EU LDT TOOLBOX

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The European Local Digital Twin TOOLBOX

Unlock the potential of your city.

Funded by
the European Union

EU LDT TOOLBOX

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Local Digital Twin

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the European Union

Local Digital Twin

An LDT is a digital replica of the city that describes and represent the current state of the city.

To create a simulation of the LDT, cities need to **collect data** about their city, **use algorithms** (like mathematical instructions) to process this data, and **build models** (like representations of how things work) to understand the city's needs.

EU LDT TOOLBOX

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The EU LDT Toolbox

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The EU LDT Toolbox

The **EU LDT Toolbox** is a set of tools that enables cities to simulate and predict **scenarios of local digital twins (LDT)**.

The **EU LDT Toolbox** allows to:

1. Acquire and manage **data**
2. Model city elements and create **insights**
3. Communicate with other city **systems**
4. Visualize analysis **outcomes**

The EU LDT Toolbox – Definition

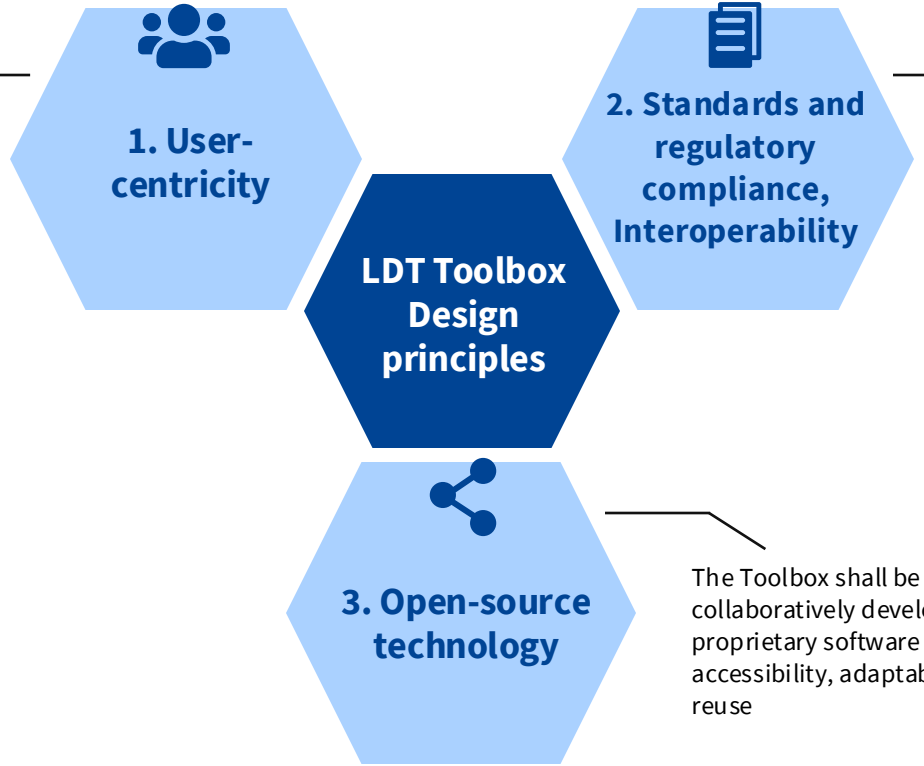
What the EU LDT Toolbox **IS**

- A Simulation Platform
- An Open Framework
- Interoperable and Standardized Guideline for LDTs
- A Resource for Best Practices
- A Tool for Strategic Planning

What the EU LDT Toolbox **IS NOT**

- Not a Local Digital Twin (LDT)
- Not a Real-Time Operations Tool
- Not a Ready-Made Product
- Not a Fully Commercial Solution
- Not a Replacement for Local Data Systems
- Not Limited to Tech Experts

EU LDT Toolbox – Design principles

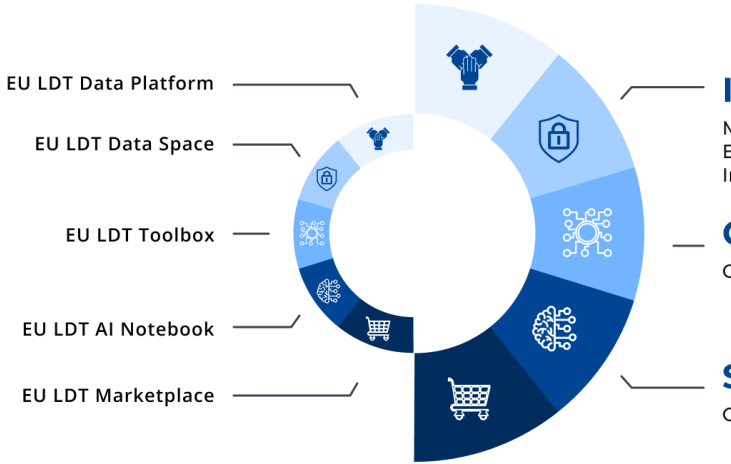


The Toolbox must support the diverse needs of European cities, allowing for customizable LDT configurations to meet each city's digital maturity level

All Toolbox components must comply with relevant industry standards, EU regulations, and Living-in.EU principles to ensure consistent functionality and interoperability across EU municipalities

The Toolbox shall be built on collaboratively developed, non-proprietary software to ensure accessibility, adaptability and broad reuse

EU LDT Toolbox – Why the EU LDT Toolbox



EU Regulation Compliance

EU AI Act, EU Data Act, Ethics and FAIR AI

Interoperability

Minimal interoperability Mechanisms (MIMs) Plus, European Telecommunications Standards Institute(ETSI) & International Telecommunication Union(ITU-T) Standards

Open Source First

Open Source tools, extensible with other tools

Sharing Intelligence

Cooperative solutions and networks of cities

Economic Sustainability

Marketplace, replicability to multiple cities and added value services

- **Digital Single Market** solution for Cities
- **EU Green Deal** support for impact and ROI analysis
- Common **EU Standards** and frameworks to address emerging **EU AI and EU Data Acts**
- **Digital Europe:**
  - Marketplace
  - Interoperability
  - Sandboxes (TEF)
  - Data Spaces (SIMPL)
  - Ethical AI best practices
- **European Digital Infrastructure Consortium (EDIC)** maintenance, valorisation and economic sustainability

LDT – How can it help address urban management challenges

Urban management challenges

Mobility Planning: Optimize traffic flow, public transport, and accessibility by simulating mobility scenarios.

Energy Optimization: Design low-emission zones and reduce energy waste to improve air quality and sustainability.

Urban Health: Monitor pollution and assess impacts to create healthier urban environments.

Urban Planning: Test land use and infrastructure options for balanced, sustainable city growth.

Sustainability: Meet emissions targets and enhance quality of life through effective environmental tracking and strategies.

DATABASE

DATABASE

European Building Database

Input

- GZF Potsdam
- Eubucco
- Global Human Settlement Layer
- EU Building Stock Observatory
- Instituto Valenciano de la Edificación

Output

The whole cities of Europe will be digitalized

- 3D City representation

MODELS

MODEL

Urban Mobility

Input

- Geospatial information,
- Number of cars entering the area

Output

- Links and intersections
- Topography
- Speed limits
- Rush hour data
- Traffic congestion zones

MODEL

Reconstruction

Input

- OpenStreetMap
- Satellite imagery
- Building archetype (Tabula)
- Expert knowledge

Output

- Reconstruction costs per building after a disaster

MODEL

Building environmental footprint

Input

- European Building Dataset
- Building Archetype (Tabula)
- Materials

Output

- CO_2-equivalent emissions

MODEL

Neighbourhood energy demand forecasting

Input

- European Building Dataset
- Building archetype (Tabula)
- Materials

Output

- Annual energy demand forecast at the neighbourhood level

MODEL

Pollution Propagation

Input

- Geospatial Information
- Meteorological Information

Output

- Large-scale polluntant concentration distribution

MODEL

Energy Efficiency

Input

- European Building Dataset
- Building archetype (Tabula)
- Materials

Output

- Building energy efficiency ratings

EU LDT Toolbox – Approach to every Urban Management Challenge

Mobility Planning
Low Emission Zone Use Case/Simulator
Urban Mobility model

Energy Optimization
Neighborhood energy demand forecasting model
Energy Efficiency model

