Buildings' energy efficiency planning towards urban energy transition

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ΚΑΠΕ CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

5th MEDENER International Conference on Energy Transition

Addressing climate change and migration in the Mediterranean region through energy transition

International policy context

Sept.2015 – UN Sustainable Development Summit
*World leaders adopted the **"2030 Agenda for Sustainable Development"***
17 Sustainable Development Goals

"Paris Agreement", Dec.2015 – UN Climate Change Conference (COP21)
Historic agreement for joint action to address climate change, signed by 175 countries

Transition to low-carbon economies is a key political priority at international level

EU Energy targets - policy context

Europe 2020 Strategy *(2010) – Climate change and energy*

1. Greenhouse gas emissions 20% lower than 1990 levels
2. 20% of energy coming from renewables
3. 20% increase in energy efficiency

2030 Climate and Energy framework *(2014)*

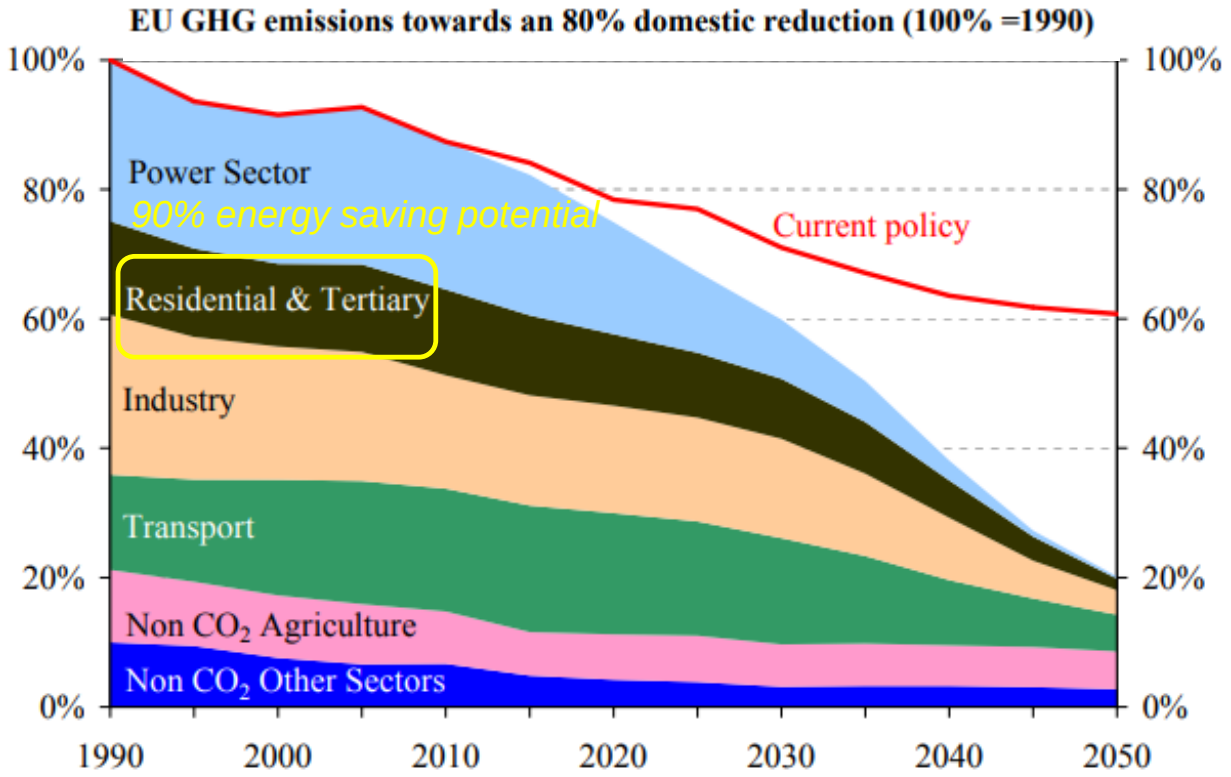
1. **At least 40% cuts in greenhouse gas emissions** (from 1990 levels)
   (binding for each MS and at EU level)
2. **At least 27% share in renewable energy**
   (binding at EU level, not for each MS)
3. **At least 27% improvement in energy efficiency** [update in 2020]
   (indicative at EU and national level)

Proposal for 30% binding target at EU level by 2030 ***'Clean Energy for all Europeans'*** *(2016)*

EU Energy targets - policy context

"A Roadmap for moving to a competitive low carbon economy in 2050" *[COM(2011)112]*

- **80% reduction of greenhouse emissions in the EU by 2050** (compared to 1990)
- Interim targets: 40% reduction by 2030, 60% by 2040



EU Energy targets - policy context



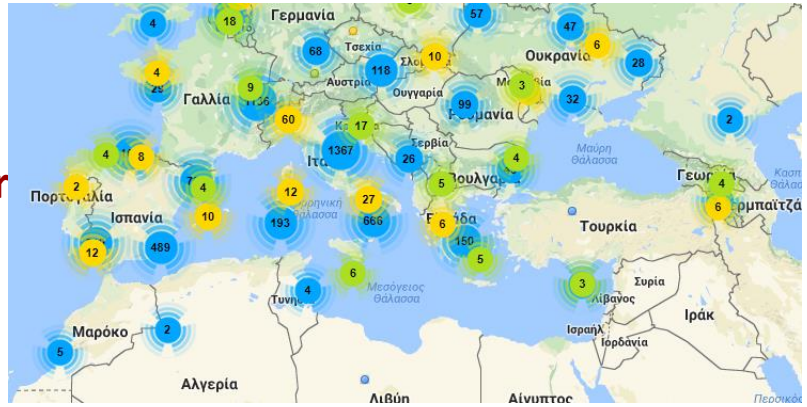
Building sector in the EU

- 40% of final energy consumption
- 36% of CO_2 emissions
- 35% of European buildings are older than 50 years
- 2/3 of European buildings were constructed prior to energy efficiency regulations and minimum standards
- Renovation rate is only ~1% per year
- **Strategic sector for achieving 2020/ 2030/ 2050 targets**

