THE FUTURE ENVELOPE

TOWARDS ZERO CARBON BUILDINGS

15-16 December 2022 Bolzano/Bozen

european facade network

THE RELEVANCE OF THE ENVELOPE MATERIALS IN THE URBAN ENVIRONMENT

EMANUELA GIANCOLA

CIEMAT

Collaborations

KlimaHaus CasaClima · UNICMI · LIVING FUTURE EUROPE

Sponsors

FINSTRAL · alpewa · rothoblaas Solutions for Building Technology · Volksbank · RUBNER

Organized by

eurac research · POLITECNICO MILANO 1863

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Ministry of Science and Innovation

CIEMAT

Center for Energy, Environmental and Technological Research

- Promote and execute R&D activities, in accordance with ministerial guidelines, in the fields of energy, environment and technology, including specific fields of basic research.

-Promote the activities derived from its R&D in terms of scientific-technical communication and dissemination, education and technology transfer

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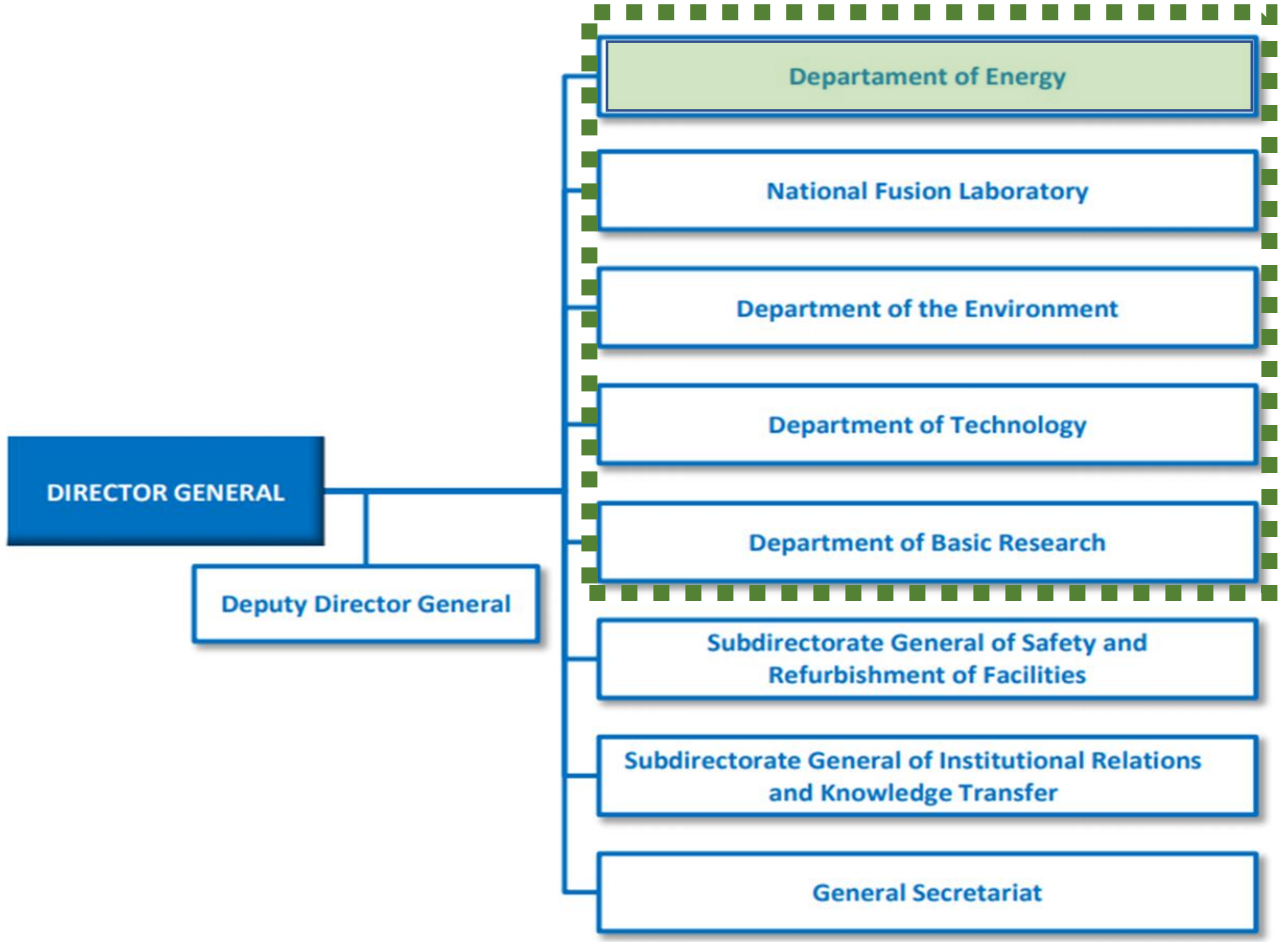
CIEMAT

Center for Energy, Environmental and Technological Research



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CIEMAT

Energy Efficiency Activities

- Characterization of climatology and environment
- Reduction of the energy demand. Passive Systems
- Envelope characterization
- Modeling, dynamic simulation, experimental evaluation and monitoring
- Efficient and integral energy management
- Integration of renewable energy
- Distributed generation based on renewable energies

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mateMAD

Optimized urban materials for more liveable and sustainable cities: characterization in the case of Madrid

Grants PID2020-114873RB-C31,
PID2020-114873RB-C32
y PID2020-114873RB-C33
Funded by

MINISTERIO DE CIENCIA E INNOVACIÓN

AGENCIA ESTATAL DE INVESTIGACIÓN

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CSIC Consejo Superior de Investigaciones Científicas

Instituto Eduardo Torroja

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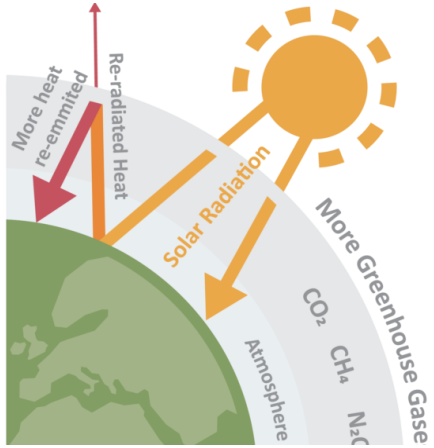
GLOBAL WARMING
Global Livel
Rise of temperature

CLIMATE CHANGE
Regional Level
Extreme weather events

IMPACT ON ECOSYSTEMS
Increased thermal stress
Heat discomfort

CITIES
Key places
Action strategies



MORBIDITY AND MORTALITY

- Old people
- Diseases
- Low socioeconomic status

MITIGATION/ADAPTATION

- 3% surfaces
- 55% population
- 67% global energy
- **Urban microclimate**

DISADVANTAGES FOR THE CHARACTERIZATION OF THERMAL COMFORT INSIDE BUILDINGS

CLIMATE FEATURES

Outdated weather files
underestimation refrigeration

CONSTRUCTIVE FEATURES

Heterogeneous energy behavior
Urban and building conditions

STANDARD COMFORT FEATURES

Rational: Fixed comfort temperatures
Adaptive: Flexible comfort temperatures

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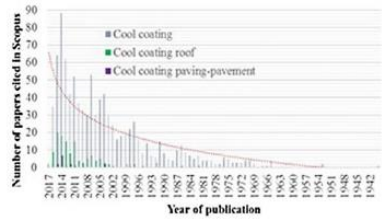
THE COOL COATING CONCEPT
- ✓ Solar reflectance and infrared emittance
- ✓ Solar Reflectance Index

STATISTICS ON COOL COATINGS



COOL COATINGS INDOOR-OUTDOOR BEHAVIOR

State of the art on the development of cool coatings for buildings and cities

MULTIPLE EFFECTS OF COOL COATINGS APPLICATIONS
- ✓ Cool coatings for cooling energy saving
- ✓ Cool coatings for urban heat island mitigation
- ✓ Cool coatings for indoor thermal comfort optimization
- ✓ Influence of cool coatings on outdoor environmental comfort conditions
- ✓ Cool coatings for optimizing HVAC and PV performance
- ✓ Cool coatings durability and life-cycle performance
- ✓ Cost-benefit analysis of cool coatings

MATERIALS FOR COOL COATINGS
- ✓ Cool Roof and Cool Façade Coatings
- ✓ Cool roof paintings
- ✓ Cool waterproof membranes
- ✓ Cool tiles
- ✓ Cool natural materials

From: A. L. Pisello, State of the art on the development of cool coatings for buildings and cities, Solar Energy, Volume 144, 2017, 660-680, https://doi.org/10.1016/j.solener.2017.01.068.

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Grants PID2020-114873RA-C33 funded by

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Spanish research coordinated project based on the hypothesis that optimized materials, like chromogenic smart materials for urban surfaces can provide efficient solutions to the Urban heat Island (UHI) effect.

