European data space
for smart communities

Building Public–Private Data Spaces for Climate-Neutral Cities: Lessons from Zaragoza and Ljubljana

White Paper

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Abbreviations

Abbreviation	Definition	Abbreviation	Definition
DS4SSCC	European Data Space for Smart Communities	IPPCP	Intelligent Private–Public Neutral Carbon Platform
DS4SSCC-DEP	European Data Space for Smart Communities deployment action	LEV	Local Emissions Insight
EDC	Eclipse Dataspace Components	SECAP	Sustainable Energy and Climate Action Plan
INSPIRE	Infrastructure for Spatial Information in the European Community	UDP Lite	Urban Digital Platform – lightweight implementation

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Executive Summary

Cities need reliable and regularly updated data to prepare emissions' inventories and monitor climate action. However, this data is produced by many public and private organisations and is often collected through separate requests, spreadsheets, forms, databases and technical interfaces. This increases administrative work and makes data quality, traceability and reuse more difficult.

The Intelligent Private–Public Neutral Carbon Platform (IPPCP) addressed this challenge through pilots in Zaragoza (Spain) and Ljubljana (Slovenia). The 16-month project ran from May 2025 to August 2026 under the third-round pilot call of the European Data Space for Smart Communities deployment action (DS4SSCC-DEP), supported by the Digital Europe Programme. It applied the principles of the DS4SSCC Blueprint[1] to emissions-inventory management.

IPPCP did not replace existing municipal systems or collect all data in one central database. Instead, it developed two local data-space implementations based on common interoperability principles. These enabled selected data and services to be described, discovered and exchanged under defined access conditions, while providers retained control over their source data.

Zaragoza built on its municipal data and open-data ecosystem and developed it towards a public–private data-space model, with particular attention to industry and other external data providers. Ljubljana built on its existing emissions-monitoring environment, based on Local Emissions Insight (LEV) and the Energy and Climate Atlas, and connected selected services to a data-space layer. UDP Lite supported the preparation of selected air-quality observations.

The pilots were evaluated through agreed indicators and technical and organisational evidence. In Zaragoza, 17 organisations formally expressed interest in joining the data space. The pilot integrated 78 unique data sources, validated 29 emissions-inventory datasets and recorded 109 interoperable services and 89 territorial and social indicators. The capability to automate parts of emissions-data ingestion was validated in pre-production, but the actual level of automation and service use could not yet be measured.

In Ljubljana, five data assets were published across four categories: energy consumption, greenhouse gas emissions, temperature and air quality. Four source systems were integrated against a target of six, and the availability target for temperature data was achieved. The pilot validated controlled two-way data exchange between the City of Ljubljana and Envirodual. The reduction in report-preparation time and actual monthly service use could not yet be measured because the implementation had not moved into sustained production operation.

The pilots demonstrated the technical feasibility of the approach and established key governance mechanisms in a pre-production environment. These results provide a foundation for continued operation and for measuring benefits such as reduced manual work, faster reporting and regular service use.

The main contribution of IPPCP was to show how existing municipal systems and workflows can incorporate governed inter-organisational data exchange. The pilots confirmed that a data space is not only a technical solution, but a cooperation model that also requires clear roles, access conditions,

[1] https://www.ds4sscc.eu/inventory

data-quality responsibilities, metadata, traceability and continued stakeholder participation before it can become operational.

Zaragoza and Ljubljana did not directly exchange emissions data or operate shared cross-city services. They shared the same use case, DS4SSCC Blueprint-based approach, governance and architectural principles, evaluation methodology and implementation experience. This enabled comparison between two different starting points and produced lessons relevant to other cities.

For other communities, the practical message is to start with a concrete use case, identify the data and stakeholders, establish governance before scaling technology and reuse existing systems where possible. The next priority is to provide the long-term governance, funding and interoperability needed to turn validated pilot capabilities into sustained operational services.

1 Introduction and context

Cities need reliable and regularly updated data to plan, monitor and report on climate action. This is especially important for emissions inventories, which are used to quantify greenhouse gas emissions and other pollutants, track progress towards climate neutrality, and support reporting under local, national and European frameworks.

The Intelligent Private–Public Neutral Carbon Platform (IPPCP) addressed this need through two pilot implementations in Zaragoza Spain), and Ljubljana (Slovenia). Both cities are working towards climate neutrality and participate in European climate initiatives, including the Covenant of Mayors[2], NetZeroCities[3] and the EU Mission for Climate-Neutral and Smart Cities[4]. Within these frameworks, cities need structured data to support Sustainable Energy and Climate Action Plans, emissions inventories and climate-related decision-making.

IPPCP was implemented in the context of the European Data Space for Smart Communities deployment action (DS4SSCC-DEP) under the Digital Europe Programme. The project used the DS4SSCC Blueprint as a reference framework for establishing trusted, interoperable and reusable data spaces. In IPPCP, these principles were applied to a concrete city task: testing how controlled and interoperable data exchange could support the preparation, maintenance and use of emissions inventories.

The two pilot cities started from different but complementary positions. Zaragoza entered IPPCP with an existing urban and open-data ecosystem, including API Zaragoza, the Zaragoza Data Catalogue, an INSPIRE-based spatial data infrastructure, dashboards and map viewers, and previous experience from the USAGE project[5]. IPPCP built on this foundation to develop a public–private data space supporting emissions inventory management.

Ljubljana entered IPPCP with an established emissions-monitoring environment based on LEV (Local Emissions Insight) and the Energy and Climate Atlas. LEV supports structured data entry, validation, automated emissions calculations and the preparation of reporting outputs. IPPCP did not replace this workflow. Within the pilot, UDP Lite was used to ingest and prepare selected environmental observations for publication through the data space. Together with the LEV-related services, this enabled the controlled discovery and exchange of selected energy, emissions, temperature and air-quality data between authorised participants under defined access conditions.

Both pilot cities, Zaragoza and Ljubljana, already had data platforms and emerging data-space capabilities. IPPCP built on these foundations to create more interoperable and trusted data spaces, enabling secure data sharing, easier data discovery and reuse, and stronger collaboration between public and private stakeholders.