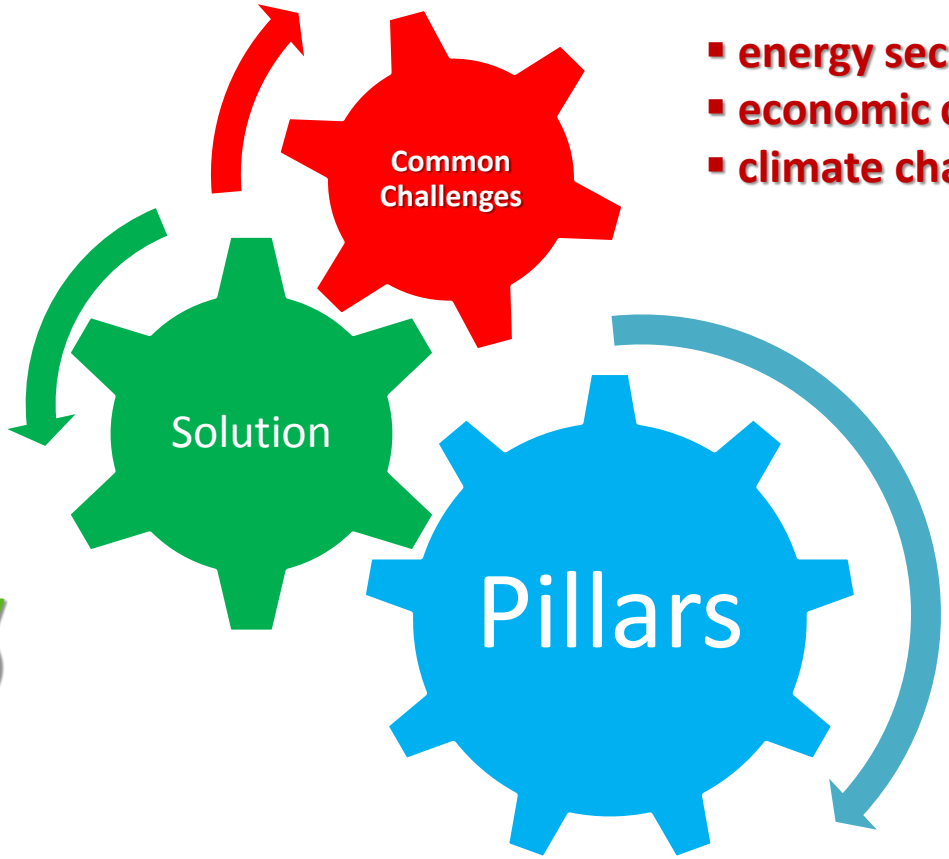
Covenant of Mayors

Covenant of Mayors for Climate & Energy

- ✓ **The largest voluntary initiative on energy and climate, of local and regional authorities, committing to achieve, on a voluntary basis, the EU 2020 targets on energy and climate in their territories**
- ✓ New strengthened **"Covenant of Mayors for Climate and Energy" (Oct.2015)**
- ✓ **Commitment of signatories to achieve 40% CO_2 reduction by 2030 and adopt a common approach for mitigation and adaptation of climate change**
- ✓ Over 7,600 signatories - **North and South Mediterranean**
- ✓ **Sustainable Energy and Climate Action Plans (SECAPs)**



Why an energy transition for the Mediterranean?



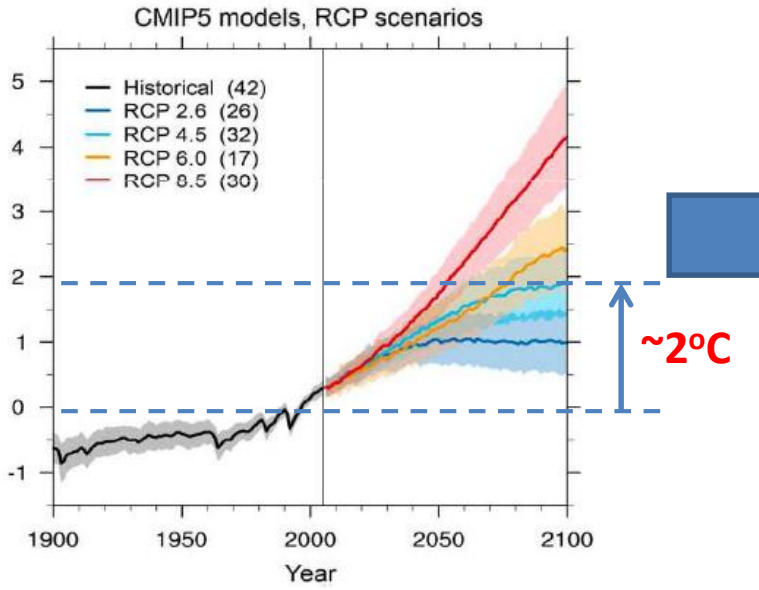
- energy security
- economic competitiveness
- climate change

Transition energy (global vision LT)

- Energy efficiency
- Renewable energy

Key Mediterranean challenges: Climate change

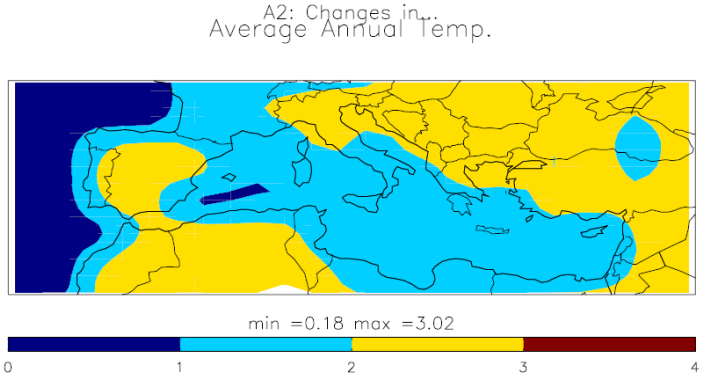
GLOBAL MEAN SURFACE TEMPERATURE CHANGE



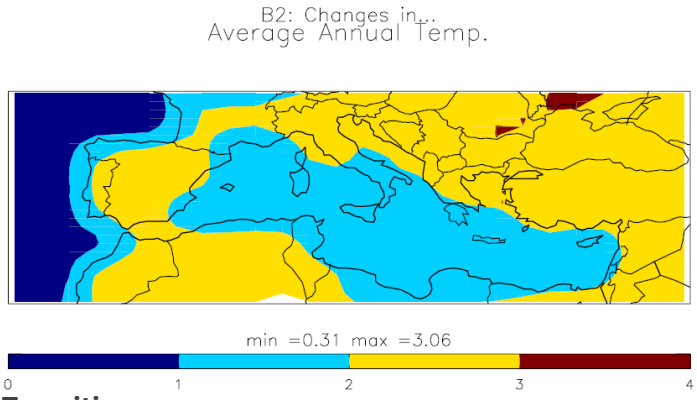
Knutti & Janek 2012

Mediterranean region
2°C global temperature rise
IPCC SRES A2 and B2 emission scenarios

Difference between the daily mean temperature averaged over 2030-2060 and over 1961-1990, for scenario A2

