



# **PROBIS**

**SUPPORTING PUBLIC PROCUREMENT OF BUILDING  
INNOVATIVE SOLUTIONS**

**CROSS BORDER APPRAISAL OF THE STATE OF THE ART**

**D 2.B**



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# 1. RESIDENTIAL VENTILATION

## 1.1. DESCRIPTION

Building ventilation is the process of **removing stale air** from inside of a structure and replacing it with **fresh air** from outdoors.

This process is part of the heating, ventilation and air conditioning (HVAC) system of a building, which is typically designed and installed by a mechanical or HVAC contractor.

Building ventilation is measured in terms of air changes per hour (ACH), which is the percentage of air volume that is removed and replaced from the building each hour. This can range from 0.5 ACH in a tightly sealed building to 1.5 ACH in a loosely-constructed home.

Structure of ventilation systems and values of air flow rates are the result of Member States national building codes and national traditions.

Proper ventilation is critical to maintaining a **healthy indoor air quality** within a building. As humans perform basic metabolic processes, they release carbon dioxide into the air. Household items like paint, furniture and flooring often contain chemicals that can off-gas into the air. Building ventilation helps to remove chemicals and carbon dioxide and replace them with fresh air.

Ventilation systems are also used to control humidity levels and reduce odours within a building.

Residential Ventilation is referred to residential buildings: single or multiple dwellings, and does not include applications of the tertiary building sector: offices, hospitals or others.

## 1.2. TYPES OF VENTILATION SYSTEMS

### 1.2.1. Natural Ventilation

Natural Ventilation systems **do not require fans**, HVAC equipment, or ductwork. Instead they rely on pressure differences between exterior and interior areas to help move air. Pressure changes are constantly occurring in a building, and may be caused by **wind**, **temperature changes**, or human activities.

A natural building ventilation system uses operable windows, louvers and grilles to help air enter or exit a building. While natural systems are highly effective at producing air changes, they are not generally successful at controlling humidity levels, especially in warmer regions.

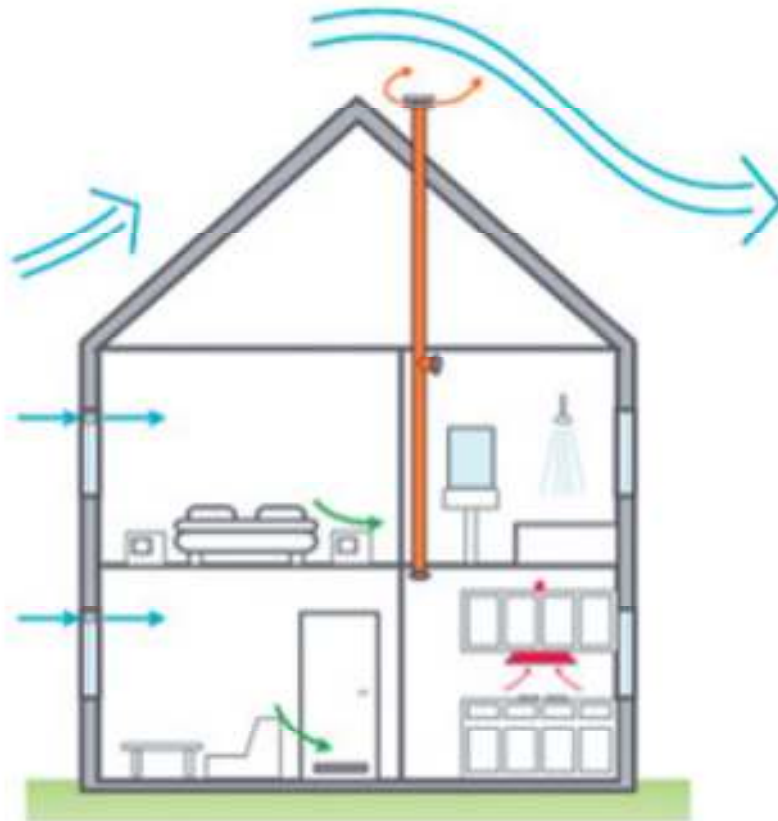
Natural ventilation is a climate control method which relies on the natural movements of air to keep fresh air moving through a building and to control temperature and humidity levels.

While this was the only ventilation option available historically, once mechanical means of ventilation were developed, many builders switched to these methods. In the late 20th century, some of the distinct advantages of natural ventilation began to be recognized, and builders started returning to the use of natural techniques.

There are several ways to create natural ventilation in the structure. Stack ventilation is one of the natural ventilation options.

With stack ventilation, people rely on natural pressure differences between air in various locations to force air up ventilation stacks. This technique is often used in factories, where tremendous amounts of heat can be generated, with the air being pulled up the stacks along with odours from the factory floor. Stack ventilation is usually facilitate with the use of intake vents which are located low to the ground, generating a steady flow of fresh, cool air.

Specialists usually separate the notion of airing (through manual window opening) from the notion of natural ventilation which is "designed" or "predictable" (see EN 12792).



**Figure 1:** Natural ventilation

Courtesy "Guide for the residential ventilation", FENERCOM, Madrid Regional Government

### 1.2.2. Mechanical ventilation

Mechanical ventilation systems use **fans** to draw fresh air inside, and rely on HVAC ducts to distribute the air throughout the building.

The fresh air is known as "supply air," and passes through the building's air handling units as it enters the home. As supply air is blown into a room, existing "return air" is forced into exhaust grilles, where it travels back through the duct network and is exhausted to the outside.

The type of ventilation system used in a building can have a significant impact on the energy efficiency of the structure. A natural building ventilation system does not consume energy to operate fans or air handling units, but does allow heated or cooled air to escape through open windows and air vents.

Mechanical ventilation systems require energy to operate fans and equipment, but do not allow as much conditioned air to escape through vents or windows. The energy efficiency of each type of ventilation system should be carefully weighed against the ventilation needs of a building before a system is selected.

Mechanical ventilation includes all the motorized devices used to renew the indoor air.

Also hybrid ventilation systems are defined in EN 12792, as "ventilation where natural ventilation may be at least in a certain period supported or replaced by powered air movement component" to enlarge the notion not only to fans but to the full building which has to be designed in a certain way.

As already mentioned, mechanical ventilation is associated to the presence of fans.

### *Ventilation fans*

A ventilation fan consists of a bladed rotor that is connected to an electric motor through a shaft or a belt. The rotor can be preceded or followed by a stationary blade row and the ventilator can be linked to inlet and outlet ducts. In the domain of ventilation the fan and the motor are sold together, whether they are linked by a shaft or by a belt.

Performances are characterized by the pressure and the airflow they can provide along with the required input power. These performances vary importantly among the vast amount of existing ventilators, a first segmentation (technical) is usually performed regarding how the air flow is deviated by the device: centrifugal, axial, or tangential fans (also called crossflow fans).

Generally speaking, axial and centrifugal fans are the most frequent technical types. A propeller is an axial fan with few blades, designed to operate through a partition. For small fans, which are the most frequent in residential ventilation, the dominant rotor will be centrifugal (with either forward or backward curved blades) and the dominant motor an asynchronous AC motor. However there are some EC (Electronic Commutation) motors and some DC motors.

### *Categories of mechanical ventilation*

Mechanical ventilation can be divided into two different categories, depending on if it is a local or a centralised system.

#### *Local mechanical ventilation*

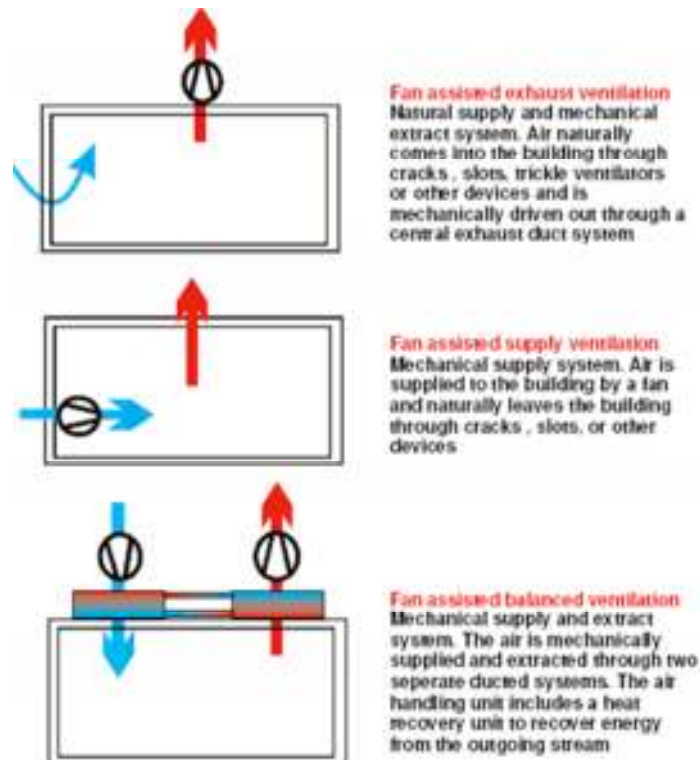
The ventilation system can be designed as such as to generate underpressure in the rooms (general case) or over pressure.

Decentralised mechanical ventilation means that several extraction ventilators are used to renew the air of a complete house (without designed transfer between rooms in the dwelling).

Three configurations are possible:

- natural air supply with mechanical extract with fans;
- mechanical air supply with natural extract- positive insufflation ventilation, forbidden in some countries for dwellings due to the risk of pushing humidity in the walls;

- mechanical air supply with mechanical extract.



**Figure 2:** Types of local mechanical ventilation systems

Courtesy ECODESIGN of Energy using Products: Introduction to Lot 10 study

The “fan assisted exhaust ventilation” is by far the most common in Europe among the three fan assisted systems: the air comes into the room through cracks, windows, slots (natural air supply) and the stale air is evacuated by small sized fans or by hoods that can be located on the roof, the ceiling, the walls or in the windows.

These fans also generate a depression enabling the outside air to naturally come into the room.

For other configurations, fans can also be used for direct introduction of outside air inside, being the fans used in these cases similar to the others.

Residential ventilation fans usually include the motor, as opposed to larger power fans, and provide lower pressure differences. They are tested under specific standards (EN 13141: Ventilation for buildings. Performance testing of components/products for residential ventilation).

The decentralised mechanical ventilation can use fans with different locations and aspects:

- Roof fans are located on the roof of the room or may be linked to a ducted system.
- Extraction fans can eject the air through the walls or the ceiling directly or through a short duct. Extraction fans are located inside whereas roof fans are located outside.
- Window fans are embedded in a window glass. They can also be located in the frame of the window.
- In the residential sector, hoods are located close to pollution sources (in the kitchen). The user can turn it on or off when he wants.

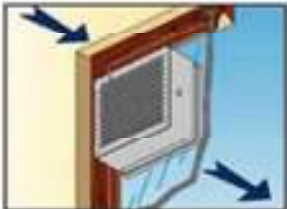


In all categories, the fact they are ducted or not is translated by type A, B, C, D in ISO 5801:

Type (A): free inlet, free outlet;

Type (B): free inlet, ducted outlet;

Type (C): ducted inlet, free outlet;

Type (D): ducted inlet, ducted outlet

Type	Operating scheme	Typical characteristics
Window glass		<ul style="list-style-type: none"> <li>- Consumption: 20 – 100 W</li> <li>- Airflow: 200 – 1400 m<sup>3</sup>/h</li> <li>- Non ducted</li> <li>- Usually axial</li> <li>- Fix</li> </ul>
Window (Inside the frame)	Another type of window fan, located in the frame of the window	<ul style="list-style-type: none"> <li>- Consumption: 120W</li> <li>- Reversible air flow</li> <li>- Non ducted</li> <li>- Usually axial</li> <li>- Movable</li> </ul>
Wall/ceiling		<ul style="list-style-type: none"> <li>- Consumption: 10 – 50 W</li> <li>- 100 – 400 m<sup>3</sup>/h</li> <li>- Connected to a short ducted system</li> <li>- Usually axial</li> <li>- Fix</li> </ul>
Roof		<ul style="list-style-type: none"> <li>- Often connected to a ducting system</li> <li>- Centrifugal or mixed fan</li> <li>- Outside the building</li> </ul>
Type	Operating scheme	Typical characteristics
Hoods	Air extraction in kitchen	<ul style="list-style-type: none"> <li>- Consumption: 100 – 300 W</li> <li>- Airflow: 200 – 1000 m<sup>3</sup>/h</li> <li>- Ducted</li> <li>- Usually centrifugal</li> <li>- Fix</li> </ul>



**Figure 3:** Fans with different locations

Courtesy ECODESIGN of Energy using Products: Introduction to Lot 10 study

### *Central mechanical ventilation*

Centralized mechanical ventilation means that one extractor and a ducted system are used to renew the air of a whole dwelling (made of several rooms).

Three configurations can be found in the residential area:

- Single extract centralized mechanical ventilation (Natural air supply and mechanical extract)
- Simple flow centralized mechanical ventilation (Mechanical air supply and natural extract)
- Balanced double flow ventilation system (Mechanical air supply together with a mechanical extract)

#### **Single extract centralized mechanical ventilation** (Natural air supply and mechanical extract)

Because of the depression generated by the extractor, the air comes through the dwelling from the less polluted rooms (bedrooms, living rooms) to the most polluted ones (kitchen, toilets) by spaces around the doors, mostly under the doors.

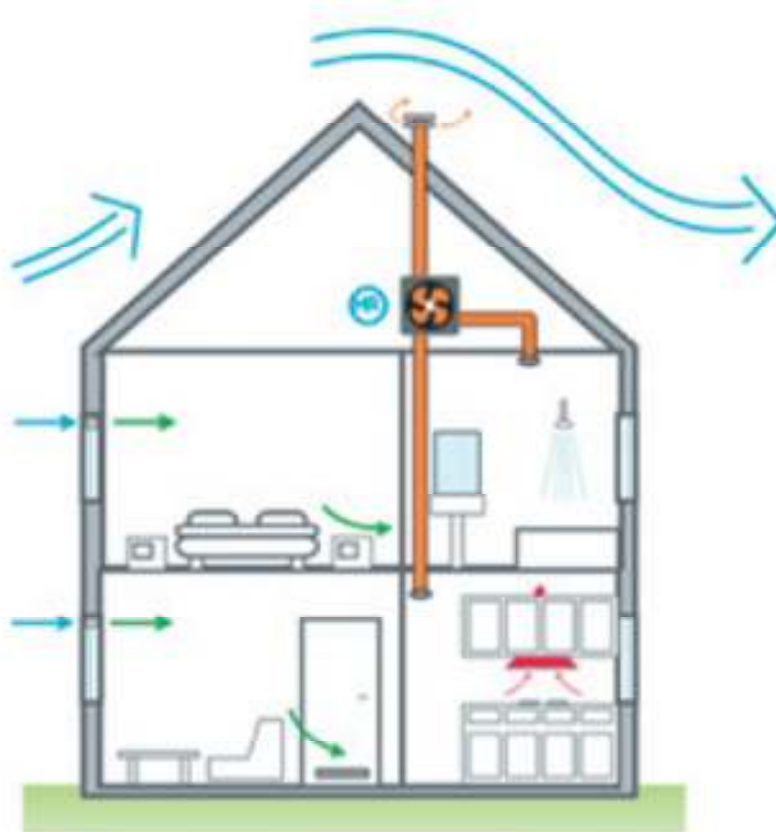
The air comes into the dwelling through cracks, windows, slots.

Extract air is sucked by the extractor, evacuated by openings from the most polluted rooms.

In terms of energy using products, this kind of ventilation requires an extractor larger than small sized fans (as defined in the previous subsection “local ventilation”).

An extractor consists generally in a centrifugal fan driven by an asynchronous motor.

Usually the electric power is under 80 W for individual houses and under 500W for collective dwellings ventilation.



