A successful nZEB story in Europe

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Why do we talk about nZEB?

1997:Kyoto Protocol | **2008: EU Climate and Energy Package** | **Target 20-20-20** | **Energy Roadmap 2050**

in Europe

2002 **Directive 2002/91/EC** of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings - **EPBD**

in Italy

2005 **Decreto Legislativo 19 agosto 2005, n. 192**: "Attuazione della direttiva 2002/91/CE relativa al rendimento energetico nell'edilizia"

2010 **Directive 2010/31/EU** of the European Parliament and the Council of 19 May 2010 on the energy performance of buildings (recast) – **EPBD recast**

2013 **Legge 3 agosto 2013, n. 90:** "Conversione in legge, con modificazioni, del decreto-legge 4 giugno 2013, n. 63, recante disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonché altre disposizioni in materia di coesione sociale"

EPBD recast introduced the nZEB concept

EPBD recast

Article 2.2

*'**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**, including energy from renewable sources produced on-site or nearby*

Article 2.4

*'**energy performance of a building**' means the calculated or measured amount of energy needed to meet the energy demand associated with a **typical use of the building**, which includes, inter alia, **energy used for heating, cooling, ventilation, hot water and lighting***

Article 2.14

***'cost-optimal level' means the energy performance level which leads to the lowest cost during the estimated economic lifecycle** […]*

Article 4.1

***Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels**. […].*

nZEB

>> energy performances

≈0 energy needs

≈100% of energy needs renewable energy

EPBD recast

Nearly-zero energy building (nZEB)

a building that has a very high energy performance whose **nearly-zero or very low amount of energy** required should be covered to a very significant extent by energy from **renewable sources**, including energy from renewable sources produced on-site or nearby

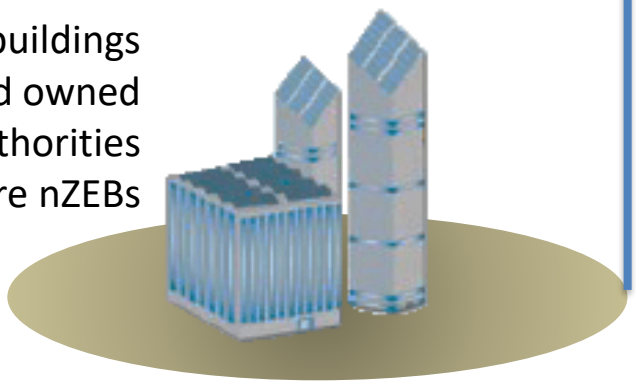
Energy performance of a building

calculated or measured amount of energy needed to **meet the energy demand associated with a typical use of the building**, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting

DISPOSITIONS

31 December 2018

new buildings occupied and owned by **PUBLIC** authorities are nZEBs



31 December 2020

ALL new buildings are nZEBs

What does nZEB mean?

nZEB

Zero Energy

Which "energy"?

Balance between the renewable energy produced on-site and the building's energy uses **(LOAD/GENERATION balance)**

← **SITE** Energy

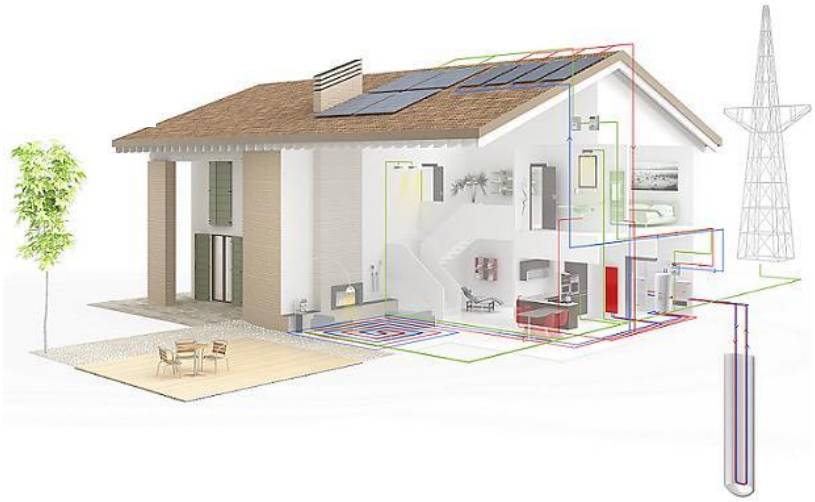
PRIMARY Energy → Balance between the renewable energy produced/bought and the building's energy uses **(IMPORT/EXPORT balance)**