Traditional data-sharing methods were insufficient for this task. Emissions inventories depend on data from municipal departments, public utilities, national agencies, private companies, industry, research organisations and service providers. In practice, data is often collected through individual requests,

[2] https://eu-mayors.ec.europa.eu/en/home
[3] https://netzerocities.eu/
[4] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en
[5] https://www.usage-project.eu/

forms, spreadsheets, emails, local databases or separate APIs. This increases coordination work, makes validation and traceability more difficult, and limits the reuse of data for reporting, dashboards, research and public transparency. The table below summarises the basic profiles and starting points of the two pilot cities.

Table 1. Zaragoza and Ljubljana pilot profiles

	Zaragoza pilot profile	**Ljubljana pilot profile**
City role	Pilot city and local public administration	Pilot city and local public administration
Territorial scope	Municipality of Zaragoza, 967 km²	Municipality of Ljubljana, 275 km²
Population	Registered population of 727,475 inhabitants as of October 2025 (municipal register)	Population of 298,227 as of July 2024 (Statistical Office of the Republic of Slovenia)
Governance context	Approved Data Governance Ordinance of the Zaragoza City Council[6] (July 28, 2026)	Mayor, Deputy Mayors, City Council, Supervisory Board, City Administration, public institutions and companies
IPPCP coordination	City of Zaragoza, in cooperation with Geospatiumlab and Universidad Politécnica de Madrid (UPM)	City of Ljubljana with relevant digitalisation, environmental, energy-management and European-project functions, in cooperation with Envirodual
Digital starting point	Zaragoza already featured a consolidated municipal data and digital services ecosystem, supported by advanced capabilities in data governance, open data, geospatial information, interoperability, and visualization	Energy and Climate Atlas and LEV emissions-monitoring tool

Source: City of Zaragoza and City of Ljubljana

The purpose of this white paper is to describe how the IPPCP pilots addressed this challenge by applying data-space principles in two different municipal environments. Section 2 describes the problem in concrete operational terms. Section 3 presents the two use cases implemented in Zaragoza and Ljubljana. Section 4 explains the deployment journey, including the project phases, implementation experience and lessons learned. Section 5 discusses the pilots' added value, sustainability and replicability. Section 6 summarises their broader relevance for other European communities.

[6] https://www.zaragoza.es/sede/servicio/normativa/13252

2 Problem statement

The core challenge addressed by IPPCP is the preparation and maintenance of reliable emissions inventories in a multi-stakeholder urban environment. An emission inventory requires data from several sectors, including energy consumption and production, transport, waste and wastewater, industry, agriculture and land use. It may also include meteorological, air quality and other environmental data to provide context and support analysis. These data are not produced by one organisation. They are distributed across public and private actors, each with its own systems, responsibilities, formats and procedures, which creates several practical problems.

First, data collection can be slow and resource-intensive. When data is not available through structured and reusable channels, the city must contact each organisation separately. Data providers may submit information through spreadsheets, web forms, emails or different technical interfaces. This requires repeated coordination and manual follow-up.

Second, the quality and traceability of data can vary. For emissions reporting, it is important to know where the data came from, who provided it, when it was updated, whether it was validated, and which methodology was applied. Without a clear data lifecycle, it is difficult to ensure consistency between years or to explain changes in reported emissions.

Third, the same data could support several uses, such as reporting, dashboards, research or planning, but it is not always prepared in a reusable form. Without clear metadata and controlled access, data collected for the emissions inventory is difficult to reuse for other city services or analyses.

Fourth, not all data can be fully open. Some data may be aggregated and published publicly, while other data may require restricted access because of confidentiality, commercial sensitivity, data protection or operational considerations. This means that a simple open data approach is not sufficient. Cities need a way to define who can access which data, under what conditions and for what purpose.

Finally, emissions inventories need to become more regular and easier to update. Climate-neutrality commitments require cities to move from occasional reporting exercises towards a more structured and repeatable monitoring process. This requires technical tools, but also governance, stakeholder engagement and long-term operating models.

While the challenges above were common to both pilots, the existing infrastructure and level of maturity differed between Zaragoza and Ljubljana.

Zaragoza already had an urban data and open data ecosystem, including API Zaragoza, the Zaragoza Data Catalogue, spatial data infrastructure based on INSPIRE[7], dashboards and map viewers, and experience from the USAGE[8] project. However, emissions inventory data collection still required stronger and more structured cooperation with external data providers, especially industry and other private actors. The challenge was to move from available city data services and existing reporting practices towards a more systematic public–private data cooperation model, with clearer onboarding, validation, access, and reuse mechanisms.

[7] https://knowledge-base.inspire.ec.europa.eu/index_en
[8] https://www.usage-project.eu/

In Ljubljana, the starting point was an established emissions monitoring workflow based on the LEV tool and the Energy and Climate Atlas. LEV already supports manual and semi-automatic data entry, API imports, validation, automated calculations, sectoral aggregation and reporting outputs. This represented a relatively mature local environment for emissions monitoring, but the relevant systems and services were not yet connected through common data-space mechanisms for discovery, access control and exchange. The challenge was not to replace this workflow, but to connect selected LEV-related services and environmental observations processed through UDP Lite to a controlled data-space exchange. This required clearer metadata, access rules and reusable data services, while keeping the existing validation and calculation process in place.

In both cities, the problem was therefore not the absence of data or tools. The problem was that existing data, systems and workflows were not yet connected through common mechanisms supporting structured public–private data sharing, controlled reuse and future interoperability with other data spaces.

3 The data space solution: the two use cases

IPPCP applies a public–private data space approach to the preparation and maintenance of emissions inventories in Zaragoza and Ljubljana. Both pilots address the same operational need: data for emissions inventories is produced by many public and private actors and must be collected, validated, described and reused in a more structured way.

The pilots apply the DS4SSCC Blueprint[9] to this concrete task. The focus is on three practical functions: making data services easier to discover, defining controlled access to data, and supporting secure data exchange between participants.

