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neZEH
NEARLY ZERO ENERGY HOTELS

www.nezeh.eu

nZEB refurbishment of Italian hotel buildings

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Energy Department - Politecnico di Torino

REHVA
Federation of European Heating, Ventilation and Air-conditioning Associations

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TECHNICAL UNIVERSITY OF CRETE (TUC)
ENVIRONMENTAL ENGINEERING DEPARTMENT
RENEWABLE AND SUSTAINABLE ENERGY SYSTEMS LAB

UNWTO

Network of European Regions for a Sustainable and Competitive Tourism
NECSTouR

REHVA
Federation of European Heating, Ventilation and Air-conditioning Associations

ENERGIES 2050

Istituto Superiore sui Sistemi Territoriali per l'Innovazione

SUST

ABMEE

creara
ESPECIALISTAS EN EFICIENCIA Y AHORRO ENERGÉTICO

EIHP

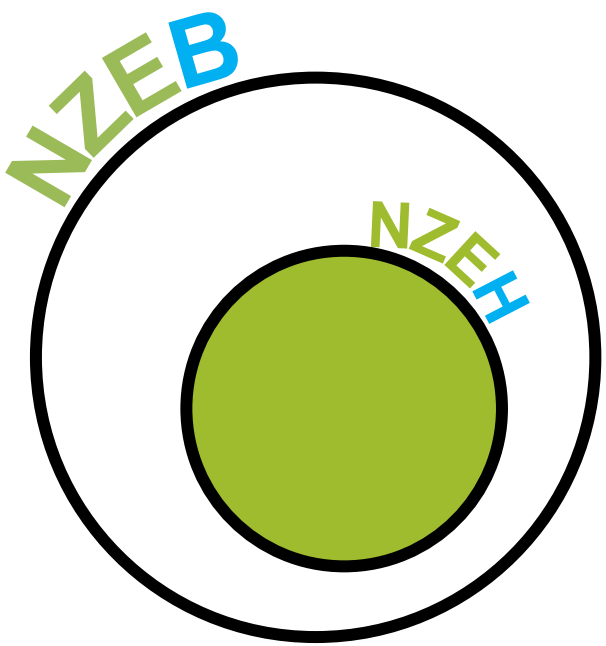
Nearly Zero Energy Building

nearly Zero Energy Building

- High Energy performance
- Low energy demand
- Residual energy demand coverd by RES

> energy performance	energy demand ≈0	**RES** ≈100% del fabbisogno

Nearly Zero Energy Hotel



from building → to hotel

Limit of energy performance related to «European Cliamtic Zones»

Indicator: Primary Energy

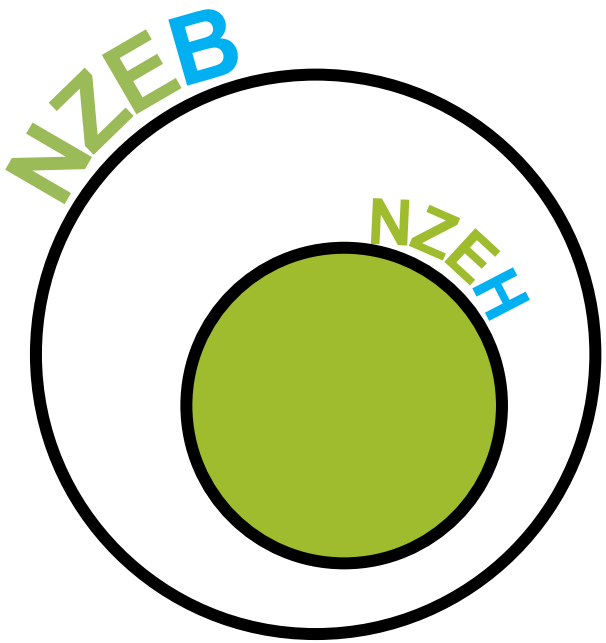
What is it considered ?

«hosting functions»

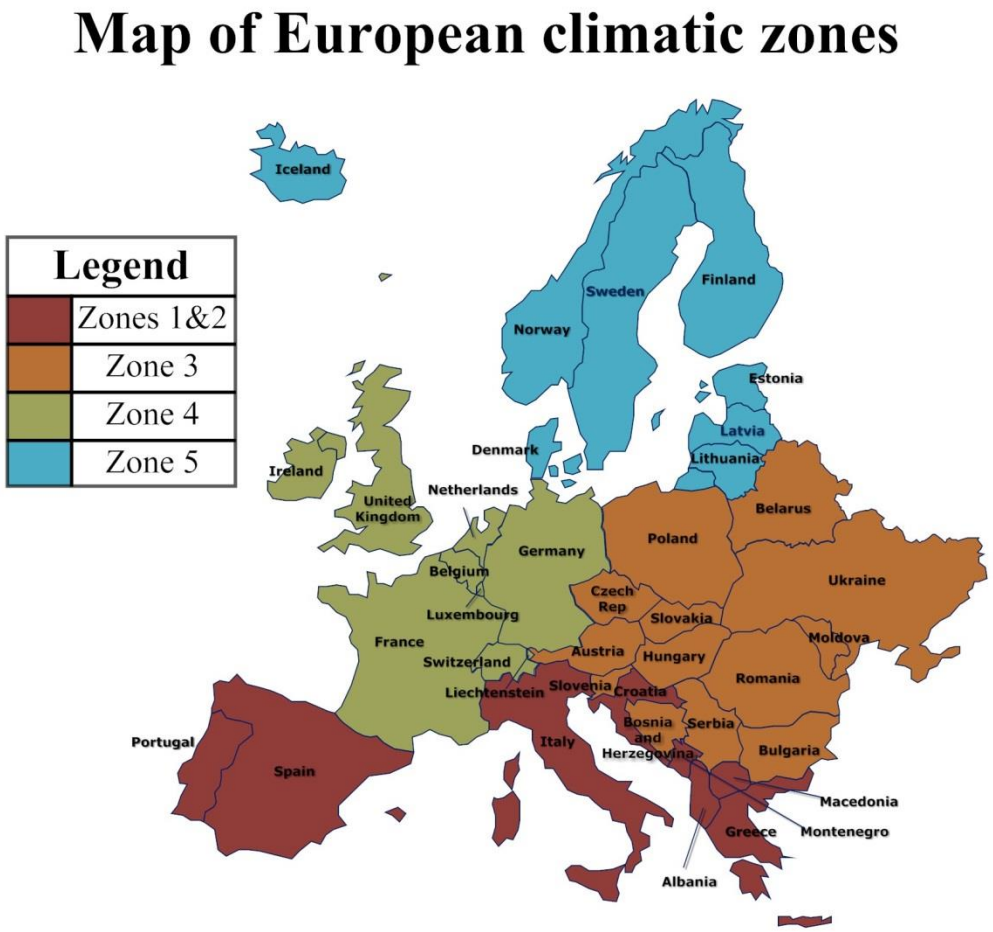
Basic funtions

- including energy uses for rooms, offices, hall
- not included extra-services: spa, laudary, swimming pool, ect.

