



SMART CITIES AND SMART MOBILITY

CO2-Mute: Fighting CO2 emission with Data Space

With the contribution of



Faubourg Numérique
FIWARE iHub



hostabee

MONTEM



FIWARE - OPEN APIs FOR OPEN MINDS

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Background

Since September 2020, FIWARE Foundation has been leading the successful i4Trust project around Data Spaces, which has been receiving funding by the European Commission under the Grant Agreement of 951975.

Thanks to the extraordinary collaboration of partners such as iShare and FundingBox, 32 selected solutions on Data Spaces have been awarded and funded. With the first impacting results available, FIWARE has decided to publish a fine selection of Impact Stories showcasing FIWARE-based solutions created by an awarded and funded consortium of DIHs and SMEs.

The CO₂-Mute project aims to support local governments in their efforts to deploy policies for sustainable mobility and urban green infrastructure as part of their local environmental and digital transition strategies leveraging the power of the Data Spaces.

Challenge & Context

The [European Union](#) has set ambitious targets to reduce CO₂ emissions by 2030 in order to mitigate climate change and pollution levels and to improve the quality of life for citizens¹. While member states are responsible for determining strategies and targets appropriate to their specific circumstances, it is the responsibility of individual regions and cities to put these policies into practice and adapt them to the local context².

¹ European Union - Communication from the Commission to the European Parliament, [The Council](#), The European Economic and Social Committee and the Committee of the Regions, stepping up Europe's climate ambitions 2030 -, Brussels, September 2020.

² European Union, v.

The transportation sector³ is one of the main contributors to negative environmental impacts due to its role in air pollution, greenhouse gases and CO₂ emissions. To reduce traffic congestion and the related environmental impact, local governments have been investing in Mobility-as-a-Service strategies and infrastructures to encourage the use of alternate means of transportation such as public transport and cycling. However, changing the habits of citizens remains a big challenge⁴.

On the other hand, urban green infrastructure such as parks, gardens, urban forests, and vertical gardens, contribute directly to air quality and carbon neutrality through the removal of air pollutants, carbon storage, and carbon sequestration. They also indirectly contribute to other policy targets such as health, well-being, climate change adaptation, biodiversity, urban regeneration, stormwater management and social equality. These solutions, known as Nature-Based Solutions (NBS), can contribute to the overall effort to reduce emissions and improve the environment⁵.

The CO₂-Mute project aims to **support local governments** in their efforts to deploy **policies for sustainable mobility** and **urban green infrastructure** as part of their local environmental and digital transition strategies. The project's focus is to help local authorities understand their situation and define policies for addressing mobility and green challenges. Additionally, the project will prepare citizens for their participation in the implementation of these policies to change mobility habits.

CO₂-Mute would like to gamify alternative mobility usage and enhance the role of green spaces in pollution mitigation by proposing collective and individual achievements for commuters and workers. These achievements will be used to evaluate impacts on costs, traffic and the environment (air and noise pollution).

³ International Institute for Sustainable Development, 2021.

⁴ European Environment Agency, 2022.

⁵ Shafique M., Xue X., Luo X., An overview of carbon sequestration of green roofs in urban areas, Urban Forestry and Urban Greening, Elsevier, 2019.

Solution

CO2-Mute uses various data sources, such as traffic data from Tom-Tom and [HERE APIs](#), data from five air quality and noise sensors provided by [MONTEM A/S](#)⁶, and data obtained from local weather stations about the environmental status and time range. This data will be correlated and a custom algorithm will be developed to calculate the estimated impact of traffic reduction on air pollutant concentrations. The results of the analysis will be made available to the concerned local government and ecosystem, and will be integrated into urban planning decision processes with a focus on green spaces. When needed, the data will be anonymized to comply with the GDPR. At each stage of the CO2-Mute value proposition, seamless **access to heterogeneous data** from **various sources** and **data providers** is crucial to deliver **relevant services** and **reliable analysis**.

