Collaboration model for participation in European initiatives within the framework of the Twin Transition

Mobility, energy, and resource management in smart cities.

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SMARTCITY EXPO WORLD CONGRESS

[CENTRO TECNOLÓGICO] 30 CARTIF ANIVERSARIO

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01 UNDERSTANDING MADRID CONTEXT

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Madrid City challenges

- Big Cities are **complex** but offer a **vast range of solutions** to face multiple challenges, from mobility to energy efficiency.
- Madrid is **always open for public-private collaboration**.
- CARTIF and the Digital Office of Madrid are collaborating to **foster innovation** in different areas **(mobility, energy, and infrastructure management)** but always via **digitalization.**
- As part of the cities mission: improve the **quality of life** in Madrid through cutting-edge technology, innovation in government policies.

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1. Strategic Framework

2. Technology Strategy

3. Operative Framework

- 5G Forum
- Enterprise Forum

Public-private collaboration

- UPM
- IoTLAB

Digital Transformation office:

- 5G Technical office

4. Main Current Activities

- Intelligent Urban Spaces (Espacios Urbanos Inteligentes)
- 5G Corridors
- Demonstrative projects
- 5G Agenda Update

IA

Cibersecurity

Data Strategy

Sustainability

Govtech

Funded by the European Union

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02

WHAT CARTIF OFFERS?

PORTFOLIO OF SOLUTIONS & PROJECTS

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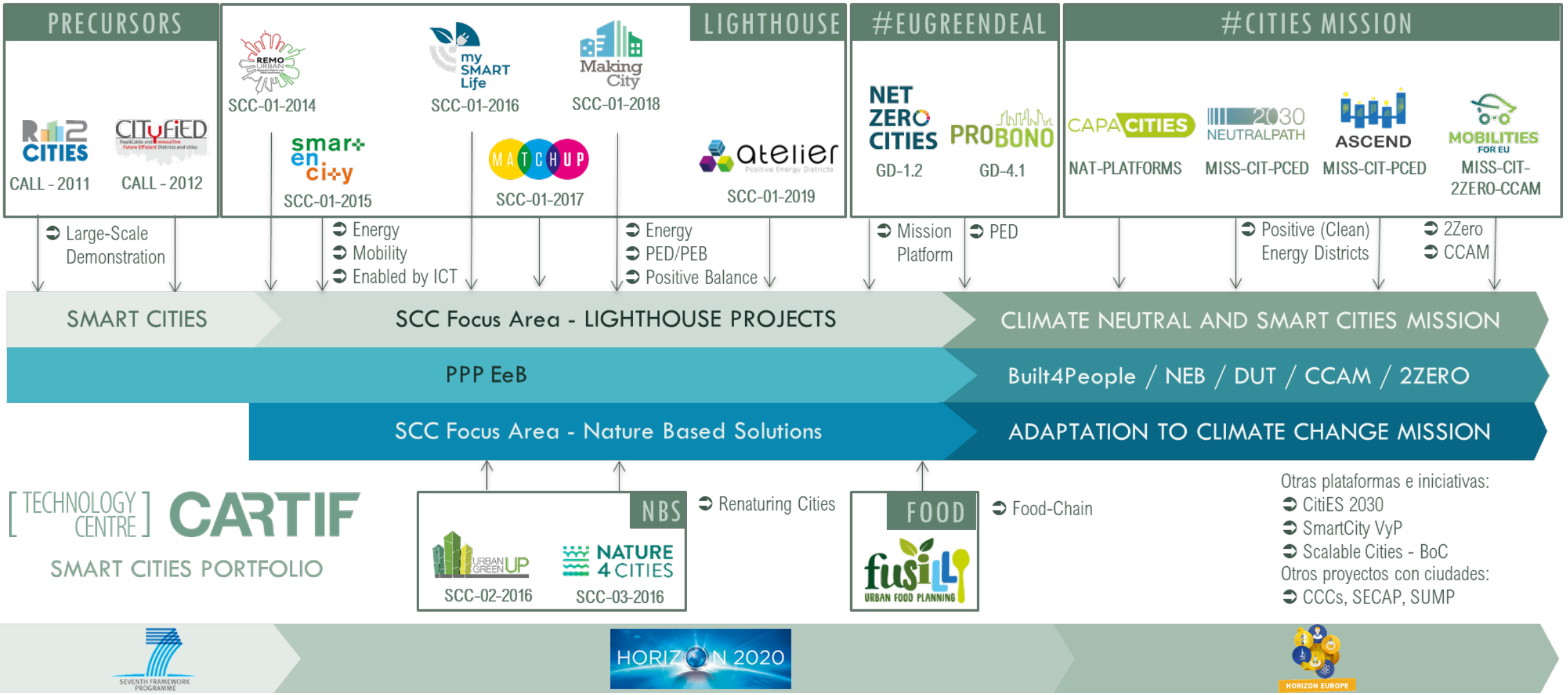