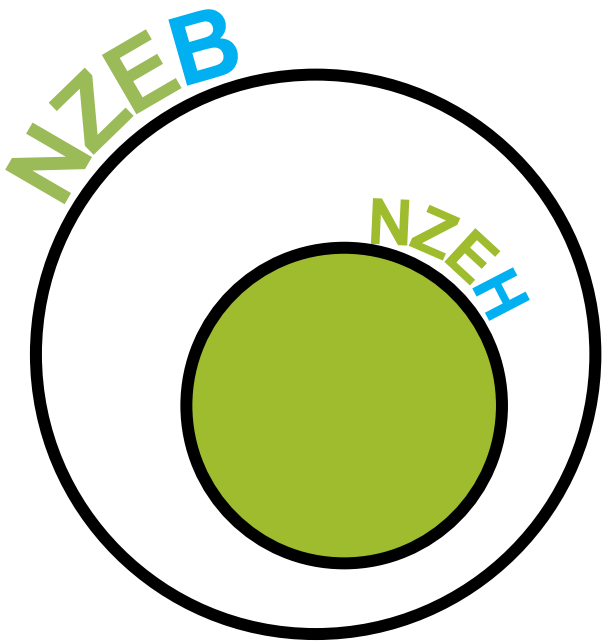
Nearly Zero Energy Hotel



Limit of energy performance related to «European Cliamtic Zones»



Nearly Zero Energy Hotel



Primary Energy Limit (for Italy)

≈ 70 kWh/m²year of primary energy

Considered final energy uses:

- Heating
- Cooling
- DHW
- Ventilation
- Lighting
- Electric equipments

Nearly Zero Energy Hotel

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Cost-optimal analysis

Energy performance

Global cost

Energy for:

