THE FUTURE
OF ENERGY EFFICIENCY
STARTS HERE

PRINCIPLES, EXPECTED EFFECTS AND NATIONAL IMPLEMENTATIONS OF EUROPEAN DIRECTIVE 31/2010 AND 27/2012

PRINCIPI, EFFETTI E ATTUAZIONE NAZIONALE DELLE DIRETTIVE NAZIONALI 31/2010 E 27/2012

Fiera Milano Rho, 17th March 2016

Associazione Italiana Condizionamento dell'Aria Riscaldamento e Refrigerazione

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Design strategies for EPBD implementation in the Mediterranean region

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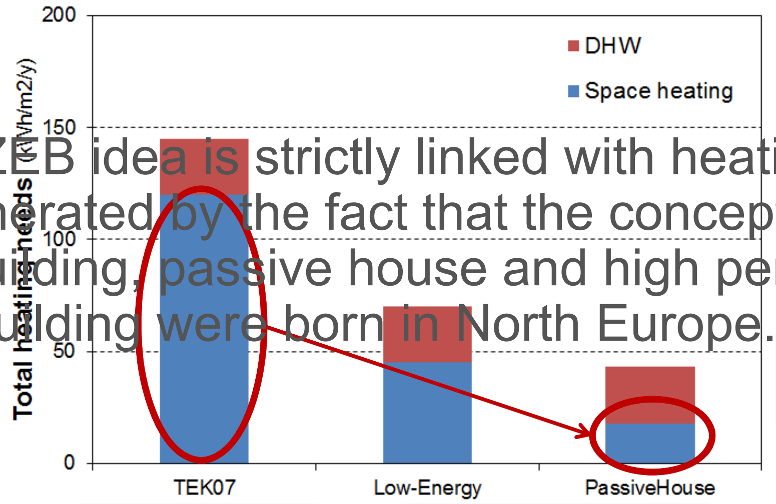
Associazione Italiana Condizionamento dell'Aria Riscaldamento e Refrigerazione

What is new in high performing buildings?

Share of space heating has got significantly smaller in the total heating needs



Usually nZEB idea is strictly linked with heating uses. This is generated by the fact that the concepts of low-energy building, passive house and high performing building were born in North Europe.

Mediterranean climate

North Europe → - Control of thermal loads in **HEATING** periods
- FREE COOLING with external air

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South Europe → - Minimization of thermal loads for both **HEATING and COOLING** periods

nZEB design

Mediterranean climate

Presence of a **variety of climates** respect to North Europe

Differences in terms of:
- winter and summer **design temperatures**
- **relative humidity** in winter and in summer

→ **Design strategies**

THERMAL INERTIA → use of the storage mass of the building

INSULATION → high insulation level

VENTILATION → optimization of natural ventilation airflows

SOLAR CONTROL → sun screens and overhangs

CLIMATE MITIGATION → use of trees and hedges

New requirements for HVAC systems

These changes have set new requirement to the HVAC systems for HPB

- Small heating and cooling loads → Reduced nominal power/size of heating/cooling systems
- Internal gains dynamics → Designing the response of «building/HVAC» system
- Daily load dynamics → Balancing thermal insulation and inertia
- Overheating problems → Balancing opaque and trasparent envelope, set-up passive cooling strategies
- Crucial role of ventilation → Integration of natural and mechanical ventilation (with heat recovery and dehumidification)
- Large fraction of DHW needs → changing strategy for DHW preparation
- Shortening of heating/cooling periods → Balancing investment/operating cost and efficiency

Effects on cost-optimality of HVAC systems

Aicarr work-group and Rehva Task Force

Lack of **quantitative DATA**

Lack of **official SOURCES** for the data

Need for an **harmonized DATABASE** to share information deriving from different case studies, building typologies and locations