Urban Health
Pollution Propagation model

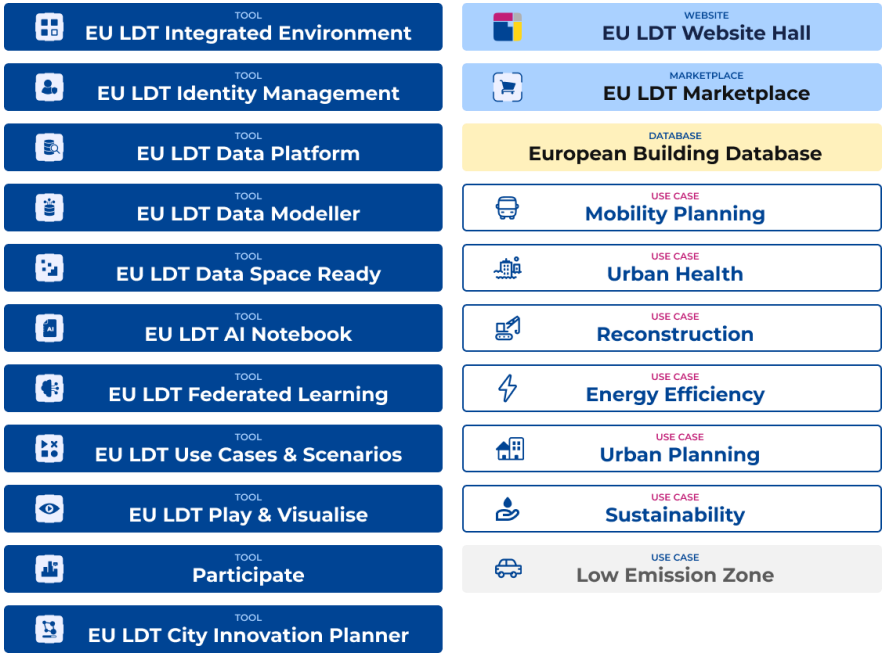
Urban Planning
EU Building Database
Reconstruction model

Sustainability
Environmental footprint model for building

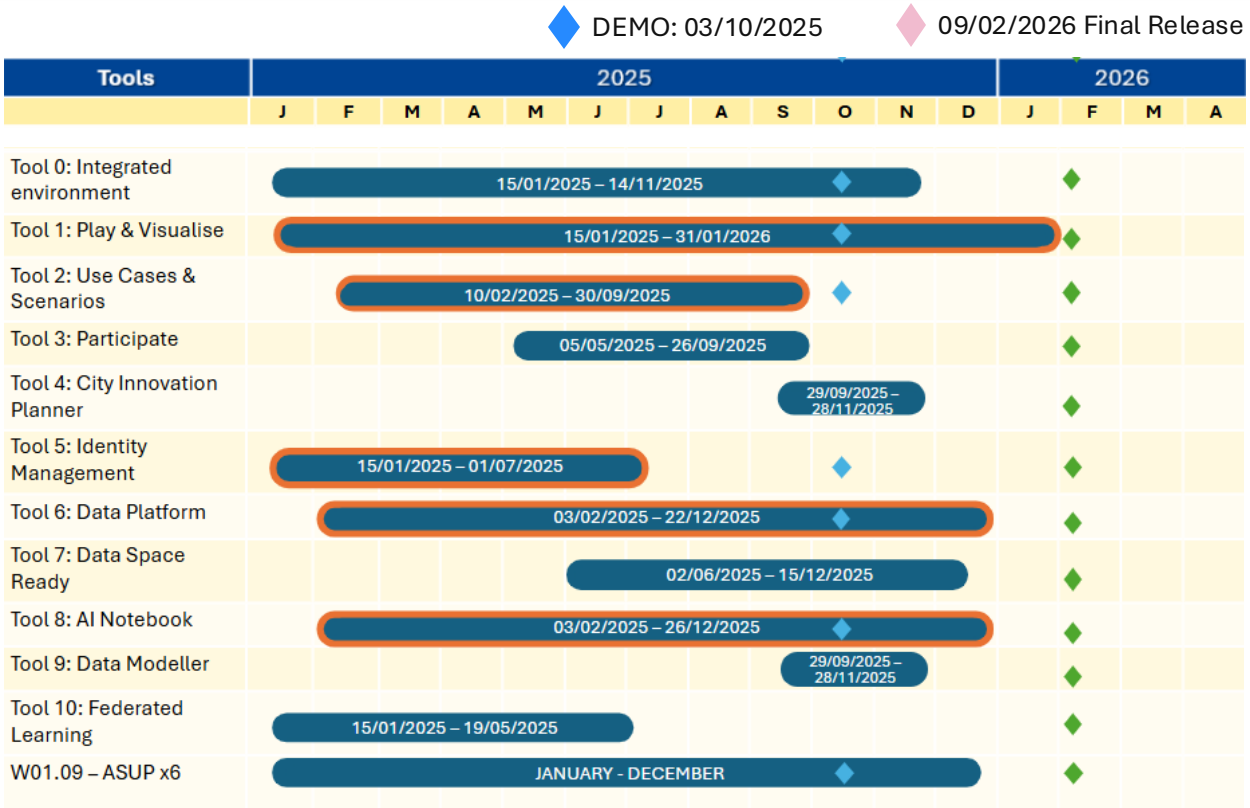
LDT Toolbox Version 1 (June 2026)

Key assets:

- 1 toolbox composed of 11 tools
- 1 EU LDT Toolbox dissemination platform
- 1 Marketplace
- 1 EU-wide Database: European Building Database
- 6 AI Models
- 1 Use Case: Low Emission Zone
- 6 Pilots to test the LDT Toolbox *(currently being defined)*
- Transfer to the EDIC



EU LDT Toolbox – Gantt Chart



The LDT toolbox is designed to engage a diverse array of stakeholders, **fostering digitalization** and **expanding the ecosystem** of **Smart Communities across Europe**.

EU LDT Toolbox Stakeholders

- **EU Smart Cities** (with different digital maturity levels)
- **EU-based technology and data platform providers**
- **Open-source software community**
- **Networks** of Smart City/Digital Twin Communities in EU Member States
- **Standardization Bodies** (ETSI, ITU-T)

How to implement your Local Digital Twin

A city that wants to implement the local digital twin of its city (starting from a level of maturity in which it already has a Smart city with data sets) **will have to take the following steps:**

1. **Secure the necessary infrastructure** to start creating your LDT.

2. **Assemble a team of expert technicians** to install the toolbox and create use cases and scenarios that support decision-making. *(It is essential to define a **transformation plan** if objectives are not yet set, to prioritise actions and identify where scenario simulations could assist decisions.)*

3. **Create specific simulators** using Marketplace algorithms or develop them from scratch.

Implementing the EU LDT Toolbox for Urban Management

Your city

Data Acquisition

Gather your data

Gather data from your city or generate new synthetic data

AI algorithms Creation & training

From Data to Knowledge

Create models, use the ready-to-use ones, and/or download from the Marketplace.