**Figure 4:** Natural air supply and mechanical extract

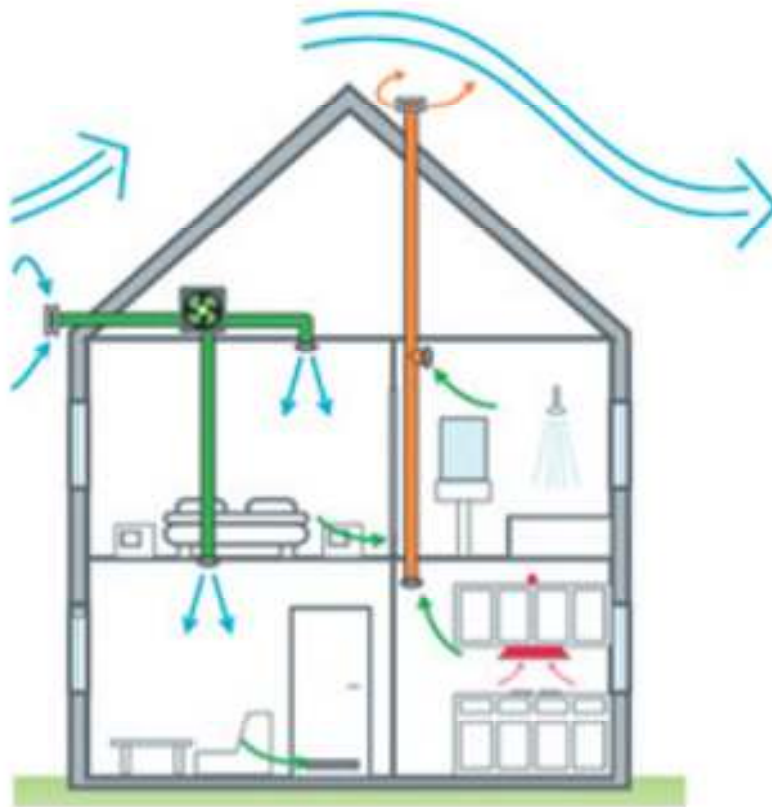
Courtesy "Guide for the residential ventilation", FENERCOM, Madrid Regional Government

#### **Simple flow centralized mechanical ventilation (Mechanical air supply and natural extract)**

Air is supplied centrally by a supply fan.

Because of the overpressure generated by the air supply inside the dwelling, the air exits the dwelling through cracks, windows, slots.

In mechanical ventilation balanced systems or positive input ventilation (PIV), the air supply is sometimes made through a ground coupled air to earth heat exchanger, also called Canadian well, which allows partial cooling of the air in summer. In that case, mechanical ventilation can help to decrease room temperature by a few degrees in summer. This system is designed by specialists on a case by case basis, built and buried on site.



**Figure 5:** Mechanical air supply and natural extract

Courtesy "Guide for the residential ventilation", FENERCOM, Madrid Regional Government

### **Balanced double flow ventilation system** (Mechanical air supply together with a mechanical extract)

The double flow balanced system is made with (following the flow):

- air collection (outside the building), one fan, air inlets into the room,
- extraction devices, another fan, air extract device,
- with typically the addition of a heat exchanger and some filters, and ducts to conduct air flows (inlet and exhaust).

The flow becomes almost independent from outside pressure conditions. The internal pressure balance becomes even more important.

The extract air is extracted in the kitchen, the toilets and the bathrooms. New air is introduced in other rooms with another network but the same extractor block.

Centralization allows to process the new air (filtration, heating, humidification...) and by gathering the two networks (extraction of stale air and extraction of new air) to preheat the new air by recovering heat on the extracted air thanks to a plate heat exchanger. As a result, double flow ventilation coupled with heat recovery heat exchanger enables to economize heating energy.

This system enables to recover an important part of the energy lost because of the introduction of fresh air for ventilation need in winter but increases electricity use in the product. Double flow heat recovery ventilation is generally a stand-alone product to be installed on the ventilation network in dwellings.

Centralized mechanical ventilation systems can become the basis of a reversible heat pump system that uses extract air as the cold source in winter and as the hot source in summer. This space heating system can be called “balanced flow thermodynamic ventilation”. It supplies both cooling in summer and heating in winter but the heating and cooling energy does not enable to cover all the heating and cooling needs because ventilation air flow rates are quite small.

As for plate heat exchanger, heat or cool recovered will depend on outside conditions. This system enables to recover from 50 % to 200 % of the energy lost because of the introduction of fresh air for ventilation need in winter and in summer. Nevertheless, both in cooling and heating modes, this system can only supply part of the thermal requirements of a standard dwelling.



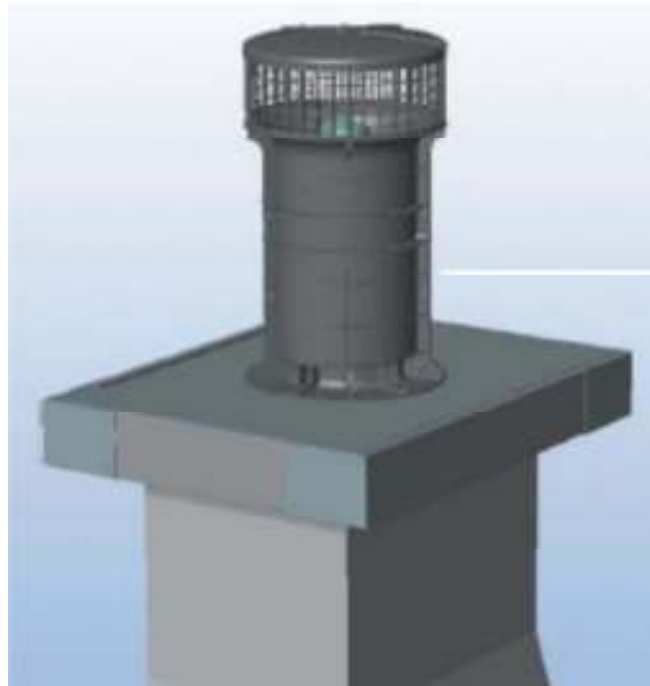
**Figure 6:** Mechanical air supply and extract

Courtesy “Guide for the residential ventilation”, FENERCOM, Madrid Regional Government

### 1.2.3. Hybrid ventilation

Natural ventilation may fail to deliver proper air renewal all year long particularly when wind outdoor is low. In those conditions, assisted natural ventilation makes use of a fan to maintain required hygienic flow rates. Typical flow rates of 300 m<sup>3</sup>/h and 10 to 20 W are common for these products.

The appearance of an assisted natural ventilation fan is showed on the figure below.



**Figure 7:** Assisted natural ventilation fan

Courtesy Aereco

## 1.3. DEFINING QUALITY ASPECTS FOR VENTILATION

### 1.3.1. Indoor Climate

#### *Indoor Air Quality*

Factors that influence indoor air quality can be separated into three groups:

- Chemical substances (CO, CO<sub>2</sub>, O<sub>3</sub>, NO<sub>2</sub>, Volatile Organic Compounds, radon, hydrocarbons aromatic, etc.).
- Particulate matter (dust, asbestos, rock wool, fiberglass, etc.).
- Microorganisms (mites, fungal spores, pollen, body odour, bacteria, etc.).

All these products are found in homes from the traffic, building materials and insulation, furniture, printers, detergents, plastics, cosmetics, poor combustion, plants and by the users thereof.

It can be seen that much of the contaminants are produced in the interior of the house.

In an insulated housing these contaminants remain in the interior. For this reason, ventilation becomes vitally important in today's homes.

Under the heading of VOC (Volatile Organic Compound) there is a wide range of substances that are considered pollutants and emanating from both furniture and construction materials such as clothes or cleaning.

The last decade has seen an increase in the VOC concentrations in homes due to imports mass from countries where there is no strict law the use of polluting substances in the manufacture of products.

The composition can vary even during the day, and it is difficult to delimit the maximum desirable values in a house, taking into account that the perception of them is subjective, in most cases.

A value below 300 mg / m<sup>3</sup> should be sufficient to reduce complaints by this topic.

The level of CO<sub>2</sub> is an important index to identify the quality indoor air.

A level of 1,200 ppm of CO<sub>2</sub> should be the maximum to avoid negative influences on health, besides being a good reference for other values, such as Organic Compounds Volatile (VOC), which evolve in parallel and affecting the olfactory sensation.

However, the target for an appropriate air quality should be established between 1000 and 1200 ppm of CO<sub>2</sub>.

In a house there is also a large production of moisture from the shower, kitchen and drying clothes. Furthermore, both for heating and cooling humid air requires more energy, which is an extra air consumption.

In the kitchen a fume hood is used to remove moisture, odours and substances emanating from it, but moreover, it is necessary to control the quality extraction air.

In the bathrooms is advisable to install extraction systems autoregulables with humidity sensor. The exhaust flow will increase at times when the sensor detects the increase in relative humidity, for example, when a person is showering.

### *Thermal Comfort*

The indoor thermal comfort comprises all parameters that influence in the thermal sensation of a person. This can be differentiated in two types:

- Overall thermal comfort (wind chill).
- Local thermal comfort.

The overall thermal comfort is determined by the air temperature, the average radiation temperature, humidity, air velocity, metabolism (activity level of individuals) and clothing used.

The local thermal comfort is given by the loss of comfort due to heating or cooling sensation due to air currents, cold asymmetries radiation (for example, a glass window) or heat (such as a heat source), and stratification elevated air temperature between soil and roof.

The admission of air causes a certain rate of air in the occupied area, that have to be carefully studied to avoid discomfort.

### *Noise Level*

Noise, along with air currents, is one of two points with the highest number of customer complaints.

The noise inside the home can come from facilities within the housing or can come from outside.

In a well-insulated house, external noise is mitigated. For this reason, there is a greater perception of noise coming from the house facilities.

Thus, when designing a ventilation system is important to prevent noise produced by the facility (duct air velocity, duct diameters, fan noise, Venturi effect) and the input noise from the street through the air renewal system.

Noise requirements are established in country regulations. Some European countries have already reduced these levels to 30 dB (A).

### 1.3.2. Energy Savings

Ventilation costs energy due to fans, and also due to the tempering (whether it be heating or cooling), of the fresh air coming from the outside into the house.

Some considerations must be followed in order to minimize energy consumption of ventilation:

- Reduce the flow of ventilation air, while ensuring health people and housing (see demand control systems CO<sub>2</sub>, VOC, sensors, time or other control).
- Systems that recover energy from the exhaust air.
- Use fans with very low power consumption.
- Install ducts with good planning: large diameters, avoiding curves and maximum individual ducts

## 1.4. FIRST FUNCTIONAL ANALYSIS FOR A VENTILATION SYSTEM

The primary function of ventilation fans is generally to change indoor air of a room or dwelling and the corresponding functional parameter is the air flow rate.

Nevertheless, double flow of systems with heat recovery or thermodynamic double flow systems, have respectively two and three primary functions:

- double flow with heat recovery: change indoor air, recover heat.
- thermodynamic double flow: change indoor air, recover heat, recover coolness.

According to this, there are two characteristics that can be considered as the primary functional parameters of a fan :

- the increase in pressure of the gaseous flow ( $\Delta p$ )
- the velocity of the flow (m<sup>3</sup>/s).

Apart from the two characteristics mentioned above there are a lot of other technical issues that have to be considered when selecting an appropriate fan.

However they are clearly secondary.

The most important ones are:

- Diameter of the fan (m)
- Volume and weight of the fan
- Type of the fan (axial/centrifugal, backward/forward-inclined etc.)
- Type of drive and electrical supply
- Noise level and vibration

- Control systems
- Mounting arrangements and inlet/outlet sizes.

## 1.5. VENTILATION SYSTEMS PROVIDED BY THE MARKET

The following is a list<sup>1</sup> of some of the high-technology ventilation systems that the market is providing:

- Balanced ventilation systems with heat recovery for:
  - Single dwelling
  - Single room
  - Multiple dwellings, apartment blocks
- Demand controlled exhaust ventilation systems for:
  - Single dwelling
  - Single room
  - Multiple dwellings, apartment blocks
- Multifunctional ventilation systems including:
  - Heat recovery
  - Heat generators for heating and/or cooling and/or hot water
- Demand controlled positive input ventilation systems
  - Single dwelling
  - Single room
  - Multiple dwellings, apartment blocks
- Air handling units for Indoor and Outdoor applications , factory assembled package or built-on-site, customised, semi-customised or mass production, with/without air dampers, filters, heating and cooling:
  - With or without control system
  - With or without DX refrigeration air or water cooled/ adiabatic cooling
  - With or without Heat Recovery
- Air handling terminals (VAV and mixing boxes, fan coils)
- Decentralised Air Handling Terminals
- Single room ventilation Units (i.e. school ventilation)
- Fans (including fans as OEM components)
- Axial-flow fans:
  - Propeller
  - Plate mounted
  - Vane axial
  - Contra rotating
  - Tube axial

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<sup>1</sup> 'Ventilation at a glance', EVIA, European Ventilation Industry Association



- Bifurcated fan
- Mixed flow fan, cross flow fan, ring-shaped fan, multi stage fan
- Centrifugal fans:
  - Forward curved
  - Radial
  - Backward inclined
  - Backward curved
  - Ducted centrifugal
- Box fan, roof fan, smoke ventilating fan, dust fan, conveying fan, spark resistant fan, ignition protected fan

## 1.6. NATIONAL CODES THAT REGULATE VENTILATION SYSTEMS

Ventilation systems must fulfil the requirements stated by the National Regulations for each country.

A list of the National Codes that applies to Ventilation System is presented below for each country.

### Hungary

- 176/2008. (VI.30) Government Decree.  
[http://net.jogtar.hu/jr/gen/hjegy\\_doc.cgi?docid=A0800176.KOR](http://net.jogtar.hu/jr/gen/hjegy_doc.cgi?docid=A0800176.KOR)
- Regulation about energy labelling the 7/2006 (V.24) TNM Decree (Ministry without Portfolio Decree No. 7/2006. (V.24.) on the determination of buildings' energy performance.  
 (It has a section about counting the values based on ventilation data and there are prescriptions in an appendix 1. chapter V.)  
[http://net.jogtar.hu/jr/gen/hjegy\\_doc.cgi?docid=A0600007.TNM](http://net.jogtar.hu/jr/gen/hjegy_doc.cgi?docid=A0600007.TNM)
- The minimum value of air exchange is regulated by: Hungarian Governmental Decree 211/2012 (VII. 30.) amending the 253/1997 (XII. 20.) Governmental Decree about the National Requirements of Building and Town Planning (Building Code).  
 (This prescribes the modes of other ways of air exchange)  
[http://net.jogtar.hu/jr/gen/hjegy\\_doc.cgi?docid=99700253.KOR](http://net.jogtar.hu/jr/gen/hjegy_doc.cgi?docid=99700253.KOR)
- 275/2013. (VII.16.) Government Decree about rules of construction products' planning, installation and confirmation of performance in case of buildups  
[https://www.emi.hu/EMI/web.nsf/Pub/legal\\_framework.html](https://www.emi.hu/EMI/web.nsf/Pub/legal_framework.html)

### Italy

- UNI EN 832 (former UNI 10344): "Buildings' heating: - Calculation of energy needs"
- EN 13465 - Ventilation for buildings - Calculation methods for the determination of air flow rates *in dwellings*
- EN 13779 – 2007 – “Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems”

- S.O. 252 – Italian Official Journal n. 276 - November 27th 2001,” “Guidelines for health protection in indoor environments”
- UNI 10339: Heat ventilation and air conditioning systems: technical rules for procurement procedures, technical specification, offer elaboration and supplies”

## Spain

- Real Decreto 1027/2007, 20th of July, Approval of the RITE (National regulations for HVAC facilities in buildings)  
<http://www.idae.es/index.php/id.27/relcategoria.1030/reلمenu.53/lang.uk/mod.pags/mem.detalle>
- Building Technical Code, Indoor Air Quality  
<http://www.codigotecnico.org/web/recursos/documentos/dbhs/hs3/>

## Sweden

- Boverket Building Regulations, especially chapter 6: Hygiene, health and environment  
<http://www.boverket.se/Om-Boverket/Webbokhandel/Publikationer/2008/Building-Regulations-BBR/>
- Public Health Agency of Sweden, FoHMFs 2014:18 The Public Health Agency's general conseil in ventiation  
<http://www.folkhalsomyndigheten.se/documents/publicerat-material/foreskrifter/fohmfs-2014-18.pdf>

## 1.7. PROFESSIONAL ASSOCIATIONS REPRESENTING THE VENTILATION SECTOR

A list of the more relevant Professional Associations that represent the interests and views for the Sector is presented below.