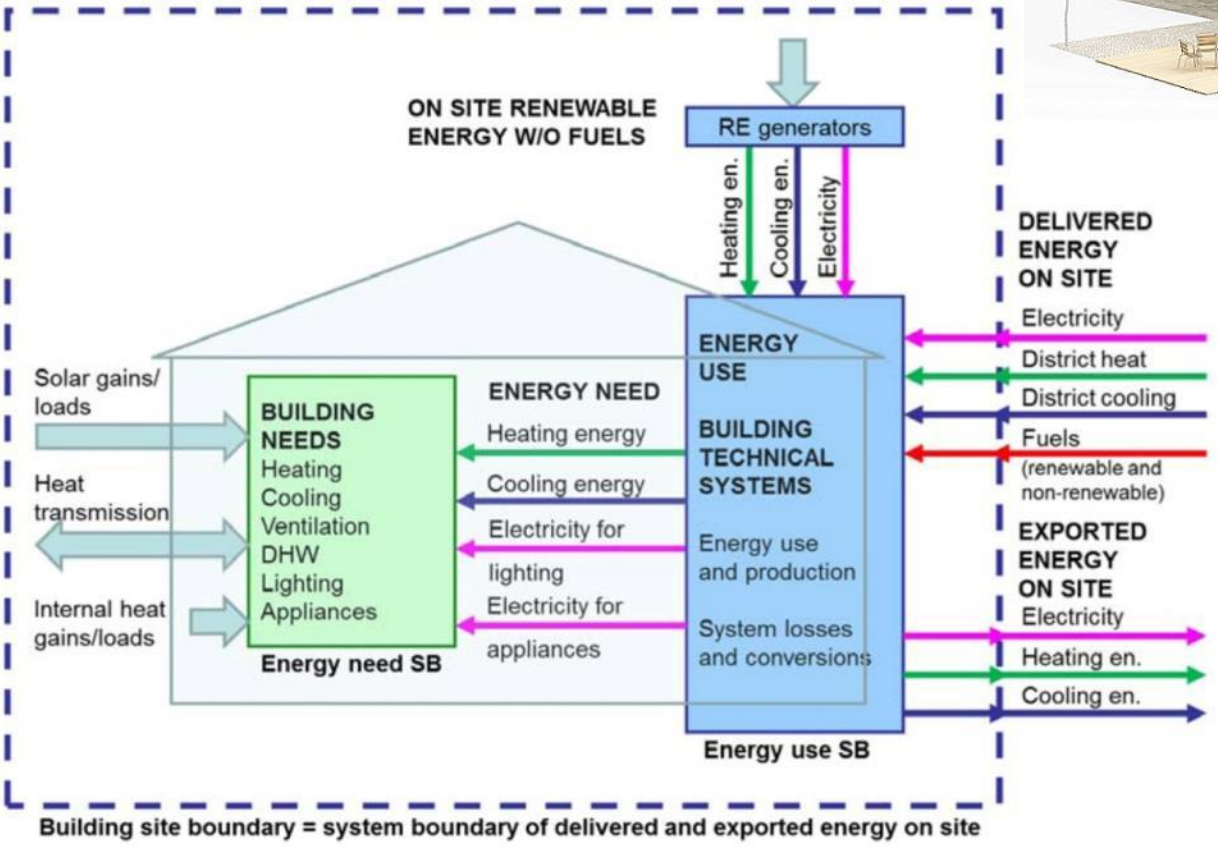
Balance between the **incomes** due to renewable energy production and the building's energy **costs** ← Energy **COST**

Energy **EMISSIONS** → Balance between the **emissions** credits gained by producing renewable (zero emissions) energy and the CO_2 emissions related the building's energy uses

Boundary conditions

Energy uses — Energy from renewable sources





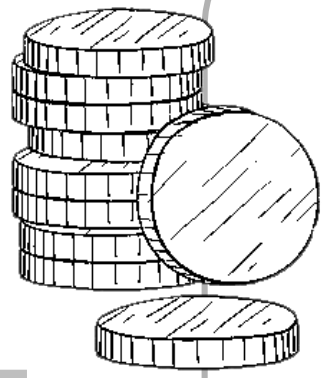
Energy needs for:

- Heating
- Cooling
- Ventilation
- DHW
- Lighting
- Appliances

Project assessment

DESIGN TEAM

- ✓ Building designer
- ✓ Energy consultant
- ✓ Economic evaluator



ECONOMIC FEASIBILITY

COST CONTROL

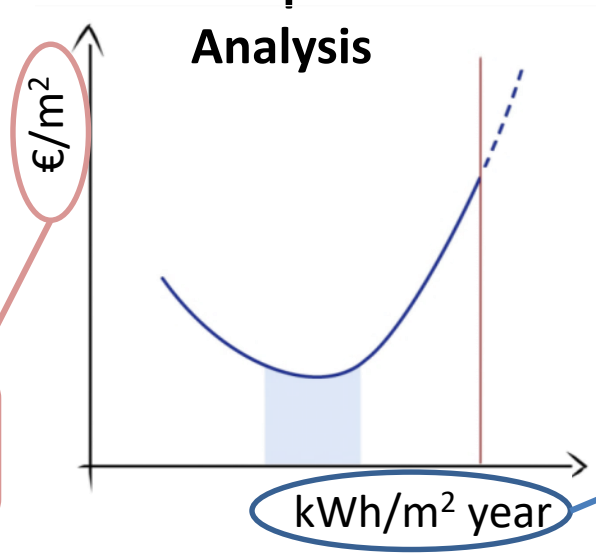
Evaluation between preliminary and final design

Customer's awareness

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

Cost-optimal analysis

Energy performance

Global cost

Energy needs for:

- Heating
- Cooling
- Ventilation
- DHW
- Lighting
- Appliances

Investment costs

Energy costs

Maintenance costs

Replacement costs

Final value

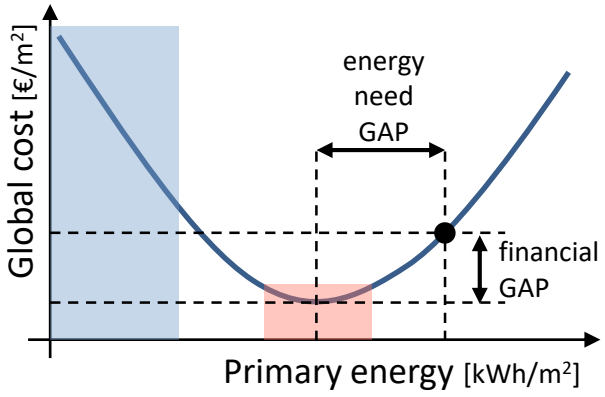
$$C_g(\tau) = C_I + \sum_j \left[\sum_{i=1}^{\tau} \left(C_{a,i}(j) \times R_d(i) \right) - V_{f,\tau}(j) \right]$$