Zaragoza builds on an existing urban data and open data ecosystem, including API Zaragoza, the Zaragoza Data Catalogue, spatial data infrastructure, dashboards, map viewers and experience from the USAGE project. In IPPCP, this basis was extended towards public–private cooperation for emissions inventory management, with a focus on industry and other external data providers.

Ljubljana built on the LEV emissions-monitoring workflow and the Energy and Climate Atlas. LEV already supported data entry, validation, automated emissions calculations and reporting outputs. IPPCP added controlled publication and exchange mechanisms for selected energy, emissions, temperature and air-quality data. UDP Lite was used to ingest and prepare selected air-quality observations for publication through the data space.

In both pilots, the data space solution adds the following functions to existing local systems:

- metadata descriptions of datasets and services;
- access rules for different user groups;
- controlled data sharing through connectors;
- catalogue-based discovery of data services;
- identity and access management;
- governance rules for roles, responsibilities and participation.

A connector is the component that supports controlled data exchange between participants. A federated catalogue helps participants find available data services. Access policies define who may access a service and under which conditions. Data sovereignty means that each data provider keeps control over its own data.

Table 2 shows how the three DS4SSCC Blueprint categories were addressed in the Ljubljana and Zaragoza pilots. It distinguishes the Blueprint building blocks from the city-specific implementations, which followed common principles but used different technical components and adaptations.

[9] https://www.ds4sscc.eu/inventory

Table 2. Alignment of IPPCP data space components with DS4SSCC Blueprint categories

DS4SSCC Blueprint Category	Blueprint Building Blocks	Ljubljana implementation	Zaragoza implementation
Data Interoperability	• Data models • Data exchange • Provenance & traceability	EDC Control Plane and Data Plane; catalogue exchange through EDC DSP catalogue requests; integration of local datasets	Customised EDC connector; federated catalogue with cached catalogue nodes; vocabulary API for configurable metadata models
Data Sovereignty & Trust	• Identity & attestation management • Trust framework • Access and usage policies enforcement	Keycloak; IdentityHub; IssuerService; DID:web; BDRS; DCP-based trust flows; connector-side trusted issuer configuration	Keycloak; OAuth2 and JWT-based identity; certificate validation; OAuth2-based authorisation extensions
Data Value Creation Enablers	• Data, services & offering descriptions • Publication & discovery • Value creation services	Project-specific Portal Frontend and Backend; asset publication and discovery through EDC; BPDM for participant data	Connector Interface; Registration Service; Strapi-based public portal; federated catalogue

Source: Adapted from D3.1, Data Space Architecture Design and Alignment with the DS4SSCC Blueprint, Tables 4-1 and 6-1.

Supporting infrastructure such as Kubernetes, PostgreSQL and Vault were used for deployment, persistence and security. These components supported the pilot environments but were not themselves city data services or data products.

3.1 The solutions to the challenges

The two use cases address the same practical needs: reducing manual data collection, improving traceability, enabling controlled access, and preparing selected data outputs for reuse in reporting, planning, research and public information.

In both pilots, the approach was similar: relevant data sources and stakeholders were identified, selected datasets or calculation results were prepared as data services, access rules were defined, and the results were evaluated through agreed KPIs. The following sections describe how this was applied in Zaragoza and Ljubljana.

3.1.1 Zaragoza Data Space

Zaragoza builds on an existing urban data and open data ecosystem. The city has experience with open data, spatial data infrastructure and environmental data services. This includes API Zaragoza, the Zaragoza Data Catalogue, spatial data infrastructure based on INSPIRE, dashboards and map viewers, and previous experience from the USAGE project.

In terms of semantic interoperability, IPPCP has developed an ontology to formally structure use case data. Using this model, semantic mapping was performed on the Municipal Emissions Inventory datasets, generating a Linked Data representation and enabling querying through a SPARQL endpoint. This work complements the interoperability mechanisms based on APIs, geospatial services, and metadata, promoting the semantic querying and reusability of the data.

In IPPCP, the purpose is not only to publish data, but to make the collection, validation and reuse of emissions-related data more structured. This is especially relevant for data that is not managed directly by the municipality and must be provided by external organisations.

A specific focus is placed on industry. These actors may hold activity data that is relevant for the emissions inventory, including data related to industrial activity, energy use, pollution sources or other sectoral inputs. Before IPPCP, such data was not always collected through a common and repeatable process. The Zaragoza pilot therefore focuses on clearer onboarding of data providers, guided data submission, validation of submitted data, and cooperation arrangements that define how data is provided and used. The Data Ingestion Application was developed and technically validated in pre-production to support direct data submission by industrial companies and reduce the need for manual emissions-data collection.

For industry and private stakeholders, the use case includes registration or onboarding into the data space, data upload, validation support and cooperation agreements. The aim is to make participation clearer and less dependent on individual ad hoc requests. The pilot also aims to provide value back to these stakeholders, for example through dashboards, emissions sheets or other information that can support decarbonisation and energy-efficiency decisions.

For city technicians and public administration, the pilot supports a more systematic way of managing the municipal emissions inventory. This includes dashboards, map services, emissions indicators, reporting support and publication channels. The objective is to reduce manual work, improve traceability and make the inventory easier to update and use for climate reporting and planning.

