Nearly Zero Energy Buildings built with AAC

To fulfil the commitments on CO_2 emission-reduction and to prove that nearly zero energy buildings can be built by conventional building envelope the European Autoclaved Aerated Concrete (AAC) industry has collected the main points that can serve as a guide for designing buildings that answer the latest energy performance requirements. The solutions which AAC materials provide are not theoretical, but practical ones which have already been realised.

In accordance with Energy Performance of Building Directive (EPBD) recast 2010/31/EU a nearly zero-energy building (nZEB) is a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources including from renewable energy produced onsite and nearby.

The EPBD requires that from 2019 onwards all new buildings occupied and owned by public authorities are nearly zero-energy buildings and by the end of 2020 all other new buildings are nearly zero-energy buildings. The definition in the European directive offers flexibility and each Member States must define the requirements on a national level reflecting local conditions. Since the EPBD (recast) was published in 2010, discussions have started in the Member States to set the targets for the energy saving requirements in 2020 and to draw national strategies for the rollout including interim targets for 2015.

The nZEB has been defined intentionally vaguely in the Directive leaving room for the Member States to shape the concept to the national needs, resulting in no single, harmonised nZEB definition throughout the EU. As by end of 2013 only 4 Member States reported a definition that comprises of both numerical target and share of renewables, in other ones the work on the definition is still in progress, this document focuses on principles of designing buildings with very low or zero energy demand fulfilling the requirements expected to be set for nZEB, and shows references built with AAC.

Major key points to design nZEBs

- **minimised energy losses**
  - compact shape of the building to reduce the surface area
  - well insulating building envelope
  - minimised influence of thermal bridges
  - air tightness
  - controlled air ventilation (heat exchanger to recover energy from ventilated air)

- **optimised solar gain**
  - optimised orientation of the building, with large openings to the South and minimised opening to the North
  - shading to prevent summer overheating
  - thermal mass to prevent summer overheating

- **use of renewable energy sources,** such as heat pumps, solar and PV panels

Building envelope regarding wall structure

Based on experience a building with an appropriate share of renewable energy source and an external wall structure erected from AAC masonry units or panels with a heat transfer coefficient of U = 0.20 – 0.25 W/(m²K) can achieve a zero or even plus primary energy need. There are three established ways to construct a well insulated masonry for a nearly zero energy building.

1. Monolithic wall construction
2. Monolithic wall construction with the combination of insulating material
3. Cavity wall with insulation

Construction Solutions in AAC
Significantly inherent product characteristics lead to AAC being an important product of energy efficient constructions in Europe, hence the reason why the use of AAC continuously increased during the past decades. Monolithic AAC masonry and AAC masonry with marginal additional insulating layers are among the common exterior wall solutions in energy efficient constructions.

A single solid leaf of AAC masonry or element can be used to meet all the requirements for the house wall design. This provides a cost optimal solution resulting in an overall structure that is robust and durable, with over 80 years of experience.

Despite low heat conductivity AAC disposes a relatively high density. That means that high room temperatures in summer – as nowadays reported of highly insulated houses - can be reduced with AAC constructions. As a consequence constructions with AAC are able to avoid or/and reduce the energy demand for cooling. Therefore, especially for hot summer regions (south Europe), AAC can provide a strong contribution to meet the goals of CO_2 reduction even under these special conditions.

Linear Thermal bridges
AAC is an isotropic building material showing the same characteristics in any spatial direction assuring low energy losses at corners and joints (thermal bridges) of buildings. In buildings with low envelop U values, thermal bridging causes a higher amount of thermal transmission. AAC provides a solution to this design issue by providing solutions developed to reduce the heat loss, including construction products such as AAC lintels and slabs, which further reduce thermal losses.

Air tightness
Airtightness also becomes a key factor in the overall heat loss balance. AAC can be used to great advantage, since it is intrinsically airtight; constructions do not need additives such as foils or other artificially produced materials that are used in order to guarantee air tightness. In addition, the indoor air climate is healthy with no mould growth and with a good humidity control. Measurements prove that low infiltration rates can be obtained from on site testing. This explains why solid constructions can compare with lightweight frame constructions in all cases. To the contrary: the AAC capacity to keep the moisture out of the room leads to a comfortable and healthy internal environment.

Thermal mass
Constructions from AAC lead to a reduction of overheating by its thermal mass and ability to retain heat during the hot periods and release during the cooling period. Good storage properties lead to a balanced room climate and offer an essential precondition for the comfort of inhabitants. AAC has both low thermal conductivity and an inherent heat storage capacity. In summer the room temperature in AAC buildings on average is 3-5 °C lower than in lightweight constructions. The cooling load in AAC buildings basically to be covered by electricity is solely reduced caused by the good combination between low thermal conductivity and high storage capacity by 10-15 %.

Thermal insulation
Building components made of AAC provide low energy losses over the building envelope due to low heat conductivity. It has the best performance of any solid load bearing material, which results in a single material capable of meeting many design functions.

Conclusion
The large number of realised low energy, passive, zero carbon, zero energy, or even plus energy houses prove, that building from AAC is an economic way of erecting houses that provide comfortable room conditions and minimise energy use and carbon emission. A practice that is relying on the fundaments of traditional construction technics providing air tightness, insulation, heat storage capacity, sound insulation and fire safety, and recyclable. In such houses, it is not neceassry to design to low external wall U values, but rather to obtain an even balance of thermal and material properties throughout the assessment for energy loss.
For further information please see on www.eaaca.org