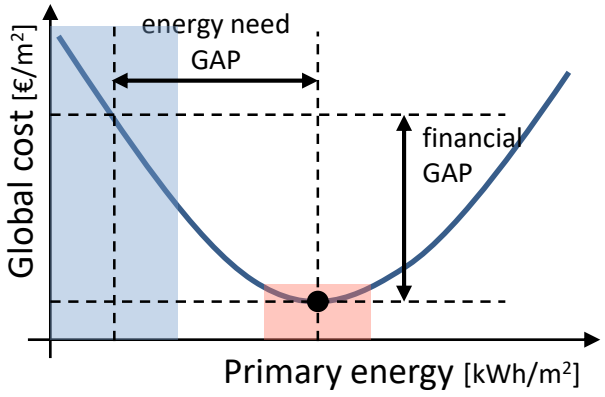
EPBD recast: expected outcomes

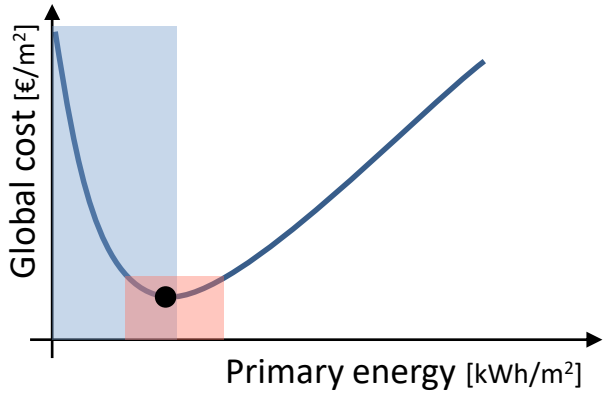
- **Minimum** energy performance requirements by law

Cost-optimal performance level

nearly Zero Energy performance level







EPBD

Minimum energy requirements are set without considering cost-optimal level nor nZEB level

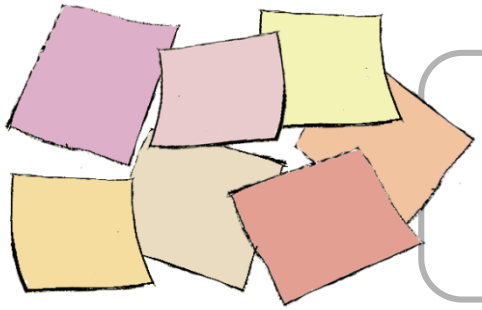
EPBD recast

Minimum energy requirements are cost-optimal; nZEB requirements are set but are not cost-optimal

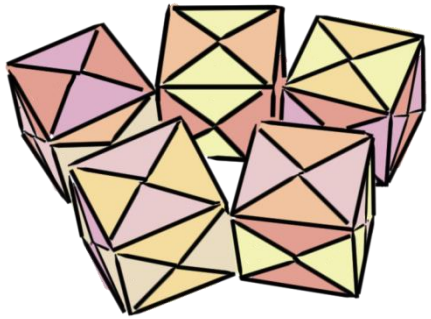
2021

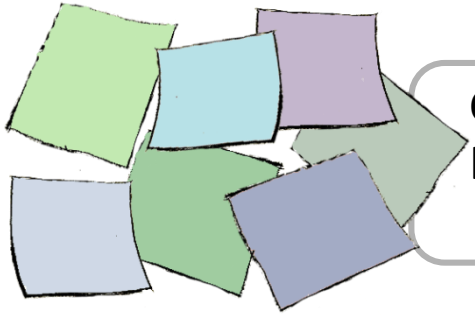
Minimum energy requirements are cost-optimal and coincident with nZEB level

Energy Efficiency Measures (EEMs) and packages

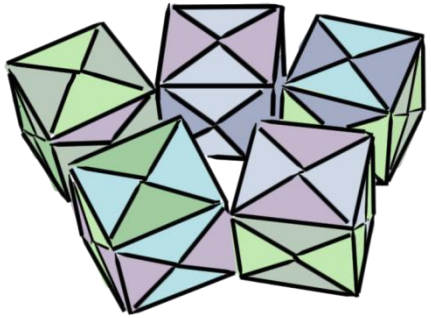


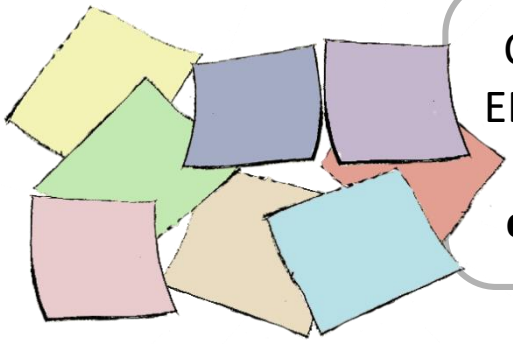
Combination of **building envelope** EEMs



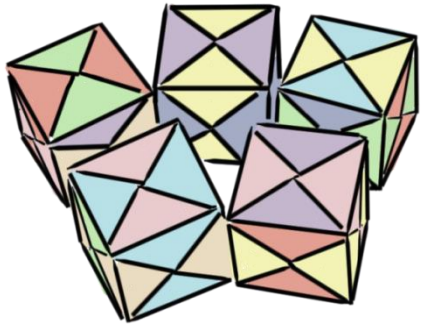


Combination of **building system** EEMs



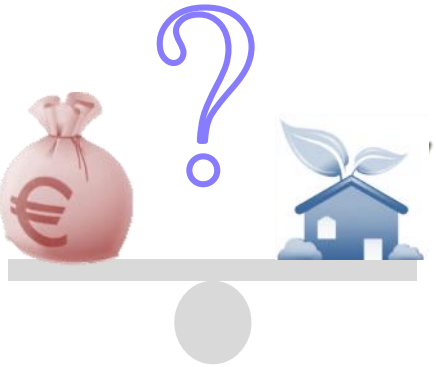


Combination of EEMs that exploit **renewable energy sources**



PACKAGES OF EEMs

Which combination leads to the cost optimal level?