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

Investment costs

Energy costs

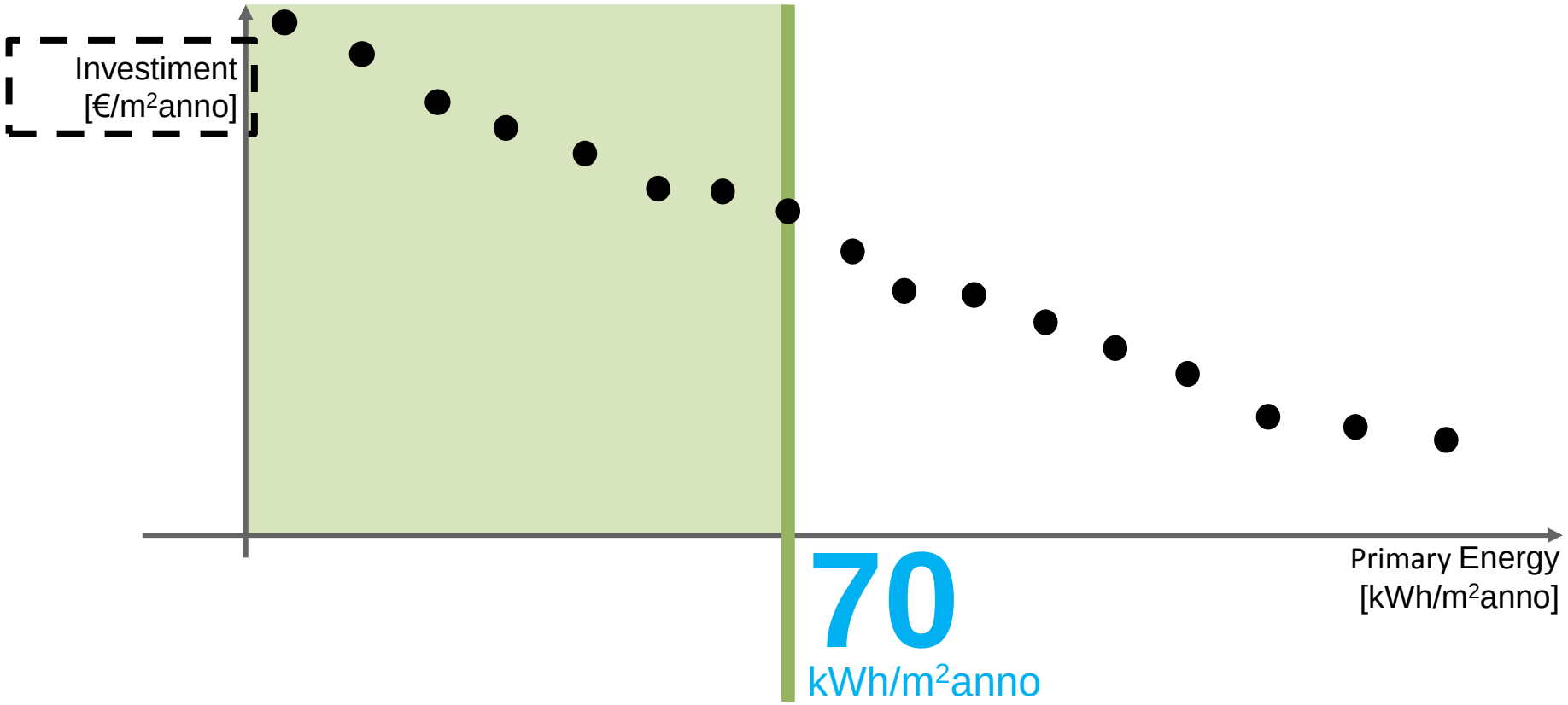
Maintenance costs

Replacement costs

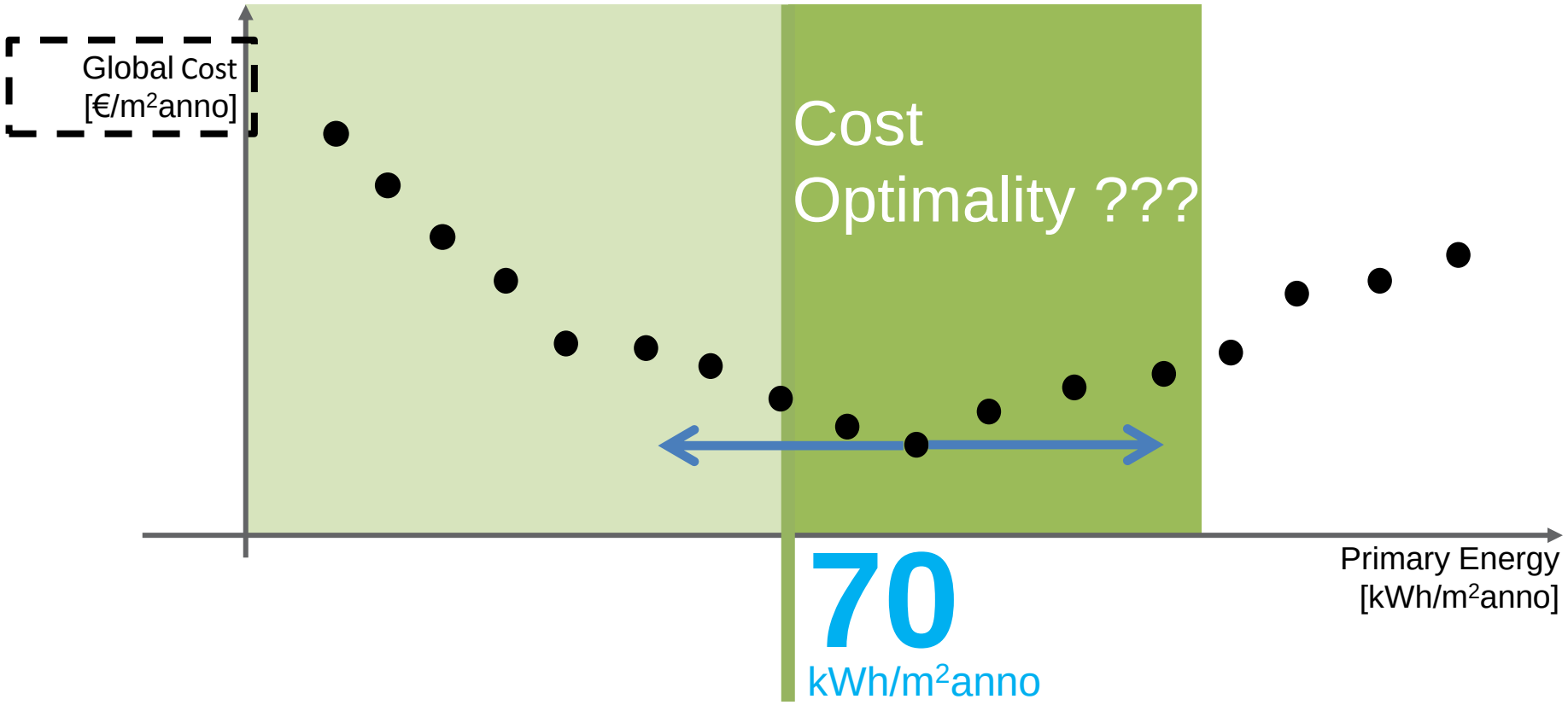
Final value

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

Nearly Zero Energy Hotel



Nearly Zero Energy Hotel



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1 Hotel Cairo

Category	3 stars
City	Turin
Number of beds	98
Year of construction	1933
Opening schedule	365 days/year
Facilities	gym
Occupancy	39% (average)
Energy carriers	natural gas and electricity

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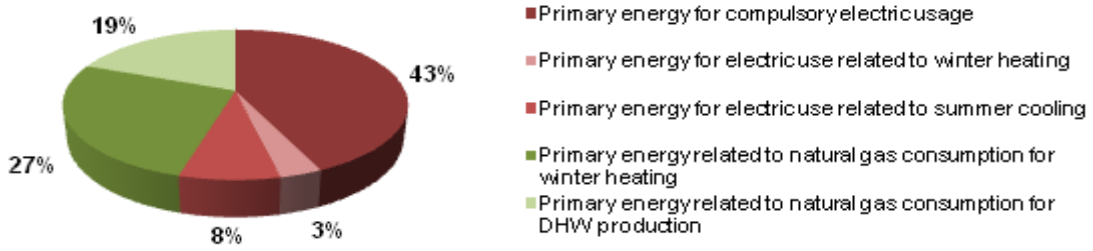
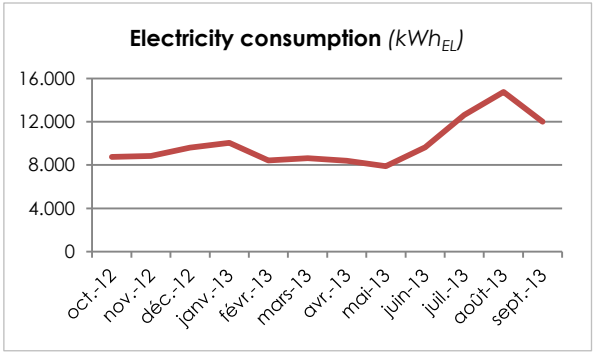
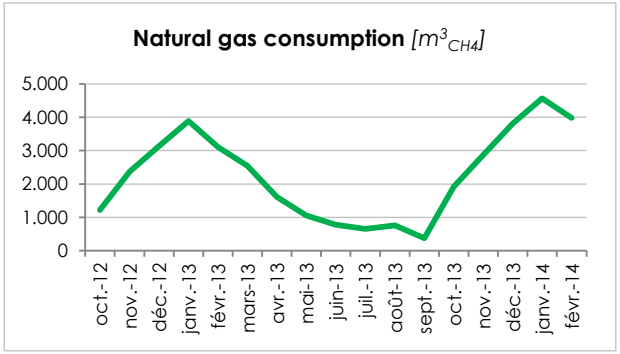
1 Hotel Cairo

Primary energy consumptions







Compulsory electricity uses (primary energy)	37,4 kWh$_p$/m^2 y
Electricity uses for heating (primary energy)	11,6 kWh$_p$/m^2 y
Electricity uses for cooling (primary energy)	27,3 kWh$_p$/m^2 y
Primary energy related to natural gas heating	91,2 kWh$_p$/m^2 y
Primary energy related to natural gas uses for DHW	65,9 kWh$_p$/m^2 y
TOTAL	**233,5 kWh$_p$/m^2 y**

Category	3 stars
City	Turin
Number of beds	98
Year of construction	1933
Opening schedule	365 days/year
Facilities	gym
Occupancy	39% (average)
Energy carriers	natural gas and electricity

info

ONLY FOR HOSTING FUNCTIONS !

