Ready for 2020
The 'nearly zero-energy buildings' of Ozzano dell'Emilia, Italy

Introduction

Buildings currently account for 30-40% of all energy consumption worldwide.

If we want to reduce energy consumption and greenhouse gas emissions we need to relook at building design.

The new demanding European Directive on energy performance of buildings requires all new buildings to be 'nearly zero-energy' by 2020 and the '2-litre houses' located in Ozzano dell'Emilia near Bologna, Italy, are a working demonstration of how to achieve this.

What makes the project at Ozzano even more special is the fact that in combination with the energy saving criteria, it also takes into account the environmental footprint of all of the materials and applications used as a fundamental principle of the design. This is sustainable building design in practice.

The Ozzano Project includes five separate family houses and an Experimental Didactic Centre, which were all completed at the end of 2009. The buildings and their performance will be monitored for five years.

The monitoring of energy consumption in the first few months of the house's life saw a consumption of about 12-15 Kwh/m^2/year for heating/refreshing and hot sanitary water, in accordance to 'Passive House' criteria. However, taking into account of the contribution from renewable sources, the Ozzano complex 'production' covers not only the 12-15 Kwh/m^2/year for heat and hot water, but also 80% of household electricity needs.

It means that the Ozzano project could be easily considered as the first example of a 'nearly zero-energy building', already available 10 years earlier than the target set by the EU.

Furthermore, the criteria of sustainability and recyclability followed for the selection of materials and components seems to have made the Ozzano complex already compliant with the proposed EU Construction Products Regulation (CPR), currently under discussion.

The '2-litre house' project was launched in 2007 as an initiative of the PVC Forum Italia (the Italian association of the PVC industry) and AIPE (the Italian association of EPS producers); the Ozzano project was designed and executed by the Studio Arkit and developed in cooperation with the University of Bologna.

Sustainability

In the building and construction sector, specific environmental and ecological requirements are frequently written into public and private tenders, in addition to technical specifications and prices.

An informed choice of materials, as well as technical and architectural solutions, can contribute to energy savings and to minimising environmental impact at the same time as increasing a building's comfort. Furthermore, the sustainability of different materials is also becoming a criterion of evaluation for certifications and for international eco-efficiency standards. Energy savings, in particular, has become a mainstream issue.

The average European citizen spends most of their time inside buildings (home, office, school, cinema, restaurant etc). As a consequence, a large part of the energy produced in Europe is used in the building sector. The building and construction sector is also responsible for a large amount of the waste produced in Europe every year.

As an example, energy is used in the building and construction cycle for the extraction of raw materials, the preparation of semi-manufactured goods, the production of single elements, as well as transport, building, maintenance, demolition and recycling.

Buildings account for 40 % of total energy consumption in the European Union. The sector is expanding, which is bound to increase its energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the European Union's energy dependency and greenhouse gas emissions.

Today, any modern concept of architecture and design must consider how to conserve resources and save energy in all the building's life-cycle.

What makes the Ozzano development so special is the fact that, together with energy saving criteria, it also takes into account the environmental footprint of all the materials and applications used as a fundamental principle of the design.

An important and innovative aspect of the Ozzano project is the overcoming of the classic 'Passive House' criteria, generally characterised by energy performance only.

The constructional approach, in fact, integrates the sustainability criteria:

- **Economic criteria**, regulating demand and supply, considering the economic analysis of construction processes and maintenance costs;
- **Functional criteria,** evaluating technical performance, durability, quality of components and internal and external comfort;
- **Environmental criteria**, evaluating the environmental impact of materials and components, energy saving and sustainable use of natural resources.

The sustainability of the materials chosen is a fundamental aspect: all the materials have to show a favourable LCA (Life Cycle Assessment) for each application. Furthermore, all the materials utilised in the Ozzano project have to satisfy, together with the technical required performance, increasingly stringent requirements in terms of safety, non-toxicity and eco-compatibility.

All the materials were controlled and certified, from raw material production to transformation, recovery and recycling. Quality certification, UNI EN standards and CE marks helped and enabled designers to define high performance materials, safe for final users.

Another innovative aspect is that the Ozzano housing complex has been design and built to be recovered, dismantled and completely recycled in the future. The initial hypothesis was based on a 100-year period with a programmed maintenance. After this time it will be possible to rejuvenate the buildings.