Multidisciplinary approach for the systematic analysis of representative case studies of **vulnerable areas of the city of Madrid**. The goal is to generate:

- knowledge about the **impact of urban materials** on the habitability and sustainability of cities
- a reliable proposal **to improve the quality of the outdoor environment, the energy demand and the well-being of the inhabitants** through the substitution of outdoor surface materials

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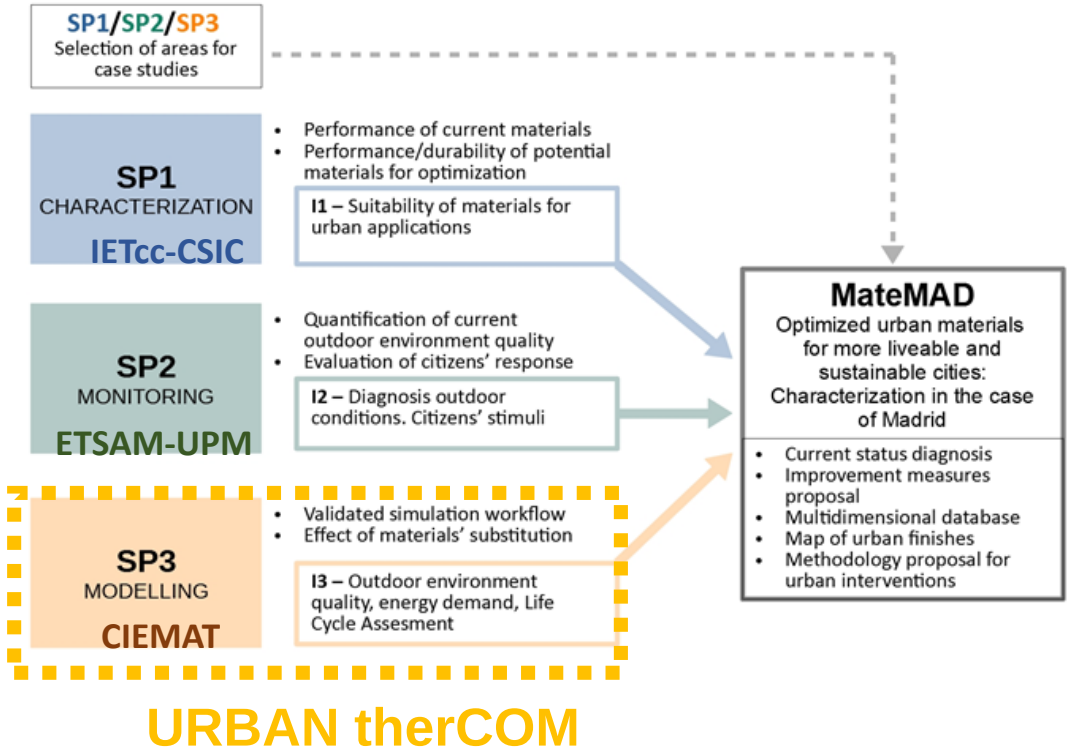
Activities performed under three subprojects:

- Subproject 1 **(SP1). Characterization of urban materials.**

- Subproject 2 **(SP2). Monitoring of environmental parameters.**

- Subproject 3 **(SP3),** named **URBAN therCOM. Modelling outdoor thermal comfort and energy demand in urban areas.**



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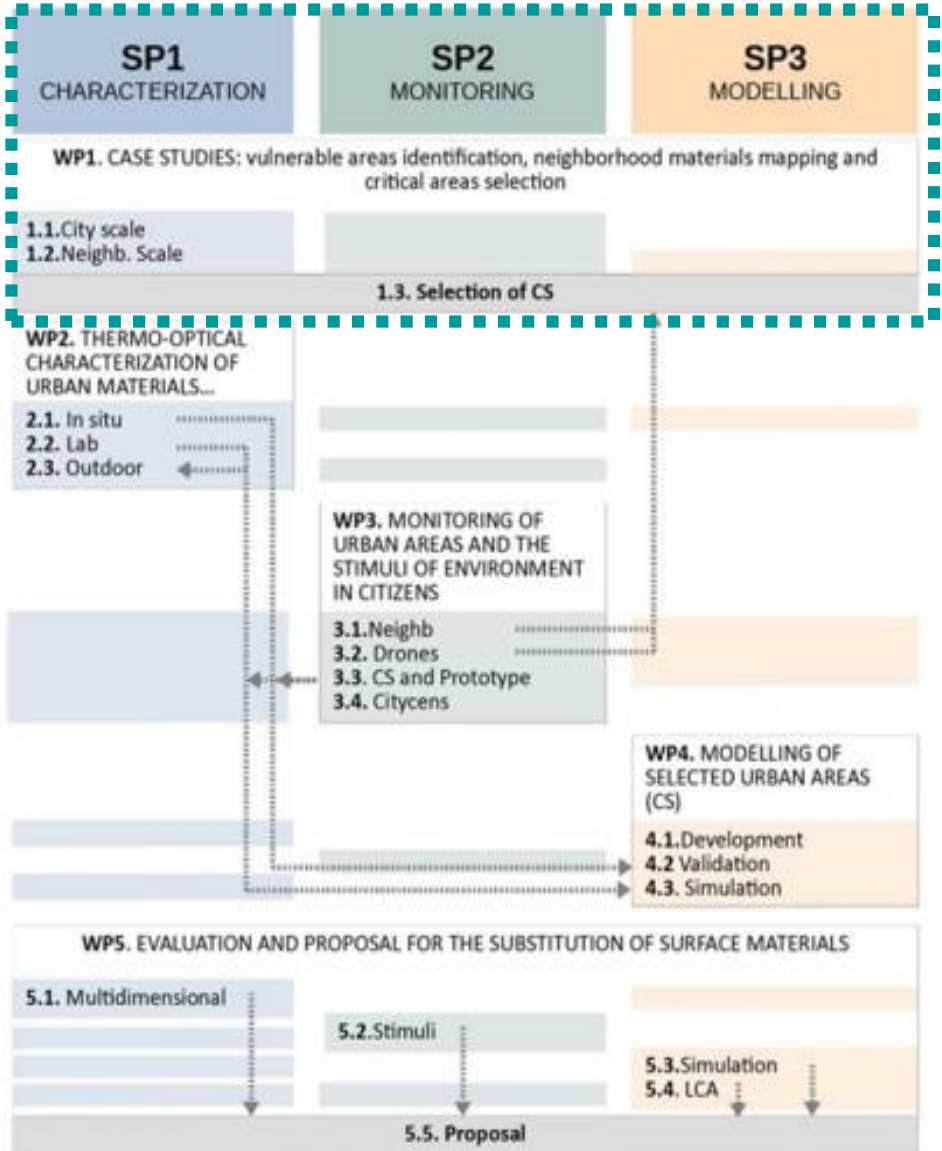
Measure, Calibration and Simulation strategy

The first step assess the **vulnerability** within the city, on those aspects related to Climate Change, discomfort



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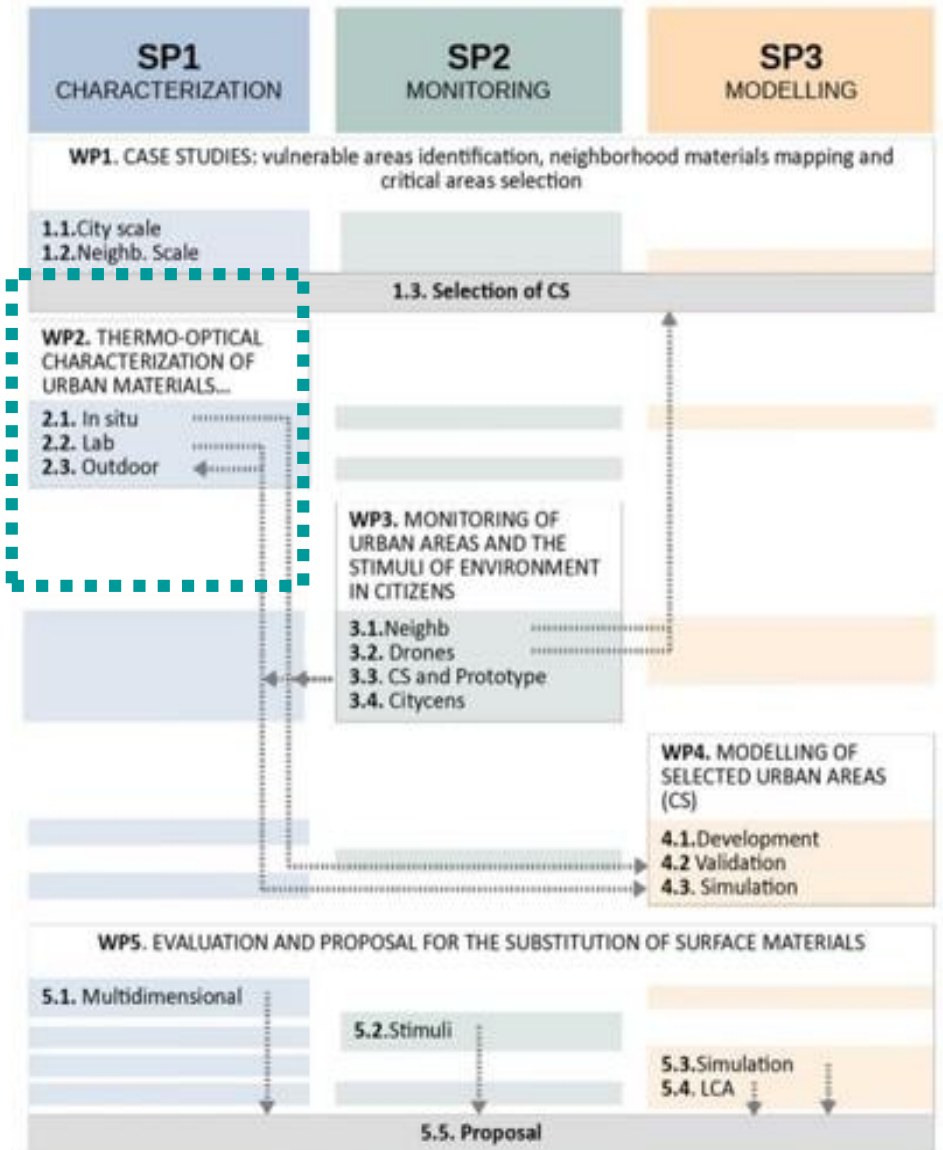
Measure, Calibration and Simulation strategy

