Bologna Digital Twin

Enhancing the public value of data

Comune di Bologna

FONDAZIONE BRUNO KESSLER

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

CINECA

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Inspiring vision

We want to create a more just, fair and sustainable city

The Administration is committed to the challenge of making Bologna the **most progressive city in Italy,** by promoting an alternative model of city capable of contributing to the **solution of economic, social and environmental challenges**.

The success of this vision lays on the implementation of major projects and investments for the social, environmental and technological transition of the city and the enhancement of Bologna's historic values:

City of Knowledge
To relocate the axis of the city's economic and social development on the knowledge dimension with the redevelopment of a large area of the city and the creation of active policies.

100 Climate Neutral Cities
To achieve climate neutrality by 2030 through investments on new mobility, education and information, energy efficiency, waste management and urban greening.

Green footprint
To improve people's health, quality of life
and public spaces with the construction of a large green infrastructure embracing the entire city.

Plan for Housing
To tackle the housing crisis by creating ten thousand homes in the next 10 years

The conditions for achieving it

A new way to learn, collaborate and develop innovative solutions

Achieving our ambitious goals will depend on our ability to

- **collect and organise all the information** we already have and the city generates;
- **managing information** democratically and with a citizen-oriented approach;
- **activate and connect** research and competence centres, decision-makers, private sector and citizens;
- build **future scenarios**, foresee changes and major emergencies;
- **research, develop and test** innovative solutions;
- **monitoring results** for continuous improvement.

We need a **new, innovative and democratic organisation** to exchange information, to design scenarios and at the same time to protect citizens data and enable us to make increasingly informed and conscious decisions in their interest.

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Digital Twin's goals

A new tool to address contemporary challenges and bring concrete change

Bologna's DT will provide a new civic infrastructure at the disposal of the entire city. It will be financed through an initial investment of **7 million euro** from PON Metro funds.

Bologna's DT will allow us to:

Using data and knowledge to **implement analysis and forecasts** to address the needs of the city, its citizens and users.

Supporting decisions that bring substantial change to city government and to **tackle environmental, economic and social challenges** by experimenting with different forms of public engagement.

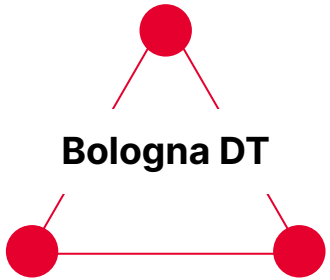
Activate knowledge processes that can generate **new economies** and responsiveness to **improve territorial governance.**

Photo credit: Margherita Caprilli

Our understanding of Digital Twin

A city model that uses data to evolve in real time to help us generate public value

It is a **POLICY** that generates awareness of the value of data, regulates its democratic and civic use and guides the generation of public value.



It is a long term **PROCESS** based on new practices, research, scenario creation, forecast development and continuous monitoring.

It is a **TECHNOLOGY PLATFORM** for collecting, analysing, integrating, visualising and simulating city data and supporting decision-making processes.

WORKING DEFINITION: A City Digital Twin is a full digital model of the city, which continually adapts based on the collected online data and information, supports decision making through analysis and forecasting and is capable of co-evolving with its physical counterpart.

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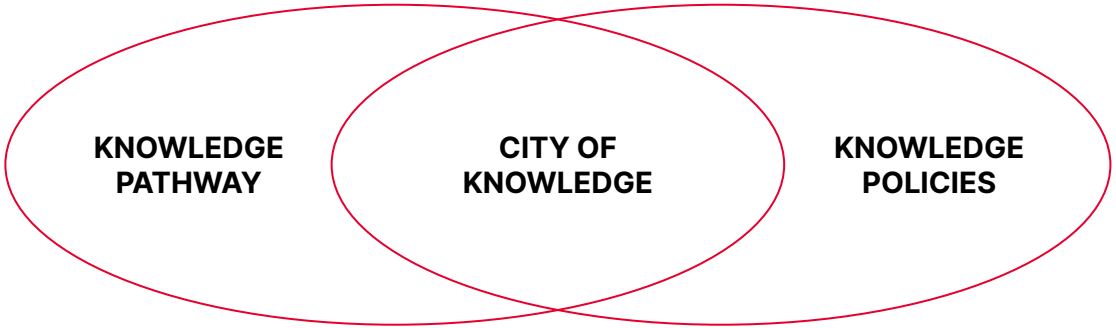
The Digital twin in Municipality's strategies