Energy Performance

The aim of the project was to develop an architectural approach based on two main concepts:

- **energy savings:** achieve energy savings and at least a 'Passive House' classification (max. 1.5 litre/m^2/year or 15 Kwh/m^2/year) evaluating bioclimatic and architectural performance criteria
- **materials'sustainability:** select affordable materials with a low environmental footprint, based on scientific data.

The bioclimatic analysis of the territory, considering characteristics such as wind, albedo, shade factors, exposure, average temperatures and geothermal conditions, was the first pillar to come up with a design approach.

Furthermore, the project follows specific requirements in terms of 'Passive House' classification, comfort (acoustic insulation, lighting quality, indoor safety), static certification, architectonical barriers, safety systems, cost verification, recyclability and environmental impact (CO_2).

In order to achieve the best energy performance possible, after the bioclimatic analysis of the location, an ad hoc range of solutions were chosen, such as heat recovery ventilation, rational heat/cool distribution, hyper insulated structures, solar shields for active and passive shadows, photovoltaic panels, solar collectors, radiant heating and condensing boilers.

The choice of materials was also very critical. Plastic materials are an ideal solution in terms of eco-efficiency and sustainable performance. Some examples are EPS and PVC for hyper-insulation and windows in order to guarantee optimal thermal performance, the use of PVC piping systems for liquids and wiring, EPS components for roofing, walls, and flooring insulation.

This approach has resulted in a building that save more than 90% in terms of energy consumption compared to an equivalent sized Italian building constructed using traditional techniques.

The monitoring of energy consumption in this first months of life shows a consumption of about 12-15 Kwh/m^2/year for heating/refreshing and hot sanitary water. But considering the contribution from renewable sources, the Ozzano complex 'production' covers not only the 12-15 Kwh/m^2/year for heat and hot water, but also 80% of household electricity needs.

On this basis, the Ozzano project can be consider the first example of a 'nearly zero-energy building', already available 10 years earlier that the target set by the EU.

The Ozzano complex is an excellent example of a sustainable residential building. However, the construction approach is also valuable for industrial sites.

The TEBO warehouse

The TEBO warehouse at San Lazzaro di Savena, a few kilometres away from Ozzano, was developed following the same criteria: energy savings and sustainable materials.

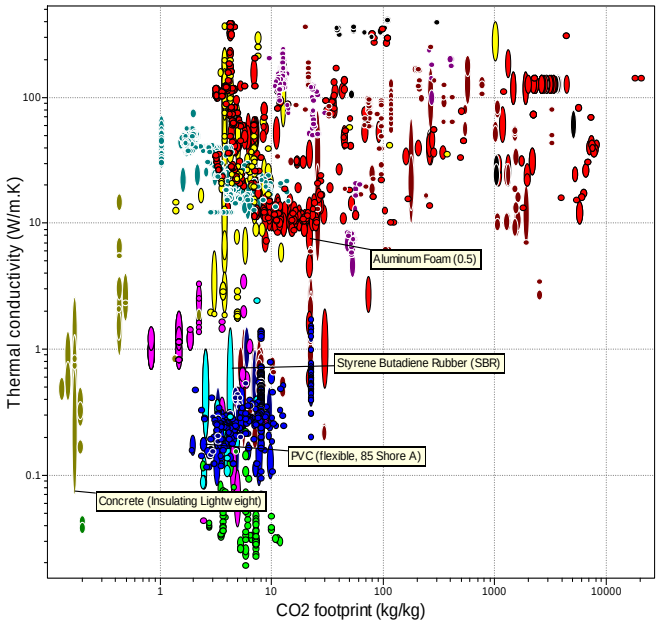
The TEBO warehouse covers an area of 2,400 m^2 (2,100 m^2 production and 400 m^2 offices). The average energy consumption for heating/refreshing and hot sanitary water is around 21 Kwh/m^2/year, which is an excellent standard for industrial buildings. But what is more important, with solar panels and photovoltaic cells it covers at least 60% of its production needs for electricity.

Plastics for sustainability

In the framework of the '2-litre house' project, PVC have been evaluated and chosen thanks to its favourable environmental performance supported by LCA studies, cost-effectiveness, recyclability and good technical performance, such as durability, easy installation and maintenance, fire resistance and insulating characteristics.

The '2-litre house' project endorses the Life Cycle Thinking concepts through the LCA tool as an effective technical and scientific tool for a sustainable choice, and considers the existence of several positive LCA studies on PVC, carried out by the PVC industry and other independent bodies (also on behalf of the EU Commission like the "Life Cycle Assessment for PVC and its applications" study).