The second details thermo-optical (**TO**) characterization of a wide range of surface urban materials: in-situ, laboratory

Solar reflectance, emissivity and "solar reflectance index" (SRI)

Visible reflectance, color coordinates in CIELab space, and texture



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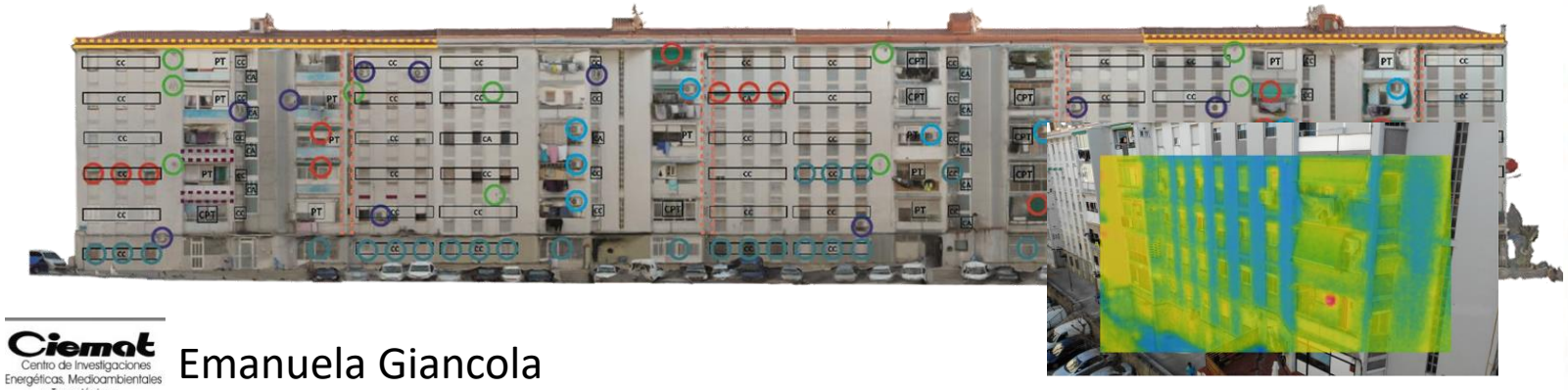
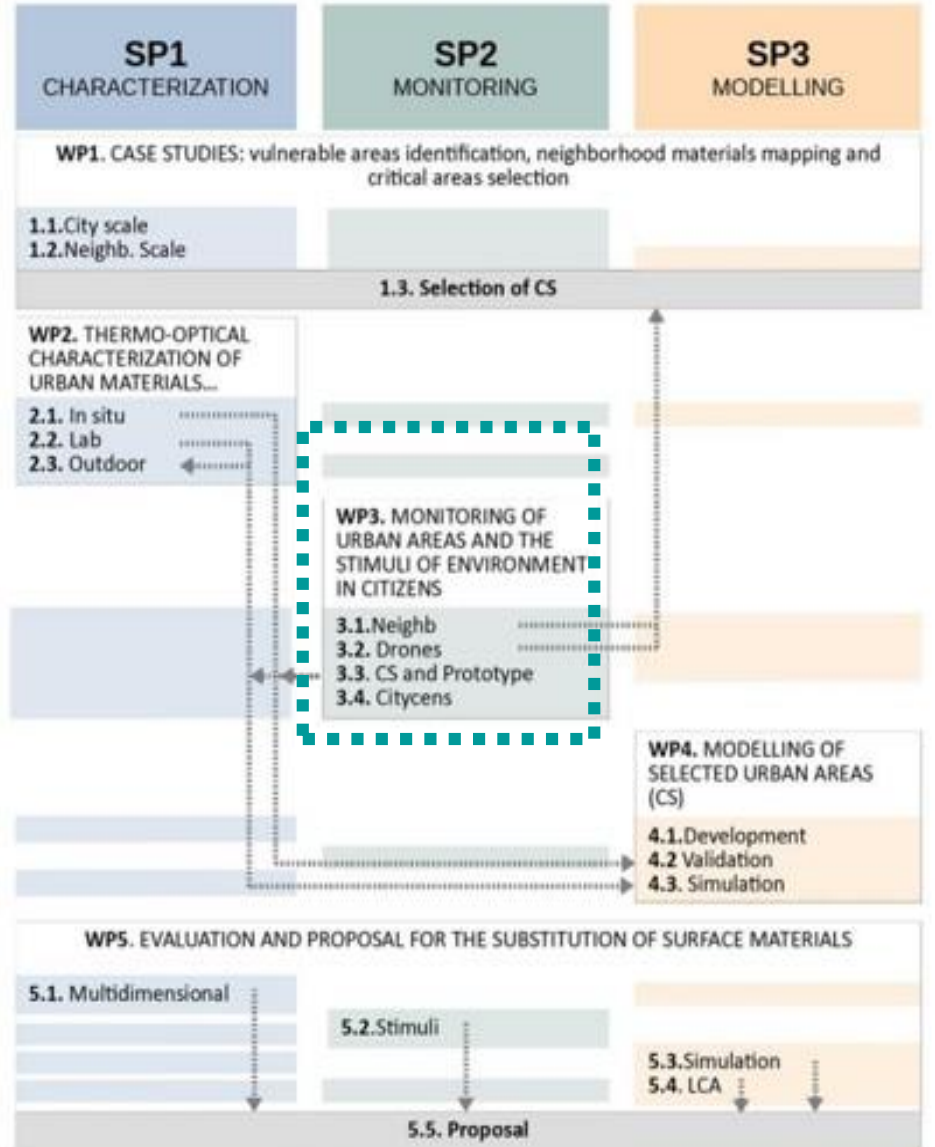
Measure, Calibration and Simulation strategy

The third step **monitors** at four levels: neighbourhood, case study areas, outdoor tests, and citizens

Analysis through drone flights; environmental parameters; Response to urban stimuli





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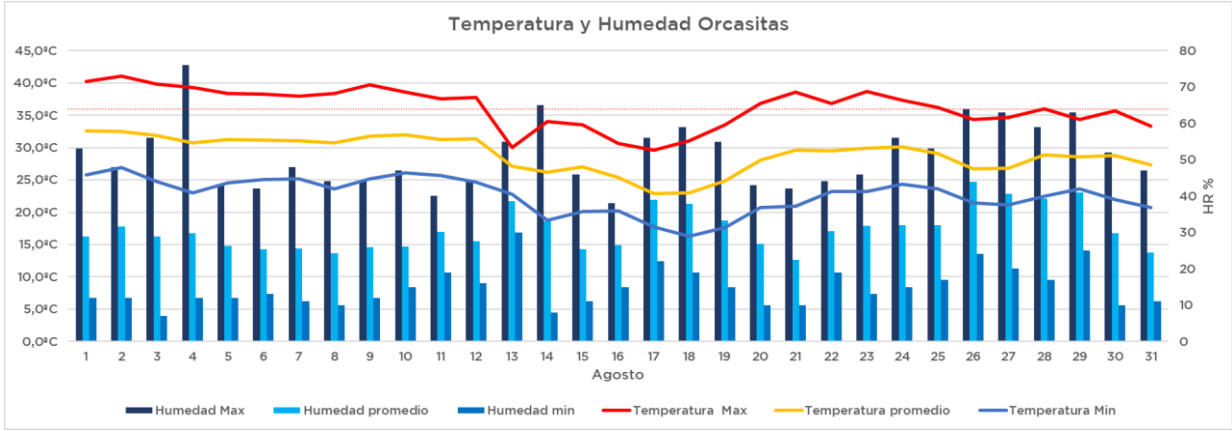
Urban space monitoring

Monitoring through fixed points

10 points, 6 neighborhoods

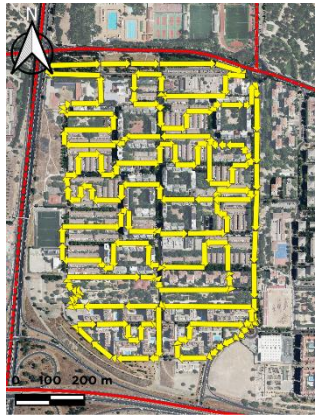
Time evolution of T, HR, WS and RG at the local scale



Monitoring through mobile points

3 days of walking around the neighborhood, twice a day

Spatial evolution of T and HR on the microclimatic scale



TRANSECTO ORCASITAS
Fuente: UPM, base cartográfica tomada de https://www.madrid.org/nomecalles/Inicio.icm

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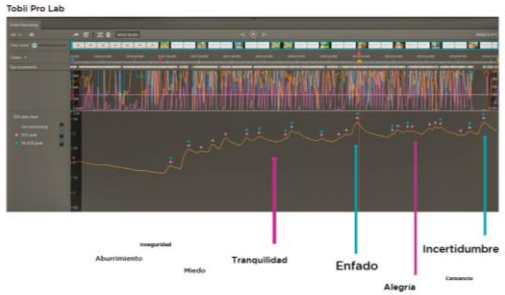
Citizens' stimuli



QUANTITATIVE

- LAB: Images (simple, real and modified)
- GUIDE WALKS: General perception

QUALITATIVE

- GUIDED WALKS: thermal perception
- FOCUS GROUPS: Interviews and surveys. Improvement proposals.

