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RESPONSE

Integrated Solutions for Positive Energy and Resilient Cities

Integrated Solutions for Positive Energy and Resilient Cities

D3.3

Dijon's Integrated and Interconnected City Ecosystem (TA#4) - V1

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CO =Confidential, restricted under conditions set out in Model Grant Agreement

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	15/09/2022	S Thiriot (EIFER)	A Grelaud (EIFER), O BenHamid (EIFER)	Sections 4.2.8 (indicators) and 4.2.9 (dashboard)
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Glossary

Abbreviation	Full form
AC	Alternative Current
ACA	Assistance to the Contracting Authority
AI	Artificial Intelligence
API	Application Programming Interface
BLOB	Binary Large Object
CO2eq	CO2 equivalent GHG emissions
DC	Direct Current
EMS	Energy Management System
FC	Fellow City
GDPR	General Data Protection Regulation
GHG	Green House Gas
GIS	Geographic Information System
IE	Innovative Element
IS	Integrated Solution
ICT	Information and Communication Technologies
IoT	Internet of Things
LHC	Lighthouse City
PEB	Positive Energy Building
PED	Positive Energy District
SLR	Systematic Literature Review
TA	Transformation Axis
V2G	Vehicle to Grid
WP	Work Package

Executive summary

This deliverable (D3.3) describes the progress of the RESPONSE project demonstration activities of the Trasformation Axis 4 (TA#4) in Dijon Metropolis that are hosted in task T3.3. The IS 4.1 "Information and Communication Technologies (ICT)" includes technologies at the scale of PEB (for monitoring energy demand, for the secured remote control of energy storage) and at the scale of the territory of the Metropolis (centralization of up to date territory data, computation of advanced indicators, representation of indicators into a dashboard). The IS 4.2 "emobility" includes V2G charging stations, and modelling tools to plan the deployment of charging stations for Electric Vehicles.

This intermediate report is focused on the reality of the field demonstration: lessons learned, update on the risks, and a highlight of the practical difficulties in the demonstrations. Most of the eight Innovative Elements (IE) are on track. A mitigation plan was validated for the deployment of Vehicle to Grid (V2G) charging stations. A delay is observed in the collection of data at the scale of the territory. We synthetize this progress in Table 1.

Table 1 Overview of the progress of Innovative Elements demonstrated in T3.3

IS	Functional group	IE	IE title	Progress
IS4.1	PEB monitoring and operation	IE 4.1.3	PEB Multi-Energy Dashboard	**[on tracks]** Off-site developments on tracks.
		IE 4.1.1	Genesys tunnelling solution	**[on tracks]** Off-site developments on tracks. New risks might lead to a delay: the need to collect GDPR agreement, and delay in PEB construction,
	Energy Climate Platform	IE 4.1.2	Shared datalake	**[Late]** The collection of data, and the creation of the infrastructure to collect it, are running late because of regulation constraints (public call for tender), the complexity of the task, and the negotiations required to access data.
		IE 4.1.4	Advanced indicators: temperature, air quality, energy & GHG, Hybrid AI	**[Late because of dependency]** The delay for data collection delayed the production of indicators for energy & GES and Hybrid AI. Provided this delay and the time required for the production, the delivery of the indicators might exceed the target M36.
		IE 4.1.5	Energy Climate Dashboard	**[minor deviation]** Change in the subcontracting scheme.

IS4.2	Preparation and deployment of V2G charging stations	IE 4.2.1	EV charging points with PV, shading and battery featuring smart-charging and V2G operation	**[Mitigation plan]** Due to the difficulty to find the vehicles to plug into the V2G stations (also due to regulatory evolution on standards), a mitigation plan was proposed and accepted.
	Support to urban planning: Positioning of EV charging points	IE 4.2.2	Smart-charging infrastructure deployment planning tool	**[On tracks]** Most of the work was done. A last stage taking into account mobility data will be realized in 2023.
		IE 4.2.3	Geographic visualization tool for enhanced decision-making	**[Starting]** Starting based on the results of IE4.2.2.

Based on this progress report, we propose a first assessment of the replication conditions of the various IEs demonstrated in T3.3. Most demonstrations lead to solutions mature enough to be replicated if the conditions are satisfied, whilst the centralization of data at the scale of the city appears more challenging for fast replication.

An update of this report will be issued as D3.7 on M36.

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Chapter 1

Introduction

Chapter 1 – Introduction

1. Introduction

1.1 Deliverable objectives

The aim of this report (D3.3) is to describe the status of the demonstration activities for an interconnected and interoperable digital ecosystem at city level, including ICT infrastructures and software specifications deployed. It also provides a focus of development and implementation of Dijon's integrated and interconnected digital ecosystem.

This is the first version of the deliverable D3.3 published at M24 of the project. A final release will be produced as D3.7 at M36.

1.2 Concepts of City Information Platforms in RESPONSE

The following concepts are described in the Grant Agreement and in this document. The *City Information Platform* (CIP) denotes the ecosystem of ICT components existing prior the beginning of the project. The CIP is described in the baseline documents in D3.1 section 3.1. During RESPONSE, the CIP is integrated with the tools, mechanisms and services implemented in TA#4. The result of this integration is denoted "*Integrated CIP*" or an "*Integrated and Interconnected City Ecosystem*". An *integrated CIP* does not represent a fully interconnected platform: only the components which provide an additional service thanks to interconnection are connected together. This also preserves the replicability of the IE which constitute the *Integrated CIP.*

Two different CIPs existed in the two Light House Cities of Dijon and Turku. Two different *Integrated CIP* are developed during RESPONSE. These two *Integrated CIP* are not interconnected, do not share common components nor protocols. Each of these *Integrated CIP* demonstrate different technologies and services suitable in the context of each LHC.

1.3 Relation to other RESPONSE tasks and work packages

T3.3 "Dijon Integrated and Interconnected City Ecosystem (TA#4) implementation and e-mobility on-site integration" hosts the demonstrations of TA#4 in Dijon Metropolis, while T3.4 "Turku Integrated and Interconnected City Ecosystem (TA#4) implementation and e-mobility on-site integration" hosts the demonstrations in Turku. Both are related to T3.1 "Master City planning for the Integrated and Interconnected City Ecosystem (TA#4) and definition of Digital Infrastructure'' which described in detail the IEs demonstrated later in tasks T3.3 and T3.4. The deliverable D3.1 is used as a reference which documents the initial status, intended planning and risks for every IE. This report contains the updates, if any, compared with this initial plan.

Task T3.2 *(“Data Governance and RESPONSE Integrated and Interconnected City Ecosystem mandating cross platform collaboration”)* analyzed the challenges to the centralization of data in a city and hosted some off-site developments for some IEs demonstrated in T3.3. The results of the task are available in D3.2.

Task T3.5 *(“IoT-enabled Smart City Diagnosis for advancing Governance through empowering citizens and towards Sustainability”)* provides new services for governance and empowerment in both LHC. In Dijon Metropolis, news services will be built upon the ICT ecosystem developed in T3.3.

Finally, task T3.6 *(“LHCs and FCs Integrated and Interconnected City Ecosystem solutions portfolio increasing Governance capacity”)* will present the digital tools demonstrated in tasks 3.3 and 3.4 as a portfolio of solutions, in order to facilitate their replication in Fellow Cities.

The KPI tool developed in WP2 will collect data from Dijon ecosystem using the ICT infrastructure developed in T3.3. The WP6 (monitoring) and WP9 (impact assessment) will also collect data from WP2, and therefore indirectly from WP3.

1.4 Structure of the document

The deliverable is structured as follows:

- **Chapter 2** presents how the teams in Dijon Metropolis are organized to manage the demonstrations of Innovative Elements (IEs). The IEs are grouped as “functional groups” made of interconnected IEs or IEs sharing similar characteristics.
- **Chapter 3** reports the progress of the IEs, with an overview and a report of activities for every functional group and IE.
- **Chapter 4** discusses the replicability of these functional groups.

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Chapter 2

Methodology

Chapter 2 – Methodology

2. Implementation methodology

Since the implementation process involved a large number of people from different partners, a key factor for the success of the demonstration was the establishment of a strong and reliable collaboration between all key representatives in the Dijon ecosystem of partners, and the partners involved in WP3 activities. The LHC managers identified groups of IEs which tackle topics similar to the spatial scale (PEB or whole territory of the city), topic (planning, monitoring, electric vehicle...), and/or are interconnected to provide a service. These functional groups are described in section 2.1, and the management structure in section 2.2.

2.1 Functional groups

In the RESPONSE project, several granularities are described:

- Innovative Elements (IE) are the technical elements that are based on pre-existing solutions from partners which are upgraded and demonstrated during the project, and would be replicated
- 10 Integrated Solutions (IS) group several IEs by general functions. For example, T3.3 tackles IS4.1 (ICT) and IS4.2 (e-mobility)
- 5 Transition Axis (TA) encompass 10 ISs sharing the same principle or finality (such as: energy storage). For instance TA#4 includes both IS4.1 and IS4.2.

In practice, several IEs are highly interdependent, and can hardly be described, analysed, or replicated, without considering their existence as a system. For instance, the existence of a shared datalake (IE 4.1.2) *per se* provides no benefit; but it provides data and hosts the computation of indicators (IE 4.1.4), which are eventually displayed in the dashboard (IE 4.1.5). They are named as *functional groups* as the IEs work strongly together. These functional groups are described in Table 2.

Table 2 Functional groups and services delivered by Innovative Elements in TA#4

IS	Functional group	IE	IE title	Description
IS4.1	PEB monitoring and operation	IE 4.1.3	PEB Multi-Energy Dashboard	A solution to monitor and control remotely assets (such as charging stations, PV, boiler, batteries…) with a high level of security thanks to the creation of a secured tunnel. Also facilitates the interfacing with various protocols.