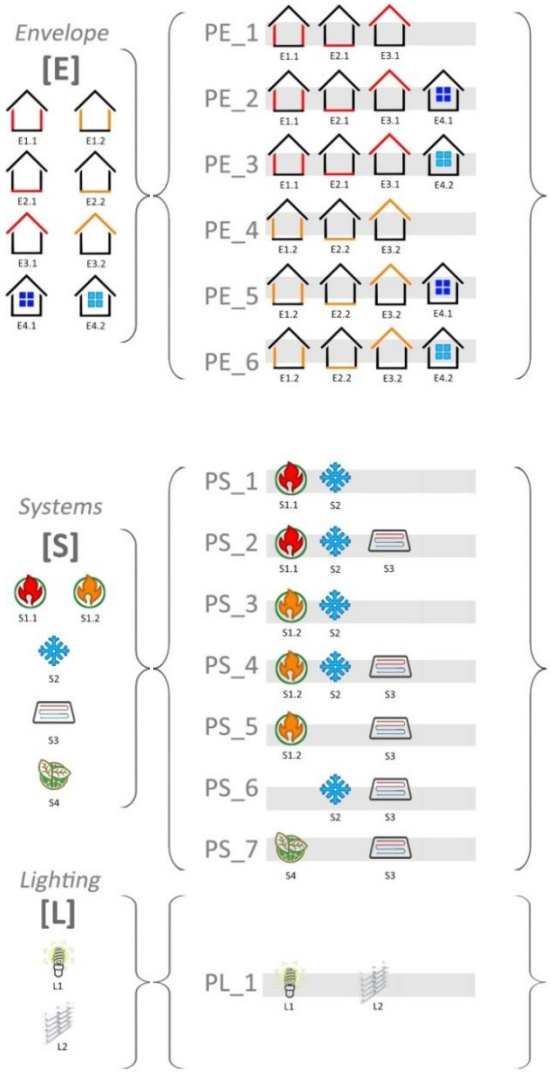


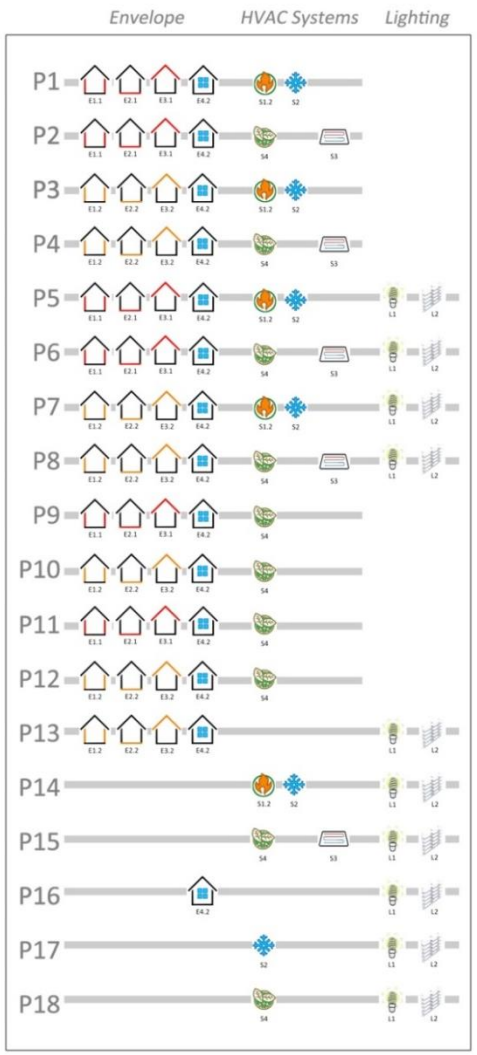
Energy Efficiency Measures (EEMs) and packages