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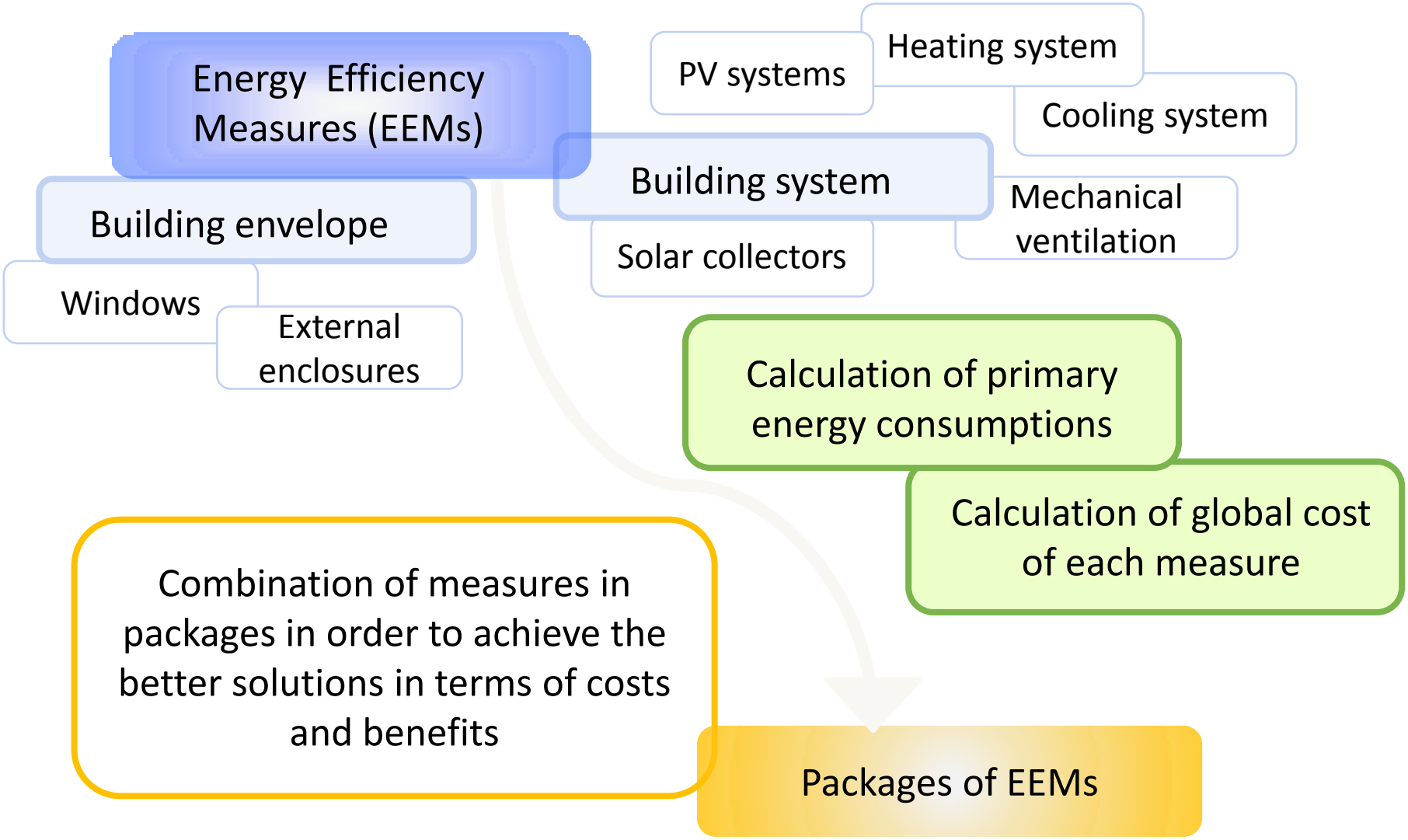

Conceptual approach

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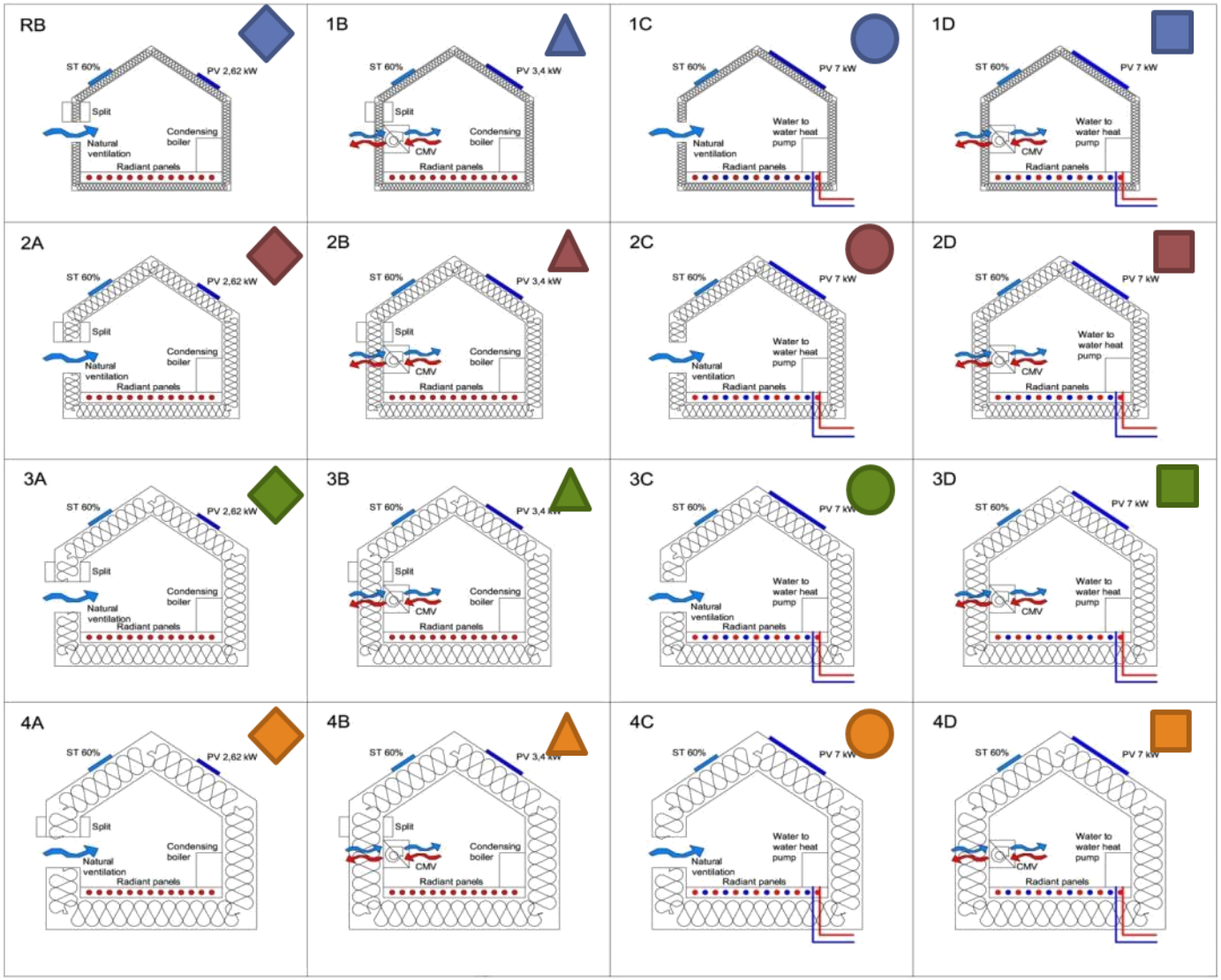
NATIONAL LEVEL	RB	1B	1C	1D
TURIN'S REGULATION LEVEL	2A	2B	2C	2D
PASSIVHAUS LEVEL	3A	3B	3C	3D
CLIMATEHOUSE GOLD LEVEL	4A	4B	4C	4D



