Technical Guidelines

COSMIC

2nd OPEN CALL

AI & Data Solutions to Boost the Green Transition

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1. Introduction

Welcome to the **Technical Guidelines** for the **COSMIC Second Open Call**. This document is designed to support **SMEs and start-ups** in preparing high-quality proposals that align with the **COSMIC project's mission**: to drive **large-scale energy resource optimisation** through innovative **data- and AI-based solutions** supporting the **EU Green Deal objectives**.

These guidelines provide applicants with the essential **technical context** and structure of the COSMIC project and will help you understand the project's expectations, assess your eligibility, and shape your application for maximum impact. **Please note** that the specific conditions and formal requirements of the open call are detailed in the Guide for Applicants.

Specifically, the Technical Guidelines describe:

- **Challenges**, which detail the specific technical or operational problems to be solved within the thematic focus areas within the COSMIC project (this is, the Key Applications guiding the overall direction for innovation in energy resource optimisation).
- **Pilots**, which are real-world implementations located across different European regions, each addressing specific energy-related challenges within the Key Applications.

These elements form **an integrated framework** together with the **Core Technical Facilitators (CTFs)**, which are transversal, AI/data-driven platforms and modules that serve as the common technical infrastructure supporting third-party solutions across pilots, as well as the **Core Social Facilitator (CSF)**, which is supporting consumer behaviour related processes. CTFs and CSF enable the technical and social deployment of third-party solutions that are embedded in pilots.

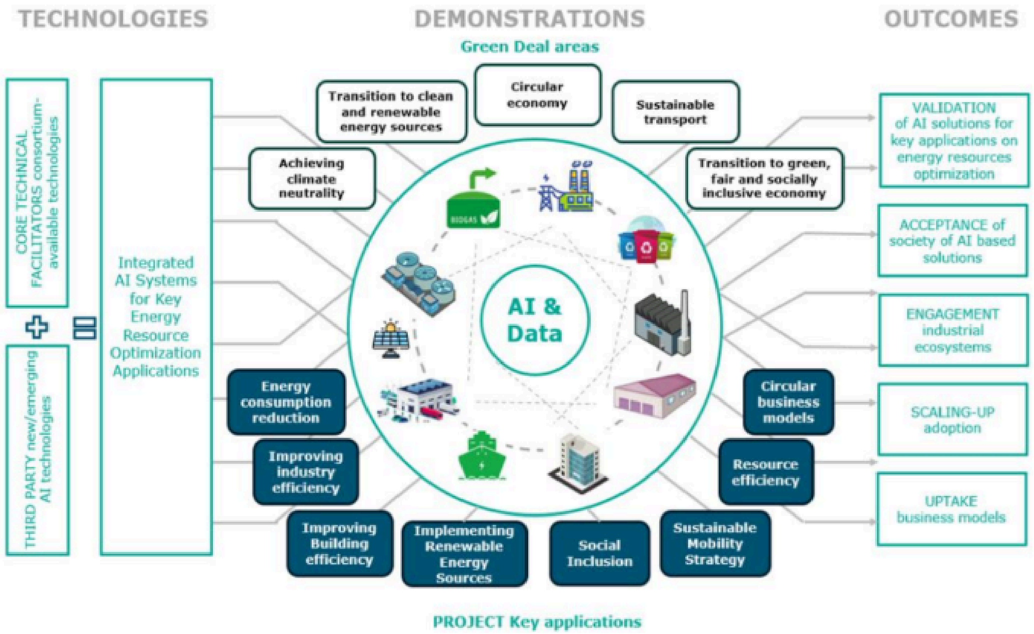
Applicants are expected to propose solutions that **integrate with or enhance** the COSMIC data ecosystem, including **energy models, AI analytics, AI-related consumer research, data-driven behaviour analytics, visualisation tools**, and **decision-support systems**.

Proposed solutions must demonstrate alignment with:

- The **real-world needs** of COSMIC's demonstration pilots
- The **technical infrastructure** and capabilities provided by the CTFs or CSF
- One or more **priority domains**, such as:
  - Smart buildings and energy efficiency
  - HVAC and predictive maintenance
  - Port operations and electrification
  - Photovoltaics and district heating

  - Urban resilience and climate adaptation
  - Industrial energy management

Selected applicants will have the opportunity to **deploy and validate** their solutions within COSMIC's **large-scale pilots**, taking place across **Spain, Belgium, Portugal, France, and Finland**. This real-world testing will help ensure **market readiness** and contribute to the development of **Integrated AI Systems (IAIS)** capable of addressing Europe's Green Deal challenges at scale.



2. Pilots

The COSMIC project is structured overall around **14 pilots located across Europe**, each representing real-world use cases where data- and AI-driven solutions will be tested, validated, and scaled.

These pilots involve large industrial players, municipalities, port authorities, energy providers, and mobility operators, ensuring the relevance and applicability of solutions to pressing Green Deal challenges.

Each pilot represents a **real operational context** where beneficiaries will deploy, validate, and demonstrate their technologies.

The specific **demonstration pilots** designated for the **deployment and validation** of third-party solutions in the **second** COSMIC open call are detailed in the list of **challenges** and within each individual challenge description.

Pilots Overview

Green Deal Category: Achieving climate neutrality

1.1. Private apartments in multi-story buildings

Pilot by Thomas & Piron Bâtiment (Belgium)

Four multi-story buildings equipped with smart meters and sensors to track energy and environmental data. 160 apartments monitored every 15 minutes for heating, water, electricity, and air quality. Enables tailored energy services and replicable diagnostics.

1.2. Renewable Energy Community

Pilot by Porto Energy Agency (Portugal)

Focus on enhancing renewable energy community (REC) operations using AI and interoperable device integration. Uses LLMs for tailored user environments and better forecasting and optimisation.

1.3. Efficient usage of the heat pumps

Pilot by Daikin (EU)

Optimising energy use of heat pumps via AI by profiling users, forecasting demand, and offering recommendations based on weather and tariffs. Aims to improve energy efficiency and comfort across different EU climates.

Green Deal Category: Transition to clean and renewable energy sources

2.1. Industrial energy communities

Pilot by Granollers Mercat (Spain)

Focuses on industrial communities sharing and optimising energy use through AI and digital tools. Tackles high energy costs, decarbonisation, and business model gaps using time-series and market data.

3.1. Tertiary use building

Pilot by OHLA (Spain)

Under-construction schools in Ireland will test GenAI and digital twins for climate resilience, predictive maintenance, habitability, and financial risk simulation. Includes VR for design testing and stakeholder engagement.

3.2. Housing buildings

Pilot by Thomas & Piron Bâtiment (Belgium)

Early-stage residential development with fossil-free energy, 35% CO_2 planned cut with respect to current practices, and “heat & cold as a service.” Includes remote monitoring, LCA, and nature-based solutions to combat overheating and energy poverty.

4.1. Predictive maintenance for optimal operation of energy resources

Pilot by PHOTOM (France)

Combines data from drones, sensors, and weather to forecast PV plant issues and optimise performance using AI diagnostics and maintenance scheduling.

Green Deal Category: Circular economy

5.1. Watercool (rainwater grid for climatic control of open spaces)

Pilot by USeville (Spain)

Expands an existing rainwater-based urban cooling system to school buildings. Integrates PV, heat pumps, and water reuse for energy and comfort in open spaces.

5.2. Waste Water Treatment Plant energy optimisation and decarbonisation

Pilot by Consorci Besos-Tordera (Spain)

Enhances WWTP efficiency using AI to optimise processes, forecast demand, and balance cost, energy use, and emissions while increasing biogas and PV integration.

5.3. Wood chips powered-District Heating pipe leak

Pilot by LRP Energiaverkot Oy (Finland)

Uses AI and sensor data to detect leaks in district heating pipelines powered by wood chips. Forecasts heat demand and tests thermal storage for optimisation.

6.1. Energy sustainability indicators from waste separation

Pilot by Porto Energy Agency (Portugal)

Integrates waste separation and recycling data into REC member sustainability scores. Includes carbon footprint tracking, visual reports, and AI-based waste sorting via computer vision.

Green Deal Category: Sustainable transport

7.1. Sizing an Energy-Storage System for OPS

Pilot by Port Authority of Balearic Islands (Spain)

Daily cruise patterns and weather swings make static diversity factors useless; accurate 24 h forecasts are vital for sizing and dispatch.