An essential pillar of the City of Knowledge

The Digital Twin is a fundamental component of the **'City of Knowledge'**, the strategy that the administration is deploying to drive Bologna into the future through the attraction of new investments with a **high innovation profile** and to foster processes of **social inclusion** and empowerment of the metropolitan **democratic fabric.**

In particular, it is one of the the **Knowledge Policies**, together with the Plan for Science and Research and the Knowledge Factories.



The Digital Twin's added value

An opportunity to improve the quality of life, generate opportunities and play a new national and international role

MUNICIPAL LEVEL

A **new civic infrastructure** that can be used to generate public value.

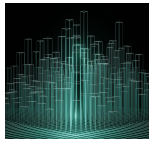
It will enable a **new pact** between the city, its citizens and other relevant stakeholders.

It will improve the **social and economic impact** of urban policies; stimulate the development of **new enterprises and services**; involve all the realities of the **territory.**

REGIONAL AND NATIONAL LEVEL

It will give Bologna a leading, innovative and frontier role in the development of **Data Valley** (Spoke 9 of the **National High Performance Computing Centre: Digital Society & Smart Cities**).

It will position Bologna as an Italian **model to be followed** in building the Digital Twin.



INTERNATIONAL LEVEL

It will increase the **city's attractiveness** to people and organisations interested in contributing to frontier issues related to global challenges.

It will allow to strengthen **relations with European cities and its excellences as Barcelona Municipality and BSC (international protocol) and Hamburg.**

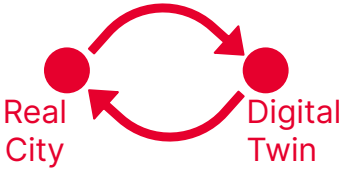
It will allow to join the **network of cities collaborating on pan-European digital services**.

Opportunities and Use cases

A useful tool for researchers, decision-makers, private sector and citizens

Analysing, correlating and visualising data to facilitate understanding and exploration of city phenomena and systems.

Anticipating urban developments and emerging risks, and **assessing their impacts**, also by constructing hypothetical scenarios and simulating their evolution over time.



Monitoring the evolution and effects of external events and government actions.

Optimising the effectiveness of services and the impact of government actions by continuously reviewing them based on data on their functioning.

Supporting **decision processes** and the translation of decisions into **actions** aiming at urban change.

Involving citizens in design activities and behavioural change processes, which start from the digital and move into the real city.

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Opportunities and Use cases

Use cases to refine tools and activate experimentations

MOBILITY

Supporting the city in the challenges that will transform urban mobility (30 km/h city, trams, cycle lanes).

Enhancing data assets: data integration and access; advanced analysis; new data sources from partner companies.

ENERGY

Analysing the energy response of the city's building stock and supporting sustainability assessments.

Simulating the impact of new projects in urban plans, design alternatives, policies and incentives.

CLIMATE CHANGE

In light of the emergency that hit the Emilia-Romagna region, a use case related to the issues of climate change and hydrogeological instability will be developed.

The planning of the activities of this use case will be the subject of the first months of activity of the working group.

Distinctive features: civic value

A public consortium of internationally recognized excellence who have chosen to team together

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Strategic management

The project sponsor and the ultimate responsible for all strategic decisions. Moreover, Municipal department have an active role in the use cases implementations.

FONDAZIONE BRUNO KESSLER

Technical Coordinator & Project Manager

General manager, coordinating the Bologna Digital Twin Project Consortium and supervising its progress.

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Scientific Manager

Scientific leader, responsible for the research development and results.

