BEST EU PRACTICES
In building design and construction

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**Definition and requirements**

**DIRECTIVE 2010/31/EU on the energy performance of buildings**

‘Nearly zero-energy building’ means a building that has a **very high energy performance** (...). The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from **renewable sources** (...).

The Member State’s detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a **numerical indicator of primary energy use expressed in kWh/m² per year**.

<table>
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<tr>
<th>Knac</th>
<th>EPmin, kWh/m²</th>
<th>EPmax, kWh/m²</th>
<th>Residential buildings</th>
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<td>A+</td>
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+ 55% RES = Nearly zero-energy building
Calculation methodology

DIRECTIVE 2010/31/EU on the energy performance of buildings

The methodology shall be laid down taking into consideration at least the following aspects:
(a) the following actual thermal characteristics of the building including its internal partitions:
   (i) thermal capacity;
   (ii) insulation;
   (iii) passive heating;
   (iv) cooling elements; and
   (v) thermal bridges;
(b) heating installation and hot water supply, including their insulation characteristics;
(c) air-conditioning installations;
(d) natural and mechanical ventilation which may include air-tightness;
(e) built-in lighting installation (mainly in the non-residential sector);
(f) the design, positioning and orientation of the building, including outdoor climate;
(g) passive solar systems and solar protection;
(h) indoor climatic conditions, including the designed indoor climate;
(i) internal loads.
Creation of the concept and standard in the late 1980s by Wolfgang Feist and Bo Adamson

First passive house 1991
Main characteristics of the nZEB

- High comfort
- Economically viable
- Healthy
- Ecological
nZEB design principles

The perfect nZEB

- Passive House windows
- Thermal insulation
- Airtightness
- Thermal-bridge-free
- Comfort ventilation with highly heat recovery

EnEffect

Energy Charter for EU4Energy

EU4Energy
nZEB design principles

1. Optimal solar gains
2. Improved thermal insulation
3. High-quality doors and windows
4. High airtightness
5. Minimizing thermal bridges
6. Ventilation with heat recovery
7. Renewable energy sources
8. Cost optimality

The perfect nZEB

Bioclimatic
Building envelope
Building systems
Climate
Social acceptance

Building physics
EU Policies

EnEffect

The Energy Charter
EU4Energy
Economic viability of the nZEB

The perfect nZEB

Demolition costs
Costs for building management and maintenance
Exploitation costs (incl. heating, cooling, ventilation, lighting, household and other equipment, water, etc.)
Cost of construction
Cost of construction materials
Accordin current regulations

Cost of the building over the whole life cycle

Passive building
Economic viability of the nZEB

PASSIVE KINDERGARTEN IN GABROVO, BULGARIA

- INVESTMENT: 726.09 BGN/m²
- INVESTMENT: 778.31 BGN/m²

Comparison of technical parameters and initial investments

**The perfect nZEB**

- ROOF ≤ 0.28
- AIRTIGHTNESS $n_{50} \leq 3$ 1/h
- WALLS ≤ 0.35
- WINDOWS ≤ 1.7

**BUILDING**

- According to the current Bulgarian norms

**BUILDING**

- According to the Passive house standard

**Actual Investment:** 720 BGN/m²

**COST INCREASE:** 7.2 %

**RETURN OF INVESTMENT:** 7.5 години

**Leading role of integrated design**

Passive kindergarten in Gabrovo, Bulgaria

According to the Passive house standard

- WALLS ≤ 0.15
- WINDOWS ≤ 0.8

**ПОКРИВ ≤ 0.15**

**AIRTIGHTNESS** $n_{50} \leq 0.6$ 1/h

**INVESTMENT** 778,31 BGN/m²

**INVESTMENT** 726,09 BGN/m²

**Actual Investment:** 720 BGN/m²

**COST INCREASE:** 7,2 %

**RETURN OF INVESTMENT:** 7.5 години

**Leading role of integrated design**
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COMFORT

The diagram illustrates the relationship between temperature (°C) and relative humidity (%) to determine comfort levels. It highlights regions for comfortable, less comfortable, respiratory diseases, mold, bacteria, viruses, and uncomfortably dry conditions.
Triple glazing

Radiation temperature
20.5 °C
Left half of the room

Radiation temperature
18 °C
Right half of the room

Double glazing

Radiation temperature
20.5 °C
Left half of the room

Radiation temperature
15 °C
Right half of the room
Outdoor temperature -5 °C / indoor temperature 20 °C and RH 50%
**Outdoor**
- Temperature: -5 °C
- Relative humidity: 90%
- Absolute humidity: 2.4 g/kg

**Indoor**
- Temperature: 20 °C
- Relative humidity: 20%
- Absolute humidity: 3.1 g/kg

*Too much infiltration!*

*Less thermal comfort*

*More energy for heating*
**Outdoor**
- Temperature: -5 °C
- Relative humidity: 90%
- Absolute humidity: 2.4 g/kg

**Indoor**
- Temperature: 20 °C
- Relative humidity: 70%
- Absolute humidity: 10.8 g/kg

+ Not enough infiltration!