Use Cases & Scenarios

Simulate what if scenarios

Simulate to assess the impact of various actions

Play & Visualise

Visualize the impact

Get virtual representation of the scenarios simulated

Participate

Ask your citizens

Get feedback and engage with citizens

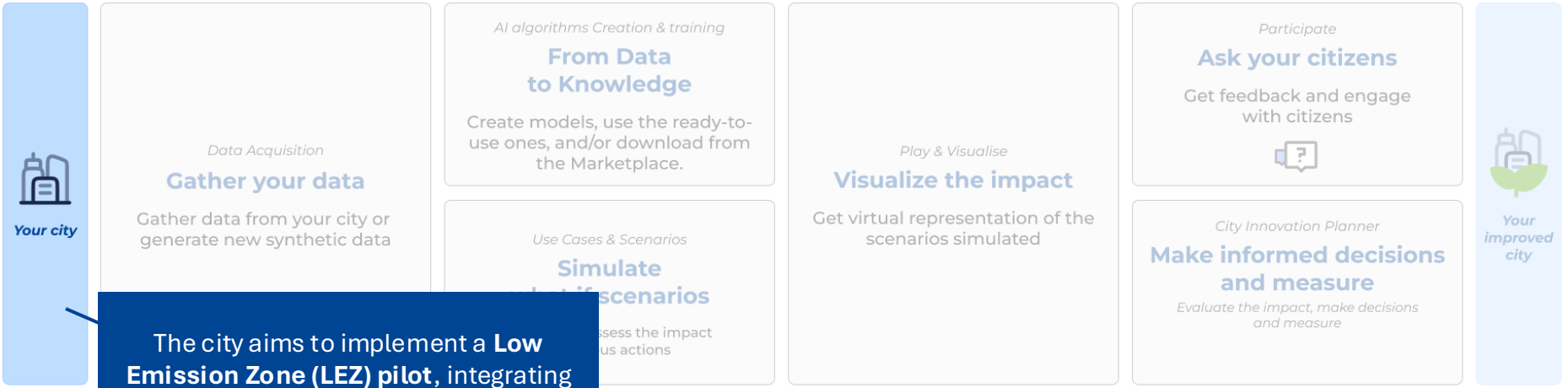
City Innovation Planner

Make informed decisions and measure

Evaluate the impact, make decisions and measure

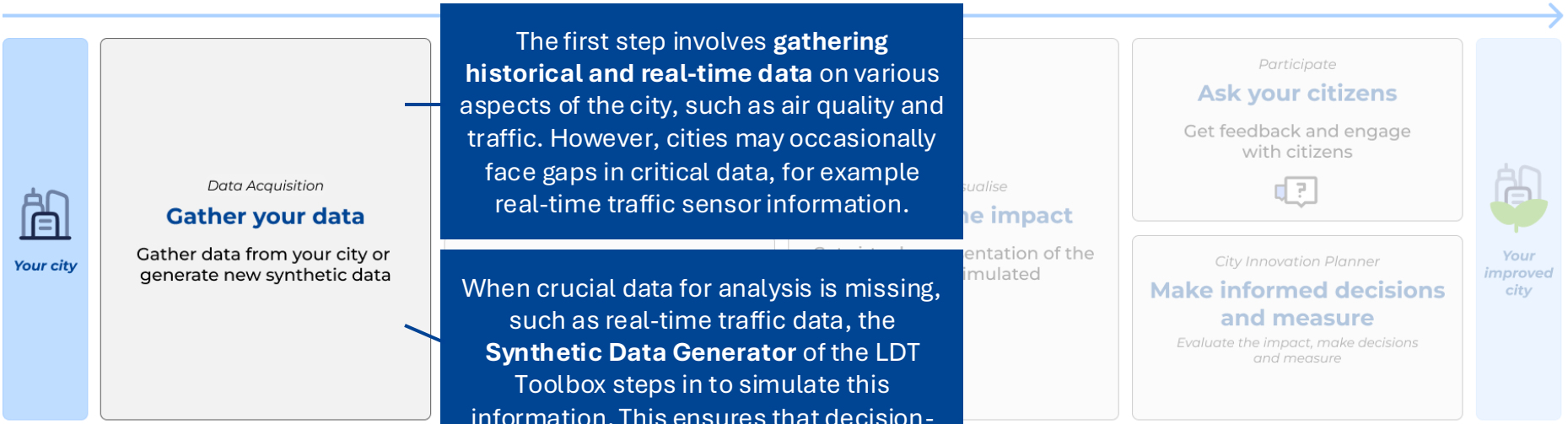
Your improved city

Implementing the EU LDT Toolbox for Urban Management



The city aims to implement a **Low Emission Zone (LEZ) pilot**, integrating comprehensive environmental and socio-demographic analyses for better urban planning.

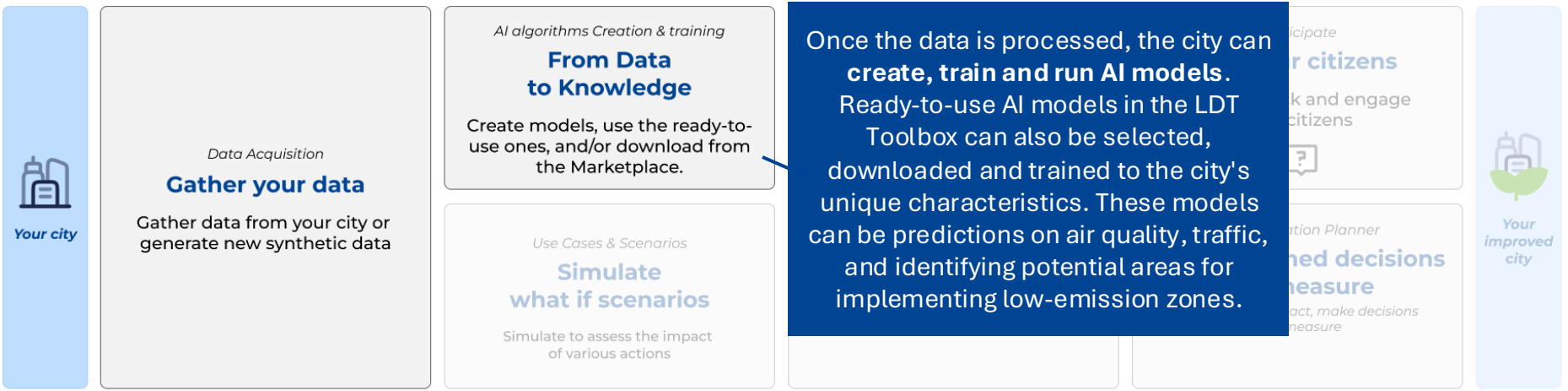
Implementing the EU LDT Toolbox for Urban Management



The first step involves **gathering historical and real-time data** on various aspects of the city, such as air quality and traffic. However, cities may occasionally face gaps in critical data, for example real-time traffic sensor information.

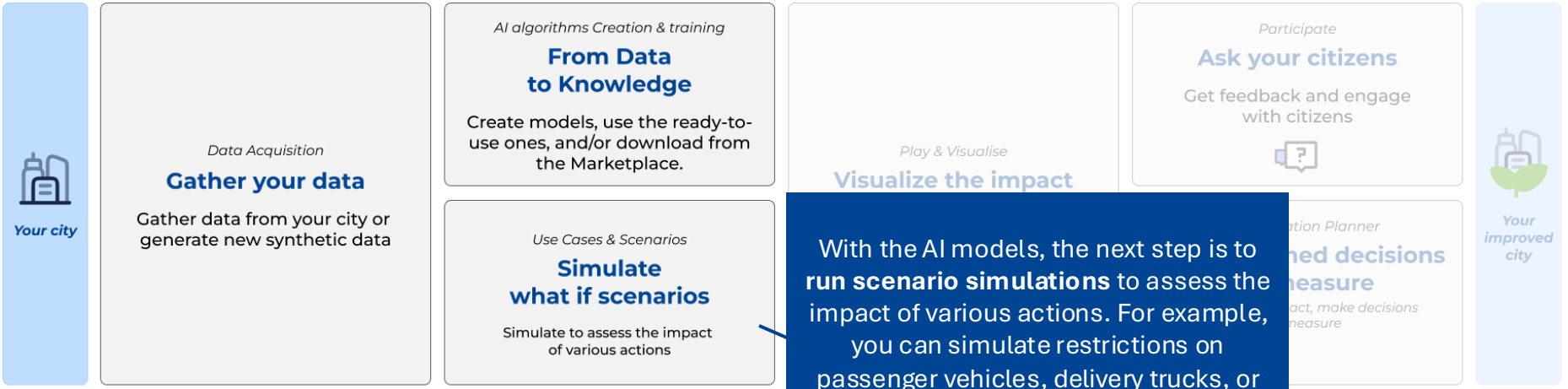
When crucial data for analysis is missing, such as real-time traffic data, the **Synthetic Data Generator** of the LDT Toolbox steps in to simulate this information. This ensures that decision-making is not limited by data gaps.

Implementing the EU LDT Toolbox for Urban Management



Once the data is processed, the city can **create, train and run AI models**. Ready-to-use AI models in the LDT Toolbox can also be selected, downloaded and trained to the city's unique characteristics. These models can be predictions on air quality, traffic, and identifying potential areas for implementing low-emission zones.

Implementing the EU LDT Toolbox for Urban Management



With the AI models, the next step is to **run scenario simulations** to assess the impact of various actions. For example, you can simulate restrictions on passenger vehicles, delivery trucks, or the closure of main roads and evaluate how these changes would affect both traffic and air quality.

Implementing the EU LDT Toolbox for Urban Management

Your city

Data Acquisition

Gather your data

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AI algorithms Creation & training

From Data to Knowledge

Create models, use the ready-to-use ones, and/or download from the Marketplace.

Use Cases & Scenarios

Simulate what if scenarios

Simulate to assess the impact of various actions

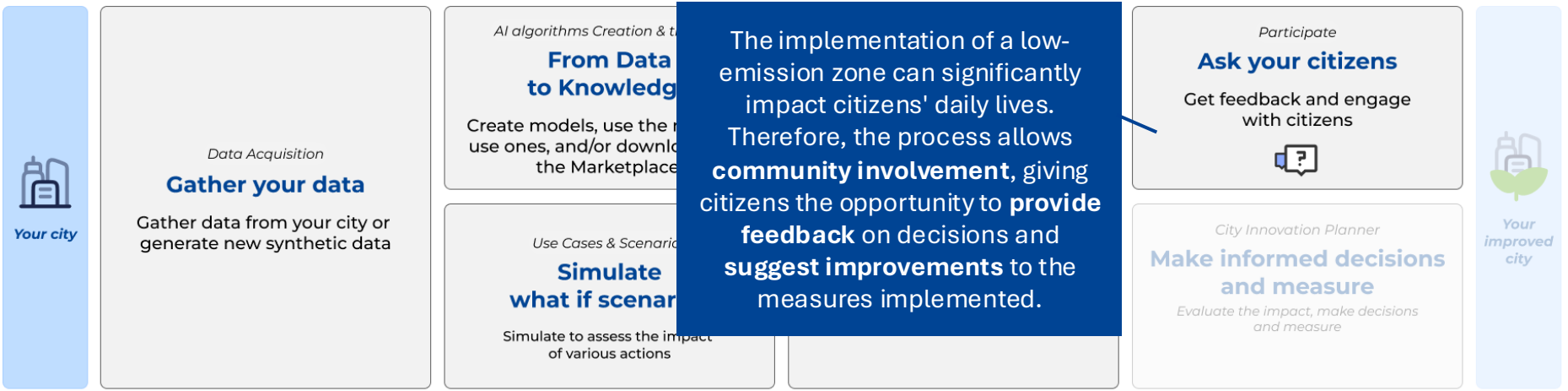
Play & Visualise

Visualize the impact

Get virtual representation of the scenarios simulated

As simulations are conducted, the results can be **visualised in a virtual way**, allowing city officials to immediately assess the impact of decisions. This visualisation is crucial for understanding how different restrictions will affect both mobility and pollution levels in the city.