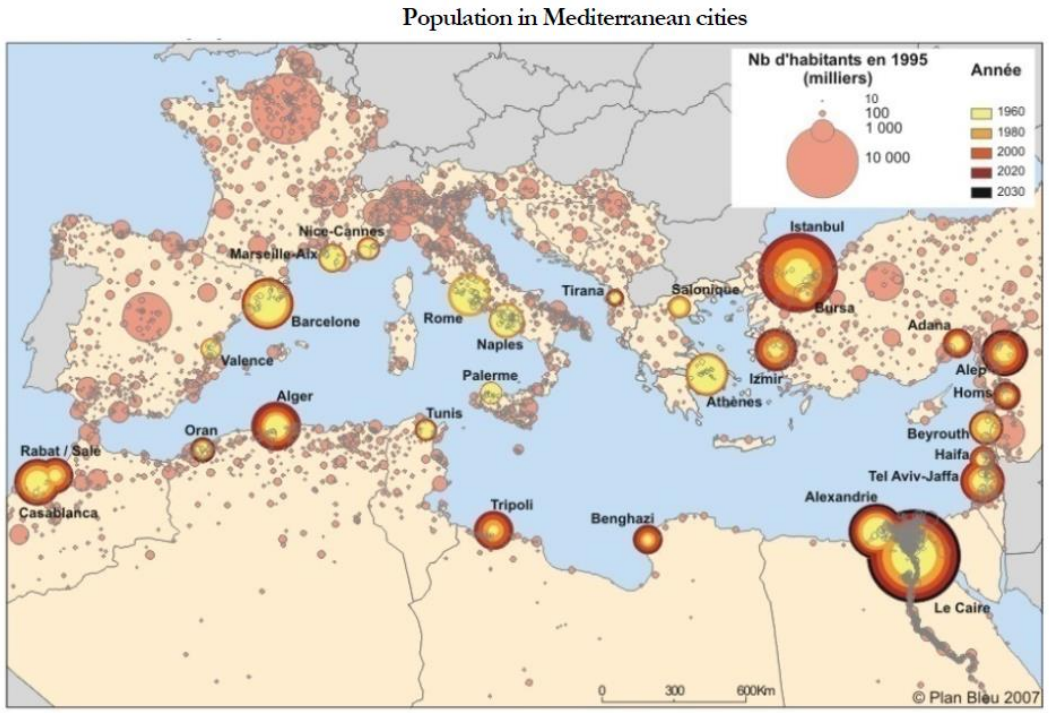


for scenario B2



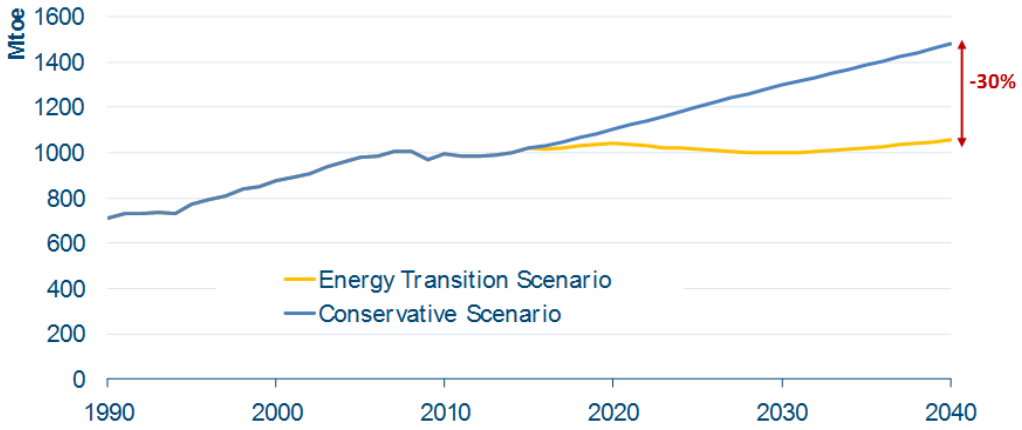
C. Giannakopoulos, 2005

Key Mediterranean challenges : Growing population



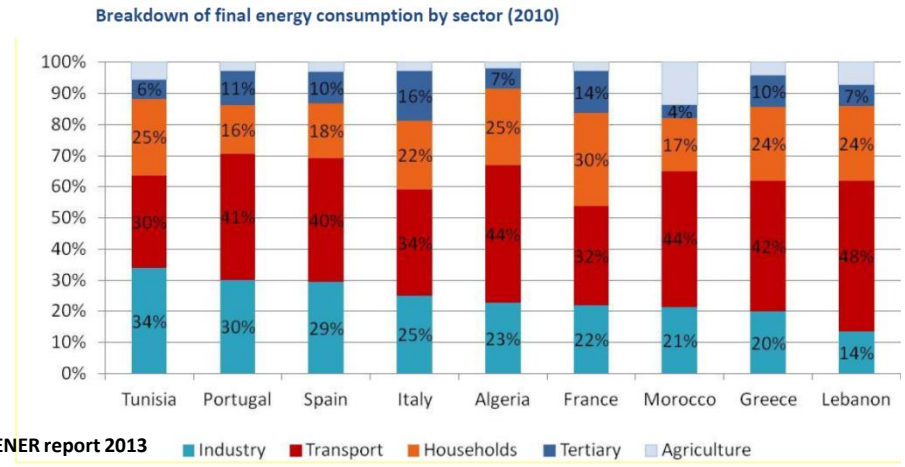
- **Northern Mediterranean Countries (NMCs)** report quite **moderate growth patterns** (0.7 % for 1970-2000)
- **Southern and Eastern Mediterranean Countries (SEMCs)** report an **accelerated urbanization** (3.6 % for 1970-2000)
- **By 2025**, the urban population is likely to exceed **243 million in the SEMCs (145 million in 2000)** and to be in the order of **135 million in the NMCs (129 million in 2000).** A sizeable third of **this growth will take place in Mediterranean coastal areas**
- It is estimated that **by 2030, a further 42 million housing will be needed**

Key Mediterranean challenges : Energy consumption



30% energy saving by 2040 (23% in 2030)

7% increase from current levels compared to more than 50% increase in the CS



MEDENER report 2013

The building sector currently accounts for 35% of total final energy consumption in the Mediterranean, with 24% for the residential sector alone and a booming services sector in the South.

The building sector, **is a key sector**, since it allows influence to be brought to bear on both demand (**energy efficiency measures**) and supply (**integration of Renewables**).

Key Mediterranean challenges : Energy inefficient building stock

…indicatively, in Greece

~60% of Greek buildings constructed before 1980, after which the thermal-insulation regulation was issued

Imagine…..

~ 2,300,000 buildings are thermally exposed, thus extremely highly energy demanding

- Average energy consumption for public buildings **150-800kWh/m²**
- Annual energy related expenses of public buildings **~450,000,000€**

Γενικά για κτίρια κατοικίας οι maximum τιμές πρωτογενούς ενέργειας ποικίλλουν μετ
Για κτίρια τριτογενούς τομέα οι τιμές ποικίλλουν από 25 έως και 270 kWh/m2/yr (π.χ.

Key Mediterranean challenges : Energy inefficient building stock

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Imagine…..

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- Average energy consumption for public buildings **150-800kWh/m²**
- Annual energy related expenses of public buildings **~450,000,000€**

NZEB standards: residential buildings upper limits of primary energy consumption vary between 20-160 kWh/m2/yr. For services/commercial buildings between 25 - 270 kWh/m2/yr (e.g Estonia, Romania etc.) This variation has to do with differences in calculation methodologies, differences in typologies, climate conditions etc.)

Barriers towards energy transition

Mediterranean EU Countries

- **Slow rate in harmonization with EPBD 2010/31/EU** : NZEB is not yet defined or it is still under development with very slow rates (the process is, however, in progress)
- **Slow renovation rates of buildings:** Slow renovation rates towards the target of 3% annual floor-area renovation of public buildings (EED 2012/27/EU); Absent affordable Energy Efficiency Action Plans for Public Buildings at local and regional level

MED region

- **No specific policy provisions to tackle urban sprawl symptoms such as Urban Heat Island (UHI)** (absent guidelines and UHI indicators)
- **Lack of funding and know-how to access innovative financing** which hinders the actual implementation of energy upgrading projects
- Huge **administrative, technical and financing shortcomings hinder local authorities to develop and/or to implement their Sustainable Energy Action Plans (SEAPs)**. Most municipalities have **not yet categorized their public building stock**, **limited energy audits**, poor energy-management systems
- **Limited exploitation of the role of the "Energy Manager"**

At the same time…

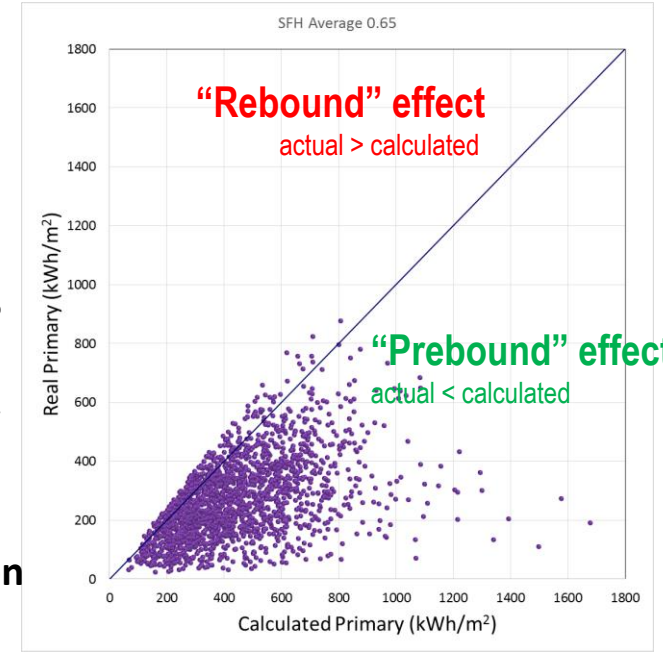
…indicatively, in Greece:

…Financial crisis

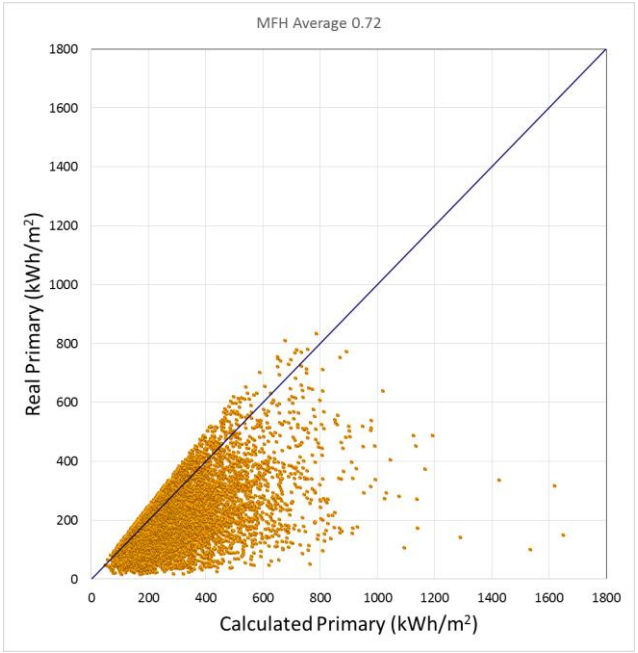
led to highly **reduced energy consumption**.