		IE 4.1.1	Genesys tunnelling solution	A solution to gather data from various energy providers, computer indicators, and display a dashboard with an overview of energy (elec, gas, heat, water…) remotely over multiple buildings. Useful for operators of Positive Energy Blocks, but also companies who manage these buildings.
	Energy Climate Platform	IE 4.1.2	Shared datalake	Automatically gathers data from energy providers. Manual insertion of data internal to the Metropolis. Contextualizes data. Stores and shares data with partners of the city and/or in open data. Enables simple computations on data.
		IE 4.1.4	Automatic online computation of advanced energy and climate indicators	Online computation and measurement of advanced energy and climate indicators
		IE 4.1.5	Energy Climate Dashboard	Web dashboard used by the City to monitor their decarbonation projects, to explain energy and GHG emissions, to track air quality and temperatures.
IS4.2	Preparation and deployment of V2G charging stations	IE 4.2.1	V2G charging stations	EV charging points with PV, shading and battery featuring smart-charging and V2G operation
	Support to urban planning: Positioning of EV charging points	IE 4.2.2	Smart-charging infrastructure deployment planning tool	A tool which optimizes the positioning of charging stations for electric vehicles, by taking into account the demography, the activities, the traffic, the available electric network. It proposes locations for a given number of charging stations.
		IE 4.2.3	Geographic visualization tool for enhanced decision-making	EV charging points with PV, shading and battery featuring smart-charging and V2G operation

2.2 Management organization

T3.3 corresponds to the implementation and demonstration of the IS4.1 (ICT) an IS4.2 (e-mobility) of TA#4 "*Integrated and Interconnected City Ecosystems*". As this task is entirely dedicated to the Dijon demonstrations, the practical organization of the work is defined locally in the LHC of Dijon. One or more local working group was created for each functional group, as shown in Table 3. Management organization

The working groups are in charge of the management of the IEs: monitor progress of off-site developments, testing, on-site deployment and demonstration; animate exchanges between the partners; detect and mitigate risks; enforce the collection of information asked by the project; dispatch information about the project. An overview of this local progress is provided to elected representatives every few months during "CoTech" meetings (technical committees) during which every working group is reviewed. The direct link with Technology Providers (the partners who actually deliver one or more Innovative Elements) is done through these working groups supervised by LHC managers, TA leader or IS leader. They facilitate the communication between the global RESPONSE project (in English, with a vocabulary specific to European projects or the RESPONSE project) and the local interlocutors (who speak French and are less aware of the process and vocabulary of the European project). Every partner leading an IE is in charge of ensuring the progress of its work, connecting their work with other activities, identifying risks, notifying the GT in case of need.

Table 3 Alignment of functional groups and local workgroups

Local workgroup	Functional group	Lead	Note
"GT monitoring" working group	PEB Monitoring and Operation	EDF (LHC Manager)	Managed by the same team who manages PEB IE supported by these ICT IE.
"GT Data" working group **"GT Platform" working group**	Energy-Climate Platform	EIFER (IS4.1 leader) DM (LHC manager)	Management of data collection, IT architecture, interoperability. Coordinates the partners DM, EIFER, UBFC, ATMO BFC, EDF
	Support to urban planning: Positioning of EV charging points	EIFER (IS4.1 leader) DM (LHC manager)	Coordinates the partners DM, EIFER and EDF
"V2G" working group	Preparation and deployment of V2G charging stations	EDF (IS4.2 leader) DM (LHC manager)	Coordinates the partners EDF and DM, hosts the monitoring and mitigation plans

Flows of communication are complex in this large project. We depict in **Error! Reference source not found.** the articulation of the organization of the RESPONSE project (structured in both coordination / WP / task hierarchy and TA, IS and IE) and the local coordination of the Dijon Metropolis' ecosystem involved in TA#4. The project coordinators ensure the communication with WP leaders during regular meetings with them. The task leader of the T3.3, which is specific to Dijon, is also in charge of managing the TA#4. Weekly meetings are held between LHC managers and the Project Coordinators to ensure a close contact. The names of people in charge of the various roles are listed in Table 4.

Figure 1 Organization for the management of T3.3 demonstrations in Dijon

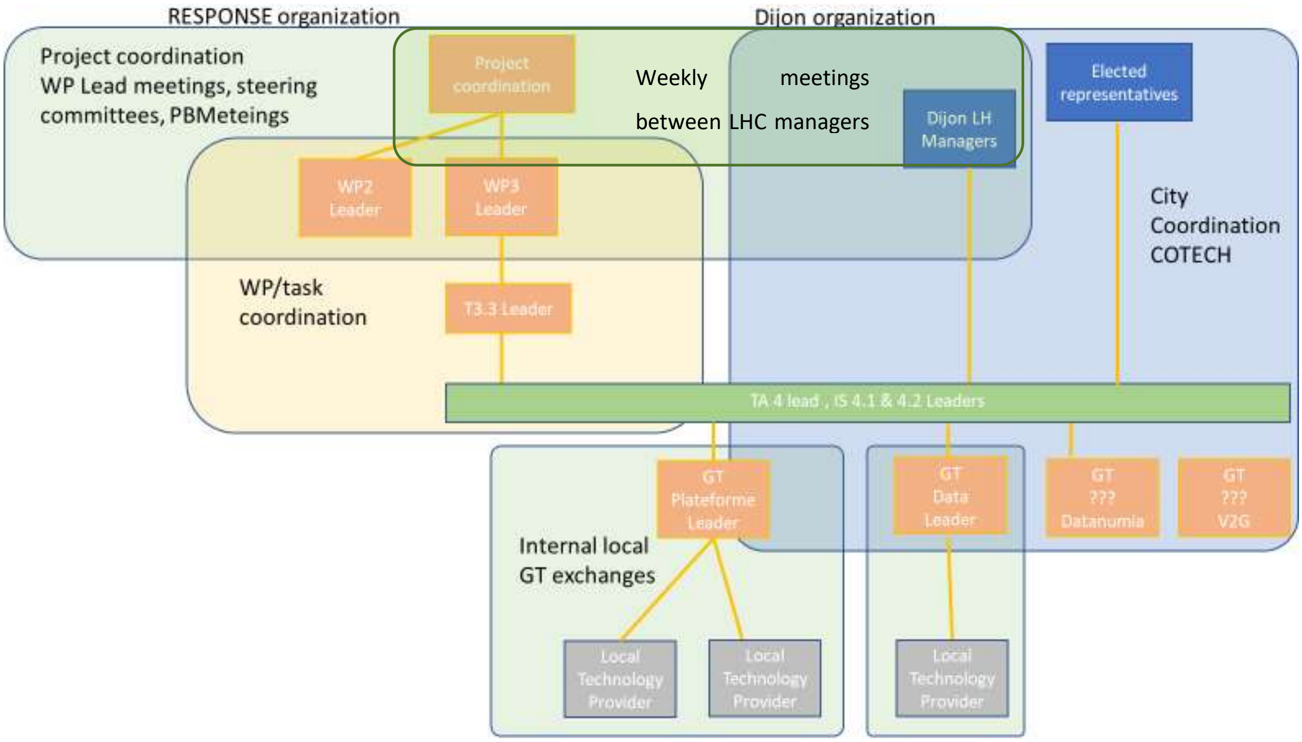

Table 4 Roles, names and partners involved in TA#4 coordination

Key Management Roles	Assigned Leaders / Representatives
LHC Manager	Oanez Codet Hache (DM) Eric Tourte (EDF)
WP3 Leader	Samuel Thiriot (EIFFER)
T3.3 Leader	Samuel Thiriot (EIFER)
LightHouse City	Dijon LHC
TA#4 Leader	Samuel Thiriot (EIFFER)
IS4.1 Leader	Samuel Thiriot (EIFFER) David Fau (DM)
IS4.1 Local Technology providers	EDF DM UBFC / BGS UBFC / CIAD ATMO BFC EDF / DataNumia (subcontractor)

	EIFER
IS4.2 Leader	Thrierry Brossier (EDF) Eric Tourte (EDF)
IS4.2 Local Technology providers	EDF EDF / DREEV EIFER

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Chapter 3

On-site development and implementation

Chapter 3 – On-site development and implementation

3. Development and implementation of the Dijon's Integrated and Interconnected City Ecosystem

3.1 Overview of progress

Table 5 provides an overview of the progress and status of the IEs demonstrated in T3.3. Then the progress of each functional group and their IEs are elaborated. However, the general presentation of these IEs as described in D3.1 (e.g. pre-demonstration activities, planned demonstration activities, technical aspects, planning and initial risks assessment) are not repeated here.

Table 5 Overview of the progress and status of demonstration activities in T3.3 at M24

IS	Functional group	IE	IE title	Progress
IS4.1	PEB monitoring and operation	IE 4.1.3	PEB Multi-Energy Dashboard	**[on tracks]** Off-site developments on tracks.
		IE 4.1.1	Genesys tunnelling solution	**[on tracks]** Off-site developments on tracks. New risks might lead to a delay: the need to collect GDPR agreement, and delay in PEB construction,
	Energy Climate Platform	IE 4.1.2	Shared datalake	**[Late]** The collection of data, and the creation of the infrastructure to collect it, are running late because of regulation constraints (public call for tender), the complexity of the task, and the negotiations required to access data.
		IE 4.1.4	Advanced indicators: temperature, air quality, energy & GHG, Hybrid AI	**[Late because of dependency]** The delay for data collection delayed the production of indicators for energy & GES and Hybrid AI. Provided this delay and the time required for the production, the delivery of the indicators might exceed the target M36.
		IE 4.1.5	Energy Climate Dashboard	**[minor deviation]** Change in the subcontracting scheme.
IS4.2	Preparation and deployment	IE 4.2.1	EV charging points with PV, shading and battery	**[Mitigation plan]** Due to the difficulty to find the vehicles to plug into the V2G stations (also due to

	of V2G charging stations		featuring smart-charging and V2G operation	regulatory evolution on standards), a mitigation plan was proposed and accepted.
	Support to urban planning: Positioning of EV charging points	IE 4.2.2	Smart-charging infrastructure deployment planning tool	**[On tracks]** Most of the work was done. A last stage taking into account mobility data will be realized in 2023.
		IE 4.2.3	Geographic visualization tool for enhanced decision-making	**[Starting]** Starting based on the results of IE4.2.2.

