Study on the 1st Elementary School of Mouzaki, a Municipality of the Karditsa regional unit.

**Bioclimatic - Passive-Intelligent Building**

**Zero Energy Consumption Building (nZEB)**

Building that can generate renewable energy so that over 60 years the cost of construction, operating costs, the cost of demolition, and the cost of recycling can be depreciated.
A few words about the ZEMedS Program

✓ The ZEMedS program is co-funded by the European Union under the Intelligent Energy Program (IEE), and promotes the renovation and construction of new Mediterranean schools in Nearly Zero Energy Conservation Buildings (nZEB).

✓ The main goals of ZEMeds are to enhance nZEB know-how and support stakeholders, public organizations, building designers, builders and other professionals, with high quality tools focused on the technical and financial aspects of nZEB Middle School Renovation.

✓ The program incorporates detailed information on the benefits, technical strategies, technologies available, public and private funding mechanisms and best practice studies for nZEB school upgrading. ZEMedS Strategic Upgrading Sets High Energy Goals by Ensuring Indoor Quality of School Buildings.
nZEB in a nutshell: Energy

Reduction of Energy Requirements and Renewable Energy Needs Coverage

(a) Annual primary energy consumption to be covered by renewables: CPE - ProdRES ≤ 0

Where:
• CPE: Annual Primary Energy Consumption for All Uses (In Harmonization with National Primary Energy Indicators)
• ProdRES: Renewable energy produced

(b) Total energy consumption:
• CFE ≤ 25 kWh / m²heat. Surface².year
• Heating, cooling, ventilation: CHVAC ≤ 20 kWh / m².year
• Lighting: Clighting ≤ 5 kWh / m².year

• BASIC STRATEGIES
• UFaçade: 0.20-0.40 W / m²K
• URoofs: 0.15-0.30 W / m²K
• UWindows: 1.40-1.80 W / m²K
• Solar protection is required
• Limited air leakage
• Basics for successful nZEB design:
  • - Complete approach
  • - Collaboration with users
  • - Energy management
  • - Monitoring, supervision
nZEB in short: Indoor Quality (IEQ)

- Ensure good indoor air quality and adequate thermal, optical and acoustic comfort
- The recommended value of carbon dioxide concentration within schools:
  - CO₂ ≤ 1000 ppm
- In addition, the recommended concentrations for VOCs <0.05 ppm
- and particles
- PM₁₀ <50 µg / m³ (24 hour average)

BASIC STRATEGIES

- Ventilation rating: 5 - 13 (l / s per person) Average amount: 8 l / s per person
- The ventilation strategy can vary depending on location and local climate, between natural ventilation and fully automated artificial heat recovery ventilation (taking into account many intermediate solutions)
- The use of non-toxic materials and the right choice of ventilation filters help improve air quality
nZEB in short: Thermal Comfort

Indoor Thermal Comfort Conditions:

- Minimum temperature in winter: 19-21°C
- Maximum summer temperature: 25-27°C
- Overheating (internal temperature greater than 28°C) should be limited to 40 hours per year

- T air above 28°C ≤ 40 hours / year
Motivations

✓ Climate change is the dominant challenge and energy saving in the building sector is at the forefront of the fight to reduce carbon dioxide emissions.

✓ Schools represent a large proportion of public buildings. There are about 87,000 schools in the Mediterranean regions of Italy, Greece, Spain and France.

✓ In the area of energy saving in buildings, the interest in school buildings is extremely high: school design has specific energy requirements but must also guarantee high levels of indoor environment.
nZEB definition in ZEMedS

✓ Due to the lack of numerical indicators for achieving nZEB in the context of this and ZEMeds the targets are numerically set

✓ School of zero energy consumption is one whose annual energy balance (in primary energy) is zero

✓ In addition, the permissible maximum final energy consumption is 25 kWh / m² / year

✓ Finally, good internal conditions (IEQ) are guaranteed, at least in terms of air quality and thermal comfort
nZEB definition in ZEMedS

✓ Primary Energy from conventional sources covered by renewable energy sources
  0 kWh / m².year (annual balance)
✓ Final energy consumption (all uses except hot water and cooking)
  CFE ≤ 25 kWh / m².year
✓ Thermal conditions
  40 hours above 28ºC per year
✓ Quality assurance of internal conditions
  CO2 ≤ 1000 ppm
Basic criteria for nZEB in Mediterranean schools

- Very low energy demand
- Thermal comfort
- Local architecture
- Energy from RES
- Increasing awareness
- Indoor quality
- User training

nZEB school

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nZEB schools: requirements

• **Required 1**
  • A zero energy school is one whose annual energy balance for non-renewables is close to zero

• **Required 2**
  • A zero-energy school has a maximum permissible final energy consumption of about 25 kWh / m^2 .y