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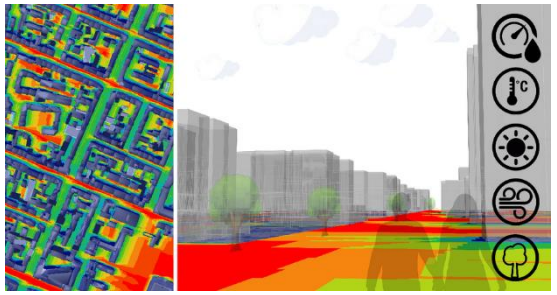
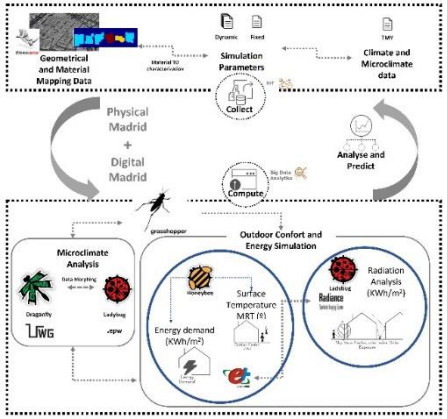
Measure, Calibration and Simulation strategy

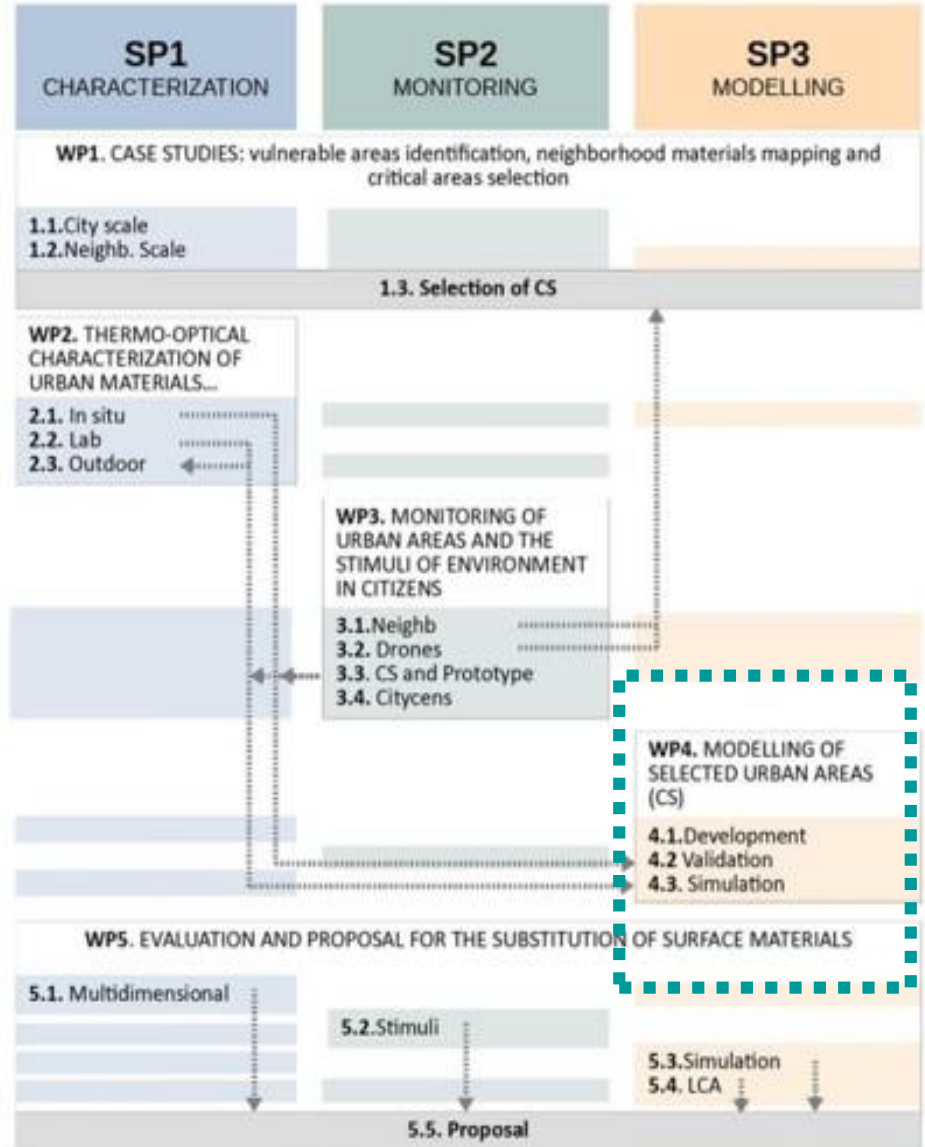
The fourth provides a **modelling strategy** to evaluate mutual relations amongst relevant urban factors building energy performance and outdoor thermal comfort





Generation of micro-urban meteorological files;

Sky view factor prediction at pedestrian level; Calculation of the Mean Radiant Temperature (MRT); Ealuation of thermal comfort; Calculation of the Universal Thermal Climate Index (UTCI)



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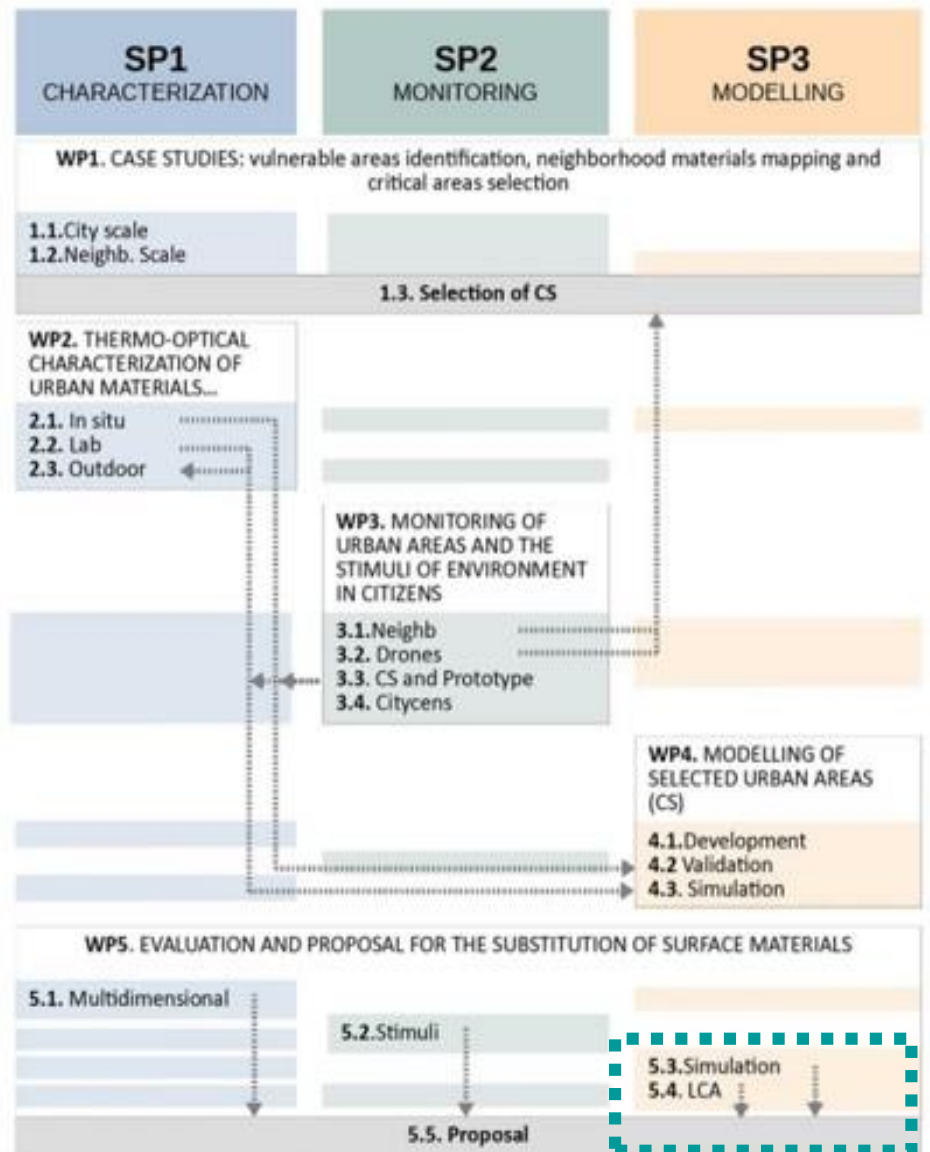
Measure, Calibration and Simulation strategy

The final step prepares a complete and justified proposal for the substitution of surface materials in the case studies based on the results obtained from previous steps. And assess the environmental impact of the materials along their life cycle. **LCA**



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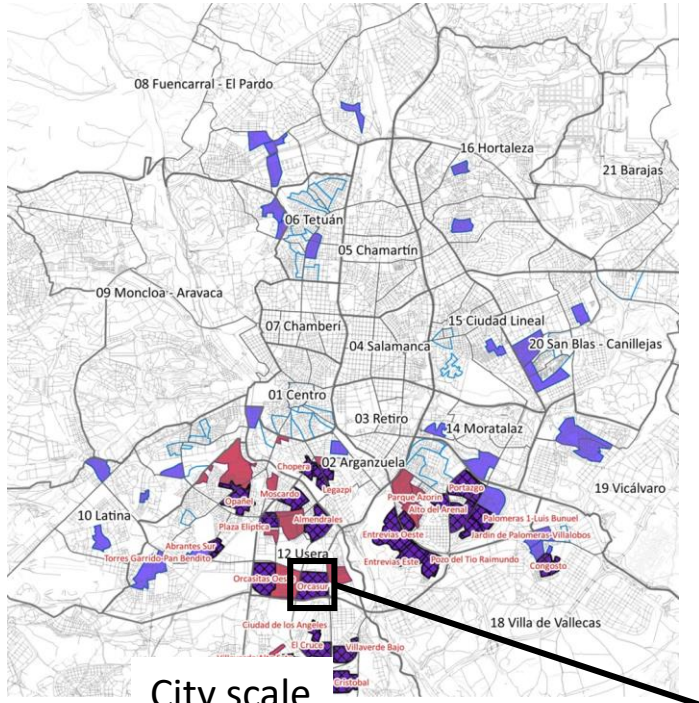
Selection of vulnerable urban areas for case studies