Green Deal Category: Transition to fair, socially inclusive economy

8.1. Fighting Energy Poverty in Social Housing

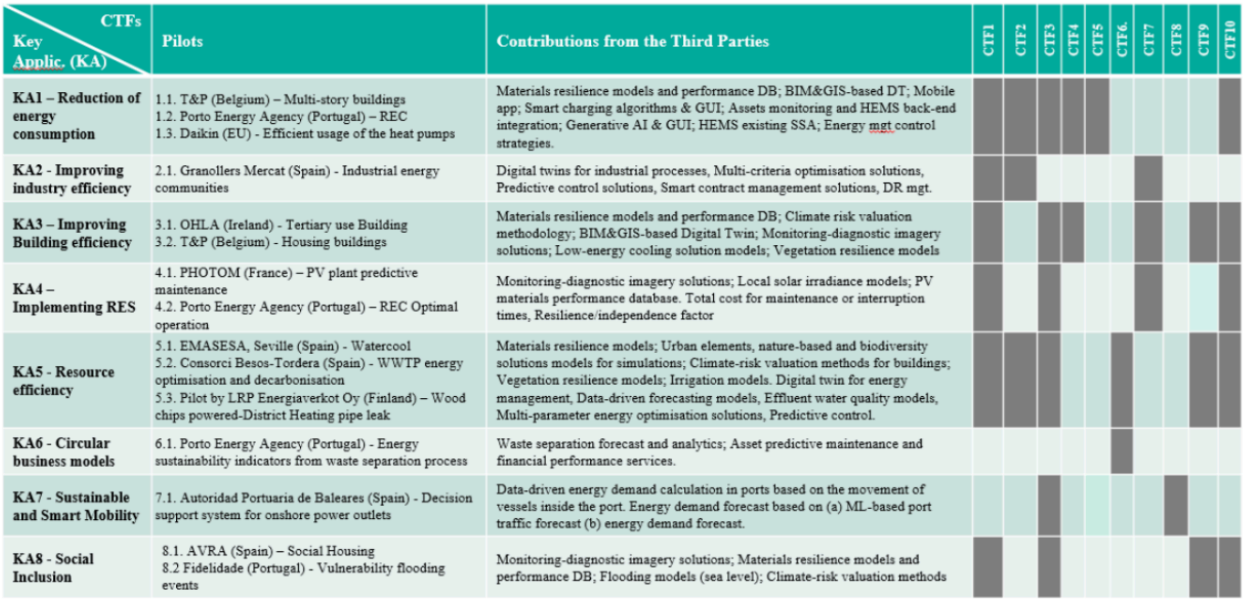
Pilot by AVRA (Spain)

Supports community managers and vulnerable tenants with app-based energy guidance, smart automation, and AI to reduce overheating, improve water usage, and cut energy costs.

8.2. Flood Risk Mapping for Fair Insurance

Pilot by FID I&D (Portugal)

Uses geo-data and insurance portfolios to assess household flood risks and offer fair coverage. Develops risk maps and tariff models for climate-exposed areas.



CTFs Key Applic. (KA)	Pilots	Contributions from the Third Parties	CTF1	CTF2	CTF3	CTF4	CTF5	CTF6.	CTF7	CTF8	CTF9	CTF10
KA1 – Reduction of energy consumption	1.1. T&P (Belgium) – Multi-story buildings 1.2. Porto Energy Agency (Portugal) – REC 1.3. Daikin (EU) - Efficient usage of the heat pumps	Materials resilience models and performance DB; BIM&GIS-based DT; Mobile app; Smart charging algorithms & GUI; Assets monitoring and HEMS back-end integration; Generative AI & GUI; HEMS existing SSA; Energy mgt control strategies.	■	■	■	■	■					■
KA2 - Improving industry efficiency	2.1. Granollers Mercat (Spain) - Industrial energy communities	Digital twins for industrial processes, Multi-criteria optimisation solutions, Predictive control solutions, Smart contract management solutions, DR mgt.	■	■					■			
KA3 – Improving Building efficiency	3.1. OHLA (Ireland) - Tertiary use Building 3.2. T&P (Belgium) - Housing buildings	Materials resilience models and performance DB; Climate risk valuation methodology; BIM&GIS-based Digital Twin; Monitoring-diagnostic imagery solutions; Low-energy cooling solution models; Vegetation resilience models	■		■	■			■		■	■
KA4 – Implementing RES	4.1. PHOTOM (France) – PV plant predictive maintenance 4.2. Porto Energy Agency (Portugal) – REC Optimal operation	Monitoring-diagnostic imagery solutions; Local solar irradiance models; PV materials performance database. Total cost for maintenance or interruption times, Resilience/independence factor	■		■				■			■
KA5 - Resource efficiency	5.1. EMASESA, Seville (Spain) - Watercool 5.2. Consorci Besos-Tordera (Spain) - WWTP energy optimisation and decarbonisation 5.3. Pilot by LRP Energiaverkot Oy (Finland) – Wood chips powered-District Heating pipe leak	Materials resilience models; Urban elements, nature-based and biodiversity solutions models for simulations; Climate-risk valuation methods for buildings; Vegetation resilience models; Irrigation models. Digital twin for energy management, Data-driven forecasting models, Effluent water quality models, Multi-parameter energy optimisation solutions, Predictive control.	■	■	■			■			■	■
KA6 - Circular business models	6.1. Porto Energy Agency (Portugal) - Energy sustainability indicators from waste separation process	Waste separation forecast and analytics; Asset predictive maintenance and financial performance services.						■				
KA7 - Sustainable and Smart Mobility	7.1. Autoridad Portuaria de Baleares (Spain) - Decision support system for onshore power outlets	Data-driven energy demand calculation in ports based on the movement of vessels inside the port. Energy demand forecast based on (a) ML-based port traffic forecast (b) energy demand forecast.			■					■		
KA8 - Social Inclusion	8.1. AVRA (Spain) – Social Housing 8.2 Fidelidade (Portugal) - Vulnerability flooding events	Monitoring-diagnostic imagery solutions; Materials resilience models and performance DB; Flooding models (sea level); Climate-risk valuation methods	■		■						■	■

Selected beneficiaries will be integrated into these pilots by bringing innovative AI/data solutions, interoperable tools, or complementary analytics aligned with the use cases.

Core Technical Facilitators (CTFs) and Core Social Facilitator (CSF)

Within the COSMIC project, **Core Technical Facilitators (CTFs)** are a suite of data- and AI-based platforms, solutions, and modules that function as **transversal core infrastructures**. These CTFs are designed to integrate and support **purpose-specific external IT assets -** namely, the data- and AI-based services and solutions developed by **beneficiaries**, such as SMEs and start-ups. The **Core Social Facilitator** (CSF) offers support to the projects drawing on Social Science expertise, making sure that solutions are user-centric by design.

Beneficiaries are expected to deliver innovative solutions tailored to the **energy resource optimisation** domain. The CTFs serve as the foundational technical environment where these third-party innovations can be **embedded, tested, and validated**.

Each **pilot** in COSMIC is aligned with one or more CTFs or CSF and addresses a **domain-specific scenario**. This structure ensures that the incoming technologies are interoperable with COSMIC's digital backbone and contribute to solving **real-world energy challenges**.

By leveraging the CTFs or CSF, beneficiaries will benefit from:

- A robust technical framework for developing and testing their solutions

- Seamless integration into COSMIC's pilot activities
- Opportunities to scale and validate their innovations in real-world settings

Each challenge/pilot aligns with one or more of the following CTFs/CSF:

- CSF - User engagement and user centric design
- CTF1 - Data standardisation and data preparation modules.
- CTF2 - Big data analytics framework.
- CTF3 - Big data microservice platform for district energy optimisation
- CTF4 - TPEE (Data-driven web platform for optimal energy management in multi-storey buildings)
- CTF5 - Home Energy Management System (HEMS)
- CTF6 - RECreation platform for managing Renewable Energy Communities
- CTF7 - Sizing tool of multi-energy communities
- CTF8 - iHELM, digital twin platform for sustainable and operational efficient maritime industry
- CTF9 - HPC based multi-fidelity and physics design of resilient built environment
- CTF10 - Intraverse, VR/AR platform

3. Challenges

To qualify, third-party proposals must respond to at least one specific challenge defined by COSMIC in connection with the pilots and Core Technical (CTFs) and Social Facilitator (CSF).

Challenge No	Challenge name	Pilot where solutions will be implemented and validated
CH20	Data-Driven Behaviour Modeling	8.1. Fighting Energy Poverty in Social Housing (Pilot by AVRA, Spain) 1.2. Renewable Energy Community(Pilot by Porto Energy Agency, Portugal) 8.2. Flood Risk Mapping for Fair Insurance (Pilot by FID I&D, Portugal)
CH21	Energy Literacy Online Game	1.3. Efficient usage of the heat pumps (Pilot by Daikin)
CH22	Port Power Digital Twin	7.1. Sizing an Energy-Storage System for OPS (Pilot by Port Authority of Balearic Islands, Spain)
CH23	Port Energy Investment Simulator	7.1. Sizing an Energy-Storage System for OPS (Pilot by Port Authority of Balearic Islands, Spain)
CH24	Port Energy Management System	7.1. Sizing an Energy-Storage System for OPS (Pilot by Port Authority of Balearic Islands, Spain)
CH25	GeoAI-Driven Optimization of DHC Networks	3.2. Housing buildings (Pilot by Thomas & Piron Bâtiment, Belgium)
CH26	Uncertainty Quantification for DHC Networks modelling	3.2. Housing buildings (Pilot by Thomas & Piron Bâtiment, Belgium)
CH27	Digital Twin of WWTP Biological Reactor	5.2. Waste Water Treatment Plant energy optimisation and decarbonisation (Pilot by Consorci Besos-Tordera, Spain)
CH28	Multi Vector Energy Optimiser in WWTP	2.1. Industrial energy communities (Pilot by Granollers Mercat, Spain)
CH29	Energy Bill LLM Microservice	1.2. Renewable Energy Community (Pilot by Porto Energy Agency, Portugal)