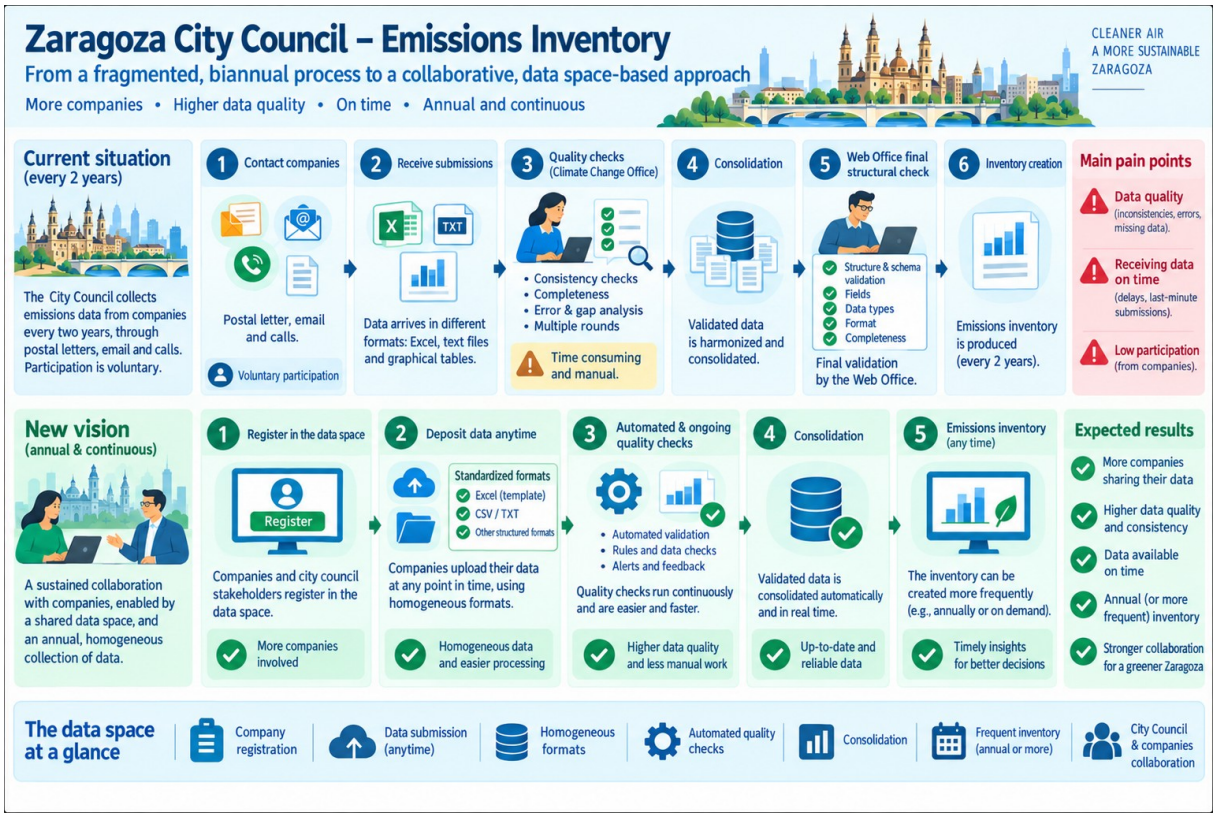


Figure 1. Zaragoza's municipal emissions inventory: comparison of the existing data collection process and the envisaged data space approach. (AI generated figure)

For researchers, the Zaragoza use case foresees access to structured and documented data in standard formats. This can support analysis, indicators, studies and data stories based on emissions inventory data. For citizens, the use case includes simplified maps, dashboards and information services related to emissions and environmental conditions. The Climate Mission Portal[10] is planned as one of the channels for public access, transparency and citizen participation.

The Zaragoza solution also includes services for automatic calculation of sectoral and territorial indicators, analysis of emissions trends and anomalies, year-on-year comparison, and publication through city channels such as the Electronic Headquarters, the Transparency Portal, the Data Space and the Climate Mission Portal.

This responds directly to the problems described in Section 2. Instead of relying mainly on repeated individual requests and manual follow-up, the pilot introduces a more structured process for data provider participation, data submission, validation and reuse. For the municipality, the expected result is a more traceable and reusable emissions inventory process. For external data providers, the process should make participation clearer and provide useful feedback through the services developed in the pilot.

[10] The portal is not yet public.

The Zaragoza pilot is monitored through KPIs related to stakeholder participation, data validation, reporting efficiency, service development and service use. These include:

- Active Organizations in the Data Space
- Active Data Sharing Agreements
- Integrated data sources
- Quality of validated data
- Datasets with Complete Metadata Following FAIR Criteria
- Interoperable services published
- Automation of the Emissions Inventory
- Use of services, viewers, and dashboards
- Integrated territorial and social indicators

Within IPPCP, the Zaragoza use case shows how an existing urban data and open data ecosystem can be extended towards more structured public–private cooperation for emissions inventory management. It is particularly relevant for cities that already have data infrastructure but need clearer mechanisms for private-sector participation, validation and reuse of emissions-related data.

3.1.2 Ljubljana Data Space

Ljubljana built on an established emissions monitoring workflow based on the LEV tool and the Energy and Climate Atlas. LEV, or Local Emissions Insight, is used for greenhouse gas emissions monitoring. It is based on a relational database and supports data collection from key sectors, including energy, transport, waste, agriculture and wastewater. The tool performs automated calculations of energy consumption and greenhouse gas emissions and generates output tables for reporting formats such as SECAP and CDP.

LEV supports several input methods. Data providers can enter data manually or semi-automatically through web forms. Some datasets can be imported through APIs or similar digital channels. The system also performs automated calculations using emission factors and conversion rules. Data is organised by sector, source and year, and validation checks are applied before the results are used for reporting outputs.

IPPCP did not replace this existing workflow. The pilot prepared and published five data assets in four validated service categories: energy consumption for 2024 and 2025, greenhouse gas emissions, temperature observations and air-quality observations. The LEV-related energy and emissions outputs were prepared through the Environmental Data Adapter. Temperature data was published through a meteorological service, while UDP Lite ingested and prepared selected air-quality observations.

In the Ljubljana pilot, LEV and the environmental data sources connected through UDP Lite acted as source systems. The Environmental Data Adapter and the UDP Lite proxy prepared selected data as services, which were then registered as EDC assets for discovery and controlled exchange.

The registered assets included the metadata and access conditions required for catalogue discovery and controlled exchange. The pilot also validated restricted access to an emissions asset, demonstrating that different access conditions could be applied to different services.

