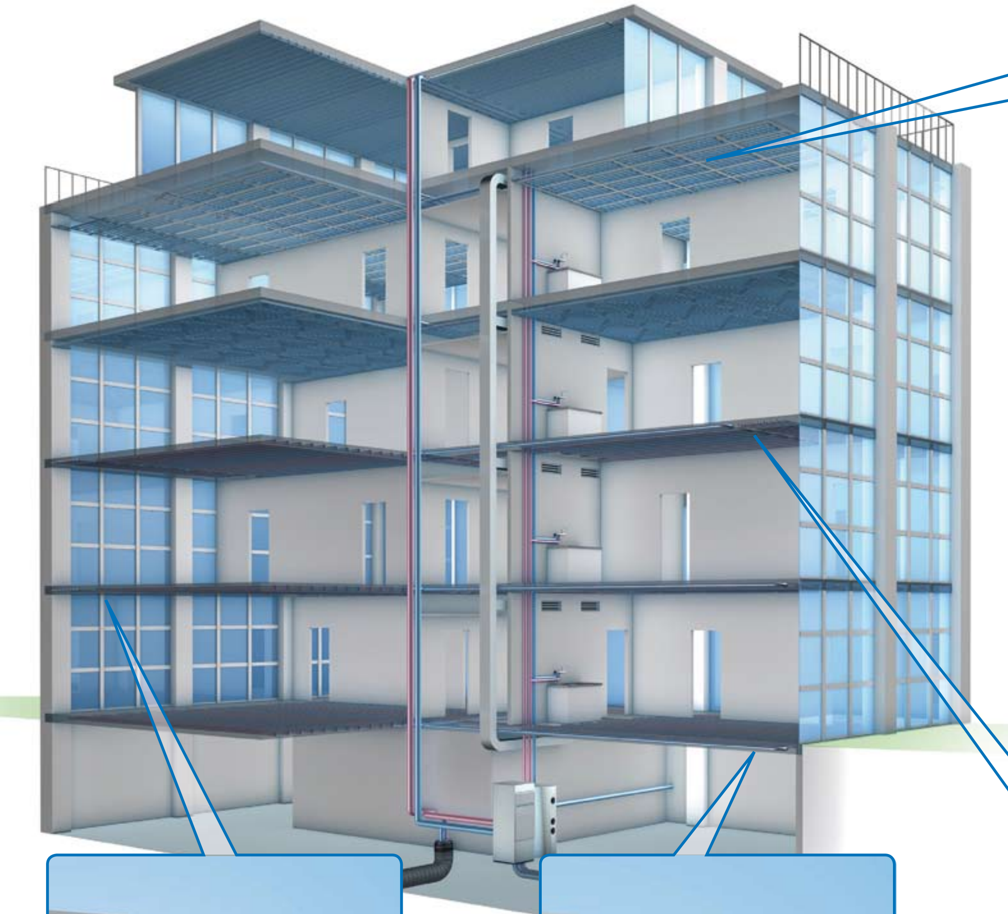

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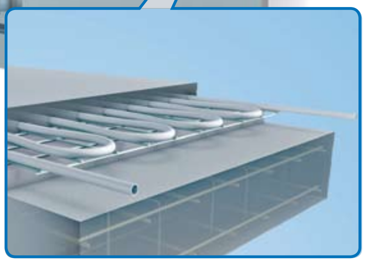

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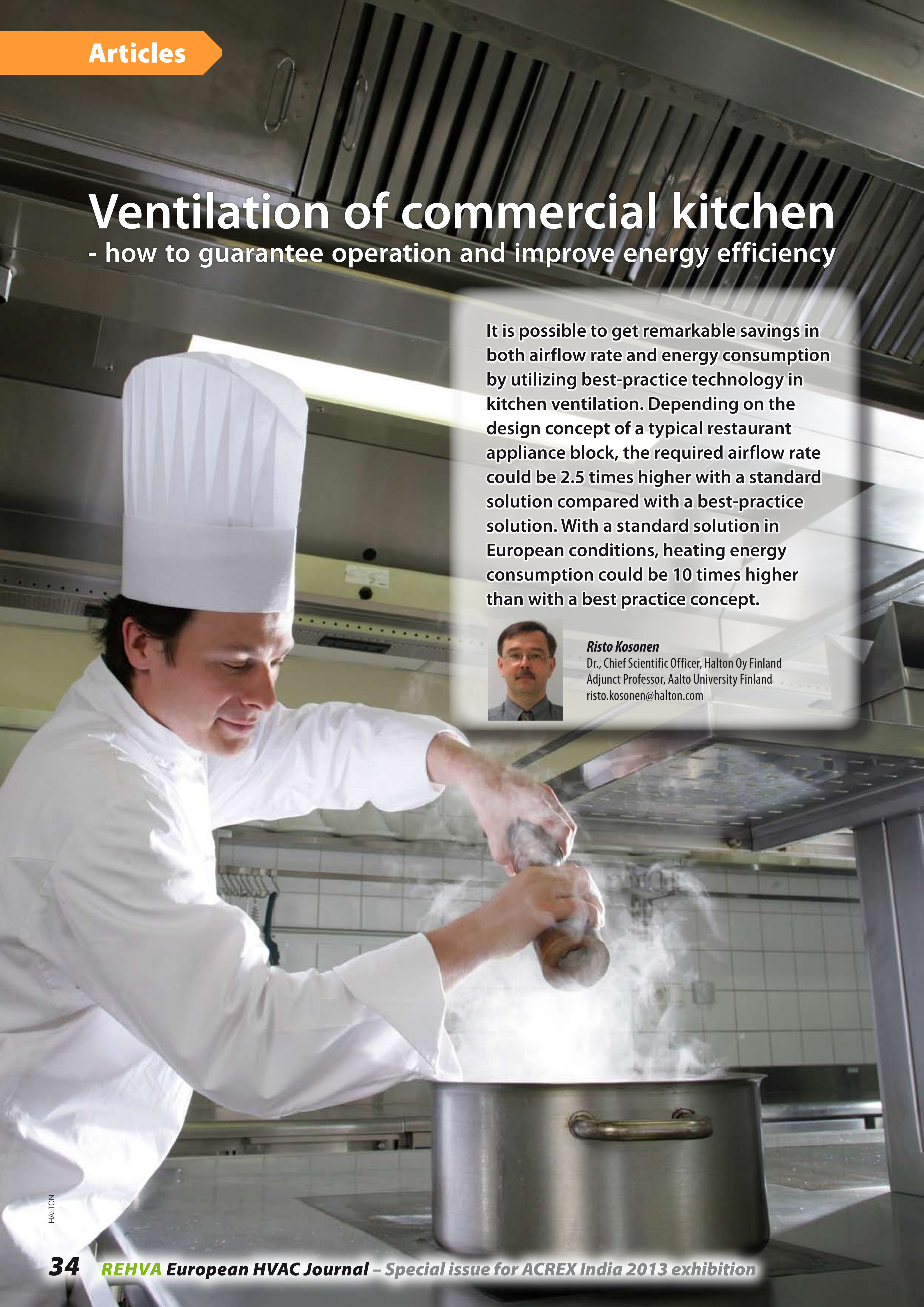

Ventilation of commercial kitchen

- how to guarantee operation and improve energy efficiency

It is possible to get remarkable savings in both airflow rate and energy consumption by utilizing best-practice technology in kitchen ventilation. Depending on the design concept of a typical restaurant appliance block, the required airflow rate could be 2.5 times higher with a standard solution compared with a best-practice solution. With a standard solution in European conditions, heating energy consumption could be 10 times higher than with a best practice concept.

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Importance of ventilation in kitchen

Concerns over the indoor environment have increased during recent years as a result of the knowledge about the significance of thermal conditions and air quality on health, comfort and productivity of the workforce. In a commercial kitchen, working conditions are especially demanding. There are four main factors affecting the thermal comfort, these being: air temperature, thermal radiation, air velocity and air humidity. At the same time, high emission rates of contaminants are released from the cooking process. Ventilation plays an important role in providing comfortable and productive working conditions and in securing the contaminant removal.

The published studies demonstrate quite clearly the health risk of cooking. Thiebaud et al. [**1**] indicates that the fumes generated by pork and beef frying, were mutagenic. Hence, the chefs are exposed to relatively high levels of airborne mutagens and carcinogens. Metveinen [**2**] carried out measurements at eight workplaces. The survey confirmed that cooking fumes contain hazardous components. It also indicated that kitchen workers may be exposed to relatively high concentration of airborne impurities.

Ventilation and air conditioning systems are required in commercial kitchens to:

1) remove odours and particles of fat
2) comply with hygiene requirements
3) remove moisture and heat, which are generated in the preparation process of meals and washing and
4) provide comfortable and productive working conditions.

To meet these tasks, supply and exhaust air systems shall be installed in the kitchen areas so that odours, air pollutants, extra heat and moisture are removed effectively.

All this indicates the importance of the well-designed ventilation in the kitchen. The efficiency of the exhaust system should be especially emphasized. The removal efficiency of the total system must be guaranteed and impurities spreading throughout the kitchen should be prevented. All this should be provided in an energy efficient manner.

Guaranteed operation preconditions

A properly designed and located exhaust hood or exhaust unit of ceiling is essential for effective kitchen ventilation. The ventilation system is used to capture the heat, odours and vapour emitted during the cooking process and to contain it until the fan exhausts them to outdoors. The ventilation system also replaces the exhausted air by bringing fresh air to the working place to maintain good air quality and comfortable thermal conditions.

There are different commonly used methods available to calculate the required airflow rates. For example, the "Rule of Thumb" method is that the number of air changes is considered. Using the "Face Velocity" method the airflow rate is established by considering the capture velocity and area under the hood. Both of these methods do not take into account the type of appliances under the hoods. Hence in many cases, the estimations typically exceed the actual requirements or demands.

Based on a study, in the medium-load case a rough method like face velocity oversized the whole system 2- or 3-times compared with the actual demand. This over-estimation is 1.4 –1.8 even with the extra-heavy load [**3**].

As for the "Heat Load" method, consideration is given to the cooking appliance convective heat output, the area of exposure, the distance of the extract unit and the effect of the general ventilation for the contaminant removal efficiency. The heat load method is proved to be suitable platform in commercial kitchen environment [**4**, **5**]. The main idea is to adjust the required airflow rate based on the convection heat gain or more specifically based on the thermal plumes of kitchen appliances. The most well-known design code which utilizes this approach is German VDI [**6**].

It should be noted that by using a hood it is only possible to capture the convection part of the heat load. Radiation will always be present in the room space and to remove the loads caused by radiation, mechanical cooling should be introduced. So, therefore the actual capture efficiency is only related to the convective part of the heat load. During the design phase, airflow rate should be determined based on the convection flow (**Figure 1**). By increasing airflow rate at the optimal point, the efficiency of the system could not be improved. On the other hand, unnecessary high airflow rates increase the investment and operation costs.

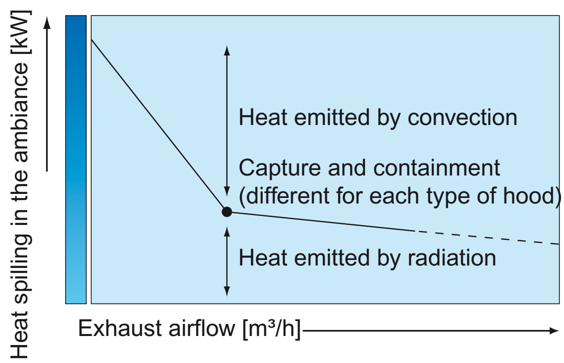

Figure 1. Airflow rate shall be specified based on the convection load.

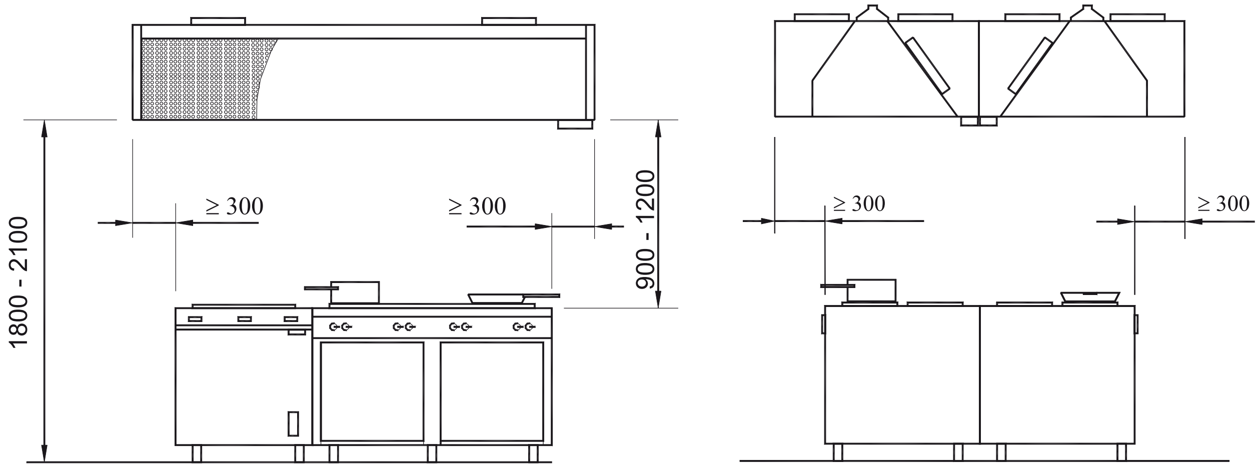

Figure 2. The dimensions of the hood exceed the size of the appliance block.

The dimensions of a kitchen hood are invariably determined by the size of the kitchen appliance block that it is serving. Unless restricted by walls, the plan dimensions of the hood shall always exceed the plan dimensions of the appliances by typically 250-300 mm on each side to prevent spillage effect [**6**].