3.2 PEB monitoring and operation (IE 4.1.1 & IE4.1.3)

3.2.1 Global Objectives & Users

The management of energy at the scale of Positive Energy Blocks (PEB) is made on both production and demand. The solutions demonstrated in T3.3, in TA#4 and IS4.1 are part of the bigger picture of RESPONSE IE deployed on PEBs in Dijon.

Regarding **energy production**, several RESPONSE Innovative Elements demonstrate solutions for electricity storage (stationary batteries, V2G stations), heat storage (building scale), decarbonation of energy mix (PV production, decarbonation of the heat network), etc. ICT is used to optimize the production, storage and distribution of the energy, so it is matching the energy demand over time with as few primary energy consumptions and GHG emissions as possible. In RESPONSE, in Dijon, the "Super EMS" (part of IS2.1) is the general solution for the optimization of this local multi energy system; based on the PEB past energy demand (heat, electricity), a forecasting algorithm anticipates the future demand in the next days or weeks. Engineers, using optimization methods, emit recommendations for the operation of storage devices (second life stationary batteries, V2G stations). This optimization is made by experts who are not located at Dijon Metropolis. In order to configure remotely the storage assets with policies proposed by the Super EMS, the IE 4.1.1 "Genesys" proposes a solution for remote control (monitoring of information) and command (pilot the asset). This solution guarantees security thanks to secure tunneling (in order to avoid attacks able to damage energy storage equipment), but also constitutes a solution for interoperability between different communication standards. The end users of Genesys are thus engineers in charge of the optimization of the PEB multi energy systems, who use it as part of the continuous optimization process demonstrated in "Super EMS".

Another facet of the creation of PEBs is to **control energy demand** so it is globally lower and/or shifted over time to smooth peaks. During RESPONSE, several solutions are demonstrated in Dijon: (IS2.1) create a self-consumption collective community which reduces the amount of energy demanded to the energy grid, awareness raising, etc. ICT plays several roles in this panorama. Inhabitants get information about their own consumption using their customer area fed with smart meters. In the collective self-consumption operation demonstrated in Dijon (IS2.1), they can also get information about collective self-consumption, PV production using a dedicated portal. The PEB operators, and specifically the collective housing managers, also need an access to the global energy demand (heat, electricity, water) so they can identify margins of progression at the scale of buildings and PEBs. IE4.1.3 *"PEB Multi-Energy Dashboard"* is dedicated to this monitoring; this platform connects to the information systems of energy providers, gathers data automatically, computes indicators at the PEB scale and publishes it in the dashboard. The end users include PEB operators, social housing operators, and RESPONSE partners who will access PEB monitoring thanks to this solution.

The solutions IE4.1.1 *"Genesys tunnelling solution"* and IE4.1.3 *"PEB Multi-Energy Dashboard"* were described in detail in the Master Planning D3.1 (with description, pre demonstration, planned demonstration activities, planning, analysis of risks). The progress of the implementation of these demonstrators and lessons learned are explained in the following sections.

3.2.2 IE4.1.1 Genesys secured control/command

3.2.2.1 Activities & progress

The Genesys platform was developed and used by EDF for the secured control/command of industrial assets such as wind turbines. In order to demonstrate the potential of this solution for the control/command of assets for PEB, EDF adds the support of additional communication protocols, tests the interfacing with energy storage assets, develops additional graphical user interfaces for the end users, and deploys the solution. This solution is strongly linked with the *Super EMS*: the optimization recommendations emitted by engineers in as part of the functioning of the *Super EMS* lead to new policies in EMS which are deployed using Genesys.

Table 6 shows the activities took place in IE4.1.1 from the beginning of the project. Note that some of these activities were reported already in D3.2 as part of the off-site developments taking place in T3.2. From the point of view of the technology provider, the off-site developments described in T3.2 and the demonstration in T3.3 constitutes one unique activity continuing from T3.2 to T3.3, as reported below.

Table 6 Activities for the implementation of the IE4.1.1 Genesys

	Task	Progress
Design	Define required interfaces	During the design phase, EDF R&D exchanged with the partners in charge of the assets to interface with (in order to identify the

		protocols which require implementation and features which could be implemented) and the partners who will use the asset remotely (control/command by EDF in the frame of the super EMS) to clarify their needs.
	Define the ICT architecture	EDF defined the protocols to add, the software to develop, the data model to implement.
Data collection	Access data streams	Data on the electric energy demand is gathered directly from the ENEDIS electricity distributor.
	Collect GDPR agreement	As the data at PEB level is considered as personal data covered by GDPR, inhabitants have to agree to the data collection by ENEDIS (the energy distributor), but also for the transmission of data to DM and EDF and their processing in the finality of optimizing the energy production. This step was discovered recently and is ongoing.
Software development	Define the data model	Definition of the data model required to implement the IEC 61850 protocol
	Configure the gateway for communication protocol	Done by EDF off-site
	Implement python scripts	EDF implements Python scripts to: (i) Manage the interface between Clevery & Genesys (ii) Manage the interface between Genesys & the DREEV platform (iii) Integrate Enedis data into the central database (as input to Clevery)
	Development of a monitoring system	EDF develops a human-machine interface in *ThingsBoard* (an open-source tool), that will allow EDF and DM engineers to monitor the system. They will be accessible to everyone with the right IP address and login parameters
In-lab testing	In lab testing of communication with assets	EDF drove tests in the laboratory of EDF R&D in Paris. It consisted in checking software implementation, data model compliance, and protocol communication with simulated assets
Deployment	Procurement	EDF ordered the needed system components from external suppliers
	Physical Deployment	EDF will deploy two physical devices (a gateway and a standard PC) in electrical cabinets in Dijon
	Integration testing	EDF will test, with DM, GDH and ORVITIS, the correct behavior of the tools

At the time of writing this report (M24), most of the off-site preparation is finished. The deployment (here, the connection to energy storage assets) is waiting for the deployment of the physical assets on-site.

3.2.2.2 Update on risks for Genesys

Up to date, the internal EDF preparation tasks are going as expected. A secured architecture with two servers (one for professional tasks i.e., visualization, data storage, communication and optimization and the other for cyber-security related actions) has been implemented. The data model and python script to interfacing Genesys and Clevery are ready. The methods for collecting consumption data from ENEDIS has been identified and preparation for implementation is ongoing.

However, several risks have emerged:

- The construction of PEB in DM is delayed, leading to the delay of implementation of the super EMS.
- The collection of consumption data via ENEDIS datahub requires the usage of a unique ID issued to the EDF group. This ID is however already attributed to another EDF project and we need to discuss with them to integrate the usage of the project and to define the method to share the same stream of data.
- Due to GDPR, not only DM but also EDF R&D needs to collect agreement of the consumers to be able to collect and exploit their data. This process may take time and may delay the project.
- If the data required by Clevery is not fully provided/accessible (due to technical impossibility to collect, or due to lack of agreement), which may lead to a bad quality for Clevery results.

3.2.2.3 Lessons learned for Genesys

- It is important to maintain a regular update among different partners participating in different tasks to ensure that the various developments would converge together in the end (e.g. slow update on the battery EMS modbus table leading to the slow implementation of the IEC 61850 data model in Genesys).
- It is less efficient to start the development of software and cyber solutions when the physical infrastructure is not yet ready, as any infrastructure changes may dictate some fundamental changes in the software inputs and hence, the software itself.
    - An agreement on the data model is necessary to start the development in parallel and this agreement needs to be maintained along the implementation of the infrastructure.
    - Generic and easily adaptable development practices should be privileged (even though they require more time and effort) in parallel development.

3.2.3 IE4.1.3 PEB Multi-Energy Dashboard

3.2.3.1 Activities & progress

Datanumia, a subsidiary of the EDF group, developed and commercialized a multi-energy dashboard which is used by managers of many sites to monitor the consumption of energy, often in the context of industry. In RESPONSE, they demonstrate that this solution might be used to monitor PEB, and optimize energy demand thanks to integrative and up to date information. They are evolving their solution by connecting new data sources (such as sensors for PV production, or heat network), adding support for multiple levels of monitoring (common areas / building / PEB / PED), and adding new indicators for the monitoring of PEB. Table 7 summarises the activities and progress of IE4.1.3 since the beginning of T3.3.

Table 7 Activities and progress for IE4.1.3 Multi level multi-energy dashboard

	Task	Progress
Design	Definition of use cases	The main use of the dashboard is to check the energy positivity of the PEBs thanks to the monitoring of fluid consumption and production. This tool is intended for the energy managers.
Data collection	Identification of the counters' locations	A list of all the counters in the PEBs is being developed. This will allow Datanumia to know how many sensors they can use and how many they need to install.
	Make the supplier's data compatible with Datanumia servers	A correlation table will be developed to solve the problem of data compatibility between Datanumia and Coriance. This is already set between Datanumia and Enedis.
	Collect production data	PV production will be measured with sensors on the network. Technical visits of these sensors will be scheduled to check the location of the sensors needed. Heat production data is exchanged directly with the supplier (Coriance).
	Collect consumption data	Electricity: Common area consumption data is already shared by the social landlords with smart meters (R4Q flux). Private consumption data will be collected individually with the consent of each tenant (the same way they consent to the CSC action (see IE 2.1.1)). Heat: Datanumia will only have access to the primary heat network data. The objective is to find a relevant repartition key for each sub-station in order to get individual consumption data. This key is yet to be defined.

Software development	Add multi-level features	Software development in the existing dashboard to facilitate the multi-level monitoring in RESPONSE, with the scale of both PEBs, one PEB, or individual buildings inside the PEB.
Deployment	Test the dashboard	Production and consumption data of the Buffon school, the city and the general services will be used to get the dashboard started.

At the time of writing (M24), the use cases were defined with the end users and software development for multi-level and new indicators is engaged. The path for the collection of data is now identified with all the data providers agreeing with the plan. The history of energy demand in PEB, used for baseline, will be collected directly from each energy operator and inserted in datanumia databases.