Matrix of EEMs

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PACKAGES OF MEASURES

COMPONENT	ENERGY RETROFIT SOLUTION	ENERGY EFFICIENCY MEASURES	INVESTMENT COST [€]	ANNUAL COST [€/y]	RESIDUAL COST [€]	GLOBAL COST [€/m²]	EP_{GL} VALUE [kWh/m²y]		ENERGY EFFICIENCY CLASS
External walls	Insulating material into the cavity wall	U < 0,25 W/m²K	44.493,8		7.118,8				
Wall s to unheated spaces	Insulated false walls	U < 0,30 W/m²K	78.601,2		12.575,8				
Ceilings to unheated attic floor	Upper ceiling surface insulation	U < 0,26 W/m²K	26.725,9		4.276,0				
Ceilings to unheated basement floor	False ceiling	U < 0,26 W/m²K	15.273,2		2.443,6				
Windows	Replacement	U < 1,2 W/m²K	310.342,9		0,0				
Central heating system	Installation of district heating substations	Heat exchanger for heating (320 kW)	26.501,0	27.817,8	5.145,7	253,10	37,3	-86%	Class A
		Heat exchanger for DHW (180 kW)							
	Heat distribution and DHW system	Insulation of distribution system	27.223,5		4.355,6				
		Replacement of DHW storage (tank)	4.244,7		824,2				
	Heating control system	External probe	6.396,0		1.241,9				
		Installation of automatic valves controlled by thermostats in each dwelling							

Example package

Envelope EEMs
+
System EEMs

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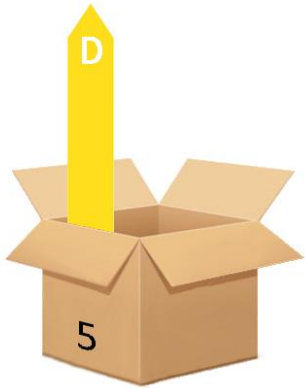
PACKAGES OF MEASURES

EP_{gl} = 61 kWh/m² (**-77%**)
Global cost = 231 €/m²



EP_{gl} = 76 kWh/m² (**-71%**)
Global cost = 234 €/m²

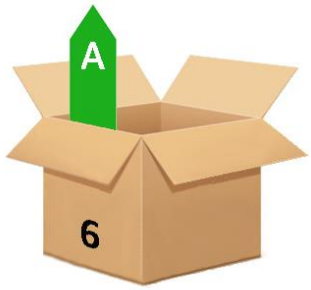
EP_{gl} = 94 kWh/m² (**-64%**)
Global cost = 264 €/m²

EP_{gl} = 160 kWh/m² (**-39%**)
Global cost = 379 €/m²

EP_{gl} = 212 kWh/m² (-20%)
Global cost = 399 €/m²

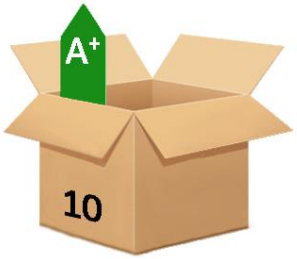
EP_{gl} = 59 kWh/m² (**-77%**)
Global cost = 269 €/m²

EP_{gl} = 45 kWh/m² (**-83%**)
Global cost = 410 €/m²



EP_{gl} = 37kWh/m² (**-86%**)
Global cost = 253 €/m²

EP_{gl} = 30 kWh/m² (**-89%**)
Global cost = 286 €/m²



EP_{gl} = 19 kWh/m² (**-93%**)
Global cost = 385 €/m²

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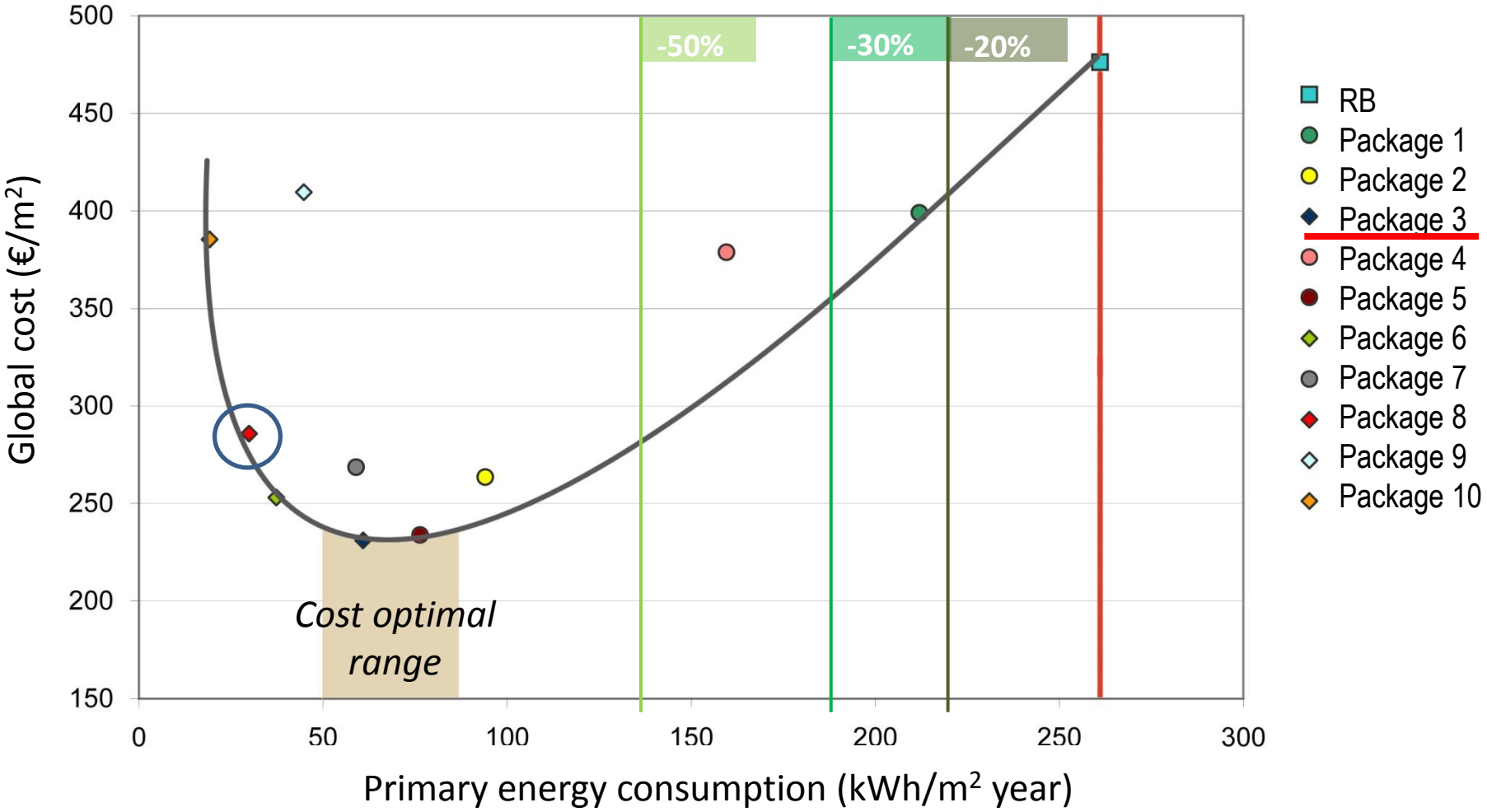
THE COST OPTIMAL CURVE