Implementing the EU LDT Toolbox for Urban Management



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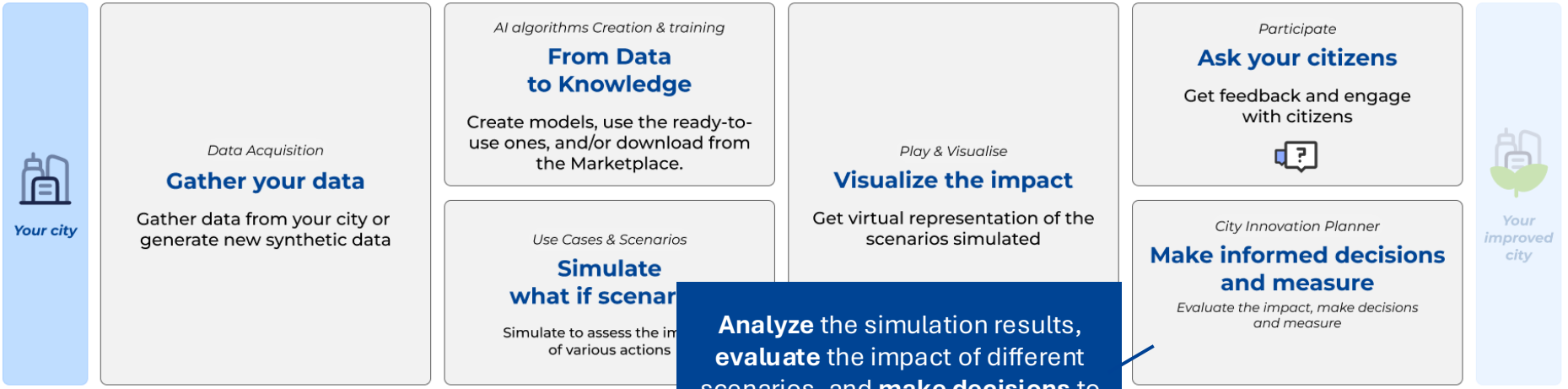

Analyze the simulation results, **evaluate** the impact of different scenarios, and **make decisions** to improve air quality, reduce traffic, and enhance the quality of life in your city.

EU LDT TOOLBOX

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An example of the LDT:
Implementing a Low Emission Zone

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Urban management challenges

Mobility Planning

Ene

Urb

Urb

Sus

Example

Better quality of urban life through Low Emission Zones (LEZs)

The Challenge:

Reduce vehicle emissions in cities.

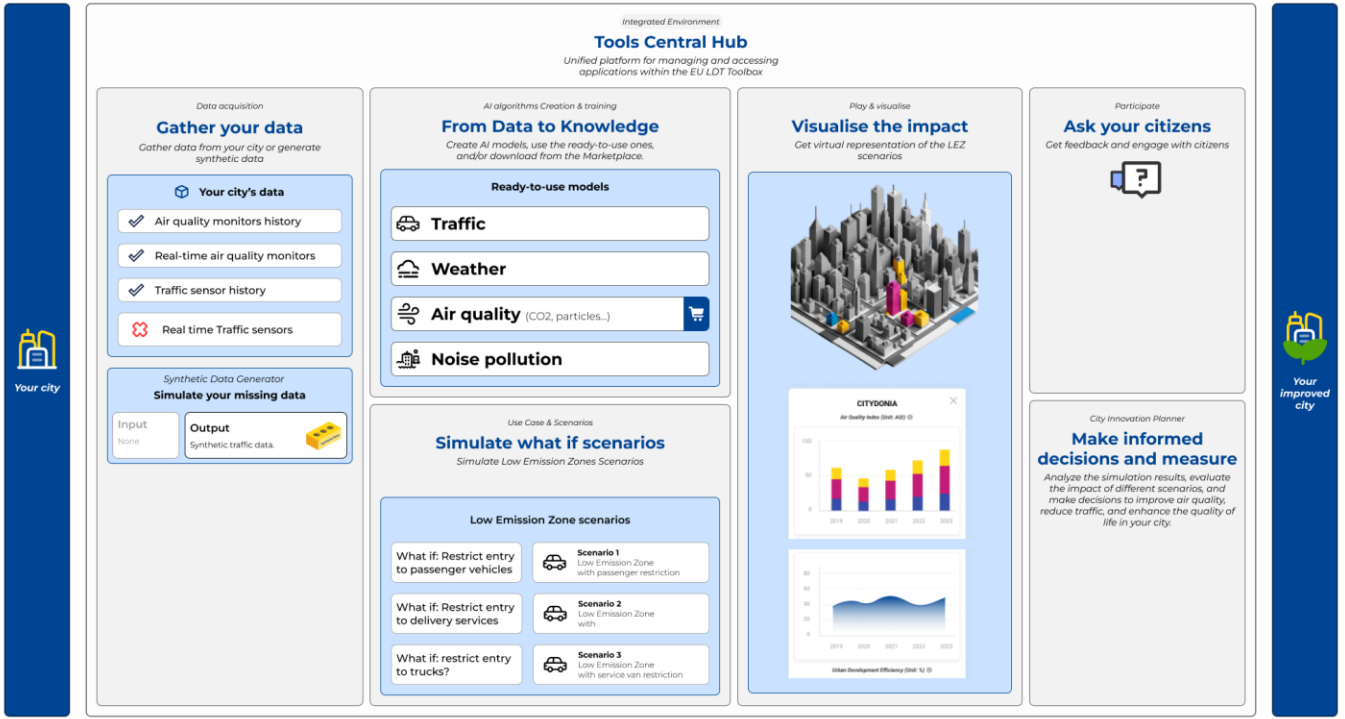
The desired solution:

A cleaner, healthier and more sustainable urban environment.

How would an LDT help?

- **Solution Design**: by simulating and testing the LEZ's emission reduction effect
- **Feasibility Analysis**: by comparing different LEZ solutions based on their simulation outcomes and supporting informed decision-making.
- **Continuous Monitoring**: by tracking real-time pollution data for continuous LEZ improvement
- **Documentation and reporting** : by documenting the LEZ design and implementation process, also for regulatory compliance and planning updates

Implementing Low Emission Zones with LDT Toolbox



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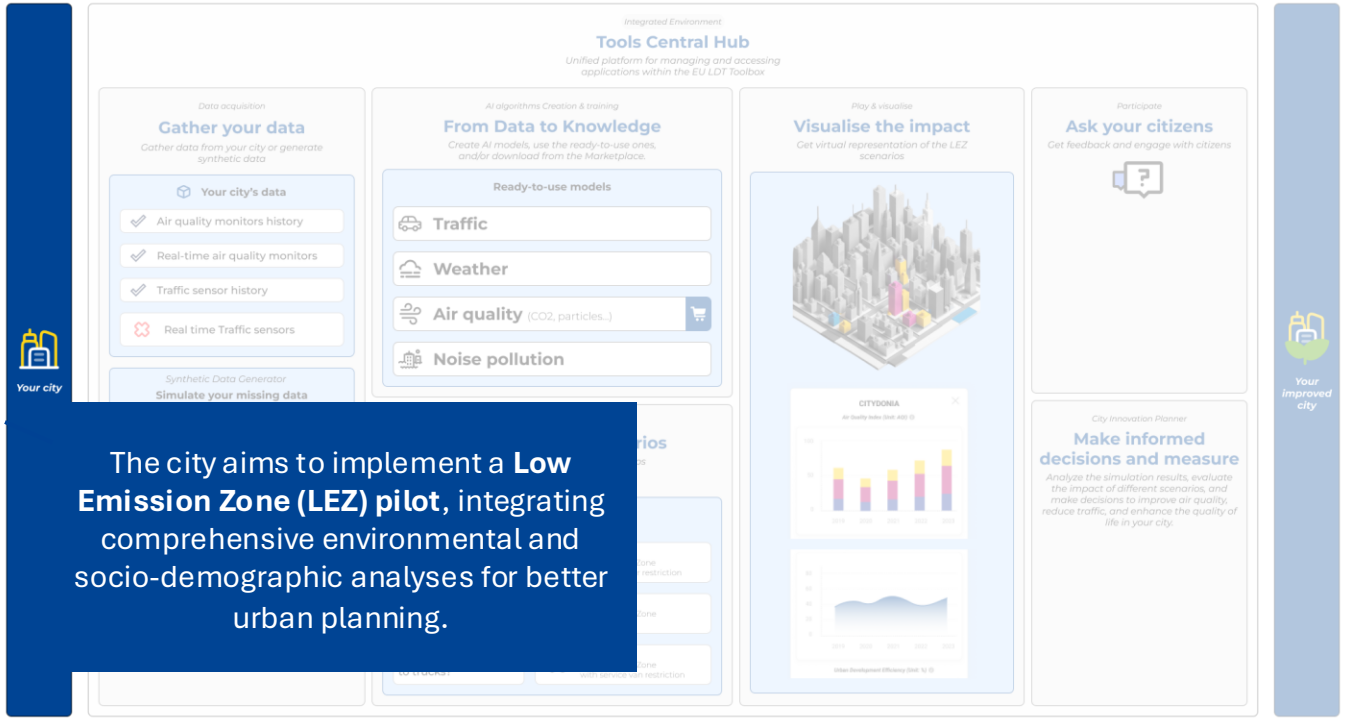