Moisture and condensation

Not enough oxygen!
Indoor pollutants
Indoor air quality

Bedroom 3 day in a row

Comfort
Indoor air quality
SHAPE AND ORIENTATION
SHAPE OF A BUILDING

GOOD BUILDING SHAPES

- High level apartment blocks
- Terraced houses
- Simple shaped single family buildings

Buildings with A/V factor less than:

\[ \text{A/V} < 0.7 \]

Volume decrease by 38%

Building envelope increase by 13%
Role of local authorities

Whole neighborhoods or whole regions

Optimum not maximum solar gains

South orientation if possible

Optimum solar gains and orientation

Be aware of other shading possibilities:
- Other buildings
- Landscape
- Trees and forest

Maximum during the winter
Minimum during the summer
**Thick thermal insulation**

For walls and roofs from 20 – 30 cm.

Depends on A/V factor and thermal characteristics of the insulation material

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**Pencil Rule**

If you sketch the thermal insulation on the drawings, you should do it without lifting the pencil from the paper

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**Install correctly**

Follow the installation recommendations
THERMAL INSULATION

Roof  $U \leq 0.15 \text{ W/m}^2\text{K}$

Wall  $U \leq 0.15 \text{ W/m}^2\text{K}$

Floor  $U \leq 0.25 \text{ W/m}^2\text{K}$
Thermal bridges could be responsible for a very big portion of heat losses in well insulated houses, so calculate them. Keep the shape simple and avoid unnecessary bridges. Think how to reduce the effect of the existing thermal bridges. If you sketch the thermal insulation on the drawings, you should do it without lifting the pencil from the paper. Thermal bridges could be responsible for very big portion of heat losses in well insulated houses, so calculate them.
THERMAL BRIDGES
AIRTIGHTNES
Airtightness test
Check the quality of the work with special equipment

n50 max. 0.60 h⁻¹

Pencil Rule
If you sketch the airtightness layer on the drawings, you should do it without lifting the pencil from the paper

Quality construction
Pay special attention to detail
AIRTIGHTNESS

WIND

STACK / CHIMNEY EFFECT
Chip board with adhesive tape

Airtight membranes

Brick walls with plaster

Concrete
WINDOWS
3 glazing layers
With selective coatings
Such as:
Low-e windows;
4 season windows etc.
U ≤ 0.80 W/m2K
g value as big as possible

High quality frames
U ≤ 0.80 W/m2K
Reduce the area of the frame
Increase the area of the glazing

Warm edge spacers
Use plastic spacers
**Appropriate installation**
Use the right place for installation
Use less shading during the winter and more shading during the summer

**No thermal bridge**

**Smart shading**
WINDOWS

- Bahama shutters
- Exterior roll blind
- Sarasota shutters
- Sun screen
- Slatted aluminum
- Venetian awning (east or west exposure)
- Porch
- Trellis & vines
- Hood awning
- Gambrel awning (for casement windows)
- Trees
- Solid aluminum awning
- Roller awning (self-storing)
HEAT RECOVERY VENTILATION
HRV Residential buildings principle
**Applicable to all building types**

**Maximum efficiency**

Heat recovery more 75%  
Fans electrical consumption less than 0.45 Wh/m³

Air to air heat exchanger with HR ≥ 75%  
DC motors (ErP Ready)  
Control: operating levels and air flow balancing  
Thermal insulation and airtightness  
Condensate drain  
Filter: Extract air + outdoor air  
Frost protection  
Summer bypass
CERTIFICATION CRITERIA
Heating energy demand $\leq 15 \text{ kWh/(m}^2\text{a)}$

or Building heating load $\leq 10 \text{ W/m}^2$

Useful cooling demand $\leq 15 \text{ kWh/(m}^2\text{a)}$

Primary energy demand $\leq 120 \text{ kWh/(m}^2\text{a)}$

Building airtightness $\leq 0.6 \text{ /h}$

Excess temperature frequency $\leq 10 \%$
Biomass boilers
- Woods
- Wood pellets
- Wood briquets
- Straw or other

Thermal pumps
- Ground sources
- Outdoor air
- Water reservoirs
- Geothermal water
- Exhaust heat utilization

Hot water solar collector
- Flat plate collector
- Evacuated tube collector
- Combined PV+hot water collector
**Photo voltaic**
Iteration in building design is very important
Possible regulation barriers

**Wind**
Almost impossible to be integrated in buildings

**Co-generation**
Too expansive and inefficient for family houses
Great for district heating and cooperatives
Good for complex of buildings
RES INTEGRATED DESIGN
EXAMPLES

Residential
EXAMPLES

Residential
EXAMPLES
Residential
EXAMPLES Residential
EXAMPLES
Non residents
EXAMPLES
Non residential
EXAMPLES
Non residential
EXAMPLES
Non residential
EXAMPLES
Renovations
EXAMPLES
Renovations
THANK YOU
Does anyone have any questions?

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