However, **it is just a reflection of Energy Poverty** in many Households in the Mediterranean.

SINGLE-FAMILY HOUSING (1,874 dwellings)



MULTI-FAMILY HOUSING (7,139 dwellings)



C.A. Balaras, E.G. Dascalaki, REPUBLIC-MED /GRASP-MED SYNERGIES CONFERENCE - Energy Performance Indicators and Methods for a Sustainable Framework of Buildings Refurbishment, Piraeus, 12 March 2015.

Strategic objectives to confront barriers

Mediterranean needs a Push…

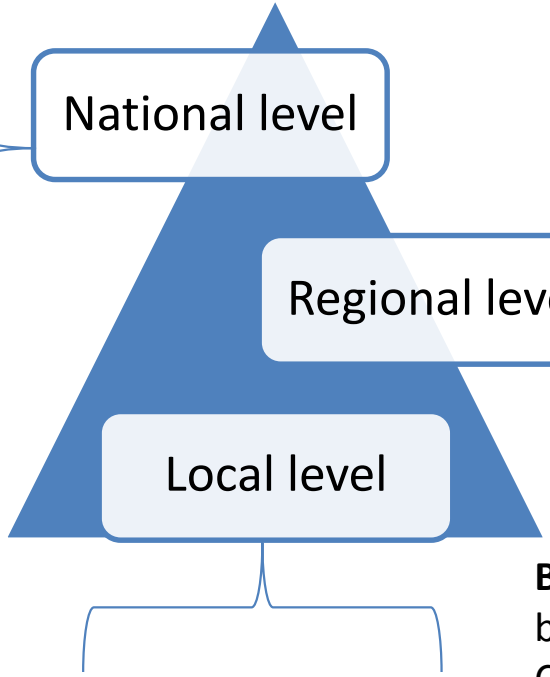
…An IMPULSE

To escape inaction in issues related to low-carbon development

Need to confront the identified challenges both at administrative and in technical level in order to contribute to Mediterranean roadmaps for a sustainable and low-carbon economy

Strategic objectives to confront barriers

Definition of NZEB and cost-optimal levels.
Allocate International/national funds to low-carbon development Programmes.
Design requirements for Urban Heat Island mitigation plans.
Innovative financing.



Sustainable Regional Operational Programmes.
Energy targets, roadmaps and credible paths.
Regional funds allocation.
Funding sources.

NZEB: More accurate Energy Performance Indicators (EPIs) prediction tools for the 244/2012/EC.
Financing: National funds share; Promotion of ESCOs and PPPs.
UHI: Develop indicators and models adapted in urban strategies.

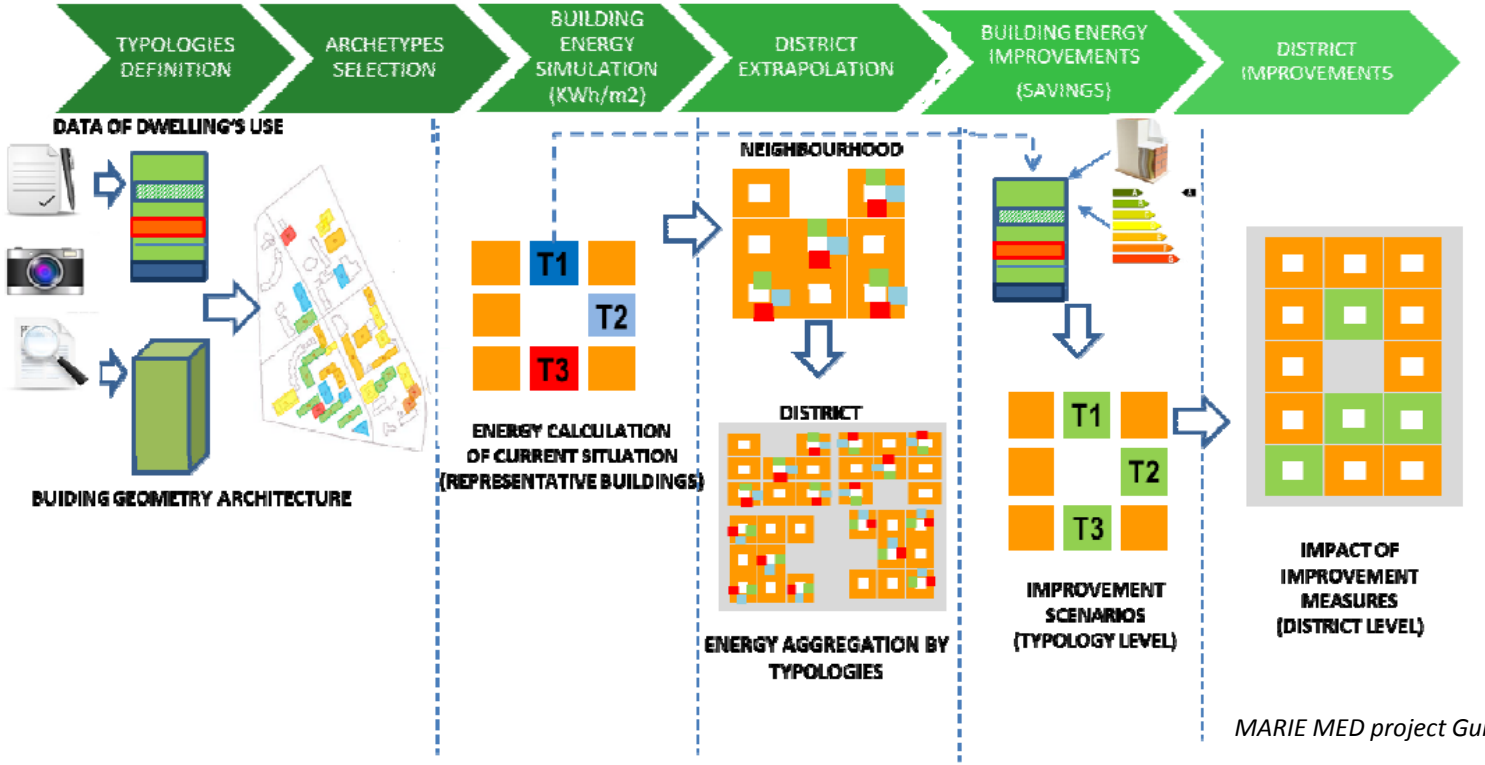
Measures for better energy management.
Implementation of SEAPs.
Exploit innovative financing.

Better energy management: Capacity building of energy managers; BEMs; Classification of public-building typologies; Monitoring; Include socio-economic indicators (energy poverty).
SEAPs: Training; Planning user-friendly tools/platforms; Monitoring effectiveness.
Funding: Training on innovative financing; Smart libraries of opportunities with how-to-get instructions.