3.2.3.2 Update of risks

Table 8 Update on risks for the PEB Multi-energy Dashboard

Description of Risk	Likelihood / Impact *(Low-Medium-High)*	Proposed risk-mitigation measures
Barriers in legislation, regulation (GDPR, sensitive data...)	Low/High	The measures taken to limit this risk are: anonymization through data aggregation and privacy protection Secure channels and servers have also been installed for this purpose. The consent of every tenant will be collected to respect this legislation.
Problem in agreeing in common standards (data compatibility)	Low/High	An upstream work of common agreement was envisaged in order to discuss and handle the exchange between the supplier and the Datanumia data server via interface contracts.
Unavailability of data provided by partners	Low/Medium	Data exchange agreements commit stakeholders to provide their data for the entire duration of the project.
Hardware malfunction (data captors)	Low/Medium	The data recovered by the partners comes from a large fleet of sensors to limit the risk of malfunctions, supported by consolidation methods to prevent marginal malfunctions.
Issues to Handle the tool	Low/High	A test phase with the first data sets is planned in order to judge the added value Datanumia brings to the collected data. Customers/end users will be accompanied by an energy manager during their use of the tool.

3.2.3.3 Lessons learned

Collecting data is a long work. It is complex in terms of legislation, as mentioned in the risks, but also technically. The data provision agreements are hard and long to write. In order to mitigate this risk, data collection is managed as the highest priority in these activities. The progress in monitored along with the LHC leaders as part of the "data workgroup".

3.2.4 Lessons learned for PEB monitoring and operation

At the functional group scale, we observe patterns related to data.

Energy data at the PEB level is considered as a personal data in the perspective of GDPR, and therefore requires residents' permission for data processing. This does not only slow down the demonstration and replicability, but also requires inhabitants to understand the finalities of giving their permission for data collection and processing, and the benefits for them. However, energy optimization is a technical topic dealing with an energy system which is unknown to most inhabitants, with no immediate benefit for the inhabitants (they would only observe a drop in the energy bill several months after data collection). This also means that to operate the solutions over time, a process would have to be defined to collect the agreements of new inhabitants moving into the PEB.

In RESPONSE, we aim to demonstrate IEs which can be replicated elsewhere, and are therefore not too dependent on other solutions demonstrated in the project. This is done at the cost of small redundancies. For instance, at the level of PEB, data on the electricity demand is collected two times for the optimization of the system (Super EMS) and for the monitoring of demand (PEB Multi Energy Dashboard).

Keeping access to data over time requires a form of organizational maintenance. For instance, if an energy meter is replaced, the consumers of this data should update their correspondence tables. If an inhabitant leaves, his agreement for data collection should be removed. The maturity of data providers today is, at the best, the ability to open data streams. In order to maintain the access to data over time, the ecosystem of data producers and users will have to agree on process, and on new data models to convey this type of information using metadata and events (such as: "inhabitant left", "counter was replaced", "new counter added", etc).

3.3 Energy Climate Platform: monitoring of air, energy and GHG at the Metropolis scale (IE 4.1.2, 4.1.4 & 4.1.5)

3.3.1 Objectives & Users

After the recognition of climate change induced by anthropogenic actions, the cities (such as Dijon) are in charge of two novel missions: contribute to climate change mitigation by *decarbonating their territory,* and *adapt their territory* to the consequences of ongoing climate change. These missions are imposed by the regulation; for instance in France, the national strategy (SNBC - Stratégie National Bas Carbone) defines targets (climate neutrality in 2050) and asks cities to decline the strategy locally in an Energy Climate Plan (see (ADEME, 2016)). Such a plan includes objectives regarding CO2eq emissions, energy demand and renewable energy production. The plan also contains a catalogue of measures, projects or actions which describe how to follow the trajectory in the next years.

In this context, city has four main needs:

- To **protect inhabitants from climate change** (including heat waves amplified by the Heat Island Effect, deterioration of air quality during these episodes (Pörtner, 2022) and from **energy scarcity** (the increase of prices augments energy poverty in the territory)
- To **monitor** the progress of the energy-climate plan and decarbonation projects compared to the objectives (see (ADEME, 2012)), and to **decide** of new actions based on up-to-date data,
- To **persuade stakeholders** to engage into decarbonation actions (Bulkeley & Betsill, 2002). They use recent data, which they put into narratives, in order to create a shared understanding of the current situation (for instance, the emissions of GHG induced by residential heating during winter), of the dynamics of the system (for instance, show how energy demand varies according to external temperature) and of the potential actions (show the drop in energy demand thanks to refurbishment of buildings).

In order to fulfill these needs, the gathering of up-to-date, integrative data at the scale of the territory is mandatory (BAILLY, 2016,). The functional group "Energy-Climate Platform" is dedicated to the collection of recent data at the scale of the territory (energy consumption and production, temperatures and air quality) with the *shared datalake* IE4.1.2, the production of *advanced indicators* IE4.1.4 (energy, GHG emissions, temperatures and air quality), and their presentation into an *energy-climate dashboard* IE4.1.5 used by the departments of the city.

3.3.2 Data collection: activities and progress

A large part of the value of the energy-climate platform is based on access to more recent and detailed (both from temporal and spatial granularity) data. Being in charge of the shared datalake (IE4.1.2) dedicated to data collection, Dijon Metropolis is also in charge of negotiating the access to this data. The French regulation on energy data enables cities to access data related to their territory, and to access a finer level of data than other stakeholders (see deliverable D3.2 for more details).

3.3.2.1 Activities and progress

We report in Table 9 the activities which take place for data collection since the beginning of T3.3.

Table 9 Activities and progress for data collection

Domain	Task	Progress / result
Data collection	Identification of data which might be collected from energy utilities	Utilities possess two types of data: data from smart counters which cover dwellings or businesses (electricity, gas) or groups of buildings (heat networks), and data from the internal information systems on energy production, injection, interconnections, transportation of energy. Utilities have difficulties guaranteeing the reliability of the data gathered from their internal infrastructure. The most mature utilities (ENEDIS) have methods, and ICT infrastructure, to clear and smooth the data. They publish data with different levels of quality: "estimated" for recent data, "verified" and "consolidated" when they guarantee additionality. Most utilities are not mature to guarantee the anonymity of data, to process data automatically and/or to open streams to the outside.
	Analysis of the regulatory framework	Deliverable D3.2 proposed a general vision, which was completed in T3.3 by a more local analysis. When a utility is a "concessionaire" of the city (heat network), they own the energy network, and therefore own the corresponding data without consideration of detail or confidentiality. Yet there is no obligation for the contracting company to provide APIs to access remotely data automatically updated. When a utility is a "délégataire" of the city, it is responsible of the data he is transmitting, has to protect personal information and business secret. Therefore a negotiation takes place to agree on the level of information proportioned to the final purpose.
	Motivate access to data	DM compiled, with the support of EDF, the goals of data collection resulting from the work on energy & climate indicators described below. The use cases identified with the end users legitimate the demand for more detailed data.
	Inventory of required data	DM compiled, with the support of EDF, the list of data and metadata which is required from every data provider.
	Create conventions with data providers	Agreements for data exchange were elaborated by the DM departments, then proofread by the data providers' legal departments.
	Sign data agreements	The signature of data agreements is ongoing

At the time of writing this report (M24), the data available/accessible/necessary was defined; the legal agreements for data access are being signed; the first samples of data were delivered. **This access to data occurs later than expected initially, and delays the development of Energy and GHG indicators.**

3.3.2.2 Update of risks

We identified two new risks with high probability and high impact.

It is likely **not all the data providers will provide data**. This means the picture of energy consumption in the territory will be incomplete with, for instance, gas data not being available or being only available at a more global spatial granularity and/or temporal granularity and/or lower freshness. We mitigate this risk by developing a method to estimate the demand based on the past consumption analyzed as a function of temperatures (thermo sensitivity of energy demand).

It is likely a few **data providers will not accept open data streams for automatic data collection**. As a consequence, the data will have to be manually transmitted. This also means the freshness of data depends on the capacity of an organization to maintain manual demands and data processing over time. We try to reduce this risk with negotiation. In the long term, the future contracts for public service delegation and concession would include the constraint to publish data flows. In the short term, we integrate graphical user interfaces to allow manual data entry into the shared datalake.

3.3.2.3 Data collection: lessons learned

The collection of data was not identified as an organizational task in the grant agreement, in which only the technical infrastructure was planned. In practice, it appeared to be so important and difficult, that a dedicated workgroup was created with LHC coordinators (DM, EDF) and the stakeholders (EIFER as data user, the IT department of DM for data manipulation, ENEDIS as data provider). Additional manpower was allocated by DM, EDF and EIFER to support the data identification and collection. Weekly meetings were organized to monitor the progress of data availability, negotiations and legal analysis.

A difficult aspect in the collection of data is the general principle of GDPR, which states data collection and processing should be limited to the minimal amount required by the finality of the data processing.

- At first, this principle limits the possibility to discover what can be done according to available data; a first round of identification of data availability (without seeing this data) should be organized, then the use cases should be identified, then only the access to data can be negotiated. This induces a long delay, as the data collection cannot be the starting point, but becomes rather the result of the precise identification of the needs.
- Secondly, every stakeholder in charge of managing data is responsible for sharing only the data relevant for the purpose according to regulation. So a different negotiation takes place with every data provided to agree on the relevance to share the amount of data. A stakeholder who would prefer not to share data (to keep secrecy on its activity, to avoid costs and risks) might invoke regulation to refuse the transmission of data.

- Thirdly, every stakeholder sharing data has to set up the right aggregation of data to transmit only the amount of data agreed on. This means a specific methodology has to be defined, implemented in the information system of the data provider, specific data streams should be opened. This induces costs (in time, manpower, computing power) which are not covered by the project, but are supported by the data provider themselves. In practice in such a project, the data providers should be part of the project to receive funding for their contribution.

The key and main surprise is that data collection is mostly not a technical difficulty, but rather an organizational challenge. Because of the points mentioned above, every stakeholder in the chain of data collection needs has to define its corporate doctrine on what data can be shared with who, to invest in data processing, to elaborate methodologies, and ultimately to integrate these costs in its structure of costs. As the RESPONSE project is the first project to negotiate this precision of data to most data providers, they have to conduct this change internally to accept to share the required data. The pioneering aspect, and a key outcome of this functional group, might be to trigger organizational changes regarding data manipulation and sharing in energy providers.