### Hungary

#### MEGSZ

[www.megsz.hu/megsz/tagjain-honlapja.html](http://www.megsz.hu/megsz/tagjain-honlapja.html)

Association of Hungarian Building Engineers

#### HKVSZ

[www.hkvsz.hu](http://www.hkvsz.hu)

Association of Heating and Cooling Enterprises -representing the companies of HC production, application and servicing. It has activities on organising the education and dissemination as well.

#### MMK-e-gepesz

[www.e-gepesz.hu](http://www.e-gepesz.hu)

Hungarian Chamber of Engineers-Chapter of Building engineer

## **EMI**

ÉMI Non-Profit Limited Liability Company for Quality Control and Innovation in Building (ÉMI Non-profit Llc.) is Hungary's largest complex building and construction materials industry approval, testing, inspection, certification, professional and innovation institution, and a member of a number of European and international organizations (EOTA, EGOLF, ENBRI, WFTAO, CIB, ECTP, UEAtc).

## **CONSTRUMA**

[www.construma.hu](http://www.construma.hu)

Annual International Building Trade Exhibition

## **Spain**

### **ATECYR**

[www.atecyr.org](http://www.atecyr.org)

The Spanish Association for Heating and Air Conditioning Systems, was created in 1974. Its main mission is to develop the HVAC sector, through the creation of technical documents and a collaborative approach between the companies.

### **AFEC**

[www.afec.es](http://www.afec.es)

The Spanish Association of HVAC Equipment Manufacturers, AFEC, represents the views and interests of the manufacturing industry with decision-makers and opinion formers, and promotes a better understanding of the HVACR sector.

### **ATEAN**

[www.atean.es](http://www.atean.es)

The Andalusian Energy Association ATEAN groups technicians, professionals, companies in the ventilation sector and all those organizations interested in the promotion of efficient energy technologies that enable sustainable development.

## **Sweden**

### **Svensk Ventilation**

[www.svenskventilation.se](http://www.svenskventilation.se)

Swedish Ventilation. An association in Sweden that represents approximately 100 ventilation companies - both manufacturers, installers, service providers, resellers and consultants.

## **European**

## EVIA

[www.evia.eu](http://www.evia.eu)

The European Ventilation Industry Association (EVIA) was established in Brussels in July 2010. EVIA's mission is to represent the views and interests of the ventilation industry with decision-makers and opinion formers primarily at the EU-Brussels level but also with a view to have a coordinated dialogue with the our partners in the EU Member States.

## EUROVENT

[www.eurovent-association.eu](http://www.eurovent-association.eu)

Eurovent, the European Committee of Air Handling and Refrigeration is the representative of the European refrigeration, air conditioning, air handling, heating and ventilation industry and representing trade associations from European and non-European countries.

## REHVA

[www.rehva.eu](http://www.rehva.eu)

REHVA is the Federation of European Heating, Ventilation and Air Conditioning Associations representing a network of more than 100 000 engineers from 27 countries. REHVA is the professional pan-European organization dedicated to the improvement of health, comfort and energy efficiency in all buildings and communities.

## EPEE

[www.epeeglobal.org](http://www.epeeglobal.org)

EPEE's mission is to promote a better understanding of the HVACR sector in the EU and to contribute to the development of effective European policies in order to achieve a long-term sustainability agenda. EPEE's main priorities for the coming years are:

## 1.8. REFERENCES

- "Guide for the residential ventilation", FENERCOM, Madrid Regional Government
- "Study on residential ventilation" - Final report- Contract TREN/D1/40-2005/LOT10/S07.56606
- "Energy and Cost Efficient Ventilation Systems with Heat Recovery- State of the Art and Enhancement", ASHRAE
- "Multi-annual roadmap for the contractual PPP under Horizon 2020", European Commission [http://www.ectp.org/cws/params/ectp/download\\_files/36D2981v1\\_Feb\\_cPPP\\_Roadmap\\_under.pdf](http://www.ectp.org/cws/params/ectp/download_files/36D2981v1_Feb_cPPP_Roadmap_under.pdf)
- "Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation)", Contract TREN/D1/40-2005/LOT10/S07.56606
- "Ecodesign preparatory study for air conditioning and ventilation systems", EuroVent, EPEE and EVIA
- "Natural Ventilation for Infection Control in Health-Care Settings", World Health Organisation,

- ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers, [www.ashrae.org](http://www.ashrae.org)

## Technical Norms and Organisations for Standardization

- CSN EN 12792: Ventilation for buildings - Symbols, terminology and graphical symbols
- BS EN 13141: Ventilation for buildings- Performance testing of components/products for residential ventilation
- EN 13 142: Ventilation for buildings. Components/products for residential ventilation. Required and optional performance characteristics
- EN 15 665: Determining performance criteria for residential ventilation systems
- DIN EN ISO 5801: Industrial fans - Performance testing using standardized airways

CEN, European Committee for Standardization, [www.cen.eu](http://www.cen.eu)

ISO, International Organization for Standardization, [www.iso.org](http://www.iso.org)

AENOR, Spanish Institute for Normalisation, [www.aenor.es](http://www.aenor.es)

DIN, German Institute for Normalisation, [www.din.de](http://www.din.de)

## European Projects

### HEATPUMP

<http://www.buy-smart.info/>

The main objective of this project is to develop a 1.2 kW air-to-air single-zone heat pump unit for heating, ventilation and air-conditioning. The aim is to present the next generation of modular, air-to-air heat pump for single-zone applications and to provide the group of SMEs and AGs with key technologies and prototype / demonstration units. The most unique feature of this heat pump is that the fan function will be integrated with the condenser and the evaporator, enabling a compact construction and needing only one motor.

### AVASH

(Advanced Ventilation Approaches for Social Housing)

The project's first goal is to analyse both thermal and air leakage in a broad range of social housing in Denmark, Ireland and the United Kingdom. Once completed, different ventilation upgrade scenarios will then be simulated using computer simulation techniques in order to ascertain the best approach for upgrading ventilation systems from a health and energy efficiency point of view. These results should then be a valuable resource throughout Europe for housing managers, who will become aware of the cost and the benefits of upgrades.

### BUILDING ADVENT

The main objective of this project was to support the implementation of low energy ventilation systems by capturing good ventilation practices and widely disseminating them. Designers are informed about 18 non-domestic buildings which have low energy ventilation systems.

## VENT DISCOURSE

Vent DisCourse adopted the distance learning method and applied it to ventilation - a core area of the energy performance of buildings. It targeted building professionals in an effort to stimulate the use of best practices in ventilation and addressed non-technological and cultural barriers via pilot training courses and awareness raising.

## 2. ENERGY MANAGEMENT SYSTEMS

### 2.1. DESCRIPTION

Energy Management Systems (EMS) or also known as Building Management Systems (BMS), or Building Automation and Controls Systems (BACS), are a comprehensive offering that combines energy and process optimization and, where appropriate, incorporates the solution into online advanced control and optimization strategies. Additional components of the solution include:

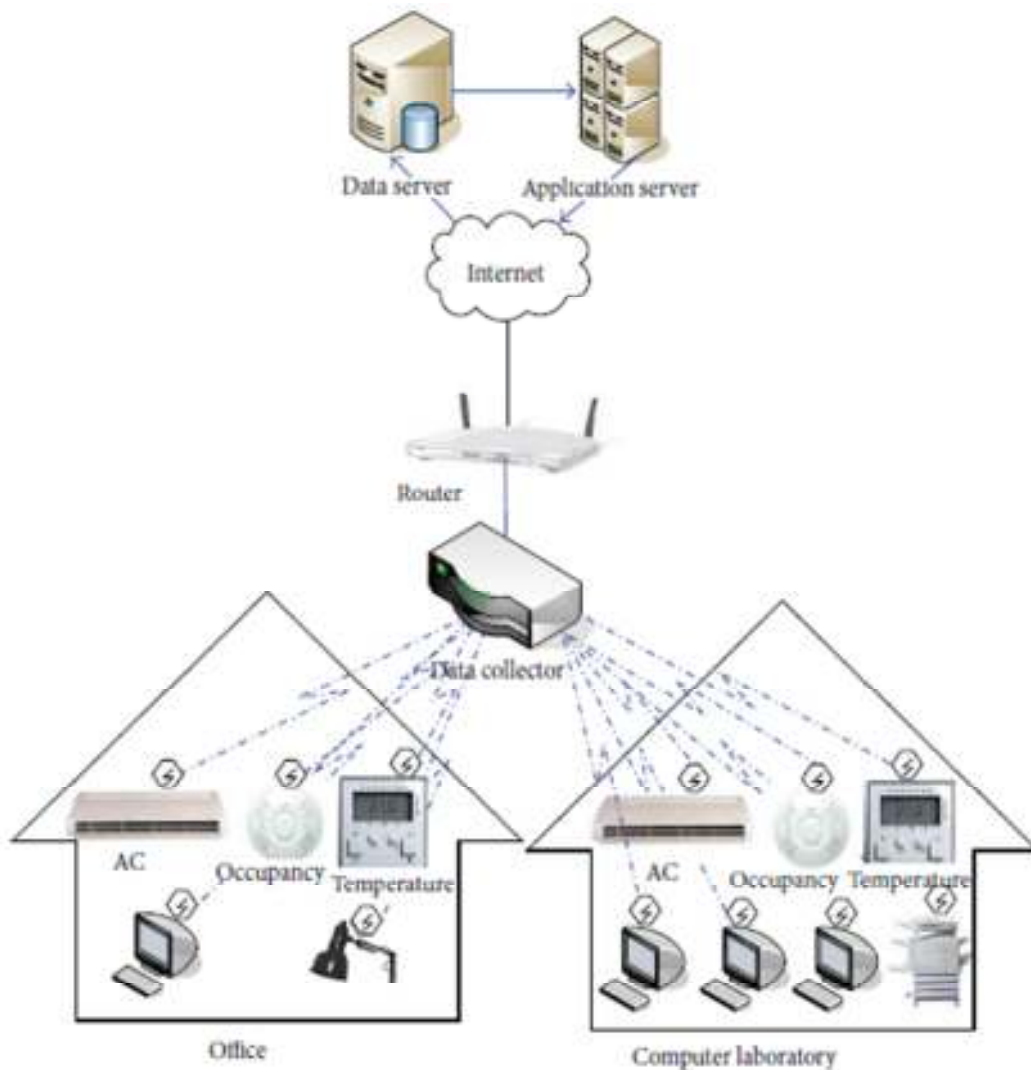
- Heat and power recovery within and across process units using pinch analysis for improved integration
- Steam and power system optimization
- Calculation of dynamic energy and emission targets
- Feedstock selection
- Energy contract management
- The introduction of renewable energy sources such as biofuels
- Services to sustain and even improve results over time

EMS can be implemented in stages starting with smaller-scale, quick return-on-investment projects and moving to more comprehensive, higher-value projects.

EMS for homes typically control central devices like HVAC units and home lighting systems. As advancements have been made in wireless technology, many homeowners are now able to control all types of appliances and fixtures across their homes. Home energy management systems provide you with the ability to have total control over your energy usage, meaning you can choose to save money and use less energy.

Non-residential buildings are also equipped with EMS technology which monitor, optimise, interlock and control heating systems, air conditioning systems, cooling systems, lighting systems, blinds, fire and security systems, elevators, etc.

An example of energy management system's high level architecture is shown in Figure 1. The system is based on a sensor network of energy consumption measuring sensors, occupancy sensors, and temperature and humidity sensors. A communication and networking protocol is used for networking and data exchange. The choice of the communication and networking protocol should be made, if possible, so that various compliant sensors can be easily incorporated into the network as required. The monitoring system collects data from sensors and sends the data to a data sever via Internet connection.



**Figure 1:** Energy Management System Architecture

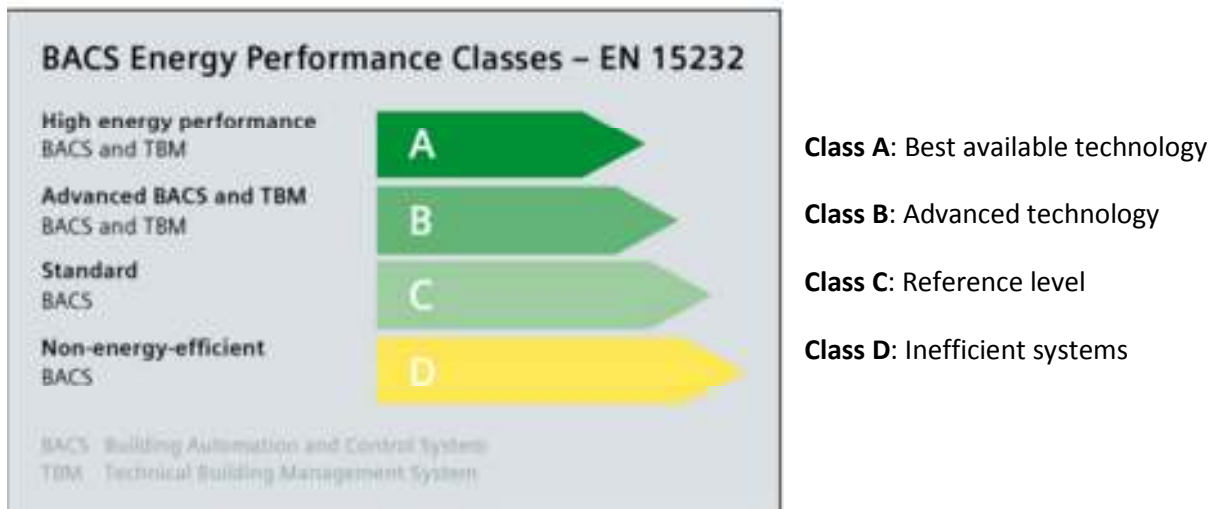
Courtesy of *An Intelligent Energy Management System for Educational Buildings*, Ahmad Al-Daraiseh et al.

## 2.2. TYPES OF ENERGY MANAGEMENT SYSTEMS

Currently, there are a variety of commercial and domestic energy management systems available and also various ways to classify them. They can be broadly divided into three categories:

- The first category consists of **energy monitoring sensors** and **energy consumption data displays**. These are basic systems that read energy consumption and show the consumption on a display. These are more suitable for domestic environment as they depend on human for judgement and actions.
- The second category of these systems is those systems that extend the capability of the first group by allowing **alert generation** on excessive usage of energy or on some conditions set by the user.
- The third category of energy management systems **employs advanced networking** and **energy monitoring technologies**. These systems allow the users to view energy consumption at appliances level and control the appliance usage from anywhere via a web interface.