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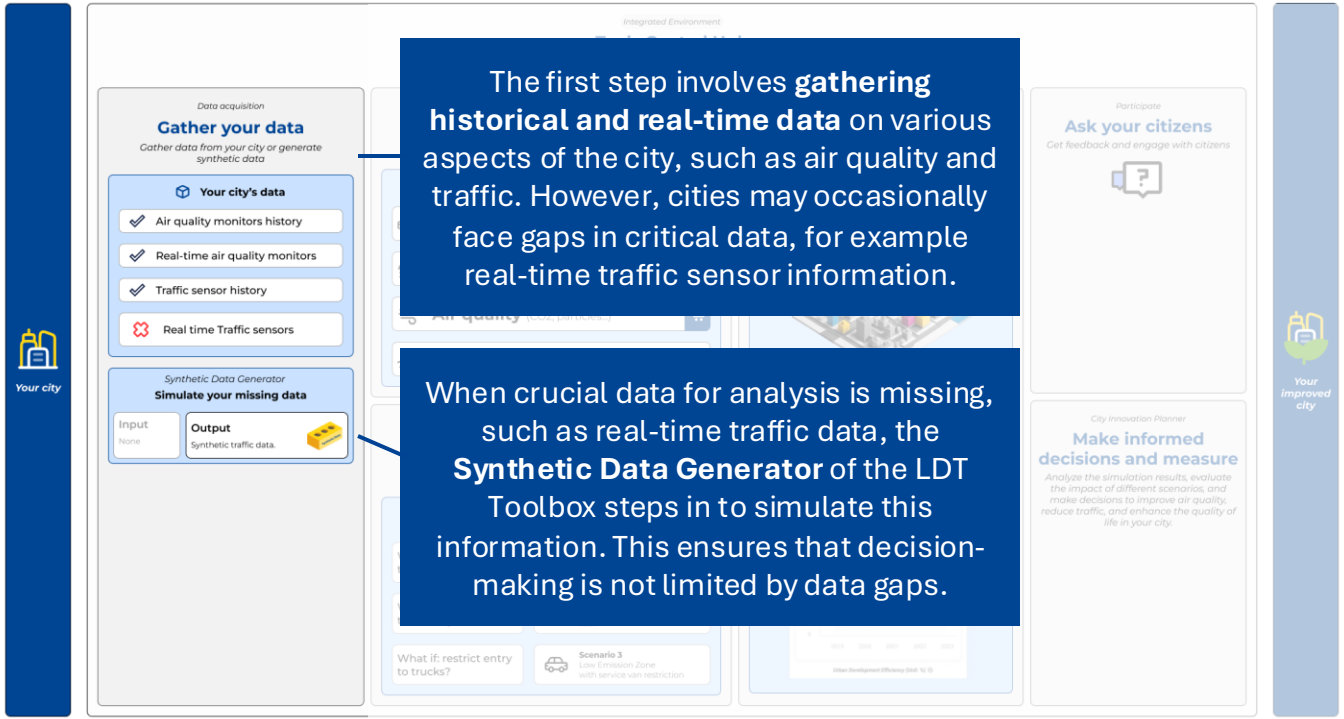
Implementing Low Emission Zones with LDT Toolbox



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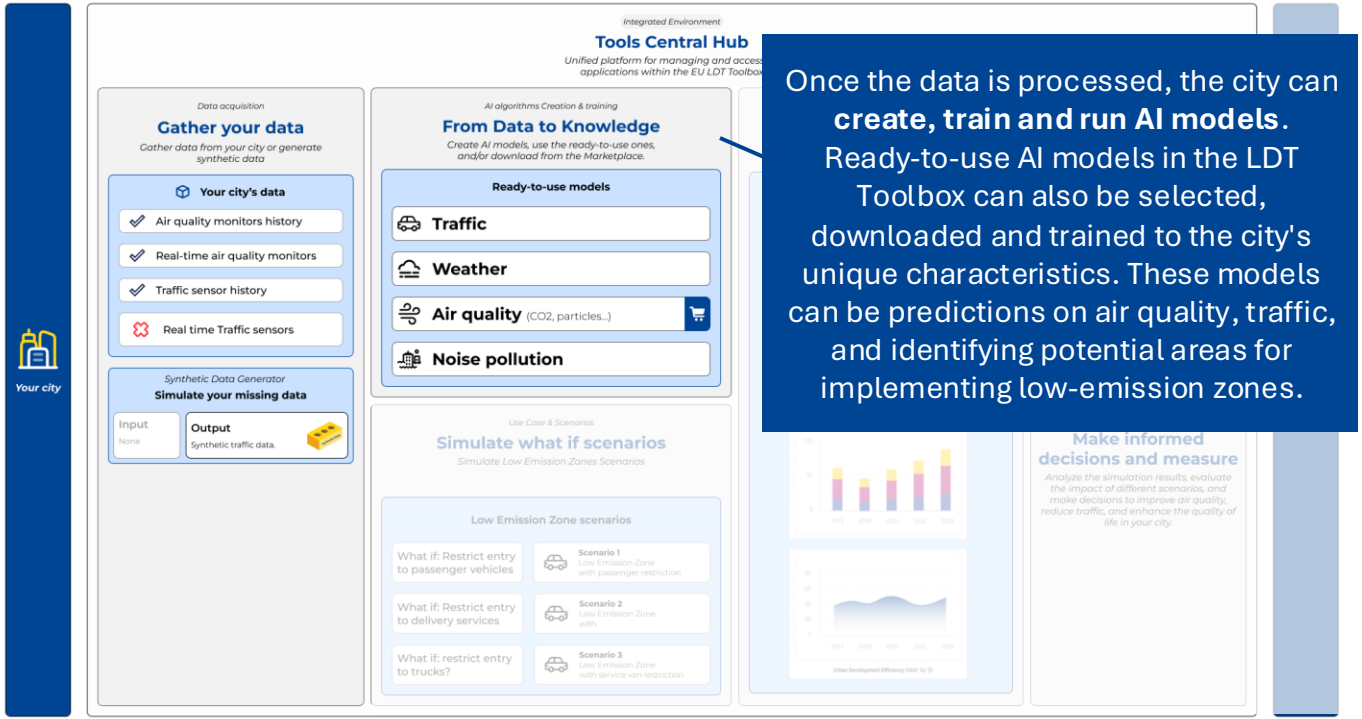

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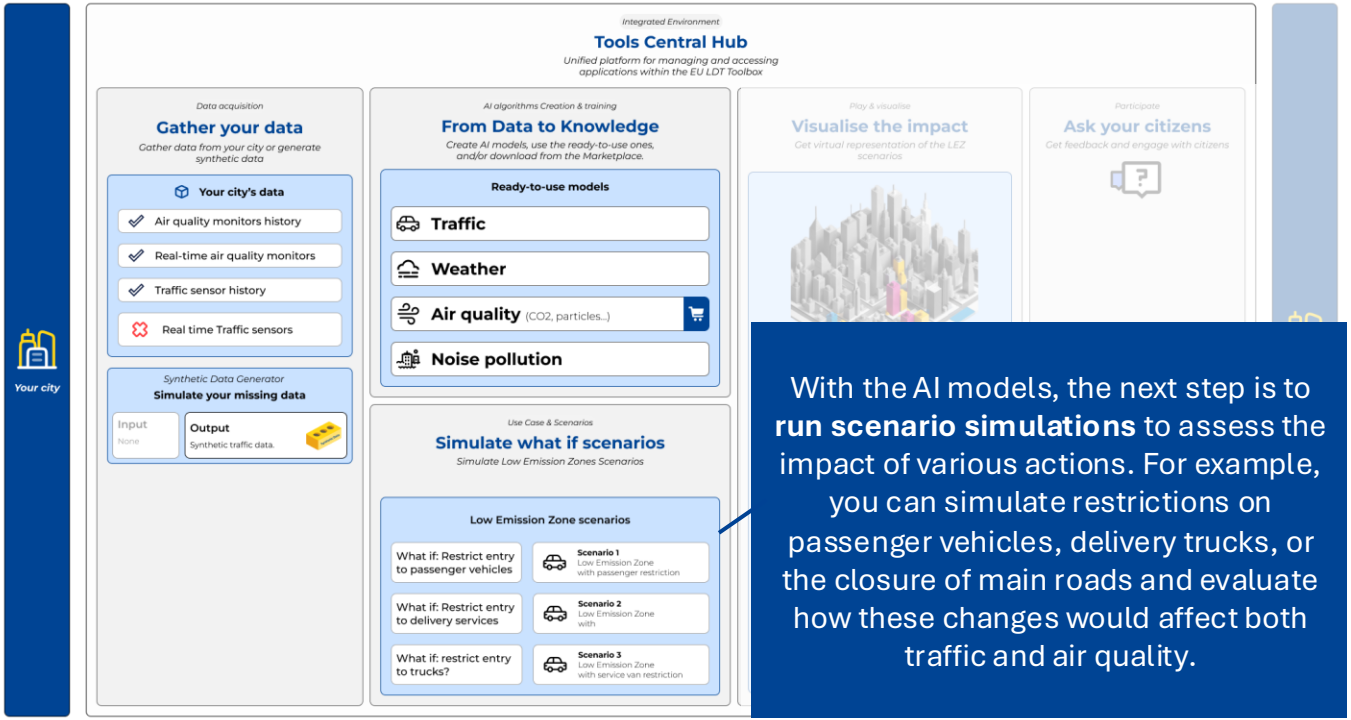