3.3.3 Shared datalake (IE4.1.2): activities and progress

3.3.3.1 Goal and users

The goals of the datalake (IE4.1.2) include:

- Facilitate the storage, sharing and access of data within the Metropolis, between the technical services, in order to make the governance more efficient (cost efficiency, quality of service delivered to inhabitants)
- Share part of the data in open data, in order to provide inhabitants with information, keep up with legal obligations, facilitate innovation and develop novel usages and local economics
- Valorize Metropolis data on a contractual basis for research partnerships, develop new services for governance and citizens
- Provide new services to the technical services of the Metropolis and to inhabitants

The shared datalake is used in RESPONSE, but is mostly developed by the city on own funds (over 400k€). The resulting datalake will be the central repository for the territorial data managed by the city. This guarantees the maintenance over time of this component critical in the RESPONSE energy-climate platform. Due to national regulation, DM has to emit a call for tender to select the subcontractor. DM subcontracted (on own funds) with an IT advising company to formulate the call for tender in the proper way.

The role of the share datalake is to store heterogeneous data dynamically and constantly updated by heterogeneous providers, respecting the volume, variety and velocity requirements of Big Data. This datalake will aggregate spatial data (maps, raster) and semantic data (such as labels added on curves, and concepts of the city explicitly formulated into ontologies) and will be used as the interface among the partners of the consortium; thus, guaranteeing access of partners to the data. Therefore, we have to refer to the state of art on information structuration. With 19 local partners working on the local experimentation in the PEB, the local infrastructure needs to organize and rationalize the several flows of data transiting between each one. Some partners do not have the appropriate architecture to store historical measurement data, or provide the respective API to request data. There is also less capability to apply any data model on them, or insert them into time series or spatial localization.

The shared datalake aims to offer the local partners a repository to store historical and collected data, apply on them a knowledge-based system provided by the CIAD laboratory, contextualize them on a spatial and temporal environment. For data consumers, it offers the opportunity to access to heterogeneous data provided by different partners through a unique generic API provided by only one platform: the share datalake.

3.3.3.2 Activities and progress

Before developing the shared datalake, DM had experience with the management of a datalake delegated to an external consortium during the OnDijon dynamics. As a consequence, they were already organized with functions of Chief Data Officers, delegation for data management from the Communes to the Metropolis, skills and experts gathered in an IT team and a Data team, had contracts for the management and support with GIS software, etc. This past experience makes Dijon Metropolis able to drive the many steps required to create an infrastructure dedicated to the collection, processing, protection and sharing of urban data. We report in Table 10 the activities of DM to create this infrastructure.

Table 10 Activities and progress for the creation of the Shared Datalake (IE4.1.2)

Domain	Task	Progress / result
Shared datahub	Research and choice of an ACA	DM asked on own funds for the support of an ACA (assistance to the contracting authority), in order to explicit the needs, prepare the call for tender, review the candidates and select the best technical solution according to the state of the art in data management and urban data management.
	Acculturation and needs gathering	DM and their ACA interviewed platform partners to clarify the nature of data, the standard of transmission, the volume and frequency of data, the modality of access (push/pull…), and other elements of importance to define an ICT infrastructure. These technical needs were formulated into a document of functional needs for the datalike.

		EIFER led interviews with the energy-climate platform partners (UBFC/BGS, UBFC/CIAD, ATMO, DM, EIFER) to explicit the functional use cases for end users.
	Create the call for tender	DM identified schemes for a call for tender, and identified a scheme which allows for technical exchanges with candidates throughout the process. The chosen procedure is a restricted tender (3 to 5 companies could submit a proposal) with negotiations (2 or 3 workshops).
	Request for information (RFI)	This first step consists on publishing the public offer for consultation. Interested companies submit files presenting references similar to the requested solution, their technical, human and operational capacities, and their economic and financial capacities. 17 companies answer to this request. 5 were chosen for the second step.
	Request for proposal (RFP)	Companies chosen for this second step submit a first proposal built on requested needs. Only 4 of 5 sent their proposal.
	Negotiation workshop	The first negotiation workshop with candidates is planned for mid-September.
Data model	Ontologies for contextualization of data	The data in the data reactor will be contextualized using the outcomes of activities of UBFC/CIAD in the Hybrid AI activity (see later).
Data protection	Identification of needs	Following the identification and collection of data describe earlier, DM identified it might have to take in charge the protection of data secrecy (no personal data, but business data in the meaning of Energy Regulation "Code de l'énergie").
	Exploration of solutions for secrecy protection	DM identified a contact in the French authority for personal data protection CNIL to get potential support. Together with EDF, DM experiments with a startup "Sarus" solutions based on differential privacy and production of noise to protect data confidentiality when sharing data. Aggregation of energy data at a temporal and spatial scale similar to the one used by energy distributors (such as ENEDIS) is the most probable option for DM to share data with partners whilst enforcing his role of secrecy preservation.

At the time of writing this report (M24), the *shared datalake* is specified, relevant technical architectures are identified, and the subcontractor is being selected. The provisioning of this infrastructure deployed in the cloud would only start after this legal call for tender process.

New needs were discovered during the process of data collection described earlier. The *shared datalake* was designed based on the principle of no GDPR data nor business sensitive data being stored into it (as this would induce another level of data security, and other responsibilities towards citizens). Yet some data providers do not enforce themselves a full anonymization of data; it is the case for heat networks which transmit data at the scale of the substation, and ENEDIS which delivers more detailed data to the city in the frame of this research experimentation, with the condition this data is only manipulated by the city. This gives DM the additional responsibility to apply this role. This stands as a challenge, because it requires not only the implementation of new data processing, but also requires the definition of a doctrine on what level of aggregation is sufficient for this goal. This is likely to induce an additional delay in the delivery of some parts of data to partners.

3.3.3.3 Evolution in terminology

During the architecture study, it appeared the term "datalake" used in the RESPONSE project is misleading. We used the term "datalake" from an organizational perspective, because it is a central repository where an organization (here the city and RESPONSE consortium) is centralizing data to facilitate its access by other parts of the organization. Yet from a technical perspective (Sawadogo, 2021), a datalake is understood as having other properties:

- In opposition to a data warehouse, a datalake is a repository of unstructured raw data, alike to a folder which might contain blobs or files with tabular data (CSV files, Excel files), binary data, spatial data, in the most unstructured way. The goal of the RESPONSE demonstrator is instead to create a repository of structured, contextualized data which facilitates querying, processing, for the production of indicators.
- datalake functions are often thought to be limited to the injection, storage and access to data. DM is also willing to include automatic data processing features in their ICT infrastructure.

As a consequence, Dijon Metropolis is now using the term "data hub" to avoid the misunderstanding of the ICT infrastructure they are building.

3.3.3.4 Update on Risks

As exposed upon, 4 proposals were received for subcontracting and will be discussed in negotiation workshops. These negotiations will be focus on following objectives:

- Understand and discuss the technical proposition, ICT architecture and the needs understood from the tenderers,
- Negotiate the scope of proposed actions: for some expressed needs, tenderers propose over quality, or extended tools that go beyond needs,
- Negotiate the financial proposal, exceeding the envisaged budget, with a prospective increase of inflation, in particular on daily costs

- Discuss the proposed deployment schedule: the proposed agendas range from 7 to 13 months after contract notification

Figure 2 depicts an updated schedule of the past stages on the *shared datalake* with a projection.

Figure 2 Schedule for the shared datahub IE4.1.2

<table>
<tr><th colspan="3">Q4 2020</th><th colspan="3">Q1 2021</th><th colspan="3">Q2 2021</th><th colspan="3">Q3 2021</th><th colspan="3">Q4 2021</th><th colspan="3">Q1 2022</th><th colspan="3">Q2 2022</th><th colspan="3">Q3 2022</th><th colspan="3">Q4 2022</th><th colspan="3">Q1 2023</th><th colspan="3">Q2 2023</th><th colspan="3">Q3 2023</th><th colspan="4">Q4 2023</th></tr>
<tr><td>M-1</td><td>M1</td><td>M2</td><td>M3</td><td>M4</td><td>M5</td><td>M6</td><td>M7</td><td>M8</td><td>M9</td><td>M10</td><td>M11</td><td>M12</td><td>M13</td><td>M14</td><td>M15</td><td>M16</td><td>M17</td><td>M18</td><td>M19</td><td>M20</td><td>M21</td><td>M22</td><td>M23</td><td>M24</td><td>M25</td><td>M26</td><td>M27</td><td>M28</td><td>M29</td><td>M30</td><td>M31</td><td>M32</td><td>M33</td><td>M34</td><td>M35</td><td>M36</td><td>M37</td><td>M38</td><td>M39</td></tr>
<tr><td colspan="8"></td><td colspan="29">Task T3.3</td><td colspan="3"></td></tr>
<tr><td colspan="7">Research and choice of assistance to the contracting authority (ACA)</td><td colspan="4">Acculturation and needs gathering</td><td colspan="4">Preparation of technical and special clauses</td><td colspan="3">Preparation of public tender</td><td colspan="3">RFI</td><td colspan="3">RFP</td><td colspan="3">Analysis and negotiation workshops</td><td colspan="7">Deployment</td><td>.</td><td>.</td><td>.</td><td colspan="3"></td></tr>
</table>

First stages begun before the beginning of T3.3. The following steps were carried out without delay, although they were difficult to parallelize. Despite all the efforts of Dijon Metropole and its partners, **the data hub will be put into production at best 3 months before the end of the task**. On the one hand, this strongly restricts the actions of the other partners before the end of the task, and on the other hand, it does not allow for the adjustment phase necessary for the implementation of such solutions.

This delay will impact the capability to compute automatically the indicators (IE4.1.3) and to feed in the energy climate dashboard (IE47.1.4). As a consequence, **the partners of this functional group consider demanding the extension of task T3.3.**

3.3.3.5 Lessons learned for the datahub

Due to the number and variety of data producers, consumers and other partners involved (such as hybrid AI), the definition of needs must be a long, collaborative and deep work. It must start with acculturation to be sure that every partner will have the same language and definition of concept, for a good collaboration and understanding during the next steps.