Measures affecting **E**nvelope components

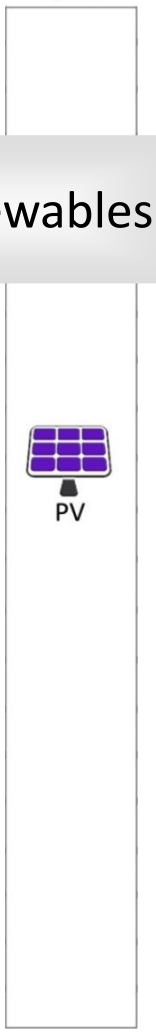
Measures affecting HVAC **S**ystems

Measures affecting the **L**ighting system

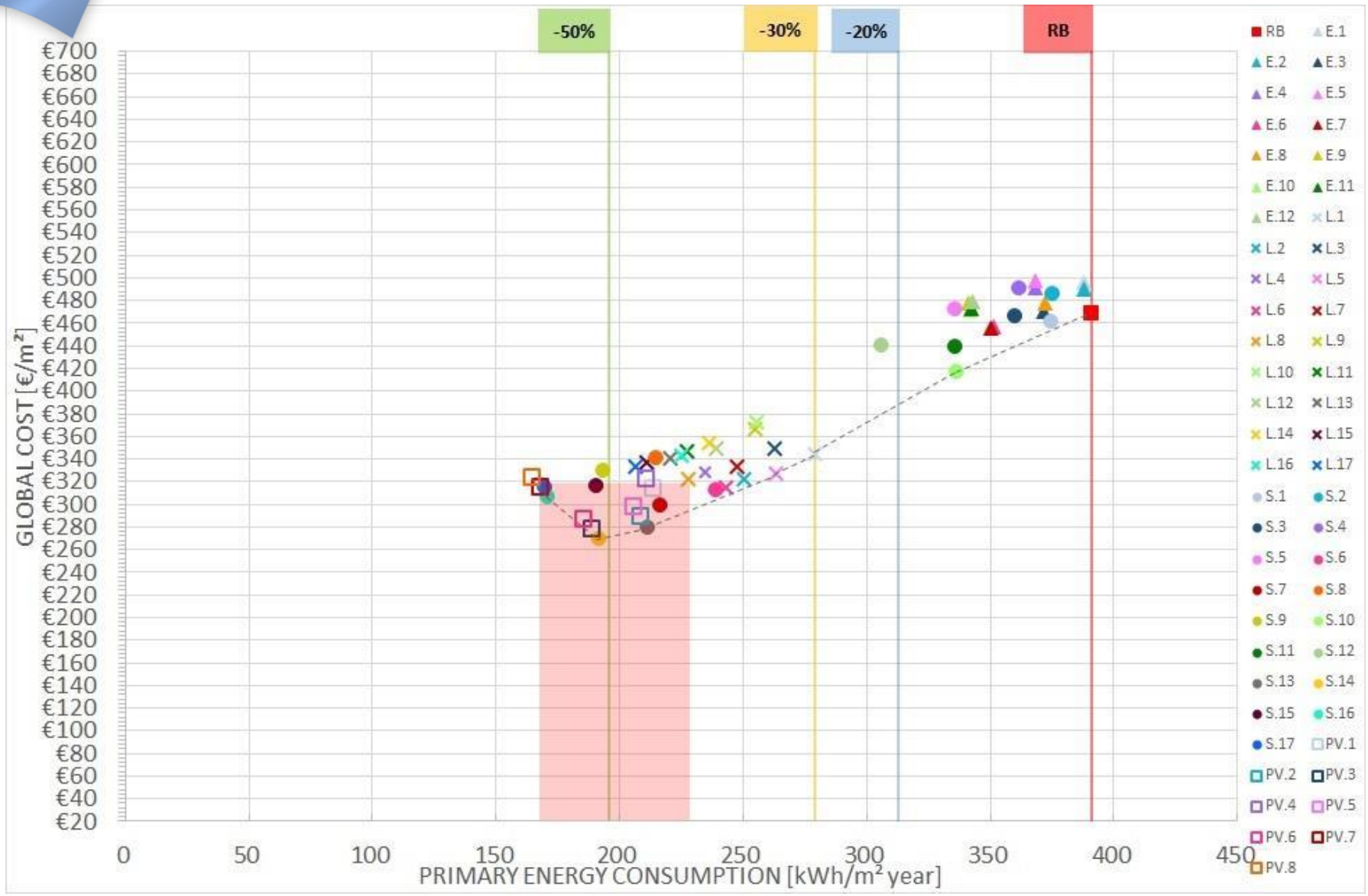




Renewables



Cost Optimal Graph



CASE STUDY

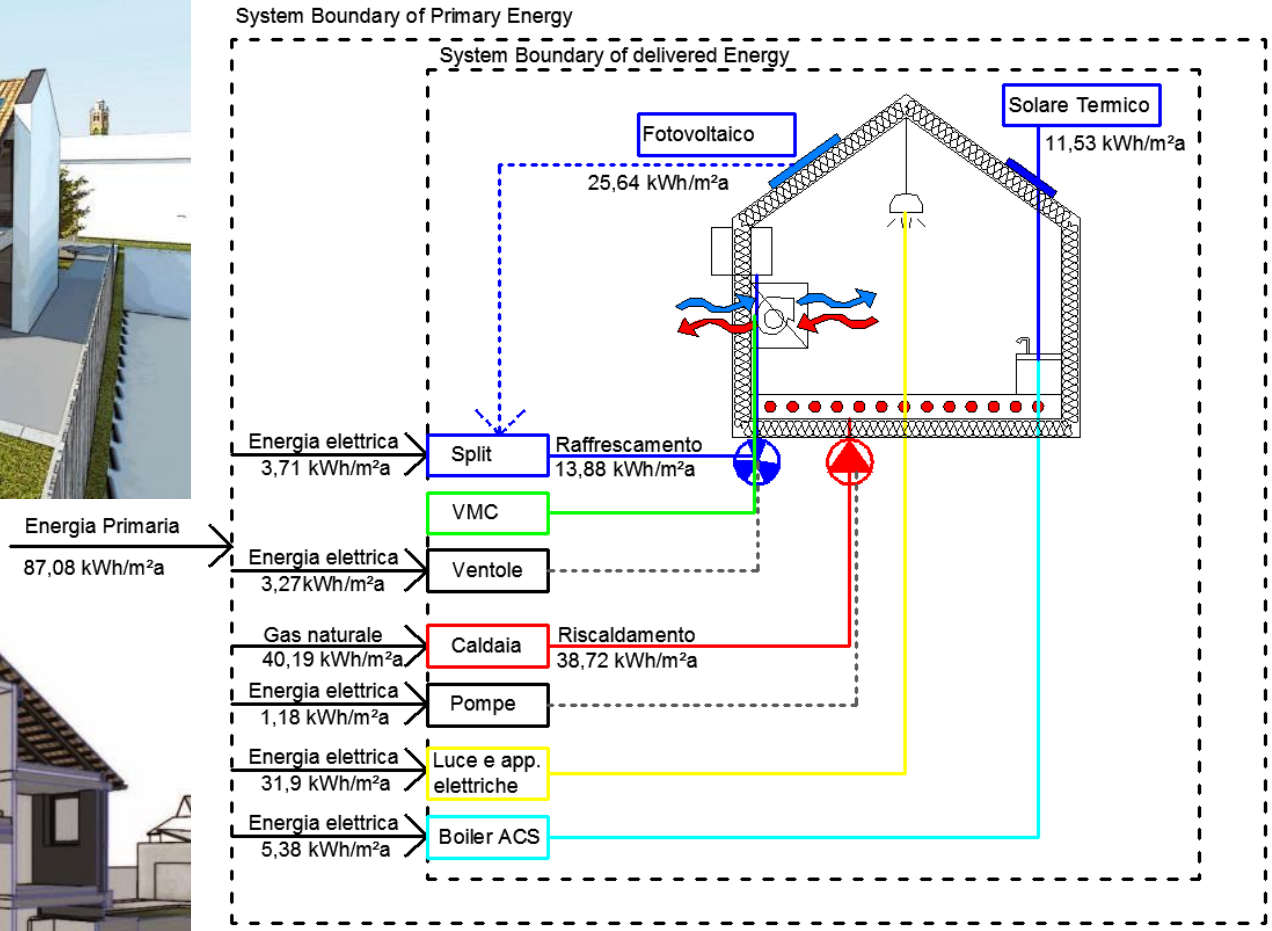
CorTau House in Piedmont (Italy)