Buildings' energy renovation planning at a glance

Buildings' energy renovation at urban scale

Approach flow-chart

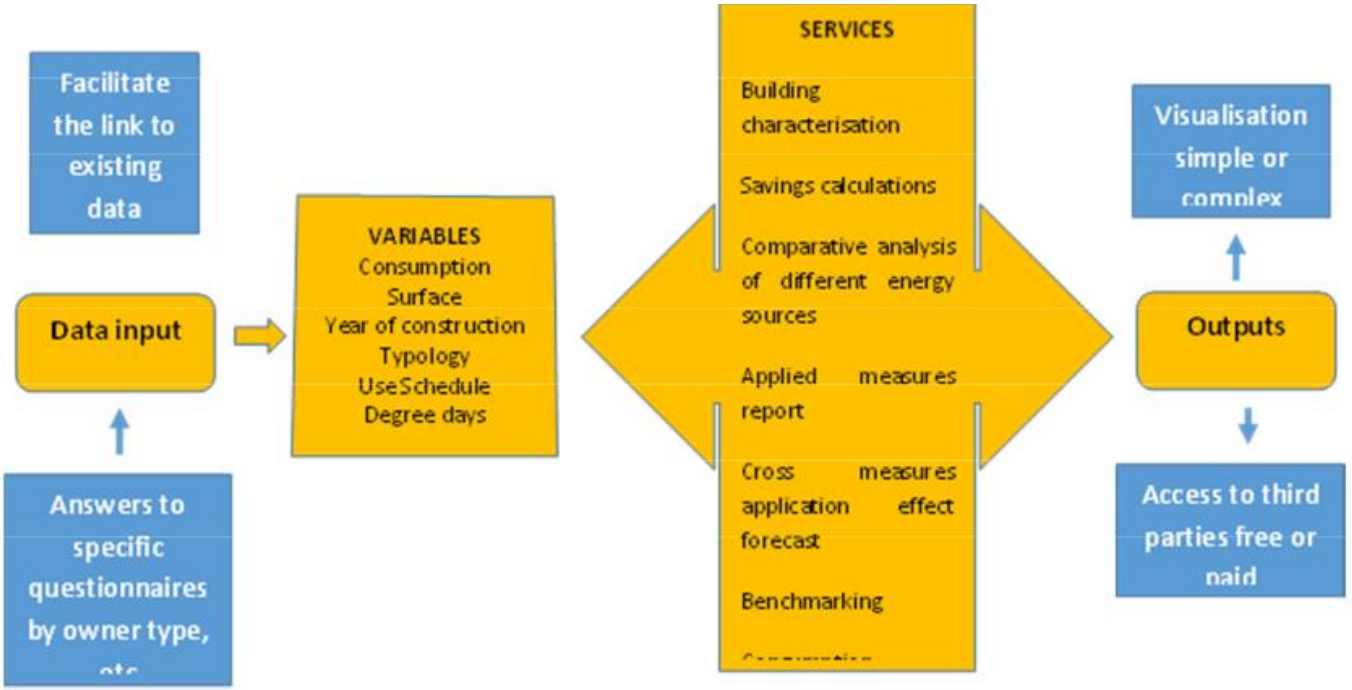


MARIE MED project Guide for ERBs at urban scale.

Buildings' energy renovation planning

WE NEED An information system model (permits to assess current situation and ERB

Description: *A model to be used in MED Regions for information integrated treatment to facilitate the public and private owners decisions but also to plan ERB at local, regional and MED scales*

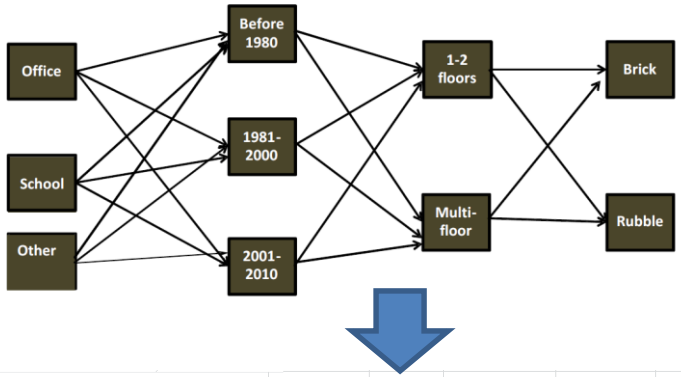


MARIE MED project, Factsheet: Information System Model.

Buildings' energy renovation planning in detail

Identification of Buildings' Typologies and Archetypes

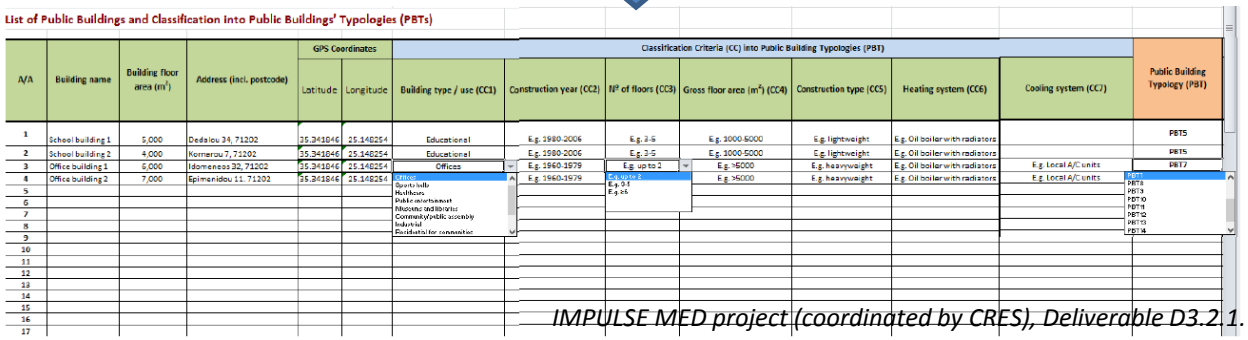
Mediterranean protocol and platform for buildings' Typologies classification



Available Typologies platforms

1) TABULA/EPISCOPE projects
http://episcope.eu/building-typology/country/

2) IMPULSE project
https://impulse.interreg-med.eu/

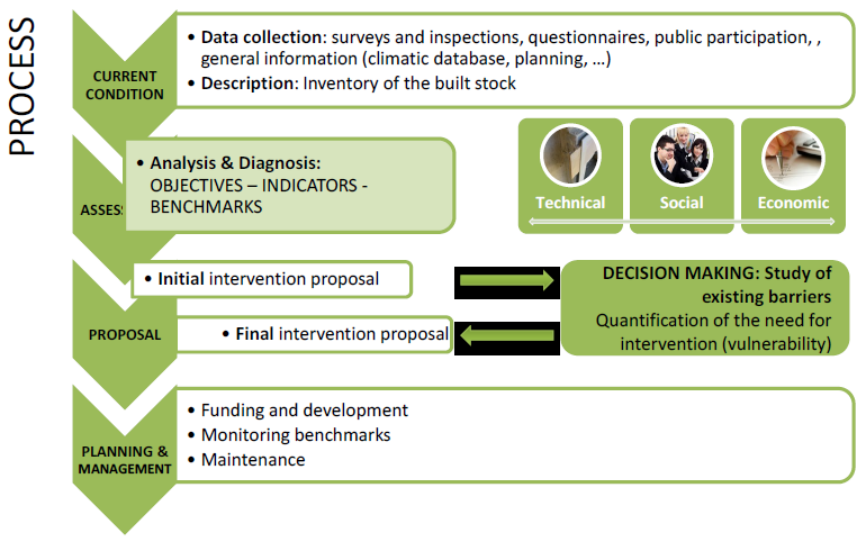

List of Public Buildings and Classification into Public Buildings' Typologies (PBTs)