CINECA

Technical Manager

Supervisor of the technology requirements, of the software development and of the technological infrastructure management.

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Community Manager

Responsible for ensuring that the knowledge produced within the project is shared with citizens and stakeholders.

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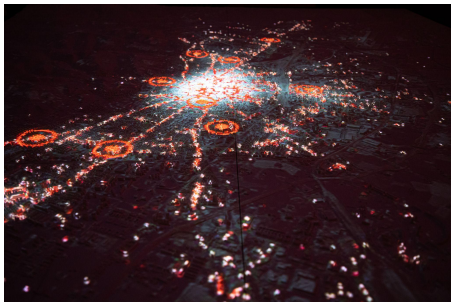
Distinctive features

3 features that make our Digital Twin unique

The **values** dimension

The project is based on the importance of ethics, respect for citizens' digital rights, transparency, fairness, neutrality and data protection.



A **Research and Innovation** approach.

Bologna wants to be a research and innovation laboratory where the administration plays a leading role in promoting cutting-edge projects and experimenting with the most advanced technologies.

The **civic value.**

The project is led by the administration and based on a pact with all city stakeholders with the aim to share data, imagine new solutions and implement them together.

Photo credit: Margherita Caprilli

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Focus

Ethical dimension and legal aspects guiding the project

The legal and ethical challenges facing the Digital Twin concern two of the project's core elements: the **algorithms** used in Machine Learning (ML) and Artificial Intelligence (AI) systems; and the **data** that feed these algorithms.

The project will ensure **compliance with international, EU and national regulations on privacy and the protection of individuals** with regard to the processing of personal data.
It will pay particular attention to the conditions defined by **current and upcoming legislation** on data exchange and sharing, also with regard to the public and private actors involved, and on AI.

The project recognises the need to facilitate the development of AI systems that are in tune with European social and ethical values in line with the principles set out in the **Ethics Guidelines for Trustworthy Artificial Intelligence of the European Commission's Independent High Level Expert Group on AI** (2019) and contribute directly to the fight against gender stereotypes in line with the **EU Gender Equality Strategy** (2020-2025)**.**

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Focus

Ethical dimension and legal aspects guiding the project

	Values	Tools/Processes	Principles
Data ethics	Accuracy Consistency Operability Non-discrimination Transparency	Data quality control Public audits of data production methods Anonymisation of personal data Data protection policy Risk management policies Deontological rules on processing for statistical and scientific research purposes Data protection guarantor Data protection compliance management model	Principle of necessity Proportionality principle Data protection by-design and by-default Substantive and risk-based approach Purpose limitation Legitimacy of processing Legality Human Autonomy FAIR (*Findability, Accessibility, Interoperability, Reusability*) Gender Mainstreaming
ML and AI ethics	Non-discrimination Neutrality Transparency Impartiality	Script analysis Data ethnography Algorithmic fairness Assessment, auditing and intervention based on AI	Compliance-by-design Fairness-by-design Accountability Algorithmic transparency Trustworthy AI Human Autonomy Risk prevention equity Gender Mainstreaming

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Focus

Existing datasets, digital and software infrastructures and platforms

The Digital Twin project builds on the experience and knowledge developed by the Municipality of Bologna, extends them and integrates them with the relevant ones of the project partners, with the aim of enhancing datasets, infrastructures, software and solutions already developed.

	Comune di Bologna	**Partner**
Datasets	Opendata Portal (Welfare, Mobility, Energy and Utilities, Climate and Environment, Economy and Governance, Infrastructure and Territory), Spatial System (SiT), Infrastructure (Invento Portal).	**CINECA**: weather (Mistral project), climate change and land management (Highlander data project). **UNIBO**: data on individual mobility, environmental data (Alma Bike sensing), water, geology, geohazard.
Digital infrastructures	Sensors (Tvcc, SIRIO/RITA cameras; ring road junction cameras; AutoVelox; Traffic counter spikes; Traffic counter thermal cameras; Green Area cameras; Traffic detection buoys; Red traffic light cameras); connectivity.	**FIU:** visualisation and communication urban innovation lab). **CINECA:** supercomputing infrastructure (Leonardo; Marconi100; Galileo100; DGX A100; ADA Cloud).
Software and reusable platforms	LabsMove (people flow monitoring); Invento (technology infrastructure cadastre).	**FBK**: data & AI platform (Digital Hub); urban mobility analysis (Scikit-mobility). **UNIBO:** water and geohazard monitoring and analysis systems.