Identification of vulnerable areas

Energy poverty, heat island and urban morphology

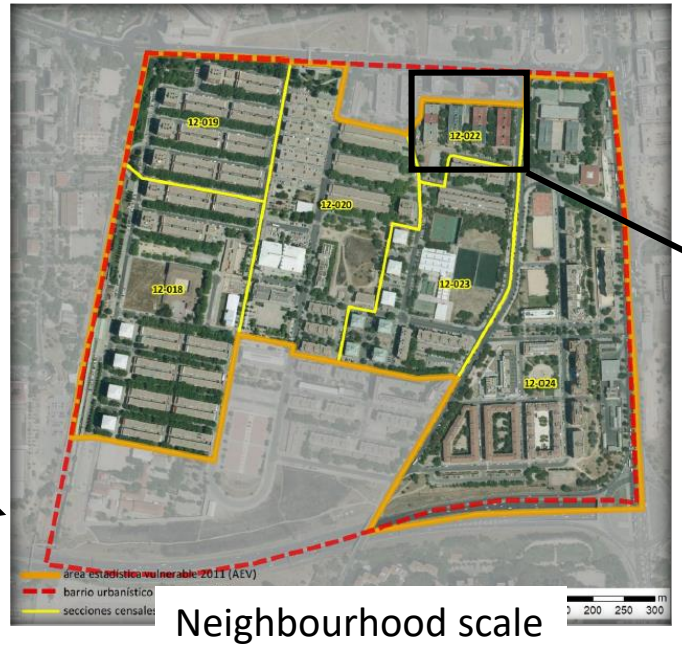


City scale

Neighborhood assessment

Map of materials in urban envelope

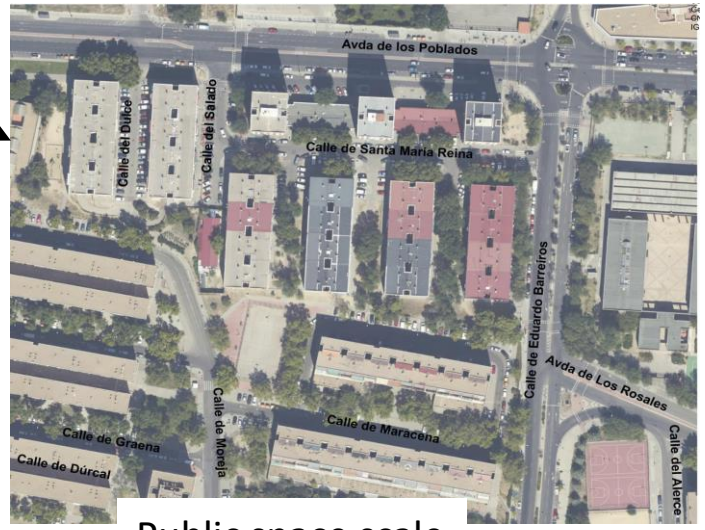
Monitoring of environmental conditions



Neighbourhood scale

Cases study selection

Critical and representative areas



Public space scale

Severity of urban vulnerability

Energy poverty index

UHI intensity day+night

SELECTION OF NEIGHBORHOODS

27 vulnerable neighborhoods affected simultaneously by problems of energy poverty and high intensity of the urban heat island

Deprived Neighbourhoods with excess summer Urban Heat Island and winter Fuel Poverty risk

From: IETcc-CSIC. Paper presented to PLEA2022

Table 1. Results for the selected neighbourhoods

DIST	NAME	POP.	DWL	DPV	EP	CDH
02	Chopera	9085	4205	VL	VC	3369
02	Legazpi	12445	5135	VS	VM	3457
02	Delicias	13770	6575	VL	VS	3457
11	T.G-P. Bend.	10420	3825	VC	VC	3374
11	Abrantes S.	3710	1490	VM	VC	3374
11	Opañel	14160	5985	VS	VC	3407
12	Orcasitas O.	11950	4835	VL	VM	3437
12	Pl. Eliptica	4280	1785	VM	VC	3473
12	Moscardo	5600	2320	VS	VL	3473
12	Almendrales	7470	3105	VC	VS	3494
12	Orcasur	6515	2295	VM	VS	3494
13	Portazgo	10105	4165	VM	VC	3327
13	A. del Arenal	5515	2235	VM	VC	3327
13	Pal.-Villalobos	12245	4655	VS	VS	3331
13	Pal.-Buñuel	12035	4710	VM	VS	3331
13	P. Azorin	6820	2885	VS	VC	3420
13	Entrevias E.	7875	3100	VM	VC	3457
13	Entrevias O.	16270	6730	VM	VC	3457
13	PT Raimundo	4065	1475	VM	VL	3457
13	Picazo	9585	4005	VC	VC	3469
17	Villaverde A. S	12535	5140	VC	VC	3325
17	Villaverde A. E	5815	2225	VC	VC	3325
17	San Cristobal	14785	5100	VC	VC	3367
17	Villaverde B.	11840	4655	VC	VS	3464
17	C de los Ángeles	5555	2470	VM	VC	3469
17	El Cruce	6130	2410	VM	VS	3469
18	Congosto	10410	4140	VM	VC	3349
	TOTAL MADRID	250990	101655			

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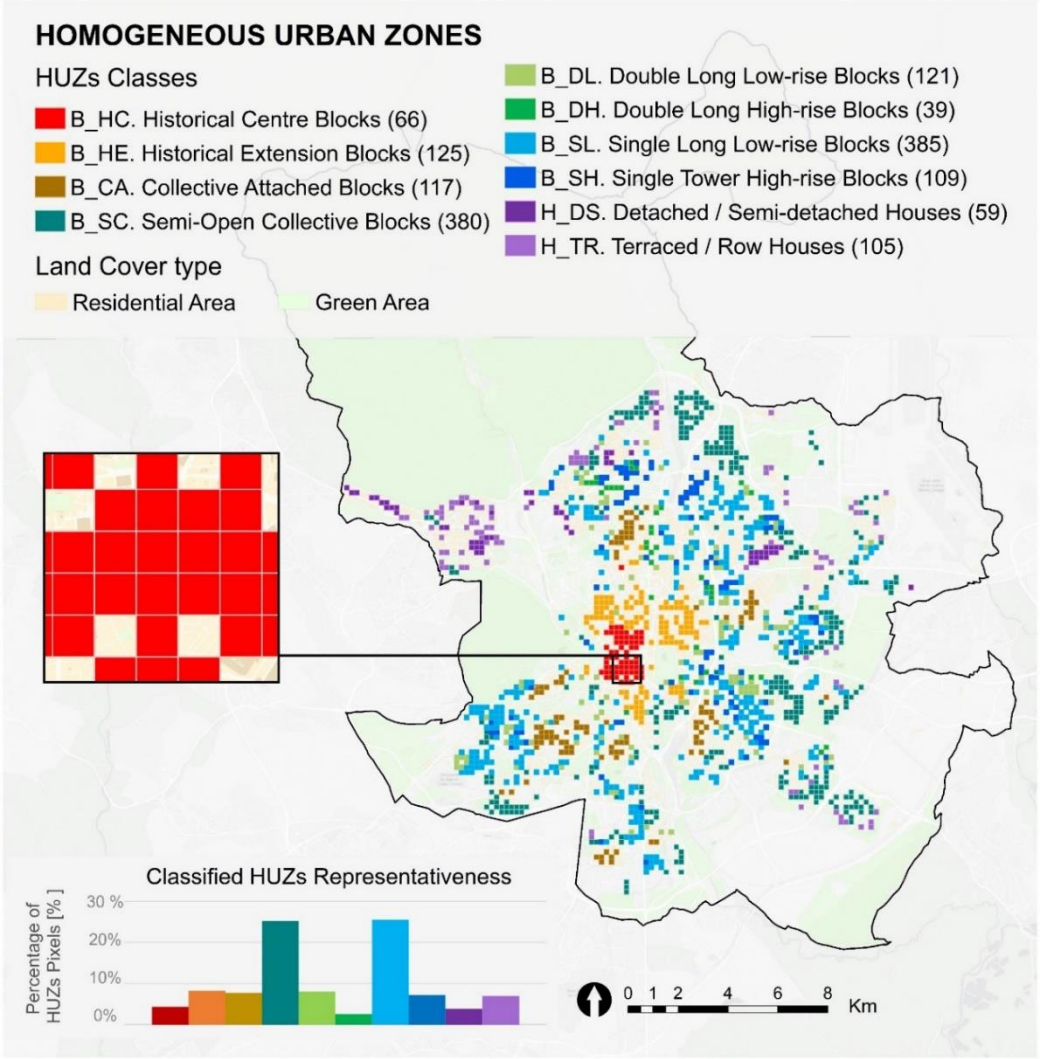
Morphology

Analysis of the urban morphology in the affected neighborhoods using the HUZs methodology

HUZ (Homogeneous Urban Zones) METHODOLOGY

Objective: Facilitate energy analysis in residential buildings.

