Danish plans towards Nearly Zero Energy Buildings

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The Danish Government has the target that Denmark should use 100% renewable energy in the energy and transport sectors by 2050. In March 2012 a new political ambitious Energy Agreement was reached in Denmark. This Energy Agreement is an important step towards fulfilling the 2050 target and contains a wide range of ambitious initiatives and covers the period 2012 – 2020. By 2020, the Energy Agreement will give the following main results:

- More than 35% renewable energy in final energy consumption
- Approximately 50% of electricity consumption to be supplied by wind power
- 7.6% reduction in gross energy consumption in relation to 2010
- 34% reduction in greenhouse gas emissions in relation to 1990.

Furthermore the Energy Agreement spells out the contents of a strategy for energy renovations of the existing building stock. The Strategy for energy renovation is due in 2014.

- There are several political energy ambitions in the future:
- 2030 – No more use of coal in power plants
- 2035 – All electricity and heating covered by renewable energy
- 2050 – All energy covered by renewable energy (electricity, heating, transports, industry).

Future decrease for energy use

The energy performance requirements for new buildings were implemented in their current form, i.e., the energy performance calculation method, in 2006, after the implementation of the first EPBD (Energy Performance Building Directive). These requirements included forecasts for the tightening of the EP requirements in 2010 and 2015 – approximately 25% compared with the 2006 requirements in each step. In 2009, the requirements were revised, and the EP (energy performance) requirements for new buildings were tightened by 25% in the Danish Building Regulations 2010 (BR10). In the 2010 revision, no forecast for the 2020 EP requirements was included, but the building industry requested this forecast. This led to a process of cost analysis for establishing the different levels of EP requirements. The outcome was the forecast for the EP requirements for new buildings in 2020 – i.e., the Danish nearly zero-energy building (NZEB) definition.

High oil prices making renewables attractive

Around 2000, increasing oil and natural gas prices gradually made use of wood for heating attractive for private consumers, and the share of renewable energy consequently grew considerably. This growth took place without any governmental efforts, apart from the energy tax system, which favours renewable energy. Today, 23% of the energy used for heating is renewable energy, mainly wood, with a minor share coming from heat pumps. To this comes the share of renewable energy in district heating. With approximately 40% of Danish district heating being based on renewables, the total share of renewables for heating adds up to 41%.

In order to reduce the use of oil and natural gas for space heating, the Energy Agreement states that from 2013 use of oil and natural gas will not be allowed in new buildings. For existing buildings within district heating areas and natural gas areas it will not be allowed to install new oil furnaces from 2016.

New buildings and integration of renewable energy in NZEB 2020 class

The existing BR10 sets the minimum energy requirements for all types of new buildings. These requirements relate to the energy frame and the envelope of the building. In addition to the minimum requirements, BR10 also sets the requirements for two voluntary low-energy classes: Low-energy Class 2015 and Building Class 2020 (NZEB 2020). These two classes are expected to be introduced as the minimum requirements by 2015 and 2020, respectively.

The integration of renewable energy in NZEB 2020 is taken into consideration in calculation of the primary factors. Primary energy factors will be lowered over time as RE (renewable energy) will make up a larger proportion of the energy mix. The primary energy factors in **Table 1** will be used.

Local, collective RE installations such as wind turbines, shared solar heating systems, solar photovoltaic arrays or geothermal systems are included in calculation so far as the building owner owns a share of the installation. There is requirement for thermal solar systems in large building with high domestic hot water use (above 2000 l/day).

Table 1. Primary energy conversion factors are being used in the calculation (primary/useful energy).

	2006	BR10 year 2010	Low-energy 2015	Building Class 2020
District heating	1	1	0.8	0.6
Fossil fuels	1	1	1	1
Bio fuels	1	1	1	1
Electricity	2.5	2.5	2.5	1.8

- Energy from RE installations can be subtracted when calculating the overall energy consumption, but only limited – e.g. only electricity for building operation in dwellings. There are limited subsidies for private solar panel installations. Produced energy that isn't used in the building is sold to the grid (by a low feed-in tariff). There is a maximum of 6 kW peak for single family buildings.