AICARR WORK GROUP

REHVA TASK FORCE

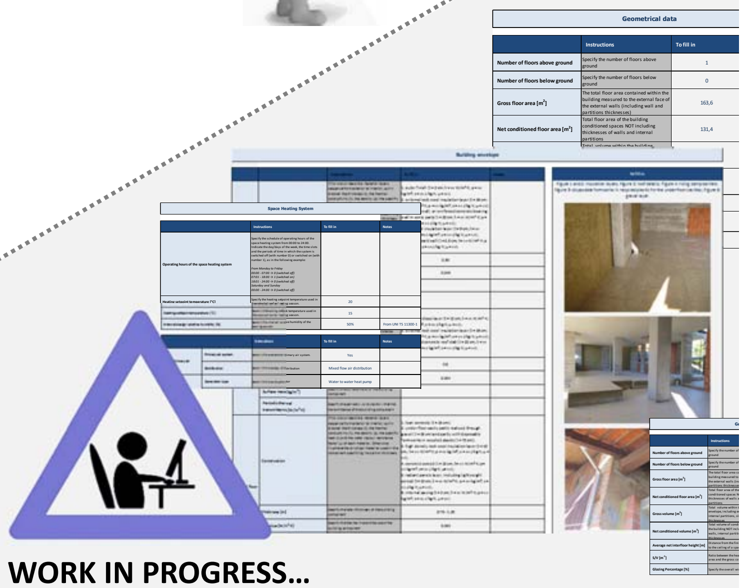
process towards

case studies **good practices**

nZEB

Structure of database

1	General information
2	Geometrical data
3	Building envelope
4	Building system
5	Space Heating System
6	Space Cooling System
7	DHW System
8	Storage
9	Ventilation
10	Lighting & Appliances
11	RESs
12	Energy Calculated Data
13	Energy Monitored Data
14	Conversion factors
15	Economic valuation
16	Sustainable and green features
17	References



WORK IN PROGRESS…

A Mediterranean nZEB: CorTau House

Design Team: M. Luciano, S.P. Corgnati

Typology of intervention: refurbishment of a traditional rural building (2014)

Features: concrete structure, rockwool external insulation, triple-glazed LowE windows, water-to-water heat pump, radiant panels for heating and cooling, PV panels (7 kW_{peak}), mechanical ventilation system with heat recovery

ALL ELECTRIC house: all building energy needs are covered by energy produced on-site with PV system

Space heating [kWh_{el}/m^2]	Space cooling [kWh_{el}/m^2]	DHW production [kWh_{el}/m^2]	Lighting [kWh_{el}/m^2]	Equipment [kWh_{el}/m^2]	Fans&Pumps [kWh_{el}/m^2]
3.94	2.62	5.78	11.17	31.9	5.76
Total energy uses [kWh_{el}/m^2]					
61.17					
PV production [kWh/m^2]					
44.47					

From design to construction

0 Pre-existing building

Preliminary design phase

1 First Design Concept

Definitive design phase

2 Final Design Concept

Executive design phase

3 Construction

Cost-optimal analysis exploited as **DECISION-MAKING TOOL** equipped to guide design team and owner's choices during the **DESIGN PROCESS**

DESIGN CONFIGURATIONS

Energy and economic evaluation

GOALS
- nZEB TARGET
- COST CONTROL

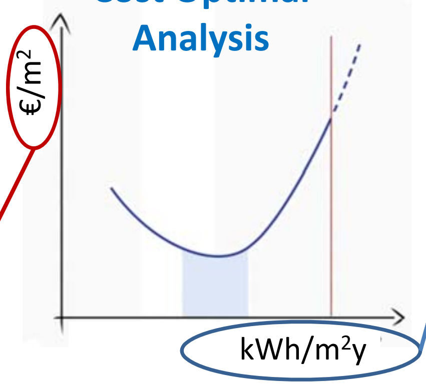
TOOL
Cost-optimal methodology

Customer's awareness

Energy and economic evaluation

Achieve the **energy performance level** which leads to the **lowest cost** during the estimated economic lifecycle [EPBD recast 2010/31/EU]

Cost Optimal Analysis



Global cost

Primary Energy Consumption

$$C_g(\tau)=C_I+\sum_j\left[\sum_{i=1}^{\tau}\left(C_{a,i}(j)\times R_d(i)\right)-V_{f,\tau}(j)\right]$$