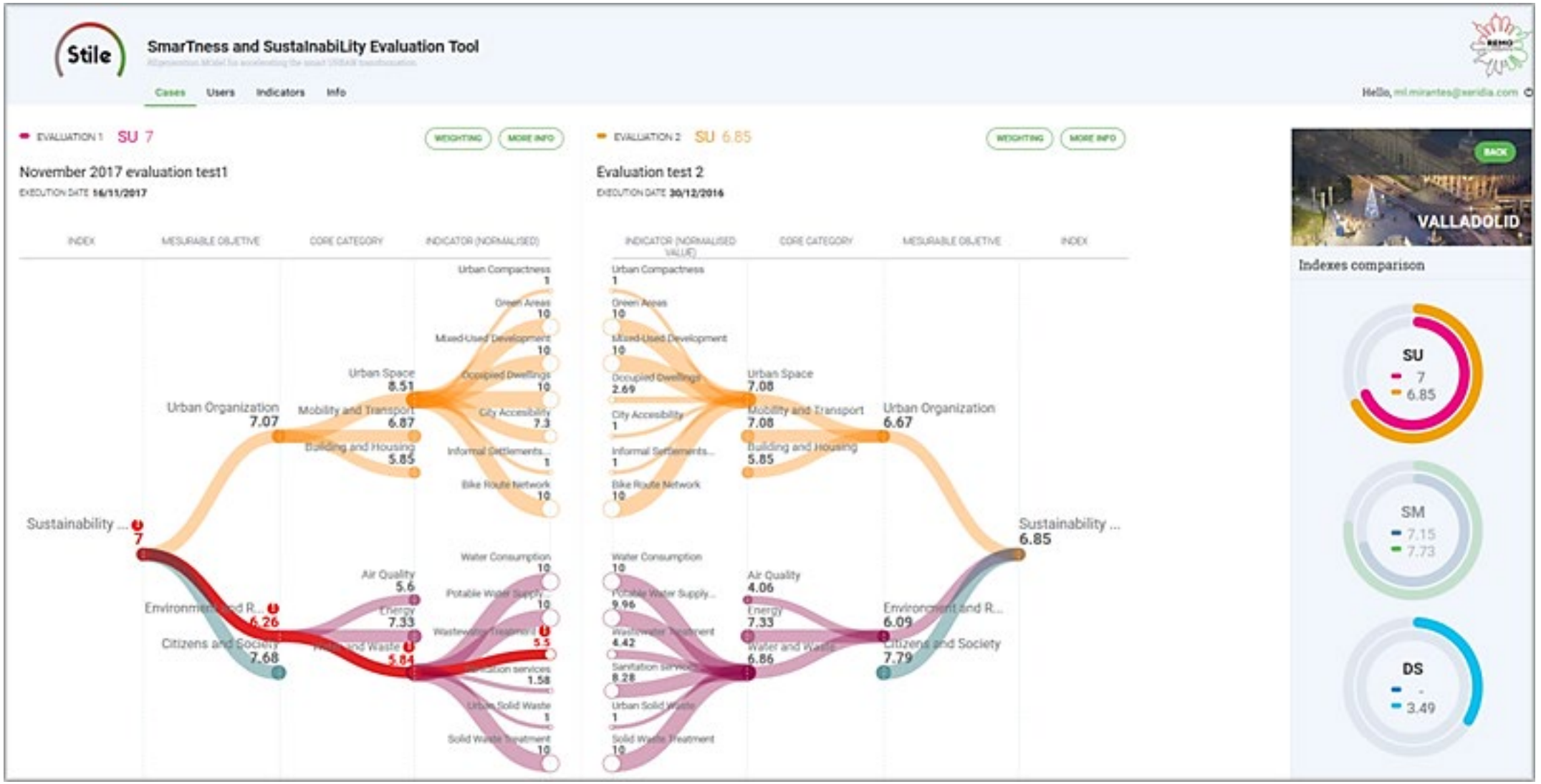

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KPISERVICE

smart en city

SmartEnCity KPI Service Logout

PILLARS

- Energy
- Comfort
- Mobility
- ICT
- Social & Citizen
- Environmental
- Economic