It should be noted that the airflow rates should be always measured and balanced to guarantee the performance of the designed ventilation system. It is recommended to keep a negative air balance (under pressure) compared with the surrounding spaces. In practice this means that the exhaust airflow rate should be at least 10% higher than the supply airflow rate in the kitchen.

As a summary of the operation preconditions of ventilation that shall be guaranteed are:

- Airflow rate is determined based on the actual convection load
- The dimensions of the hoods are determined based on the appliance blocks
- In kitchen the negative pressure is maintained compared to the surrounding spaces
- Airflow rates are measured and adjusted according to the design values

Effect of design and technology

With the optimization of exhaust airflow rates and operation times, savings can then be inferred from

1) the energy cost (heating, cooling and fan energy)

2) the initial capital investment (the size of the equipment installation).

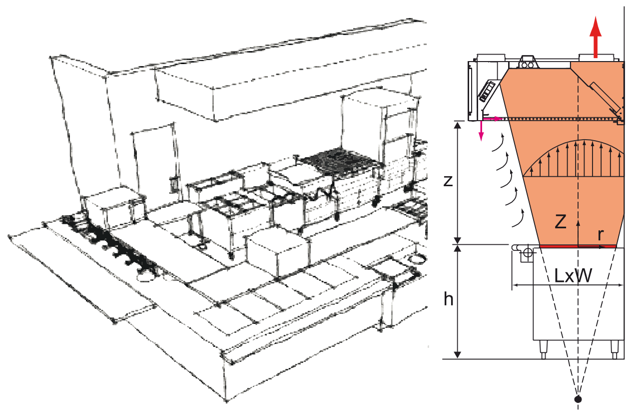

Figure 3. The amount of open side of appliance block is a critical factor to entrainment.

Design concept selection is playing a significant role on the operation costs and life-cycle costs. Lower airflow rates have a direct effect on heating, cooling and fan energy costs. In addition due to energy tariffs, reduced peak load demands may give savings in operation costs.

The location of appliance block has a significant effect on the required airflow rate. If the operation in kitchen allows, the appliance block should be installed close to the wall. In the wall-installation, the entrainment will be reduced compared with the island-type of installation (**Figure 3**). To reach the same contaminant removal efficiency, the exhaust airflow rate should be 1.6-times higher in the island-type of installation than using the wall-type of installation [**6**].

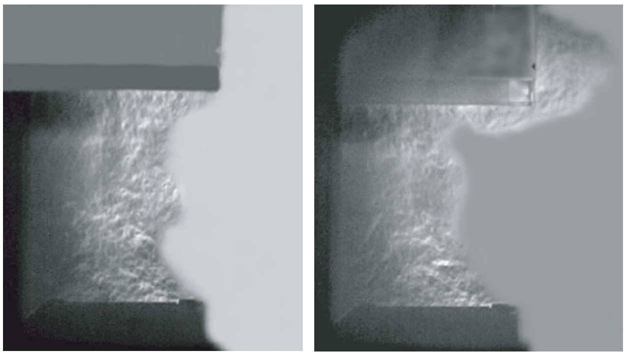

Figure 4. High efficiency hood (left panel) improves the contaminant removal efficiency compared to standard exhaust hood (right panel).

The hood efficiency is possible to illustrate using Schliering thermal imaging. **Figure 4** illustrates the operation of a high performance and a standard hood using the same airflow rate. In a series of tests conducted by Architectural Energy Corporation (AEC) in USA, the capture jet hood performed favorably over traditional style back-shelf hoods. The standard exhaust hood required 30% greater exhaust air compared high efficient hood [**7**]. The similar improvements using capture jet were also demonstrated in a ventilated ceiling application [**8**].

The total approach for the ventilation system should be kept in mind. The application of a low velocity displacement ventilation system allows a reduction in the exhaust airflow compared to a conventional mixing ventilation system. Low velocity air distribution (thermal displacement) does not disturb the thermal plumes of kitchen appliances (**Figure 5**). Using mixing ventilation, the performance of the hood decreases and the exhaust airflow rate should be 1.2-times higher than with low velocity system [**6**].

In cold and temperate climates during the operation phase, energy efficiency of the ventilation system is possible to be improved using heat recovery. Waste heat of

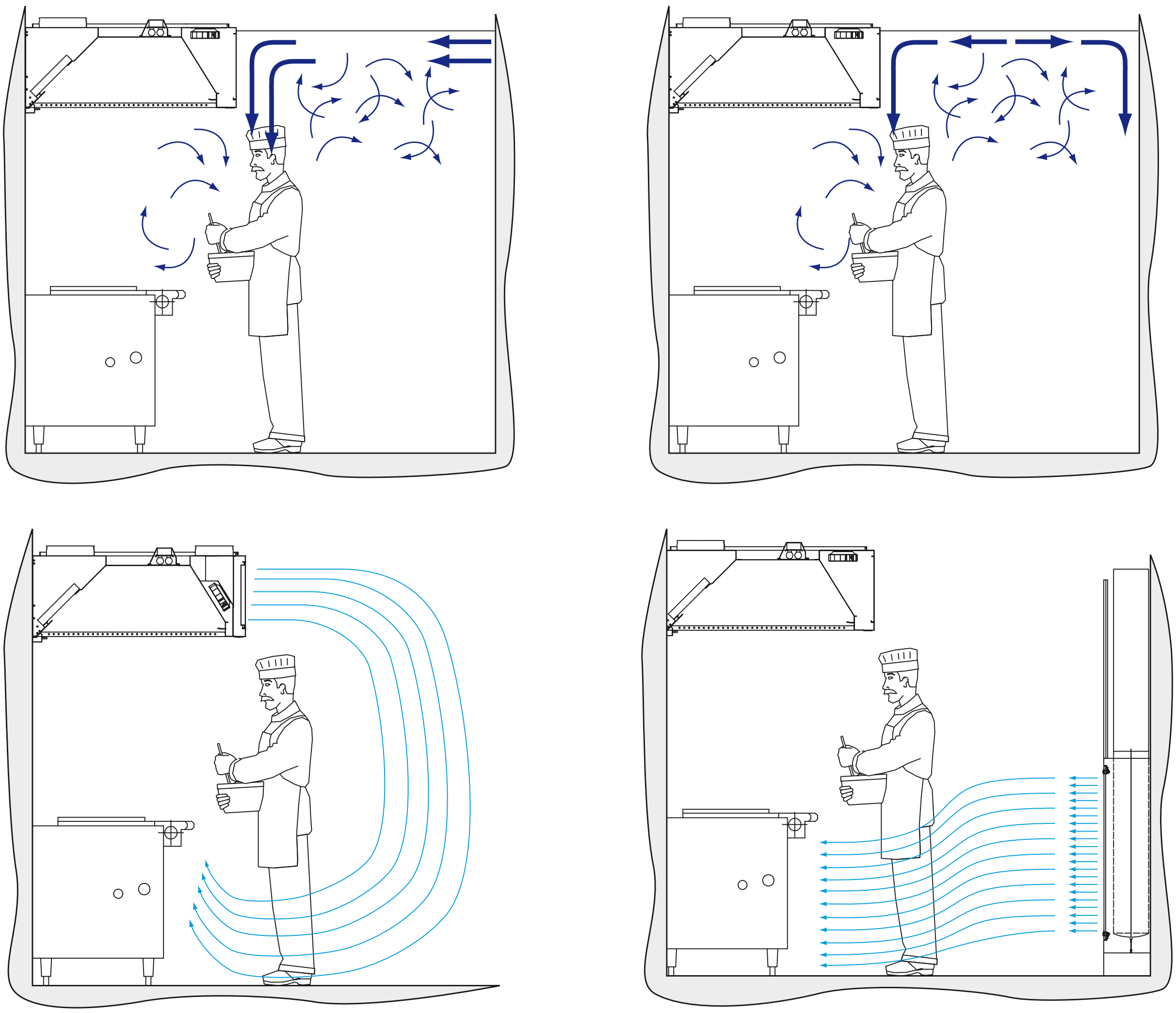

Figure 5. Air distribution concept has a significant effect on the hood efficiency.

exhaust air can be used directly for supply air preheating or alternatively using a heat pump for hot water heating. With a typical heat recovery unit (efficiency of 50%), energy consumption of heating is more than halved. It should be noted efficient grease filtration is required to guarantee undisturbed use of heat recovery. In many case, this means that the system should be equipped with both mechanical grease filters and more efficient filtration e.g. UV-filters.

In operation phase, demand-based ventilation gives savings in heating, cooling and fan energy. The saving potential is strongly depending on the actual use of the appliances. In many kitchens, it could be assumed that the idle mode is longer than 50% of the whole operation time. This means that energy saving potential is approximately 50% in those kinds of applications.

Table 1. The comparison of the standard and best practice solutions on airflow rates and energy consumption.

Measure (Reduction)	Standard solution (factor compared to best-practice solution)	Best-practice solution (reference factor 1)
A) Location of appliance block (airflow rate and energy)	1.6 (island)	1 (wall)
B) Air distribution (airflow rate and energy)	1.2 (mixing)	1 (low velocity)
C) Efficiency of hood (airflow rate and energy)	1.3 (traditional)	1 (high efficiency hood)
D) Heat recovery of exhaust air (heating energy)	2 (No heat recovery)	1 (heat recovery efficiency of 50%)
E) Demand based Ventilation (energy consumption)	2 (constant airflow rate)	1 (Idle mode 50% of operation time)
Total effect on airflow rate (AxBxC)	2.5	1
Total effect on heating energy consumption (AxBxCxDxE)	10	1

It is important to note that in many cases at the same time there is possible to reduce both energy consumption and exhaust airflow rates. The effects of the previously described design concepts and technologies on energy consumption are summarized in **Table 1**. Selected design has a huge effect on heating energy consumption: energy consumption of a standard solution could be even 10 times higher than with the best-practice solution. Respectively, airflow rate could be 2.5 times higher than with the best-practice solution.

Conclusions

In a commercial kitchen, working conditions are especially demanding. There are four main factors affecting thermal comfort, these being: air temperature, radiation, air velocity and air humidity. Ventilation is a key element in the creation of excellent working conditions and this should happen in an energy efficient manner. By using total design approach and best-practice technology, it is possible to get significant reduction of airflow rate and remarkable savings in energy consumption. The required airflow rate of a standard solution could be 2.5 times higher than the airflow rate using the state-of-the art technology. In European type of climate, the heating energy consumption of standard solution could be 10 times higher than those realized by using the best-practice concept.

Acknowledgement

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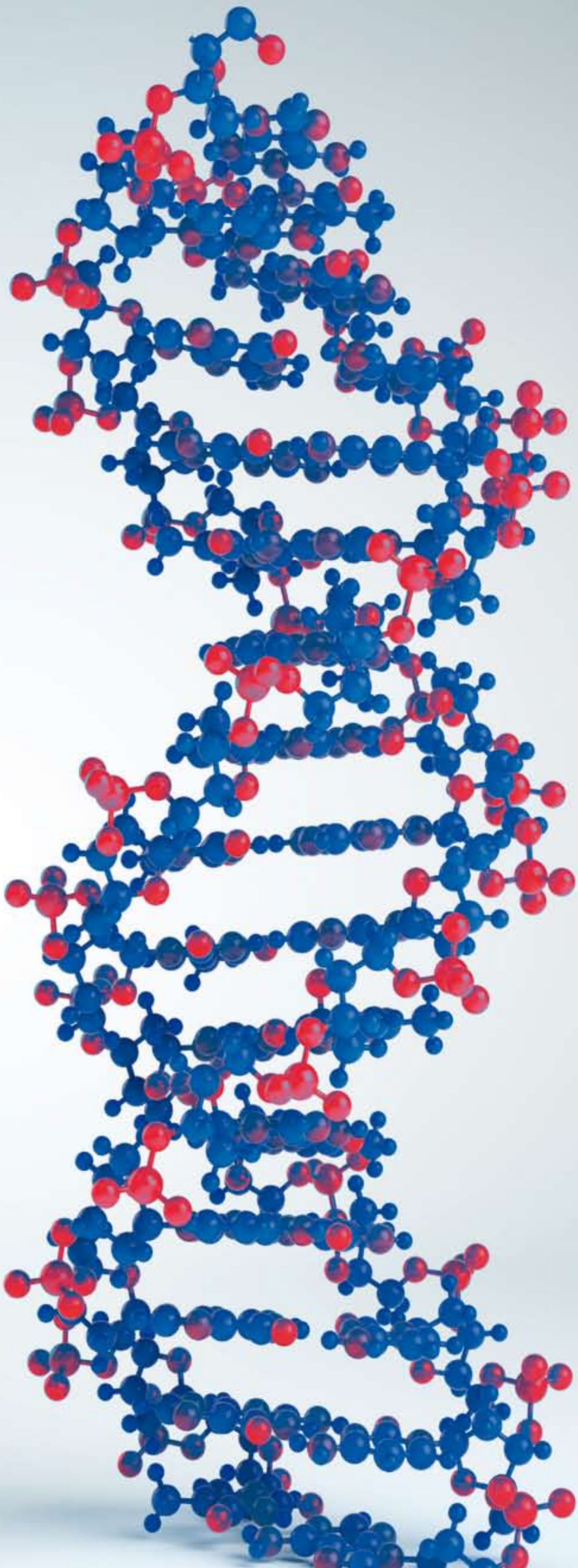

Use of life time indicators during the design and operation of building

The built environment needs practices that lead to improved indoor environment quality, more efficient building performance and to real carbon emission reduction. We need indicators and tools that are cost effective and simple to use in any building or project, but in the other hand they support the professional property owners to demonstrate the performance of their buildings in international property market. More comprehensive indicators require more and better data. Collection and storage of information need to be planned already in design phase. Building Information Management (BIM) system helps to follow the targets both in design and in operation face, but it is also a good tool for data storing and management over life time. Accurate design and transparent indicators set also new requirements for product data, which needs to be correct and more comprehensive in order to get all advantages of improved processes.