Following the norm EN 15232, the classification is done depending on the EMS equipment. Labels inform about the consumption of thermal and electrical energy and promote the use of energy efficient technologies in this way:



**Figure 2:** Labelling of EMS Equipment

Courtesy of *The New Dimension of Energy – Efficient Homes and Buildings*, eu.bac

However, Organisations as CEDOM (Spanish Association) has its own evaluation system for building automation systems, where the level assigned to a home automation system is divided in three levels as a result of the weighting of existing devices and home automation applications covered as following:

- Level 1<sup>2</sup>. It includes facilities with a minimum level of devices and/or home automation applications. The weighted sum of the devices included in the home automation system must be a minimum of 13, provided that in turn covers at least 3 home automation applications. That is, these 13 points must be achieved with devices distributed between at least 3 different applications that are distinguished by having different colour in the table. A facility will not achieve the minimum level of automation with a score of 13 but only having air conditioning installed devices and shutter control; need to have installed a third application such as the video door entry devices.
- Level 2<sup>1</sup>. These are facilities with an average level of devices and / or home automation applications. In this case the sum of points must be at least 30, provided that at least 3 applications covering.
- Level 3<sup>1</sup>. These are facilities with a high level of devices and/or home automation applications. In this case the sum of points must be at least 45, in at least 6 distributed applications.

<sup>2</sup> Values and colours obtained from CEDOM's Table of Automation Level, accessible in <http://www.cedom.es/sobre-domotica/evaluacion-de-instalaciones-domoticas>



## 2.3. DEFINING QUALITY ASPECTS FOR ENERGY MANAGEMENT SYSTEMS

### 2.3.1. Energy Management Systems Control Parts

Generally, building automation begins with control of mechanical, electrical, and plumbing systems. For instance, the heating, ventilation, and air-conditioning (HVAC) system is almost always controlled, including control of its various pieces of equipment such as:

- Chillers
- Boilers
- Air Handling Units
- Roof-top Units
- Fan Coil Units
- Heat Pump Units
- Variable Air Volume boxes

Lighting control is, likewise, “low-hanging fruit” for optimizing building performance.

Other systems that are often controlled and/or brought under a complete automation system include:

- Power monitoring
- Security
- Close circuit video (CCTV)
- Card and keypad access
- Fire alarm system
- Elevators/escalators
- Plumbing and water monitoring

### 2.3.2. Energy Savings

In comparison with other technologies, building automation and control systems are widely available on the market, are cost efficient and have short pay-EMSk times. The potential reduction with the introduction of building automation and controls in thermal and electrical energy consumption in all sectors is substantial<sup>3</sup>, for instance:

- 26% in educational institutions and hospitals
- 27% in residential buildings
- 41% in hotels and restaurants
- 49% in wholesale and retail buildings
- 52% in offices and lecture halls

While most buildings use a variety of simple controls to manage HVAC and lighting systems, many facility executives have not taken advantage of sophisticated options capable of wringing more savings out of facility operations. Tighter control may entail more points and programming, as well as greater levels of commissioning and maintenance to ensure continuity of savings. Getting the most out of controls also requires building systems capable of adjustment, such as variable speed drives or gradual dimming, as

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<sup>3</sup> High energy efficiency (Class A) compared to standard equipment (Reference Class C) EN 15232 – Impact of BACS and TBM on energy performance of buildings.

opposed to simple on/off control. Here are some of the latest trends in measures to save energy and money, consequently.

### *Air handler fan speed*

Varying air handler fan speeds reduces power consumption significantly during the many hours of the year when peak fan speed is not needed to meet comfort and air quality requirements. Even a slight reduction in fan speed of 15 per cent can yield a noticeable drop in fan motor power demand — almost 30 per cent — because of the inverse square law inherent in fan motor loading.

Fan speeds may be adjusted not only in response to heating or cooling needs but also to limit peak electrical demand. Most buildings exhibit thermal inertia, meaning that the mass of the structure and its contents tend to stabilize temperature changes even when heating and cooling systems work to alter them.

Some facility executives have taken advantage of this stabilizing effect by reducing air handler fan speeds and the cooling or heating inherent in circulating air for brief periods — for example, 10 minutes out of an hour — when power is most costly. By sequentially shifting this reduction among all air handlers, no one space feels the reduction long enough to result in a significant change to occupant comfort.

### *Coil water supply temperature*

Cooling and heating coil water supply temperatures may be reset instead of remaining at constant levels without occupants sensing the change regardless of outdoor conditions. In many systems, the chilled water temperature or circulating hot water temperatures for baseboards and coils are set at a constant level designed to handle the hottest or coldest day expected. Temperature is controlled by either cycling flow or shunting it around heating and cooling coils. Peak conditions occur relatively few hours a year, so the energy use to produce such temperatures is higher than needed the rest of the time.

An outdoor air sensor may be used with appropriate programming to raise baseboard water temperature as outdoor temperatures drop, and lower it on moderate days. The same may be done for chilled water temperatures, though the need to maintain a defined humidity may place an upper limit on that water temperature.

Supply water temperatures also may be reset based on return water or return air temperature where they reflect the need for conditioning specific zones or on a time schedule to reflect occupancy. When no one is in a space, its temperature may be allowed to vary widely. For some systems where air is both heated and cooled, such as dual duct systems, mixed air temperatures may also be reset based on time or outside temperature. In all cases, energy used by boilers or chillers is reduced and distribution losses are cut when circulating-water temperatures are moderated.

### *Enthalpy economizer controls*

They take into account the humidity content of return and outside air, adjusting dampers and fans to move more of whichever has a lower overall heat content. Doing so may allow relatively warm outside air to be used for cooling when it is drier than return air. This process expands on standard economizer cycles based solely on dry bulb temperatures.

### *Carbon dioxide sensors*

CO<sub>2</sub> Sensors can be used to control outside air intake. As with temperature control, good HVAC design provides sufficient fresh air to deal with the worst-case scenario, including full occupancy in a zone such as

auditoriums and cafeterias. Most of the time, however, spaces are only partially filled, so that far more outside air is brought in than required by code or comfort. The conditioning of outside air, especially when it is very humid, may account for nearly half the load on an air conditioning unit.

By measuring carbon dioxide in return air, a reasonable estimate of the number of occupants may be made, allowing for a reduction in outside air. Reducing outside air intake means, if it is variable, less cooling, heating, dehumidification and exhaust fan speed, thus saving energy several ways.

### *Carbon monoxide sensors*

CO sensors can be used to control outside air intake for garages where cars emit carbon monoxide. Exhaust fan systems are typically designed to supply enough fresh air when many cars are running at one time. Even when such air is not heated, fans may run at full speed all the time to ensure that no health or comfort problems occur. By measuring carbon monoxide, however, a reasonable reduction in ventilation fan speed and power use for many hours of the day may be accomplished when vehicle traffic is less than the peak.

### *Chilled and circulating hot water pump speed*

It may be reduced, where variable speed drives exist, at primary and secondary water pumps. Primary pumps may be adjusted based on outside air temperature and humidity. Where zone coil water flow is maintained by secondary pumps and controlled by on-off coil valves, a change in pressure may be sensed when many are in the closed position, indicating that full flow is not needed at that moment.

This option does not work well where three-way valves exist, because such valves allow a bypass flow that could make it difficult to sense valve closure. Once again, a small reduction in pump speed yields a significant reduction in electricity use.

### *Cooling tower fan speed*

This speed can be reduced during periods of low outdoor humidity or temperature. Two-speed cooling tower fans are now common, but appropriate controls are needed to shift between high and low speeds. In many parts of the country, high speed is needed less than 20 per cent of the time, allowing major savings during the other 80 per cent.

### *The speed of condenser water pumps*

The speed of condenser water pumps feeding cooling towers may be reduced when low outdoor humidity or temperature conditions exist, as long as the temperature and flow of water leaving the tower remain appropriate for best chiller operation.

### *Cooling-tower water*

It can be used in lieu of chilled water through the use of a heat exchanger during transitional seasons or when winter cooling is needed for such areas as computer banks. When outdoor conditions are right and when tower fan speed is at full, cooling-tower water may be sufficiently cool to allow chiller compressors to be shut off, taking full advantage of the evaporative cooling capability of the tower. While tower fan and pump electricity use may rise, the net result may be a drop in electric demand when the chiller compressors are off. This process is often called “free cooling” or “waterside economizer” operation.

### *Hot gas bypass*

Hot gas bypass on electric chillers may be minimized when consistent with chiller specifications and controls. Doing so improves overall chiller performance. Similar measures may be taken regarding refrigerant pressure in some packaged air conditioning systems. Under recent federal efficiency standards, many new chillers already incorporate this technology.

### *Lighting*

Lighting may be significantly dimmed in response to incoming daylight, occupancy or time schedules where dimming ballasts and appropriate sensing and programming have been installed. Even without dimming ballasts, a portion of lighting may be controlled as a result of on-off schedules, occupancy sensing, daylight response or dimming on a schedule, or in response to peak building power demand. Where many fixtures are present in open common areas, temporarily turning off every third or fourth fixture is rarely noticed. In office spaces, studies have shown that gradual temporary dimming by about 20 per cent is either unnoticed or noticed and accepted by the vast majority of occupants. When done in conjunction with outdoor light entering a space, significant savings in both lighting and cooling may result.

### *Cycle minor process loads*

Some of these loads such as refrigerators and vending machines may be shut down when possible to minimize peak demand and cut overall consumption. This may be done with add-on devices that allow wider device temperature swings, consistent with maintaining product quality. It should be noted that a standard vending machine, one lacking internal cooling, remains on at all hours, costing facilities 150 € to 250 € a year at average national power pricing. Specialized occupancy sensors for such machines have been successfully used at many facilities.

### *Fume hood exhaust fan control*

It can be deployed in labs and kitchens. Through add-on devices, closing of fume hood sashes reduces exhaust fan speed, cutting power use and outside air intake. Similar actions may be taken in kitchens to reduce fan speed during periods when ovens are not in use.

### *Building peak electric demand*

Building peak electric demand may be reduced when pre-defined loads are minimized or briefly shut off by an automated system that senses building demand and sequences load reductions to meet a set level. Such control may be applied to loads such as fans, lighting, heat pumps, packaged air conditioning units and electric heating coils.

By integrating some of these options in a programmed sequence, facility executives have developed automated procedures for cutting peak load when it is most cost effective to do so, thereby saving on peak demand charges, or when called upon to do so by the local utility. Some utilities also offer rate cuts to those having a defined portion of interruptible load.

By sequencing brief — 10 to 15 minute — service reductions in spaces that people continuously occupy and for longer periods in other areas, such rotation avoids or reasonably shares any minor discomfort.

### *EMSkup generator*

When allowed under environmental and utility regulations, load shedding with a EMSkup generator may be especially profitable where high peak demand charges exist. As peak demand approaches a defined limit,

the generator is deployed to feed pre-defined loads that are disconnected from utility service. Alternatively, the generator may feed into the general building electrical system.

Additional options exist, such as converting to reverse-acting thermostats, replacing three-way cooling coil valves for two-way valves, and recovering exhaust heating and cooling, but may require significant system-wide upgrades. The payEMSk for each may be sensitive to prevailing energy costs and tariff rate design. All require a well-operating EMS, multiple zones and appropriate controls.

For owner-occupied facilities, even greater savings may be achieved during extreme weather by educating occupants that it is a good idea to dress appropriately.

## 2.4. FIRST FUNCTIONAL ANALYSIS FOR AN ENERGY MANAGEMENT SYSTEM

Energy management can be achieved through various activities such as using more energy efficient devices and utilizing power quality improvement. Both of these activities deliver significant energy savings to the customer. However the next stage of improvement is to implement a strategy for energy efficient production. This can be done through detailed analysis of energy and process data and through equipment and facility optimization.

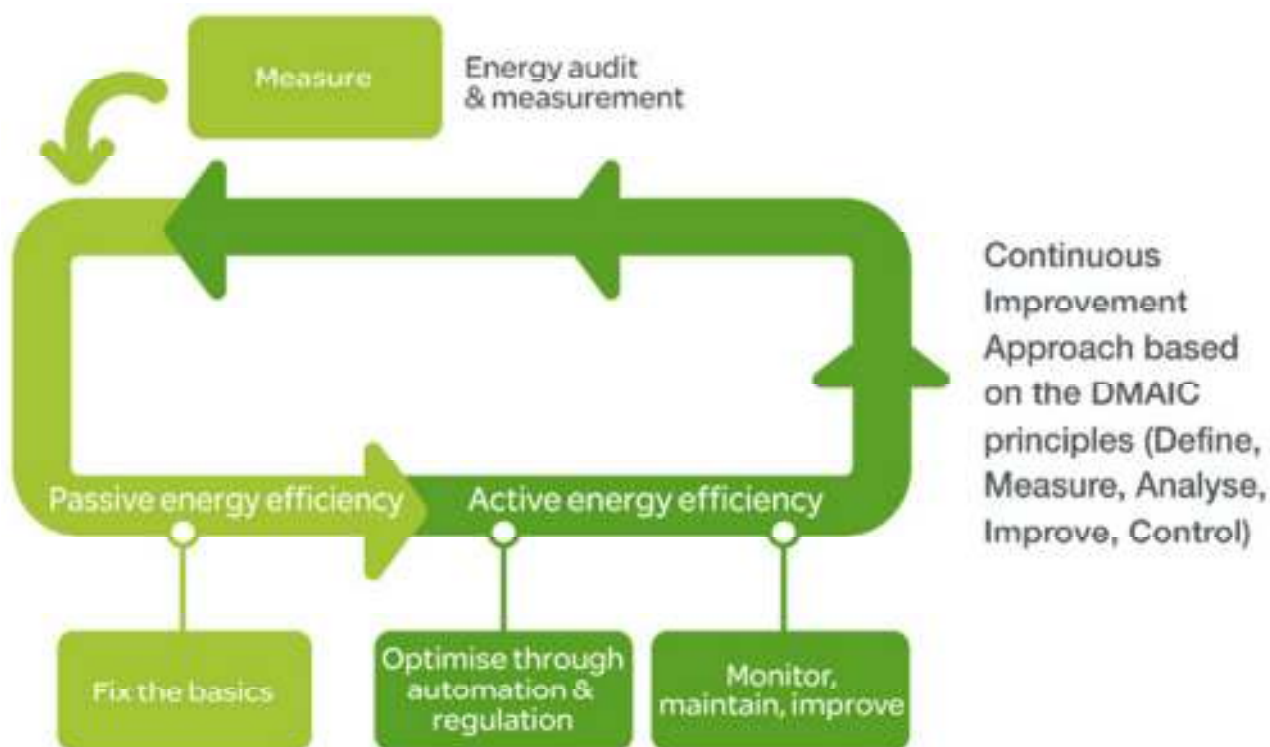


Figure 3: Continuously Improving Energy Management

Courtesy of Schneider Electric

EMS Systems are an essential part of the technical infrastructure in buildings. It is necessary to stipulate requirements because of their important functionality and the promotion of the energy efficiency of buildings.

Boilers, heating systems, air conditioning systems, cooling systems, lighting systems, blinds, fire and security systems, elevators etc. in buildings should be equipped, by default, with EMS devices to monitor, interlock, control and optimise different processes in buildings.