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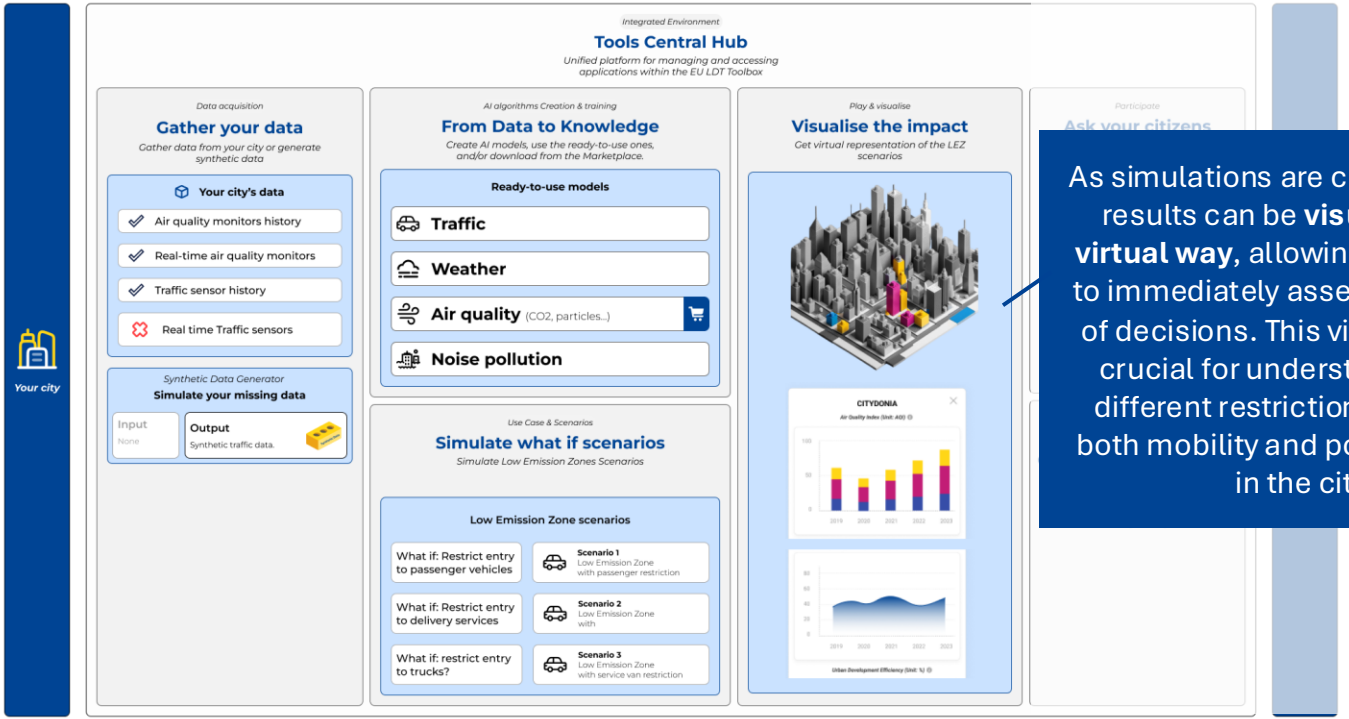
Implementing Low Emission Zones with LDT Toolbox

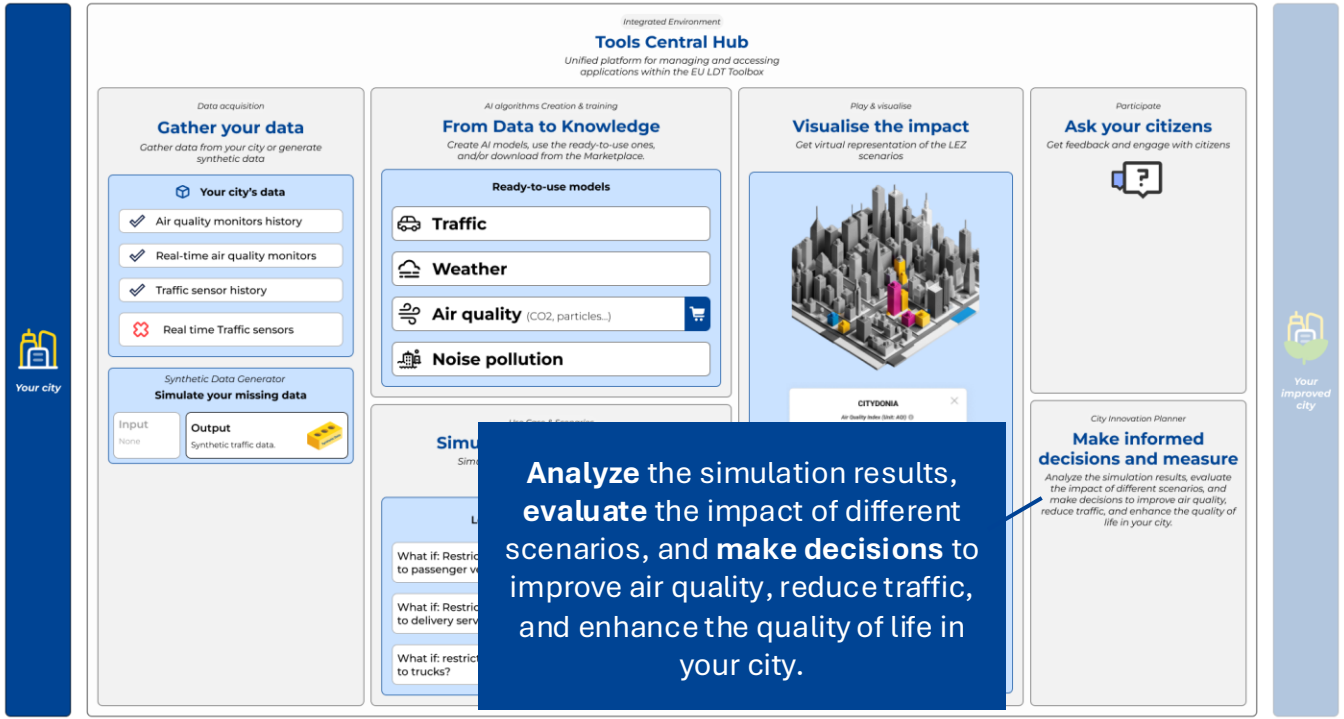


As simulations are conducted, the results can be **visualized in a virtual way**, allowing city officials to immediately assess the impact of decisions. This visualization is crucial for understanding how different restrictions will affect both mobility and pollution levels in the city.

Implementing Low Emission Zones with LDT Toolbox

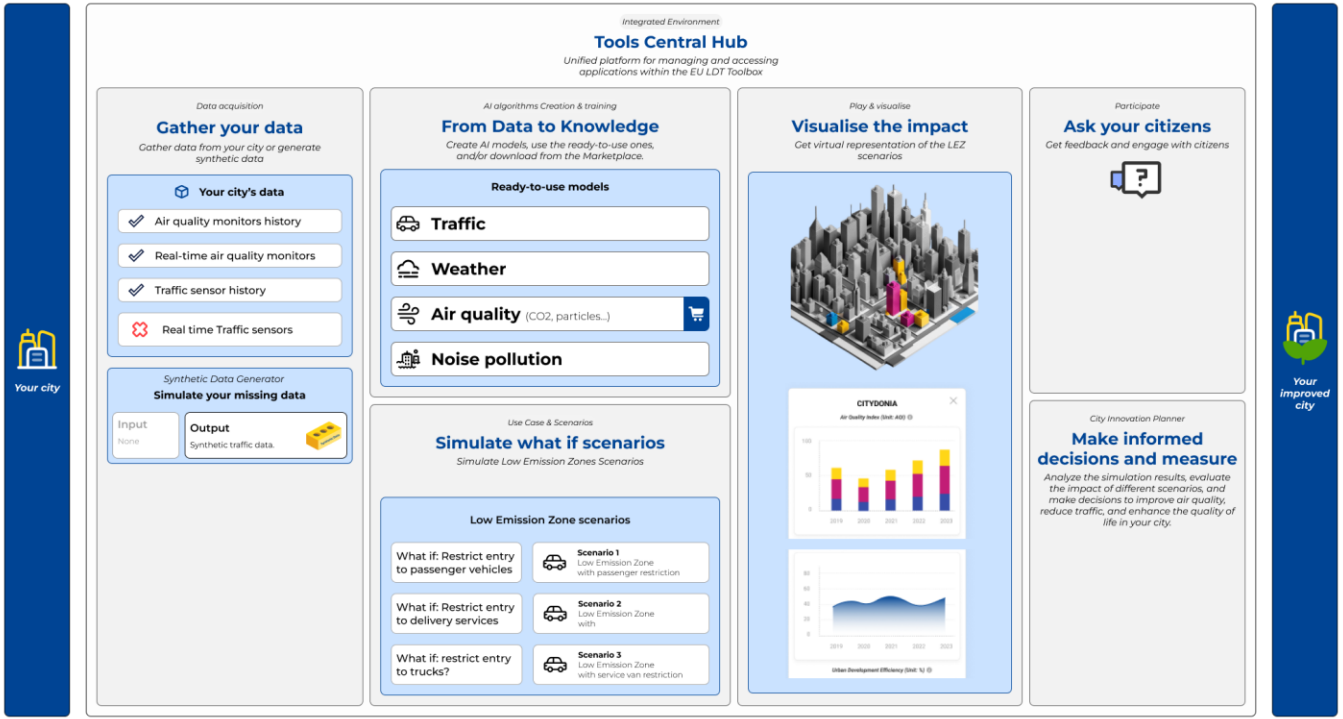
The implementation of a low-emission zone can significantly impact citizens' daily lives. Therefore, the process allows **community involvement**, giving citizens the opportunity to **provide feedback** on decisions and **suggest improvements** to the measures implemented.