The Ljubljana pilot connected existing source services with data-space components, including EDC connectors, catalogue mechanisms, identity and trust services, and access policies. LEV remained the

source system for energy and emissions calculations, while UDP Lite supported the air-quality data flow. The pilot technically validated controlled two-way data exchange between the City of Ljubljana and Envirodual, including asset publication and discovery, contract negotiation, policy-based access and data transfer.

LEV covers data from several emissions-inventory sectors, including stationary energy, transport, waste and wastewater, IPPU and AFOLU. Within the IPPCP test environment, the services technically validated for data-space exchange covered four data categories:

- energy consumption;
- greenhouse gas emissions;
- temperature observations;
- air-quality observations.

The wider Ljubljana emissions-data ecosystem includes municipal departments, public utilities, national agencies, energy providers and other organisations relevant to the emissions inventory. Not all identified providers were technically connected during the pilot. Within LEV, data from selected sources was entered through forms or imported through digital channels and used to calculate the resulting energy and emissions indicators.

This responds to the problems described in Section 2 by moving selected outputs from an internal emissions monitoring workflow towards a more reusable and governed data-sharing model. The main objective was to keep the existing validation and calculation process in place, while making selected results more structured, traceable and reusable for reporting, planning, analysis and public information.

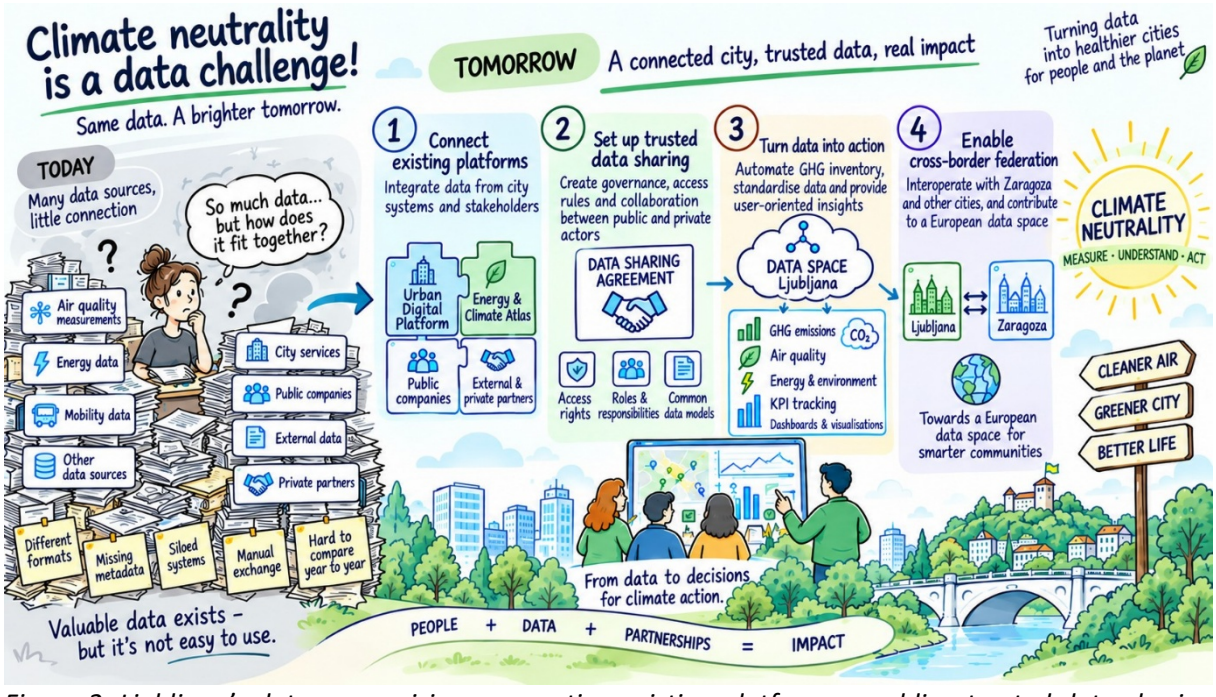


Figure 2. Ljubljana's data-space vision: connecting existing platforms, enabling trusted data sharing and supporting climate action, with cross-border federation as a future ambition. (AI generated figure)

The pilot also clarified governance and access questions. It defined which organisations provide data, who can use selected data services, and under which conditions. This is important because the emissions inventory depends on data from several public and private actors, and not all data can be treated as fully open.

The Ljubljana pilot was evaluated in a test-bench, pre-production environment using API and connector logs, catalogue records, service responses and other technical evidence. Five assets were published across four data-service categories: energy, emissions, temperature and air quality. The target for the number of service categories was achieved, and the meteorological API availability target was achieved for temperature, while pressure and humidity remained only partially verified. Four integrated data sources were validated against a target of six.

The reduction in report-preparation time and actual monthly service usage could not yet be measured objectively because the pilot had not moved into full production operation. These indicators would need to be evaluated under real operational use.

Within IPPCP, the Ljubljana use case demonstrated at pre-production level how an existing emissions-monitoring workflow can be connected to a data-space layer without replacing established tools. It is particularly relevant for cities that already collect and process emissions data but need clearer mechanisms for controlled access, metadata, service publication and reuse.

4 Deployment journey

The IPPCP deployment journey followed the structure of the project work packages and moved from concept definition towards implementation, validation and sustainability planning. It was implemented over 16 months, from 1 May 2025 to 31 August 2026. It was funded through the third round of the DS4SSCC-DEP call under the Digital Europe Programme.

4.1 Project phases and funding

For the purpose of this white paper, the deployment journey can be summarised through six implementation steps. These steps do not replace the formal work package structure of the project. They describe the practical path from the initial use case definition to pilot implementation and validation.