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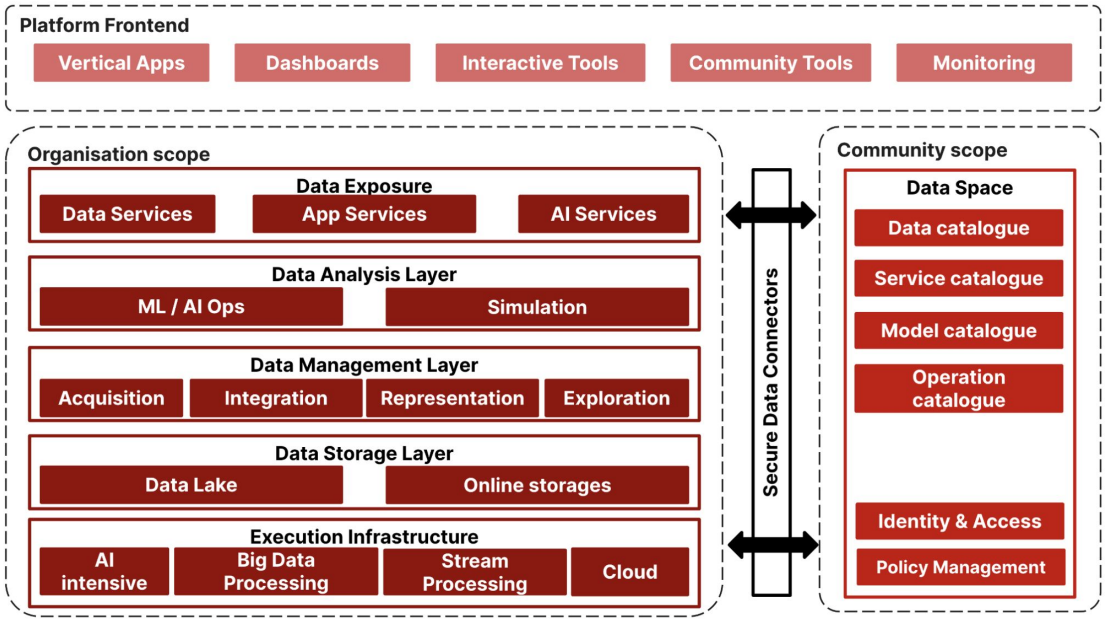
Focus

A platform based on innovative technological layers



The implementation of the Digital Twin aims to define and implement a **cutting-edge technology platform.**

The logical architecture of the platform is based on the pillars of organisation, **community, and platform frontend.**

It includes a number of technology layers to meet the requirements of **data collection, correlation, modelling, analysis, and visualisation.**