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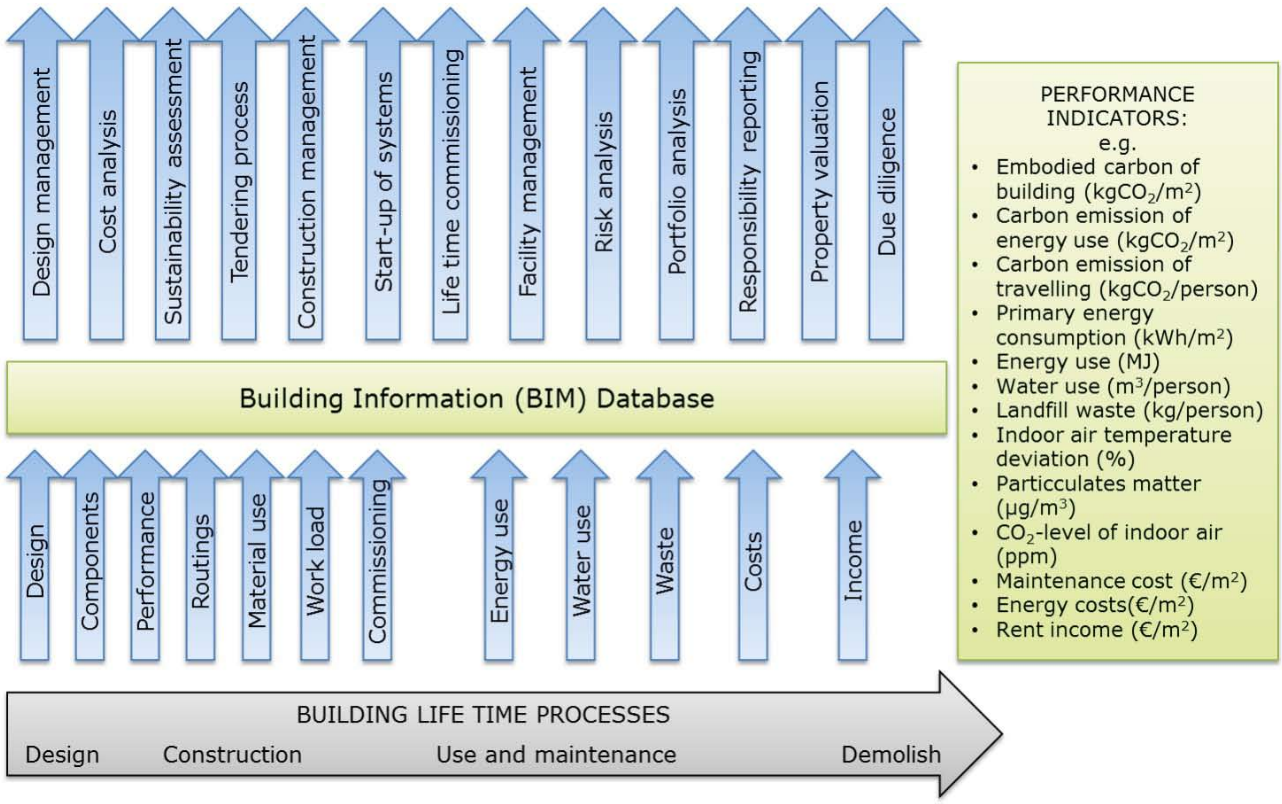
Life time indicators of building's performance

Industry needs key performance indicators (KPI) for sustainable buildings that ensure the sustainable operation of building over the life time. Today e.g. LEED certification is used for evaluation but as it is not evaluating the actual performance of a building, it is important to set also other measures for construction projects and management of existing buildings.

The main focus needs to be on the environmental, social and economic sustainability over the life time of building. Data need to be collected and followed already in pre-design and design phases from planning documents

Example of building's key performance indicators.

	Project phase		Operation phase	
Indoor environment	Indoor environment class (EN 15251)	A/B/C	User satisfaction (thermal comfort, IAQ, lighting and acoustics separately)	%
Carbon footprint	Life time carbon footprint (EN 15978)	$kgCO_2/m^2$	Operational carbon footprint (GHG protocol)	$kgCO_2/m^2$,a
Energy	Calculated primary energy consumption (EN 15217)	kWh/m^2,a	Measured energy use (electricity, heating, and district cooling separately)	kWh/m^2,a
			Unoccupied electricity power	W/m^2
Economy	Life cycle cost (EN 15643-4)	€/m²	Value of building (discounted cash flow DCF)	€/m²



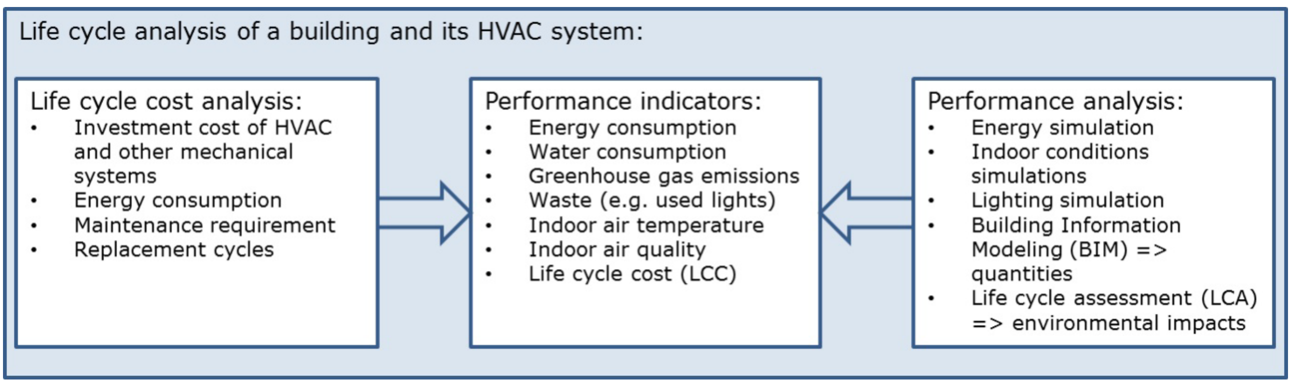
Building's performance data should be collected throughout the life time of the building i.e. product manufacturing, design, construction, commissioning, facility management and demolishing. Once the data is stored in one place, management and different analysis are easy and fast to make and performance indicators are continuously up-to-date.

and later from the building management system and building's users.

The objective is that performance evaluation becomes part of the normal design, maintenance and portfolio management. By following KPIs and making decisions accordingly, we can improve the user satisfaction and wellbeing; make sure that spaces are efficiently used; reduce the operation and maintenance costs; and reduce the environmental load.

It is important that different evaluation and reporting systems use the same calculation specification as this way the extra work to specify same KPI with different specifications can be avoided. Therefore it is good to use indicators specified in international standards, like CEN TC 350 "Sustainability of Construction Works".

KPIs can be used for different purposes. One is to evaluate and manage the operation of a building over the years. This case the best benchmark values are the values



Performance indicators can be calculated in design phase after life cycle cost and performance analysis are made.

of previous years. Second way is to compare building to other buildings with same purpose. This can be done in a property portfolio level or based on a national or international database. Unfortunately only few KPIs have a good database for general comparison; especially because the specification has not been uniform.

Sustainability evaluation needs to be based on the life time evaluation of building and its usage. Service life planning is the basis of all evaluations made in design phase. There are several areas to be considered:

- predicted service life of building and major components (defined by developer);
- usage of spaces and possible changes over life time;
- indoor environment quality in different usages;
- environmental impacts over life time (including deconstruction and re-use of materials);
- lifetime costs.

Use of life time indicators requires new tools

During the design phase the values of indicators can be collected from different performance analysis e.g. energy and indoor conditions simulations. Quantity data can be collected e.g. from building information modeling (BIM).

Building information modeling (BIM) is the process of generating and managing building data during its life cycle. Typically it uses 3D, real-time, dynamic building modeling software. It eliminates many clashes usually found during the construction phase since they can be identified already during the design. Also, during construction the BIM model will be automatically updated with any changes.

Building information modeling (BIM) can be used to demonstrate the entire building life cycle, including the processes of construction and facility operation. Quantities and shared properties of materials can be extracted easily.

If all performance related data is saved and continuously updated in the BIM model throughout the life time of the building, different performance and sustainability analysis are easy to make during operation years. The BIM model provides up to date data for e.g. technical due diligence (DD) process, which are made much faster and with less costs. The BIM-model also provides information required for Life Cycle Cost Analysis (LCCA) and Life Cycle Assessment (LCA) of the building, as well as data for calculating performance indicators. In addition, this information can be easily assessed by a third party and afterwards integrated case by case into the valuation process.

Especially "Life time carbon footprint" and "Life cycle cost" indicators require lots of data and calculation work. That is why they have not been calculated as part of normal design process and neither are they part of the LEED design. But the new tools, like BIM and energy simulation tools, enables the efficient data collection and processing. Therefore the decisions during the design process can be made based on the life time evaluation of building.

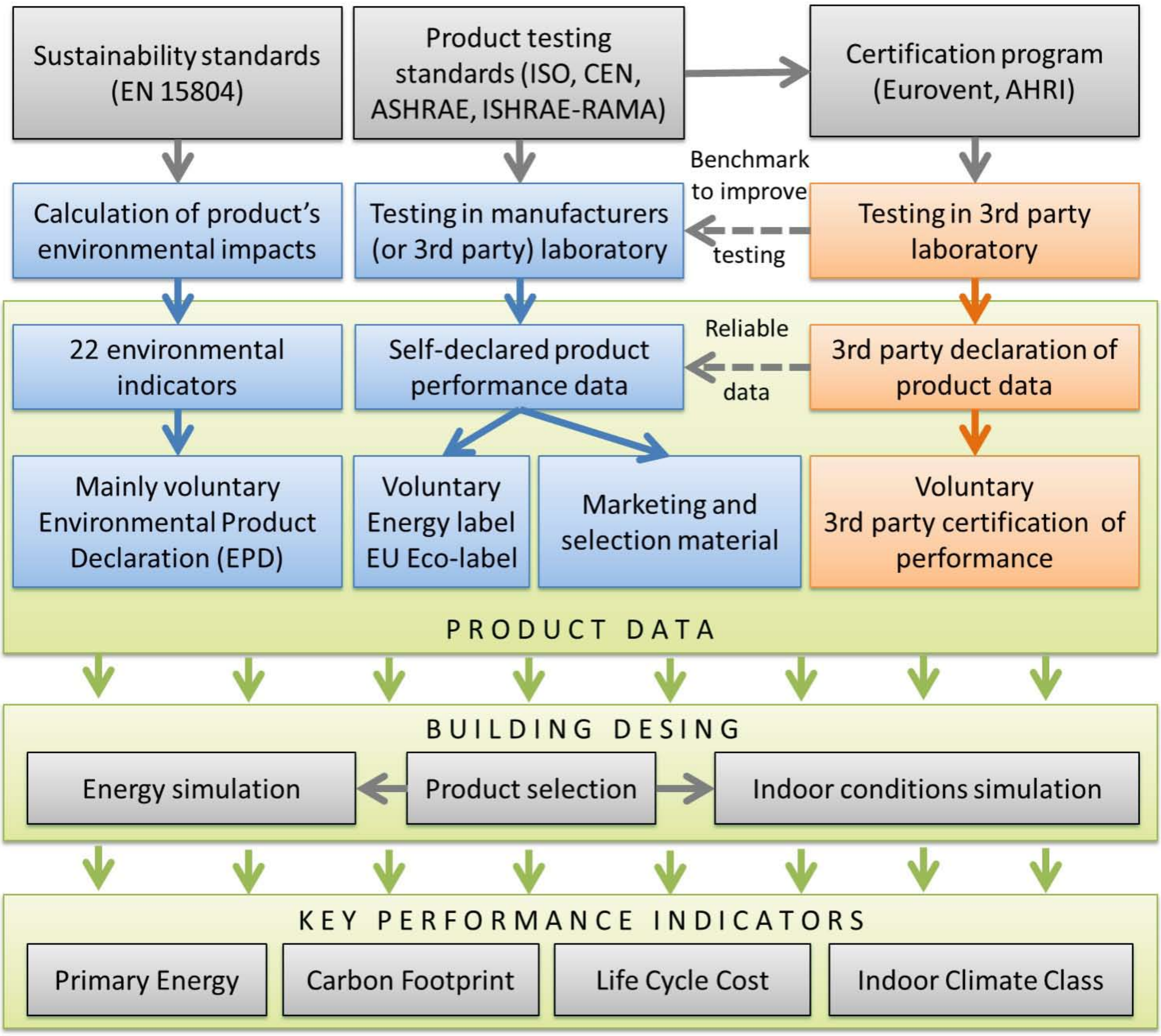
Accurate design requires precise product information

Life time indicators are used to produce better designs. But more detailed and accurate the design process is, more precise product data is required during the design phase.

Usually the product manufacturers are using the product performance data measured in their own laboratories. Measurements are typically made based on international testing standards. In Europe the measurements are based on ISO or CEN standards, in USA based on ISO or ASHRAE standards and in India there will be soon available also ISHRAE-RAMA standards, like the chiller testing standard.

Product performance data is used to make a design of a building. As the energy efficiency has such an important role in performance evaluation nowadays, it is very important that designers are using energy efficient products and that products' performance data is precise. If the performance data is correct, the design can be made correctly and no unnecessary safety margins need to be added. This means savings in investment costs as products are smaller in size. System will also perform more efficiently, as each product performs longer period of time in optimum performance area. In a typical design the product performance is optimized to design conditions. But in oversized systems the product operation hardly ever meets the design conditions but operates in partial load conditions. Many products consume more energy in non-optimum conditions.