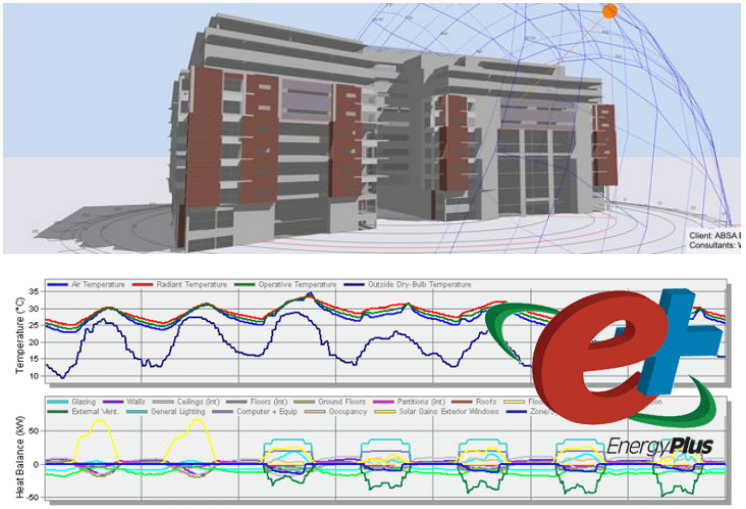
A/A	Building name	Building floor area (m²)	Address (incl. postcode)	GPS Coordinates		Classification Criteria (CC) into Public Building Typologies (PBT)							Public Building Typology (PBT)
				Latitude	Longitude	Building type / use (CC1)	Construction year (CC2)	N° of floors (CC3)	Gross floor area (m²) (CC4)	Construction type (CC5)	Heating system (CC6)	Cooling system (CC7)	
1	School building 1	5,000	Dedalou 34, 71202	35.341846	25.148254	Educational	E.g. 1980-2006	E.g. 3-5	E.g. 3000-5000	E.g. lightweight	E.g. Oil boiler with radiators		PBT5
2	School building 2	4,000	Kornarou 7, 71202	35.341846	25.148254	Educational	E.g. 1980-2006	E.g. 3-5	E.g. 3000-5000	E.g. lightweight	E.g. Oil boiler with radiators		PBT5
3	Office building 1	6,000	Idomeneos 32, 71202	35.341846	25.148254	Offices	E.g. 1960-1979	E.g. up to 2	E.g. >5000	E.g. heavyweight	E.g. Oil boiler with radiators	E.g. Local A/C units	PBT7
4	Office building 2	7,000	Epimenidou 11, 71202	35.341846	25.148254	Offices	E.g. 1960-1979	E.g. up to 2	E.g. >5000	E.g. heavyweight	E.g. Oil boiler with radiators	E.g. Local A/C units	PBT7

IMPULSE MED project (coordinated by CRES), Deliverable D3.2.1.

Buildings' energy renovation planning

Buildings' Archetypes simulations and decision-making





- Energy analysis of the existing case/diagnosis of vulnerabilities.
- Parametric testing of renovation scenarios and identification of cost-optimal solutions.

Use of scientifically validated tools:

- National software for building energy analysis.
- Take advantage of dynamic modelling software e.g. EnergyPlus, TRNSYS, etc.

Buildings' energy renovation planning

Processing of KPIs and extrapolation to district level

Mediterranean protocol for KPIs' processing

KPIs for the base-case scenario		Ambassador_PBT1
Building name		
Building floor area (m^2)		
Energy Performance Indicators: Total annual primary energy consumption	kWh/m^2/yr	
	kWh/yr	0
Annual final energy consumption for space heating	kWh/m^2/yr	
	kWh/yr	0
Annual final energy consumption for space cooling	kWh/m^2/yr	
	kWh/yr	0
Annual final energy consumption for domestic hot water	kWh/m^2/yr	
	kWh/yr	0
Annual final energy consumption for lighting	kWh/m^2/yr	
	kWh/yr	0
Annual electricity consumption	kWh/m^2/yr	
	kWh/yr	0
Annual consumption of fossil fuel	kWh/m^2/yr	
	kWh/yr	0

KPIs for the minor-retrofit scenarios			Ambassador_PBT1	
Retrofit scenario			Scenario1_PBT1	Scenario2_PBT1 (optional)
Building name				0
Building floor area (m^2)				0
Short description				
Energy Performance Indicators: Total annual primary energy consumption	kWh/m^2/yr			
	kWh/yr		0	0
Annual final energy consumption for space heating	kWh/m^2/yr			
	kWh/yr		0	0
Annual final energy consumption for space cooling	kWh/m^2/yr			
	kWh/yr		0	0
Annual final energy consumption for domestic hot water	kWh/m^2/yr			
	kWh/yr		0	0
Annual final energy consumption for lighting	kWh/m^2/yr			
	kWh/yr		0	0
Annual electricity consumption	kWh/m^2/yr			
	kWh/yr		0	0
Annual consumption of fossil fuel	kWh/m^2/yr			
	kWh/yr		0	0

Projection of results from Ambassador to the initial testing sample of buildings (e.g. 90 buildings)

Building No.	Key Performance Indicators															
	Energy Performance Indicators						Environmental indicators				Cost indicators					
	Total annual primary energy consumption		Annual electricity consumption	Annual consumption of fossil fuel	Annual generation of Renewable Energy		Total annual CO_2 emissions	Annual CO_2 emissions from electricity consumption	Annual CO_2 emissions from fossil fuels consumption		Annual total energy-related operational cost		Annual electricity cost			
	KWh/m^2/yr	kWh/yr									National Currency/m^2/yr	National Currency/yr	National Currency/m^2/yr	National Currency/yr		
1		0	0	0	0	0	0	0	0	0	0	0	0	0		
2		0	0	0	0	0	0	0	0	0	0	0	0	0		
3		0	0	0	0	0	0	0	0	0	0	0	0	0		
4		0	0	0	0	0	0	0	0	0	0	0	0	0		
5		0	0	0	0	0	0	0	0	0	0	0	0	0		
6		0	0	0	0	0	0	0	0	0	0	0	0	0		
7		0	0	0	0	0	0	0	0	0	0	0	0	0		
8		0	0	0	0	0	0	0	0	0	0	0	0	0		
9		0	0	0	0	0	0	0	0	0	0	0	0	0		
10		0	0	0	0	0	0	0	0	0	0	0	0	0		
11		0	0	0	0	0	0	0	0	0	0	0	0	0		
12		0	0	0	0	0	0	0	0	0	0	0	0	0		
13		0	0	0	0	0	0	0	0	0	0	0	0	0		
14		0	0	0	0	0	0	0	0	0	0	0	0	0		
15		0	0	0	0	0	0	0	0	0	0	0	0	0		
16		0	0	0	0	0	0	0	0	0	0	0	0	0		
17		0	0	0	0	0	0	0	0	0	0	0	0	0		
18		0	0	0	0	0	0	0	0	0	0	0	0	0		
19		0	0	0	0	0	0	0	0	0	0	0	0	0		
20		0	0	0	0	0	0	0	0	0	0	0	0	0		

Automated prioritization of retrofit levels and scenarios in terms of investment and energy savings

REFERENCE COST INDICATOR: Total investment cost per total annual energy saved (National Currency/(kWh of energy saved))	Minor retrofit		
	Scenario1	Scenario2 (optional)	Scenario3 (optional)
PRIORITIZATION OF SCENARIOS FOR EACH			
Ambassador_PBT1			
Ambassador_PBT3			
Ambassador_PBT4			
Ambassador_PBT7			
Ambassador_PBT8			
Ambassador_PBT9			
Ambassador_PBT10			
Ambassador_PBT11			
Ambassador_PBT12			
Ambassador_PBT13			
Ambassador_PBT14			
Ambassador_PBT15			