Challenge No	Challenge name	Pilot where solutions will be implemented and validated
CH30	REC Discovery & Onboarding Platform	1.2. Renewable Energy Community (Pilot by Porto Energy Agency, Portugal)
CH31	AI-driven Social Support Tool	8.1. Fighting Energy Poverty in Social Housing (Pilot by AVRA, Spain)
CH32	Maintenance Scheduling Optimizer	4.1. Predictive maintenance for optimal operation of energy resources (Pilot by PHOTOM, France)
CH33	AI - Accelerator for Urban CFD simulations	3.2. Housing buildings (Pilot by Thomas & Piron Bâtiment, Belgium)
CH34	Long-Term Prediction Model for Energy Demand	3.2. Housing buildings (Pilot by Thomas & Piron Bâtiment, Belgium)
CH35	Energy Community Marketplace	2.1. Industrial energy communities (Pilot by Granollers Mercat, Spain)

Challenge 20 Data-Driven Behaviour Modeling

Contextualisation of the Challenge

Problem: This challenge focuses on designing and deploying data-powered consumer research to identify behavioural drivers, fairness perceptions, and trust mechanisms that shape engagement with residential energy flexibility services. This is needed because there is limited empirical evidence on how consumers understand, evaluate, and engage with energy flexibility services (e.g. dynamic pricing, automated load shifting, demand response). In particular, uptake, trust, and perceived value across different household segments including energy-vulnerable and non-vulnerable users are not well understood.

Energy providers often lack robust consumer research on how benefits and risks of flexibility services are perceived, whether these services are seen as fair and trustworthy, and which factors drive willingness to adopt, remain engaged, or opt out. As a result, flexibility solutions are frequently designed and rolled out without sufficiently strong behavioural and market evidence for the targeted social groups, increasing the risk of low adoption, inequitable outcomes, or resistance at scale.

Challenge description

Goal: Develop and implement scalable and data-science-powered consumer research that captures how different user segments perceive and respond to AI and data-driven services. Participating SMEs are expected to have access to or be able to collect large data samples (>1000 representative participants) and be able to co-develop survey content. Alternatively, applicants should have innovative approaches to using synthetic samples.

The effectiveness and validity of components must be evaluated via A/B testing or RCT approaches. The results must support evidence-based service design, pricing, and communication strategies for various service providers.

Innovation focus: Combination of behavioural research techniques such as randomized surveys, discrete choice experiments, and A/B digital interface testing with AI or advanced statistical modeling to segment users, predict behaviour, and quantify perceived value. Approaches should generate transferable methodologies that can be applied across different sectors and use cases, enabling both technical and commercial scalability..

Pilot and testing environment

The primary use cases will focus on residential users connected to AVRA and Porto Energy and may include: evaluation of real or prototyped flexibility offerings (e.g. tariffs, automation concepts), user-facing materials such as explanations or pricing offers, segmentation by socio-economic status, housing type, tenancy status, and energy vulnerability.

A secondary use case on consumers' risk perception in the context of flood risks and connection to trust (Fidelidade pilot) should be likewise included. Research may be implemented via online panels or synthetic samples, could include survey experiments showing simulated interfaces, and should allow for controlled testing of alternative designs, benefit-sharing mechanisms, or communication strategies. Additional COSMIC use cases in connection with consumer trust may be included where relevant.

Expected impact

Industry impact: Improved understanding of consumer expectations and limitations in relation to data-driven services and AI-based solutions, as well as potential to – based on learnings – increase trust and usability; understanding of distributional effects of residential energy flexibility services. The insights generated will also contribute to more inclusive and impactful digital product design, ensuring that AI technologies are tailored not only to technical conditions but also to user realities. Practical guidance for service providers on designing flexibility services that do not disadvantage vulnerable households should result..

SME Benefits: Opportunity to develop reusable analytics and research tools that can be adapted across domains and client needs.

Evaluation criteria and success metrics

Criteria: Valid sampling (including appropriate use and validation of synthetic samples where applicable), well-designed surveys and/or simulated environments, publishable datasets, segmentation accuracy by user profiles (e.g. location, household size), robustness and validity of employed data science models (AI, statistical, or simulation-based models), clarity and usability of results for decision-makers, and visual clarity of results.

Metrics: User comprehension of materials (e.g. low dropout rates, high attention in studies with human participants), publishable results about various users' perceived usefulness, fairness, and reliability of AI suggestions, and users' trust and psychological flexibility towards adopting AI solutions (i.e., openness to change routines based on AI), as well as robustness and consistency of findings across empirical and/or synthetic data scenarios (based on data quality and quality of delivered model results and reports).

Challenge 21 Energy Literacy Online Game

Contextualisation of the Challenge

Problem: Integrating large shares of renewable energy requires greater energy flexibility at the household level, as variable wind and solar generation must be balanced by more adaptive electricity demand. At the same time, decentralised participation – such as prosumers who both consume and produce energy – is becoming essential for maintaining system resilience under fluctuating supply conditions. However, these systemic requirements are not well understood by most citizens. Energy flexibility remains an abstract concept, and the link between everyday household behaviour, energy system participation, and renewable integration is often unclear.

Within the COSMIC project, AI- and big data-driven technologies are being developed to optimise energy and resource use, but their impact depends on whether people understand, accept, and adopt flexible behaviours, including interaction with technologies such as heat pumps, smart appliances, and distributed generation assets (e.g. rooftop PV). Without sufficient public awareness, energy literacy, and behavioural readiness, technical optimisation cannot translate into measurable sustainability gains. This challenge therefore addresses the need for an accessible, scalable, and scientifically grounded educational tool that makes energy flexibility, active participation, and AI-based optimisation intuitive and understandable for a broad audience.

Challenge description

Goal: Develop and launch a **free, open-access web-based game** that teaches energy flexibility, renewable energy production, system resilience, and AI-enabled resource optimisation to a broad public audience. The game should increase understanding of why flexibility and decentralised production are necessary for integrating large shares of renewable energy, and how households can contribute through flexible behaviours and interaction with distributed energy assets. The content must cover renewable variability, demand-response, load shifting, small-scale production (e.g. rooftop PV), and the role of flexibility in maintaining system resilience. It should demonstrate trade-offs between comfort, cost, emissions, and grid stability, allowing players to explore how decisions influence system-level outcomes. It should be designed for non-expert users while maintaining scientific accuracy.

Innovation focus: The innovation lies in combining serious game design with behavioural science and AI-based energy optimisation in a scalable public engagement tool. The solution should combine evidence-based behaviour change mechanisms with interactive system simulation to help users understand both consumption-side flexibility and production-side participation.

Pilot and testing environment

The game will be deployed online as an open-access platform and will be disseminated through COSMIC communication channels, partner networks, as well as Third Party networks. It should be scalable and adaptable for multilingual implementation. Participating companies are expected to co-develop the content with COSMIC partners to ensure technical validity and behavioural grounding. The design must enable integration of impact measurement components consistent with the COSMIC impact evaluation framework, allowing assessment of knowledge acquisition, behavioural intention, and engagement.

User interaction data should allow monitoring of engagement indicators such as completion rates, time spent, progression, and repeat play. Educational effectiveness to be evaluated through embedded assessments or pre-post comparisons measuring knowledge gain and awareness of energy flexibility requirements. Where feasible, experimental variations of game mechanics may be tested to assess their impact on comprehension & behavioural intention.

Expected impact

The challenge aims to increase public awareness of the systemic requirements of renewable-based energy systems, including energy flexibility, decentralised production, and system resilience. By translating complex optimisation processes into engaging and intuitive experiences, the game should strengthen energy literacy and foster behavioural readiness to adopt flexible consumption practices and active participation in energy systems.

Expected outcomes include improved understanding of renewable variability and distributed generation, increased acceptance of automated optimisation technologies, stronger intention to adjust energy use, and greater recognition of the individual role in supporting system stability and climate objectives.

Evaluation criteria and success metrics

Criteria: Scientific accuracy of energy flexibility, renewable production, and system resilience content; behavioural validity of the educational approach; usability and accessibility of the web platform; scalability across languages and regions.

Metrics: Number of unique players; completion and retention rates; average playtime; user ratings and recommendations; measurable knowledge gains regarding energy flexibility, renewable production, and system resilience; and demonstrated increases in stated behavioural intention to adopt flexible and participatory practices. A predefined quantitative target for minimum reach and engagement should be established to ensure meaningful impact.

Challenge 22 Port Power Digital Twin

Contextualisation of the Challenge

Problem: Port electrical grids managed by port authorities such as Autoridad Portuaria de Baleares (APB) present a non-standard topology: a fragmented tree network connecting to the public grid (DSO) at multiple isolated points, serving a heterogeneous mix of concessionaires with diverse consumption profiles. This complexity makes real-time visibility of energy flows practically impossible with conventional monitoring approaches. Without an accurate and dynamic representation of the network state, active energy management - demand response, PV integration, BESS dispatch - cannot be performed reliably, limiting the port's ability to reduce its dependence on contracted DSO capacity.