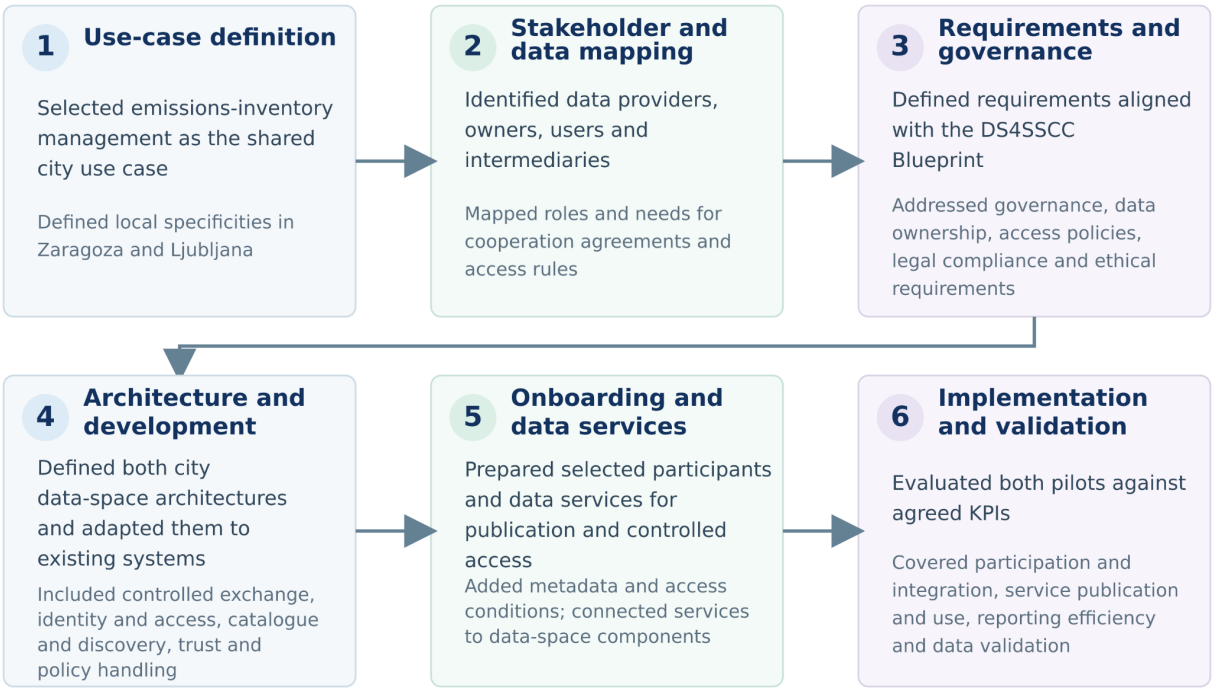


Figure 3. IPPCP deployment journey from use-case definition to pilot validation

The six-step deployment journey combined technical development with stakeholder engagement and governance. It involved municipal departments, public utilities, national agencies, private companies, industry, research organisations and technology partners. The architecture was based on the principle that data remained under the control of the original providers and was shared through agreed rules and technical mechanisms. Zaragoza focused particularly on industry and other external data providers, while Ljubljana onboarded Envirodual and tested selected energy, emissions, temperature and air-quality services for controlled exchange with the City of Ljubljana. The pilots were then evaluated to assess the practical management and potential reuse of emissions-inventory data.

IPPCP was funded under the Digital Europe Programme, within the European Data Space for Smart Communities initiative. The project duration was 16 months, from May 2025 to August 2026. The total project budget was EUR 2,460,055.19, with EUR 1,230,027.60 requested as grant support and the remaining part covered through co-funding.

4.2 Experiences and lessons learned

Several lessons were drawn from the IPPCP pilot experience.

- **Start with a concrete operational need.** The most useful starting point was not the abstract idea of building a data space. It was the concrete need to improve emissions inventories. This gave the pilots a clear purpose, identifiable data sources and measurable results. Other cities considering a data space should start with a similar recurring task where data is needed across organisations and where better sharing can improve a real process.
- **Build on existing systems.** Both pilots were brownfield cases. Zaragoza and Ljubljana already had digital platforms, data services and emissions-related workflows. IPPCP added governance and data space components to these existing systems instead of replacing them. This approach was practical for cities because it reduces the need for a completely new platform and respects local investments already made.
- **Governance must be operational.** Governance cannot remain a policy statement. It must be connected to concrete processes: onboarding, access approval, metadata management, validation, publication, logging, monitoring and offboarding. The distinction between data governance and data space governance proved useful. Data governance defines how data is managed. Data space governance defines how participants cooperate. The pilots also confirmed that data quality, ownership, metadata, traceability and access conditions require continuous management. Technical connectivity alone does not resolve these organisational responsibilities.
- **Private-sector participation requires clear value.** The Zaragoza pilot showed that private actors need a clear reason to participate. If the process is seen only as a reporting obligation, engagement may remain limited. The pilot therefore linked data contribution with services such as dashboards, emissions sheets, guidance, validation support and potential recognition.
- **Technical concepts need simple explanations.** Concepts such as connectors, federated catalogues, access policies and data sovereignty are important, but they can be difficult for non-technical stakeholders. The pilot experience showed the need to explain these terms through practical examples: who provides data, who can access it, and how the process is controlled.
- **Interoperability requires a shared understanding of the data.** Connecting systems through APIs or data-space components is only the first step. Participants must also agree on the meaning, structure, units and context of the exchanged data. Without this semantic alignment, technically connected systems may still interpret the same data differently.
- **Implementation requires learning and iteration.** Data-space concepts were new to many participants and could not be transferred into practice through technical guidance alone. Training, practical testing and repeated adjustments were necessary to develop a shared understanding and improve the implementation. Cities should therefore plan for gradual organisational learning rather than expect immediate operational maturity.
- **Federation as a gradual evolution.** The current pilot brings together two interoperable local data spaces, while federation remains a future objective. This experience shows that communities do not need to start with a federated model. Instead, they can first establish local data-sharing capabilities and progressively build towards federation as interoperability, governance and trust mechanisms mature.