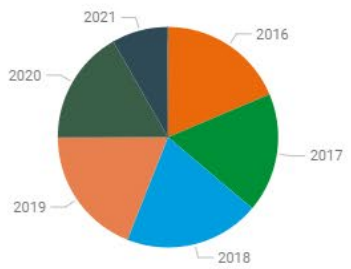
Total Primary Energy (kWh/m2·yr)

66,08

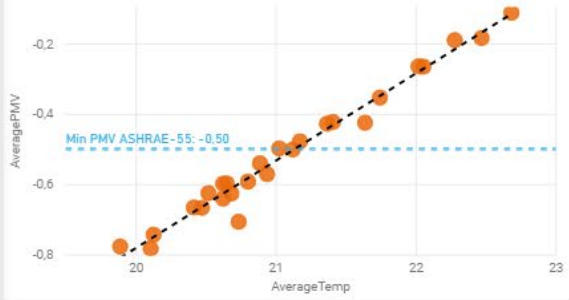
Address	Building Code
ALDABE 10	59_530_3
ALDABE 12	59_531_1
ALDABE 16	59_530_6
ALDABE 19	59_499_4
ALDABE 26	59_521_1
ALDABE 3	59_507_1
ALDABE 5	59_506_1
ALDABE 7	59_505_1
BADAIA 5	59_553_3
BADAIA 7	59_553_2
BADAIA 8	59_508_5
CERCAS BAJAS 35	59_553_6
CORONACION VIRGEN BLANCA 13	59_454_4
CORONACION VIRGEN BLANCA 3	59_444_5
CORONACION VIRGEN BLANCA 6	59_516_1
CORONACION VIRGEN BLANCA 8	59_516_2
DOMINGO BELTRAN DE OTAZU 18	59_512_1
DOMINGO BELTRAN DE OTAZU 22	59_513_1
EULOGIO SERDAN 4	59_473_5

Total Energy use (kWh/m2) per building

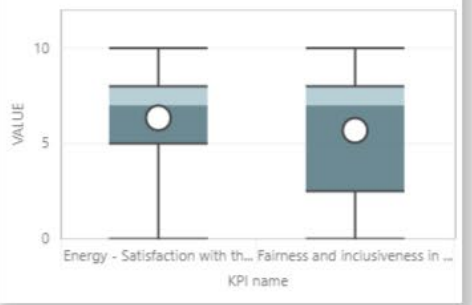
Total primary energy due to buildings by year



Indoor temperature vs PMV per building



Satisfaction and involvement of citizens



- 73 %

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691883.

[TECHNOLOGY CENTRE] CARTIF

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RENERMAP

Renewable potential available at municipal level: Solar and mini-wind potential (on rooftops and land), Biomass and geothermal energy to meet the energy demand.

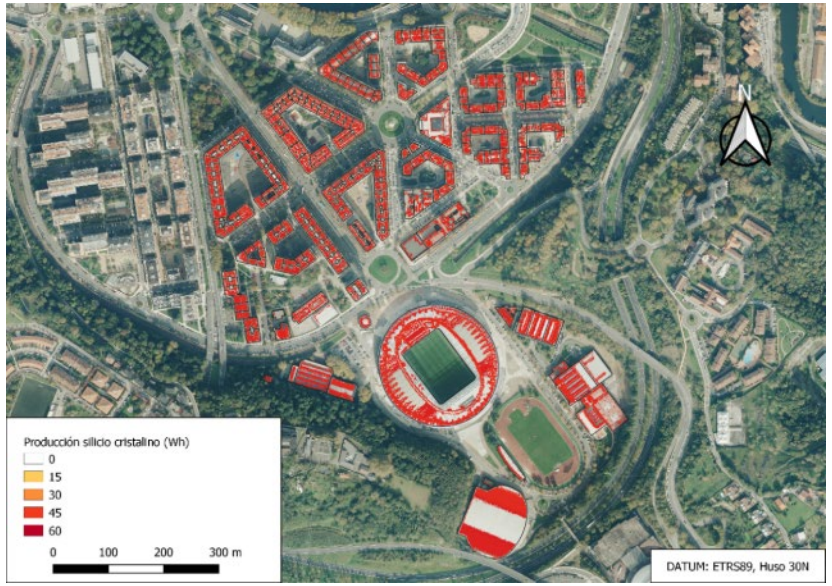
Balance production vs. demand (territorial and building level), considering electrical and thermal demand of buildings.