Among these are the examples of the LCA studies on pipes and window profiles commissioned to the Politecnico of Milan and to the Turin based consultancy Life Cycle Engineering.



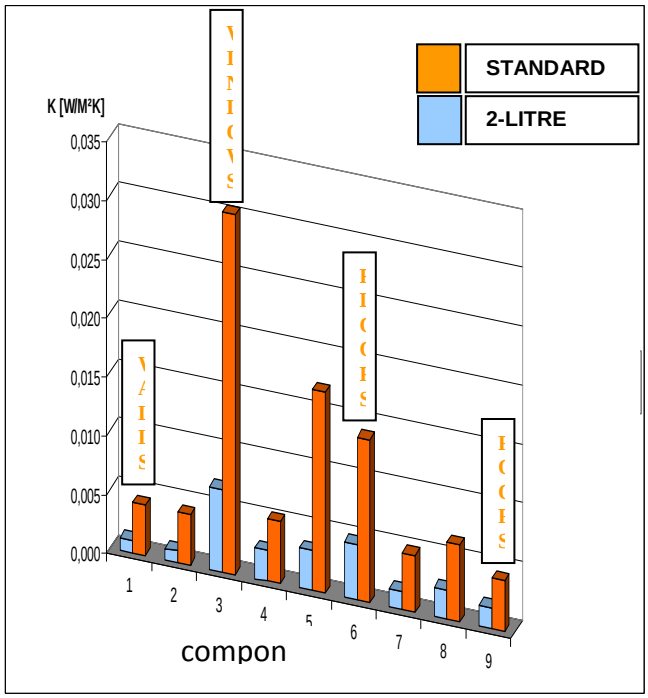
Other documents such as the PVC Eco-profiles and EPDs developed by ECVM and PlasticsEurope for PVC resin and the eco-efficiency studies on profiles, pipes, cables and membranes developed by the University of Catalonia, were also considered in the evaluation of PVC sustainability.

Furthermore, in order to guarantee the best technical and environmental performances of PVC applications for building and construction, the PVC Forum Italia, with the support of its sectoral working groups, has developed in parallel specific 'quality and sustainability labels' for PVC compounds, pipes and roller shutters.

The sustainability labels provide both technical and environmental guidelines:

- labelled compounds for example must avoid the use of lead stabilisers and other heavy metals, and the companies should be certificated ISO 14000 or follow the principles of the Responsible Care;
- the label PVC pipes certifies the compliance with the standards UNI EN 1401, UNI EN 1452 and UNI EN 1329;
- the label for roller shutters requires, when possible, the use of labelled compounds and the compliance with the UNI EN 13659 and UNI EN 13245-1 standards.

Optimal thermal insulation is fundamental to increasing sustainability in terms of energy efficiency and energy savings; this forms the basis of the '2-litre house' project. PVC windows profiles were chosen for their excellent characteristics particularly in thermal transmittance.



PVC components contribution to thermal transmittance

In the Ozzano project, PVC is used for

- ***Roofing and water proofing membrane***

  Recyclable PVC roofing and waterproofing membranes are used as a barrier to water migration and humidity thanks to their insulating properties. This helps to improve the sustainability of buildings, protecting the structures, improving internal comfort, requiring less maintenance and therefore less consumption of materials and resources.

- ***Windows and greenhouses***

  PVC windows profile and greenhouses are fundamental in ensuring the best thermal insulation.

  Research conducted by the PVC Forum Italia demonstrates that modern PVC window profiles, thanks to optimal performance in terms of insulation, can contribute up to 20% reduction of heating costs in a standard flat. This corresponds to an equivalent savings of 200 litres of gas oil per year. As a solution, this leads to both economic and environmental benefits, equivalent to the reduction of pollutant emissions in the atmosphere equivalent to 16kg of CO_2.

  For these reasons, the use of PVC window profiles has been included, for example, in the materials that satisfy the 'Passive House' criteria.

  PVC offers reduced replacement and repair costs which directly benefits the consumer. PVC profiles are durable, recyclable and recycled through several recycling schemes across Europe.