The 3rd party certification of product data is a good process to ensure the accurate performance data of product and avoid the need of unnecessary safety margins. The certification mark ensures that the products have been



Accurate and more detailed product data is required, when designing buildings in the future and calculating the key performance indicators during the design.

submitted to independent checking. This mark guarantees designers, installers and end users that products marketed by a company have been accurately rated. It also ensures a healthy and solid competition on a market open to all manufacturers.

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Air distribution
- how to guarantee high performance?

The main objective of diffusers in mixing ventilation is to dilute room air effectively with supply of clean and conditioned air and at the same time establish low velocity conditions in the occupied zone. Using well-designed air distribution ventilation, it is possible to achieve good environment quality in energy efficient manner.

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Nature of mixing ventilation

Mixing room air distribution aims at diluting of polluted and warm/cool room air with cleaner and cooler/warmer supply air. The air is supplied to the room with high initial mean velocity.

The established velocity gradients generate high turbulence intensity aiming to promote good mixing and uniform temperature and pollution distribution in the occupied zone. Mixing ventilation is an expression for an air distribution pattern, and not for a ventilation system. It can also be called an air distribution pattern with mixing effect or mixing air distribution.

Often the mixing in rooms is not complete and changes in time due to effect of changing heat load (solar heat load, number of occupants, lighting, etc.), disturbances from walking occupants [**1**], local supply or exhaust flows, etc. Therefore room air distribution in space and in time should be carefully considered in order to avoid zones of with high velocity and low temperature as well as zones of polluted air which may affect occupants' comfort and well-being.

The location of the air supply and air exhaust openings in relation to the direction of gravity is also important. A high location of the air supply opening will in some cases give a different air distribution pattern than a low location of the air supply opening. Furthermore, the location of the air exhaust opening can also be important for the ventilation effectiveness [**2**].

The design methods of mixing ventilation are described in more detail in a new REHVA design guide [**3**] that will be published in Spring 2013. In this guide together with the relevant theory, practical examples of the system performance with different design solutions and load conditions are presented.

Design of mixing ventilation

Ventilation air supplied to spaces aims to generate healthy, comfortable and work stimulating environment for occupants in the occupied zone. Airflow with different characteristics, including air temperature, mean velocity, turbulence intensity, frequency of velocity fluctuations, flow direction, etc., can be generated which affect occupants' thermal comfort and inhaled air quality.

When a person feels thermally neutral or cooler the increased local heat loss due to high velocity may cause local discomfort due to draught. The risk of draught increases when airflow temperature decreases and mean velocity and turbulence intensity increase. In design, analysis of possible draught risk is one of the main concerns to guarantee the performance of air distribution.

Beside thermal comfort also the aspect of acoustic comfort is a relevant criteria in HVAC applications, since whenever mechanical power is generated or transmitted, a fraction of the power is converted into sound power.

The main objective of diffusers in mixing ventilation is to dilute room air effectively with supply of clean and conditioned air and at the same time establish low velocity conditions in the occupied zone. Air diffusion could happen with high or low momentum air flux of diffusers. The jet of high momentum flux diffusers (e.g. swirl diffusers and nozzles) dominates air distribution and they are strong enough to mix the whole volume. Whereas with low momentum flux diffusers (e.g. textile terminals and floor diffusers), the driving force of the mixing is mainly buoyant force by heat sources.

The starting point of air distribution design is to take into account the specific needs and characteristic of the room space. It should be noted that there are typically plenty of solutions that can fulfill the set targets of indoor conditions. Also quite often, there is necessary to compromise different needs and the select the most suitable solution for that specific application.

A wide range of air terminals are available on the market. During design process, it is important to select terminal unit that is able to:

- discharge the required air flow rate without causing draught
- operate with low noise level
- and regulate air flow rate

In **Figure 1** the critical locations in the boundaries of the occupied zone, where air velocities should be analyzed, are presented. The critical boundary points are:

1) Location below detachment point (u_1);
2) Location where air reach floor level (u_2);
3) Location where jets are colliding (u_3).

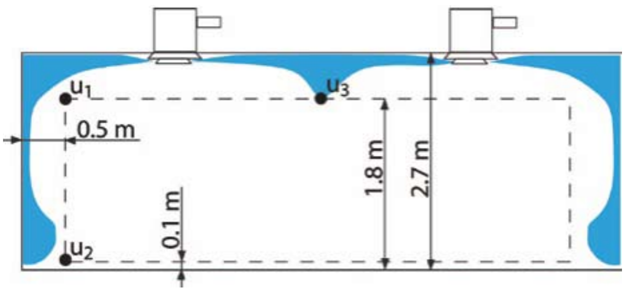

Figure 1. Critical points where air velocities should be checked (u_1 detachment point, u_2 floor area and u_3 colliding point at the boundary of the occupied zone). [4]

Together with airflow rate and supply air temperature, the selection of the location and the number of diffusers have a significant effect on the air distribution. In **Figure 2**, appropriate and impropriate ceiling and wall design schemes of air distribution are presented.

In the demand-based ventilation, airflow rates vary according to the need. This variable volume flow systems are operated by one or more volume control units and it should be combined with an intelligent fan speed control system preventing high pressure drops. A wide airflow control range can lead to draught problems with the minimum airflow rates (**Figure 3**). In order to avoid draught problems, it is important to maintain an appropriate throw pattern both at minimum and maximum air flow rates. The performance of a diffuser should always be checked over the required air flow range.

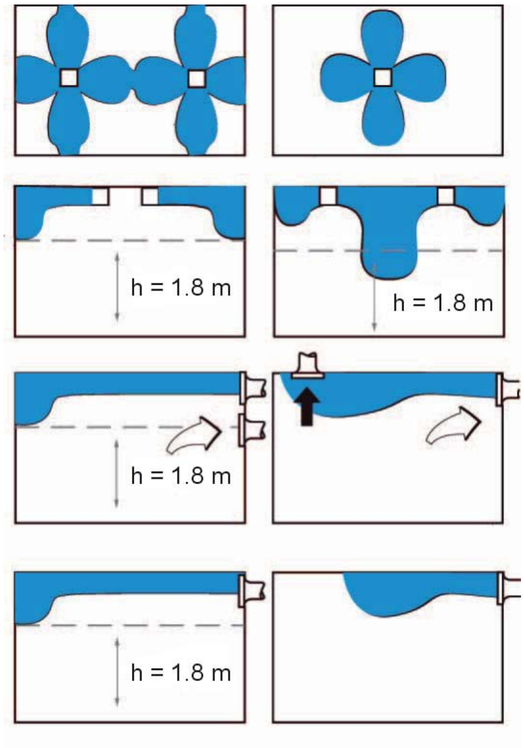

Figure 2. Some examples of appropriate (left panels) and impropriate (right panels) air distribution schemes in isothermal conditions.

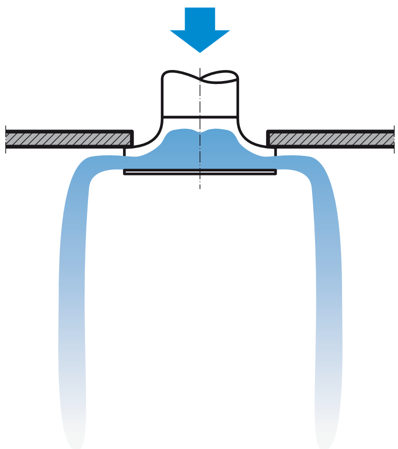

Figure 3. With traditional diffuser, initial air velocity of minimum air flow rate is too low to prevent detachment.

In active diffusers, airflow rate controlled pressure-dependent at the diffuser. The active diffusers require constant pressure conditions in the duct branch. The pressure levels in the branch ducts are kept constant by a pressure control damper at the beginning of each branch. Because the pressure level is constant in the ductwork, there is no need to have a measurement unit in the diffusers.

In **Figure 4**, a concept for constant thrown pattern is shown. The constant thrown pattern is possible to maintain by using the method where the air is supplied between a controlling plate with a distance that varies according to the airflow rate needed). Other method is based on variable supply area. In both methods the thrown length is independent on the air flow rate.

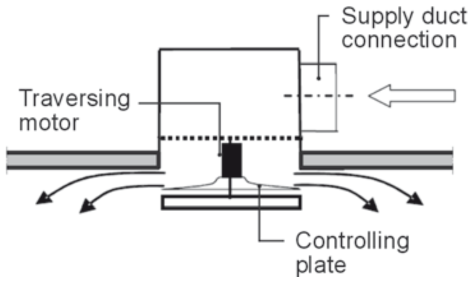

Figure 4. A diffuser concept for constant throw length over air flow rate range.

A convection natural flow is the air current that rises above warm object like person, computer or warm window (**Figure 5**). The convection flow rising above a hot object is called a thermal plume. Thermal plumes have a significant effect on air distribution in the room space. The interaction between thermal plume and jet can create unexpected macro-flow over the room space.

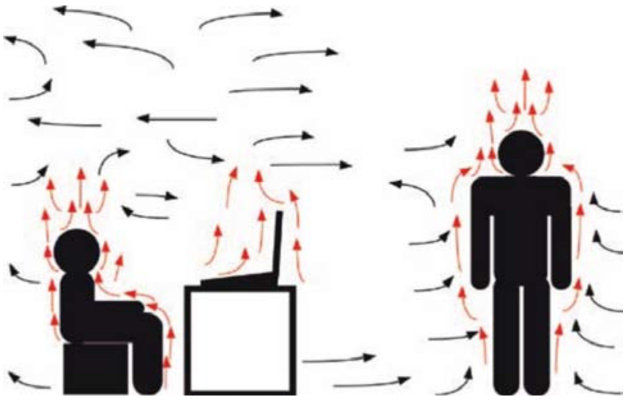

Figure 5. Thermal plumes of equipment and persons.

It should be noted that simple analytic modelling of the jets and thermal loads that affect the air flows of a room space has its limitations. Therefore, it is possible to accurately analyse the various load situations only by using laboratory model tests or air flow simulation (CFD).

Evaluation of mixing ventilation

The air movement generated in rooms has a major impact on occupants' thermal comfort and inhaled air quality. Therefore one of the stages of indoor environment design improvement includes identification of the air distribution in room, its assessment by measurements and evaluation of its impact on occupants comfort.

Typically this is performed in two stages: first, at the design phase air distribution is assessed based on CFD predictions and physical measurements performed under laboratory conditions and then a field survey of air distribution and its impact on occupants is performed when the building is accomplished and occupied. Room air distribution assessment is also performed in existing buildings where complaints of occupants from the indoor environment are reported.

Today, air distribution assessment performed in full-scale rooms under laboratory conditions is a common practice. The full-scale air distribution studies performed under laboratory conditions aim to mimic as close as possible typical conditions as expected in rooms in practice, i.e. room size, furniture layout, air terminals type and location (supply and exhaust air terminal devices), supplied flow rate and temperature, heat and pollution sources, etc.

The advantages of the full-scale room assessment is that the experimental conditions can be controlled accurately, the impact of a particular parameter, e.g. location of heat sources, etc., can be studied and repeatable measurements can be performed. The disadvantages of the full-scale room air distribution assessment under laboratory conditions are that it is difficult to reproduce the boundary conditions realistic for practice such as occupants' activities, heat load changes in time and space, solar load, etc.

The importance of proper simulation of the heat source for the air distribution in rooms is demonstrated in **Figure 6**. Ventilation air is supplied at rate of 1.5 L/s/m² from chilled beam installed in a room with heat load of 50 W/m² generated by two occupants and heated window. The importance of the airflow interaction for the room air distribution can be clearly seen [**5**]. The air supplied from the chilled beams on the side of the window is deflected by the strong thermal plum toward the second occupant generating velocity as high as 0.25 m/s at his head region.

Airborne pollution, such as bioeffluents generated and

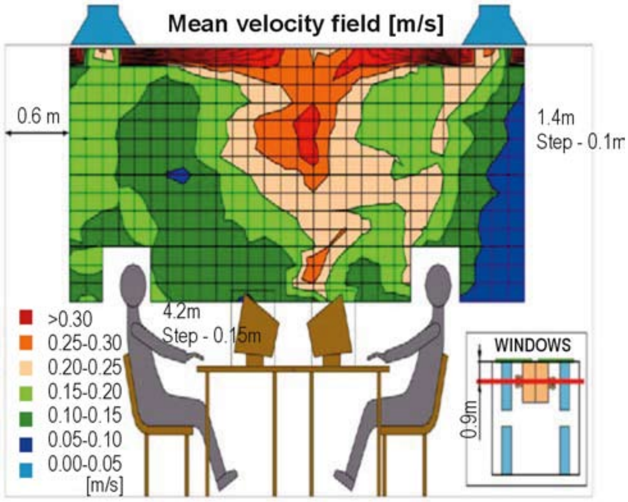

Figure 6. Contours of constant mean velocity measured in a full-scale room ventilated by chilled beams.

air exhaled by occupants, gasses emitted from furniture, building material, floor covering, office equipment, etc. is simulated in full-scale rooms by tracer gas in order to identify the air distribution efficiency in their removal from the occupied zone.

Pollution generated by heat sources (known as active pollution sources) and from unheated sources (known as passive pollution sources) can be simulated. The pollution generated by active pollution sources initially is transported by the thermal flow generated by the same sources while the pollution generated by passive pollution sources is initially transported by the airflow at the vicinity of the object (can be ventilation flow, thermal flow or flow as a results of their interaction). Examples

Figure 7. Flow visualization with smoke generator.

of active pollution source are office equipment, human body (bioeffluents, exhaled air, etc.). Floor covering, furniture, etc. are examples of passive pollution sources.

Room air distribution evaluation in buildings in practice has several advantages: measurements are performed under realistic conditions, including realistic human activities which may affect the air distribution substantially; results allow for direct improvement of the environment, etc. However in practice it is almost impossible to perform repeatable measurements because the conditions can not be controlled accurately. It is recommended that the measurements start with flow visualization with simple smoke generator (**Figure** 7).