Dependencies: The challenge builds on existing measurement infrastructure already deployed at the port, including smart meters, partial SCADA systems, and an IoT platform accessible via API, among other available sources.

No new sensor deployment is required.

The network topology model (MT/BT, transformer substations, DSO connection points) is provided by APB.

Concessionaire data (supply points, associated meters, contractual attributes) is managed through structured files during the development phase, with integration into port management systems planned for subsequent phases.

The Digital Twin also receives from the EMS optimisation results, calculated incentives, and CO2e data, which it exposes to users according to their role.

In subsequent phases, the Digital Twin shall also provide the network model to the Port Energy Investment Simulator (CH3) in sandbox mode, acting as the single source of truth for the port network model in that context as well.

Challenge description

Goal: Develop a **real-time Digital Twin** of the port's private electrical network capable of representing the current state of energy flows across the full MT/BT infrastructure. The system must ingest data from heterogeneous sources - meters, SCADA, IoT platform, and others as available - without requiring new hardware, maintain an updated network model aligned with the provided topology, and expose this model to downstream systems - particularly the EMS - through a well-defined interface. A multi-user access layer must allow concessionaires to visualise their own energy data, while APB retains validation authority over shared information. In addition, the Digital Twin shall expose network capacity limits - per branch, transformer substation, and DSO connection point - as part of its interface with the EMS, acting as the single source of truth for both network state and operational constraints. The basic reporting layer shall include, at minimum: generation and consumption data per concessionaire, incentives calculated by the EMS, CO2e emissions per operating period, and fault/outage notifications for APB operators.

Innovation focus: The innovation lies in three combined dimensions absent from standard DT solutions:

1. modelling a fragmented, multi-connection-point port grid as a coherent operational object;
2. implementing a governed data-sharing model where concessionaires access their own information within a structure validated and controlled by the port authority; and
3. providing a live network state representation specifically designed to feed an active EMS in closed loop.

The development phase operates at hourly granularity using Port of Palma simulation data, with the architecture designed to scale to real-time operation upon production deployment.

Pilot and Testing Environment

The implementation in the pilot will use real operational data from the Port of Palma, provided by the port authority (APB) in the form of network topology models and structured data files.

Development and validation are conducted in a simulation environment replicating the port's electrical network structure and measurement points.

Production deployment on live infrastructure is contingent on APB's internal IT integration process and falls outside the scope of this challenge.

Expected Impact

A validated Digital Twin architecture for fragmented port grids addresses a gap affecting a large share of European port authorities managing private distribution networks. The resulting model - covering heterogeneous data ingestion, multi-actor access governance, and EMS interfacing - is replicable across other ports, contributing to the decarbonisation of port energy systems at European scale.

SME benefits: Companies addressing this challenge gain hands-on experience developing a grid digital twin in a real operational environment, with access to actual network topology and measurement data from APB.

The open and modular integration approach - connecting to existing IoT platforms, meters, and SCADA without new hardware - makes the solution transferable to other port or industrial microgrid contexts, expanding the commercial applicability of the developed technology.

Evaluation Criteria and Success Metrics

Criteria: Technical soundness of the network model and its alignment with the provided topology; robustness and flexibility of data ingestion from heterogeneous sources; accuracy of the real-time state representation; usability and correctness of the multi-user access and validation layer; quality and completeness of the EMS interface specification.

Metrics:

- Network state update latency within defined thresholds (hourly in development phase, configurable for production)
- Successful ingestion from a minimum number of heterogeneous source types (meters, SCADA, IoT API)
- Data accuracy validated against ground-truth measurements provided by APB
- Role-based access correctly enforced across all defined user profiles (APB administrator, concessionaire)
- EMS interface operational and tested against the simulation environment
- Capacity limits exposed through the EMS interface validated for consistency against the technical parameters of the network model provided by APB.

Challenge 23 Port Energy Investment Simulator

Contextualisation of the Challenge

Problem: Port electrical grids managed by port authorities such as Autoridad Portuaria de Baleares (APB) present a non-standard topology: a fragmented tree network connecting to the public grid (DSO) at multiple isolated points, serving a heterogeneous mix of concessionaires with diverse consumption profiles. This complexity makes real-time visibility of energy flows practically impossible with conventional monitoring approaches. Without an accurate and dynamic representation of the network state, active energy management - demand response, PV integration, BESS dispatch - cannot be performed reliably, limiting the port's ability to reduce its dependence on contracted DSO capacity.

Dependencies: The challenge builds on existing measurement infrastructure already deployed at the port, including smart meters, partial SCADA systems, and an IoT platform accessible via API, among other available sources. No new sensor deployment is required.

The network topology model (MT/BT, transformer substations, DSO connection points) is provided by APB.

Concessionaire data (supply points, associated meters, contractual attributes) is managed through structured files during the development phase, with integration into port management systems planned for subsequent phases.

The Digital Twin also receives from the EMS optimisation results, calculated incentives, and CO2e data, which it exposes to users according to their role.

In subsequent phases, the Digital Twin shall also provide the network model to the Port Energy Investment Simulator (CH3) in sandbox mode, acting as the single source of truth for the port network model in that context as well.

Challenge description

Goal: Develop an **energy investment scenario simulation tool** for the Port of Palma, aimed at APB's technical team. The tool must allow virtual definition of modifications to the port's infrastructure - new PV assets, BESS, grid upgrades - and evaluate their technical and economic impact against the current configuration, through simulation on real historical data. The analysis must be configurable by time period and network extent, allowing evaluation of infrastructure subsets without the need to simulate the entire port.

The tool must include a backtesting section that retroactively quantifies the impact the proposed infrastructure would have had if it had been operational during the historical period analysed.

Innovation focus: The innovation lies in a semi-agentic architecture composed of specialised tools orchestrated autonomously:

- a Scenario Builder that translates user intent into structured modifications of the network model;
- a Simulation Engine that runs the modified network against historical time series;
- a Technical Analyser and an Economic Analyser that evaluate impact comparatively;
- a Constraint Validator that checks the technical limits of the infrastructure;
- a Regulatory Framework Tool that applies applicable electrical regulations according to a configurable context (country, installation type, voltage level), making the tool transferable to other European ports; and
- a Report Generator that synthesises results including the backtesting section. The APB technician defines the scenario; the agent executes, validates, and justifies.

Pilot and testing environment

The pilot uses the Port of Palma network model provided by APB in static format and real historical consumption and generation data. Development is conducted in a simulation environment, with the tool operating on configurable subsets of the network. Integration with the Digital Twin in sandbox mode is planned for phases subsequent to CH1 development. Validation includes scenarios involving PV and BESS incorporation at different points in the network, with technical, economic, and backtesting analysis against the available historical period.

Expected impact

Industry impact: A validated energy investment scenario simulation tool in a real port environment addresses a widely shared need among European port authorities managing private electrical grids.

The semi-agentic architecture and the context-configurable regulatory module make the tool transferable to other ports and industrial microgrid environments across different European regulatory frameworks, with high replicability potential.

SME Benefits: Companies awarded this challenge develop an energy investment evaluation tool in a real and complex operational environment, combining electrical network simulation, economic analysis, and agentic architecture applied to a concrete industrial use case.

The result is a solution with high commercial value in the European port and industrial energy planning market, backed by validation in a real environment.

Evaluation criteria and success metrics

Criteria: Quality and robustness of the semi-agentic architecture and tool orchestration; simulation accuracy against historical reference data; coverage and correct application of the Regulatory Framework Tool in the configured context; usefulness and clarity of generated reports including the backtesting section; configurability of analysis by time period and network extent; ease of use for APB's technical profile.

Metrics:

- Simulation accuracy validated against real historical port data
- Full report generation time (technical + economic + backtesting) within defined thresholds
- Regulatory coverage correctly applied for at least two configurable European regulatory frameworks
- Scenarios with technical or regulatory violations correctly detected and communicated without continuing the simulation
- Backtesting reports generated with quantification of energy and economic savings for the analysed historical period
- Analysis configuration by network subset and time period operational and validated.

Challenge 24 Port Energy Management System

Contextualisation of the Challenge

Problem: Energy management in a port with a private electrical grid requires real-time coordination of multiple distributed generation sources, heterogeneous loads, and physically separated DSO connection points. Without an active management system, energy allocation is passive and linear, leading to local grid saturation, underutilisation of available generation, and structural dependence on contracted DSO capacity. This is compounded by the absence of automatic mechanisms to quantify and demonstrate the economic and environmental value of energy management decisions, making it difficult to justify investments and articulate incentives for concessionaires.

Dependencies: The Energy Management System (EMS) depends on the Digital Twin (addressed by Challenge 1 from the first open call) as the single source of truth for network state, real-time energy flows, and capacity limits per branch, transformer substation, and DSO connection point. It also depends on the forecasting service (addressed by Challenge 2 from the first open call) for day-ahead and intraday optimisation horizons. Controllable assets - including OPS and BESS - are integrated through their existing intermediate control systems (PLC, SCADA, BMS), without requiring hardware replacement. The EMS feeds the DT with optimisation results, calculated incentives, and CO2e data for user-facing exposure and reporting.