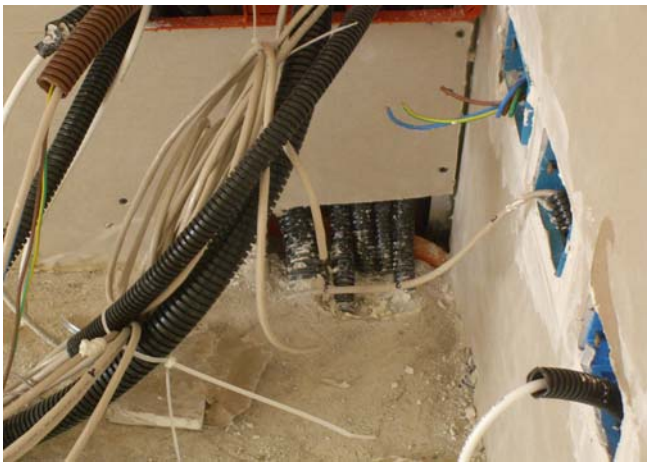
- ***Gutters***

  PVC gutters provide an excellent combination of stiffness and strain capacity and are also easy to assemble.

- ***Cables insulation, cable ducts***

  Thanks to its excellent versatility, PVC is widely used for many types of cable insulation: from electric and phone cables to coaxial cables for TV/computers/Hi-Fi as well as cables for automotive vehicles and cables for data transmission, LAN and IT.

  PVC is also used for electric applications such as plugs and pins, electric boxes, etc., for its properties of insulation, chemical and fire resistance, easy workability and temperature resistance.



- ***Sewing and water supply***

  PVC pipes have been used for more than 60 years and demonstrate that they have very long-lasting material properties. PVC pipes do not rust, scale, pit or react chemically with the material they are designed to convey. They also resist bio-film formation better than metal or concrete pipes, helping to provide constant water quality.

  PVC pipes are strong, yet flexible enough to bend without breaking, allowing them to endure earth movement. PVC pipes offer a projected life span of more than 100 years without any loss in strength. Experience has demonstrated that PVC pipes help to reduce leakage. PVC also is compatible with all the

other materials used in pipe networks and therefore ensures a secure interface is maintained.

At the end of their life, PVC pipes are collected and easily recycled to be used in new products.

PVC Pipes have an excellent cost-price performance connected directly with their low maintenance and low installation costs, long life-span and efficient waste management.

- ***Drainage***

  Drains are not required to contain water under high pressures, and pipe designs may be constrained only by the need to support earth loads transmitted to them. Thanks to its stiffness and strain properties, PVC is the best material to be used.

- ***Irrigation system***

  In this application, PVC is used because of its flexibility and low cost in terms of material as well as installation.

- ***Solar ducts***

  Solar ducts provide a smart and simple solution to improve energy efficiency and decrease energy consumption for the lightening of cellars and underground floors. A solar duct is a simple PVC pipe with an internal reflecting surface collecting the solar light from the roofs that reflects the solar light in the cellars.

EPS an effective insulation material

Expanded Polystyrene, or EPS, is a lightweight, rigid, plastic foam insulation material produced from solid beads of polystyrene.

EPS can be used to thermally and acoustically insulate walls, roofs or floors; it is a cost-effective and easy-to-use material in all types of buildings, from houses and offices to factories and schools. EPS is used by civil engineers as a lightweight fill or void-forming material. It is also used as a flotation material.

From an environmental point of view EPS is safe, non-toxic and totally inert. EPS is recyclable directly into new building products and fulfils nearly all fire and safety requirements.

EPS, as an effective insulation material, prevents energy loss and therefore helps to conserve fossil fuels, prevents carbon dioxide emissions which cause the greenhouse effect and global warming.

In the Ozzano project, EPS is used for:

- *ETICS insulation*
- *Roofing insulation*
- *Floor insulation*
- *Acoustic floor*
- *Interior wall*
- *Foundations*
- *Roof gardens*

A new Architectural and Constructional Approach for Sustainable Buildings

Exploring new processes, new methodologies, new use of materials and elements whilst using everyday materials and simple technologies that anyone can afford; this was the basis for the development of the new building approach of the Ozzano dell'Emilia complex.

2LHouse in Ozzano dell Emilia, affordable to be sustainable

This means building on conceptual innovation, energy efficiency and resource saving, but with construction costs comparable to traditional buildings and with significant savings in terms of running costs.

The same building approach, used in Ozzano and San Lazzaro for residential and industrial buildings, is applicable for any kind of public and private buildings.

Tebo Industrial Plant

Dozens of similar projects are already under construction in Italy for residences, campus, motorway restaurants, SPAs and shopping centres.

Source : www.pvc.org – September 2010