The European Building Automation and Controls Association (eu.EMS) suggests specifications for EMS Systems and devices to be used for the following applications:

- Each room of residential and non-residential buildings with heating systems should be equipped with devices, which control the room temperature depending on time and usage.
- Domestic hot water systems should be equipped with automated devices, which control the temperature of storage water heater depending on time and usage, preventing legionnaire's disease.
- Air conditioning systems in buildings with rooms of similar type and use should be equipped with automated devices, which control the room temperature depending on time and usage. In addition to this, requirement offices, hospitals and indoor swimming pools should be equipped with automated humidity controls if needed, and restaurants, theatres, and conference facilities etc. should be equipped with automated indoor air quality controls.
- Cooling systems in non-residential buildings should be equipped with automated devices, which control the room conditions depending on time and usage.
- Lighting systems in non-residential buildings should be equipped with automated devices, which control the illumination depending on time and usage and/or presence of persons.
- EMS Systems and devices with an important impact on the energy efficiency of buildings should be maintained at regular intervals at least once a year or earlier if required.
- To support the implementation of the Energy Performance of Buildings Directive (EPBD) eu.EMS suggests defining:
  - Respective process parts for the different types of buildings according to Annex of EPBD
  - Different applications (Heating, Air conditioning, Domestic hot water, Cooling and Lighting)
  - Specific requirements on EMS Systems devices.
- eu.EMS suggests in accordance with CEN/TC 247 (European Building Management Standardisation) calculating energy efficiency of EMS systems and devices for four parts of processes (emission, distribution, storage, generation) to make sure that all different impacts are considered .
  - Process part:  
Emission Depending on the quality of EMS Systems, the same emission system may achieve different efficiencies.
  - Process part: Distribution  
Depending on the energy load of the emission system, the quality of EMS Systems/devices results in different demands for heating and electrical energy. The average load (temperature & flow) of the distribution is relevant.
  - Process part: Storage  
Depending on energy load of the distribution system and the quality of EMS Systems/devices, different heating needs arise. The average load (temperature & flow) of the distribution is relevant.
  - Process part: Generation  
Depending on energy load of the distribution system or the storage and the quality of EMS Systems/devices, different needs for heating and electrical energy are required. The average load (temperature & flow) of the distribution and generation is relevant.

In the past, the different process parts - emission, distribution, storage, generation - in the different technical building systems/services (heating, domestic hot water, air conditioning, cooling, lighting) were separately controlled. Nowadays, EMS Systems/devices link the most important functions of different technical building systems/services. EMS Systems/devices optimise, operate and control all the building processes (Energy Management). This is producing marked improvements of the energy efficiency in buildings.

## 2.5. EMS SYSTEMS PROVIDED BY THE MARKET

The following review<sup>4</sup> covers the best and most popular tools on the market. Features are cross-compared, product websites are examined, and feedback from enterprises that have implemented these systems is taken into account. Each product is evaluated across several categories to make the reviews easier to digest. The pros and cons of each system are weighted and their notable features highlighted:

### 2.5.1. Utilities Direct

#### *Overview*

Utilities Direct is a UK based market leading consultancy specialising in energy management, sustainability and multi-site outsourced services. The company was the first and remains the only business utility switching company to offer full online gas and electricity supplier switching. The comprehensive software capabilities include; Energy Management, Automated Invoice Validation, Asset Register and an Integrated Procurement Tool which operates with all suppliers across Multi Sites, SME's and Half Hourly Meters.

#### *Pros*

Utilities Direct enables businesses to access any reports they require regarding their energy usage, and the Energy Management software at Utilities Direct enables the company to access a fully detailed breakdown of energy consumption through the AMR Meter. This hugely beneficial feature outlines real-time and precise information showing energy consumption every 30 minutes across all sites. A submeter breakdown is also included. The package is offered as both standalone and web version. Utilities Direct offers users with multiple sites a portal into single-site or aggregate information for monitoring performance and meeting internal targets.

#### *Cons*

The software is designed for larger energy users so it is not really suitable for the smaller business operating a smart meter on lower consumption volumes. The focus is on consumption management rather than sustainability and green issues, so the platform is not ideal if you are looking for a total sustainability and carbon strategy tool.

#### *Notable Features*

One of the stands out features at Utilities Direct is the Procurement Tool. It is fully integrated with all suppliers and can provide instant quotes. In addition, the Procurement Tool can be fully monitored for business by the team at Utilities Direct which maintains strong relationships with the energy providers. Invoice validation takes as little as 6 seconds to complete which saves vast amounts of time. Demand

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<sup>4</sup> "Review Of Top 10 Energy Management Software (EMS) Comparison", Alex Loijos in linkcycle

Management at Utilities Direct means that customers can benefit from savings in cases such as being overbilled for their KVA.

### *Data*

The advanced Energy Management Software Utilities Direct transforms complex information into easy to view and detailed graphs and tables which can be viewed on a monthly, weekly and even a 30-minute basis. This provides business with an easy to understand, specific breakdown of their energy consumption across their sites and the data can then be input via either the web portal or the company software.

### *Verdict*

Utilities Direct offers a vast and flexible range of Software and the unique ability to easily switch suppliers. The advanced capabilities and complexity of the Utilities Direct Energy Management Software ensures that it suits all business needs and can provide up to date, reliable and continuous data for all its customers across a large national and international multi-site span. The nature of the software would be most beneficial for medium to large sized business.

## **2.5.2. SAP Energy Management Software**

### *Overview*

SAP is a company that creates a variety of modules to increase business productivity and reduce costs. One of their most recent projects is their energy management software. This module is specifically tailored to increase sustainability while increasing profits and streamlining processes. SAP's energy management software allows a business to gather reports on energy use site by site or the entire enterprise. It is built to identify the best way to find and use cost-effective energy strategies, whether to make a company more green or for environmental compliance.

### *Pros*

The biggest draw when it comes to SAP is that its data aggregation is superb, pulling together disparate energy data of all types and merging it with financial data for easy analysis. It also allows for data integration across all energy types and operational data sources. Consumers can view data in real time or trends to quickly analyse how they are using their energy and where they can save. It is also really easy to share SAP data, which is a major benefit for companies with varied organizational structure. A company can integrate energy management with financial data by using SAP, which can help decrease environmental impact while lowering costs.

### *Cons*

SAP products all suffer from one major problem: configuration. Even though most businesses could benefit by implementing SAP, using its interface is mandatory and many businesses have difficulty making the system work for them. For example, a study showed that even with professional consultant help, it was still difficult to configure SAP's ERP software. While SAP's energy management system is slightly more user friendly, it still falls short.

### *Notable Features*

SAP allows multiple users to report and access data. It works with various source systems which allows for integrated data. It also allows the user to set reminders as to when a Key Performance Indicator (KPI)



request is due, which can be forwarded to others by someone with access. It also has a large library of metrics which can help the user choose their social, environmental, and economic goals.

### *Data*

SAP supports automated KPI data collections from various source systems and also allows manual collection from more than one contributor. It is possible to collect both qualitative and quantitative data on either flexible schedule or ad hoc requests from a variety of sources, such as customers, suppliers, stakeholders, and much more.

### *Verdict*

If a business is already using SAP programs, SAP's energy management system is probably the best as it, unsurprisingly, works well with other SAP modules. SAP is also good for businesses that are unsure of what energy goals are best for their company, as it can help the user find goal metrics with its library. The real-time data is definitely a perk, as well as audit functionality. As long as a business is able to quickly adapt to a new interface, SAP is a great energy management system.

## **2.5.3. EnergyCAP**

### *Overview*

EnergyCAP is one of the oldest energy management systems and in many ways has set the bar for others. They have been providing their software to users for over 30 years. They have 10 different features in their software that help businesses achieve their energy goals, including reducing billing errors, improving budgeting, identifying energy inefficiencies, and much more. EnergyCAP assists with choosing low-cost vendors, gives businesses a unified tool for submeter readings, and allows the user to compare different sites in order to identify which facilities are inefficient.

### *Pros*

Originally, EnergyCAP was only marketed to big organizations, considering its big price tag. Now, it is offering EnergyCAP Express, which has all of the features of EnergyCAP, but is intended for companies without large IT resources. EnergyCAP has always made sure that support and updates are available as needed. There is also a 30-day trial for the web-based version, which means that companies shopping around for an energy management system can try before they buy.

### *Cons*

Most of the features available with EnergyCAP are standard with almost every energy management system, even the lower-priced options. EnergyCAP is a more expensive product, due to its regular updates and complex features. Even with EnergyCAP Express, it may be more logical for a small business to use an energy management system that better fits into their budget. It is also Windows-only, so businesses running Apple or UNIX systems will have to look elsewhere.

### *Notable Features*

EnergyCAP comes in two different packages marketed towards businesses, EnergyCAP enterprise and a cloud-based system called EnergyCAP Express. There are also web-based and traditional software versions of their products. EnergyCAP has features to take advantage of "Green Energy" credits and to gain Energy Star ratings on buildings.

## *Data*

EnergyCAP Express uses cloud-based data storage, while EnergyCAP Enterprise uses traditional data storage. A business can upload utility data and get a detailed analysis. It is also possible to submit data directly to the Energy Star Portfolio Management program. Over 200 customizable reports and graphs can be generated for Excel, Access, or Crystal Reports.

## *Vedict*

EnergyCAP is one of the leaders for a reason. Any business that can afford its price tag and can run it on their systems would probably be better off using it. It is flexible, provides all the necessary data points, and its complex analyses are top-of-the-line. Its regular updates (multiple annually) mean that compliance standards and algorithms are always up-to-date. However, EnergyCAP is for everyone, as there are better tools for companies that want more flexibility or more Green features.

### **2.5.4. Schneider Electric PowerLogic ION EEM**

#### *Overview*

Like the SAP's energy management system, Schneider Electric's PowerLogic ION EEM is meant to unite business and energy strategies. It focuses on looking at energy in financial terms, but can also be used to achieve environmental goals or to comply with green programs. Unlike SAP, it uses a web portal that a business can customize to see the data most important to the business in real time. It automatically uploads and cleans up energy data and helps in eventually predicting, controlling, and reducing energy-related expenses.

#### *Pros*

One of the major benefits of this energy management system is being able to customize the dashboard. Every contributor can set up their portal to show the data that is most important to them. The one-way integration with enterprise software is also a huge perk, as it allows a business to better track the overall impact of energy management, and exporting the data EMSk out is easy. Sharing data with interested parties is very easy. Reports can be sent to their website and viewed by anyone via a standard browser.

#### *Cons*

The PowerLogic ION EEM is more focused on financial gains and losses. If a business is interested in reducing their environmental footprint over saving money, another energy management system might be more appropriate. The business software integration can also be overwhelming for companies that do not want or need it. Some companies may find it easier to use a cheaper, simpler energy management system.

#### *Notable Features*

The web capability of this energy management system is probably its strongest feature. This allows energy management on the go, rather than just in the office. Another key feature is the ability to manage other consumed utilities besides energy by important that data, on top of integrating with many enterprise system databases. It also has the capability to manage and analyze greenhouse gas information.

## *Data*

With a powerful reporting engine, PowerLogic ION EEM can handle complex data and graphics, turning them into models and graphs for easier visualization. It can also import data from a variety of enterprise

system databases, and export EMSk out to them. Data can be controlled either through the software or the dashboard on the web portal.

### *Verdict*

When looking at an integrated energy management system, PowerLogic ION EEM is a little bit more user-friendly than SAP. It does not have all the business functionality, but it is still a very powerful tool. The web-based dashboards allow for complete control and real time analysis on the go, which is a must for most top-level decision makers. Many institutions have chosen PowerLogic ION EEM, including the University of Texas at Austin because it is versatile and well put together.

## **2.5.5.Credit360**

### *Overview*

Credit360 is used by a variety of top companies, including Barclays and Swiss Re. Credit360 as an energy management system, is specifically geared towards forecasts and planning, so that businesses can work on energy reduction initiatives while understanding the impact it will have on their performance. They also received a gold standard certificate from the Carbon Disclosure Project, a non-profit organization working to promote sustainability.

### *Pros*

This energy management system is all about helping a business become greener without cutting into profit. It allows for reporting in line with different agencies to achieve energy and carbon emissions compliance, reports on reduction initiatives, and has a built-in carbon factor management system. Credit 360 also provides a variety of training programs to help a business become acquainted with their software.

### *Cons*

Credit360 is more about reducing a company's environmental footprint and less about increasing business productivity. It lacks a lot of the tools one would find in another energy management system, like more complex data analysis. It is capable of importing data from other enterprise reporting platforms, but simply is not meant to integrate the way SAP or PowerLogic ION EEM can and does not have breadth of tools one would find in EnergyCAP.

### *Notable Features*

The more prominent feature of Credit360 is its reporting, as a major part of its objective is to provide consumers with information on the company's environmental footprint. It also compensates for gaps in the data with sophisticated estimating techniques. Another bonus of Credit360 is that it does not just manage energy; it also collects data on carbon emissions.

### *Data*

Credit360 gathers real time information from meters and automatically tracks high impact areas. It is able to import data on carbon emissions and create carbon factor management goals as well as energy goals. Credit360 can also import energy information from existing enterprise reporting platforms.

### *Verdict*

For a company that wants better transparency and to reduce their footprint, Credit360 is a flexible tool. But it is not very powerful as an energy management system, considering its single focus on green initiatives. Choosing another energy management system will give a business the bonus of meeting their environmental goals while focusing on slashing budgets and increasing productivity. The main reason to choose Credit360 is if a business is extremely interested in reporting their footprint to their customers, or if they are extremely concerned about carbon emissions.

### 2.5.6. eSight

#### *Overview*

What makes eSight different than another energy management system is that it is an entirely web-based software-as-a-service (SaaS) product, or can be installed on site. It also focuses on both small businesses and large enterprises, unlike many other systems which only target the latter. It boasts that it can reduce consumption, costs, and carbon emissions by up to 30%.

#### *Pros*

The web-based nature of eSight means that it can be accessed anywhere. For companies who are not ready to invest in an energy management system, eSight also allows a subscription service, where businesses can choose a pay-as-you-go model with eSight's software as a service version. It is also a worldwide service, able to work with multiple currencies and local guidelines.

#### *Cons*

Tools to verify billing data are more basic and not provided with any type of associated service. eSight enables users to import data from virtually any hardware manufacturer or source data stream. In doing this, the system does not offer any controls, or vendor specific alignment.

#### *Notable Features*

eSight directly converts a company's consumption data into monetary units, making it easier to digest. One thing that really sets it apart is its ability to set up a revenue contract, which is meant to be used in tenant billing.

#### *Data*

eSight is specifically set up to handle contracts, with regards to energy consumption. It focuses heavily on calculating tariff details, including calculating variations at up to 1-minute intervals. It can do invoice validation when it has imported financial data to run against it.

#### *Verdict*

It is hard to tell if eSight will actually make good on cutting energy consumption by 30%, but it does have a variety of tools that can help a company manage their billing and contract information. There is not a lot of energy management system software that is marketed as global, with so many of them being US-based, so using eSight would be perfect for an international company. The pay-as-you-go model and focus on small businesses might appeal to some who cannot afford the initial investment in an energy management system.

## 2.5.7. JouleX Energy Manager Solutions

### *Overview*

JouleX is an energy management system that monitors, analyzes, and controls energy usage of any devices connected to a network, without a client-side agent or hardware meters. JouleX advertises that their customers reduce their energy costs by up to 60% and comes in a variety of different packages for different types of businesses.

### *Pros*

JouleX is set up so that power can be managed automatically and remotely, which means that once it is in action, it can be mostly hands-off. It has trademarked Load Adaptive Computing and Networking, which alters capacity depending on demand throughout the entire network. It also takes into account a company's need to become sustainable as well as increase profits with its Sustainable Procurement practices.

### *Cons*

Getting to the point where JouleX practically runs on its own can take some time, so it is not a magic bullet. This energy management system is also more focused on businesses with heavy server loads and large data centers, rather than looking at the management techniques factories or other non-office oriented businesses could utilize.

### *Notable Features*

JouleX is constantly adding new features and has claimed many industry firsts, like device support for computer room air conditioning, rack and floor power distribution units, and uninterruptible power supplies. It was also the first energy management system to support all the top power management networking vendors, like Cisco, Intel, and VMware. But what sets JouleX apart is its ability to measure dynamic energy consumption as well as how any device attached to the network is being utilized, making it easy to optimize energy use and reduce waste.

### *Data*

On top of its amazing ability to integrate, as noted above, JouleX is optimized for both virtualization and cloud computing. It supports demand response programs, including IT equipment. It provides corporate sustainability reports for better company transparency and customized internal reports with detailed analysis to identify power hogs and poor utilization, and suggests solutions to resolve them.