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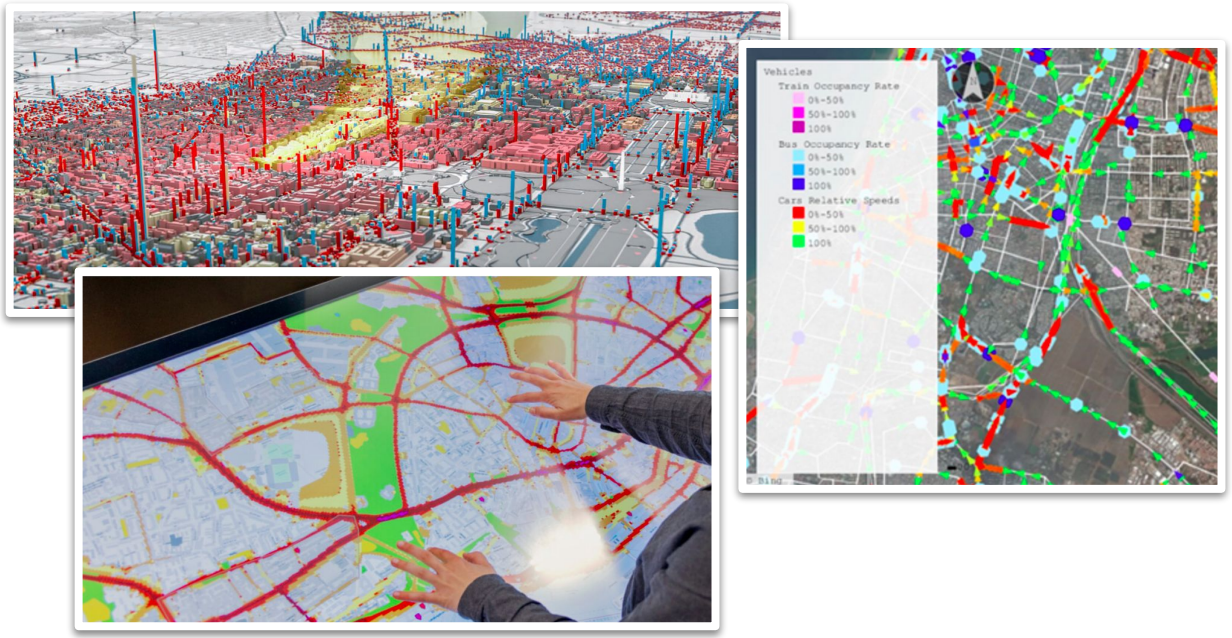
Focus

Possible developments of the Digital Twin



To **explore data and analyses** on the city through enriched interfaces

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Focus

Possible developments of the Digital Twin

To **simulate alternative hypothetical scenarios**, acting on key parameters that determine the functioning of the city

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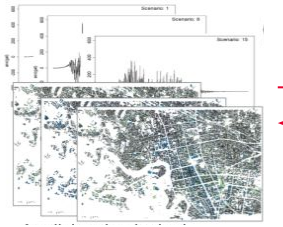
Focus

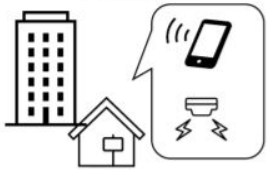
Possible developments of the Digital Twin