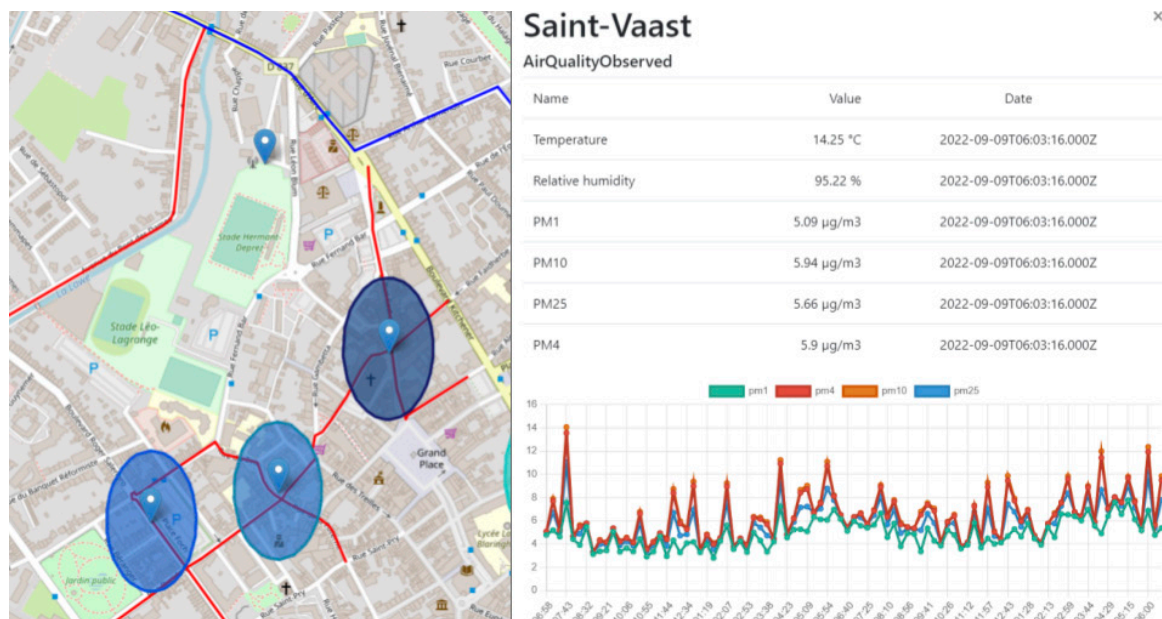


Figure 1 - An overview of the MVP app delivered by Hostabee to the pilot city of Béthune

⁶ MONTEM specialises in creating holistic solutions for the urban environment, creating more liveable cities through technology. MONTEM have: CityFlow is hardware-/technology agnostic real-time view of the urban environment. CityProbe 2 is a hardware platform for sensing noise, pollutants and meteorology data.

CO2-Mute has a high level of flexibility in its configuration and a strong ability to deal with various types of data thanks to its ‘interoperability by design’ approach and the use of a Digital Twin⁷ platform implementation based on the [NGSI-LD standard](#)⁸. This ability to personalize and correlate data based on local situations is crucial for measuring impacts. To ensure fair and controlled sharing of heterogeneous data and transparent business models, CO2-Mute relies on [i4Trust](#) architecture.

The pilot city area – **Béthune city center** – has been analyzed based on several characteristics that influence the measured pollution and traffic flow. This analysis helps to **understand** which **factors** may have contributed to any **reductions** in particulate matter **concentration observed** during the [Béthune Rétro Festival](#) (26–28 August, 2022).

Further partners carried out mission-critical activities: [Sis.Ter srl](#)⁹ performed the expected impact calculation and shared insights through the NGSI-LD notification mechanism and direct access to the shared NGSI-LD entities (GET/entities). [Hostabee](#)¹⁰ provided relevant information about the test results to the pilot city by creating a dashboard that presents analysis and global results and suggests a local mobility strategy.

⁷ A Digital Twin is a digital representation of an intended or actual real-world physical product, system, or process that serves as the effectively indistinguishable digital counterpart of it for practical purposes, such as simulation, integration, testing, monitoring, and maintenance.

⁸ FIWARE NGSI is the API exported by a FIWARE Context Broker, used for the integration of platform components within a “Powered by FIWARE” platform and by applications to update or consume context information.