Energy frame

The energy frame is the maximum allowed primary energy demand for a building, including e.g. thermal bridges, solar gains, ventilation, heat recovery, cooling, lighting (non-residential buildings only), boiler and heat pump efficiency, electricity for operating the building, and sanctions for overheating. The overheating sanction is calculated on a fictive energy use, equal to the energy needed in an imaginary mechanical cooling system in order to keep the indoor temperature at 26°C. This additional energy use is included in the calculated overall energy consumption of the building.

The energy frame for the primary energy demand in new buildings has been tightened by 25% compared with the 2006 baseline Low-energy. Class 2015 introduces a 50% tightening compared with the 2006 baseline, and Building Class 2020 further tightens the energy frame by 25%, thereby reducing the allowed energy frame by 75% compared with the 2006 baseline (**Figure 1**).

The BR10 minimum energy frame requirement is:

> 52.5 + 1,650 / A [kWh/m² per year] for residential buildings, and

> 71.3 + 1,650 / A [kWh/m² per year] for non-residential buildings,

where A is the heated gross floor area.

The energy frame for the voluntary Low-energy Class 2015 is:

> 30 + 1,000 / A [kWh/m² per year] for residential buildings, and

> 41 + 1,000 / A [kWh/m² per year] for non-residential buildings.

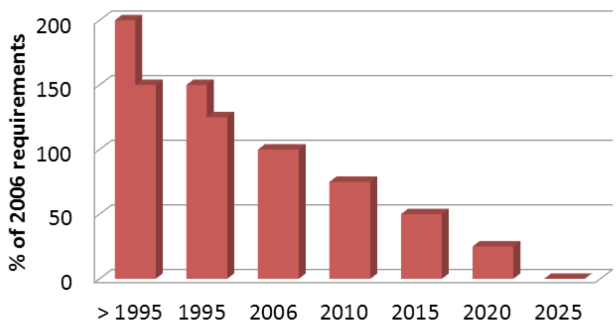

Figure 1. Development of energy use in Danish buildings by construction year, the requirements in 2006 as reference (=100%).

Figure 2. An example of a NZEB in Denmark, Green Lighthouse. It was built in less than a year in a close public/private partnership. The partners are the University of Copenhagen, VELUX, VELFAC, the Danish Building and Property Agency (UBST) and the City of Copenhagen. Green Lighthouse is located at the Faculty of Science at the University of Copenhagen and is a one-stop-shop where students can get advice on their studies, exams etc. (Photo: greenlighthouse.ku.dk)

Finally, the energy frame for the voluntary Building Class 2020 is:

20 [kWh/m² per year] for residential buildings, and
25 [kWh/m² per year] for non-residential buildings.

The building code also sets requirements for calculating the design transmission heat loss for the opaque part of the building envelope for new buildings (it fixes the temperature differential indoors-outdoors at 32°C), as well as the minimum requirements for components and installations. The minimum component requirements are primarily intended to eliminate the risk of mould growth due to cold surfaces. It is not possible to construct a building, meeting the energy frame solely by fulfilling the minimum component requirements. Both sets of requirements work in parallel with the requirements for the energy frame, and are set in order to avoid having new dwellings and/or building components and installations with a high level of renewable energy, but poor insulation. A Building Class 2020 building must be constructed so that the designed transmission loss does not exceed 3.7 W/m² of the building envelope in the case of single-storey buildings, 4.7 W/m² for two-storey buildings and 5.7 W/m² for buildings with three storeys or more.

Indoor climate in NZEB 2020 class

There are also special requirements for airtightness, windows and the thermal indoor climate in the NZEB 202 class, e.g.:

- The thermal indoor climate on sunny days must be documented through calculation for dwellings, institutions, offices, etc. in low-energy class 2015 and NZEB 2020 class
- For dwellings, a temperature of 26°C must not be exceeded for more than 100 hours per year, and a temperature of 27°C must not be exceeded for more than 25 hours per year
- In non-residential buildings the limit threshold is defined by the Danish Working Environment Authority and requests by the building owner
- NZEB 2020 class must have a glazed area of at least 15% of the floor area in habitable rooms and kitchen/family rooms if the light transmittance of the glazing is higher than 0.75. If the light transmittance is lower, the glazed area must be increased correspondingly.

As an example of a NZEB in Denmark is shown the Green Lighthouse (**Figure 2**). ■