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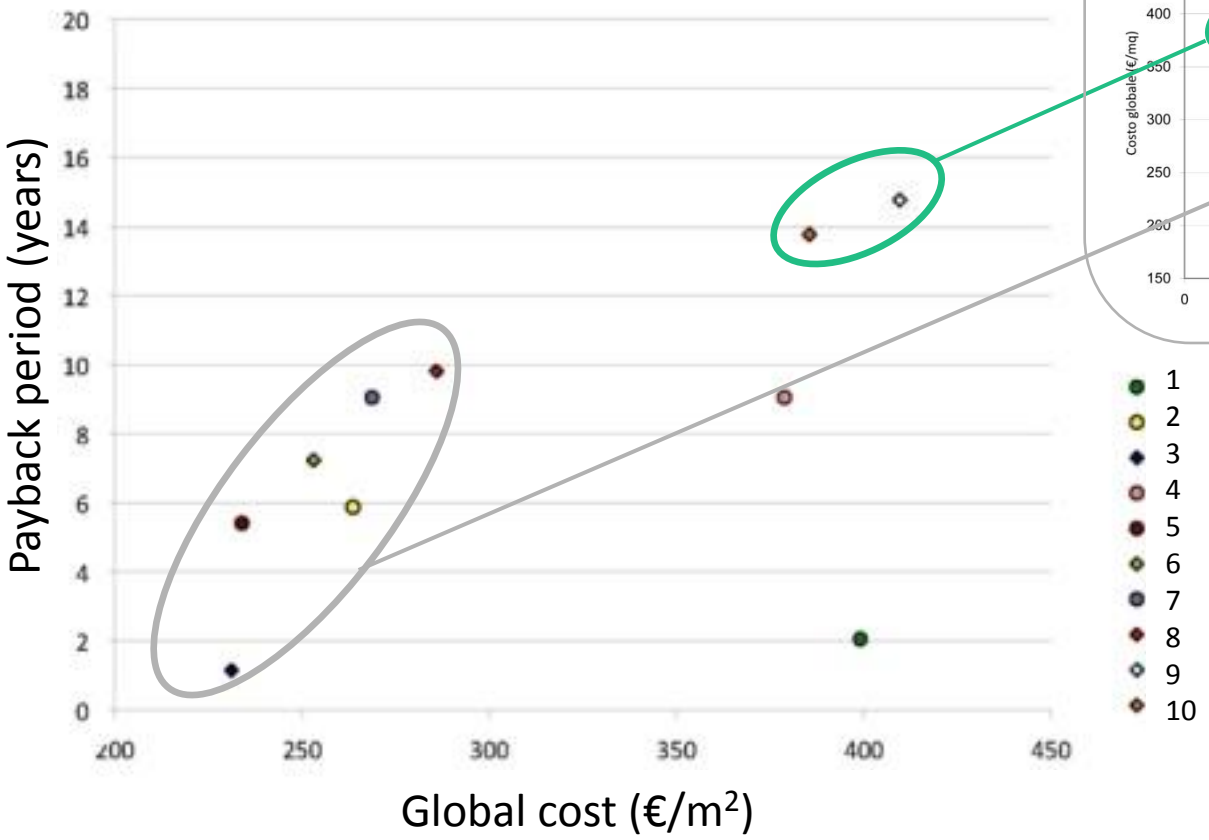
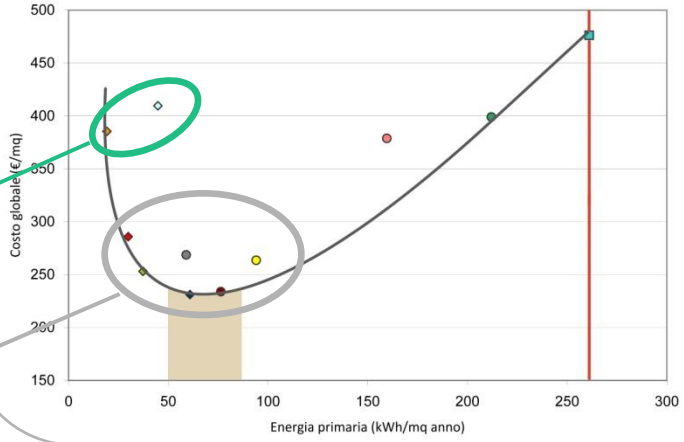
PAYBACK PERIOD