4.3 Results and achievements

By the end of the project, IPPCP had established the main foundations for further operation of public–private data cooperation environments for emissions inventories in Zaragoza and Ljubljana. The project demonstrated how existing city systems and data workflows can be connected with data space components to support more structured data sharing, clearer governance and more reusable climate-related data. The main achievements included:

- mapping the organisations that provide, manage or use emissions-related data;
- identifying the main data sources, data types and input methods;
- defining the Ljubljana and Zaragoza use cases;
- defining and applying a KPI framework to evaluate pilot results;
- designing the data space architecture in line with the DS4SSCC Blueprint;
- preparing the data governance framework;
- addressing ethics, risk management and data protection requirements;
- preparing and testing data services and data-sharing mechanisms;
- supporting stakeholder engagement, communication and dissemination.

In Zaragoza, the pilot established a more structured approach for public and private actors to contribute data to the city's emissions inventory. A specific focus was placed on industry and other external data providers. The pilot supported clearer onboarding, guided data submission, validation and feedback through services such as dashboards, maps and emissions-related information. This helped move the emissions inventory process towards a more systematic and traceable model.

In Ljubljana, the pilot built on the existing emissions-monitoring workflow and connected selected source services to a data-space layer without replacing the established data-collection, validation and calculation processes. Five assets were published across four data-service categories: energy consumption, greenhouse gas emissions, temperature and air quality. UDP Lite supported the ingestion and preparation of selected air-quality observations. The pilot technically validated controlled two-way data exchange between the City of Ljubljana and Envirodual, including asset publication and discovery, contract negotiation, policy-based access and data transfer.

The pilots validated or prepared a range of services and reuse mechanisms. Depending on the pilot, these included:

- structured contribution of data from industry and other data providers;
- services for updating emissions inventories;
- emissions dashboards and map-based visualisations;
- comparison of emissions over time;
- data services for research and analysis;
- mechanisms supporting the future publication of emissions and environmental information;
- reuse of emissions and energy data for reporting and planning.

Overall, IPPCP showed that data spaces can be applied to a concrete municipal task: supporting the preparation and maintenance of emissions inventories. The project did not replace existing city systems. Instead, it added governance, metadata, access-control, catalogue and data-sharing mechanisms that enabled selected outputs to be described, discovered and exchanged under defined access conditions.

5 Future outlook

The future outlook of IPPCP is linked to three main directions: operational sustainability, broader stakeholder participation and future federation.

By the end of the pilot, 31 August 2026, both cities implemented and validated the main data space components and services defined for the project. This included preparing data services, onboarding selected participants, testing access and data-sharing mechanisms, evaluating KPIs and documenting the results.

The next step is to move from project-based governance towards more stable operational governance. This means maintaining roles, access policies, service catalogues, technical components, support processes and cooperation agreements after the end of the project.

In the longer term, the pilots provide a basis for federation with other European data spaces. Federation should be understood as a gradual process. It requires technical interoperability, common metadata, trusted identities, clear access rules and governance alignment. It also requires a shared understanding between participants about what data is exchanged and for what purpose.

The wider relevance of IPPCP is that many European cities face similar challenges. They need emissions and environmental data for climate action, but this data is distributed across public and private actors. The IPPCP experience shows that cities can start from existing systems and gradually build a governed data space layer around them.

5.1 Added value and impact

The value of IPPCP can be described from several perspectives.

- **Operational value.** For city administrations, the pilot can reduce manual effort in collecting and validating data. It can also improve the regularity and traceability of emissions inventory updates. Instead of repeating fragmented data requests each year, cities can move towards more structured data flows and reusable services.
- **Strategic value.** For climate policy, the pilot supports evidence-based decision-making. More reliable and regularly updated data can support SECAP, CDP-ICLEI and other reporting frameworks. It can also help cities monitor progress towards climate neutrality and assess the effects of policies and measures.
- **Governance value.** The project clarifies roles and responsibilities between data providers, data users, data intermediaries and public authorities. This is important because data sharing depends on trust. Clear rules on access, purpose, ownership and responsibilities make cooperation easier to sustain.
- **Economic and organisational value.** For private-sector data providers, particularly in the Zaragoza pilot, the pilot can reduce the uncertainty of data reporting and provide useful feedback. Dashboards, emissions sheets, benchmarking or recognition mechanisms can help make participation more valuable. For public utilities and municipal services, the pilot can support more structured feedback on the environmental footprint of services and infrastructure.
- **Societal value.** For citizens and civil society, the pilot can improve transparency. Simplified dashboards, maps and public portals can make emissions and environmental information easier to understand. This does not replace policy decisions, but it can support public awareness and accountability.

- **Technical value.** From a technical perspective, the pilot created reusable data services, standardised metadata, controlled access mechanisms and components that can be connected to other systems. This supports interoperability and future federation.

5.2 Sustainability and replicability

Long-term sustainability requires more than technical deployment. It requires governance, resources, skills and clear responsibilities after the project ends.

The main sustainability needs include:

- maintaining data services, APIs, catalogues and connectors;
- keeping access policies up to date;
- supporting data providers and users;
- monitoring data quality and service usage;
- updating metadata and documentation;
- maintaining legal and organisational agreements;
- securing operational funding and ownership arrangements;
- continuing training and capacity-building.

The post-project governance model should clarify who operates the data space components, who approves access, who manages metadata, who supports participants, and how decisions are made when new data providers or services are added.

The next phase after IPPCP should focus on moving from pilot validation towards operational deployment. Both cities plan to further develop the solutions, progressively onboard new participants, data sources and services, and increase their maturity towards production readiness. The results will also be reused in new projects and use cases, strengthening their integration into wider municipal digital infrastructures and climate-related processes. This incremental approach will allow the data spaces to scale while securing the organisational, technical and financial conditions required for long-term sustainability.

As part of its planned post-project continuation, Ljubljana intends to build on the validated results through integration with its wider NextGen digital infrastructure and the gradual onboarding of additional participants and use cases. Potential further reuse includes cooperation with the University of Ljubljana and the use of temperature observations for urban heat-island analysis and local digital-twin applications.