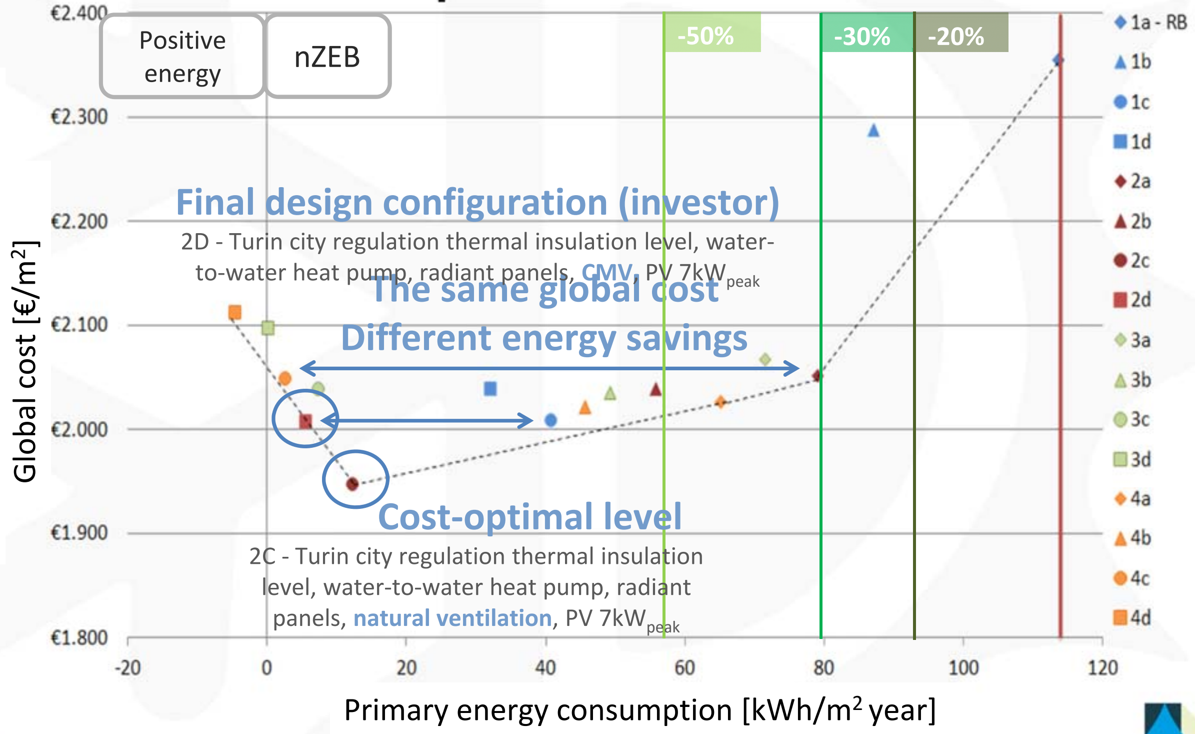
Investment costs

Energy costs **Maintenance costs** **Replacement costs**

Final value

Energy uses for:
- Space Heating
- Space Cooling
- Ventilation
- DHW
- Lighting
- Appliances

The cost-optimal level



Orientation

As the preexisting rural building, the new volume is characterized by a mostly glazing southern façade while the northern one presents little windows.

Space distribution

Rooms are located to maximize indoor comfort during use; the living room, the kitchen and the master bedroom facing South, while a single bedroom, the study and the bathrooms facing North.

Design strategies

THERMAL INERTIA

INSULATION

AIR TIGHTNESS

SOLAR CONTROL

CLIMATE MITIGATION

VENTILATION

Thermal inertia

Insulation

Insulation

Insulation

Air tightness

Air tightness

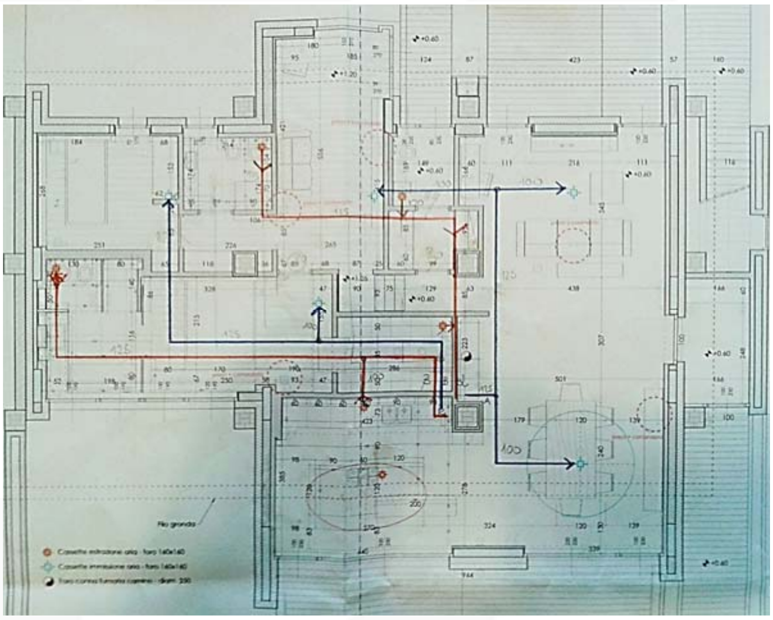
Solar control

On the southern side windows are equipped with exterior horizontal overhangs carefully designed in order to maximize useful solar gains in winter and to avoid overheating in summer.

Climate mitigation

The arrangement of some trees and hedges was accurately studied with the dual function of acoustic protection and solar control.

Controlled mechanical ventilation



Conclusions

CorTau House

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Energy goal + Design goal + Economic goal + Quality + Comfort

- Energy goal → **nZEB**
- Design goal → **Enhancement of distinctive rural features**
- Economic goal → **Cost control**, **Cost-optimal methodology as design tool**
- Quality → **Materials**, **Design team**, **Skilled manpower**
- Comfort → **IAQ**, **Thermal comfort**, **Humidity control**

Designing and building an **nZEB** is **economically viable** taking into account the **costs incurred** during the **whole building life cycle**

The purpose of wrapped **control of costs** and **nZEB targets** influence **design and energy configurations** and their evolution.