Most often air distribution evaluation by physical measurements in rooms in practice includes also questionnaire survey of occupants' response to the room environment. Occupants' response to the environment collected by questionnaires is used for identification of problems with air distribution in rooms. The questionnaires covered both occupants' thermal comfort (general and local), perceived air quality as well as several other factors including design of the workstation, job satisfaction, health, clothing garment checklist adapted to regional customs, human sensitivity to the environmental parameters, noise, lighting, air quality, ergonomics, social relations and the level of privacy, which all are important issues that can influence human response to the indoor environment.

Conclusions

The air distribution in spaces is a major important factor for occupants' health, comfort and performance as well as for efficient energy use. Air distribution in such spaces and in ventilated spaces in general depends on inertia and buoyancy forces, initial conditions of the supplied flow and its turbulence structure, boundary conditions in the space, etc. Different air distribution strategies based on mechanical systems for air transportation are used today to achieve the goal of ventilation. Using well-designed air distribution ventilation, it is possible to accomplish good environment quality in energy efficient manner. At the design phase air distribution is assessed based on CFD predictions and physical measurements performed under laboratory conditions. Room air distribution assessment should also be performed in existing buildings where complaints of occupants from the indoor environment are reported.

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15 years of reliable European Certification of HVAC&R products

EUROVENT
CERTIFIED PERFORMANCE

"The growing demand for innovation to improve energy efficiency and reduce carbon emissions in domestic and non-domestic buildings, and the industrial sector, clearly means that manufacturers are facing new challenges to comply with the objectives of carbon footprint reduction and address the constraints of building code regulations that require precise calculation based on performance data.

In that context, reliable product performance is becoming a key driver for today's HVAC-R business decisions and product investments. And when you think about the energy bill reduction, at the end of the day you realize that third party certification is a real value-add for your technical and business decisions.

With this special ACREX issue of REHVA Journal Eurovent Certification welcomes the opportunity to present you 15 years of third party performance certification expertise and know-how, applied to more than 300 manufacturers, 18 HVAC-R product ranges and more than 50 000 product references."

Erick Melquiond
Managing Director of Eurovent Certification Company

In today's international context of a growing pressure on climate control and CO_2 emissions, certification is more than ever the route forward for product selection and specification. The involvement in energy efficiency control of the European Air Conditioning Industry is clearly demonstrated by the very existence of the voluntary certification programmes established and administrated by Eurovent and its evolution throughout the years.

Comparison of product performance by third party testing based on well-defined procedures ensures healthy, solid competition within a market, which is open to all manufacturers.

Founded in 1993, Eurovent Certification Company (ECC) is recognized as a world-class leader in the field of industrial third party product performance certification for Heat, Ventilation, Air-Conditioning and Refrigeration products (HVAC-R), according to European and international standards.

The Eurovent Certification programmes have in common the verification of manufacturer's claimed performance by third party testing based upon well-defined procedures compliant to ISO/CEN/CENELEC/ECC or equivalent standards.

Eurovent Certification sets new industry standards in Europe and creates the conditions for a fair competition

Throughout the years, Eurovent Certification has contributed to the definition of common set of criteria for rating products, leveling the competition playing field

- ACCREDITIA – **Italy**
- AKKREDITIERUNG – **Austria**
- BELAC – **Belgium**
- CIA – **Czech Republic**
- COFRAC – **France**
- DAkkS – **Germany**
- DANAK – **Denmark**
- ENAC – **Spain**
- FINAS – **Finland**
- INAB – **Ireland**
- IPAC – **Portugal**
- NA – **Norway**
- PCS – **Poland**
- RvA – **The Netherlands**
- SAS – **Switzerland**
- SWEDAC – **Sweden**
- TURKAK – **Turkey**
- UKAS – **United Kingdom**

with the creation of a common and standardized platform allowing comparisons of product performances on an equal basis.

The increased integrity and accuracy of the industrial performance ratings also provide clear benefits for the end users who can be confident that the product will operate in accordance with design specifications, and predicted energy costs are reliable.

Eurovent certified products get international recognition

As an accredited certifier (certificate #5-0527 Industrial Product Certification), Eurovent Certification's product performance certificate is recognized with a legal ground in a very large number of countries.

The COFRAC accreditation was granted according to ISO/IEC guide 65:1996 or EN45011:1998. The Scope and Validity can be checked on line at www.cofrac.fr. This accreditation is compliant with the European co-operation of Accreditation [**1**] (EA) also member of International Accreditation Forum [**2**] (IAF) with mutual recognition agreement signed by the following countries:

A voluntary certification scheme open to manufacturers and distributors

ECC offers a wide range of certification programmes. Based on a voluntary scheme, the Eurovent certification is open to any manufacturer willing to participate, but also to distributors who can also apply via our Brand Name (BN) scheme.

When a manufacturer participates in a certification programme he is required to present the list of models or model ranges together with their performance data. The files are then evaluated by ECC and a pre-defined number of units is set. Following a random selection, performance testing in the scope of Certification is carried out by independent laboratories under contract with Eurovent Certification, which clearly means no commercial contact between test houses and participants.

New programmes were launched in 2012 including the Rooftops and Variable Refrigerant Flow Systems (VRF).

To participate in the following programmes, manufacturers must certify all production models in the scope of the programme ("Certify all" programmes).

All models in the production has to be certified in the following programmes:

- Close control air conditioners (CC)
- Comfort Air Conditioners (AC)
- Chilled Beams (CB)
- Fan Coil Units (FCU)
- Air Filters class M5-F9 (FIL)
- Heat Exchangers for Refrigeration (HE)
- Liquid Chilling Packages and Heat Pumps (LCP-HP)
- Rooftop (RT)

[1] www.european-accreditation.org

[2] www.iaf.nu

To participate in the following programmes manufacturers may select ranges of products to be certified.

Selected range of models in the production has to be certified in the following programmes:

- Air to Air Plate Heat Exchangers (AAHE)
- Air to Air Rotary Heat Exchangers (AARE)
- Air Handling Units (AHU)
- Cooling and Heating Coils (COIL)
- Cooling Towers (CT)
- Drift eliminators (DE)
- Refrigerated display cabinets (RDC)
- Variable Refrigerant Flow (VRF)

Third party testing coupled with a stringent certification process can also result in Certification suspension

If a product falls below catalogue performance by more than the specified tolerance in sample testing, the participant will be required to re-rate not only the specific product but also the range from which it was taken. A new performance testing procedure is then carried out. Each participant is only allowed to use this exception process once. If over the years the failure rate is above a defined threshold it will result in a Certification suspension.

Lists of Eurovent certified products and companies are reviewed on a regular basis. Up-to-date data is available in real time and on line at www.eurovent-certification.com or www.certiflash.com.

Eurovent Certified Performance – the mark of confidence

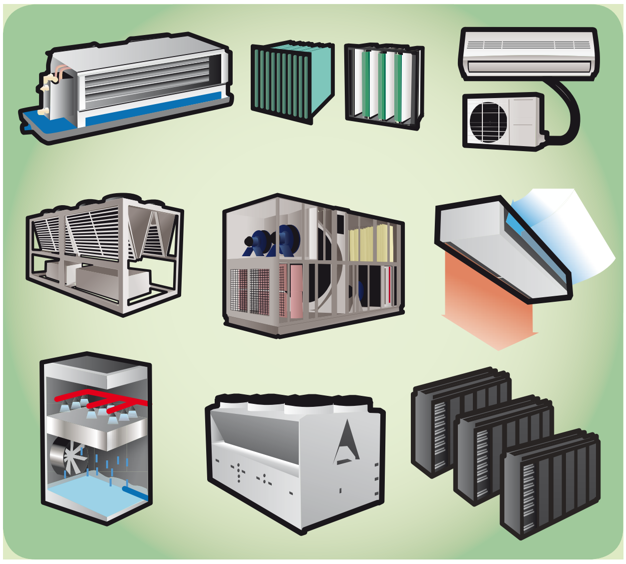
All products certified are listed at Eurovent website.

In addition, certified products display the Eurovent certification symbol that guarantees specifiers that products marketed by a Eurovent certification programme participant have been accurately rated.

Specification sheets, literature and advertising of certified ranges display the Eurovent symbol.

EUROVENT CERTIFIED PERFORMANCE www.eurovent-certification.com

ECC MARK LOGO.



Exciting outlook for the HVAC-R industry with the introduction of the 1st European "One Stop Shop" for Certification in 2013

Eurovent Certification and Certita, leading certification companies in the field of HVAC-R products will be merging their activities in 2013. The intention of the signatories is to develop the proposed certification, in line with the services already provided, with the marks NF, CSTBat and Eurovent Certification, while enlarging the scope of products dealt with and increasingly operating at international level. A full service will be proposed, expected to be better suited to the specific background of each country regarding voluntary certification of performance of HVAC-R products.

The aim of the merge is to back up the development of innovative equipment and to provide useful guidance to users and prescribers. This issue is embedded within the general objectives of decreasing the greenhouse gas emissions and improving the energetic efficiency, in which regard the promotion of product performance plays a key role. The considered merge would provide manufacturers with a single access to get the certification best suiting their marketing needs.

CERTITA is mainly involved in the fields of heating (NF Mark Radiators and NF Mark Heat Pumps), Thermal solar (NF Mark Domestic Solar Heaters, CSTBat Mark Solar devices and Solar Keymark) and ventilation (NF Mark Mechanically controlled ventilation and CSTBat Air inlets.).

Both companies are certification bodies accredited against the EN 45011 reference standard.

Eurovent Certification Programmes

- Air Filters Class M5-F9 *
- Air Handling Units*
- Air to Air Plate Heat Exchangers*
- Air to Air Rotary Heat Exchangers *
- Chilled Beams*
- Close Control Air Conditioners*
- Comfort Air Conditioners*
- Cooling & Heating Coils
- Cooling Towers
- Drift Eliminators
- Fan Coils Units*
- Heat Exchangers *
- Heat Pumps*
- Liquid Chilling Packages *
- Remote Refrigerated Display Cabinets
- Rooftop (RT)*
- Variable Refrigerant Flow (VRF)*

* All models in the production has to be certified

Air Handling Units

CERTIFY ALL

Swegon has participated in the program for Air Handling Units from the start. The first priority at that time, and still is, was to find a way for fair competition. This is a long term struggle were we try to cover all aspects from manufacturing to software performance predictions and its agreement with tests. We discuss and take decisions about mandatory performance in software print-out, rules for the energy labelling, how to test and what to apply in the, on site, auditor check. Customers should go for Eurovent certified products, to get reliable data, and then they can cut the main cost and take care of the environment by minimising the use of energy.

Committee chair:
Mr Gunnar Berg
Development Engineer, Swegon

Scope of certification

This Certification Programme applies to selected ranges of Air Handling Units.

Participants shall certify all models in the selected product range up to the maximum stated air flow.

A range to be certified shall include at least one size with a rated air volume flow below 7 m³/s (25 000 m³/h).

Certification requirements

For the qualification procedure: the selection software will be audited by our internal auditor. A visit on production site will be organized. During that visit, the auditor will select one real unit per range, as well as several model boxes that will cover all mechanical variations.

The selected models will be tested and performances delivered by the selection software will be compared to the performances measured in our independent laboratory.

For the repetition procedures, the auditor will annually check the software conformity against the production data, and tests will be repeated every 3 to 6 years

Certified characteristics & tolerances

- External Pressure: 4% or 15 Pa
- Absorbed motor power: 3%
- Heat recovery efficiency: 3%-points
- Heat recovery pressure drop (air side): max. of 10% or 15 Pa
- Water coil performances (heating/cooling): 2%
- Water coil pressure drop (water side): max. of 10% or 2 kPa
- Radiated sound power level casing: 3 dB(A)
- Sound power level unit openings:
  - 5 dB @ 125 Hz
  - 3 dB @ 250 – 8 000 Hz

ECC Reference documents

- Certification manual
- Operational Manual OM-5
- Rating Standard RS 6/C/005

Testing standards

- EN 1886: "Ventilation for buildings – Air handling units – Mechanical performance"
- EN 13053: "Ventilation for buildings – Air handling units - Rating & performance for units components and sections"

Cooling Towers

The importance of air conditioning and industrial cooling is constantly increasing in modern architecture and industrial process cooling. The human perception of comfort and the new challenges to reduce the electrical power consumption and CO_2 footprint have designers striving for optimal system performances with the highest possible efficiencies. Reliable thermal performances are crucial to ensure these best efficiencies which are typical for cooling circuits driven by evaporative cooling equipment. On a yearly basis, one random picked cooling tower of each Eurovent-CTI certified product line will be full scale thermal tested by applying the CTI standard 201.

Eurovent Certification Company guarantees the consistency of thermal testing and manufacturing of European and non-European companies that subscribe to the program.

Committee chair:
Mr Rob Vandenboer
Product Manager, Quality Manager
Evapco Europe, BVBA

The first ECC / CTI collaborative certification program for Cooling Towers

The Eurovent Certification Company (ECC, Brussels, Belgium) is pleased to announce the Certification programme for cooling tower thermal performance developed in cooperation with the Cooling Technology Institute Est.1950 (CTI, Houston, Texas, USA). The scope of the program includes standardized model lines for open circuit cooling towers, typically factory assembled. Standardized model lines are composed of individual models that are required to have published thermal rating capacities at corresponding input fan power levels.

Thermal performance certification via this program offers a tower buyer assurance that the capacity published for the product has been confirmed by the initial and on-going performance testing per the requirements of the program using CTI STD-201. It also offers for regulators of energy consumption related to cooling towers, that the capacity of the towers has been validated. Minimum energy efficiency standards such as ASHRAE 90.1, which requires cooling tower energy efficiency validation by the CTI certification process, are used by governments and by green building certification programs such as LEED™.