Characteristics (solar potential):

- **Python library for photovoltaic production**
- **Detailed calculation of photovoltaic solar production**:
  - Spatial resolution of 1 meter.
  - Hourly production data.
  - Hourly calculation of shadow effects.
- Panels are integrated in the same plane as the roof.
- The calculation considers the area required for panel access and losses (due to aspect and slope).
- Two different technologies: crystalline silicon and amorphous silicon.
- The library is configured (command-line interface) to select a building or a group of buildings (municipality, district).

Results (solar potential):

- Hourly photovoltaic solar production (8760 raster maps),
- Solar radiation (8760 raster maps),
- Hourly photovoltaic solar production of each building considering the available roof space (CSV file).



Photovoltaic potential of the rooftops in the study area, considering the panel's location on the roof plane for May 1st at 12:00 PM with crystalline silicon technology.
Note: Each pixel in the image represents 1 m², so the potential is in Wh/m².

Process

1. Data from public databases → **MODULE 1- INFORMATION INPUT**
2. Solar production algorithm → **MODULE 2- CALCULATION ENGINE**
3. GIS Maps (radiation + production) + csv file → **MODULE 3- VISUAL OUTPUT + DATA**

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GIS4ENER

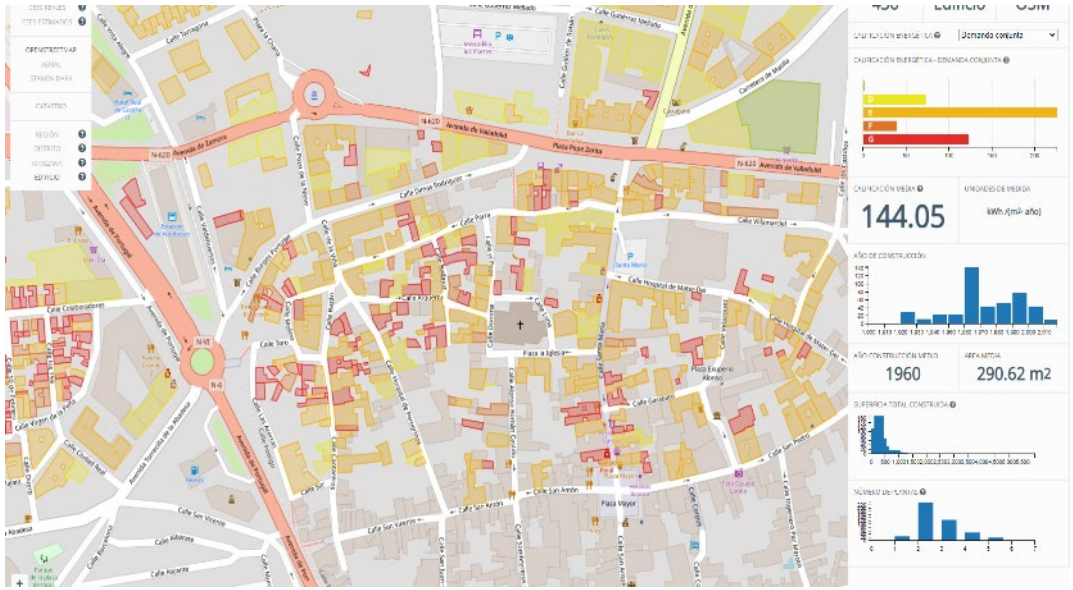
Mapping of energy demand and consumption, as well as CO2 emissions of buildings within a district, city, or region, based on information from public data sources (electronic headquarters of the cadastre and a materials catalog).

Characteristics:

- Multiple calculation approaches:
  - Demand calculation >> large-scale **automation of the CE3X tool** (neighborhood or city level).
  - **Demand, consumption, and CO2 emissions** >> typologies automatically generated with actual **Energy Efficiency Performace Certificates (EPC).**
  - **Demand, consumption, and CO2 emissions** >> calculations based on the **Energy Performance of Buildings Directive (EPBD).**
- Georeferencing of information and data aggregated by blocks and districts.
- Process automation, reducing time needed to obtain results compared to conventional methods.
- Results can be viewed from any browser and open-source GIS software.