⁹ Company offers consulting, design, research and development services in the field of Geomatics, Smart City and Decision Support Systems. Smart knowledge management, through digital solutions, applicable in value chains, networks, assets management and territorial analysis.

¹⁰ Hostabee wants to be a pioneer in universal and affordable connected hives and is today a global leader in the agri-tech sector. In close collaboration with Orange (<https://www.orange.com/en>), a long-term FIWARE member, their solutions use the latest technologies in terms of connectivity and artificial intelligence. Hostabee combines new technologies with ongoing research in the field, in direct contact with professionals from the sector and beekeepers, to meet their needs as closely as possible.

How it works

The proposed architecture for CO2-Mute aims to implement the value chain involving the three SMEs (Sis.ter, MONTEM and Hostabee) and the pilot city. From a technical perspective, all partners will implement their own instances of [NGSI-LD Context Broker](#)¹¹, [KeyRock](#)¹², and Kong¹³. The information flow in CO2-Mute mainly consists of two phases:

- Data collection/analysis during the period of local mobility challenges, such as Béthune Rétro Festival, where mobility and environmental information is collected and analyzed to understand the local situation
- Impact and results dissemination after the end of each local mobility challenge, such as Béthune Rétro Festival (26–28 August 2022).

Data collection, sharing and analysis during the mobility challenges

All data collected is accessible to the data science service provider (Sis.Ter srl) via the NGSI-LD API. Sis.Ter can then remotely analyze the necessary data using Big Data/ML¹⁴ techniques through the [Context Broker](#)¹⁵ and specific Node-Red processors that make the data accessible for tools like [PySpark](#)¹⁶. Access policies for the data are managed through the CO2-Mute Marketplace in association with offers, which allows Sis.Ter to retrieve data provided by MONTEM, Hostabee, and the pilot city.

¹¹ See footnote number 8.

¹² Keyrock is the FIWARE component responsible for Identity Management. Using Keyrock (in conjunction with other security components such as PEP Proxy and Authzforce) enables you to add OAuth2-based authentication and authorization security to your services and applications.

¹³ Kong is an open source API gateway and platform that acts as middleware between compute clients and the API-centric applications.

¹⁴ Big data refers to vast amounts of data that traditional storage methods cannot handle. Machine learning is the ability of computer systems to learn to make predictions from observations and data. Machine learning can use the information provided by the study of big data to generate valuable business insights.

¹⁵ A Context Broker component is the core and mandatory component of any “Powered by FIWARE” platform or solution. It enables the management of context information in a highly decentralized and large-scale manner.

¹⁶ PySpark is an interface for Apache Spark in Python. It not only allows you to write Spark applications using Python APIs, but also provides the PySpark shell for interactively analyzing your data in a distributed environment.