Challenge description

Goal: Develop a **Port Energy Management System** for the Port of Palma capable of optimising the operation of Autoridad Portuaria de Baleares's (APB) private electrical network in real time and across a combined horizon (real-time, intraday, and day-ahead).

The system must minimise power demand from the DSO at each connection point, maximise collective self-consumption across the port, and minimise APB's overall energy cost, applying these objectives in lexicographic priority order.

The EMS must generate and transmit setpoints to controllable assets through existing intermediate control systems, automatically calculate incentives associated with concessionaire generation and self-consumption, and transfer all relevant information to the Digital Twin for exposure and reporting.

Innovation focus: The innovation lies in the application of lexicographic multi-objective optimisation via MILP solver in a fragmented port microgrid environment, consuming in real time the network model and operational constraints provided by the Digital Twin. The integration with heterogeneous control systems (PLC, SCADA, BMS) without hardware replacement, and the ability to automatically demonstrate the economic and environmental value of management decisions, are differentiating factors with respect to conventional EMS solutions.

The system operates as a functional demonstrator of the port energy community model, including automatic incentive calculation for concessionaires with photovoltaic generation.

Pilot and testing environment

The pilot is developed in a simulation environment using real data from the Port of Palma, in direct coordination with the Digital Twin developed in Challenge 1 and the forecasting service from Challenge 2 (both from the first open call).

The EMS operates on the network model provided by APB and historical and synthetic generation and consumption data.

Validation includes grid saturation scenarios, PV generation integration, and BESS dispatch.

Deployment on live infrastructure is contingent on APB's internal IT integration process and falls outside the scope of this challenge.

Expected impact

Industry impact: A validated EMS for fragmented port grids with multiple DSO connection points addresses a need unmet by standard commercial solutions, which assume simple network topologies and single actors.

The demonstrated model - multi-objective optimisation, legacy system integration, and automatic incentive quantification - is transferable to other European ports and industrial microgrid environments with energy communities.

SME Benefits: Companies awarded this challenge develop an EMS in a real and complex operational environment, with access to actual APB data and in direct integration with the other system components (DT, forecasting).

Experience in port energy community optimisation, OPS and BESS asset management, and interoperability with industrial control systems represents a high-value commercial asset in the context of the European port energy transition.

Evaluation criteria and success metrics

Criteria: Quality and robustness of the optimisation problem formulation and its MILP solver implementation; integration capability with the Digital Twin as the source of network constraints; correct implementation of the objective hierarchy; demonstrated interoperability with intermediate control systems (PLC, SCADA, BMS); consistency of incentive calculation with APB-defined rules; completeness of information transferred to the DT for reporting.

Metrics:

- Demonstrated reduction in DSO power demand versus baseline scenario in simulation environment
- Collective self-consumption rate achieved in active PV generation scenarios
- Optimisation cycle latency within defined thresholds for each time horizon
- Setpoints correctly generated and transmitted to controllable assets through intermediate systems
- Incentives automatically calculated and transferred to the DT consistently with generation and consumption data
- CO2e emissions quantified and transferred to the DT per operating period.

Challenge 25 Geo-AI-Driven Optimization of DHC Networks

Contextualisation of the Challenge

Minimizing network length considering land usage and ground composition while respecting existing infrastructure and strategic planning constraints is critical to reduce construction costs, improve efficiency, and ensure practical feasibility. Currently, no unified workflow integrates automated network optimization with multi-layer spatial data for transparent comparison and early-stage district heating planning.

Challenge description

Develop an **automated workflow to generate and optimize district heating networks** that minimize total network length while selecting buildings or communities to serve, respecting existing infrastructure, and producing GeoJSON outputs with building footprints and optimal network layouts for detailed simulation and interactive GIS-based refinement.

Goal: Evaluate three relevant district heating network scenarios per district against a minimum spanning tree baseline, compare their layouts, identify the optimal scenario, and integrate site-specific data (e.g., permitting, existing infrastructure) to support practical planning decisions.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated under Pilot 3.2 Housing buildings, in the planned district in Jambes (Wallonia), involving 450 housing units.

Solutions will receive inputs from 3D digital twin/BEM, and Wallonia geoportal for GIS info and require integration with CTF7 (VPPOPT, a sizing tool of multi-energy communities, managed by Cenaero).

Expected impact

Enables automated, interoperable workflows that save time on GIS data handling, allow transparent comparison of network designs, and support informed, sustainability-oriented planning decisions

SME benefits: Opportunity to provide backend analytics or visualization services for planning platforms.

Evaluation criteria and success metrics

Criteria: Transparency and interpretability of output metrics; clarity of comparison between scenarios.

Metrics:

- Network efficiency and coverage accuracy: minimize total network length (≤10% above MST baseline) while serving 100% of selected buildings;
- scenario comparison and refinement: clear ranking of 3 scenarios with interactive adjustments;
- workflow automation and data integration: reduce manual GIS processing time by ≥50%, producing GeoJSON outputs fully compatible with simulation tools and QGIS.

Challenge 26 Uncertainty Quantification for DHC Networks modeling

Contextualisation of the Challenge

Analyzing the potential of DHC networks under climate and energy market uncertainties and optimizing network layouts.

Problem: In small to medium-scale DHC networks-and even in larger ones-it is challenging to determine which nodes or buildings most influence energy flows, or contribute disproportionately to hydraulic or thermal losses. Simple rules of thumb based on energy demand are insufficient, particularly when multiple buildings are connected to a common junction.

Challenge description

The focus is to develop a **high-level tool for uncertainties quantification using ML/AI**, to analyze how uncertainties in input data (e.g., building energy demand, climate conditions, energy prices) impact network layouts and key performance indicators (KPIs) such as total cost of ownership, payback periods, and overall energy efficiency.

This involves generating optimized network designs that account for both hydraulic and thermal interactions between nodes, enabling robust, data-driven planning of DHC networks.

All these KPIs are computed in a deterministic way in CTF7 (VPPOPT, a sizing tool of multi-energy communities, managed by Cenaero).

Goal: Identify statistically which network sections (pipes) need to be optimized against climate, market uncertainties, compare the KPIS w.r.t optimize under uncertainty versus without uncertainty to identify robust and strategic pathways.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated under Pilot 3.2 Housing buildings, in the planned district in Jambes (Wallonia), involving 450 housing units.

Solutions will receive inputs from 3D digital twin/BEM, and Wallonia geoportal for GIS info and require integration with CTF7 (VPPOPT, a sizing tool of multi-energy communities, managed by Cenaero).

Expected impact

Enables informed, data-driven decision-making by identifying critical buildings or junctions, reducing reliance on heuristics, providing transparent evaluation under uncertainty, and offering SMEs opportunities for analytics and visualization services.

SME benefits: Opportunity to provide backend analytics or visualization services for planning platforms.

Evaluation criteria and success metrics

Criteria: Improved network efficiency, robustness under uncertainty, building coverage, asset sizing accuracy, workflow interoperability, and scenario comparison clarity.

Metrics:

- KPI stability under uncertainty (±30% for TCO, payback, and energy efficiency),
- correct pipe/substation sizing,
- ≥50% reduction in manual GIS processing time, and
- clear ranking of optimal scenarios.

Challenge 27 Digital Twin of WWTP Biological Reactor

Contextualisation of the Challenge

In the wastewater treatment plant at Granollers, the biological reactor is currently controlled using fixed-rule strategies based on the operator's experience. Its aeration system is responsible for approximately 30% to 50% of the plant's total electricity consumption. Under the current model, aeration cycles follow periodic ON-OFF patterns that are not dynamically adjusted to the actual variability of incoming wastewater or to the influent mass load.Current fixed-rule strategies are not synchronized with renewable generation from PV/CHP at the plant, nor with dynamic electricity and gas market price signals, leaving considerable room for optimisation.

It is necessary to develop a Digital Twin (DT) integrated with a flexible AI-based optimisation engine that can predict the oxygen demand and generate daily operation plans that optimise the economic costs, increase the use of renewable energy and reduce the GHG emissions while ensuring strict compliance with water quality regulations.

Challenge description

Goals:

1. Develop a **Digital Twin of the biological reactor** that simulates different aeration strategies, incorporates process constraints, and predicts system responses to varying operational scenarios.
2. Create an **AI-based multi-criteria optimiser** that integrates the outputs of the developed Digital Twin with forecasted renewable energy generation and day-ahead market energy prices in order to produce optimal aeration schedules that minimise the energy cost and GHG emissions and maximise the renewable energy self-consumption.
3. Design and develop a **graphical user interface (GUI)** that enables the interaction with the Digital Twin and the multi-criteria optimiser for the generation of daily operation patterns, for the following day or for the weekend ahead, and facilitates visualisation of results for plant operators.

This solution will enable the transition from manual management to automated and predictive operation scheduling of the WWTP.

Innovation focus: Development of a Canonical Data Model (CDM) to align and harmonise data from SCADA, laboratory analytics, and external data sources such as meteorological data; simulation of alternative aeration cycles; modular, containerised, API-based deployment enabling real-time decision support. Development of a “Twin-in-the-loop” methodology (iterative simulations between the optimiser and the DT).