The IPPCP experience is also replicable for other cities. A city does not need to start with a fully mature data space. It can follow a step-by-step pathway:

1. identify a concrete use case, such as emissions inventory;
2. prepare a data inventory;
3. map stakeholders and their roles;
4. define which data is open, restricted or internal;
5. assess existing platforms and workflows;
6. prepare selected outputs as data services;
7. define metadata and access rules;
8. implement connectors or other controlled sharing mechanisms;

9. validate the use case through KPIs;
10. build towards federation only after the local model is stable.

This pathway is relevant for cities with different levels of digital maturity. Cities with existing data platforms can add governance and data space components to their current systems. Cities with less mature systems can start with stakeholder mapping, a data inventory and a limited set of priority datasets.

The main lesson from IPPCP is that a data space should not be treated as a technology project only. It is a cooperation model supported by technology. Its sustainability depends on clear responsibilities, trusted participation and continued use by the organisations that provide and rely on the data.

6 Conclusion

IPPCP addressed a practical and recurring challenge for cities: emissions inventories depend on data from many public and private actors, while traditional data-sharing methods are often slow, fragmented and difficult to reuse.

The project demonstrated two complementary routes towards data-space-enabled emissions monitoring. Zaragoza showed how an existing urban data and open data ecosystem can be extended to support more structured public–private cooperation, especially with industry and other external data providers. Ljubljana showed how an established emissions monitoring workflow, based on the LEV tool and the Energy and Climate Atlas, can be connected to a data space layer without replacing existing tools.

The broader significance of IPPCP is that a data space should not be understood only as a technical solution for emissions inventories, but as a cooperation model supported by technology. The project showed how existing municipal systems and workflows can begin incorporating controlled inter-organisational data exchange, and which governance, organisational and technical conditions are needed for this approach to become operational. Within the DS4SSCC-DEP context, IPPCP applied the principles of the DS4SSCC Blueprint to emissions-inventory management under real urban conditions.

The cross-collaboration between Zaragoza and Ljubljana was central to the value of the pilot. The two cities applied a common methodological framework to different local contexts. Zaragoza contributed experience from an advanced urban data and open data ecosystem, while Ljubljana contributed experience from a structured emissions monitoring workflow. This enabled comparison, shared learning and a clearer understanding of what can be replicated by other cities.

For other communities, the main message is practical: start with a concrete use case, understand the data and stakeholders, define governance before scaling technology, build on existing systems where possible, and use the DS4SSCC Blueprint as a reference for trusted and interoperable data cooperation.

The IPPCP experience provides a practical reference for cities that want to support the improvement of emissions inventories and climate-related decision-making through data spaces. The next step for cities and policy-makers is to support the long-term governance, funding and interoperability conditions that allow such data cooperation models to continue beyond pilot projects.

About the European data space for smart communities

The European data space for smart communities (DS4SSCC-DEP) initiative is a pivotal deployment following the preparatory action for a Data Space for Sustainable and Smart Cities and Communities (DS4SSCC). Emphasising sustainability aspects and diversity in communities, DS4SSCC developed a multi-stakeholder data governance scheme, created a catalogue of building blocks and a high-level reference architecture, delivered priority datasets, developed a roadmap towards implementing a mature data space on various governance levels.

DS4SSCC-DEP's vision revolves around creating a well-governed data space available for communities, developers and other supporting actors, aligning with the prospects outlined in Europe's Digital Decade objectives. DS4SSCC-DEP aims to build a territorial, place-based cross-sectoral data space for smart communities. This cross-sectoral approach distinguishes itself from sectoral data spaces by encompassing diverse domains, underpinning governance across all levels of society. The key objectives of the project are:

- **Objective 1: Establishing a Federated and Innovative Data Space**. This phase focuses on creating a large-scale data space controlled by public data holders, ensuring alignment with the Smart Middleware Platform[11] and broader data space ecosystems. It also aims to offer middleware service solutions facilitating data sharing and management while refining the blueprint based on gained experience.
- **Objective 2: Pilots and Refinement of the Data Space Blueprint**. Through 10-12 cross-sectoral data pilots in various EU communities, this objective aims to validate and refine the data space blueprint. Using common high-value data sets, it seeks to create added value by combining data from various domains, contributing to the sustainability plan, and minimising infrastructure investment.
- **Objective 3: Fostering Innovation and Ecosystem Alignment**. Engaging stakeholders, compliance with sector-specific legislation, establishing links with Horizon Europe missions, creating services available via trusted application catalogues, and enhancing ethical considerations and AI-enabled local solutions constitute the focus of this objective.

DS4SSCC-DEP, building upon established European networks, aims to significantly contribute to the sustainability goals of European citizens. It emphasises co-creation, standardisation, business models, strategies for data spaces, and envisions a federated platform.

DS4SSCC-DEP consortium includes the following partners:

OPEN & AGILE SMART CITIES & COMMUNITIES	imec	IDC
serendipity	TAL TECH, FinEst Centre for Smart Cities	Gospodarska zbornica Slovenije, zit ICT Association of Slovenia

[11] https://digital-strategy.ec.europa.eu/en/policies/simpl

About the Intelligent Private-Public Neutral Carbon Platform

The Intelligent Private–Public Neutral Carbon Platform (IPPCP) was a 16-month European pilot project implemented from May 2025 to August 2026 under the third-round pilot call of the European Data Space for Smart Communities deployment action (DS4SSCC-DEP), supported by the Digital Europe Programme.

IPPCP tested how public–private data spaces can support the preparation and maintenance of city emissions inventories. Pilot implementations in Zaragoza and Ljubljana enabled selected climate, energy, emissions and environmental data to be shared through governed and interoperable mechanisms, while data providers retained control over their source data.

The project built on the cities' existing systems and applied the principles of the DS4SSCC Blueprint to data governance, stakeholder participation, controlled access, interoperability and data reuse. Its results provide a foundation for continued operational development, the inclusion of additional participants and services, and future federation with other European data spaces.

The IPPCP consortium brought together five partners:

- City of Zaragoza, project coordinator and pilot city;
- City of Ljubljana, pilot city;
- Universidad Politécnica de Madrid, research and technology partner;
- GeoSpatiumLab, geospatial technology partner;
- Envirodual, environmental and energy-data technology partner.