• **Required 3**
  • A zero-energy school ensures a healthy environment and comfort for building users
Methodology

• **We carry out a "dynamic thermal simulation"**
  - To validate the projected final energy consumption
  - To validate the thermal comfort target
  - To help decision makers optimize proposed interventions

• **We calculate other energy consumption**
  - To estimate the consumption of hot water
  - To estimate the specific electrical consumption depending on the appliances
  - To determine the equipment with the highest energy consumption

• **We are doing a RES study**
  - To appreciate the local energy potential
  - To determine the techno-economic feasibility
  - To consider, if necessary, nearby or network RES
Methodology

• **Measurement of airtightness of the building**
  • After work, a measurement is performed to evaluate the implementation in accordance with the specific requirements of the program and to apply corrective measures.

• **Monitoring of the building**
  • To measure actual consumption per use
  • To measure indoor conditions in order to evaluate the comfort and quality of the environment
  • Adopting remedies or new actions to optimize the use of the building
  • To support a communication plan involving users

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Remarks

• The NZEB objectives need to support an integrated approach, including dynamic simulations. Current regulatory processes in Italy, France, Spain and Greece do not allow the objectives of a ZEMedS approach to be achieved.

• NZEB goals are more difficult to achieve in a renovation / upgrade than in new buildings

• The NZEB goals are a long-term approach. Many measures may not prove effective if taken separately

• Why an absolute price? Because with the NZEB approach we are talking about the same energy result. If the energy target is a relevant criterion (eg -70% of thermal demand), energy consumption varies for each building due to different starting points

• In some cases, the NZEB approach is simply not feasible

• In addition to the work, it is necessary to organize the maintenance / use of the school to maintain the level of efficiency. The NZEB approach is not just for one year

• Users should be provided with documentation and instructions. The NZEB approach is related to the energy behavior of the user
Legislative and regulatory compliance

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European Legal Framework

• **Three guidelines** promote the public effort to upgrade and energy efficient buildings:

• **- Energy Performance of Buildings Directive (EPBD):** The directive sets various requirements, including the need for public buildings to be almost zero energy consumption by 2019 and all new buildings by 2021. It also requires from Member States to set a minimum energy efficiency requirement for new and refurbished buildings in order to achieve an optimum cost level.

• **- Energy Efficiency Directive (EED):** The directive contains a series of mandatory measures aimed at achieving energy savings in all sectors and requires Member States to establish a long-term strategy to mobilize investment in housing renovation and commercial buildings.

• **- Renewable Energy Directive (RED):** The directive is part of the legislation leading to the development of renewable energy solutions in buildings and their integration into local energy infrastructures.
European Legal Framework

• The nearest definition for a nZEB building at European level is referred to in the Energy Performance of Buildings Directive EPBD, Article 2, as' a building which has a very high energy efficiency. The almost zero or very low amount of energy required should be largely covered by renewables, including energy from renewables either in or near the same site. “

• The same directive states that “Member States should ensure that by 31 December 2020 all new buildings are virtually zero energy, and after 31 December 2020 all new buildings which will either be owned or used by public authorities. principles will be almost zero energy “

• Member States will also "develop national plans to increase the number of near-zero energy buildings and, following the public sector leadership, will develop policies and take appropriate measures such as setting targets to enhance the renovation of the buildings in question." to become almost zero-energy buildings
Greek National Framework

• nZEB Definition: To date there is no national legislation incorporating Directive 2012/27 EED as regards the definition of nZEB, which includes both a numerical target and the percentage of renewable energy sources.

• Legislative Framework: Law N.3851 / 2010 on RES (FEK 85 / A / 4.6.2010); All public buildings from 2015 and all new buildings from 2020 should cover primary energy consumption from RES, combined heat and power generation, local heating or cooling, and energy efficient heat pumps. National targets by 2020: 20% contribution from RES to national gross final energy consumption (from 5% in 2007), 40% to gross electricity generation (from 4.6% in 2007), and 20% to final energy consumption for heating and cooling

• Application: To date no application is recorded. It should be based on intermediate targets to improve the energy efficiency of new buildings by 2015, with more emphasis on enhancing energy efficiency in new buildings.
Energy and Environmental Benefits

• Emission Reduction

• The likelihood of significant emissions reductions in buildings is significant, as 80% of the operating costs of new buildings can be saved through advanced design principles, often at no or minimal additional cost in the long run.

• Participation of Public Agencies in a new energy standard

• Analyzing the situation from a macro-economic point of view, it is important to involve the public sector in the development of specific activities aimed at shaping an energy model. This creates significant conflicts due to the heavy dependence of the Mediterranean regions on imported energy and makes them vulnerable to external and international energy crises.
Economic benefits

• Reducing energy demand
  • Implementing nZEB solutions will reduce fuel demand at public sector facilities. Long-term optimization of nZEB solutions will result in lower energy costs and a more sustainable approach

• Secondary actions
  • The successful implementation of nZEB solutions in educational buildings will have a lasting impact on other public sector buildings and services and will ultimately have a significant impact on the overall public budget.