Scope of certification

The Eurovent Certification Programme for Cooling Towers applies to product ranges (or product lines) of Open-Circuit series Cooling Towers. The programme applies to product ranges that:

- Are manufactured by a company whose headquarter or main facility are located in Europe, Middle-East, Africa or India. After getting the Eurovent Certification, the CTI certificate could be requested.
- Have already achieved and hold current certification by the Cooling Technology Institute (CTI) according to CTI STD-201.

Certification requirements

For the qualification & repetition procedures (yearly): our internal auditor will visit the production place and review the conformity of Data of Records. One unit per range will be selected and tested by one of our independent test agency.

Certified characteristics & tolerances

- Certified characteristic shall be per CTI STD-201
- Entering wet bulb temperature: –12.8°C to 32.2°C (55°F to 90°F)
- Cooling range > 2.2°C (4°F)
- Cooling approach > 2.8°C (5°F)
- Process fluid temperature < 51.7°C (125°F)
- Barometric pressure: –91.4 to 105.0 kPa (27" to 31" Hg)

ECC Reference documents

- Certification manual
- Operational Manual OM-4
- Rating Standard RS 9/C/001

Testing standards

- CTI STD-201
- ECC OM-4

Air Filters Class M5-F9

CERTIFY ALL

Today, people spend most of the time inside of buildings. Hence, indoor air quality is a key factor to human health. Air filters removing fine dust from the air stream are the key component in building heating, ventilation and air conditioning systems to supply air of the required cleanliness and to ensure a high level of indoor air quality. With the air filter certification program, reliable and transparent filter data are ensured to customers. On a yearly base, four different filters are selected out of the product range of each participant for testing at independent laboratories according to EN 779:2012, verifying the initial pressure drop, the filter class and the initial and minimum efficiency, as well as the energy efficiency class to Eurovent document 4/11. Additionally, with the new energy efficiency label, Eurovent provides valuable data to enable users to select the most energy efficient air filters.

Committee chair:
Dr. Thomas Caesar
Head of Filter Engineering Industrial Filtration Europe
Freudenberg Filtration Technologies SE & Co. KG

Scope of certification

- This Certification Programme applies to air filters elements rated and sold as "Fine Air Filters F5-F9" as defined in EN 779 and with a front frame size of 592 x 592 mm according to standard EN 15805.
- When a company joins the programme, all relevant fine air filter elements shall be certified.

Certification requirements

- For the qualification & repetition procedures: 4 units will be selected and tested by one of our independent laboratory.

Certified characteristics & tolerances

- Filter class: no tolerance.
- Initial pressure drop: +10% + 5 (minimum 15 Pa)
- Initial efficiency for F7 to F9
- Discharge efficiency for F7 to F9
- Eurovent energy class
- Annual energy consumption

ECC Reference documents

- Certification manual
- Operational Manual OM-11
- Rating Standard RS 4/C/001

Testing standards

- EN 779 including annex A
- Eurovent 4/11

Liquid Chilling Packages & Heat Pumps

CERTIFY ALL

Scope of certification

- This programme applies to standard chillers and hydronic heat pumps used for heating, air conditioning and refrigeration.
- They may operate with any type of compressor (hermetic, semi-hermetic and open) but only electrically driven chillers are included.
- Only refrigerants authorised in EU are considered. Chillers may be air cooled, liquid cooled or evaporative cooled.

Certification requirements

Qualification and repetition: a certain number of units will be selected by Eurovent Certification and tested every year, based on the number of ranges and products declared.

Certified characteristics & tolerances

- Cooling & heating capacity and EER & COP at full load: < –5%
- A-weighted sound power level: > +3 dB(A)
- Water pressure drop: +15%
- Available pressure: –15%

ECC Reference documents

- Certification manual
- Operational Manual OM-3
- Rating Standard RS 6/C003
- Rating Standard RS 6/C/003A

Testing standards

- Performance testing: EN 14511
- Sound testing: EN 12102

Rooftop (RT)

CERTIFY ALL

The Eurovent rooftop certification (RT) program covers air-cooled and watercooled packaged rooftop units below 100 kW in cooling mode, with an option to certify units from 100 kW to 200 kW. The Rooftop program participants represent the five main European rooftop manufacturers.

Eurovent certifies indoor and outdoor sound levels, cooling and heating capacity and efficiency. Certified performances provide transparency and fair comparison between manufacturers. It is also the basis for the reliable study of HVAC system energy performance.

Currently the program evolves towards part load efficiency (SEER, SCOP) and certification of performance simulation tool data. Current work done on EN 14825 aims to address rooftops in the calculation hypothesis. The software certification is a key item to comply with existing and coming certification of building energy calculations in the EU countries.

Committee chair:
Mr Philippe Tisserand
Product Manager for rooftop & commercial unitary for Trane EMEIA – Chairman of Eurovent Rooftop program compliance committee

Scope of certification

- This Certification Program applies to air-cooled and water cooled rooftops rated below 100 kW.
- Models with cooling or heating capacity ranging from 100 kW to 200 kW can be certified as an option.
- Models of rooftops using gas burners for heating shall be only certified for cooling.

Certification requirements

- For the qualification and repetition procedures (yearly) between 1 & 3 units are selected and tested by Eurovent Certification, depending on the number of products declared.

Certified characteristics & tolerances

- Capacity (Cooling or Heating): –5%
- EER or COP: -8%
- Condenser water pressure drop: +15%
- A-weighted Sound Power Level: +3 dBA.
- Eurovent Energy Efficiency class (cooling and heating)

ECC Reference documents

- Certification manual 6/C/007
- Operational Manual OM -13
- Rating Standard RS

Testing standards

- EN 14511 for Performance Testing
- EN 12102 for Acoustical Testing

Fan Coils Units

CERTIFY ALL

Scope of certification

- This Certification Programme applies to Fan Coil Units using hot or chilled water. It concerns both non ducted and ducted fan coils:
- Non ducted units: Fan Coil Units with air flow less than 0.7 m³/s and a published external static duct pressure at 40 Pa maximum.
- Ducted units: Fan Coil Units up to 1 m³/s airflow and 300 Pa available pressure.
- Participating companies must certify all production models within the scope of the programme.

Certification requirements

- Repetition procedure: the number of units to be tested each year will be proportional to the number of his basic models listed in the Directory, in an amount equal to 20% for Fan Coil Units with a minimum of one test.

Certified characteristics & tolerances

- Capacity (cooling, sensible, heating): –5%
- Water pressure drop: +10%
- Fan power input: +10%
- A-weighted sound power: +2 dB(A)
- Air flow rate: -10%
- Available static pressure 0 Pa for medium speed and –5 Pa for other speeds
- FCEER & FCCOP
- Eurovent energy efficiency class

ECC Reference documents

- Certification manual
- Operational Manual OM-1A-2011
- Rating Standard RS 6/C/002-2011
- Rating Standard RS 6/C/002A-2011

Testing standards

- Eurovent 6/3 for Performance testing
- Eurovent 8/2 for Acoustic testing

WOLF CENTROGULF SUSTAINABLE ENERGY

Wolf - Comfort and energy efficiency by combining the concrete core cooling with efficient air handling units

The combination of concrete core cooling with energy efficient dehumidification and cooling process in air handling unit is a key for sustainable solution.

Sensible heat is removed with Wolf Concrete Core Cooling

Concrete Core Cooling is the water-based radiant cooling systems, where pipes are embedded in the building structure (floors, ceilings, walls). Its scope is to cool down the space and keep the temperature of building structure at a comfortable level preventing the overheating of structure.

There are many benefits related to concrete core cooling. It ensures thermally comfortable indoor environment as the thermal mass of concrete slabs cools the space by radiation and convection. Therefore both the mean radiant temperature and air temperature can be controlled and human body is thermally in balance with higher room air temperature. Cooling operation of a ceiling is not dependent of the primary air flow and there is less air movement in the space due to radiant heat transfer. It also means that ventilation and air conditioning system can be designed to ensure good indoor air quality for occupants. Therefore fresh air volumes are smaller than in traditional systems and less dehumidification and fan energy is needed.

The building mass performs as energy storage. The thermal mass of concrete slabs absorbs coldness during night-time and utilizes heat load during day-time. System does not need to be designed for peak load conditions. Finally surface cooling systems use water at a temperature close to room temperature. This increases the possibility of using renewable energy sources and increasing the efficiency of chillers and in most conditions heat pumps or Geothermal systems.

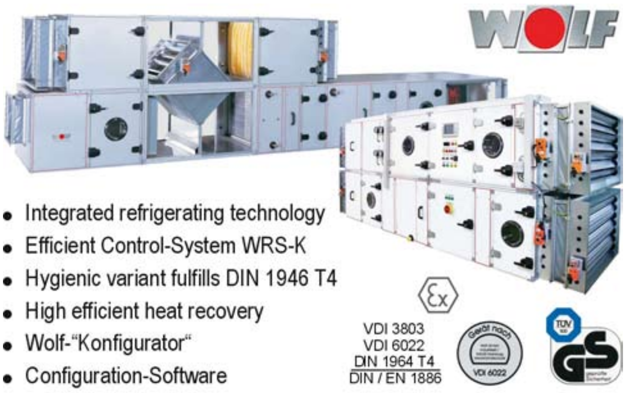
Latent heat is removed with efficient air handling units like Wolf KG-Top

The latent heat of people and outdoor air can be removed by using tight, factory made air handling units which have an efficient energy recovery and cooling system. The new KG Top air handling unit with integral refrigeration technology and range of energy recovery solutions (cross-flow, sensible, enthalpy and sorption) ensures a holistic energy savings concept. It offers up to 70 % energy savings due to intelligent combination of free and conventional cooling. Low air speeds inside the unit mean low pressure drop and therefore low energy consumption. Compact factory-assembled appliances are tight preventing the moist outdoor air to mix with conditioned air in outdoor installations. KG Top is equipped with highly efficient components, such as EC high performance fans and digital controlled scroll compressors. Wolf KG Top air handling unit (hygiene version) meets the hygiene requirements necessary to comply with the specifications for ventilation systems in hospitals and rooms where medical examinations, treatment and procedures are performed. 3E

Reference projects:

Airport, Munich

Fairground, Vienna



Energy efficient air handling unit: Wolf KG-Top: 20 Sizes 2 100 m³ – 100 000 m³.

Volker Rühle
Dipl.-ing., Director Middle East
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Sustainable energy
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REHAU - Unlimited Polymer Solutions

www.rehau.com

EXPERTISE AND INNOVATIVE SPIRIT have made REHAU a leading systems and service provider for polymer-based solutions in construction, automotive and industry. By combining strong development capabilities with decentralized sales and service excellence, we have become one of the top providers in the market. The highest levels of professionalism from material development through manufacturing, together with a passion for the unlimited potential of polymers are the foundation of our worldwide success as a premium brand. REHAU is in more than 70 nations with 17,000 employees worldwide.

CONSTRUCTION - As a leading provider of innovative system solutions in energy efficiency, water management, infrastructure and renewable energy, REHAU is revolutionizing ecology, economy, design and functionality as well as the safety and comfort of construction. Our high-performance product ranges in window and curtain walling technology, building technology and civil engineering and infrastructure are in great demand worldwide.

REHAU®
Unlimited Polymer Solutions

"Unlimited Polymer Solutions" stands for REHAU's passion for redefining the limits of what is possible with polymer-based solutions on a daily basis. Since 2008, REHAU has produced over 10,000,000 meters of GENEO window profiles from the high-tech material RAU FIPRO. This unique lightweight material delivers outstanding energy efficiency and long-lasting stability. This makes us the innovation leader in the window industry.

New efficient filter from Camfil *for air handling units*

Camfil has developed a low pressure drop filter that removes the particulate matter effectively but also gaseous pollutants including ozone from ventilation air.

Advantages

Its pressure drop is exceptionally low and it meets the Eurovent Certification energy class A. City-Flo XL has the same plastic frame (a single-piece casting) used in many of Camfil other filters. When upgrading the existing filters, there is no need to replace the filter system. City-Flo XL has been developed to achieve a better indoor environment that satisfies EN13779:2007, the European standard for indoor air quality.

Innovation

Camfil new air filter, City-Flo XL, is a combination filter that removes both particles and gases from ventilation air. Filter contains activated carbon, it also removes odours and aromas that ordinary air filters miss. Unique filter media has classF7 particle removal. For gas cleaning, activated carbon is integrated in the non-woven filter media. City-Flo XL filter removes also ozone from the ventilation air.

Technical data:

Filter type: Particle and gas filter.

Frame: Plastic XTL frame, single piece casting, good air distribution in the filter.

Filter media: Fiberglass particle filter layer (fine fibres) with very high quality coconut shell carbon integrated into non-woven media.

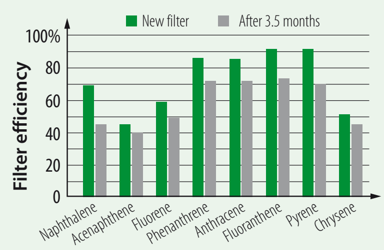
Filter class: F7 (as pr EN779:2012).

Filter design: Stiff bags – carbon composite media downstream. Atmospheric humidity in test conditions 70%.

Performance:

- Filter class F7 regarding the particle removal efficiency according to European standard EN 779:2012.
- Pressure drop and removal efficiency of some gaseous pollutants below.
- Significant improvement of perceived quality of air passing through the filter.
- City-Flo XL is also Eurovent certified and P marked by Swedish Testing Institute.

More information: www.camfil.com



CITY-FLO XL combination filter.

The Municipal House where the Farewell Congress Night-Out – dinner will take place.