This background also has to infuse the organization of the collectivity, to validate the action plan, and financial and human resources needed for driving this kind of complex tool. Thus, Dijon metropole installed an internal data committee, chaired by the Director General of Services, in presence of the executive management and 2 elected representatives, that arbitrate the data roadmap, including the data reactor. This data governance is a prerequisite to support the deployment of such solution.

These elements show that, for the replication of such a solution in a city, the city must be ready to dedicate the effort, human resources, and budget require to centralize data.

3.3.4 Temperatures: interpolation and prediction

3.3.4.1 Goal

This work on temperature is part of the IE4.1.3 "Advanced indicators for energy and climate". The laboratory "BioGéoSciences" (later written BGS) of the University of Burgundy (UBFC) is leading this work, especially the Centre de Recherche de Climatologie team (later CRC). The team is a postdoctoral researcher and a research engineer with the advising of the professor and head of the CRC team. The goal is twofold:

1. monitor air temperature at near real-time by producing hourly temperature maps at 100m resolution based on statistical interpolation of temperature measured by sensors spread over the territory;
2. predict hourly temperature in the next two days or so by producing temperature maps at 100m resolution based on statistical interpolation of Météo France weather forecasts.

The approach to monitor air temperature was presented in detail in Master Planning deliverable D3.1, section 4.3.3. The approach to predict air temperature differs from that developed for air temperature monitoring. The temperature maps are defined as the sum between air temperature background forecasted over Dijon Metropolis and theoretical spatial patterns of temperature anomalies induced by the topography and land use. The background temperature is predicted and provided by Météo France weather forecasts. The theoretical spatial patterns of temperature anomalies are based on the same approach as developed by Biogeosciences for air temperature monitoring (i.e., multiple linear regression) but account also for the vertical profiles of the atmosphere as forecasted by Météo France. According to weather conditions, the annual and diurnal cycles, we average the regression coefficients obtained for each hour of the historical period (2014-2021) to derive the theoretical spatial temperature anomalous patterns. This approach has been developed using the Global Forecast System (GFS) but gives mitigated results because of forecast errors. Such errors should be reduced by considering Météo France forecasts, which have much higher resolution in both time and space and assimilate fine scale observations, unlike GFS. We now wait for the convention to be signed between Dijon Metropolis and Météo France to get access to the forecasts for the historical period, a necessary step to apply our methodological framework.

3.3.4.2 Activities and progress

The activities and progress for the construction of temperature indicators are illustrated in Table 11.

Table 11 Activities and progress for temperature indicators

Domain	Task	Progress / result
Data collection	Access to sensor data	UBFC/BGS developed in the past the MUSTARDijon network of temperature sensors, one of the most dense networks of this kind in France, network labeled by the INSU CNRS within the SNO Observil. They enforce the collection of sensor data over time and its storage.
	Cleaning of sensor data	UBFC/BGS is working on network maintenance, deployment of new stations and sensors (wind and solar radiation) and preparation of sensor data to eliminate outliers and fill data gaps.
	Identify necessary meteorological data	After analysis of the data accessible without specific license (GFS), UBFC/BGS identified it is not sufficient to work on predictions of local temperatures, and asked DM to negotiate an access to high quality predictions with the national institute Météo France.
	Access meteorological data	DM is negotiating an access with Météo France, will pay a license for data access on own funds, and will set up a dedicated data stream to feed UBFC/BGS needs.
Scientific modelling	Spatial interpolation to produce maps	Statistical interpolation is based on multiple linear regression. Weather conditions used for air temperature prediction will be identified through a clustering approach.
Scientific communications	Conference	Richard et al. 2022, COMMENT ET POUR QUI CARTOGRAPHIER L'ÎLOT DE CHALEUR URBAIN (ICU) ? 35ème colloque annuel de l'Association Internationale de Climatologie (oral and peer-reviewed manuscript)
	Peer reviewed communication	Crétat et al., Hourly temperature spatialization in an urban environment with contrasted topography, Dijon (France) 2014–2020. In preparation for International Journal of Climatology Crétat et al., CANICULES ET VARIABILITE SPATIO-TEMPORELLE DE LA TEMPERATURE DE L'AIR A DIJON. In preparation for Climatologie
Preparation for integration and deployment	Define the future integration into the datalake	EIFER organized meetings with UBFC/BGS which develops the code which creates the maps, and the IT department of DM is in charge of integrating the code and data in their shared datalake. They converged to an agreement on the integration of a code delivered into a virtual machine, where: BGS develops the code, gives it to DM, as well as an access to temperature data and topography and land use descriptors DM run the code in the datahub. Resulting data is consumed as tabular data by EIFER to produce quantitative indicators and maps

		The maps are stored and shared by DM GIS infrastructure
	Define the formats for exchange	EIFER led tests with DM data department in order to test the best formats for the transmission of data between BGS (who gathers sensor data and creates maps), DM (who stores and transmits the data), and EIFER (who creates maps and other indicators based on BGS maps, and displays them into a dashboard). Two distincts data flow appear: • one data flow between BGS and EIFER to compute indicators; this data flow is better transmitted with grid data, for instance with CSV or netCDF • one data flow between BGS and DM, and EIFER and DM, in which BGS and EIFER produce maps which have to be integrated into a GIS framework. To ingest such a raster data into a GIS software, we identified the creation of a "TPKX" (tile package) is the most suitable solution.
	Test the creation of indicators in the energy-climate dashboard	EIFER and DM prototyped the integration of data into GIS frameworks and in dashboards. EIFER started the implementation of the computation of indicators accordingly
Preparation for indicators	Identification of needs	EIFER animated, with the support of DM and UBFC/BGS, a workshop to define the indicators useful for the target users. Historical indicators will monitor the evolution of temperatures and their spatial repartition at yearly and monthly temporal scales. They will be used by the planning department, and by the social department to update their "heat wave" plan. Short term indicators will monitor the evolution of temperatures in the last hours and their previsions for the next two days. These indicators will be used by the social department to alert inhabitants in case of heat wave, and to protect the employees of the city from extreme conditions. These needs were traced in a functional specification document.
	Functional specifications	EIFER defined, with the support of UBFC/BGS, the list of the indicators which should be computed and how they should be represented. EIFER prototyped the computation of these indicators.
	Implementation of computation	EIFER implemented the computation of the temperature indicators in the form of scientific workflows implemented in the KNIME tool.

3.3.4.3 Temperature: update of risks

- BGS needs the convention to be signed between DM and Météo France to test their solution to predict air temperature over the territory;
- New sensors that automatically send air temperature data to a server are more complicated to manage that originally thought (e.g., false alarms because of battery problems, transmission problems, missing values)

3.3.4.4 Lessons learned

The statistical interpolation model developed for air temperature monitoring allows to identify the topography and land use descriptors affecting the temperature spatial patterns along the annual and diurnal cycles.

3.3.5 Air quality maps and indicators

3.3.5.1 Goal

The goal of the work is to provide maps and forecasts of air quality on a daily basis at high spatial resolution in the territory of Dijon Metropolis. The data set provided will give a detailed view of the air quality topic, offering:

- the display of 10-meter spatial resolution maps showing the distribution of the daily Particulate Matter (PM) concentrations
- the visualisation of hourly PM concentrations measured with both reference and micro- air quality stations settled in the Dijon Metropolis
- the possibility of providing air quality indicators, based on the European Directives
- the implementation of short-term air quality forecasts for tomorrow

The approach was presented in detail in Master Planning deliverable D3.1, section 4.3.2.

The air quality ATMO-BFC network is composed of five reference stations for the PM measurements in the Dijon Metropolis: four fixed stations (an urban station, a traffic station, two suburban station), and one mobile. ATMO-BFC usually uses these measurements to create maps and predictions of air quality in the Metropolis. During RESPONSE, ATMO-BFC uses the SIRANE high-resolution model to produce daily maps of air quality. UBFC next exploits the 20 QameleO micro-stations network in order to increase air quality maps and forecasts accuracy in Dijon Metropolis. The model/micro-stations interoperability work, leaded by ATMO and UBFC, may better represent the PM concentrations in the Dijon Metropolis.

3.3.5.2 Activities and progress

We report in Table 12 the activities taking place for the production of air quality maps.

Table 12 Activities and progress for the production of air quality maps based on sensor data

	Task	Progress / result
Data collection	Deployment of QameleO micro stations	UBFC, with IRD/UMMISCO, deploys additional QamaleO micro-stations, with a target of 20 stations.
	Data collection	UBFC enforces the collection and storage of QameleO data.
	Optimization of the modelling chain	Reduction of file sizes, standardization of file format, improvement of the chain unrolling to accelerate the delivery of outputs. Data used for the forecast chain were selected (emissions inventories from 2016, data modulated temporally, etc.) and various aspects are also in place for modelling with a 10m resolution exit. Integration of $PM_{2.5}$ - The work on emissions and the consideration of background pollution, allowed the generation of new maps and a system of calculation redesign of the Atmo index. Improvement of model outputs - Available database storage, automated calculation of indicators, review of mapping methods and optimization of output files. Planning and availability - The cards are available from 9.30 am, providing a backup process and a security of the IT infrastructure.
Methodology	Quality assurance Level 1 of the QameleO dataset	Automatic process for cleaning and filtering the QameleO micro-stations data in order to remove outliers, inconsistent or defective values(anomaly detection with isolation forest method)
	Evaluation of the model outputs based on quality-ensured QameleO datasets	In the first instance, 9 study cases (days) were chosen to evaluate the model accuracy. For this part, we used 4 QameleO sites: a traffic station, two urban stations, a suburban station. Model agreement with observed data was quantified by calculating mean error (BIAS) and root mean square error (RMSE). These analyses highlighted that the model predominantly accounts for the impact of the traffic on the PM concentrations, poorly representing the surface land cover and other PM's sources. This work put in evidence the need to lead a sensitivity study of the model.
	Reliability and optimization of the existing modelling chain	SIRANE sensitivity test - Different values have been tested for the different parameters of the weather site and dispersion site necessary for the launch of the SIRANE v.126 model: albedo, roughness of the domain, roughness of the site and emissivity. Taking into account the more precise values suggested by the UBFC and the LMFA (Laboratory of Fluid Mechanics and Acoustics of Lyon). Another test using the multigrid

		function specific to SIRANE v.148 was also tested. The multigrid is a function that differentiates the residential and tertiary cadastre from the total cadastre (considering all emission sectors) by varying the time factors and roughness (by applying different profiles). These various tests allowed adjusting the forecast chains to optimize both the calculation time and the quality of the results. Further improvements will come with the coupling of Qameleo measures.
	Tests of interoperability of micro-sensors data with the SIRANE model	The goal is here to correct the modelled raw maps using quality-ensured QameleO measurements . This work (under process) is carried out in 3 steps : (i) produce a high-resolution land cover database based on Local Climate Zone parameters, Sky View Factor or Digital Elevation Model ; (ii) look for the statistical relationship between the model results and the micro-stations measurements in each QameleO site ; (iii) attribute the appropriate statistical relationship to each point of the grid depending on its typology (defined in step (i)).
	Integration of the QameleO data sets into the SIRANE grids	Work to come after - Application of the methodology previously defined for the air quality maps at J-1 and the forecasts at J0 and J+1.
Implementation	Migration to SIRANE	ATMO used in the past the ADMS Urba modelling software to model the transport and chemistry of air quality in Dijon Metropolis. They switched to another reference tool, SIRANE.
	Implement the process in the operational platform	Work that has not yet started since the methodology is still under development.
	Check operation and validate performance	
	Supply the datalake	