Pilot and testing environment

Solutions addressing this pilot will be implemented and validated under Pilot 5.2. Waste Water Treatment Plant energy optimisation and decarbonisation by Consorci Besos-Tordera, at the Wastewater Treatment Plant (WWTP) in Granollers, using five years of historical SCADA data and operator expertise for model validation, with planned integration of photovoltaic (PV) and biogas cogeneration (CHP) systems.

The plant is equipped with real-time influent sensors at:

- the influent (pH, conductivity, suspended solids)
- at the outlet of the biological reactor (ammonia, oxygen, nitrate, suspended solids)
- the WWTP effluent (suspended solids, phosphorus).

Laboratory analyses (GICA database) are also available.

Expected impact

Industry impact: Enables WWTPs to implement predictive aeration control, reducing energy usage without compromising regulatory compliance. Forms the basis for AI-supported automation in a traditionally manual sector.

SME benefits: Strong reference project in municipal infrastructure. Scalable solution with high replication potential (1,000+ WWTPs in Spain). Entry into the smart utility market with demand for modular, interoperable solutions.

Evaluation criteria and success metrics

Criteria: Delivery of open Canonical Data Model (CDM) supporting the energy optimisation of biological reactors. Delivery of the solution as an open-source software. Forecast accuracy of aeration and oxygen demand in terms of blower operation (m3/h air necessary over time schedule); adaptability of the model to different operational scenarios; ease of integration into the existing SCADA environment. Generation of operationally valid day-ahead operating patterns.

Metrics: All relevant variables for the energy optimization considered in the CDM; forecast deviation for oxygen demand < 10%; real-time simulation latency < 5 seconds; operator validation score of ≥4 out of 5.

Challenge 28 Multi Vector Energy Optimiser in WWTP

Contextualisation of the Challenge

Catalonia's wastewater sector faces the EU 2045 energy neutrality target under Directive (EU) 2024/3019, with current neutrality at 19% (source: Catalan Water Agency). Scaling renewable energy in WWTPs is essential to meet 2035 (40%), 2040 (70%), and 2045 (100%) milestones. Consorci Besos-Tordera (CBT) manages 28 WWTPs across five Catalan regions. The goal is to achieve operational maximal energy neutrality by balancing biogas production, biogas cogeneration (CHP), solar PV, with minimal energy cost and environmental impact.

Challenge description

Develop an **AI-based optimisation solution at plant level** that allows optimised simultaneous coordination between energy consumption, energy production, and import and export of energy to the electricity and gas grids. The plant may include consumption of electricity and heat from different processes, and energy generation from solar PV and biogas.

The paths for use of the generated energy at the plant are described in continuation. The generated PV could be used for self-consumption behind the meter or be injected into the electricity grid. The produced biogas could be stored to the limit of the available storage capacity or used in one of the following paths:

- to be upgraded and injected into the gas grid;
- used in a CHP motor dedicated to produce electricity for injection into the electricity grid;
- used in a CHP motor dedicated to produce electricity for self-consumption;
- used in boilers to generate heat for digester heating.

Input for the solution will be the hourly or sub-hourly time series of historical data of the overall Wastewater Treatment Plant's (WWTP) energy consumption, the historical time series of the PV generation plants (one or several), and those of the biogas production, as well as meteorological data. In addition, the biogas storage capacity, the CHP characteristics and constraints, and the day-ahead electricity and gas market prices will be provided.

Goals:

1. Develop **forecasting models** for the time series of energy consumption and generation.
2. Create an **AI-based multi-criteria optimiser** that uses as an input the forecasted consumption and generation timeseries, the energy market prices for buying and selling

energy and produces as a result the optimal schedules and quantities for each timestep for:

- selling energy as biogas injected in the gas grid,
- for operating the CHP for selling electricity to the grid,
- for operating the CHP for self-consumption,
- for the PV selling to grid, and for the PV for self-consumption,
- electricity procurement from the market.

The optimisation criteria should include multiple objectives, such as minimum overall cost of the energy for plant operation, maximum benefit from the sold energy, minimum GHG emissions generation, maximum energy neutrality or combinations of them.

3. Design and develop a **graphical user interface (GUI)** that enables the interaction with the optimiser, selection of energy consumption and generation timeseries and forecasting, configuration of optimisation criteria and constraints, and visualisation of the results from the optimisation in a user-friendly form for the plant operators, with clear recommended daily operation patterns for the following day or for the weekend ahead.

This solution will enable the transition from manual management to automated and predictive operation scheduling guaranteeing the achievement of the set objectives for the WWTP.

Innovation focus: Development of a multi-objective optimisation solution and user-friendly GUI for simulation of scenarios of operation and decision-support; modular, containerised, API-based deployment.

Pilot and testing environment

Solutions addressing this pilot will be implemented and validated under Pilot 5.2. “Waste Water Treatment Plant energy optimisation and decarbonisation” by Consorci Besos-Tordera, at the Wastewater Treatment Plant (WWTP) in Granollers, using available historical data.

The implementation will be supported and tested with the Big Data infrastructure (CTF1 & CTF2 managed by CIMNE).

Expected impact

Industry impact: Enables WWTPs to implement optimal management of the energy flows and energy market interaction allowing them to progress towards their economic and climate neutrality objectives.

SME benefits: Strong reference project in municipal infrastructure operation. Scalable solution with high replication potential (1,000+ WWTPs in Spain). Entry into the smart energy market with demand for modular, interoperable solutions.

Evaluation criteria and success metrics

Criteria: Delivery of the solution as an open-source software. Versatility for integration with digital twins (e.g. anaerobic digester for biogas production, biological reactor for water treatment). Possibility to combine multiple timeseries and set multiple objectives. User-friendliness of the solution. Modular, containerised, API-based deployment.

Metrics:

- Forecast deviation < 10%;
- Computation time < 30 s;
- Feasible solution rate > 95%;
- Optimality gap ≤ 2%;
- Operator validation score for usability of ≥4 out of 5.

Challenge 29 Energy Bill LLM Microservice

Contextualisation of the Challenge

Energy bills in Portugal are among the most complex consumer documents in the utilities sector. A typical residential electricity invoice contains a wide range of charges, tariff components, and regulatory fees - including energy consumption costs, power capacity charges (potência contratada), network access tariffs (Acesso às Redes), taxes (IVA, IEC), and operator-specific surcharges - many of which are poorly labelled, inconsistently structured across suppliers, and subject to frequent regulatory updates. This complexity is not merely an inconvenience: it creates a systematic barrier to energy literacy and consumer empowerment, even among individuals with strong digital and financial skills, and limits users' ability to understand the environmental and CO_2 implications of their energy consumption.

Studies and consumer advocacy reports consistently highlight that a significant proportion of Portuguese households are unable to verify whether they are being billed correctly, identify opportunities to reduce costs or change their energy contracts, or understand the implications of their contracted tariff. This is particularly acute for vulnerable households, elderly users, and those on social tariffs (Tarifa Social de Energia), who are most exposed to billing errors and least equipped to challenge them. Beyond individual impact, this opacity undermines trust in the energy system, reduces the effectiveness of demand-response mechanisms, and limits the broader transition to informed, active energy consumers, including awareness of how consumption patterns relate to emissions and environmental impact.

Yet, despite growing digitalization in the energy sector, no accessible AI-powered solution currently exists in the Portuguese market to help consumers interpret their bills and verify whether they are being charged correctly, while also translating energy use into understandable CO_2 and environmental impact indicators.

Challenge description

Develop an **intelligent, user-facing application or platform** that enables consumers to **submit their energy bills** - whether as PDF documents or photographs - **and receive an AI-powered/automated analysis** that translates complex billing information into clear, actionable insights.

The solution must help users understand what they are being charged for, whether those charges appear correct, and what steps they could take to optimize their energy costs or contracted tariff, as well as how their consumption translates into CO_2 emissions and environmental impact.

The platform should be capable of processing complex invoice data from multiple Portuguese energy suppliers (e.g. EDP Comercial, Galp, Endesa, Iberdrola), extracting and normalizing key billing components, and presenting results in a way that is accessible to users with varying levels of energy and digital literacy.

Core output should include a structured breakdown of bill components, anomaly or inconsistency flags, benchmarking against typical household profiles, and personalized recommendations - such as tariff switching, contracted power adjustments, or time-of-use optimization.

It should additionally provide a clear translation of energy consumption into estimated CO_2 emissions, comparisons with average households, and guidance on how behavioural or contractual changes could reduce environmental impact.

It should also compare different energy tariffs on the market and suggest the most beneficial, including where possible differences in environmental or emissions-related performance.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated in the pilot 1.2. Renewable Energy Community: APP-based tools for Bill validation (by Porto Energy Agency), including about 40 households;

Required integration in existing CTF6 - RECreation platform for managing Renewable Energy Communities managed by COSMIC partner INESC TEC.

Expected impact

Development of a consumer-facing AI tool that meaningfully reduces the information asymmetry between energy suppliers and households, empowering users to understand, verify, and act upon their energy billing. The developed solution should evaluate and suggest tariff switching, contracted power optimization, and access to social support schemes, while increasing user awareness of the environmental and CO_2 implications of their energy use.