Promote energy rehabilitation and urban regeneration.



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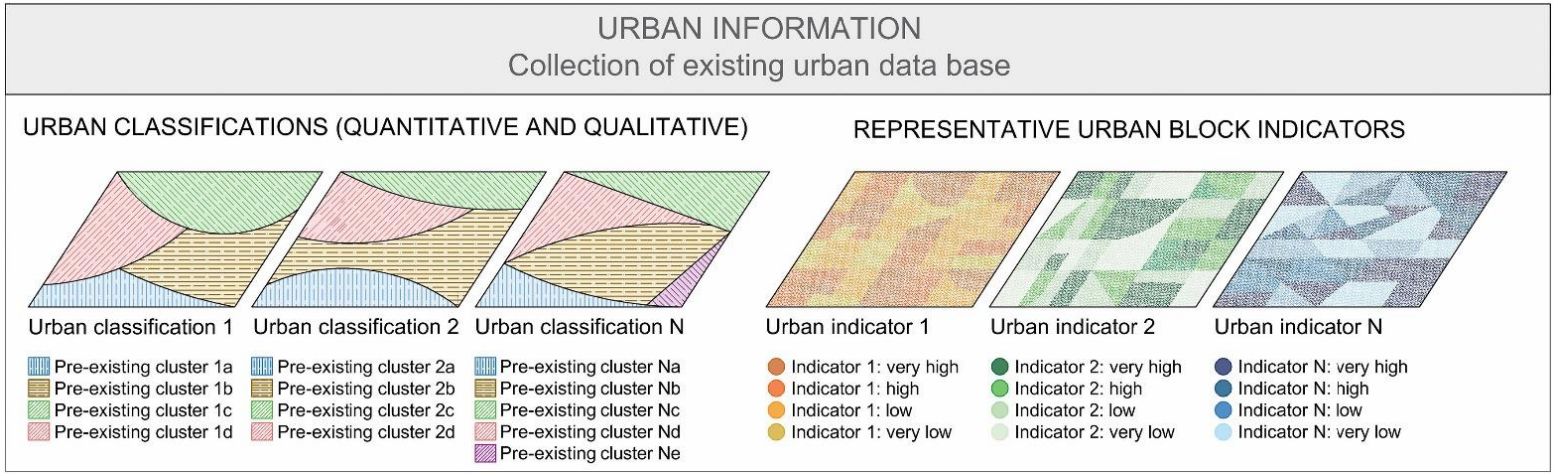
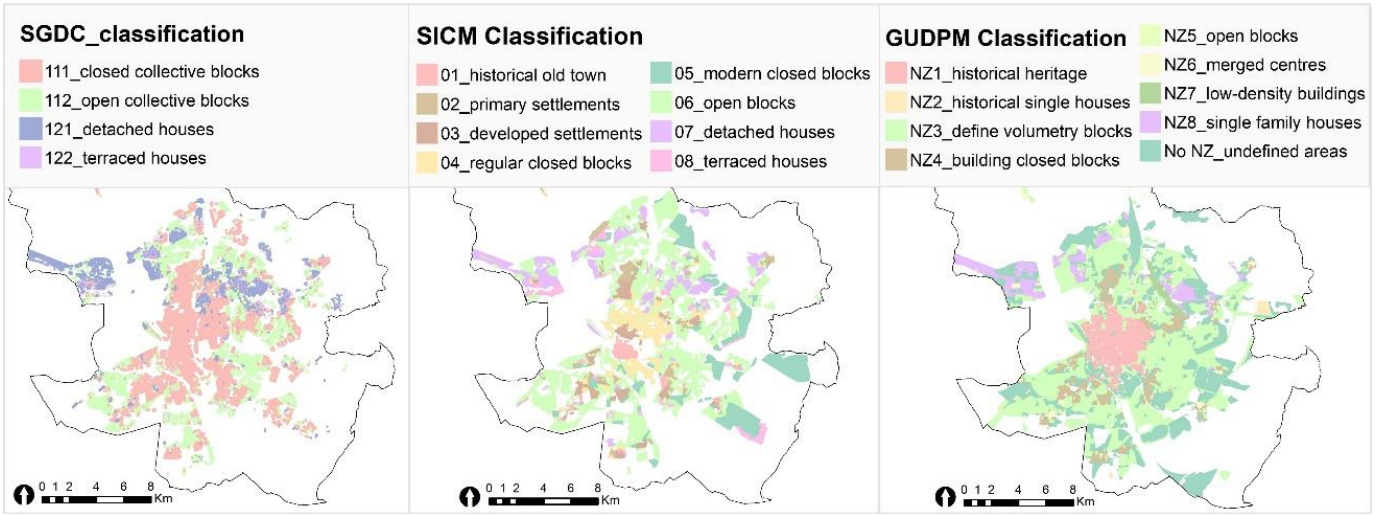
HUZ (Homogeneous Urban Zones) METHODOLOGY



Phase 1 collect relevant data from existing urban databases



From: H. López-Moreno, et al., On the identification of Homogeneous Urban Zones for the residential buildings' energy evaluation, Building and Environment, Volume 207, Part B, 2022, 108451, https://doi.org/10.1016/j.buildenv.2021.108451.

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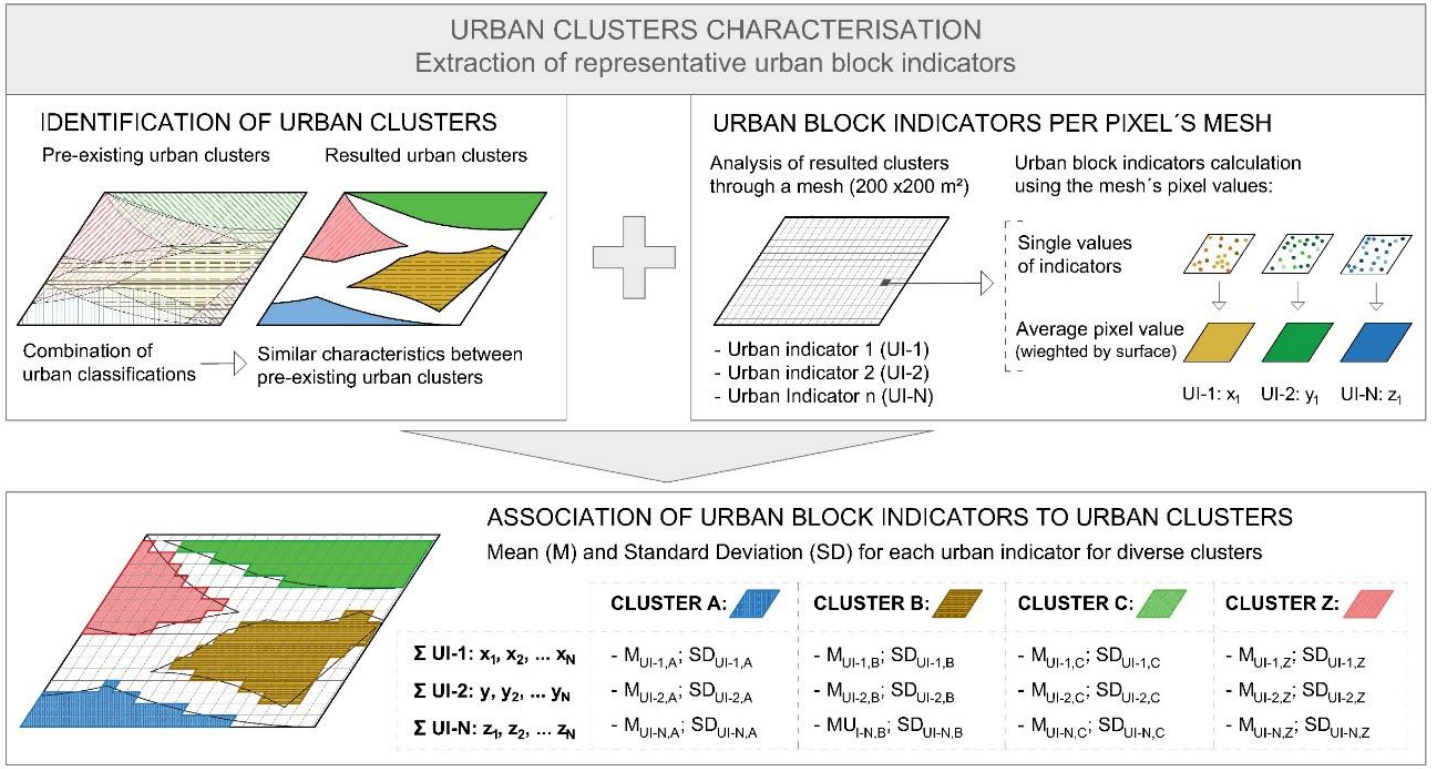
HUZ (Homogeneous Urban Zones) METHODOLOGY