3.3.5.3 Lessons learned

The SIRANE model mainly accounts for the traffic influence on the PM concentrations (underestimating the other PM sources). The maps produced, therefore, show less spatial variations than initially expected.

The QameleO network is still under development (production solution in progress). Thus, for now, we have less than 20 micro-stations with a 1-year temporal depth. Fortunately, the 4 "full" QameleO stations used in RESPONSE are representative of different urban environments, which gives confidence to the results obtained. The risk identified here lies in the reproducibility of the method using other QameleO micro-sensors.

Integrating the QameleO data sets into the SIRANE model is a real challenge. As a first step, we propose to work with post-processing methods which appear more promising and robust than others.

3.3.6 Hybrid AI

3.3.6.1 Goals

In the H2020 RESPONSE project, the main goal of CIAD laboratory is to propose a solution based on hybrid AI to ensure more coherence and value to Smart City data, and help decision-maker to give right decisions. Hybrid AI combines two different approaches: symbolic and connectionism. Symbolic uses deductive reasoning while connectionism uses inductive reasoning to reach a result. These two types of reasoning are usually operated separately from each other, and research combining them is recent. CIAD' activities aim to fit into this new paradigm to bring value to Smart City data.

Smart city data comes from various sources such as third-party companies or sensors, this data is very heterogeneous. In the smart city context, constrained by a large number of laws and standards, it is necessary to ensure that the data depicts the real world as accurately as possible. Checking the consistency of data is a way to ensure that the data is true. This verification must be done as soon as the data is received as well as after the data is processed by a model. Thus, we can guarantee a coherence of the results obtained thanks to the models. When we combine this consistency check with model explainability, we obtain more reliable and exploitable results, which are necessary in a highly constrained universe such as that of the Smart City.

To achieve data consistency and model explainability, CIAD uses hybrid AI. This type of AI is currently the most suitable for this problem. Deductive reasoning is made possible by using ontologies capable of describing rules and applying them on data. Ontologies allows to guarantee the respect of certain constraints. Moreover, ontology, thanks to its semantic part, also enable the integration of data coming from multiple heterogeneous sources. Inductive reasoning is made possible using machine learning which allows, among other things, to discover association rules in the data. Data processing by machine learning is also efficient and does not need to be manually programmed by developers. The use of machine learning algorithms saves a considerable amount of time in processing data, sometimes at the expense of consistency and explainability, so it seems important to us to address this issue. We hope that our work will also be useful to ensure the consistency of predictions on data.

The CIAD laboratory of UBFC, carries out these research works thanks to a PhD student in computer science entirely dedicated to the H2020 RESPONSE project.

3.3.6.2 Hybrid Ai: activities and progress

Table 13 Hybrid AI: activities and progress

Field	Task	Progress/ Result
Scientific research	Information Services of smart cities	Read articles and write a technical report on the different Information Services of Smart City
	Hybrid AI	Creation of a Systematic Literature Review (SLR) about the combination of machine learning and ontologies based on more than 400 articles filtered and summarized as a scientific journal article. Creation of an overview of the combination between machine learning and ontologies.
Scientific communications	Journal	Our SLR has been sent to Artificial Intelligence Review (peer review) but is already available as a preprint.
Data collection	Temperature	The most recent temperature data of Dijon are available on Meteo France, they are more complicated to retrieve older data (from 2012). We are working on how to do this. If the metropolis concludes an agreement with Meteo France (under the impulse of BioGeoScience) this could help our own research.
	GIS	Geographic data of Dijon have been sent to us by the metropolis. They are also available in OpenSource on the French government platform.
	Energy	For now, no building energy data has been provided by the metropolis because the agreement with the third party energy services is still under discussion. In the meantime, we are using Open Source data, accessible to all, provided by RTE and ENEDIS for our experiments.
Experiments	Verification of data consistency when changing granularity	Start of the experiment: data collection and quick state of the art on time series disaggregation.

3.3.6.3 Update on risks

In order to work, CIAD must use the data provided by the other project actors. Without this data, the relevance of the results obtained is compromised. Work has started on open source data that is as close as possible to the future data. We hope to be able to easily adapt our research to the Dijon data as soon as we receive it. The risk is that they will not arrive quickly enough to allow us to finish the work in time.

3.3.6.4 Feedback on this experience

Hybrid AI is a new field that is getting more and more attention. The combination of machine learning and ontologies is more and more used to improve the results of models while allowing more explicability. However, hybrid AI is still not widely used for consistency checking. Therefore, using hybrid AI to ensure data consistency is an innovative research topic.

3.3.7 Energy and Climate indicators

We depict in Table 14 the activities and progress for the creation of energy and climate indicators.

Table 14 Activities and progress for energy and climate indicators

Field	Task	Progress/ Result
Framing of activities	Identify topics	DM and EIFER analyzed the topics of interest for target users which might be realized according to available data. They agreed to develop indicators for the monitoring of energy & GHG emissions over the territory, to monitor the energy & emissions of the estate of the Metropolis, the heat network, the residential energy demand and energy poverty and the mobility.
	Identify target departments and users	DM identified the relevant departments who might use the indicators, and identified interlocutors for every department.
Thematic workshops	Preparation by experts	For every topic (energy and GHG, residential, heat network, estate, temperatures), a workshop was prepared with experts from EIFER and partners (EDF for energy, UBFC for temperatures). The preparation included the creation of a list of proposed indicators which seem suitable by experts, written in the form of a document for preparation.
	Animation of workshops	With the logistic support of DM, EIFER organized in the LHC 8 thematic workshops with the departments of the city (transportation, energy, estate, urban ecology, social action, etc.). During workshops, the end users are proposed the suggestions of experts, then define on paper representations of a dashboard the indicators of interest, the contextual information they need, the graphical representations suitable, etc.
	Functional specifications	For every theme, a document of functional specifications is written to explain which indicators should be computed and how it would be represented.
Implementation	Prototyping	EIFER prototypes the computation of indicators with the support of experts.
	Development of computation	Once the data will be available, EIFER will implement the computation of indicators so it can be automatically updated when

		input data is updated. Peer reviewing of code ensures a correct code quality.
	Creation of representations	When the dashboard will be available, EIFER will create the graphical representations of the indicators in the form of maps and/or graphical representations.

3.3.7.1 Update on risks

Among the risks already identified in D3.1, the main risk appearing today is the one of data availability, and the risks on data quality. As long as data is not transmitted by data providers, it is difficult to identify the actual quality.

Due to this lack of data, the timing to define the methodology of computation and the implementation of indicators becomes delicate. Part of the work might be parallelized in 2023, but an iteration with the end users would be preferable to ensure they are satisfied of the result. As a consequence, we would ask for an extension of T3.3 to finish this work with the expected quality.

3.3.7.2 Lessons learned

Indicators on energy and GHG depend on the use cases of these indicators. In our case, end users want to monitor projects, but also put the data into words to persuade stakeholders to contribute decarbonation of the territory. As a consequence, the indicators they ask for are simple so they are easy to explain and trust. During workshops, we often observed an opposition between the experts who recommend indicators suitable for regulation or monitoring of performance (for instance, energy data corrected from climate variations), whilst end user asked for intuitive indicators for communication (for instance, energy data not corrected from climate variations).

3.3.8 Energy-Climate dashboard

3.3.8.1 Goal and users

The Energy-Climate dashboard is the part of the Energy-Climate Platform visible to the end users of the city (administrative departments of Dijon Metropolis). The dashboard provides an access to the data, and represents graphically the indicators we listed earlier (temperature, air quality, energy and GHG) in a form suitable for the activities of the users. EIFER develops it following a user-centric approach with a strong involvement of the future users in DM, with the support of EDF for the ergonomics, and in close contact with the partners UBFC and ATMO who produce the data to be visualized in the dashboard.