Implementing Low Emission Zones with LDT Toolbox



Analyze the simulation results, **evaluate** the impact of different scenarios, and **make decisions** to improve air quality, reduce traffic, and enhance the quality of life in your city.

Implementing Low Emission Zones with LDT Toolbox



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The Toolbox

Tool by Tool

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The Toolbox – Tool by Tool

Your city

EU LDT Integrated Environment

Tools Central Hub

EU LDT Hall

Dissemination Platform

EU LDT Marketplace

Marketplace

Data Acquisition

Self Data Collector & Integrator

EU LDT Data Platform

Integrate with 3rd party data

EU LDT Data Space Ready

Synthetic Data Generator

EU LDT Data Modeller

EU LDT AI Notebook
EU LDT Federated Learning

From Data to Knowledge

Create models or use the ready-to-use ones from the Marketplace

EU LDT Use Cases & Scenarios

Simulate what if scenarios

Run scenario simulations to assess the impact of various actions

EU LDT Play & Visualise

Visualise the impact

Get virtual representation of the scenarios' results

EU LDT Participate

Ask your citizens

Get feedback and engage with citizens

EU LDT City Innovation Planner

Make informed decisions and measure

Evaluate the impact, make decisions and measure

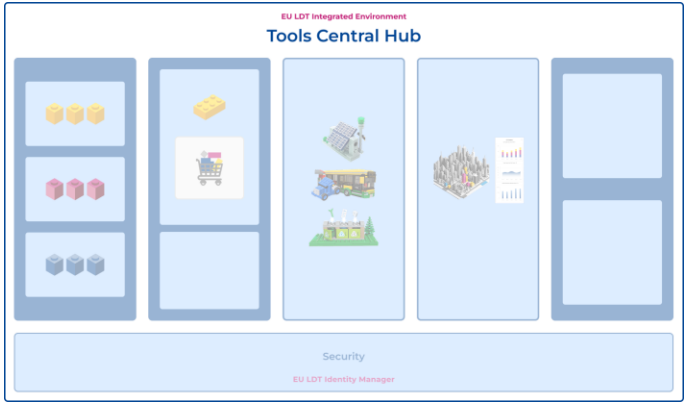
EU LDT Identity Manager

Security

Your improved city

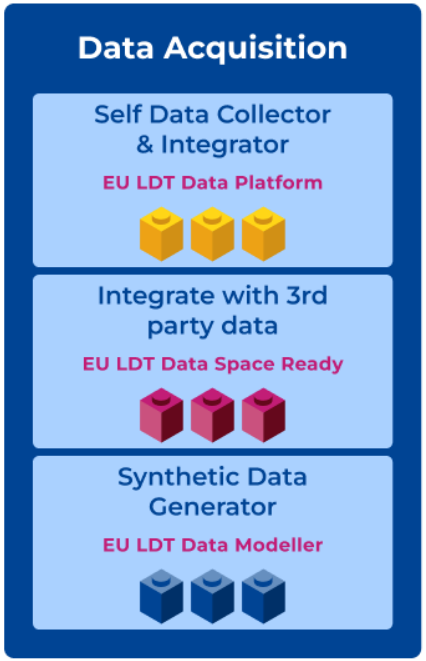
The Central Hub

Functions as a centralised hub for the **management and interaction** with the tools in the EU LDT Toolbox.
It provides a **unified user interface** that allows seamless **navigation and interaction** between the toolbox applications while ensuring **consistency and usability** across the system.



Gather your Data

The **data of your city** is collected from sensors, data spaces, and more.
This data can be integrated with **synthetic data** if the existing data is insufficient and complemented with **third-party data** to address specific needs.



From Data to Knowledge

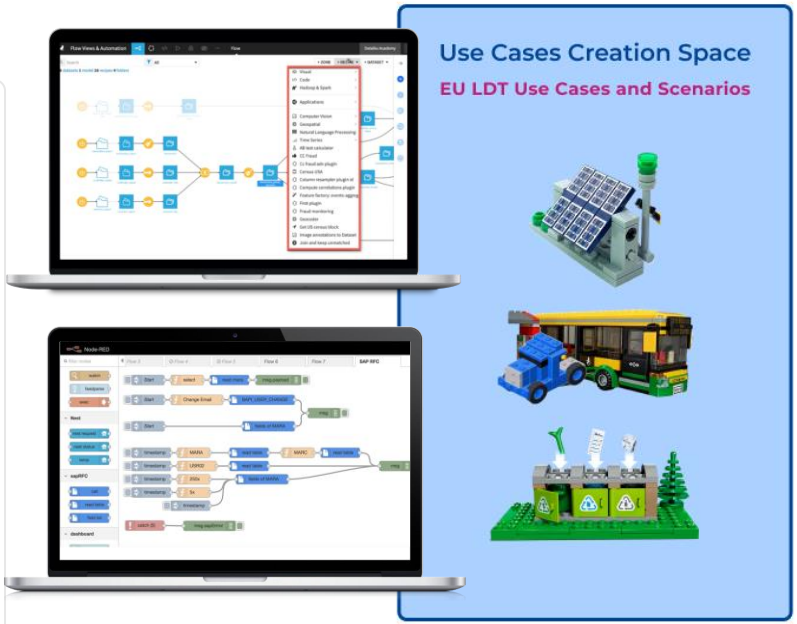
Users can create, edit, and train algorithms in three ways:

1. Train **your own private data**.
2. Use a **default repository** offering algorithms (e.g., pollution, traffic, weather).
3. Import solutions **from the Marketplace**.

The LDT also provides **Federated Learning** for training and scaling models securely with third parties without compromising private data.

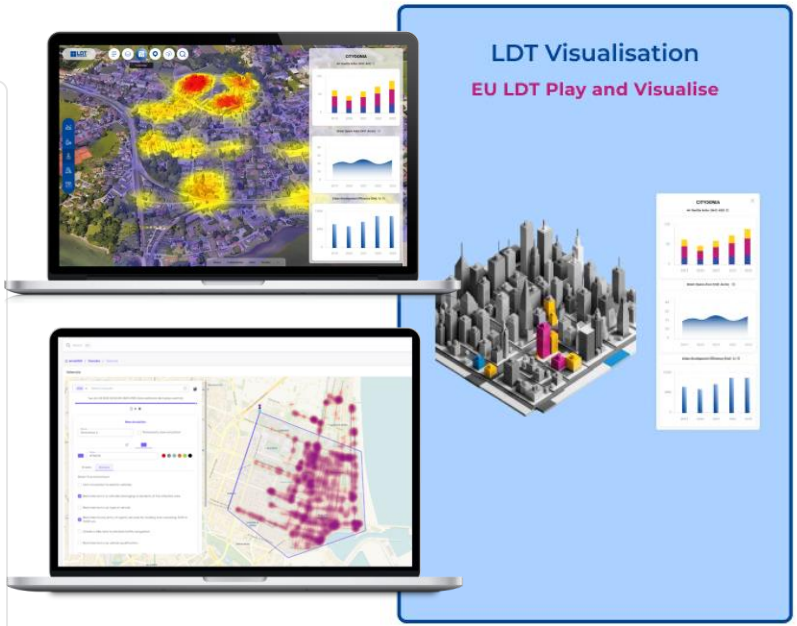
Simulate What if scenarios

Use Case and Scenarios functions as a space for creating and simulating urban scenarios to evaluate strategies before implementation.



Visualize the impact

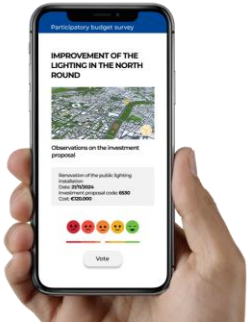
It helps you visualize the results through **extended reality**, **geospatial visualisations** and **advanced analytics**.
Make faster and more informed decision-making by providing insights that are easy to interpret and share with stakeholders.



Ask your citizens, make informed decisions and measure

Simplify community engagement by allowing you to easily gather and integrate citizen feedback.

The **City Innovation Planner** helps monitor city evolution by setting KPIs based on the simulation of key verticals.



Service Applications

Citizen Engagement
EU LDT Participate

City Digital Transformation Road map Manager
EU LDT City Innovation Planner

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and be part of the revolution

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Ready to upgrade?