High number of submitted abstracts to REHVA CLIMA 2013 Congress predicts a great success

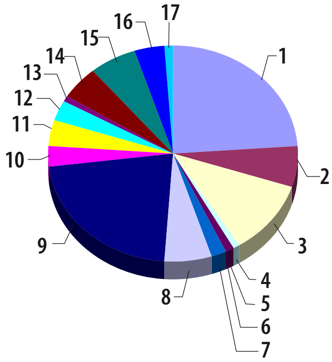
In June 2013, Prague will host one of the most significant professional events of the year focused on heating, ventilation and air conditioning in buildings – the REHVA Congress CLIMA 2013. The Congress will be the 11th REHVA international Congress in a row and, integrating also in the programme the IAQVEC, the 8th Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings. Professor Karel Kabele, the president of the Clima 2013 Congress is glad to announce that "*more than 850 experts from 60 countries submitted their abstracts for presentations at the conference with theme, Energy Efficient, Smart and Healthy Buildings*".

The Clima 2013 conference will have a significant participation outside Europe, especially from Japan and USA as the distribution of abstracts indicates.

The CLIMA2013 puts a great emphasis on contributions that will address those skilled in this art. Therefore, the Congress Programme includes presentations of contributions, posters, workshops, as well as an additional expert lessons such as the ASHRAE Course entitled "*High Performance Building Design: Applications and Future Trends*", for example.

The Topic distribution of abstracts on 21.07.2012 (total of 928 abstracts).

1. Energy Efficient Heating, Cooling and Ventilation of Buildings, 24%
2. Renewable and High Efficient Energy Sources, 6%
3. Advanced Heating, Cooling, Ventilation and Air Conditioning Systems for Buildings, 11%
4. Energy Efficient Domestic Hot Water Supply Systems, 1%
5. Sanitary Systems - Hygiene of Domestic Water Supply Systems, Efficient Use of Potable Water, Environmental Friendly Sewage Disposal, 1%
6. Advanced Technologies for Building Acoustics, 0%
7. Artificial and Day Lighting, 2%
8. Technologies for Intelligent Buildings, 6%
9. Quality of Indoor Environment, 22%
10. Building Certification Schemes, 3%
11. Integrated Building Design, 4%
12. Commissioning and Facility Management, 3%
13. HVAC Best Practise Examples, 1%
14. Directive on Energy Performance of Buildings Implementation, 5%
15. Zero Energy Buildings, 6%
16. HVAC in Historical Buildings, 4%
17. Fire Safety of the Buildings, 1%



The International Scientific Committee consisting of more than 100 leading experts of all continents guarantee a high professional level of the programme. At this moment, the interest of the industry shows that the capacity of the 20 REHVA workshops, ie. expert lessons organised by our industrial partners within the framework of the Congress CLIMA 2013, as well as within the framework of the REHVA projects (Task Force) have been almost used up, which workshops were primarily aimed at solutions of up-to-date issues of the implementation of the EU Directive on the Energy Performance of Buildings and associated problems in the technological development. A special theme connected with historical traditions of Prague deals with problems of historical buildings, which should be pointed out certainly.

Reputed keynote speakers invited from the expert community recognised worldwide will open each of four Congress days. The Congress will be held under a patronage of important industry partners, as well social organisations and in co-operation with partners that represent the top in this art. Among REHVA CLIMA2013 Congress partners can be mentioned, for example, the ASHRAE - a professional organisation with 118 years history associating 50 000 professionals worldwide, the SHASE – a Japanese organisation with more than 80 years tradition and more than 20 000 members and the ISHRAE, professional partner from India, as well as the IIR, AIVC, AHRI and a number of other professional organisations. ∃Ɛ

Register now at www.clima2013.org

The European Business and Technology Centre:

A platform to promote EU-India collaboration in Green Buildings and more

The **European Business and Technology Centre (EBTC)** is a programme co-funded by the European Union and coordinated by EUROCHAMBRES the Association of European Chambers of Commerce and Industry. Key role is played by 16 European partners combining business organizations, academic and research institutes from all over the EU, all of them with a successful track record in their respective field.

A dedicated team of sector specialists provide core competencies in EBTC's 4 key focus sectors – **Biotech, Energy, Environment and Transport** and with a pan India reach across India, with presence in the cities of New Delhi, Mumbai, Bengaluru and Kolkata; EBTC is well-equipped to link EU clean tech companies and researchers to collaborate with Indian researchers and businesses.

EBTC offers end-to-end solutions to EU cleantech companies who want to enter the Indian market. In every case customized and personalised support across the business lifecycle is available.

One of the concerns for EU technology transfer is protection of intellectual property. To help EU businesses and researchers, an IPR Helpdesk has been established with the explicit purpose of addressing EU concerns related to IPR, facilitating technology commercialization, as well as the management of IPR issues related to India.

For organisations looking to understand the Indian market, EBTC provides market intelligence, insight and exploration through various ways - from reports to webinars, to field trips. For organisations that are looking to enter the Indian market, EBTC helps to identify projects and partners, develop a market entry strategy, and provide hand-holding; incubation service, and events.

EBTC's Signature Event 2013: Greening Cities will be taking place in April 2013 – from B2B's and site visits, to a Green tech exhibition, there are a number of ways to get involved. For more information, please visit www.ebtc.eu/events.html

European Business and Technology Centre

All the VDI Guidelines are available in hard copy or in PDF at www.beuth.de

VDI Guidelines published October – December 2012

VDI 2169 "Functional checking and yield rating of solar thermal systems"

This guideline is intended for planners and executing companies, pointing out the options for functional checking and checking of output of solar thermal components in installations and listing the prerequisites to their application

VDI 6003 "Water heating systems; Comfort criteria and performance levels for planning, evaluation and implementation"

The guideline provides information about the expert planning, evaluation and implementation of water heating systems that are built in sanitary facilities of residential properties and similar buildings.

D VDI 2073/1 "Hydraulic systems in building services; Hydraulic circuits"

Each distribution system in a building must be tailored to the conditions in the building and calculated individually to meet user requirements. This guideline is intended to specify the fundamentals for the design of hydraulic distribution systems. It aims at conveying, to the planning engineer, contractor or user of a heating or air-conditioning or other hydraulically supplied system the basics of the conceptual design of the structure of hydraulic distribution systems to be observed for various applications.

VDI 2077/ 3.1 "Energy consumption accounting for the building services; Determination of reimbursable costs of heat generation by CHP systems"

The guideline is applied to cogeneration systems (CHP generation systems) subject to the German heating-cost ordinance (HeizkostenV), where heat is used completely (excluding emergency cooling), and describes methods for billing those costs for heat generation which can be apportioned.

VDI 2262/2 "Workplace air; Reduction of exposure to air pollutants; Processing and organization measures"

The guideline is addressed to employers. By way of example it provides guidance and ideas on how to comply with legal stipulations regarding occupational health and safety for air pollutants. A well-structured and documented organization aids in ensuring unimpeded and controllable production processes. The generation and release of air pollutants during the production process must be avoided or reduced. Air pollutant concentrations in the air at the workplace can be reduced by preventing or reducing emission and by air-conditioning.

D = Draft Guideline

D VDI 3807/2 "Characteristic values of energy consumption in buildings; Characteristic heating-energy, electrical-energy and water consumption values"

This guideline applies to the use of characteristic energy and water consumption values for buildings supplied with heating energy, electrical energy and water, especially where values for individual buildings are compared to the averages and standard values given in this guideline.

VDI 6025 "Economy calculation systems for capital goods and plants"

This guideline deals with all dynamic methods of calculation of economic efficiency for capital goods and plants, which are characterized by the following features: use of different change rates for various costs or types of payment, explicit allowance for costs and payments which occur at different periods, i.e. doing away with average cost rates per period, in contrast to the static method, and taking account of the uncertainty or risk of future costs or payments.

VDI 6008/1 "Barrier-free buildings; Requirements and fundamentals"

The present part 1 of the series of guidelines shows the main needs and basics for planning barrier free buildings regarding the technical building services. The supplements also deal with broader, user-specific needs of people of all ages with and without mobility limitations or disabilities.

VDI 6008/2 "Barrier-free buildings; Aspects of sanitary installation"

The guideline gives a summary overview of the main needs of persons and the requirements they place on sanitary installations. This guideline deals with requirements and solution approaches in real estate properties regarding sanitary installations and their useful combinations with solutions from electrical installation and furnishing.

D VDI/VDE 6008/3 "Barrier-free buildings; Aspects of electrical installation and building automation"

The guideline gives a summary overview of the main needs of persons and requirements they place on electrical installations and building automation.

D VDI 6022/7.1 "Ventilation and indoor-air quality; Branch-specific guides; Waste treatment plants"

The guideline is complementary, industry-specific information on VDI 6022 Part 1 for use in waste treatment plants. It applies to design, construction and operation of all HVAC systems and equipment and their centralized and decentralized components that influence the supply air in waste treatment plants according to Waste Law.

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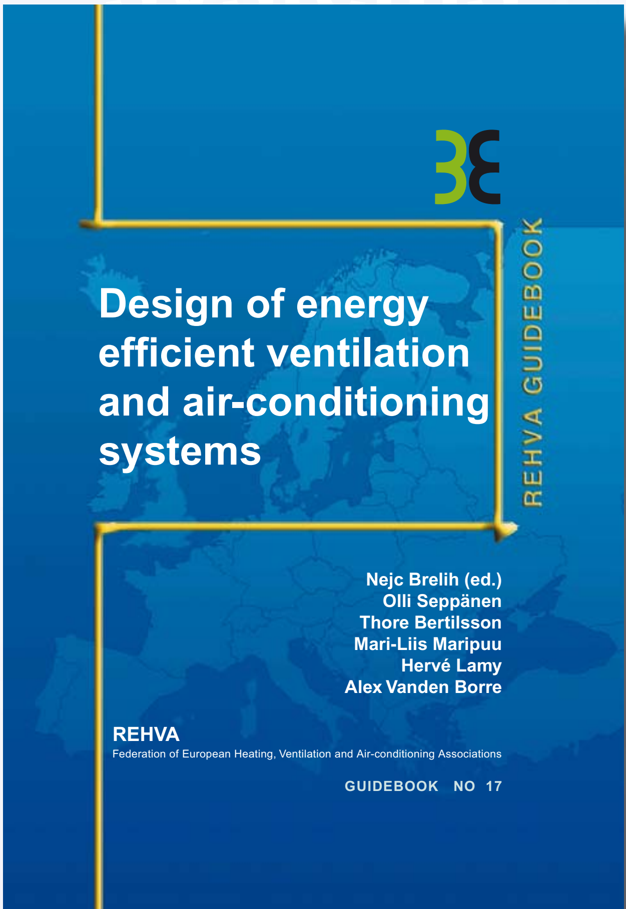
Review of the REHVA Guidebook No. 17 - Design of energy efficient ventilation and air conditioning

by Professor **Tim Dwyer**, Bartlett School of Graduate Studies, UCL, London | Originally published by the CIBSE Journal

www.cibsejournal.com

A new REHVA guide on energy efficient ventilation and air conditioning is a great starting point for designers and consultants wanting to get up to speed on the latest systems.

As REHVA heads into its 50th year, the Federation has expanded its series of guidebooks with the publication of the book Design of energy efficient ventilation and air conditioning systems, edited by Nejc Brelih, which marks the 17th booklet in the series. Despite the title, the modest 100 pages quickly establish that this is not a design manual but clearly a 'starting point', aimed at designers and consultants so that they can update their knowledge on contemporary, state-of-the-art commercial systems. Having provided a brief glossary of terminology, the book considers the state of the European building stock.



Contents of the REHVA Guidebook No. 17 - Design of energy efficient ventilation and air conditioning

Although there are different climatic conditions, the common factor in Europe's buildings (of which about 29% is non-residential) is that a substantial proportion is more than 50 years' old, with nearly 60% having been constructed prior to 1975. The implication is that the principles conveyed in this book are potentially as important in the operation and refurbishment of existing buildings as they are for new build.

Providing some useful context, the proportion of built environment energy used in European non-residential buildings (with buildings consuming approximately 40% of total European energy consumption) matches their proportion at (just over) 30% of the total energy use. The guide laments that there is no detailed breakdown of the energy use in European non-residential buildings, but looks forward to the outcome of two ongoing projects – available to be reviewed at **ecbc-sa53.org** and **iservcmb.info** – which will provide this missing intelligence.

The importance of being able to examine – and benchmark – the nonresidential building stock with greater discrimination is highlighted by wide variations in electrical energy use recorded in buildings across Europe. This will, of course, be influenced by climate, but without proper differentiation it is almost impossible to assess relative performance of buildings, and to head towards the visionary expectation of net zero energy buildings laid out in the Energy Performance of Buildings Directive (EPBD).

Having set the scene, the succeeding 11 technical chapters provide a somewhat eclectic mix of topics related to the energy performance of building services systems. That is not to criticise, as it would be an unrealistic expectation that this pocket-sized volume would provide the breadth and the depth of a 'Faber and Kell' style textbook. The contributions appear well informed and the book was also independently peer reviewed.

And so turning to the technical chapters, (as listed in the box), these rightly open with the almost obligatory review of indoor environmental quality – the maintenance of which is the very reason for the existence of the industry represented by REHVA. The chapter successfully conveys the need to have a holistic understanding of the parameters that define a wholly appropriate internal environment, from the basics of temperature and the influence of clothing and activity, through to outlining the impact on the economic performance of the building. The layout of the subsequent chapters start with 'Recommendations in a nutshell', relating to the subject of each of the specific sections. The form of these naturally imply 'rules of thumb' that are bound to be keenly sought by students and developing practitioners alike and can, when properly informed, give a useful steer to the uninformed or forgetful.

The strength of these particular recommendations is that the reader can, and should, within a few hundred words, read the rationale and justification behind them. The description of the application of equipment associated with air handling units (AHUs), and particularly filters, fans, heat recovery units and pumps, is orientated towards minimising life cycle costs (LCC). There are some interesting examples comparing the effect that face velocity (the velocity that the air passes through an AHU) has on the LCC of AHUs, indicating the benefits of larger section AHUs and in conjunction with discussion on appropriate speed control of properly selected fans and pumps.