### *Verdict*

For any tech company or office environment, JouleX is probably one of the best picks for an energy management system. Time and time again, JouleX has put their money straight into improving their software, adding features, and claiming industry firsts. It may seem like a big leap to go after the new guy, but JouleX was so innovative that they were picked up by Cisco for \$107 million. For anyone who is a Cisco EnergyWise this would be a wise purchase, as after the purchase, JouleX put out a special build for EnergyWise users.

## 2.5.8.C3

### *Overview*

C3 is another energy management system that markets itself to enterprises and small businesses, but even has a residential version. It allows for real-time insight that pulls together incredibly varied sets of data and creates a cohesive energy management strategy out of them. It is focused on both supply-side and demand-side operations. By using smart grid analysis, C3 helps businesses as a comprehensive demand response tool by calculating the full value of shifting energy usage, including the impact it can have on a company.

### *Pros*

C3 is very user-friendly and generates accessible information that makes business decisions easier. It also supplies recommendations to help businesses of all sizes not just save energy, but also gain access to rebates.

### *Cons*

C3 is another SaaS module, which means that it suffers from the same security concerns as eSight. It is also incredibly new, so while it is up-to-date, there is not a lot of product history to rely on. While it is user-friendly, it lacks some of the more sophisticated tools one might find in a more complicated program like EnergyCAP.

### *Notable Features*

The ability to put together "disparate data" as C3 puts it is probably one of the strongest features of the energy management system. It looks at a lot more variables than some other systems might. By separating supply-side and demand-side analytics, C3 makes it easier for some companies to understand their energy management. This system is specifically built to help companies take advantage of their smart grid investment.

### *Data*

C3 is a software-as-service program, which means that it runs in most standard browsers. There is even a mobile version, specifically tailored for the iPad. C3 has a large library of rebate options, which when paired with its ability to make suggestions as to how to achieve the goals necessary to meet the rebate standards, is a powerful tool.

### *Verdict*

It is hard to tell if C3 is going to take off or if it is going to fall short as an energy management system. It might be a wise choice for a small business or a residential owner, but choosing a more established energy management system is probably a wiser move, considering C3 does not seem to have many features that are unique. Over time, C3 might come into its own, but for now, there are better alternatives.

## 2.5.9.Hara

### *Overview*

When Hara came onto the market in 2009, the founder said that it was designed for the "post-carbon economy era." Hara is now marketed as both an energy management system and a sustainability tool, and was backed with Al Gore's support. The hosted software application allows enterprises to organize and

monitor their water and fuel consumption on a basic dashboard in order to lessen their environmental impact and maintain profits.

### *Pros*

Hara does not just support electricity; it also looks at travel fuel consumption, GHG emissions, and water use. Its interface is extremely user-friendly and breaks down the various types of output in easy to digest terms. It measures the "payback periods" of different environmental projects, as well as letting a company keep tabs on the status of them.

### *Cons*

The CEO of Hara left SAP in order to build the start-up, and it shows in that Hara is completely unlike the other module. But while Hara is easy to use, it may too simplistic of an energy management system for some. Its primary focus is on sustainability, which means that companies looking for a cut and dry analysis of how to best allocate their energy resources in order to maximize profit may want to shop around first.

### *Notable Features*

One cool thing about Hara is that a company can set up their dashboard with an RSS feed, keeping company and industry news close by as they monitor sustainability. The Project Manager is also an incredibly powerful tool for companies trying to gain rebates or meet green standards. Companies looking for an energy management system can try out Hara free for 30 days.

### *Data*

Hara generates reports for both internal and external stakeholders which can be exported to Excel or CSV. The reports are highly customizable, choosing the range, the activity type, the unit type, and the country. Hara has a search capability to easily find supplier and billing data. This energy management system is a cloud-based software platform, meaning it is another SaaS.

### *Verdict*

Hara definitely works, considering major corporations like Coca-Cola have adopted it, but it is very simple. This may be a plus for some companies, but for others it might be a drawEMSk. It takes the best ideas from SAP and reorganizes them around sustainability, so if that is a company's goal, it is definitely worth trying the 30 day no-guarantee period. If a company is looking for a more traditional energy management system, they might want to look elsewhere first.

## **2.5.10. CA Technologies**

### *Overview*

These are actually three different products, CA ecoGovernance, CA ecoMeter, and CA ecoDesktop. CA ecoGovernance is has what you would expect from an energy management system; it allows you to measure and analyse energy as well as carbon, water, and waste, while focusing on corporate social responsibility initiatives. CA ecoMeter specifically focuses on managing data centres and clouds, as well as power and cooling, in order to increase IT agility. CA ecoDesktop reduces wasted energy by managing desktop and PC power consumption.

### *Pros*

Being able to specifically pick which programs you want can help businesses that are looking for a very specific kind of energy management system. CA Technologies' products do not require any more modules to run, which means it is one-stop shopping. CA ecoGovernance does a good job of combining sustainability and an energy management software, not sacrificing flexibility, data, or analysis.

### *Cons*

An energy management system like JouleX combines the functionality of all three CA Technologies products, while having features like dynamic energy measurement. While CA ecoMeter does not require other architecture to run, its functionality is severely limited without EnergyWise products.

### *Notable Features*

CA ecoGovernance works with more than energy, helping a company focus on carbon, water, and waste as well. It has web-based questionnaires to help access facilities and suppliers. CA ecoMeter is able to analyze and manage global data. CA ecoDesktop allows for remote forced adherence to power management policies, something you do not see often.

### *Data*

CA ecoGovernance integrates with a variety of third-party ERP's, but they do not specify which ones. It processes sub-metered data, invoice data, and lifecycle analysis data. Data collection can be automated and KPIs can be tracked in real-time. All three products have some sort of mobile functionality, although the capability of the software is limited. The mobile functionality is more to allow monitoring on the road.

### *Verdict*

CA Technologies has put some great sustainability software out there that combines Green initiatives and energy management. But beyond ecoDesktop, nothing really stands out about their programs. It is a flexible tool that could definitely help an enterprise save money and manage their social initiatives, but there are better programs out there.

## **2.5.11. Conclusion**

While looking for the catch-all energy management system, what is learned is that there really is not one. There is no "best-in-class." An enterprise should choose an energy management system based on its needs and what the software has to offer.

EnergyCAP, for example, is one of the top tools for handling more complex financial data. Companies who are looking to save money might be best off with it. But if a company is using SAP modules already, it could be far more powerful for them with its heavy integration. Companies that are looking for a powerful energy management system that is more user-friendly might want to try PowerLogic ION EEM.

If a company is heavy on servers, everything changes. JouleX might be best for a web-based company or data storage. CA Technologies covers some of the best advantages of JouleX though, with the option of modules that help companies adhere to PC usage policies. If a company has invested in the smart grid, C3 could provide them with the tools they need to take advantage of it. A global company could probably take advantage of eSight's international data focus.

And if a company is more focused on sustainability, there are so many good options. Credit360 sets the bar in some ways, with great transparency and a solid focus on Green technology. However, there is slightly more power behind Hara, considering the CEO came from SAP and wanted to merge the two technologies.



Then there is Johnson Controls, which carefully tracks all data a company needs to look at in order to assess their carbon footprint.

Once a company has identified their goals, these reviews should set them in the right direction to see what energy management system is right for them.

## 2.6. NATIONAL CODES THAT REGULATE ENERGY MANAGEMENT SYSTEMS

Energy Management Systems must fulfil the requirements stated by the National Regulations for each country.

A list of the National Codes that applies to Energy Management Systems is presented below for each country.

### Spain

The activity related with this topic does not have a specific norm, being the main general norm the following:

- Royal Decree 314/2006 of the 17th March, approval of the technical building code (CTE).  
<http://www.boe.es/buscar/doc.php?id=BOE-A-2002-18099>
- Law 9/2014, of 9th May, general telecommunications.  
[https://www.boe.es/diario\\_boe/txt.php?id=BOE-A-2014-4950](https://www.boe.es/diario_boe/txt.php?id=BOE-A-2014-4950)
- Royal Decree 346/2011, of the 11th March, approval of the regulatory rules of the common telecommunications infrastructure for access to telecommunication services inside buildings.  
[https://www.boe.es/diario\\_boe/txt.php?id=BOE-A-2011-5834](https://www.boe.es/diario_boe/txt.php?id=BOE-A-2011-5834)
- Royal Decree 244/2010, of the 5th March, approval of the regulatory rules of the activity of installation and maintenance of equipment and telecommunications  
<http://www.boe.es/buscar/doc.php?id=BOE-A-2010-4851>
- Royal Decree 842/2002 of the 2nd August, approval of the electronic regulations for low voltage.  
<http://www.boe.es/buscar/doc.php?id=BOE-A-2002-18099>
- Building Technical Code, Safety in Case of Fire, Salubrity, Energy Savings  
<http://www.codigotecnico.org/web/recursos/documentos/>

### Europe

- The EU Energy Performance of Buildings Directive (EPBD), transposed into Irish Law from 2006 onwards, contains a range of provisions to improve the energy performance of new and existing buildings.  
[http://www.eceee.org/policy-areas/buildings/EPBD\\_Recast/EPBD\\_recast\\_19May2010.pdf](http://www.eceee.org/policy-areas/buildings/EPBD_Recast/EPBD_recast_19May2010.pdf)

## 2.7. PROFESSIONAL ASSOCIATIONS REPRESENTING THE ENERGY MANAGEMENT SYSTEMS SECTOR

A list of the more relevant Professional Associations that represent the interests and views for the Sector is presented below.

### Spain

#### A3E

[www.asociacion3e.org](http://www.asociacion3e.org)

The Association of Energy Efficiency - A3e, constituted in 2009 to group and represent the interests of companies working in the field of energy efficiency: energy consulting / auditing, engineering, energy service companies, manufacturers of equipment and components, maintainers and installers.

#### CEDOM

[www.cedom.es](http://www.cedom.es)

The Spanish Automation Systems Association (CEDOM) was formed in 1992 and, since then, CEDOM has gradually adapted to changes and difficulties suffered by the Home Automation sector. Currently, CEDOM is the only national association that brings together all industry Spanish players of automation systems: home automation manufacturers, auxiliary equipment manufacturers, wholesalers, integrators, installers, technology and training centres, universities and communication media.

#### DOMOTYS

[www.domotys.org](http://www.domotys.org)

The Spanish Association for the Internationalisation and Innovation of Smart Homes and Building Companies is a non-profit making, voluntary organisation, with the following purposes:

- Encourage and help the internationalisation of the Spanish Smart Homes & Buildings Industry
- Develop an industry based on technology and innovation.
- Promote the networking and cooperation among Spanish companies, international companies and institutions.

The association plays a key role in fostering internationalisation and innovation within its members, with the support of the Central Government, autonomous regional bodies and other trade associations.

#### KNX PROFESSIONALS ESPAÑA

[www.knxprofessionals.es](http://www.knxprofessionals.es)

KNX Professionals is an association to be used as meeting platform for professionals in the KNX technology. It was created in Spain in 2007, sponsored by the International Association KNX, following the successful model of existing similar associations in other countries like the Netherlands, Austria and Germany

### European

## ECEEE

[www.eceee.org](http://www.eceee.org)

The European Council for an Energy Efficient Economy, eceee, is a membership-based non-profit association. We generate and provide evidence-based knowledge and analysis of policies, and we facilitate co-operation and networking through our Summer Studies, workshops, and social media.

## EU.BAC

[www.eubac.org](http://www.eubac.org)

The European Building Automation and Controls Association, eu.bac, represents the European manufacturers for Home and Building Automation and Energy Service Companies.

## EU.ESCO

[www.euesco.org](http://www.euesco.org)

The European Association of Energy Service Companies (eu.ESCO) was founded in 2009 by the European Building Automation and Controls Association and aims at boosting the energy services market by increasing its transparency and its trustworthiness.

## KNX ASSOCIATION

[www.knx.org](http://www.knx.org)

KNX Association is the creator and owner of the KNX technology – the worldwide STANDARD for all applications in home and building control, ranging from lighting and shutter control to various security systems, heating, ventilation, air conditioning, monitoring, alarming, water control, energy management, metering as well as household appliances, audio and lots more. The technology can be used in new as well as in existing home and buildings.

## 2.8. REFERENCES

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- “Understanding Building Automation and Control Systems”, KMC Controls [http://www.kmccontrols.com/products/Understanding\\_Building\\_Automation\\_and\\_Control\\_Systems.aspx](http://www.kmccontrols.com/products/Understanding_Building_Automation_and_Control_Systems.aspx)
- “Energy Management with SCADA”, Schneider Electric [http://www2.schneider-electric.com/sites/corporate/en/products-services/automation-control/scada-options/vijeo\\_energy\\_management.page](http://www2.schneider-electric.com/sites/corporate/en/products-services/automation-control/scada-options/vijeo_energy_management.page)
- “An Intelligent Energy Management System for Educational Buildings”, Al-Daraiseh A. et al., International Journal of Distributed Sensor Networks
- “Five key elements that will enable the Directive to raise energy efficiency, to generate growth and to create jobs across the European Union”, eu.EMS Position Paper <http://www.euEMS.org/>
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- “Energy Management”, BSI Group  
<http://www.bsigroup.com/en-GB/Sustainability-Standards-Navigator/Themes/Resource-Management/Energy-Management/>
- “Energy Management Systems”, Honeywell  
<https://www.honeywellprocess.com/en-US/explore/products/energy-and-emissions-management/Pages/Energy-Management-Systems.aspx>
- “Energy Management Systems”, Global Efficient Energy  
<http://www.globalefficientenergy.com/energymanagement/>
- “Building Controls: Types of Energy Management Systems”, Lindsay Audin in facilitiesnet  
<http://www.facilitiesnet.com/buildingautomation/article/EMS-On-the-Trail-of-Energy-Savings--2427#>
- “The New Dimension of Energy-Efficient Homes and Buildings”, eu.EMS <http://www.euEMS.org/>

## Technical Norms and Organisations for Standardization

- UNE-EN 50491-6-1:2014: General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (EMSS) - Part 6-1: HBES installations - Installation and planning
- UNE-CLC/TR 50491-6-3:2013 IN: General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (EMSS) - Part 6-3: HBES installations - Assessment and definition of levels
- UNE-EN 15232:2014: Energy performance of buildings - Impact of Building Automation, Controls and Building Management
- BS EN 15232:2012: Energy performance of buildings - Impact of Building Automation, Controls and Building Management
- CEN/TC 247: European Building Management Standardisation.
- BS EN ISO 50001:2011: Energy management systems – Requirements with guidance for use, is a voluntary International Standard developed by ISO (International Organization for Standardization)
- BS EN ISO 14001: Environmental management systems. Requirements with guidance for use
- BS EN ISO 9001: Quality management systems. Requirements

Other norms for other related materials and standards in development in: <http://www.bsigroup.com/en-GB/Sustainability-Standards-Navigator/Themes/Resource-Management/Energy-Management/>

CEN, European Committee for Standardization, [www.cen.eu](http://www.cen.eu)

ISO, International Organization for Standardization, [www.iso.org](http://www.iso.org)

AENOR, Spanish Institute for Normalisation, [www.aenor.es](http://www.aenor.es)

DIN, German Institute for Normalisation, [www.din.de](http://www.din.de)

## European Projects

### AIM

<http://www.ict-aim.eu/>

AIM's main objective is to foster a harmonised technology for profiling and managing the energy consumption of appliances at home. AIM will introduce energy monitoring and management mechanisms

in the home network and will provide a proper service creation environment to serve virtualisation of energy consumption, with the final aim of offering users a number of standalone and operator services.

## BE AWARE

<http://www.energyawareness.eu/beaware/>

It is a game-like tool with several levels of difficulty. On each level, we are exposed to new challenges regarding our energy consumption.