• Innovation
  • The nZEB refurbishment and tools used will boost innovative materials in a new market by displacing older technologies

• Maintaining economic activity
  • The implementation of nZEB solutions will help to enhance the professional activity
Health and Safety Benefits

• Improving air quality
  • Air quality in nZEB schools is improved compared to buildings constructed in accordance with current practice. Improving air quality will result in a much safer and healthier environment for students and school staff.

• Reduce the impact of allergies and respiratory problems
  • According to some studies buildings equipped with mechanical exhaust ventilation and heat exhaust systems show an association with health problems (allergies and respiratory problems) that will be reduced with nZEB solutions.

• Reduce artificial lighting
  • Reducing the use of artificial lighting will have a positive impact on the well-being of students and their educational environment.

• Reduce the risk of mold formation
  • Mold fungal cultures tend to grow in high humidity environments. Humidity usually increases in places occupied by a significant number of people, such as in the case of schools. Mold and fungi can be prevented by good thermal insulation.
Social benefits

• Reducing fuel needs
• One of the main benefits of implementing nZEB solutions stems from the need to reduce fuel demand. It is important to note that, as with the other benefits of nZEB solutions, depreciation will be fully achieved over time.

• Development of a new model in the construction sector
• In broad view, the development of a new model in public buildings management will have an impact on the economic and social conditions of the region

• Strengthening a new economic model of the sector
• The nZEB approach can help overcome current obsolete values and behaviors in a key area for economic and social development. A process by which public procurement needs to be accelerated

• Regeneration of local working conditions
• The implementation and development of new technical skills and competences in the field of construction and renovation will have a significant impact on the regeneration of a sector which is deeply affected by the financial stagnation of recent years.

• Innovation for society
• Supporting nZEB building development is a statement about the society we want for our children and the environmental and social values we want to give to younger generations
Educational benefits

• Promoting education in ecological environments
• Allowing the younger generations to grow up and be educated in ecological environments like nZEB schools will result in a profound awareness of our children. In turn this will create a cultural process that will have a major impact when these children become adults.

• Promoting the "naturalness" of energy efficient solutions in children
• Promoting the "naturalness" of energy-efficient solutions to young people's values and behaviors is one of the most valuable outcomes of nZEB targeted actions

• Allowing students to better understand their energy consumption
• In energy-efficient schools, students can monitor their school's energy consumption from energy databases and have the opportunity to learn about the benefits of smart energy management

• Greater comfort will result in improved academic performance
• Thermal comfort is an important factor for schools, since it guarantees student living
Aesthetic and Cultural Benefits

• Preserving the Architectural and Cultural Heritage

• The construction boom in the Mediterranean countries in recent decades has had an impact on the construction of school buildings from the beginning. Although these new buildings were constructed following the highest technical and energy standards, in the process the great architectural and cultural heritage of the area may have been forgotten. The nZEB outlook should be seen as a valuable mechanism to improve the situation.
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**Zero Energy Consumption Building (nZEB)**

Building that can generate renewable energy so that over 60 years the cost of construction operating costs the cost of demolition and the cost of recycling can be depreciated
• BASEMENT AREA = 977.76 sq.m.
✓ 4 GYM FACILITIES
✓ BOYS’ TOILETS
✓ BOYS’ LOCKER ROOMS
✓ BOYS’ SHOWERS
✓ BOYS’ SCHOOL LOCKERS
✓ GIRLS’ TOILETS
✓ GIRLS’ LOCKER ROOMS
✓ GIRLS’ SHOWERS
✓ GIRLS’ SCHOOL LOCKERS
• Ground floor area = 977.76 sq.m.

3 Classrooms
• Multipurpose Hall
• Canteen
• Dining Room
• Teachers’ Office
• Headmaster’s Office
• Boiler Room
• Girls’ Toilets
• Teachers’ Toilets
• Boiler Room
• 2 Stairways
• 1 Elevator
• FLOOR SIZE = 701.49 sq.m.