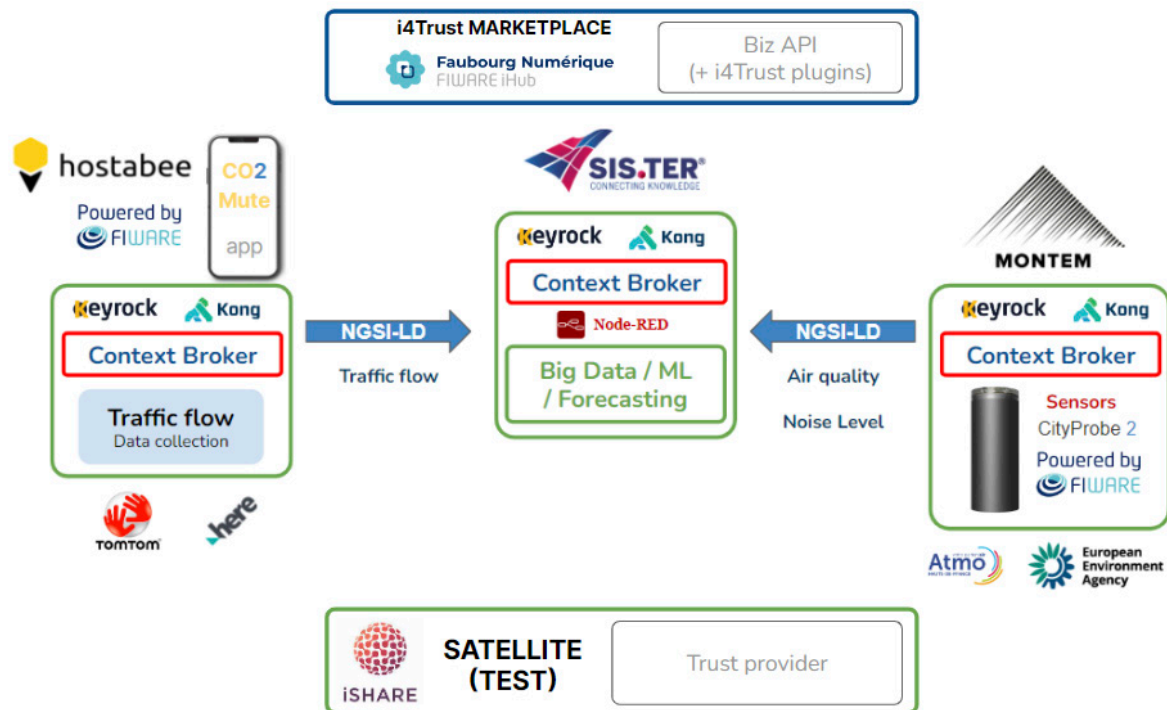


Figure 2 - Overview of the main components used by the CO2-Mute partners (data collection phase)

When Sis.Ter acquires specific offers from Hostabee and MONTEM, the CO2-Mute Marketplace submits the relevant policies to the Authorization Registries of the different data owners (MONTEM, Hostabee, and the pilot city).

Impact and results dissemination

The results of the analysis conducted in the CO2-Mute project are shared in the marketplace using a suitable FIWARE data model. The Key Performance Indicator (KPI) was selected as the most appropriate for the project's goals. This model allows for a wide range of results and has keys that align with the project's objectives. The analysed data will be submitted to the CO2-Mute Marketplace, which submits the policies to the relevant Authorization Registries of the data owner (Sis.Ter srl) for access by the application provider (Hostabee).

Identification, authentication and authorisations

As all stakeholders in the CO2-Mute project were involved as data providers, they were required to make their services available on the i4Trust Marketplace¹⁷ instance managed by the [DIH Faubourg Numérique](#)¹⁸. The data flows in the project involve only Machine-to-Machine interactions between the systems of the stakeholders. To ensure secure data exchange, all partners were required to obtain certificates from [iSHARE](#)¹⁹ and authenticate their systems through the use of [JSON Web Tokens](#)²⁰. The validation process involving iSHARE satellite was also used to validate access tokens when requested. In this architecture, an identity provider and authorization registry are provided for each entity. It is important to note that these are certified roles within the iSHARE framework, and that each party must be onboarded as a certified party in accordance with the [iSHARE framework](#)²¹. This process includes additional steps compared to onboarding data consumers and providers.

Benefits & Impact

The CO2-Mute experimentation clearly demonstrated that seamless access to heterogeneous data from various sources and data providers is crucial at

¹⁷ i4Trust Marketplace is a global instance offered to all participant organization. It supports multiple IDPs thanks to iShare protocol, so providers and customers can sign in using its own IDP. Each data provider organization is owning its own IDP, API Umbrella and Context Broker. iShare JWT are used to authenticate the Marketplace in the different IDPs and retrieve user profiles.

¹⁸ Digital Innovation Hub, certified FIWARE iHub. This DIH supports local innovators leveraging global networks and communities! Local Evangelist(s) in Robotics: Vincent Demortier.

¹⁹ iSHARE started from a real business challenge in the Dutch Logistics sector, where the challenge of solving low levels of utilization in logistics led to the question why organizations don't share data. The conclusion of the first stages was the need for a Trust Framework, allowing organizations to control what is happening with their data in full detail. Which is not role based but rather attribute based.

²⁰ JSON Web Tokens are an open, industry standard RFC 7519 method for representing claims securely between two parties.