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Patricia Tamarit

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Contact:

Dr. Antonio Jara

jara@libelium.com

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Reference Architecture

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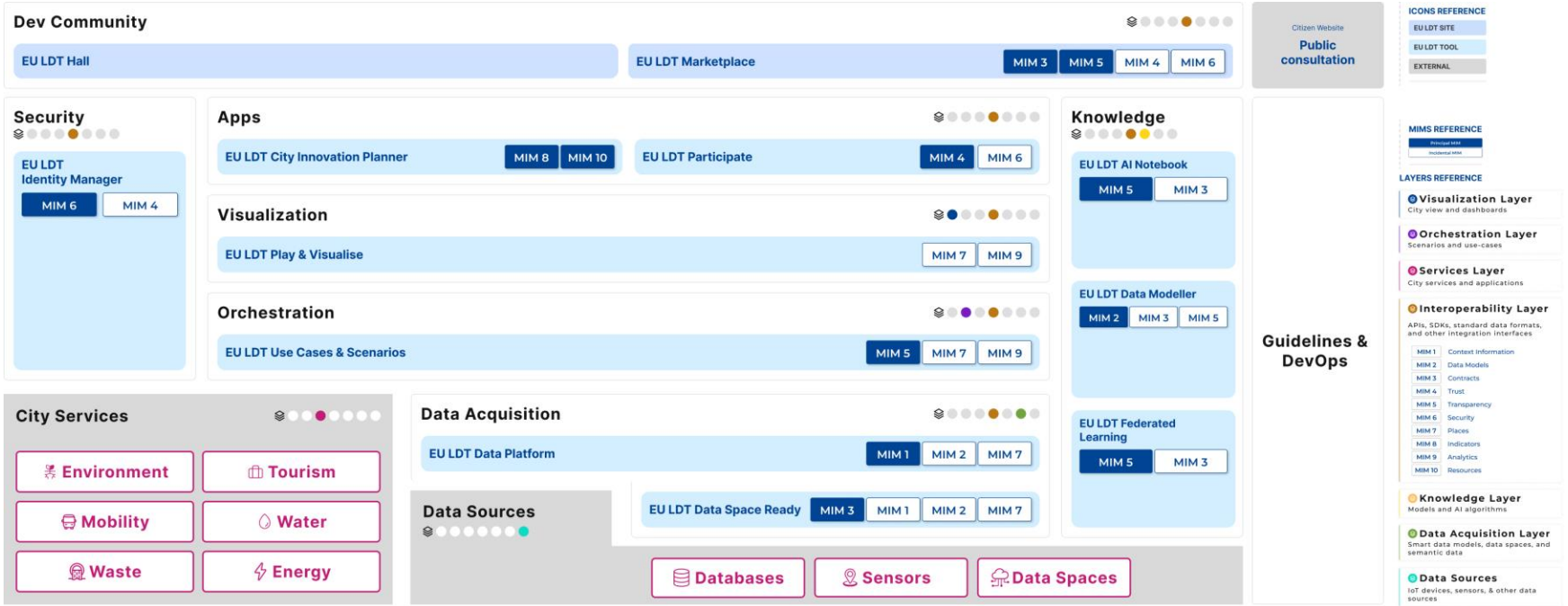
Dev Community
EU LDT Hall
EU LDT Marketplace
MIM 3
MIM 5
MIM 4
MIM 6
Citizen Website
Public consultation
ICONS REFERENCE
EU LDT SITE
EU LDT TOOL
EXTERNAL
Security
EU LDT Identity Manager
MIM 6
MIM 4
Apps
EU LDT City Innovation Planner
MIM 8
MIM 10
EU LDT Participate
MIM 4
MIM 6
Visualization
EU LDT Play & Visualise
MIM 7
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MIM 5
MIM 3
EU LDT Data Modeller
MIM 2
MIM 3
MIM 5
EU LDT Federated Learning
MIM 5
MIM 3
Guidelines & DevOps
MIMS REFERENCE
LAYERS REFERENCE
Visualization Layer
City view and dashboards
Orchestration Layer
Scenarios and use-cases
Services Layer
City services and applications
Interoperability Layer
APIs, SDKs, standard data formats, and other integration interfaces
MIM 1 Context Information
MIM 2 Data Models
MIM 3 Contracts
MIM 4 Trust
MIM 5 Transparency
MIM 6 Security
MIM 7 Places
MIM 8 Indicators
MIM 9 Analytics
MIM 10 Resources
Knowledge Layer
Models and AI algorithms
Data Acquisition Layer
Smart data models, data spaces, and semantic data
Data Sources
IoT devices, sensors, & other data sources
City Services
Environment
Tourism
Mobility
Water
Waste
Energy
Data Acquisition
EU LDT Data Platform
MIM 1
MIM 2
MIM 7
Data Sources
EU LDT Data Space Ready
MIM 3
MIM 1
MIM 2
MIM 7
Databases
Sensors
Data Spaces

EU LDT TOOLBOX

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Extra details:

Use Case
Low Emission Zones

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Use case for Low Emission Zone – Low emission Regulations

Monitor the compliance with local, regional, and national low emission regulations.

A. **Prerequisites**:
   a. Pollution models
   b. Traffic models

B. **Tools**:
   a. EU LDT Use Cases & Scenarios
   b. EU LDT Data Platform
   c. EU LDT AI Notebook
   d. EU LDT Play & Visualise

C. **Assets**:
   a. City Traffic Dataset
   b. Sentinel satellite Dataset
   c. IoT sensors Dataset
   d. LEZ models collection

Use Case: Low Emission Zone (LEZ)

The city wants to implement a **Low Emission Zone (LEZ) pilot**, integrating comprehensive environmental and socio-demographic analyses.

The *EU LDT Toolbox* helps to:

- **Simulate** the impact of various LEZ strategies, examining potential outcomes and optimizations.
- **Visualize** the potential for enhanced social cohesion and support for the city's transition to sustainable practices.

Use Case: LEZ - Benefits

Optimal Implementation and Design

Tests various urban development scenarios to enhance green zones and reduce emissions, ensuring environmentally and socially beneficial strategies are applied.

Feasibility Analysis

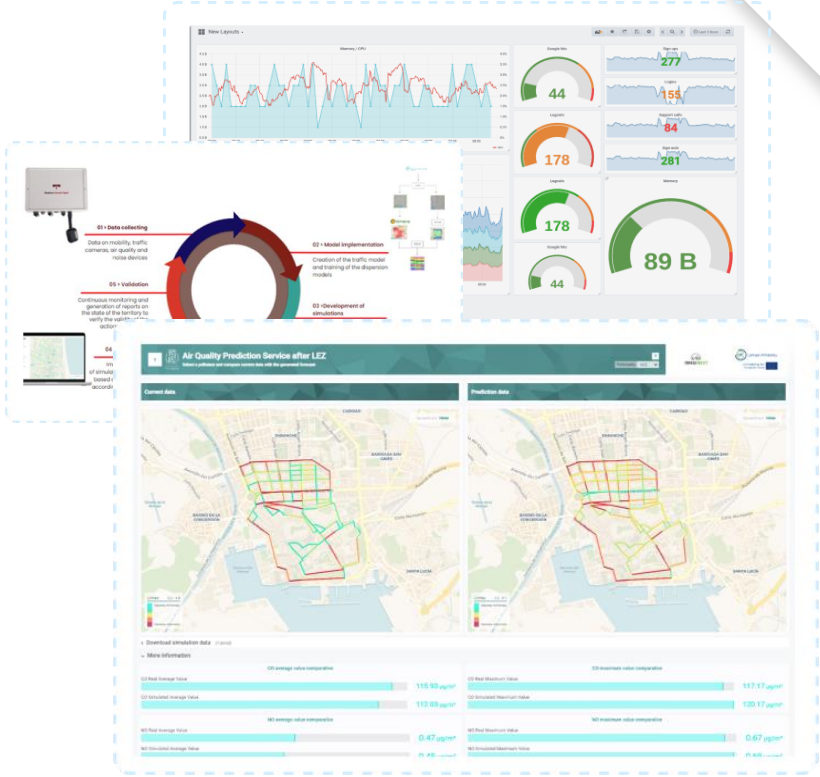
Facilitates pre-implementation analysis, allowing stakeholders to visualize potential outcomes and make informed decisions.

Continuous Monitoring

Monitor ongoing projects, compare real conditions to initial simulations, and provide continuous feedback for adaptive management.

Documentation and Reporting

Maintains detailed records of planning and implementation processes within the EU LDT Toolbox, ensuring compliance, future planning accuracy, and public transparency.



Use Case: LEZ - Actions

With the insights gained from his simulations, formulate a comprehensive plan for the city, introducing innovative projects:

❑ Green Zone Expansion

Expand green spaces with air-purifying plants and sensor-based air quality monitors.

❑ Smart Access Management

Deploy smart cameras and AI to control vehicle access and optimize traffic in the LEZ.

❑ Sustainable Mobility Solutions

Enhance public transport and non-motorized travel options to reduce reliance on private vehicles.

❑ Community Integration Programs

Host bi-monthly workshops to align LEZ projects with community needs and feedback.

Use Case: LEZ - Evaluation of Results

Initial Results:
Significant gains in environmental sustainability and community cohesion have been achieved, enhancing safe and inclusive urban spaces.

Pilot Success:
Motivated by the pilot's achievements, continuously refine the city urban strategies using the EU LDT Toolbox, promoting an active sustainability agenda.

Broader Applications:
The positive outcomes inspire to explore the EU LDT Toolbox for wider use in urban development projects.