✓ 5 CLASSROOMS
✓ 1 PH / CH LABORATORY
✓ 1 COMPUTER ROOM
✓ 1 LIBRARY HALL
✓ 1 ROOM FOR A PARENT AND CAREER ASSOCIATION
✓ 2 STAIRWAYS
✓ 1 ELEVATOR
TOTAL SQUARE FOOTAGE OF THE SCHOOL AREA

2657,01 sq.m.
BASIC ELEMENTS OF PLANNING THE FIRST ELEMENTARY SCHOOL

- BIOCLIMATIC PLANNING
- PASSIVE DESIGN (SHELL-AIRTIGHTNESS)
- PHOTOVOLTAIC
- SOLAR PANELS WITH VACUUM TUBES FOR ZHN
- NATURAL VENTILATION WITH INTELLIGENT MANAGEMENT SYSTEM CONNECTED WITH ELECTRICAL REFLECTION WINDOW
- WEATHER STATION
- TEMPERATURE - PRESSURE - HUMIDITY AND CO2 DENSITY MEASUREMENT SENSORS
- 90% HEAT RECOVERY SYSTEM VENTILATION
- SOUND INSULATION
- SUN-PROTECTION WITH EXTERNAL CURTAINS MANAGED BY AUTOMATIC SYSTEM
- SCHOOL HEATING WITH NATURAL GAS
BASIC ELEMENTS OF THE DESIGN OF THE 1ST ELEMENTARY SCHOOL

Required 1

✓ A zero-energy school is one whose annual energy balance for non-renewables is at most zero:

✓ CPE - ProdRES ≤ 0

✓ CPE: Annual primary energy consumption for all uses (heating, cooling, ventilation, hot water, food preparation, lighting and electrical appliances). National conversion rates are considered as conversion factors.

✓ ProdRES: Annual production of local renewable energy in primary energy

✓ At the 1st Mouzaki Elementary School we will have photovoltaic energy production twice the amount that the school will consume annually
Required 2

✓ A zero-energy school has a maximum permissible energy consumption of 25 kWh / m²·year:

✓ CFE ≤ 25 kWh / m²·year

✓ 1st Mouzaki Elementary School CFE ≤ 15 kWh / m²·year

✓ CFE: Final energy consumption for all uses (heating, cooling, ventilation, lighting and electrical appliances)

✓ Indicative maximum values have been set for the final energy consumption of specific uses

✓ Heating, cooling, ventilation  CHVAC ≤ 20 kWh / m²·year

✓ 1st Mouzaki Elementary School  CHVAC ≤ 10 kWh / m²·year

✓ Lighting  Clighting ≤ 5 kWh / m²·year

✓ 1st Mouzaki Elementary School  Clighting ≤ 5 kWh / m²·year
BASIC ELEMENTS OF THE DESIGN OF THE
1st ELEMENTARY SCHOOL

Required 3

✓ A zero-energy school ensures a healthy environment and comfort for building users
✓ Internal carbon dioxide concentration:
  ✓ CO2 ≤ 1000 ppm
✓ 1st Mouzaki Elementary School CO2 ≤ 1000 ppm
✓ Summer comfort:
  ✓ Maximum overheating time: T over 28 °C ≤ 40 hours / year during operation
BASIC ELEMENTS OF PLANNING THE FIRST ELEMENTARY SCHOOL

✓ The following have also been taken into account:
✓ Indoor air quality (eg HCHO Formaldehyde, PM particulate matter)
✓ The noise
✓ The natural light
✓ The effect of cold surfaces
✓ In addition, the recommended concentrations for VOCs <0.05 ppm
✓ and PM10 particles <50 µg / m3 (24 hour average)
The following have also been taken into account:

- UFaçade: 0.20-0.40 W / m2K
- 1st Mouzaki Elementary School: Ufacade 0.10-0.20 W / m2K
- URoofs: 0.15-0.30 W / m2K
- 1st Mouzaki Elementary School: URoofs 0.10-0.20 W / m2K
- UWindows: 1.40-1.80 W / m2K
- 1st Mouzaki Elementary School: UWindows 0.07-1.20 W / m2K
BASIC ELEMENTS OF PLANNING THE FIRST PRIMARY SCHOOL

✓ The following have also been taken into account:

✓ Indoor Thermal Comfort Conditions:

✓ • Minimum temperature in winter: 19-21°C

✓ • Maximum summer temperature: 25-27°C

✓ • Overheating (internal temperature greater than 28°C) should be limited to 40 hours per year

\[ T \text{ air above } 28 ^\circ C \leq 40 \text{ hours / year} \]
PLOT OF THE BASEMENT OF THE SCHOOL
PLOT OF THE BASEMENT OF THE SCHOOL, SQUARE FOOTAGE = 977.76 m²

ΣΥΜΠΛΗΡΩΜΑΤΙΚΟ ΥΠΟΓΕΙΟ = 977,76 m²
PLOT OF THE GROUND FLOOR OF THE SCHOOL,
PLOT OF THE GROUND FLOOR
SQUARE FOOTAGE = 977.73 sq.m.
PLOT OF THE 1ST FLOOR

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PLOT OF THE 1ST FLOOR
SQUARE FOOTAGE= 701.49 sq.m.

EMBAΔΟ ΟΡΟΦΟΥ =701,49 m2
EAST SIDE
NORTH SIDE
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