## EEPOS

<http://eepos-project.eu/>

EEPOS stands for Energy management and decision support systems for Energy POSitive neighbourhoods. It is developing a new system for energy management and automated load control on the neighbourhood level, the EEPOS Neighbourhood Energy Management System. With the new system, we aim to achieve the following goals by automated shifting of controllable electrical loads and active end-user involvement in energy management processes:

- Matching of local electricity generation and consumption
- Congestion management in local electricity grids
- Increase of energy efficiency

## HEMOS

<http://hesmos.eu/>

HESMOS is a research project funded by the EU - SEVENTH FRAMEWORK PROGRAMME with these major objectives:

- Provide advanced simulation capabilities to decision makers in the whole life-cycle of buildings, taking into account energy savings, investment and life-cycle costs
- Integrate a Virtual Laboratory to connect CAD and eeTools (energy efficiency Tools) in order to enhance building industry actor's ee-competences
- Close the gap between Building Information Modelling (BIM) and Building Automation Systems (BAS) so that decisions can be made economically (energy & cost related) in all life-cycle phases
- Integrate surrounding areas extending current BIM to eeBIM

## SMART CAMPUS

<http://greensmartcampus.eu/>

SMART CAMPUS aims at the development of services and applications supported by a data gathering platform that integrates real time information systems and intelligent energy management systems. This integration drives a bi-directional learning process such that both the user and the building learn how to interact with each other in a more energy efficient way.

## VERYSCHOOL

<http://www.veryschool.eu/>

VERYSchool will integrate smart LED lighting, smart metering, BEMS, energy simulation and energy action management software into a platform called the "Energy Action Navigator" and demonstrate it in four Pilot locations scattered in Europe.

More projects related to Energy Management Systems in:

[http://ec.europa.eu/information\\_society/activities/sustainable\\_growth/funding/prj\\_buidings/index\\_en.htm](http://ec.europa.eu/information_society/activities/sustainable_growth/funding/prj_buidings/index_en.htm)

### 3. RESIDENTIAL VENTILATION

The most widespread definition of window products describes them as an **opening in a wall used to provide lighting and ventilation** inside the building, usually made up of a fixed frame that sits tightly and securely in the opening, with one or more casements, fixed or mobile, in which the glazing is inserted.

The Spanish Building Technical Code does not speak of window products; instead, it regulates the concept of “**apertures**”, defining them as: “transparent or semi-transparent elements in the building’s envelope. It includes windows and skylights, as well as glass doors with the semi-transparent surface occupying more than 50% of the total surface”.

This definition is similar to the one found in the European regulation **EN 12519 “Windows and pedestrian doors – Terminology”**:

*“Window: Building component (glazing) for closing an opening in a wall or pitched roof that will admit light and may provide ventilation, including the frame of the window which is defined as the component forming the perimeter of a window, enabling it to be fixed to the structure.*

*Roof Window: Window intended for installation in a roof or the like which is inclined. Roof windows have the same characteristics as windows installed in walls with regard to function, cleaning, maintenance and durability.*

*External Doors: Doorset which separates the internal climate from the external climate of a construction for which the main intended use is the passage of pedestrians, including the frame of the door which is defined as the component forming the perimeter of a door, enabling it to be fixed to the structure.”*

In order to narrow down the definition of a window product, the European regulation directly related to window products **EN 14351-1 “Windows, French windows, screens for installation in vertical wall apertures or roof windows”** should be consulted, since it clearly specifies what falls into the definition of a window products and what does not. The regulation applies to:

“Manually or power operated windows, French windows and screens for installation in vertical wall apertures and roof windows for installation in inclined roofs, complete with:

- related hardware, if any;
- weather stripping, if any;
- glazed apertures when intended to have glazed apertures;
- with or without incorporated shutters and/or shutterboxes and/or blinds;

And manually or power operated windows, roof windows, French windows and screens that are

- fully or partially glazed including any non-transparent infill;
- fixed or partly fixed or openable with one or more casements/sashes (e.g. hinged, projecting, pivoted, sliding).

While it does not apply to:

- windows and pedestrian doorsets subject to regulations on smoke leakage and resistance to fire according to prEN 16034 but individual characteristics and performance requirements given in clause 4 can be relevant for these doors and windows (see prEN 16034);
- roof lights according to EN 1873 and EN 14963;
- curtain walling according to EN 13830;
- industrial, commercial and garage doors and gates according to EN 13241-1;
- internal pedestrian doorsets according to prEN 14351-2 but individual characteristics and performance requirements given in clause 4 can be relevant for internal doors (see prEN 14351-2);
- revolving doorsets;
- windows for escape route”.

Window products are crucial to buildings since their main functions are to provide light and ventilation, which in turn, help maintain a **healthy indoor quality** within a building. Also, windows play an important role as a thermal barrier (hot / cold) for the air conditioning inside the building and its contribution to reducing the cost associated to these systems.

### 3.1. TYPES OF WINDOW PRODUCTS

The main components of window products are the frame, acting as the structure, and the glazing, acting as a barrier between the interior and exterior of a building. If the glazing is fit into a sliding part, this part is called sash, for tilt and turn windows it is called casement. Gaskets are used to prevent air leakage, thermal insulation or thermal breaks are included in the frames in order to improve thermal performance, while profiles for protection against weather are used to improve durability.

It is important to mention that the characteristics of window products depend strongly on the country and region in which they are going to be used. In this sense, solar shading devices or shutters will be more common in southern countries, while coupled or double windows will be used in northern latitudes. Also the type of opening (inward/outward) or the opening mechanism (sliding, tilt and turn etc.) will also depend on the construction heritage of the region/country.



**Figure 1:** Typical cross sections of windows by frame material

Courtesy window manufacturers: Extrupel, Iberadria and Aluplast.

### 3.1.1. Design options

Depending on the design of the building, windows can take up many different configurations. The types of window products described below are the most common designs.

#### *Single windows*

##### **Tilt and turn windows:**

- One frame/casement
- One transparent filling element (single glass, double IGU, or triple)

##### **Sliding windows:**

- One frame and two sashes, being one of them sliding.
- Two transparent filling elements, one per sash (single glass, double IGU, or triple).

Additionally, shutters or blinds can be installed either on the inside or outside of the aperture, depending on the climate conditions. Also, IGU with integrated blind can be installed.

#### *Coupled windows*

These types of window products offer high sound insulation and are as easy to operate as single windows since both casements are coupled. They are made up of:

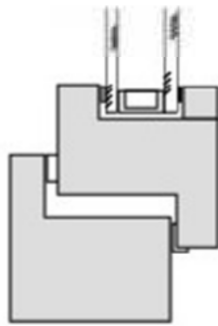
- One frame/two casements.
- Two transparent fillings, one per casement (single glass, double IGU, or triple).

Usually, single glass is used for the outer sash, while IGU is reserved for the inner sash. Also, as with single window products, shutters or blinds can be installed either on the inside or outside of the aperture, but will usually be installed in between the sashes.

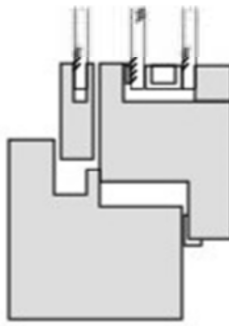
#### *Double windows*

Double windows are two complete windows installed in series separated by a cavity of approximately 100 mm. These windows differ from coupled windows in the fact that they are operated individually, in other words, in order to open or close the window, each sash has to be operated one after the other. The remaining characteristics such as glazing, shutters or blinds are the same as those of single windows.

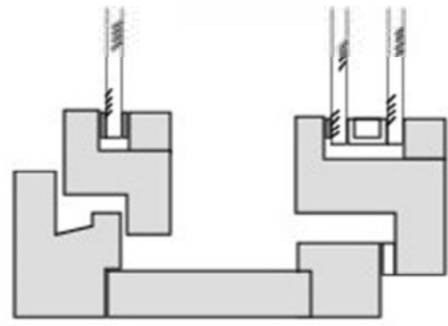




**Single Window**



**Coupled Window**



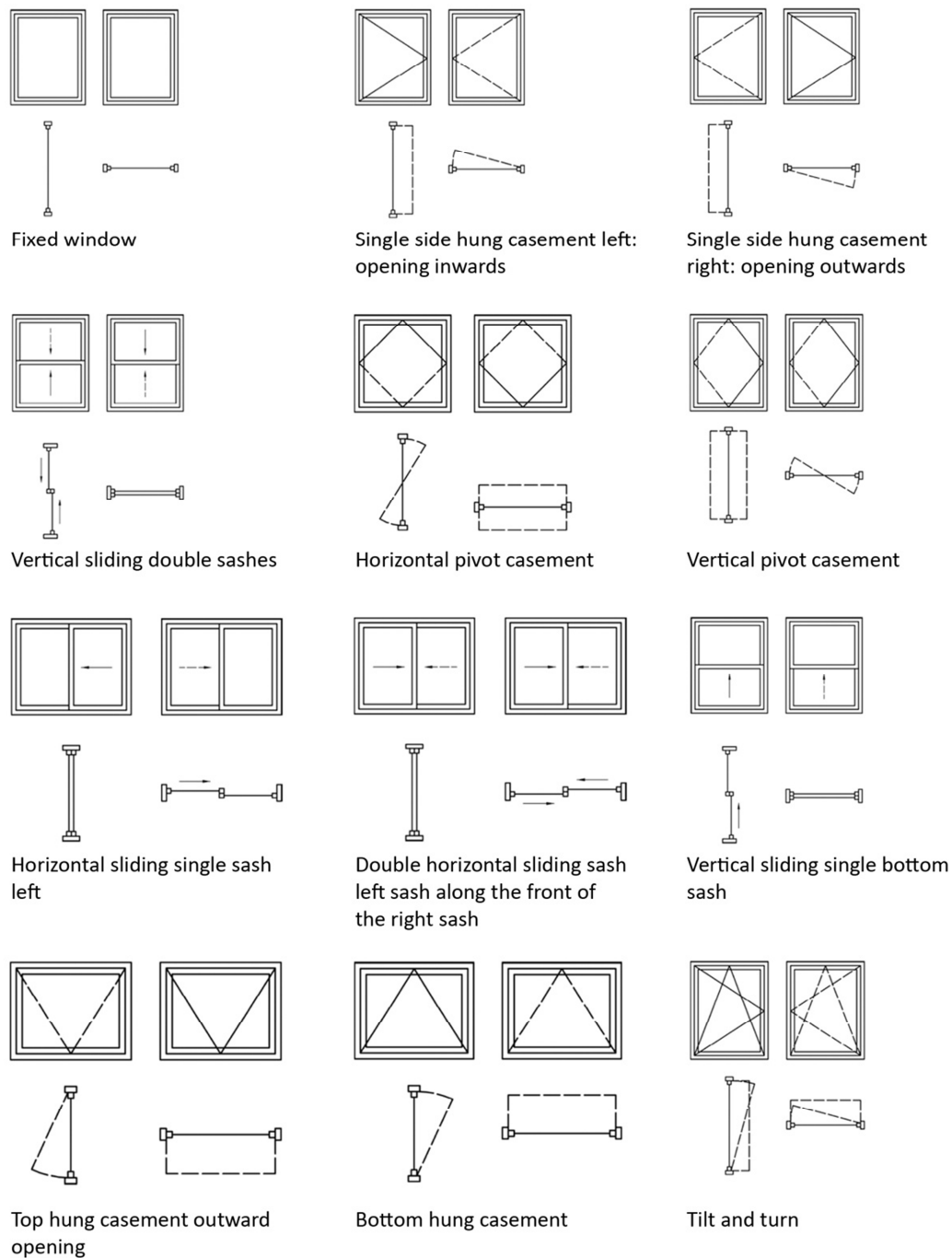
**Double Window**

**Figure 2:** Construction of windows / sashes

Courtesy "Ecodesign of Window Products", VITO NV

### *Opening types*

For windows there are several types of opening. The following drawings, taken from the regulation EN 12519 "Windows and pedestrian doors – Terminology", describe common types of opening.



**Figure 3: Opening types (EN 12519)**

Courtesy "EN 12519 Windows and pedestrian doors - Terminology"

### 3.1.2. Frame material

The frame of a window represents approximately 25-35% of the surface of the aperture, influencing the thermal insulation provided by the window, due to its thermal transmittance and its absorptivity.

Frames can be categorized by the material in which they are built. The following frame materials are most commonly used for windows:

- Metal (aluminium, steel; with or without thermal break)

- Timber (wood);
- Plastics (PVC).

The energy related characteristic of the frame is the thermal transmittance  $U_f$ , which defines the amount of heat passing through a window through time, area and temperature difference; a lower value of  $U_f$  corresponds to higher values of insulation. The units are  $W/m^2K$ , using as an accepted value for  $U_f=5,7 W/m^2K$ .

### *Metal*

Two are the most common materials used for metal window frames: steel and aluminium. This last one, aluminium, is more common due to its characteristics and low need of maintenance.

In metal frames it is important to include a thermal break, which translates into the inclusion of one or more separating elements with a low thermal conductivity in order to separate the interior elements from the exterior ones. By including a thermal break, the possibility of energy crossing through the frame is greatly reduced, thus improving the thermal performance of the window as a whole.

A metal frame, more specifically, an aluminium frame with no thermal break has approximately a  $U_f = 6.0 W/m^2K$ . If this frame is improved by adding a thermal break, this value can be greatly reduced. Other construction characteristics that influence the thermal transmittance of a frame are:

- Distance between the metal sections.
- Width of the material of the thermal break zones.
- Thermal conductivity of the thermal break material.
- Ratio of the width of the thermal break to the projected frame width.

### *Timber*

The alveolar nature of solid timber frames acts as a natural insulating element with high values of thermal insulation and low thermal conductivity. It is important to keep in mind that these types of frames require a great amount of maintenance, which is greatly reduced with the use of other materials.

The main parameters influencing the  $U_f$  value of timber frames are:

- Thickness of the frame.
- Thermal conductivity of the wood.

Normally, these frames have thicknesses that range between 60 and 90 mm. Depending on the species of which they are made up of, their thermal conductivity will vary, but it will usually vary from  $U_f = 2,2 W/m^2K$  up to  $U_f = 2,0 W/m^2K$ .

The different thermal conductivities and their correlation to the different wood species can be found in EN ISO 10077-2. As an approximation, the thermal conductivity of soft wood can be considered approximately of  $0.11 - 0.13 W/(m K)$ , while for hard wood are  $0.16 - 0.18 W/(m K)$ .

In order to achieve lower values of  $U_f$  in timber frames, it is necessary to integrate thermal insulation products.

## Plastics (PVC)

Generally plastic window frames are built in PVC and show a great thermal performance. The most commonly accepted value for PVC frame range from  $U_f = 2,2 \text{ W/m}^2\text{K}$  up to  $U_f = 1,8 \text{ W/m}^2\text{K}$ . In addition, these types of frames usually take up more surface of the aperture, which improve the thermal performance of the window as a whole, due to its high insulation level.

The main parameters influencing the  $U_f$  value of timber frames are:

- Quantity of chambers.
- Thickness of the profile.
- Design of the gasket system.

The regulation **UNE-EN ISO 10077-1 “Thermal performance of windows, doors and shutters - Calculation of thermal transmittance”** provides a table with a summary of the thermal transmittance depending on the material of the window frames.

### Thermal performance of windows, doors and shutters - UNE-EN ISO 10077-1

Frame material	Thermal Transmittance ( $\text{W/m}^2\text{K}$ )
Metallic	5,7
Metallic with thermal break ( $4\text{mm} \leq d < 12 \text{ mm}$ )	4,0
Metallic with thermal break ( $d \geq 12 \text{ mm}$ )	3,2
Hard wood ( $\rho = 700 \text{ Kg/m}^3$ and 60 mm thick)	2,2
Soft wood ( $\rho = 500 \text{ Kg/m}^3$ and 60 mm thick)	2,0
PVC hollow frames (2 chambers)	2,2
PVC hollow frames (3 chambers)	1,8

### 3.1.3. Transparent filling elements (Glazing)

Glazing can be considered the most important element of window products in terms of energy performance, since it occupies most of the surface of the aperture. Its main property is its transparency that allows the entrance of high levels of illumination inside the building, without compromising the thermal insulation.