Results:

Demo GIS4ENER



1. Data from public databases → **MODULE 1- INFORMATION INPUT**
2. Energy Performance Certificates → **MODULE 2- CALCULATION ENGINE**
3. Sistemas de información geográfica → **MODULE 3- VISUAL OUTPUT**

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PEDTOOL

Web tool to guide cities during the pre-design process of a Positive Energy District (PED). The tool qualitatively assists urban planners / designers in the decision making process, suggesting technical and non-technical solutions for the city.

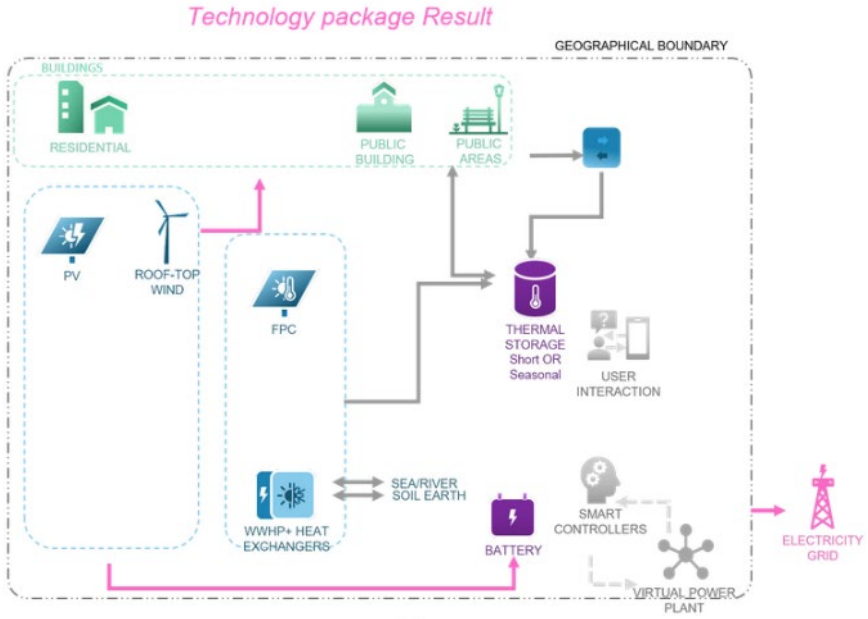
https://tools.cartif.es/ped-tool/

Main Features (key points):

- **8 categories of questions to assess the district's viability**
  - Level of ambition and boundaries of the district
  - Energy needs to be met
  - Available resources (for on-site generation)
  - Urban form (area of regeneration, protected, etc.)
  - Types of buildings (use) in the district.
  - Energy infrastructure (existing and desirable)
  - Energy services (existing and desirable)
  - Social structure
- 3 functionalities: Create a PED scenario + Edit a PED scenario + Explore the PED technologies catalogue

Results:

- **PED layout**
- **Recommendations for technical solutions** with different energy vectors and their energy exchange with external networks and the mobility sector, tailored to the specific city needs.



1. Questionnaire (save + edit available) → MODULE 1- INPUT DATA
2. Internal logic → MODULE 2- DSS MODULE
3. PED layout (to be exported as .pdf) → MODULE 3- VISUAL LAYOUT OUTPUT

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*The Tool for PED technologies selection is the result of a successful collaboration between **ATELIER** and **Making City** H2020 Projects for supporting the promotion of PEDs as a powerful instrument to be a step closer in the energy transition towards the desired city*

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REWARDHeat

Tool to guide users in the preliminary design of a low-temperature urban district heating network, based on the assessment of existing urban energy generation sources and potential heat recovery sources.