Automated ranking of scenarios based on affordability

Available platform

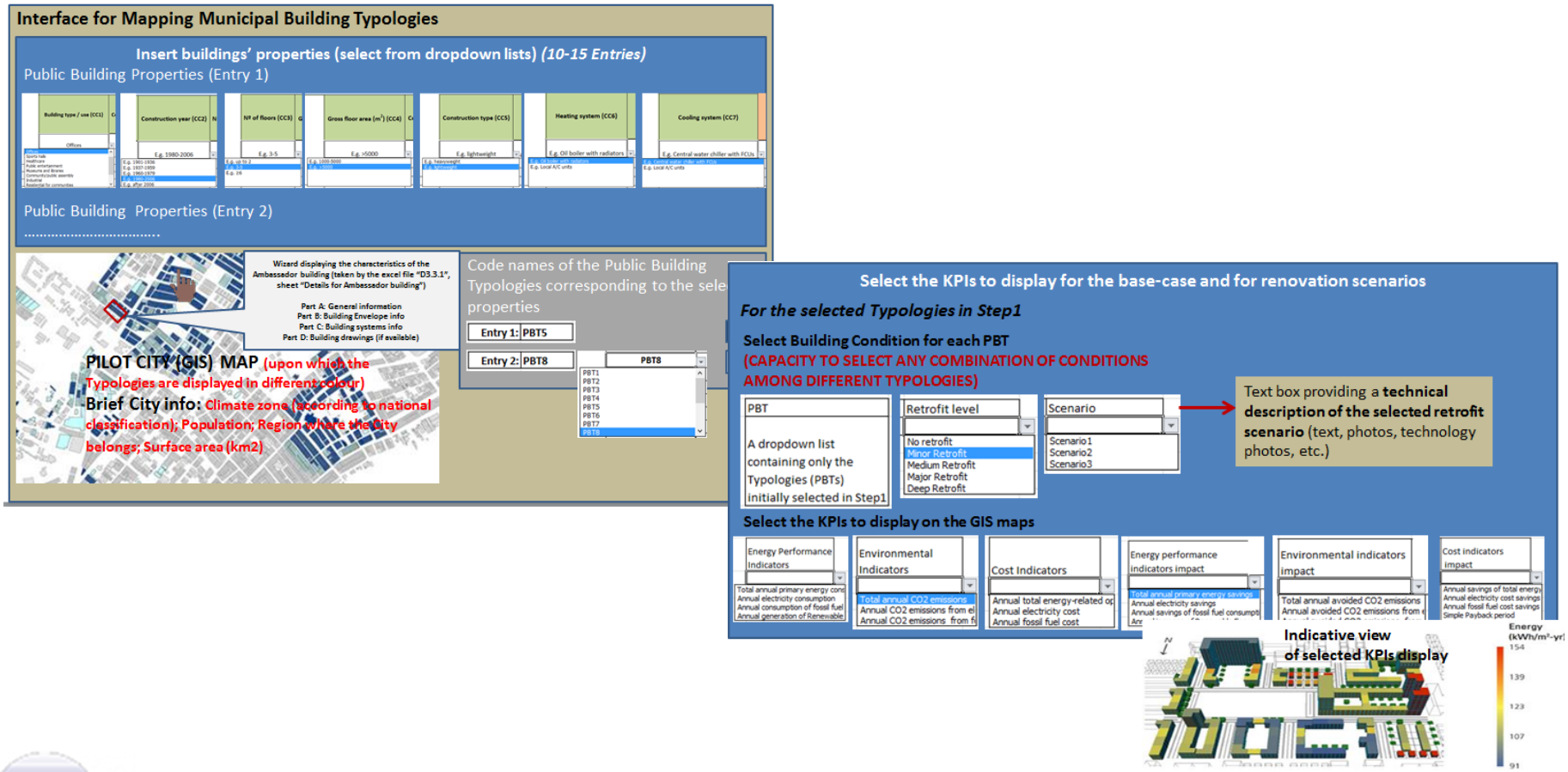
IMPULSE project
https://impulse.interreg-med.eu/

IMPULSE MED project (coordinated by CRES), Deliverable D3.2.1.

Buildings' energy renovation planning

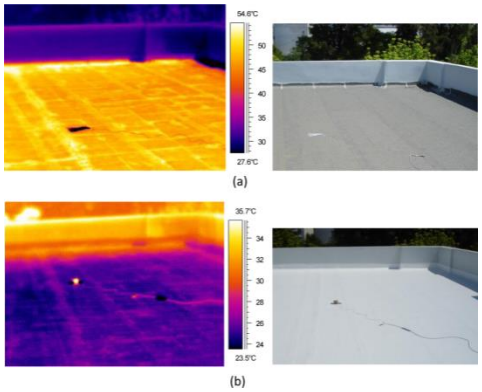
Mapping of building-stock energy renovation plans

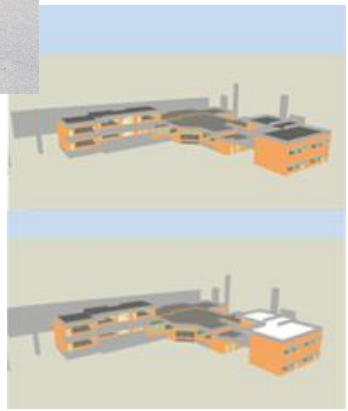
Take advantage of geo-informatics systems

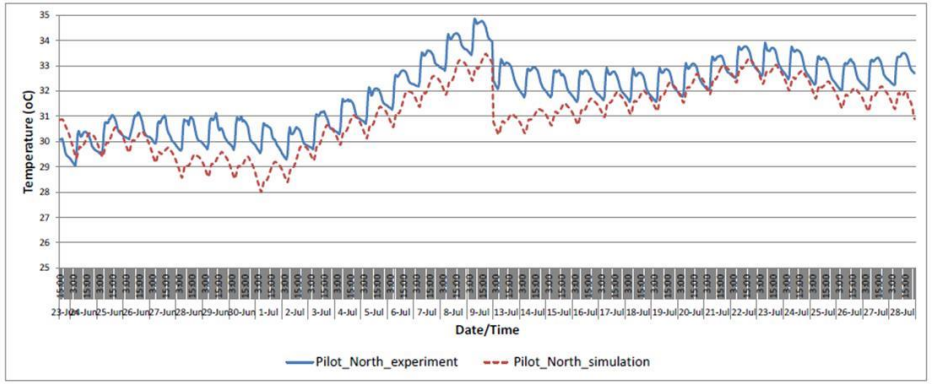


Building energy renovation: Implementation and monitoring

Example of cool-roof (CRES project: CRIBUTE)



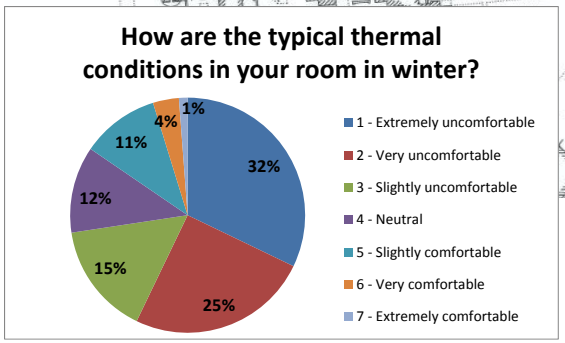




		Ceiling fans	Air conditions
Impact	$\%\Delta E_{Fans}$ or $\%\Delta E_{ACs}$	29.28	20.14
	$\%\Delta E_{heating}$	−12.22	−12.22
	$\%\ \Delta E_{tot,prim}$	−4.85	4.52
	Comfort hours within operating hours	+6	+18

Building energy renovation: Implementation and monitoring

Energy renovation of 5 Student Accommodation buildings (CRES project: ELIH-MED)



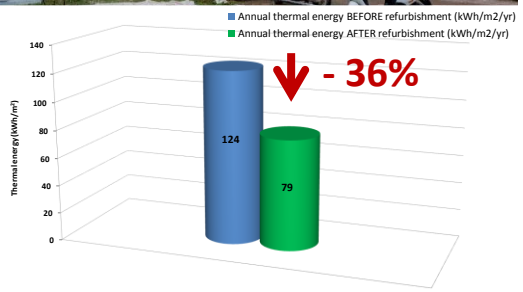
- **DIAGNOSIS OF CURRENT STATE**
- **FEASIBILITY OF ENERGY RENOVATION SCENARIOS**
- **TECHNICAL - FINANCIAL ACTION PLAN**

Implemented measures:

- External insulation to all walls and exposed floors
- Solar hot water collectors on roofs
- Replacement of all lamps in student rooms
- Space heating controls

- **IMPLEMENTATION**
- **MONITORING-EVALUATION**
  - Central heat and electricity meters
  - Wireless transmission of energy data and display in near-real time on screen at central location
  - Electricity meters / temperature meters on indicative rooms