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

nZEB

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

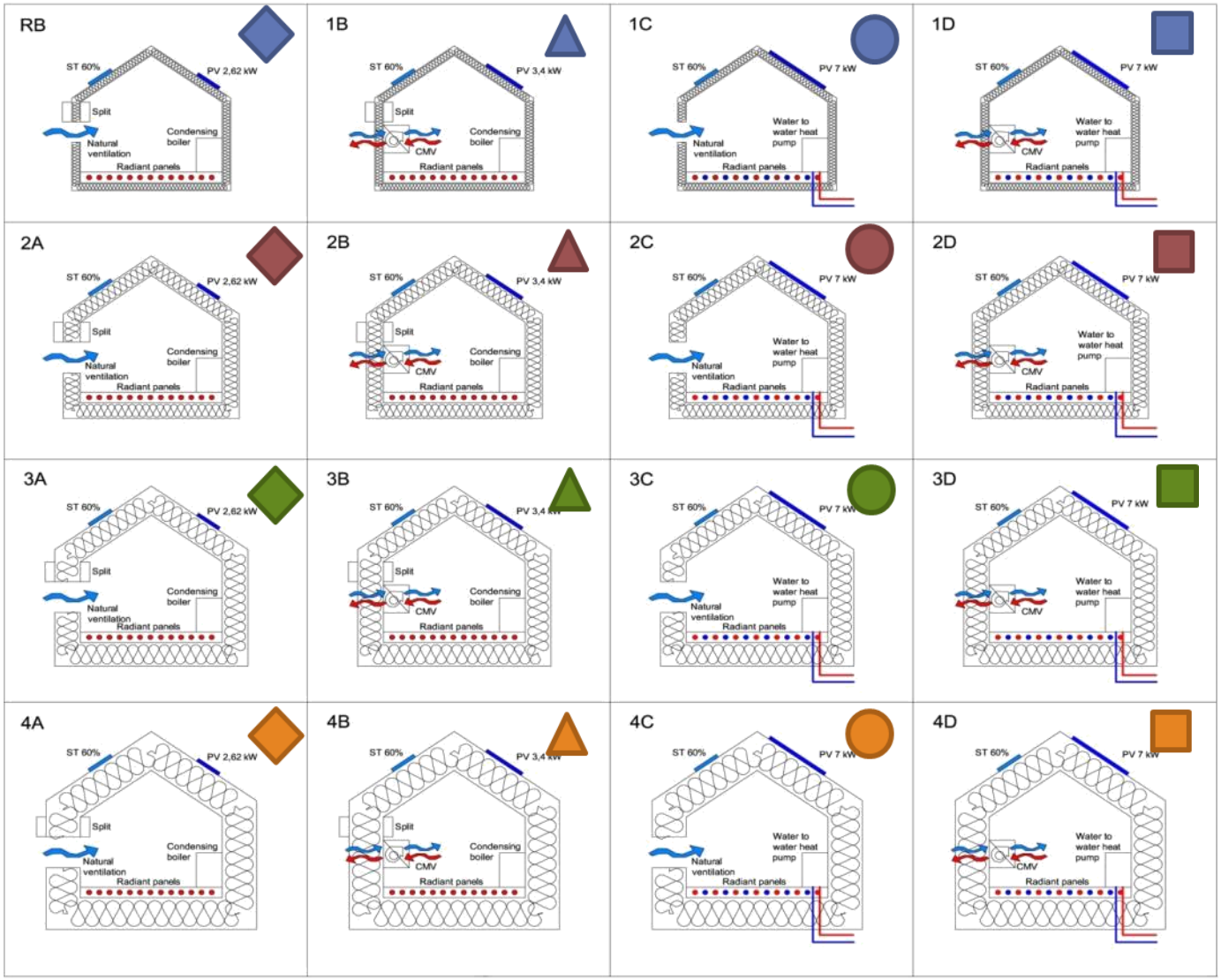
CorTau House: *first* concept



Preliminary design phase
Basic HVAC System
Energy Fluxes

CorTau House in Piedmont (Italy)

NATIONAL LEVEL	RB	1B	1C	1D
TURIN'S REGULATION LEVEL	2A	2B	2C	2D
PASSIVHAUS LEVEL	3A	3B	3C	3D
CLIMATEHOUSE GOLD LEVEL	4A	4B	4C	4D