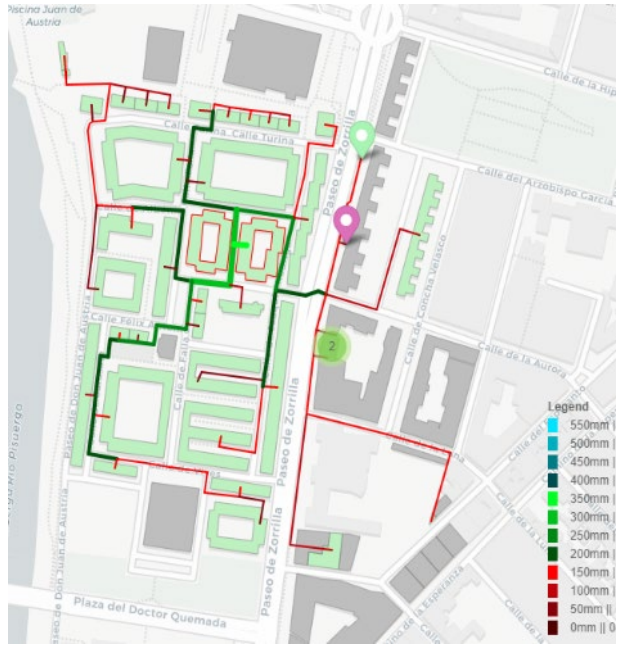
REWARDHEAT Tool

Main Features:

- The tool provides an easy-to-use interface for designing District Heating Networks (DHN) under a client-server architecture.
- Allows testing **different network configurations**: **conventional, 4th generation, 5th generation**
- Uses open databases for inputs such as:
  - Climate data: Solar radiation and temperature → PVGIS and Copernicus C3S
  - Building height: Envelope area → Analysis using Copernicus Urban Atlas → Height = f (Area)
  - OpenStreetMaps for street layout and building identification

Results

- Calculation of building energy demand (based on EPBD)
- Optimized design of the heating network (optimal routing)
- Network sizing (calculation of flow at each node)
- Scenario comparison with respect to the baseline (KPIs: Final energy, primary energy, CO2, OPEX)
- Option comparison (KPIs: Thermal losses, pressure losses, CAPEX)



Buildings & Facilities → **MODULE 1- Baseline calculation**

Buildings, Energy sources, Streets → **MODULE 2- Scenario builder**

DHN Type & Substation Parameters → **MODULE 3- Options evaluation**

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03

CLIMATE NEUTRAL AND SMART CITIES MISSION: THE PERFECT OPPORTUNITY

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EU Missions are “away to bring concrete solutions to some of our greatest challenges”

- **The cities mission "involve local authorities, citizens, businesses, investors as well as regional and national authorities to Deliver 100 climate-neutral and smart cities by 2030 and to ensure that these act as experimentation and innovation hubs for the others to come”**

- Leading digital and climate innovation
- Showcase solutions for other cities to follow
- Madrid is among the 53 European cities (7 in Spain) that received the “EU MISSION LABEL” through the 'Climate City Contracts.'

European Green Deal

Capacidades Digitales
Servicios Públicos
Infraestructuras digitales
Transformación de empresas

NET ZERO CITIES

EU MISSION LABEL
CLIMATE-NEUTRAL & SMART CITIES

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European Projects as Innovation Drivers

- The opportunities that EU funding offers for financing innovative projects in smart cities.
- **EU Cities mission**: Identifying opportunities in areas such as **digitalization in mobility and energy**, with projects funded by Horizon Europe and other European programs.
- Example: MOBILITIES FOR EU