By lowering the literacy and accessibility barriers that currently prevent many households from exercising their consumer rights, the challenge directly supports energy justice and a more inclusive energy transition, as well as more environmentally informed consumption decisions.

Evaluation criteria and success metrics

Criteria: Accuracy and completeness of bill data extraction across different supplier formats and input types (PDF, photograph); clarity and accessibility of AI-generated explanations for users with varying literacy levels; correctness of anomaly detection and billing validation logic against Portuguese regulatory tariff structures; quality and relevance of personalised recommendations; usability and user experience across device types and age groups; maturity and robustness of the technical implementation; clarity and accuracy of CO_2/emissions-related information and its understandability for non-expert users.

Metrics:

- ≥90% accuracy in extraction and correct categorization of key billing components across a diverse invoice test set,
- ≥85% of test users able to correctly identify their main charges and understand their bill summary without external assistance,
- ≥80% user satisfaction score on clarity and usefulness of AI-generated outputs, user trust in outputs (in relation to other LLMs such as ChatGPT),
- Measurable increase in user ability to identify tariff optimization opportunities (+30% vs. baseline in user testing),
- Successful processing of invoices from a minimum of three major Portuguese energy suppliers,
- Solution demonstrably accessible and usable by users aged 55 and over, assessed through structured usability testing;
- Measurable increase in user understanding of the CO_2 impact of their energy consumption (e.g. % of users correctly interpreting emissions information).

Challenge 30 REC Discovery & Onboarding Platform

Contextualisation of the Challenge

Renewable Energy Communities (RECs) represent one of the most promising mechanisms for democratising access to clean energy and fostering local energy resilience. In Portugal, the legal framework governing energy communities - transposing the EU's Clean Energy for All Europeans package - has been progressively established, creating a pathway for citizens, municipalities, and local businesses to collectively produce, share, and manage renewable energy. However, despite growing regulatory momentum and public interest, the actual uptake of energy community membership among Portuguese citizens remains limited.

A critical barrier is the complexity of the onboarding process itself. Joining an energy community involves navigating a set of technical, administrative, and geographic eligibility requirements that are far from intuitive for the average citizen. Prospective members must understand concepts such as shared injection points, proximity rules tied to the electricity distribution network, metering infrastructure requirements, and contractual obligations - all before even identifying whether a suitable community exists near them. This information is fragmented across institutional sources, rarely available in accessible formats, and requires interaction with multiple entities, including DGEG (Direção-Geral de Energia e Geologia) and E-Redes, the main national electricity distribution network operator responsible for validating technical eligibility.

The result is a significant participation gap: many citizens who are willing and potentially eligible to join an energy community simply do not know where to start, cannot easily determine what is available near them, and have no straightforward channel to express interest or receive updates.

Challenge description

Develop a **user-friendly digital platform** that simplifies and streamlines the process of **discovering, simulating joining benefits, or expressing interest in joining a Renewable Energy Communities in Portugal**.

The solution should allow any citizen to enter their address (or postal code), contracted power, assets and a few other inputs and immediately receive clear, relevant information about nearby energy communities (if at all) - whether already active, under development, or in early planning stages - along with a guided overview of what joining would entail for their specific location, and what benefits they would attain. Target users will be the users themselves and community managers subscribed to the platform.

The platform should be designed to: enhance users' psychological capability by improving understanding of energy communities and related benefits; increase physical and social opportunity by making relevant communities visible and accessible based on location and context; and strengthen reflective and automatic motivation by clearly communicating personalized benefits, reducing uncertainty, and enabling low-effort expressions of interest.

The platform must support three core user journeys:

1. discovery and onboarding for users in areas where active communities exist and are accepting new members;
2. subscription to updates for users in areas where a community is currently being formed; and
3. expression of interest for users in areas with no current community, triggering a message to subscribed community managers.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated in the pilot 1.2. Renewable Energy Community: APP-based tools for Bill validation (by Porto Energy Agency), including about 40 households;

Required integration in existing CTF6 - RECreation platform for managing Renewable Energy Communities managed by COSMIC partner INESC TEC

Expected impact

Development of a nationally accessible platform that significantly lowers the barriers to participation in Renewable Energy Communities, accelerating the growth and geographic spread of the sector across Portugal. By making the discovery and onboarding process intuitive and transparent, the solution will increase the number of active community members, reduce the administrative burden on community operators and supporting institutions, and help direct development efforts towards areas of demonstrated citizen demand.

Beyond individual onboarding, the aggregated interest data generated by the platform will serve as a valuable input for policymakers, municipalities, and energy community promoters - enabling more strategic, evidence-based decisions about where to prioritise new community development. This contributes directly to national and EU targets for renewable energy community uptake and supports a more inclusive and geographically equitable energy transition.

Evaluation criteria and success metrics

Criteria: Accuracy of community data presented to users, dependent on integration quality with DGEG and E-Redes data sources; clarity and accessibility of the user journey for citizens with no prior knowledge of energy communities; robustness of location-based eligibility logic and proximity detection; usefulness and intuitiveness of map-based or visual discovery interfaces; the platform as new communities are registered; and the degree to which the solution reduces friction for both prospective members and community operators.

Metrics:

- Successful integration with DGEG and/or E-Redes data sources, covering a minimum of all currently registered energy communities in Portugal,
- ≥85% of test users able to correctly determine their eligibility status or nearest community without external assistance,
- ≥80% user satisfaction score on clarity, ease of use, and usefulness of the platform, demonstrated capability to aggregate and visualise interest data at geographic (parish or municipality) level,
- threshold-based demand alert system validated and functional for a minimum of three simulated geographic scenarios,
- platform accessible and usable on both desktop and mobile devices, verified across representative user groups including non-technical users.

Challenge 31 AI-driven Social Support Tool

Contextualisation of the Challenge

AVRA manages a large social housing stock (more than 50.000 dwellings) where decisions on energy efficiency measures and social interventions are currently based on fragmented data and time-constrained manual assessments. Technical building data and social information are not systematically integrated, making it difficult to prioritise interventions and address both energy costs and thermal comfort effectively, particularly for vulnerable households.

At the same time, new data sources are becoming available through monitoring systems, digital twins, and a consumer application, but are not yet translated into actionable insights for planners and social workers. This limits the ability to identify priority cases and define appropriate interventions in a consistent and scalable way.

Challenge description

Goal: Develop an **integrated decision-support tool for AVRA planners and social workers** that generates clear, prioritised recommendations for energy efficiency refurbishment in EE projects and social interventions at building and household level, with the objective of prioritising the buildings with most needs of intervention, reducing time and energy costs in decision-making - at management level - and to improve energy costs and thermal comfort - at user level.

The solution should combine actual management data, available buildings, monitoring, and social data, and be designed to integrate additional data sources such as digital twin outputs and consumer app data as they become available. Outputs must be simple, interpretable, and directly usable in daily workflows, requiring minimal time and expertise.

The system may include a layer enabling interaction with tenants via the consumer application, supporting communication and follow-up of interventions.

Innovation focus: The solution should integrate heterogeneous data sources, including building characteristics, monitoring data, social questionnaire data, and future digital twin outputs, into a unified decision-support framework (together with management data). It should apply data-driven methods to identify patterns, prioritise interventions, and generate actionable recommendations that combine technical and social dimensions.

A key innovation lies in translating complex data into simple, interpretable outputs tailored to non-technical users, enabling fast and consistent decision-making. The system should be modular and scalable, allowing integration of additional data sources and potential extension to other housing contexts.

Pilot and testing environment

The solution will be piloted within two AVRA buildings in Sevilla with approx. 110 apartments, with 20% tenants participation. Initial development will rely on available building data and social questionnaire data, with planned integration of monitoring data and digital twin outputs as they become available. Testing should reflect real-world workflows of planners and social workers, ensuring that the tool supports prioritisation and intervention decisions under time constraints. Where relevant, integration with the consumer application can be tested to enable communication with tenants.

Expected impact

The solution will improve the ability of AVRA to prioritise and implement energy efficiency and social interventions in a consistent and data-driven way. It will contribute to reducing energy costs and improving thermal comfort, particularly for vulnerable households. By combining technical and social perspectives, the tool will support more efficient allocation of resources and more targeted interventions. It will also provide a basis for scalable decision-support approaches in social housing management.

Benefits for SMEs: the challenge offers the opportunity to develop a reusable and scalable decision-support solution that can be adapted to other social housing providers and public sector contexts facing similar challenges. It enables the development of transferable capabilities in integrating technical and social data for decision-making, as well as user-centred tools for non-technical stakeholders. This can support market entry into the growing domain of data-driven public housing management and energy efficiency services.

Evaluation criteria and success metrics

Criteria: The solution should demonstrate the ability to generate clear and relevant intervention recommendations based on available data, and to integrate additional data sources without major redesign. Outputs should be interpretable and usable by non-technical users, and aligned with the needs of planners and social workers.

Metrics: Success will be measured by the usability of the tool in real workflows, the relevance and consistency of generated recommendations, and the system’s ability to incorporate different data types. Additional metrics include user acceptance, time savings in decision-making, and the quality of prioritisation outcomes in relation to energy costs and thermal comfort.