Analisi e simulazioni

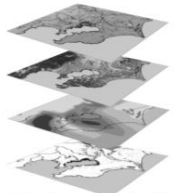
Modelli di città

Feedback agli stakeholder



Dati dai sistemi della città

Esplorazione dei dati e delle analisi



Estrazione di viste diverse e analisi alternative

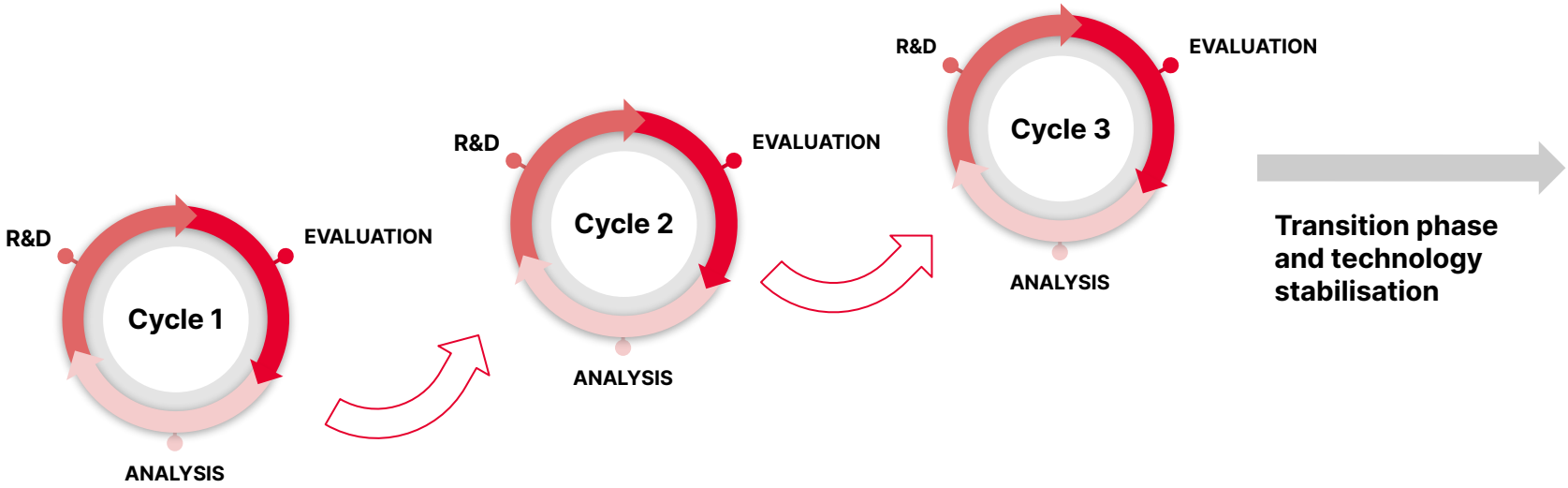
Ability to use an **integrated solution to collect data**, perform analyses and simulations, explore results, extract views and representations, and share them with stakeholders

Focus

An incremental approach to design and test innovation

The development of the Digital Twin of Bologna requires a progressive and incremental project:

- starting from what we know how to do and studying what we do not yet know how to do
- starting from problems that are already clear and codified in order to make new, more complex problems emerge
- building broader and more structured partnerships and collaboration networks



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Roadmap

Our roadmap to 2026

PHASE 1
Inception ✅

Acquiring information on the environment in which the project will be executed and **defining strategies** for civic engagement, communication and conceptual models in a coherent design that will guide the subsequent phases.

PHASE 2
Analysis, Research & Development and Evaluation

It consists of three cycles of one year each in which the **technological, methodological, legal and organisational elements of the Digital Twin will be developed**. Each cycle corresponds to specific and incremental use cases, objectives, communication and engagement targets.

PHASE 3
Transition

Consolidation of the project results and making them sustainable beyond the end of the project, both technologically, organisationally and economically.

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Roadmap

Research and development cycles

	Year 1	**Year 2**	**Year 3**
Milestone	Definition of the model and methodologies	Scale-up adoption and impact of the Digital Twin	Digital Twin deployment and sustainability plan
Use cases	Specific domains to meet already codified needs	Specific domains to meet strategic planning needs	Cross-sectoral domains/ social and economic dimension
Platform Maturity	First version of platform, with focus on data platform. Installation in development and testing environment.	Extended platform version, focus on simulation and decision support. Development and testing environment.	Finalisation of platform. Migration to production environment. MEV start-up.
Industrial partners role	Observers and advisors; collaboration in pilot activities.	Involvement as project partner; participation in design, development, definition of sustainability plan.	Strategic partners of the city of Bologna.
Communication	Data ethics	Active involvement of citizens and stakeholders.	Data-driven decisions
Main target engagement	Internal users and utilities	Citizens and stakeholder	Private sector
Networking activities	Consolidation of the Italian and European strategy (Barcelona and Hamburg)	Enlargement of the network; launch of joint projects and initiatives	Launch of business strategy. National / international sustainability plan.
Ethics and privacy	Ethics and data protection by design	Trustworthy AI e algorithmic privacy preserving	Digital Twin System Ethics and Privacy

Roadmap

Next steps

FIRST RESULTS

- Clear and shared vision, objectives and work plan
- Economic resources and expertise needed
- Partnership with the National HPC Centre and with Barcelona and Hamburg
- First prototype platform

NEXT STEPS

- Construction of the **datasets**, involving citizens and companies in data collection
- **Engagement** of internal users and citizens
- **Use cases:** demonstrate the potentials of the proposed model
- Public kick off

Thank you!

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