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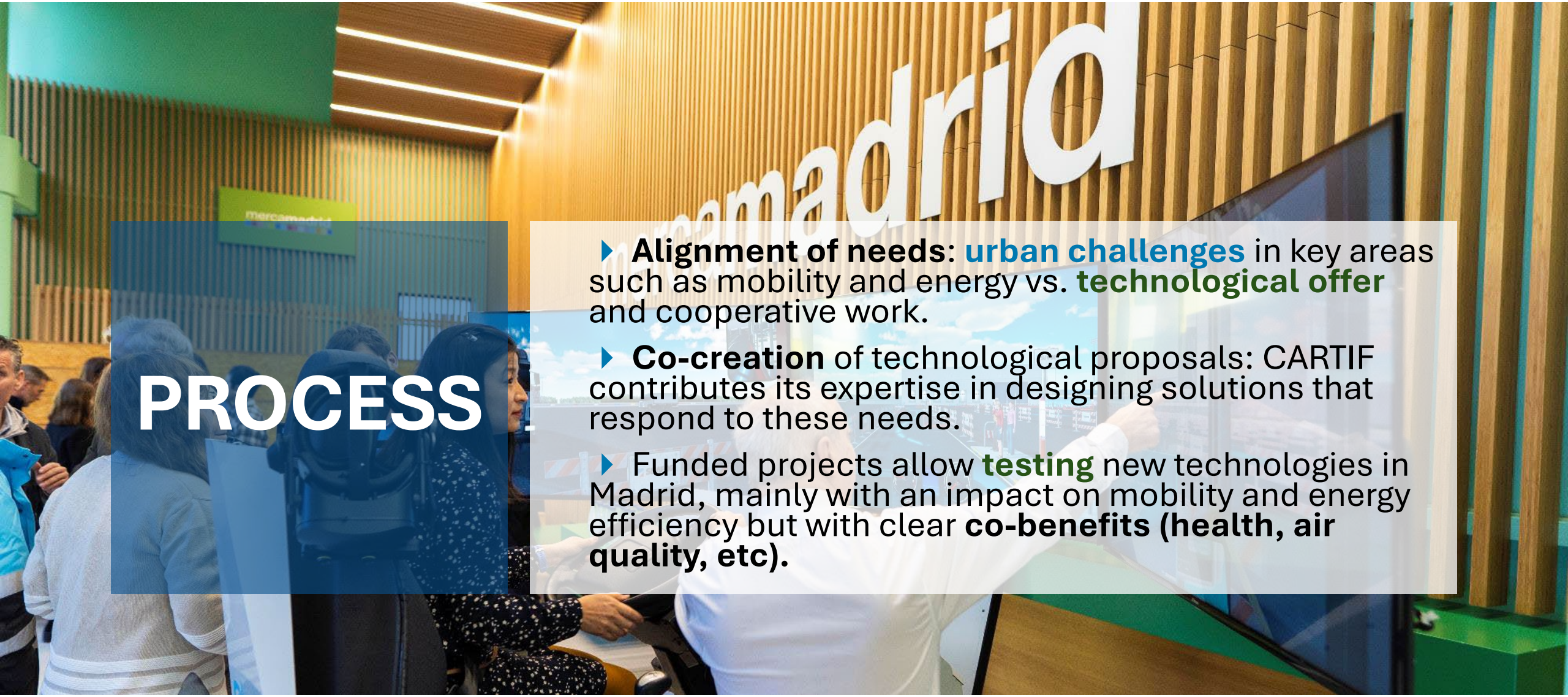

PROCESS

- **Alignment of needs**: **urban challenges** in key areas such as mobility and energy vs. **technological offer** and cooperative work.
- **Co-creation** of technological proposals: CARTIF contributes its expertise in designing solutions that respond to these needs.
- Funded projects allow **testing** new technologies in Madrid, mainly with an impact on mobility and energy efficiency but with clear **co-benefits (health, air quality, etc).**

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MOBILITIES FOR EU

...wants to demonstrate that innovative **passenger mobility** and **freight transport** concepts designed and implemented following **participative and user-center principles.** These **cost-effective and feasible** solutions contribute significantly to the cities' transformation towards climate-neutrality, allowing to speed up the process even to reach SCOPE 2 emissions reduction in 2030.

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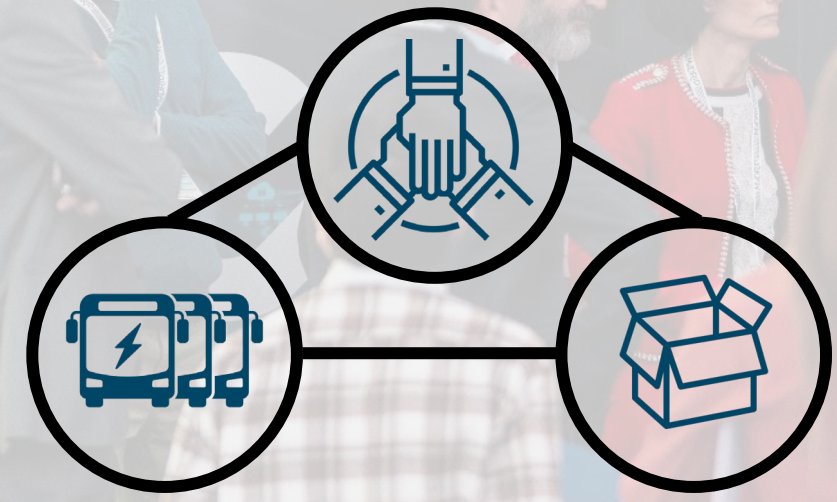
...**co-design** and **implementation** of innovative solutions for **mobility of people and freight**...



...exploiting the **combined potential of electrification, automation and connectivity** acting as **experimentation and innovation hubs** to help all EU cities to follow suit by 2050

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MOBILITIES FOR EU

Dresden.