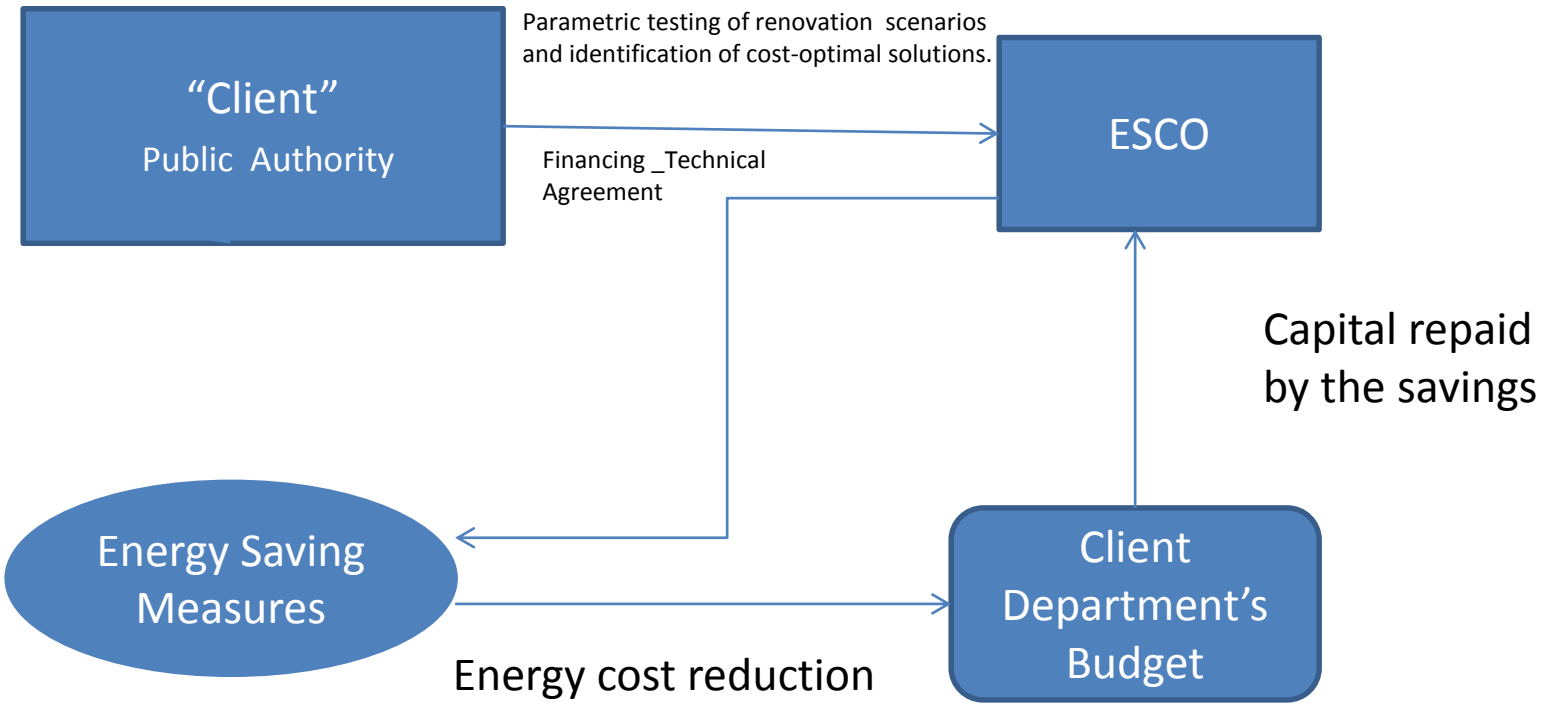
Scenario	Pilotis Insulation	External Walls Insulation	Roof Insulation	Rooms Incandescent light bulbs replacement	Solar Hot Water Collectors	Space Heating Controls
1	√	√				√
2	√	√	√			√
3	√	√		√		√
4	√	√	√	√		√
5	√	√	√	√	√	√
6	√	√		√	√	√



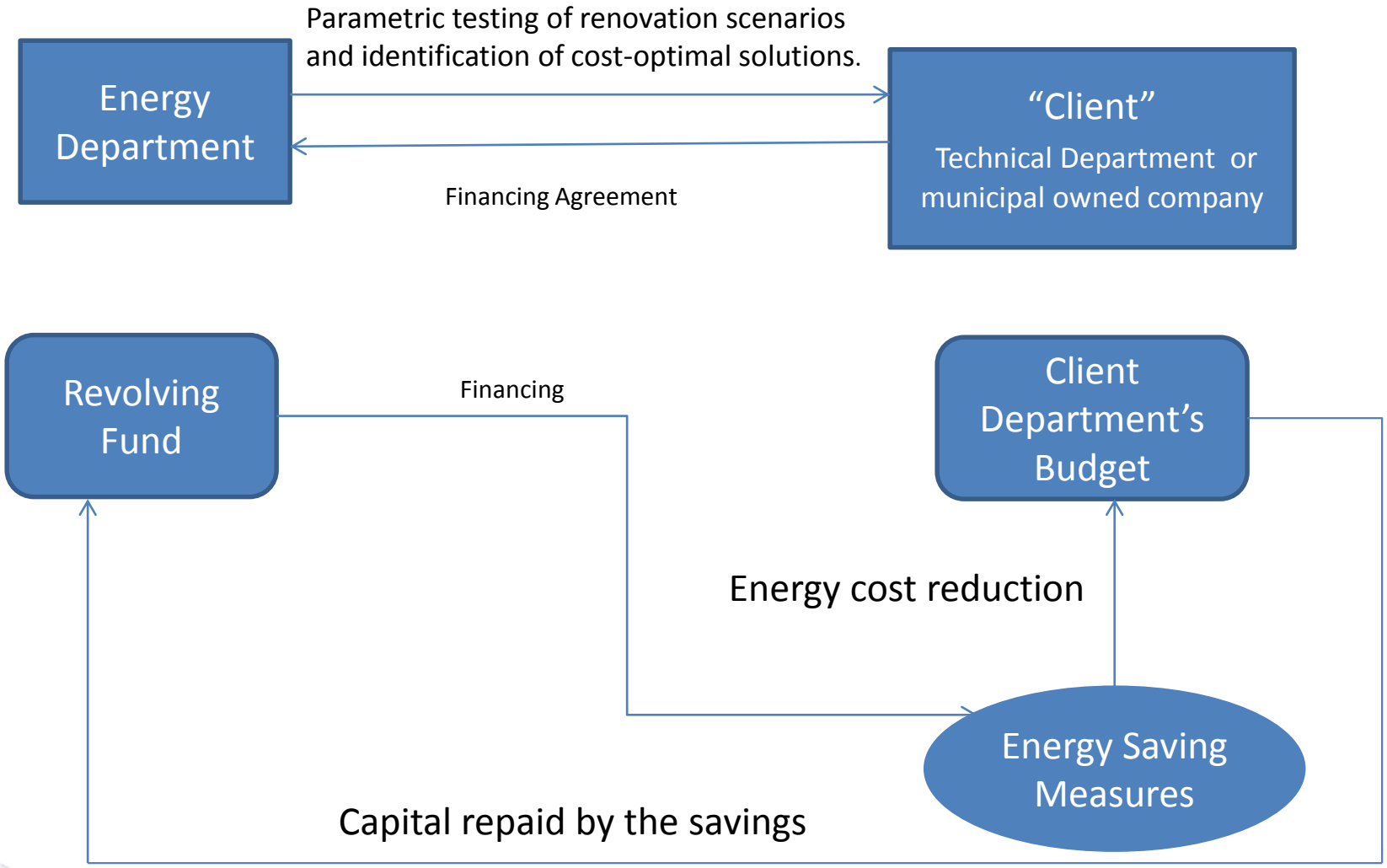
Funding energy efficiency projects (in builidngs)

- Classical financing within the annual budget of the institutions - "owners" of buildings (usually incorporation of EE measures in long term projects such as reconstruction)
- Financing from National, EU Funds / banks and other International Institutions (Structural Funds, INTERREG, EuropeAid) EBRD, World Banks (limited resources an/or difficulties in access to capitals)
- External Contracting (EPC) (some barriers such as unsolved yet issues regarding certification of saving/contracting, PPPs procedures etc)
- Internal Contracting (urgent small scale projects, know-how available, internal financing)

Energy Performance Contracting



Internal Contracting Principle



Thank you for your attention

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