The inclusion of a dedicated chapter on motors and speed control is to be applauded in what otherwise may be thought of a 'mechanical services' publication – the brevity of the material is still capable of providing some important 'keynote' facts that may otherwise be marginalised. These core technical chapters provide a good grounding in the sensitivities of selection in centralised air conditioning and ventilation. The most extensive chapter covers on demand controlled ventilation (DCV), which contains some useful background on the benefits of using such systems, together with the practicalities of their impact on airflows into rooms and control.

Oddly, the book ends with a chapter on passive solar shading – no doubt an important influence on building performance – but the space may well have been used to cover areas conspicuous by their absence, including general room air distribution and decentralised systems, such as fan coils, chilled beams and hybrid embedded systems. Some of these are covered in other dedicated books in the series but, then again, so is solar shading. This guidebook provides a quick, well presented read of specific aspects of energy efficient centralised ventilation and air conditioning system technologies applied in commercial buildings. To cover such a potentially broad area, while including detailed discussions in such a condensed format, is challenging.

REHVA Guidebook No. 17 "Design of energy efficient ventilation and air-conditioning systems" is available at **www.rehva.eu**

New book from Swegon Air Academy:

Simply GREEN – Certification systems in a nutshell

Swegon Air Academy published a new book 'Simply GREEN' on energy and environmental certification systems for sustainable buildings written in an intelligible way. The book describes how the different environmental and energy systems actually affect the daily work from a practical point of view. The book can be used primarily for orientation purposes, as teaching material and as a basis for helping to decide which system to use.

In the book, several *environmental* certification systems are described including BREEAM, LEED, DGNB, GREEN STAR, Miljöbyggnad and HQE. The book also contains *energy-based* certification systems such as GreenBuilding, Minergie and Passive House. Other certification systems compromise of brief description of Casbee, IGBC, ENERGY STAR and Effinergie.

Professor Emeritus Brian Edwards evaluates the book with the following: *"In this publication I am struck by the way a complex field is reduced to simple language and straightforward principles and facts. Too often building certification is mired by excessive technical description and construction jargon. In the spirit of knowledge sharing and technological exchange, Swegon Air Academy has served Europe's construction industry well by funding this simple GREEN guide to environmental and energy certification."*

The book is available in English and Swedish languages at the Swegon Air Academy´s Bookstore for external price of € 20 and the special price of € 15 (this price applies for Swegon Air Academy´s members). The prices include VAT and exclude postage. The iBOOK and eBOOK versions will be available early in 2013!

www.swegonairacademy.com/bookstore

News

REHVA at ASHRAE winter meeting and AHR Expo in Dallas

The REHVA reception was well attended. It was the place to be on Monday afternoon January 28th. REHVA's president **Michael Schmidt** and our board members **Karel Kabele** (president elect), **Jarek Kurnitski**, **Bjarne W. Olesen** and **Jan Aufderheijde**, REHVA's Secretary General were very happy to welcome all the guests. Those present raised their glasses to REHVAs' upcoming 50th anniversary and to congratulate Bjarne Olesens' election as an ASHRAE board member.

REHVA seminar speakers: Jarek Kurnitski, Jaap Hogeling and Bjarn Olesen.

REHVA's Seminar "Building Labeling in Europe, European Standardization to meet the Energy Performance Directive" was well attended, too. The seminar speakers reviewed the European initiatives to evaluate building energy performance and to couple energy use with environmental quality. This involves revision of several CEN standards. **Jaap Hogeling** explained the EU mandate to develop the second generation of energy performance standards. Jarek Kurnitski informed the audience about REHVA's work concerning definitions and system boundaries of nZEB buildings. Bjarne W. Olesen presented the revision of EN 15251, 'Indoor Environmental Criteria'. All presentations will be available on REHVA's website.

The REHVA Journal January 2013 special issue on Airtightness was available at ASHRAE's bookstore in the Conference Center, at REHVA's Reception and in the Magazine Resource Center at the AHR Show.

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1 ENERGY MANAGEMENT
From Radiant Heating & Cooling to uPVC Windows & Doors

2 WATER MANAGEMENT
From Rain Water Harvesting to Sound Insulating Domestic Waste Water System

3 MODERN LIVING
From Outdoor Furniture to AC Trap Door

1

uPVC Windows & Doors

1

Radiant Heating & Cooling

2

Rain Water Harvesting

2

Sound Insulating Domestic Waste Water System

3

AC Trap Door

3

RAUCORD Furniture

Send information of your event to Ms Cynthia Depradel cd@rehva.eu

Events in 2013 - 2014

Conferences and seminars 2013

March 18 - 19	International Workshop – Quality of Ventilation Systems in Residential Buildings	Brussels, Belgium	http://tightvent.eu/events/qvs-workshop-2013
April 2 - 4	2nd IIR International Conference on Sustainability and the Cold Chain	Paris, France	www.iccc2013.com
April 10 - 11	European Biomass to Power	Krakow, Poland	www.wplgroup.com/aci/conferences/eu-ebp3.asp
April 11 - 12	CIBSE Technical Symposium 2013	Liverpool, UK	www.cibse.org
April 15 - 17	3rd International Conference in Microgeneration and Related Technologies in Buildings - Microgen III	Naples, Italy	www.microgen3.eu
April 18 - 19	AIVC-TightVent Workshop on Building and Ductwork Airtightness	Washington, DC, USA	www.aivc.org
April 22 - 23	4th European Conference on Renewable Heating and Cooling	Dublin, Ireland	www.rhc-platform.org
April 24 - 26	SB13 Munich: Implementing Sustainability - Barriers and Chances	Munich, Germany	www.sb13-munich.com
May 9 - 11	5th International Conference on Amonia Refrigeration Technology	Ohrid, Macedonia	www.mf.edu.mk
May 27 - 28	36th Euroheat and Power Congress	Vienna Austria	www.ehpcongress.org
May 30 - 31	Energy Performance of Buildings and Related Facilities	Bucharest, Romania	www.aiiro.ro
June 3 - 8	eceee 2013 Summer Study on energy efficiency	Toulon/Hyere, France	www.eceee.org/summerstudy
June 7 - 8	The Latest Technology in Air Conditioning and Refrigeration Industry	Milan, Italy	www.centrogalileo.it/milano/CONGRESSODIMILANO2013english.html
June 16 - 19	11th REHVA world congress Clima 2013	Prague, Czech Republic	www.clima2013.org
June 19 - 21	Intersolar Europe 2013: Innovative Technologies and New Markets	Munich, Germany	www.intersolar.de
June 22 - 26	2013 ASHRAE Annual Conference	Denver, Colorado	www.ashrae.org/membership--conferences/conferences/ashrae-conferences/denver-2013
June 24 - 28	EU Sustainable Energy Week 2013 in Brussels	Brussels, Belgium	www.eusew.eu
June 26 - 28	Central Europe towards Sustainable Building Prague 2013	Prague, Czech Republic	www.cesb.cz/en
September 25 - 26	34th AIVC- 3rd TightVent- 2nd Cool Roofs' - 1st Venticool	Athens, Greece	www.AIVC2013Conference.org
September 25 - 27	5th International Conference Solar Air-Conditioning	Germany	www.otti.eu
September 25 - 29	International Conference on Sustainable Building Restoration and Revitalisation	Shanghai, China	www.wta-conferences.org/conference/1869
October 3 - 4	CLIMAMED - VII Mediterranean Congress of Climatizacion	Istanbul, Turkey	www.climamed.org
October 15 - 16	European Heat Pump Summit	Nürnberg, Germany	www.hp-summit.de
October 15 - 18	IAQ 2013 - Environmental Health in Low Energy Buildings	Canada	www.ashrae.org/membership--conferences/conferences/ashrae-conferences/iaq-2013
October 16 - 18	Building Services for the Third Millenium	Sinaia, Romania	www.aiiro.ro
October 18 - 19	COGEN Europe Annual Conference & Dinner	Brussels, Belgium	www.cogeneurope.eu
October 19 - 21	ISHVAC	Xi'an, China	http://ishvac2013.org/
October 20 - 21	Energy Efficiency & Behaviour	Helsinki, Finland	www.behave2012.info

Conferences and seminars 2014

January 18 - 22	ASHRAE 2014 Winter Conference	New York, NY, USA	www.ashrae.org/membership--conferences/conferences
February 24 - 26	Fist International Conference on Energy and Indoor Environment for Hot Climates	Doha, Qatar	www.ashrae.org/HotClimates
February 26 - 28	49th AiCARR International Conference	Rome, Italy	www.aicarr.org
May 13 - 15	11th IEA Heat Pump Conference 2014	Montreal, Canada	www.geo-exchange.ca/en/canada_to_host_the_11th_international_energy_agenc_nw211.php
August 31 - Sep 2	11th IIR-Gustav Lorentzen Conference on Natural Refrigerants - GL2014	Hangzhou, China	
October 18 - 19	CCHVAC Congress	China	

Exhibitions 2013

March 5 - 7	ecobuild 2013	London, UK	www.ecobuild.co.uk
March 7 - 9	ACREX 2013	Mumbai, India	www.ishrae.in
March 12 - 16	ISH Frankfurt	Frankfurt, Germany	www.ish.messefrankfurt.com
March 20 - 22	écobat Paris 2013	Paris, France	www.salon-ecobat.com
March 21 - 24	SODEX ANKARA 2013	Ankara, Turkey	www.sodexankara.com
April 8 - 10	ISH China & CIHE	Beijing, China	www.ishc-cihe.com
April 23 - 24	VVS Mässa Öresund - Trade Fair for Heating and Air Conditioning	Malmö, Sweden	www.easyfairs.com/fr/events_216/byggmaessa-oeresund-vvs-maessa-oeresund_23609/vvs-maessa-2013_24034/
May 14 - 17	Aqua-Therm Kyiv	Kiev, Ukraine	www.en.aqua-therm.kiev.ua
September 3 - 6	Aqua-Therm Almaty	Almaty, Kazakhstan	www.aquatherm-almaty.com
October 23 - 26	Aqua-Therm Baku	Baku, Kazakhstan	www.aquatherm-baku.com
November 4 - 8	Interclima+Elec	Paris, France	www.interclimaelec.com

Exhibitions 2014

January 21 - 23	AHR Expo	New York, NY, USA	www.ahrexpo.com
April 1 - 4	NORDBYGG 2014	Stockholm, Sweden	www.nordbygg.se
March 18 - 21	MCE - Mostra Convegno Expocomfort 2014	Fiera Milano, Italy	www.mcexpocomfort.it
March 30 - Apr 4	Light + Building	Frankfurt, Germany	www.light-building.messefrankfurt.com
May 7 - 10	ISK - SODEX 2014	Istanbul, Turkey	www.hmsf.com
October 14 - 16	Chillventa 2014	Nuremberg, Germany	www.chillventa.de/en/
September 30 - Oct 3	Finnbuild 2014	Helsinki, Finland	www.finnbuild.fi

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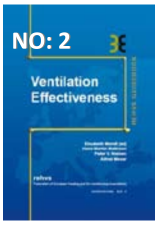
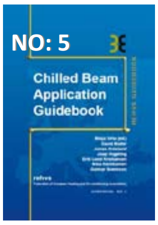
REHVA
Federation of European Heating, Ventilation and Air-conditioning Associations

REHVA GUIDEBOOKS

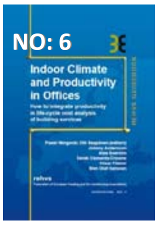
REHVA Guidebooks are written by teams of European experts



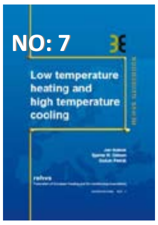
Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook provides easy-to-understand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



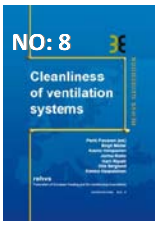
Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system.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



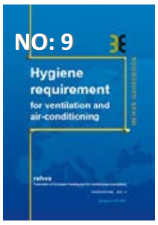
Indoor Climate and Productivity in Offices Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The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



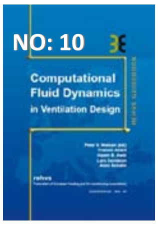
This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at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



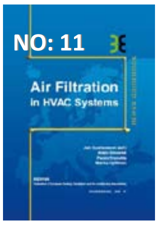
Cleanliness of ventilation systems Guidebook aims to show that indoor environmental conditions substantially influence health and productivity. This Guidebook presents criteria and methods on how to design, install and maintain clean air handling systems for better indoor air quality.



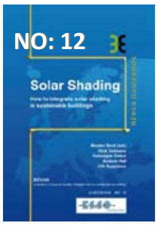
Hygiene requirement is intended to provide a holistic formulation of hygiene-related constructional, technical and organisational requirements to be observed in the planning, manufacture, execution, operation and maintenance of ventilating and air-conditioning systems. These requirements for ventilating and air-conditioning systems primarily serve to protect human health.



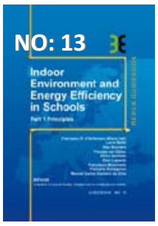
CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) –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



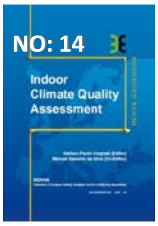
Air filtration Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such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



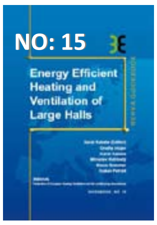
Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for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



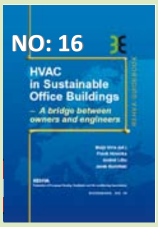
School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly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



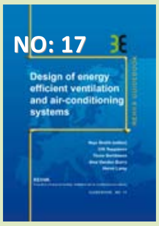
This new REHVA Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring has allowed enlarging significantly number of possible applications, especially in existing buildings.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



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



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



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

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REHVA Guidebooks are available at www.rehva.eu