Matrix of EEMs

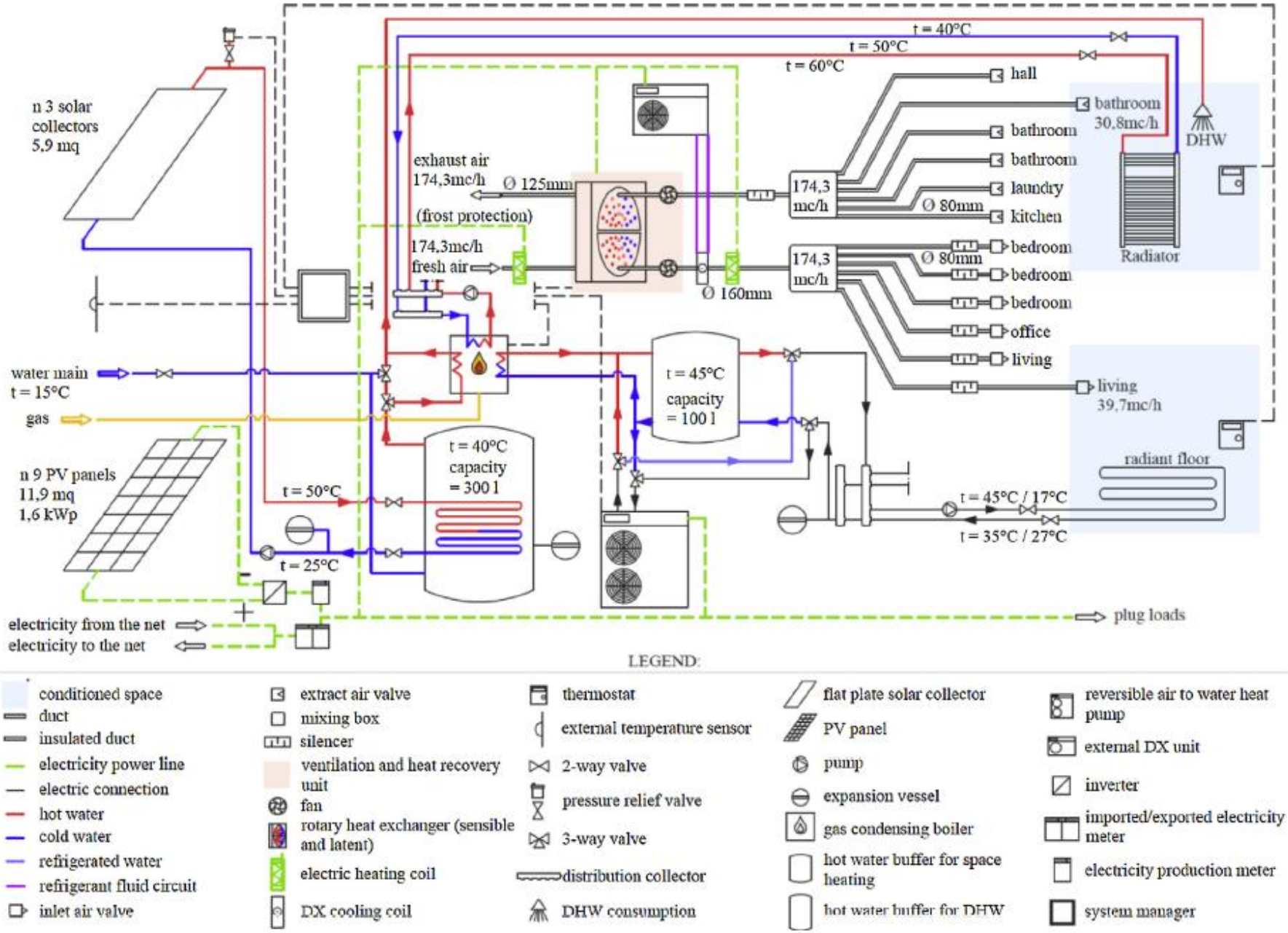
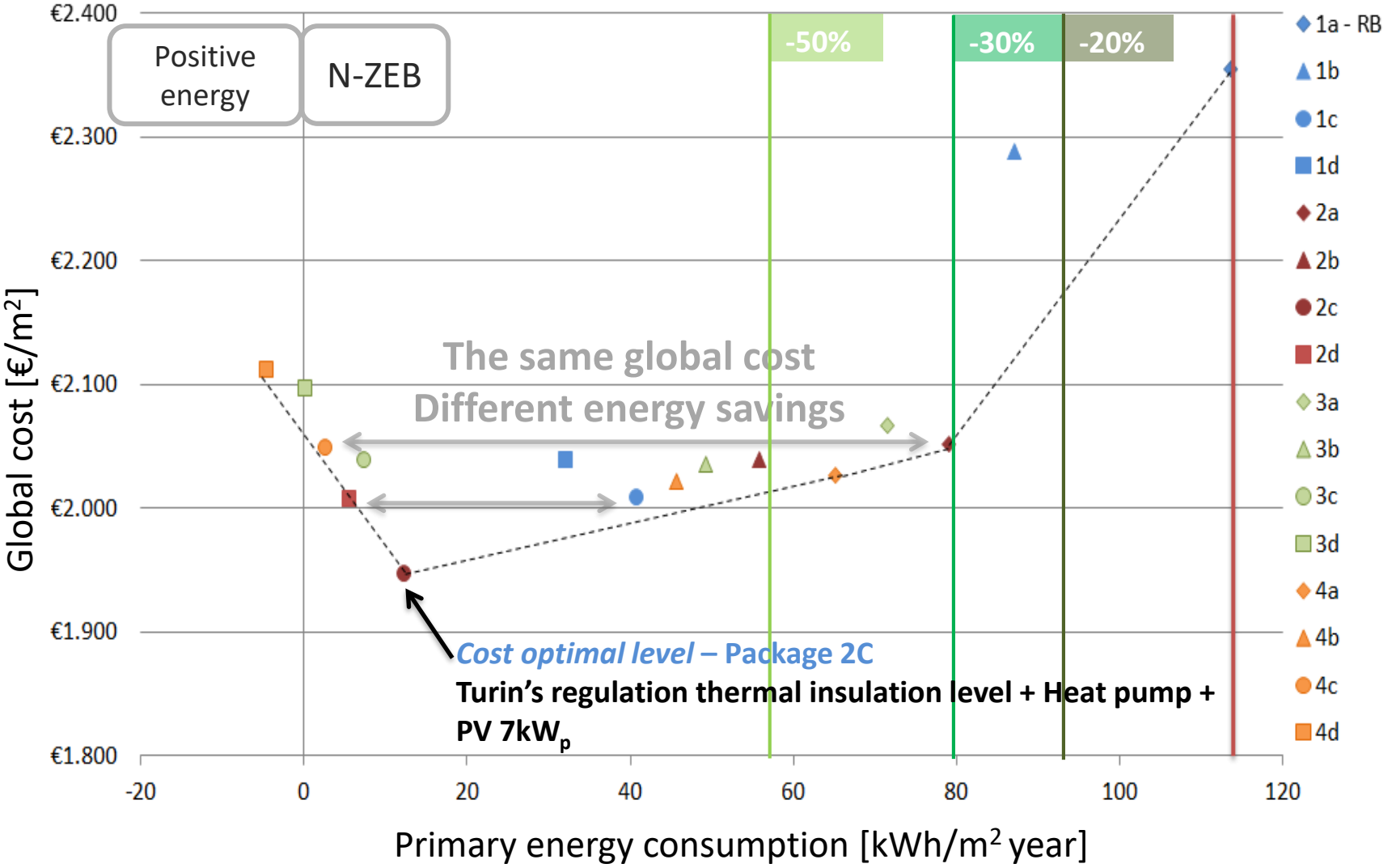