of the initial investment costs



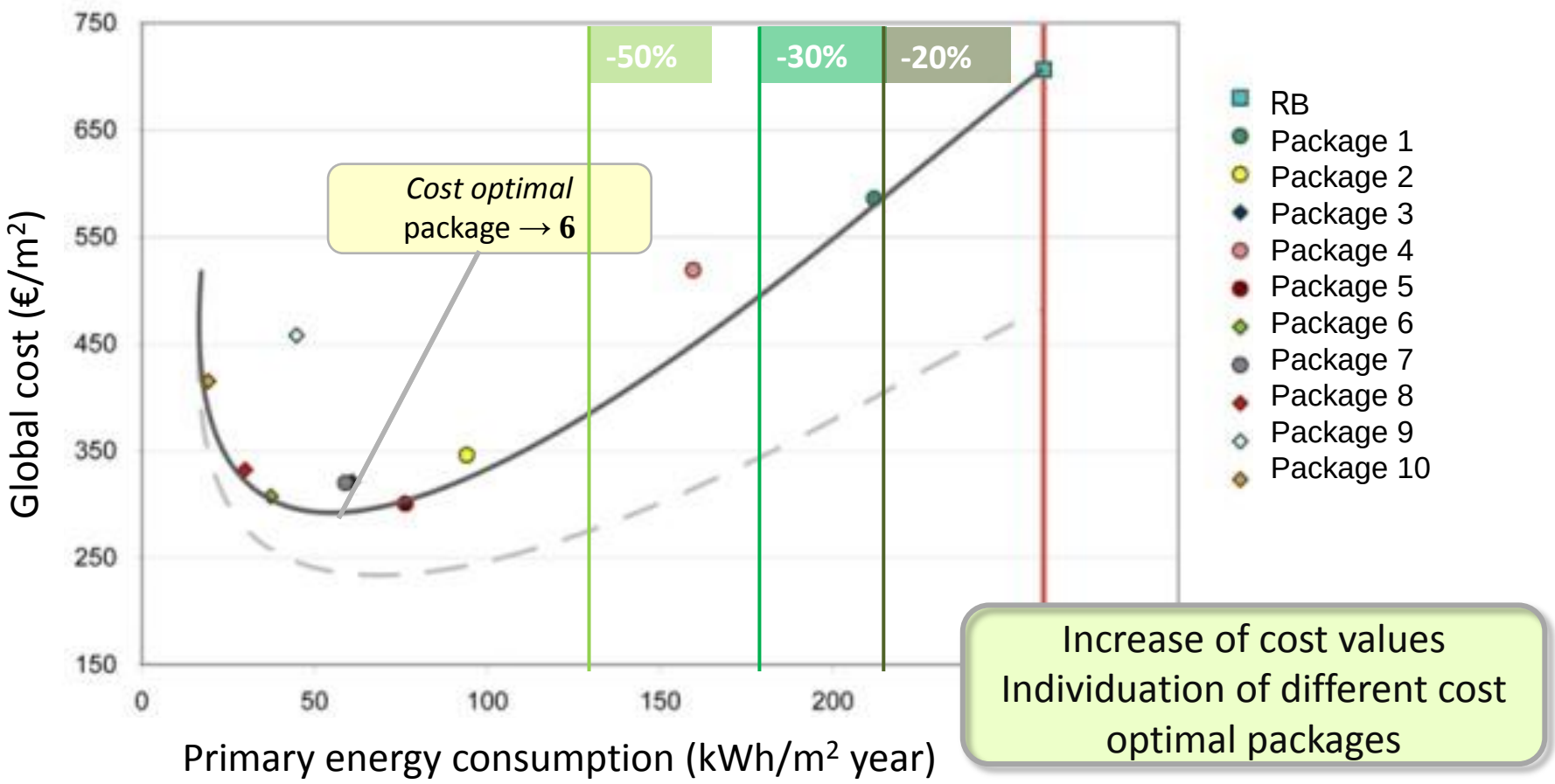
Referring to the *cost optimal curve*



Cost optimal packages present lower payback period than packages of high energy performance

SENSITIVITY ANALYSIS

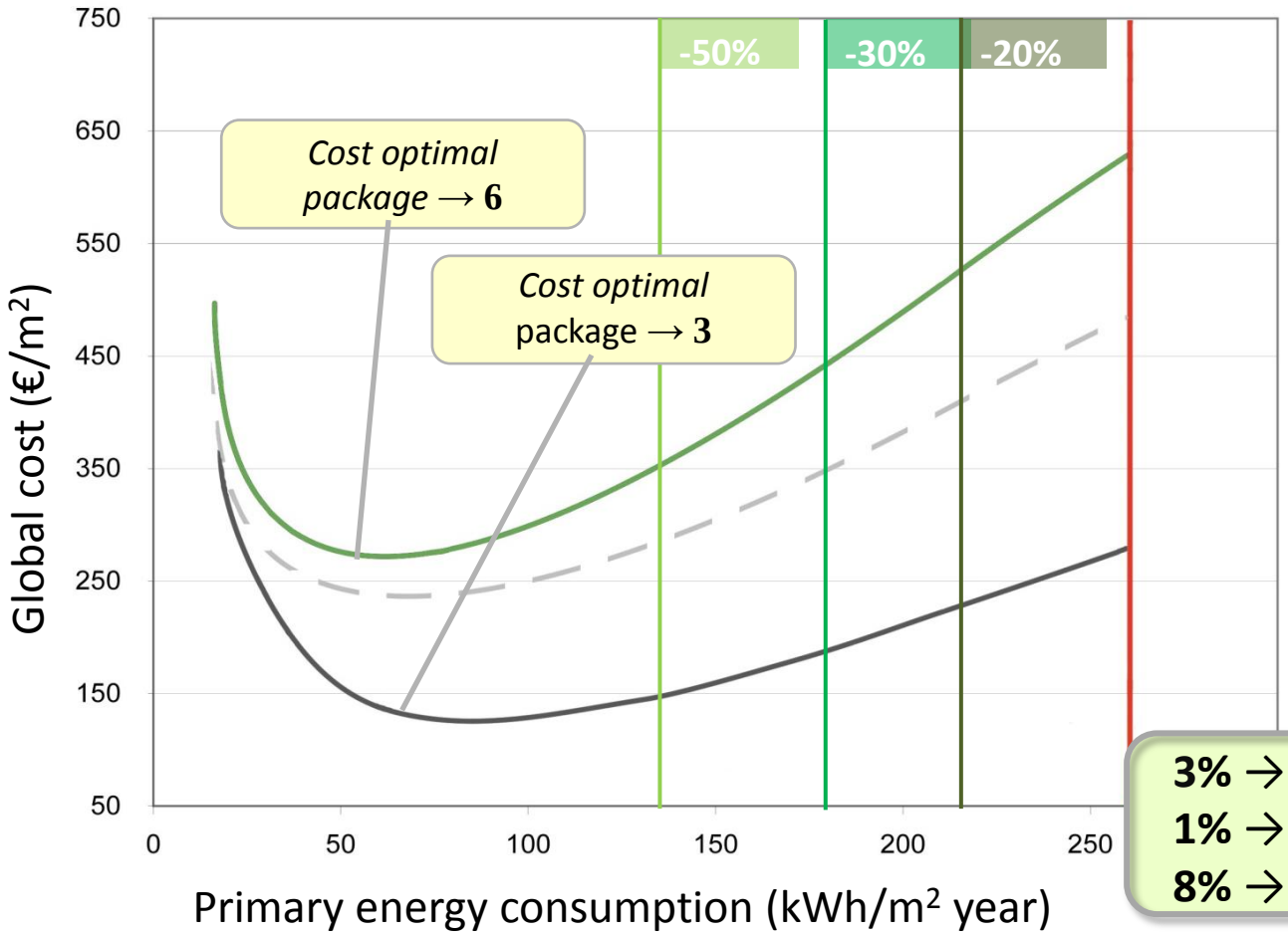
Scenario 1: increase of prices for all energy carriers used with an annual percentage rate of 3% (European Commission, EU energy trends to 2030, 2009)



Increase of cost values
Individuation of different cost optimal packages

SENSITIVITY ANALYSIS

Scenario 2: variation of the discount rate



Variation of:
energy costs
maintenace costs
replacement costs

3% → basic scenario
1% → economic viewpoint
8% → financial perspective

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1 Hotel Cairo

	Interventions	Annual economic saving [€]	Initial investment cost [€]	Reduction in CO_2 emissions [kg CO_2]	Priority*
maintenance	Consumption reduction of the restaurant appliances	1.148	0	13.665	-
	No stand-by consumptions in unoccupied rooms	1.670	0		
	Lower temperatures	2.239	0		

Maintenance of energy appliances not optimized, especially for unoccupied spaces

Control of the heating plant is performing bad

→ High temperatures (24°C) both for occupied and unoccupied spaces

No renewable energy systems

No domotic appliances for the lighting system

critical aspects

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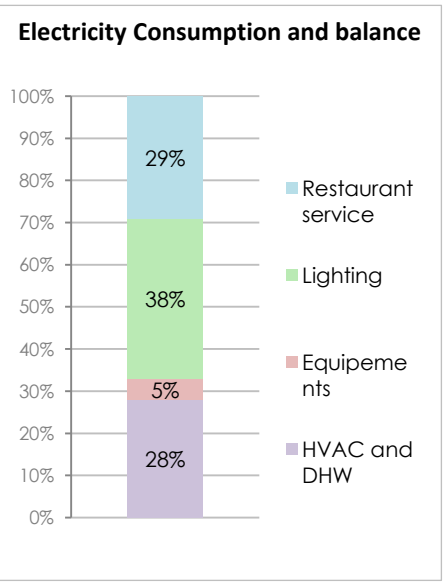
2 Grand Hotel Royal Terme di Valdieri

The energy demand of the structure is **entirely covered by renewable energy sources** (thermal hot springs)

The hotel owners has installed a **small hydroelectric power plant** which allow to use the water coming from the thermal source to produce heating, hot water and also electricity.