MADRID

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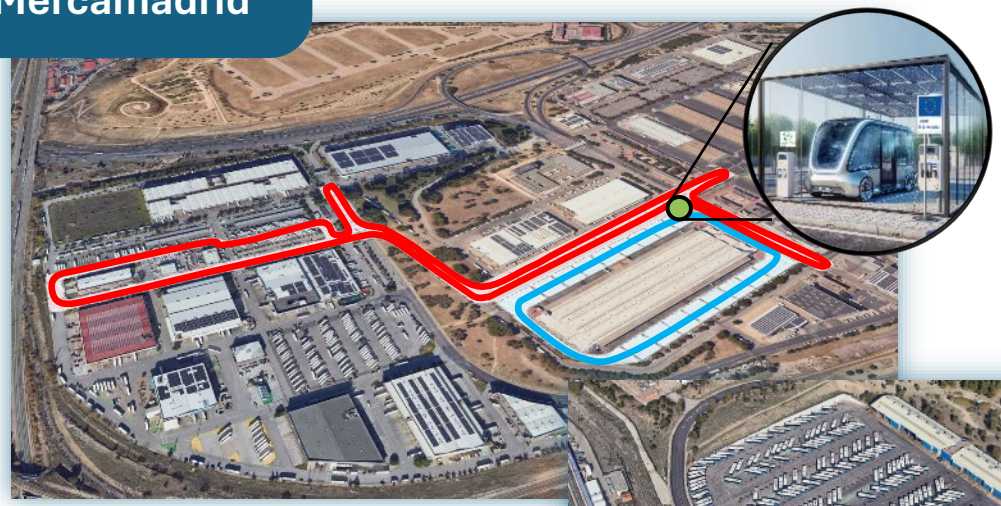
MADRID

Dresden.

Mercamadrid



EMT Entrevías bus Depót station

Ostra sports area & Messe Dresden area

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MADRID

- **1 autonomous e-vehicle** for last mile goods transport
- **1 autonomous e-vehicle**, 20 trolleys for automation of 12 waste collection points

- **1 mid-size autonomous e-bus** for mobility of people

Dresden.

- **2 charging robots** for dynamic charging tasks with 25kWh batteries
- **2 Autonomous small-scale freight transport vehicles** for service carts in sports sites

- **2 analysis of routes to tender autonomous mobility** in Dresden Fair and TV tower

4 AUTONOMOUS VEHICLES for FREIGHT TRANSPORT

2 AUTONOMOUS VEHICLES for PEOPLE TRANSPORT

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MADRID	Dresden.
■ RES-based Smart Grid for Transportation ■ Development of 7 fast V2G chargers ■ Flexibility and Digital Twin management ■ AI for digital/green connected charging infrastructure	■ 20 pantographs for e-buses ■ 6 smart energy tower/charging stations for small-scale transport vehicles (service cart) ■ Power-grid flexibility: demand-oriented transport and e-charging solution
■ 10 H2 fuel cell buses for mobility of people ■ 329 e-buses for mobility of people ■ H2 refuelling station ■ Electrification of bus depot (412 buses)	■ 3 VW electric vehicle models to test charging robots in real operation conditions ■ 20 e-buses ■ 1 tuneable e-car for mobility of people with bi-directional charging

7 Innovative CHARGING INFRASTRUCTURE and RES

7 CLEAN and GREEN FUEL

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MADRID

Dresden.

- Green energy data space in mobility for the decarbonization of cities
- Development of 5G Stand Alone private Network

- Platform integration of an image processing system
- Platform for systems servicing people and freight-based systems with AI
- Mobility Data Space: sovereign mobility data ecosystem for automated driving
- Stand alone and non-stand alone communication network. Slicing and preparation for 6G
- Infrastructure assistance and automated driving via Control Center - V2X Communication for autonomous driving.

4 Innovative SERVICES

3 INFRASTRUCTURE CONNECTIVITY for CCAM

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WHY IT WORKS?

- Mutual trust
- Do not force things.
- CARTIF: Development of technologies and pilot tests in urban contexts.
- Madrid (DO) provides the perfect urban environment for implementation with the local ecosystem of innovation.
- Madrid (DO) facilitates interaction with citizens.
- Collaboration benefits: Integration of solutions tailored to local needs in Madrid, optimizing city management.

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THANK YOU!

Mobility, energy, and resource management in smart cities.

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