Fig. 3. Layout of the building technical system 1 (BTS1).

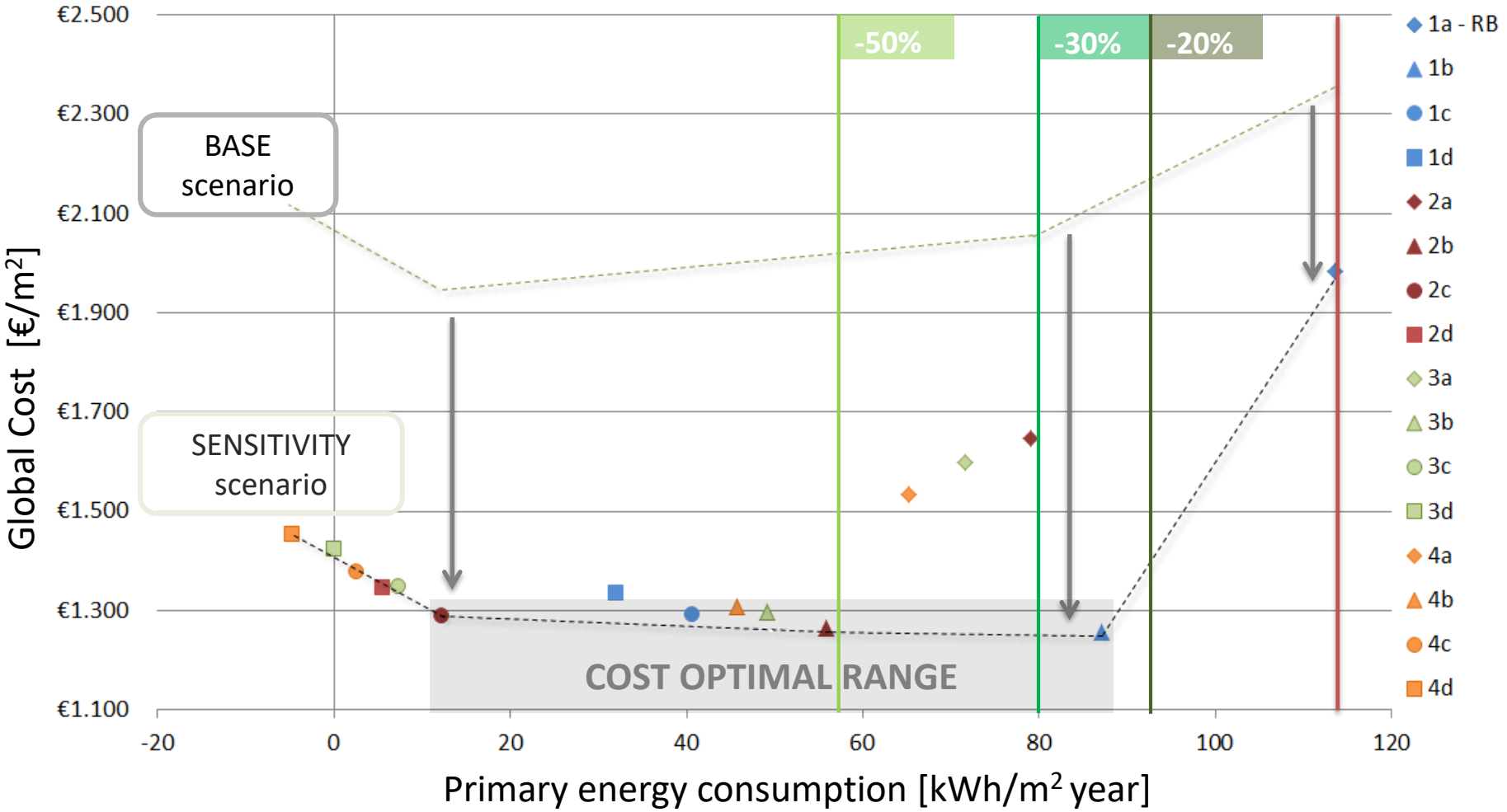
CorTau House in Piedmont (Italy)

Cost Optimal Curve



CorTau House in Piedmont (Italy)

Sensitivity analysis: national tax deductions
- **65%** → Eco-bonus
- **50%** → Refurbishment



CorTau House in Piedmont (Italy)

Construction site phases

THANK YOU FOR YOUR ATTENTION

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TEBE
TECHNOLOGY ENERGY BUILDING ENVIRONMENT

REHVA

Federation of European Heating, Ventilation and Air Conditioning Associations