On the market can be found different types of glazing, but the main material in their composition are still soda lime glass. The differences between them rely on the thermal insulation they provide, being or not reinforced, the level of solar protection they offer, the degree of acoustic insulation, security and low maintenance, without forgetting about the multiple options that design and decoration might offer.

From a thermal insulation point of view, the main characteristics that affect glazing are:

- $U_g$ -values or thermal transmittance ( $\text{W/m}^2\text{K}$ ): the lower the  $U_g$ , the less thermal losses.
- $g$  or Solar factor: the higher the  $g$  value, the less solar heat will enter the building.
- Light transmittance: the higher the light transmittance is, the more daylight comes into the space.

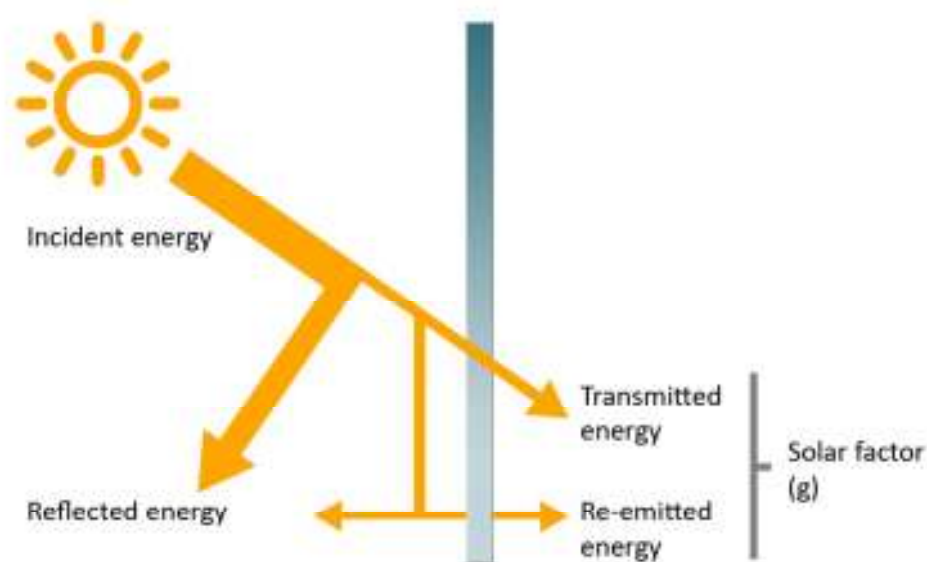


Figure 4: Solar factor

### *Single glass (monolithic)*

Single glass or monolithic glass are those transparent filling elements made up of one single pane of glass (float glass) or those composed of two or more panes of glass joint all over their surface, also known as laminated glass. The following options are found on the market for single glass:

- Colourless glass
- Coloured glass
- Screen printed glass
- Security glass

Also, different treatments are available to modify the mechanic, thermal and spectrophotometric properties.

The thermal performance of colourless single glass can be considered stable, since its thermal transmittance and solar factor vary minimally as the thickness increases. The reference values are  $U_g = 5,7 \text{ W/m}^2\text{K}$  and  $g = 0,83$ .

### *Insulating glass units*

Insulating glass units are composed of two or more units of single glass (which can also be low-e glazing or reinforced thermal insulation glazing) separated by a spacer and hermetically closed throughout their perimeter. This creates a chamber filled with dry and immobile air that, due to the low thermal conductivity of air, limit the exchange of heat by convection and conduction.

All of this translates into a drastic reduction of the thermal transmittance, going as low as  $U_g = 3,3 \text{ W/m}^2\text{K}$  for the most basic combination (6+4+6<sup>5</sup>). This reduction continues as the air chamber's width increases

<sup>5</sup> (6+4+6) indicates the width of the single glass layers and of the air chamber in millimetres (exterior glass layer + air chamber + interior glass layer).

until it reaches the limit of approximately 17 mm and convection currents start to appear in the interior of the chamber.

Thermal transmittance (W/m <sup>2</sup> K) depending on the width of the air chamber <sup>6</sup>				
Composition	4-6-4	4-8-4	4-10-4	4-12-6
W/m <sup>2</sup> K	3,3	3,1	3,0	2,9

Regarding the solar factor (g), it is lower than single glazing, approximately  $g = 0,75$ , and it can be further reduced if solar control or low-e glazing is used as the exterior glass.

### Low-e glass

Low emission glass is a monolithic glass in which a thin layer of metal oxides has been incorporated in order to reinforce its thermal insulation capacity. Normally, these types of glass are used in insulating glass units.

### Solar control glass

Solar control glass includes many varieties such as colour glazing, screen-printed glazing or coated glazing, being this last one the most commonly used. Since there is a wide variety of options, it is important to remember, that depending on the process applied to the glass, its solar control performance can range from 0,10 for the most reflective ones, to 0,60 for colour-less glass.

Typical constructions of thermally insulating glass used in windows				
Description	Typical cross section	Typical values		
		Thermal transmittance Ug in W/m <sup>2</sup> K	Solar factor g	Light transmittance $\tau_v$
Single glass	Float glass: 4-8 mm	5,9	≈0,85	≈0,90
	Laminated glass: 6-10 mm			
Double glass units	Single panes: 4-8 mm Air chamber: 12-16 mm Low-e coating: - Gas filling: air	≈2,7	≈0,78	≈0,82
Double insulating glass units	Single panes: 4-8 mm Air chamber: 12-16 mm Low-e coating: $\epsilon_n = 0,03-0,05$ Gas filling: air, Argon	≈1,1-1,3	≈0,62	≈0,80
Triple insulating glazing units	Single panes: 4-8 mm Air chamber: 12-16 mm Low-e coating: $\epsilon_n = 0,03-0,05$ Gas filling: air, Argon	≈0,6-0,7	≈0,55	≈0,70

<sup>6</sup> Data from "Technical Guide for the Refurbishment of the Building's Thermal Envelope. Insulation solutions for glazing and walls" Spanish Government, Ministry of Industry, Tourism and Commerce.

## 3.2. DEFINING QUALITY ASPECTS FOR WINDOW PRODUCTS

### 3.2.1. Window products performance parameters

In addition to the already described characteristics for window frames and transparent filling elements, there are a series of additional aspects which are not necessarily always mandatory, but make window products more efficient depending on the situation.

The following requirements have been extracted from the regulation **EN 14351-1-1:2006**, the regulations following each characteristic are those directly related to its performance, verification and certification.

- Resistance to wind load: EN 12210, EN 12211.
- Resistance to snow and permanent load: the manufacturer should provide enough information to determine these resistances.
- Fire characteristics: EN 13501-1, EN 13501-5.
- Water tightness: EN 1027, EN 12208,
- Dangerous substances: the manufacturer should provide enough information to determine if there are any dangerous substances included in the materials.
- Impact resistance: EN 13049.
- Load-bearing capacity of safety devices: EN 14609, EN 948.
- Height and width of door sets and French windows: EN 12519:2004.
- Ability to release: EN 179, EN 1125, EN 1935, EN 13633, EN 13637.
- Acoustic performance: EN ISO 140-3, EN ISO 717-1.
- Thermal transmittance: EN ISO 10077-1:2006, EN 10077-2, EN ISO 12567-1, EN ISO 12567-2, EN 10077-1:2000.
- Radiation properties: EN 410, EN 13363-1, EN 13363-2.
- Air permeability: EN 1026, EN 12207:1999.
- Durability: the manufacturer should provide information on maintenance and replaceable items as well as guarantee the durability of its products during a reasonable life span.
- Operating forces: EN 12049-1, EN 13115, EN 12046-2, EN 12217.
- Mechanical strength: EN 14608, EN 14609, EN 12046-1, EN 1192.
- Ventilation: EN 13141-1:2004.
- Bullet resistance: EN 1523, EN 1522.
- Explosion resistance: EN 13124-1, EN 13123-1, EN 13124-2, EN 13123-2.
- Resistance to repeated opening and closing: EN 1191, EN 12400.
- Behaviour between different climates: ENV 13420, EN 1121, EN 12219.
- Burglar resistance: ENV 1628, ENV 1629, ENV 1630, ENV 1627.

As stated before, not all of these characteristics are mandatory. For example, the Spanish Building Technical Code sets out the standards for the following characteristics, being these mandatory.

- Thermal transmittance.
- Superficial condensation.
- Resistance to wind load.
- Air permeability
- Radiation properties
- Airborne sound insulation (acoustic performance).

### 3.2.2. Energy Savings

A great deal of energy costs in buildings comes from HVAC systems. If the building is designed correctly and the window products are selected accordingly, the need of heating or cooling for the air inside is greatly reduced.

As seen before, the energy performance of window products is directly related to its materials. On one hand, the main characteristic of the frames must be taken into account:

- **Uf- values** or thermal transmittance ( $W/m^2K$ ): the lower the  $U_f$ , the higher insulation values will the frame have.

On the other hand, since frames usually take up around 25-35% of the aperture, the most important characteristics of window products relating to energy efficiency are those corresponding to the transparent filling element:

- **Ug-values** or thermal transmittance ( $W/m^2K$ ): the lower the  $U_g$ , the less thermal losses.
- **g** or solar factor: the higher the  $g$  value, the less solar heat will enter the building.
- **Light transmittance**: the higher the light transmittance is, the more daylight comes into the space.

In this sense, the use of low-e glass, increasing the air chamber and using glass with low solar factor will increase the overall thermal insulation. These decision become really important when dealing with façades with direct solar radiation (south, southeast, southwest, east and west orientations) where the use of a glass with a very low solar factor is highly recommended.

When using low-e glazing, the **position of the low-e layer** does not affect the  $U_g$  values offered by the glass. Nevertheless, if a higher solar protection is aimed at, the low-e layer should be placed over the glass in layer 2, while for greater solar contribution it should be positioned in layer 3<sup>7</sup>.

But in order to reduce energy consumption, not only a correct selection of window products is necessary, but it is also important to notice certain aspects of design that correspond to the building itself. The energy performance of a building in relation to its windows depends strongly on the:

- **Climate zone** in which the building is located.
- **Façade orientation** in which the window is located.
- **Percentage of surface** occupied by the apertures in relation to the total surface.

By correctly applying these concepts to a building, the need for energy consumption is greatly reduced without the need of using additional energy. In this sense, these choices can be considered passive elements in the energy performance of the building which, when correctly used, do not only not add to the general electricity consumption but also reduce it, improving thus the overall energy performance.

The following recommendations should be kept in mind when designing a building and deciding on the window products to be used, however, in order to efficiently improve the energy performance of the building, a complete analysis of the building should be carried out.

- In **northern orientations** there are low heat gains and low, but constant, levels of illumination. For these orientations, it is important to use low  $U_g$  values, allowing the maximum light transmittance

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<sup>7</sup> The nomenclature for the layers starting from the exterior layer to the interior one is: layers 1 to 4, being layer 2 the layer inside the air chamber of the exterior glass, while layer 3 is inside the air chamber of the interior glass.



and lowest thermal transmittance. In other words, the use of reinforced thermal insulation glazing that will let as much light in as possible is recommended.

- In **southern orientations and warm weather climates**, the heat gains are present in the winter and average in the summer, while the levels of illumination are high and constant during the day. Since there is direct solar radiation, it is essential to use reinforced solar factor glazing as well as keeping low Ug values. Also, a correct design of solar protections is necessary in order to allow the entrance of solar radiation in the winter and block it in the summer.

### 3.3. NATIONAL CODES THAT REGULATE WINDOW PRODUCTS

Window products must fulfil the requirements stated by the National Regulations for each country.

A list of the National Codes that applies to Window products is presented below for each country.

#### Spain

- Building Technical Code.  
<http://www.codigotecnico.org/web/recursos/documentos/>
- Spanish Energy Certification of Buildings - Royal Decree 235/2013, 5th of April 2013  
<http://www.boe.es/boe/dias/2013/04/13/pdfs/BOE-A-2013-3904.pdf>

### 3.4. PROFESSIONAL ASSOCIATIONS REPRESENTING THE WINDOW PRODUCTS SECTOR

A list of the more relevant Professional Associations that represent the interests and views for the Sector is presented below.

#### Spain

##### Asefave

<http://www.asefave.org/>

Spanish Association of Manufacturers of Light Façade and Window

##### Asoven

<http://www.asoven.com/>

Spanish association of PVC windows.

##### Aesfaveal

<http://aesfaveal.org/>

Spanish Association of Manufacturers of Aluminum Windows

##### Asoma

<http://www.asomatealaventana.org/>

Spanish Association of Manufactured of timber windows

## **CONFVICEX**

[www.confvicex.com](http://www.confvicex.com)

Spanish Business Confederation of Glass and Ceramics

## **European**

## **FAECF**

<http://www.faecf.org/>

Federation of European Window and Curtain Wall Manufacturers' Associations.

## **CONSTRUCTION PRODUCTS EUROPE**

<http://www.construction-products.eu/>

Construction Products Europe is the European Association that represents the interests of all construction products manufacturers throughout Europe.

## **Glass for Europe**

<http://www.glassforeurope.com/en/>

Glass for Europe is the trade association for Europe's manufacturers of building, automotive and transport glass, all derived from the base material known as flat glass.

## **Glass alliance Europe**

<http://www.glassallianceeurope.eu/>

Glass Alliance Europe is the European Alliance of Glass Industries.

## **European Aluminium Association**

<http://www.alueurope.eu/>

The European Aluminium Association (EAA) was founded in 1981 and represents the aluminium industry in Europe.

## **EPPA**

<http://eppa-profiles.eu/>

European PVC Window Profile And Related Building Products Association

## 3.5. REFERENCES

- “Ecodesign of Window Products”, VITO NV
- “Technical Guide for the Refurbishment of the Building’s Thermal Envelope. Insulation solutions for glazing and walls”. Spanish Government, Ministry of Industry, Tourism and Commerce.
- “Technical guide for windows in energy efficiency certification in buildings”. ASEFAVE.
- 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.
- “EPBD implementation in Hungary”, “EPBD implementation in Spain”, “EPBD implementation in Italy” and “EPBD implementation in Sweden”. <http://www.epbd-ca.eu/>

## Technical Norms and Organisations for Standardization

- EN 14351-1 “Windows, French windows, screens for installation in vertical wall apertures or roof windows”.
- EN 12519 “Windows and pedestrian doors – Terminology”
- UNE-EN ISO 10077-1 “Thermal performance of windows, doors and shutters”

CEN, European Committee for Standardization, [www.cen.eu](http://www.cen.eu)

ISO, International Organization for Standardization, [www.iso.org](http://www.iso.org)

AENOR, Spanish Institute for Normalisation, [www.aenor.es](http://www.aenor.es)

DIN, German Institute for Normalisation, [www.din.de](http://www.din.de)

## European Projects

### CLIMAWIN

<http://www.climawin.eu/>

Climawin is an integrated ventilation window system that uses heat normally lost through a window to bring in and preheat fresh air and save energy.

### EXTRUWIN

<http://www.extruwin.eu/>

The objective of this research project is to develop and manufacture a window profile based on a wood-plastic composite (WPC) formulation without PVC.

### SMARTBLIND

<http://www.smartblind-project.eu/>

The SMARTBLIND project aims at developing an Energy Efficient Smart Window including a hybrid film constituted of an electrochromic LC film and a photovoltaic film both printed on the same long-lasting flexible substrate. The realization process will be implemented thanks to electrochromic and photovoltaic

inks especially formulated to be ink-jet printed. A reduction of the windows U-value down to  $0.3 \text{ W/m}^2\cdot\text{K}$  is targeted by combining the hybrid film to an appropriate window frame.