Challenge 32 Maintenance Scheduling Optimizer

Contextualisation of the Challenge

Problem: Even with accurate predictions, maintenance resources must be allocated wisely. While maintenance is happening, there is a decrease in energy production, and this could be even worse if at the moment of the repair the expected productions were highest (based on forecasts). Apart from this, several jobs can be executed into a single run, therefore there is an opportunity to reduce the number of site visits from the dispatch team. The cost of the maintenance should also be taken into account as a metric for the optimization.

Solution: a decision support system to optimize technician dispatch, taking into account:

- Technical Criteria: fault urgency, location optimization.
- Energy Production Criteria: energy production downtime minimization.
- Economical Criteria: Cost of the maintenance run.

Challenge description

Goal: Build a **scheduling support tool** that generates **optimized maintenance plans** based on predicted faults, operational constraints and energy production criteria.

Innovation focus: Multi-criteria optimization (logistics, cost, criticality); interface with CMMS; human-in-the-loop scheduling design.

Prioritize alerts based on their criticality and expected production losses.

Estimate the operational and economic impact of each intervention scenario, including potential energy losses and intervention costs.

Support decision-making on whether the preventive maintenance schedule should be modified.

Generate optimized technician schedules considering logistics, site locations, resource availability, and intervention priorities.

Importantly, the tool will operate as a human-in-the-loop decision support system, where final decisions remain with the operators.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated in pilot 4.1. Predictive maintenance for optimal operation of energy resources (by PHOTOM) and will be deployed alongside predictive alerts in the Donjon site's CMMS.

Testing activities will include:

- generation of optimized intervention plans,
- comparison between AI-supported planning and historical maintenance practices, and
- validation through feedback from operators and maintenance managers.

Expected impact

Technical Impact: Improved integration between predictive maintenance outputs and operational planning tools. Enhanced decision-support capabilities for PV plant O&M teams.

SME benefits: Development and testing of scheduling algorithms in a real-world PV infrastructure setting.

Economic Impact: Reduction in unnecessary site visits and improved technician dispatch efficiency. Lower operational costs through optimized scheduling and prioritization of interventions. Reduction of production losses by addressing critical faults earlier.

Environmental Impact: Increased PV energy yield through faster response to faults.Reduced travel-related emissions thanks to optimized technician routing.

Social Impact: Improved working conditions for maintenance teams through clearer and better-organized planning. Greater trust in AI-supported tools through human-in-the-loop decision making.

Evaluation criteria and success metrics

Criteria: Feasibility and quality of proposed schedules; technician feedback; Adaptability to real-world constraints (e.g. weather, workforce limits, Negative price hours).

Metrics:

- Reduction in total O&M costs (modeled);
- % of AI-suggested plans implemented by operators.

Challenge 33 AI - Accelerator for Urban CFD simulations

Contextualisation of the Challenge

Problem: High-fidelity CFD simulations are essential for understanding how urban design decisions affect thermal comfort and energy demand.

However, such simulations aiming at improving climate resilience require advanced expertise and important HPC resources (cpus/time), making them impractical for early-stage design when frequent iterative testing is most valuable.

Challenge description

Goal: Develop/Propose/Integrate an **AI-based add-on for OpenFOAM to accelerate computational time for urban flow simulations**.

The idea is to keep the complexity of the model but use AI/ML to accelerate numerical convergence during CFD simulation, either for steady-state or unsteady simulations.

Innovation focus: use AI/ML to accelerate numerical convergence during CFD simulation.

Pilot and testing environment

The performances (accuracy/computation time) will be compared with/without the AI-accelerator on the pilot 3.2. Housing buildings by Thomas & Piron Bâtiment (planned district in Belgium, involving 450 housing units) for different building design in order to show the advantage in design phase.

Since at design phase, no experimental data / measures are available in the pilot.

The GURUS simulation chain (part of CTF9) and HPC infrastructure at Cenaero support the workflow.

Expected impact

Allows city planners to consider climate resilience in early-stage urban design, reducing risks for vulnerable populations and long-term energy demand.

Opportunity to develop or apply AI models in urban simulation environments, addressing a growing demand in sustainable city planning.

Evaluation criteria & success metrics

Criteria: Reduction of runtime.

Metrics:

- Simulation time reduced from days to hours, allowing to study multiple scenarios --> reduction of heat stress;
- reduction of overheating hours due to uprising heat waves.

Challenge 34 Long-Term Prediction Model for Energy Demand

Contextualisation of the Challenge

Problem: Urban district planners need to assess long-term energy demand early in the design process, but often lack detailed building data. Existing tools typically don't account for dynamic factors like climate evolution, occupancy changes, or price uncertainty, leading to rigid and suboptimal infrastructure planning.

Challenge description

Goal: Develop a **forecasting model** that predicts heating, cooling, DHW and electricity demand over a 20-year+ lifecycle using limited early design stage inputs.

Innovation focus: Use of regression or machine learning methods combined with historical energy consumption data (from TPEE) and digital twin models to simulate energy profiles in hourly resolution.

Pilot and testing environment

Solutions addressing this challenge will be implemented and validated in pilot 3.2. Housing buildings by Thomas & Piron Bâtiment, in a planned district in Jambes (BE), involving 450 housing units.

Available data include GIS, 3D models and HVAC specs, IFC but no measurement since design phase.

Test cases will be co-developed jointly with CENAERO in which the predictions would be used in a multi scenario analysis (e.g., use of solar panels, DHCN, ...).

Required integration with CTF7 (VPPOPT, a sizing tool of multi-energy communities managed by Cenaero)

Expected impact

Empowers planners to compare solutions based on realistic energy demand forecasts before major design decisions are made.

SME benefits: Opportunity to create a modular forecasting engine applicable in multiple early-stage design contexts.

Evaluation criteria & success metrics

Criteria: Forecast accuracy across different typologies; robustness under varying design constraints.

Metrics: Based on historical data , the estimated demands should have same trend or level of accuracy compared to already established database.

Challenge 35 Energy Community Marketplace

Contextualisation of the Challenge

Context: In Spain, PV plants share energy with consumers within a 5 km radius. In order to share energy, consumers must be organised into groups linked to a single PV plant. The sharing rates are reported to the energy supplier/DSO for each PV plant and remain fixed for four months, with the possibility of changing in the following period.

Challenge description

Organisation of a marketplace for linking companies with excess energy from their PV plants (producers) willing to sell and companies willing to buy renewable energy (consumers).

The challenge to be addressed will be a multi-criteria optimisation of the energy sharing among energy producers and consumers organised in an energy community around each PV plant that maximises the benefits for all participants and shares the energy in a fair and equitable way.

Goals:

1. Develop an **AI/ML-based tool for the optimal association of consumers and producers** into an energy community for sharing of PV-generated energy based on available historical data on energy consumption, generation and market data. The tool will maximise the benefits for all participants while ensuring that differences remain below a certain threshold and that restrictions from existing energy tariffs and minimal PV generation shares are observed, and minimal benefits for the producers are achieved.
2. Develop a **user-friendly Graphic User Interface (GUI)** supporting the different types of users:
    - For the energy consumers and producers to provide access to data, select preferences and approve proposed energy sharing conditions.
    - For the marketplace organiser to operationalise the matching of producers and consumers based on the AI-based multi-criteria optimisation and support the establishment of energy sharing contracts among them.

Innovation focus: Development of a multi-criteria optimisation solution and user-friendly GUI for simulation of grouping and sharing scenarios and decision-support, with integration of market and economical constraints; modular, containerised, API-based deployment.

Pilot and testing environment

Solutions will be implemented and validated in pilot 2.1. Industrial energy communities by Granollers Mercat, using data and information on current electricity tariffs, and consent for access to historical energy consumption data of each potential member. PV plant owners provide access to energy generation data.

The implementation will be supported and tested with the Big Data infrastructure of CIMNE (CTF1 & CTF2).

Expected impact

Industry impact: Enables energy community manager and companies to test a solution for optimal configuration, creation and management of industrial energy communities that are open for the participation of companies in industrial estates, where some of the companies offer the excess of the energy generated from their own PV plants to other companies around.

SME benefits: Strong reference project in industrial energy communities, applicable also to citizens and SME ECs. Scalable solution with high replication potential (800+ ECs in Spain). Entry point into smart energy management of energy sharing projects.

Evaluation criteria and success metrics

Criteria: Delivery of the solution as an open-source software. Convergence and robustness of optimization algorithms; ability to dynamically reprioritize based on regulatory and economic inputs; energy manager and company users acceptance and usability; ability to combine multiple timeseries and set multiple criteria. User-friendliness of the solution for different users (managers, potential members). Modular, containerised, API-based deployment.

Metrics:

- At least 15% reduction in electricity costs compared to baseline operation ensured through optimal sharing coefficients;
- At least 20% increase in renewable energy self-consumption;
- Energy manager usability rating of at least 4 out of 5;
- Time of convergence for optimal solution < 3 min.

MEET THE CONSORTIUM

Universidad de Sevilla 1505
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Ben Tordera
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