²¹ The iSHARE trust framework is providing immediate value to all parties in the value chain, from Data Owner, Provider to Consumer. Really driving and enabling trust in the entire chain while keeping full control as Data Owner.

every stage of the value proposition in order **to deliver relevant services and reliable analysis**. The SMEs involved in the project, both as service providers and consumers, had the opportunity to experience the added value of a **concrete implementation of a data space, leveraging the i4Trust architecture composed of mature components from iSHARE and FIWARE communities**. As a result, these SMEs are now ready to evolve as early adopters and even pioneers in the new paradigm of the data economy.

The **DIH also reinforced its capacity to deliver services related to [Data Spaces](#)²² and Digital Twins implementation**, in preparation for its strategic participation in the [European Digital Innovation Hub network supported by the Digital Europe Programme](#)²³ and to leverage the expected deliverables from the [Data Spaces Support Center](#)²⁴.

In addition, new cross-border business connections and trusted relationships have been established between the involved organizations and individuals through the opportunity to meet and work together at the **FIWARE Global Summit 2022**.

²² The European strategy for data aims at creating a single market for data that will ensure Europe's global competitiveness and data sovereignty. Common European data spaces will ensure that more data becomes available for use in the economy and society, while keeping the companies and individuals who generate the data in control.

²³ By providing access to technical expertise and testing, as well as the possibility to 'test before invest', EDIHs support companies to improve business/production processes, products, or services using digital technologies. They also provide innovation services, such as financing advice, training, and skills development that are central to successful digital transformation. Environmental issues are also taken into account, in particular with regard to the use of digital technologies for sustainability and circularity.

²⁴ The Data Spaces Support Centre, as described in the Digital Europe Programme, will set up and operate a Support Centre to operationalize the European Strategy for Data. This Data Spaces Support Centre will facilitate common data spaces that collectively create an interoperable data sharing environment, to enable data reuse and secondary use within and across sectors, fully respecting EU values, and contributing to the European economy and society.

Added value through FIWARE

Within the working group that collaborated on the project, there were different levels of knowledge and experience with FIWARE applications. Faubourg Numérique and Hostabee are organizations that have had several experiences using FIWARE enablers in the past, and Faubourg Numérique (DIH) in particular provides its technical support and its powered by FIWARE ouranos-ws console, thanks to its two certified [FIWARE Technical Experts](#). MONTEM and Sis.Ter, on the other hand, did not have this kind of experience with FIWARE before the project. However, by the end of the project, MONTEM was able to accredit their [CityProbe 2²⁵](#) product as a 'Powered by FIWARE' device and it is now referenced on the [FIWARE Marketplace²⁶](#).

In terms of communication and dissemination, one of the largest impacts was achieved by Sis.Ter when presenting the CO₂-Mute experiment at [IFAT Munich #22](#). The CO₂-Mute demo was implemented in the Smart Open MetaWorld supported by the FIWARE community.

Next steps

The next step of the CO₂-Mute concept will be to gamify the use of alternative transportation by proposing collective and individual achievements for commuters, workers, and other citizens. These challenges will be directly linked

²⁵ Powered CityProbe is a point in a city-wide network and will transmit the status of the urban environment in real-time. The new CityProbe 2 introduces an elegant and sturdy outer shell made from aluminium, as well as a built-in GPS for easy positioning.

²⁶ FIWARE Marketplace is there to help users and their customers find innovative and the best open-source-based products and services and grow revenue by identifying customer needs and repeatable solutions leveraging FIWARE technologies and FIWARE partner ecosystem, at scale. Offers are provided by the FIWARE community, may it be companies, organizations or cities, and are FIWARE validated. The FIWARE Marketplace is ideal for organisations who are looking to build and launch products, solutions and services to support their customers' digital transformation journeys.

to local government policies, available transportation options, and the state of urban green infrastructure. The ultimate goal is to evaluate the impact on costs, traffic, and the environment.

An important challenge for the replicability, sustainability and scalability of the CO₂-Mute solution is the construction of the business model and the identification of possible revenue streams. One strategy is to offer the solution to local governments to aid in the deployment of their MaaS policies. The primary business model would be to sell the CO₂-Mute through public procurement processes. Additional revenue streams may include generating qualified leads for public or shared transport operators.

References

- [CO₂ Mute – Youtube Channel](#)
- [ouranos-ws – Youtube Channel](#)

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