Phase 2 characterize urban clusters based on existing classifications



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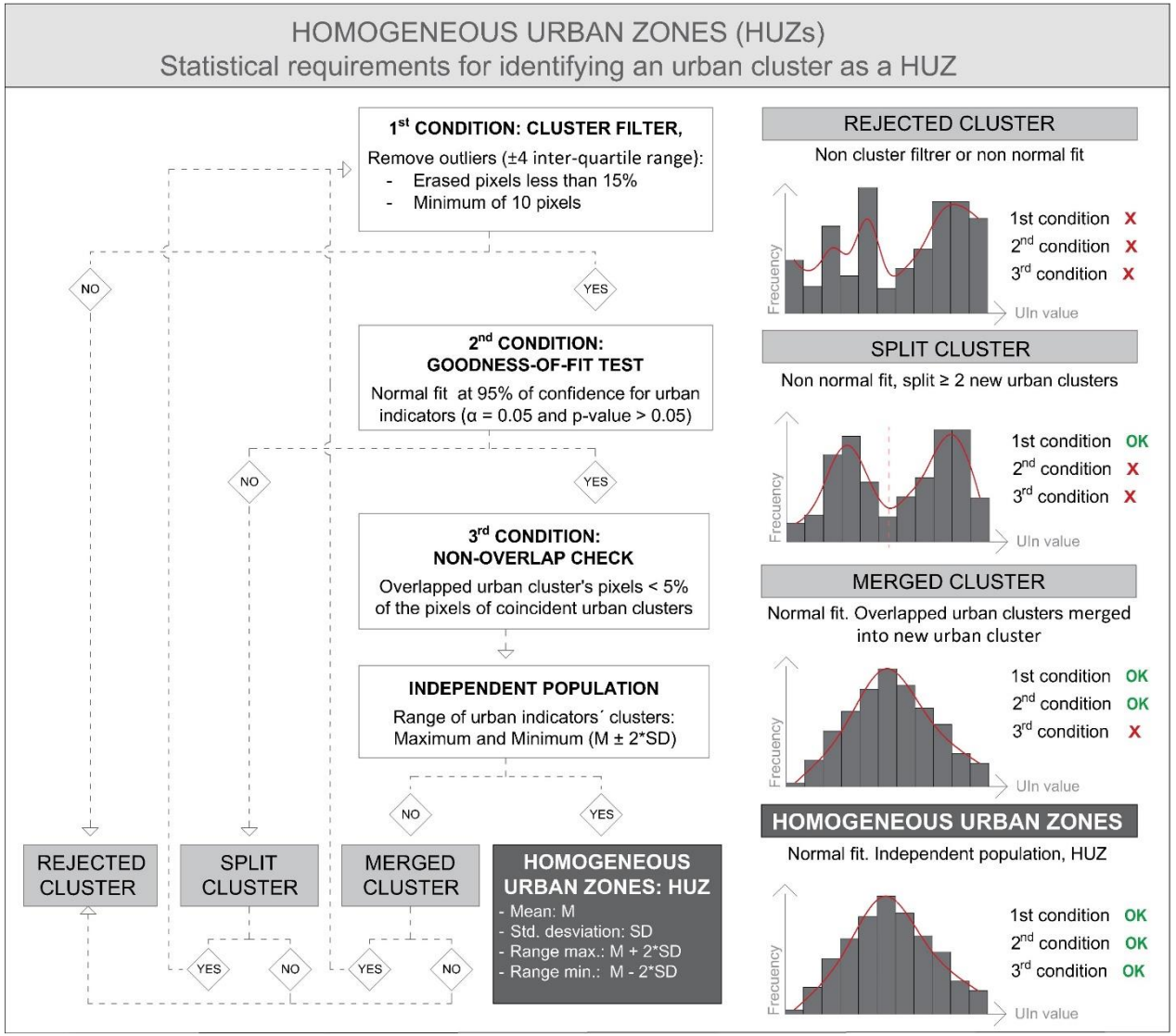
HUZ (Homogeneous Urban Zones) METHODOLOGY

Phase 3 statistical validation of urban clusters such as HUZ



From: H. López-Moreno, et al., On the identification of Homogeneous Urban Zones for the residential buildings' energy evaluation, Building and Environment, Volume 207, Part B, 2022, 108451, https://doi.org/10.1016/j.buildenv.2021.108451.

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HUZ (Homogeneous Urban Zones) METHODOLOGY in Madrid

B_HC. Historical Centre Blocks

B_HE. Historical Extension Blocks

B_CA. Collective Attached Blocks

B_SH. Single Long High-rise Blocks

B_DL. Double Long Low-rise Blocks

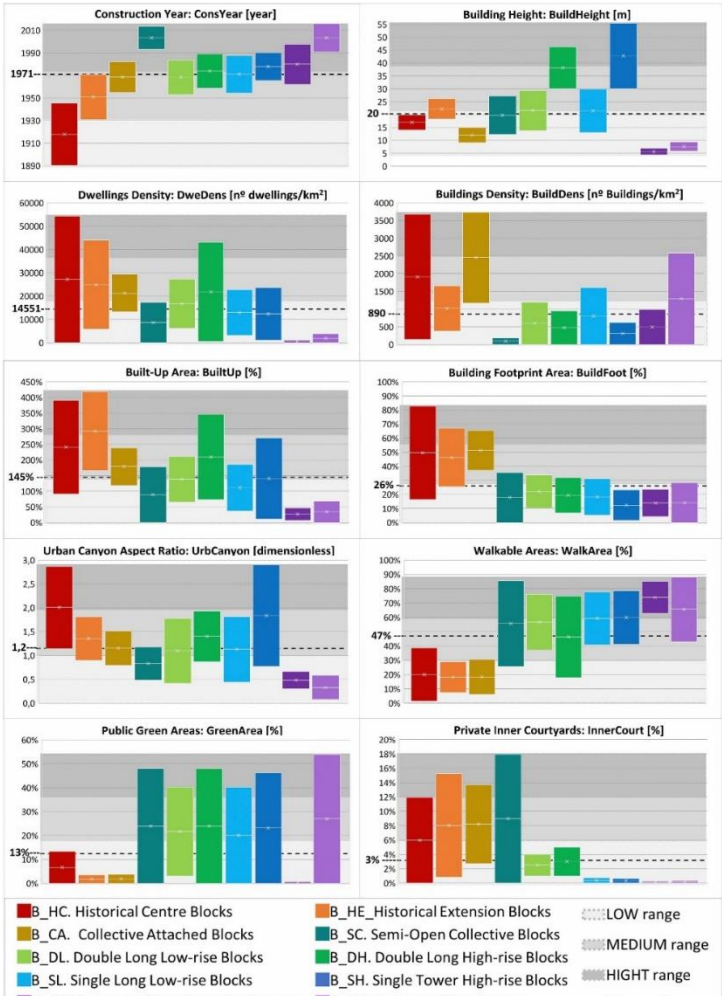
B_DH. Double Long High-rise Blocks

B_SL. Single Long Low-rise Blocks

H_TR. Terraced/ Row Houses

H_DS. Detached/ Semi-detached Houses

B_SC. Semi-open Collective Blocks

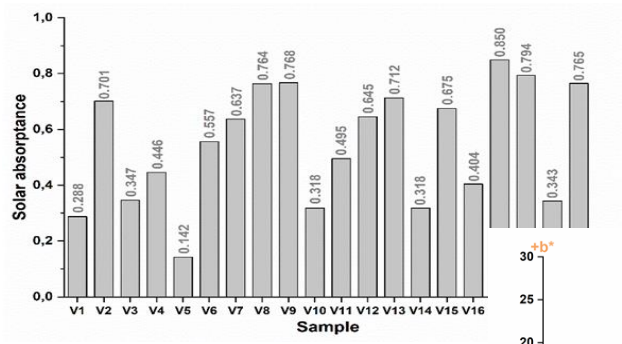


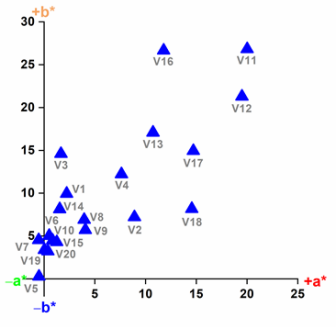
The relevance of the envelope materials in the urban environment

Thermo-optical characterization of urban materials

On-site materials

- In-situ characterization with portable equipment





Neighborhood	**Picazo**
Date of data collection	18/01/2022
Campaign	1 - Identification
VERTICAL FINISHING MATERIALS	
A. GENERAL DATA	
Reference	**TVS-5**
Image	
Location	García Llamas 16
Wall height	3 to 5
Wall orientation	South-east
Frequency of use	>50%
B.1. MORFO-MATERIAL CHARACTERISTICS	
Surface material	Brick
Color	Orange
Tone	Mean
Ageing level	Mean
Texture	Mean
Unit size (cm)	4x9
B.2.OPTO-THERMAL PARAMETERS	
Solar absorptance	0.495
Visible absorptance	0.657
Color coordinates (L*/a*/b*)	60.6/20.0/26.8
Infrared emissivity	Pending

From: Pérez, G et al. Infrastructures 2022, 7, 116. https://doi.org/10.3390/infrastructures7090116

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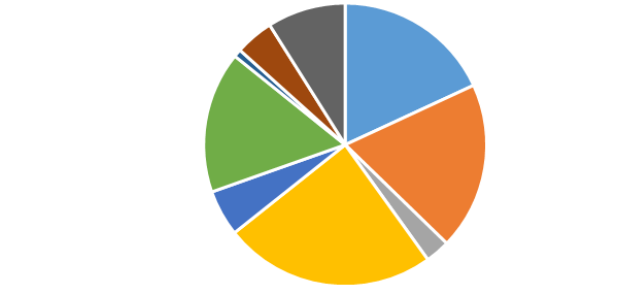
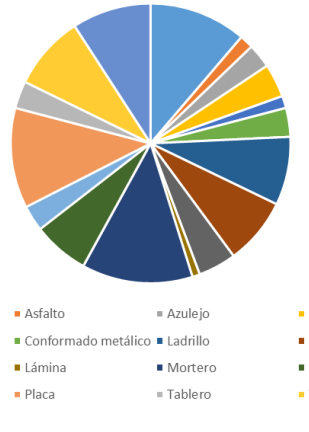
Thermo-optical characterization of urban materials