Only 10% of the thermal energy is used in the area!



Category	3 stars
City	Valdieri (CN)
Number of beds	210
Year of construction	1857
Opening schedule	120 days/year
Facilities	Spa
Occupancy	25% (average)
Energy carriers	water from thermal source

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2 Energy consumptions

Grand Hotel Royal Terme di Valdieri

Interventions	Energy consumption $[kWh_p/m^3y]$
Current state	131
LED lighting system in rooms	128
LED lighting system In common spaces (24 h/d)	116
LED lighting system In common spaces (8 h/d)	121
Occupancy sensors in connecting spaces	122
Occupancy sensors in connecting spaces + LED lighting system	115
Thermostatic valves and connected devices	103
Combination of all interventions	74

CONSIDERING THE WHOLE BUILDING (not only for the hosting functions) !

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1 Grand Hotel Royal Terme di Valdieri

Interventions	Annual economic saving [€]	Initial investment cost [€]	Reduction in CO_2 emissions [kg CO_2]	Priority*
LED lighting system in rooms	755	7.560	1.479	low
LED lighting system In common spaces (24 h/d)	3.642	2.800	7.133	high
LED lighting system In common spaces (8 h/d)	2.405	5.600	4.709	medium
Occupancy sensors in connecting spaces	2.052	3.600	4.018	medium
Occupancy sensors in connecting spaces + LED lighting system	3.871	6.400	7.581	medium
Thermostatic valves and connected devices	6.728	9.800	13.175	high
Combination of all interventions	13.759	29.360	26.945	-

** As to cost optimal and break even point approaches*

Interventions suggested

Regulation equipment of the heating plant badly performing

- → High temperatures
- → thermal discomfort
- → opening of windows

No domotic appliances for the lighting system

Obsolete lamp bulbs

Electricity consumptions during the closing month (35% of the annual usage) caused by the power of the heating pumps (to prevent freezing of water pipes)

critical aspects

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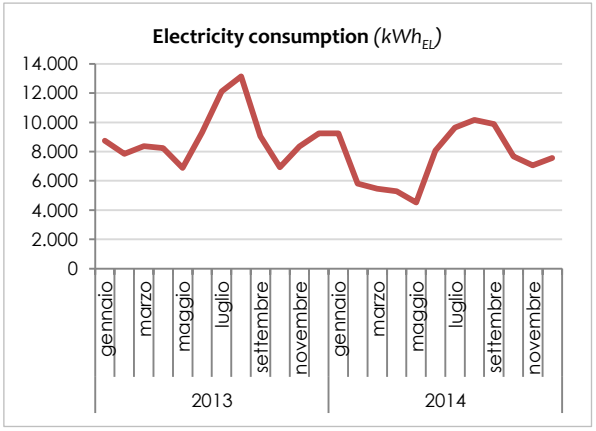
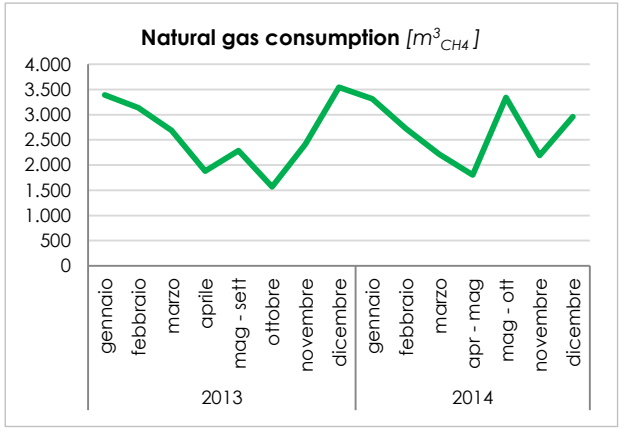
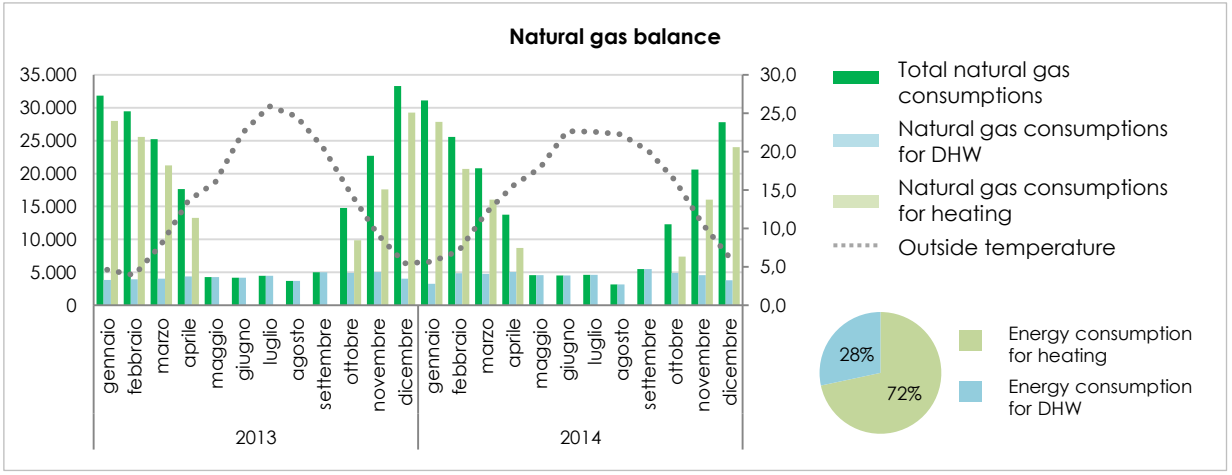
3 Residence L'Orologio







Category	No star ratings
City	Turin
Number of beds	46 (20 apartments)
Year of construction	1910
Opening schedule	365 days/year
Facilities	Gym, kitchenette
Occupancy	74% (average)
Energy carriers	natural gas and electricity

info

The electricity balance and The energy performance indexes are not yet defined as **the energy audit is in progress.**