Materials available for substitution

- Laboratory characterization
- Commercial and innovative materials

32 COMPANIES
569 SAMPLES

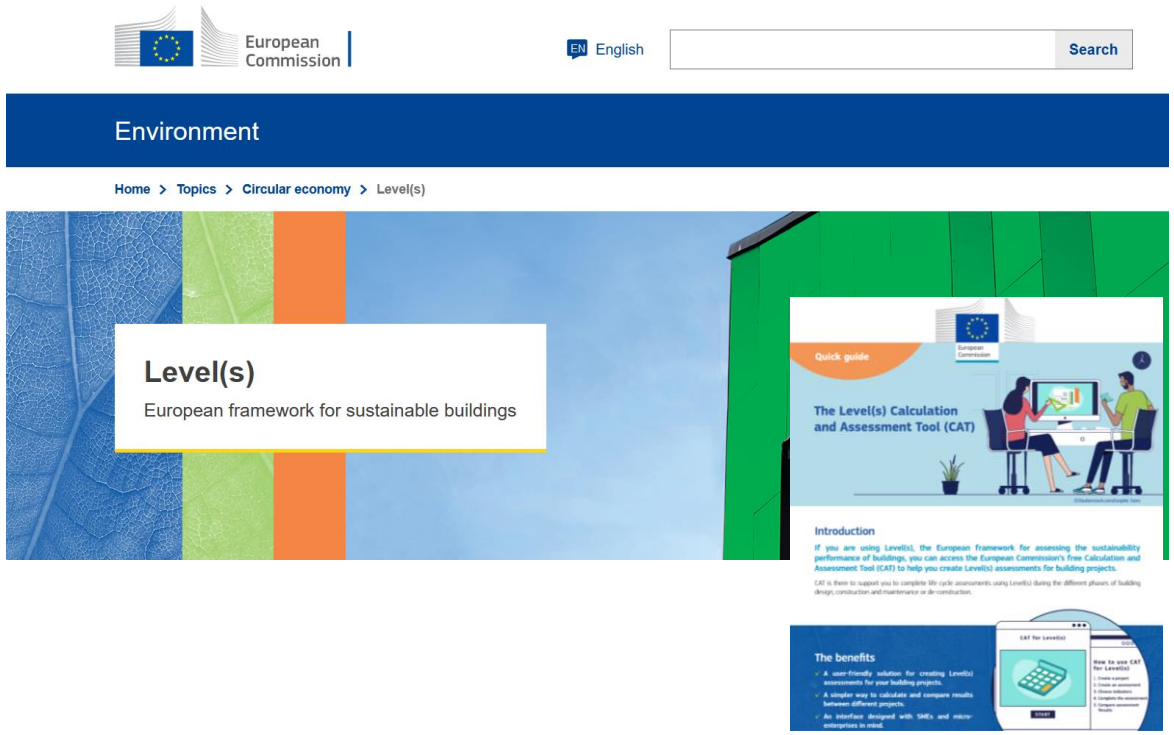




The relevance of the envelope materials in the urban environment

Conclusions

LCA in CE



European Commission > JRC > JRC Publications Repository > The JRC-EU-TIMES model - Assessing the long-term role of the SET Plan Energy technologies

The JRC-EU-TIMES model - Assessing the long-term role of the SET Plan Energy technologies

2013 | *Science for policy* | Energy and transport | Environment and climate change

Abstract: The JRC-EU-TIMES model is one of the models currently pursued in the JRC under the auspices of the JRC Modelling Taskforce. The model has been developed over the last years in a combined effort of two of the JRC Institutes, IPTS and IET. The JRC-EU-TIMES model is designed for analysing the role of energy technologies and their innovation for meeting Europe's energy and climate change related policy objectives. It models technologies uptake and deployment and their interaction with the energy infrastructure including storage options in an energy systems perspective. It is a relevant tool to support impact assessment studies in the energy policy field that require quantitative modelling at an energy system level with a high technology detail. This report aims at providing an overview on the JRC-EU-TIMES model main data inputs and major assumptions. Furthermore, it describes a number of model outputs from exemplary runs in order to display how the model reacts to different scenarios. The scenarios described in this report do not represent a quantified view of the European Commission on the future EU energy mix.

Authors: GAGO DA CAMARA SIMOES Sofia; NIJS Wouter; RUIZ CASTELLO Pablo; SGOBBI Alessandra; RADU Daniela; BOLAT Pelin; THIEL Christian; PETEVES Efstathios

Citation: Gago Da Camara Simoes S, Nijs W, Ruiz Castello P, Sgobbi A, Radu D, Bolat P, Thiel C, Peteves E. The JRC-EU-TIMES model - Assessing the long-term role of the SET Plan Energy technologies . EUR 26292. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC85804

Publisher: Publications Office of the European Union

JRC number: JRC85804

Grants PID2020-114873RA-C33 funded by

Conclusions

The present project aims to advance to fill gap, presenting a to optimize urban materials and validating their viability via experimental research, monitoring and simulation.

This kind of strategy will be useful for planners and designers and will be support for assisting the public policymakers and regulators in decision making processes and in public purchase and sale.

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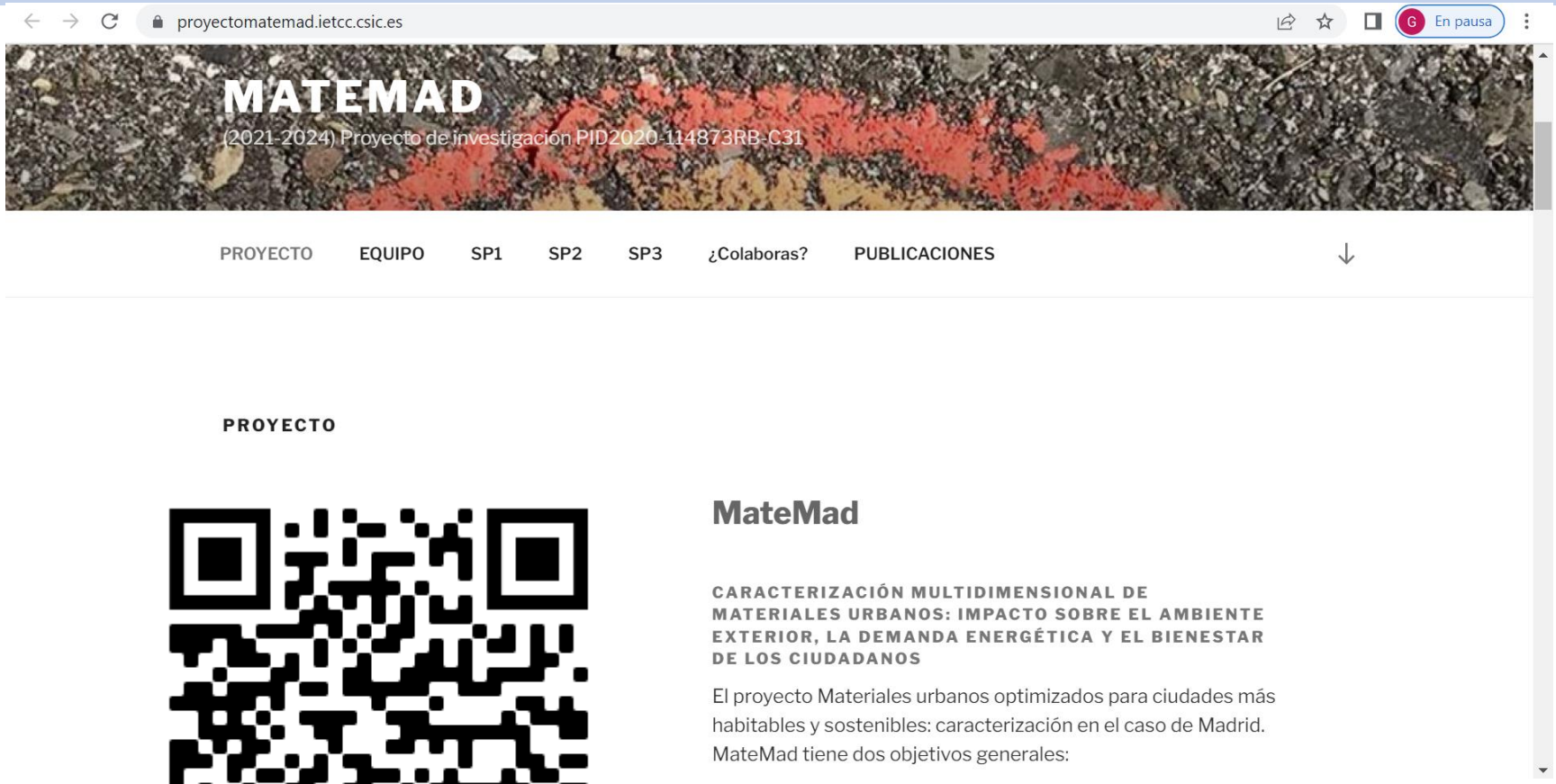
The relevance of the envelope materials in the urban environment



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THE FUTURE ENVELOPE

TOWARDS ZERO CARBON BUILDINGS

15-16 December 2022 Bolzano/Bozen

THE RELEVANCE OF THE ENVELOPE MATERIALS IN THE URBAN ENVIRONMENT

Questions and Comments

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