3.3.8.2 Activities and progress

Table 15 Progress and activities for the Energy-climate dashboard

Field	Task	Progress/ Result
Identification of the needs	Identification of technical possibilities	EIFER led workshops with the partners to identify how new data on temperatures (UBFC/BGS), Hybrid AI (UBFC/CIAD and ATMO BFC), Energy and GHG indicators (DM and EIFER), might propose added value. We identified 20 potential use cases which include a long-term approach (monitor energy-climate plans annually, update plans for heat waves or energy climate plans, support urban planning) and short-term usages (protect populations from environmental conditions induced by heat waves).
	Understanding of the target audience	DM identified the potential users in the various departments of the Metropolis. EIFER and EDF piloted an intervention of an ergonomist who interviewed 25 potential users of DM (head of department, policy officers, elected people), observed the tools they already use and analyzed their activities (Guibourdenche, 2021). In a user-centric design, this enables to understand the future users of the tool, and to ensure the tool will integrate in their activities and articulate with their existing process and tools. This also enables to abstract the needs expressed by specific persons by identifying the structural activities of a city engaged in the decarbonation and adaptation of its territory. The key activities identified in the Metropolis are: gather and format data from various sources; compute indicators; analyze the indicators along with internal data to find explanations and support decision-making; monitor plans and projects; use data to persuade internal services and departments, and territory stakeholders, to engage into action.
	Literature review	Multidisciplinary literature review on information systems, Decision-support methods, Climate Plans efficiency, usage of data for governance, modelling methods for urban planning.
	Use cases for indicators	Relying on the workshops led in the Energy & GHG indicators work, EIFER identified the finalities of the users (namely decarbonate the territory, decarbonate the emissions of the Metropolis, protect inhabitants and personal from environmental conditions and energy poverty). EIFER identified key use cases to satisfy with graphical representations.
	Functional specifications	Under the supervision of EDF and EIFER, the ergonomist

		wrote the functional specifications for an energy-climate dashboard, in the form of a website which facilities the search for data, the monitoring of projects and plans, and communication towards external stakeholders. An Axure mockup of the dashboard was produced and tested with the users. Weekly meetings took place with the EIFER teams in charge of indicators and dashboard implementation to ensure technical feasibility and alignment with the needs detected for the representation of indicators.
Creation of an organizational dynamics	Identification of potential users	DM identified the departments and interlocutors susceptible to use the future dashboard.
Technical analysis	IT Architecture	EIFER analyzed the various technical approaches to build the dashboard. On-the-shelf solutions from editors of geographical information systems (such as ESRI) propose solutions which are suitable to geographic data manipulation, but do not fit the needs for quantitative data representation. Dashboarding frameworks (such as Graphana, Dash, Tableau, Business Analytics) do not propose suitable cartographic representations. As a consequence, EIFER decided to develop an adhoc dashboarding tool by integrating into a CMS (content management system) the cartographic representations from a GIS framework, and the scientific visualization for data. EDF provided support on the IT architecture to ensure replicability of the tool.
	Prototyping	EIFER prototyped the integration of maps and scientific data into a dashboarding tool.
	Technical specifications	EIFER pieced together the functional specifications and constraints from the ergonomist, the use cases for indicators, and the functional specifications for indicators, into a document describing the technical specifications for a Minimal Viable Product (MVP).
Organization of software development	Search for subcontractor	EIFER emitted a call for tender, identified 5 potential subcontractors having the skills for the implementation of the web dashboard, for the manipulation of data models, and for the representation of geographic and cartographic data. EIFER led interviews with the technical experts of the 5 subcontractors who emitted proposals for the subcontracting.

	Analysis of candidates subcontractors	The candidates to the call for tender proposed good quality solutions exceeding the budget planned for subcontracting by an order of magnitude (budget planned for development: 60k€; estimations ranging between 200k€ to 500k€). After a round of negotiation by disclosing the target budget, 3 candidates withdrawed their applications, and 2 proposed partial answers exceeding the target budget. **This makes the original option of subcontracting the development of the software impossible. This constitutes a small deviation of the original plan.**
	Mitigation of the deviation	After analysis, EIFER decided to take in charge the management of the development on its own PM, and to recruit the required expertise with a freelance full stack developer. EIFER published an offer in two wide platforms (Uptowork and GULP), and excluded all the proposals from freelance out of the EU perimeter. EIFER led 5 interviews and selected one suitable freelance developer.
	Management of quality	The software development will be driven in agile way with iterations of two weeks. EIFER will peer review the code at the end of every iteration to guarantee the quality of the solution.

3.3.8.3 Feedback

The usage of a user-centric method, with the intervention of an ergonomist and the analysis of activities, provides us with a very good understanding of our users and their needs. Thanks to this work, we identified several features we would not have foreseen, and which would have likely led to the rejection of our dashboard:

- The dashboard will be used for analysis; the users need to display together the data (for instance on energy) and the potential causes or explanations (for instance the temperature, surface heated, etc.).
- The users have to create ad hoc representations of data, and often have to compute several variations of indicators. As a consequence, they need the possibility to download data in a convenient format.
- The users need a control to indicators at a department level. Some indicators might be misinterpreted if read by a person without the necessary expertise, so there are indicators reserved for the department having the right expertise, and some indicators which are consolidated and might be shared with other departments.

- The city spends a large amount of time putting data into words. The decarbonation of their territory is mostly feasible by motivating external stakeholders to engage into decarbonation. They use data to explain the dynamics of energy and GHG, highlight the existing projects, and persuade to engage into new projects.

3.3.9 Lessons learned for the Energy Climate Platform

Support of the city is visible, and necessary, on every aspect of this functional group:

- Data collection: according to national regulation, the Metropolis is the actor having the best access to data (access to data of its own infrastructures, or access for public usage, or access with more details). It also has the legitimacy to contact national supporting agencies (such as CNIL for personal data protection). It also has access to expertise, such as legal advising, which would not be accessible to other partners such as universities. It mobilizes its own expertise (for instance, on GIS data processing) to facilitate the access to data. In this context, it plays the role of a global support to the research activities. This means that, in the current state of maturity of actors and regulation, the replication on another territory requires a strong support from the target city. It also means the support inside the city is strong enough in different parts of the organization (Elected decision makers, managers of administrative services, data department...) to
- The data collection stands as a bottleneck for the whole project, despite of an activity started before the beginning of the task.
- Automatic access to data: the automatic access to data requires negotiation, but also updates in the organization of partners.
- Costs for subcontracting. During this RESPONSE project (2020-2025), several exogeneous dynamics impacted the job market of ICT. With an increase of salaries, along with inflation, the budgets assessed at the beginning of a European project are likely not to match the budgets during the realization. This means a partner declaring the cost of subcontracting in a European project has to anticipate the potential volatility of his costs, and likely carries the financial cost of this risk. This should be included in the future construction of budgets.

3.4 V2G charging stations (IE 4.2.1)

3.4.1 Objectives & Users

The V2G charging stations demonstrated in Dijon enable inhabitants of the PEB to charge electric vehicles (6 vehicles with rapid and smart charging), but also enable the usage of the connected vehicle as an electricity storage equipment (87 kWh capacity – 14,5 kWh/vehicle) which contributes the decarbonation and energy balance of the PEB: (1) maximization of usage of renewable energy by storing it and using it at peak hour, (2) control the energy demand by smoothing demand thanks to smart charging, (3) contribute the PEB energy balance by storing energy produced locally and using it when necessary.

3.4.2 Description of the solution

The technical solution was described in detail in the Master Planning deliverable D3.1, section 5.1.

The V2G charging stations, delivered by EDF DREEV, are made of a V2G charging station (ABB), an aggregator platform, a communication protocol to interface the station and the platform, and a V2G mobile application which enables the user to control the charging of his vehicle.

The key partners and roles are:

- DM/EDF: look for use cases to implement the 6 V2G charging points
- DREEV: design of the control platform and installation of the V2G charging point
- GDH: buildings' owner in RESPONSE project, beneficiary of 1 charging point
- CITIZ: beneficiary of 1 charging point

3.4.3 Progress and mitigation plan

During the demonstration, it appears that the key challenges for this Innovative Element are not technical but rather on the side of usage.

3.4.3.1 Commitment in the Grant Agreement

In the Grand Agreement, DM is committed to install 6 V2G charging points, 3 in each PEB. These will participate in the operation of collective self-consumption of 2 zones: zone of the social landlord Orvitis, zone of the social landlord Grand Dijon Habitat (GDH). It is important to note that there will be 3 zones of collective self-consumption (see **Error! Reference source not found.**).

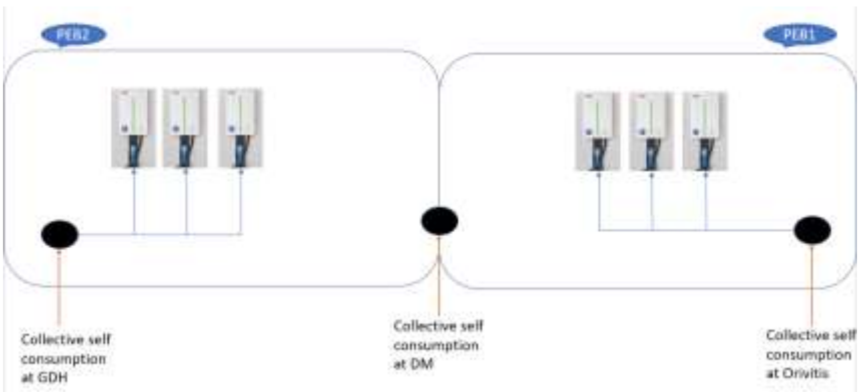

Figure 3 DM's commitment according to the GA

3.4.3.2 Initial use case

The initial use case that was intended consists of:

- 3 charging points linked to Grand Dijon Habitat buildings participating in the GDH Collective self-consumption operation.
- 3 charging points linked to Orvitis buildings participating in the Orvitis Collective self-consumption operation.

3.4.3.3 Challenges and complications

The major challenge of this innovative element is that the V2G charging points are not compatible with all types of electric vehicles. EDF and Dijon Metropole have been working together since the beginning of the project to try to find use cases by carrying out a thorough survey; fleets of electric vehicles in the 2 PEBs that can participate in the operation.

The complication of the topic lies in the following points:

- There are very few electric vehicles in Dijon Metropole, and within the PEBs in particular.
- For the V2G charging points currently available on the market, there are only 2 vehicles that are compatible: Nissan Leaf & Peugeot iOn. This narrows the scope of possible uses.

In the end, only 1 EV can be located within the PEB with a charging station. This is a car-sharing system that will be set up by DM using its own funds.

3.4.3.4 Mitigation plan

For the 5 V2G charging points to be installed, we found two use cases with the social landlord GDH, one terminal linked to a GDH building, outside the PEBs, but only a hundred meters away (Figure 4). The 4 remaining terminals can be installed at the GDH headquarters, which is outside the Fontaine d'Ouche district (5Km to the PEBs).

To keep the demonstration aspect of the solution, it is proposed to pilot the 5 charging points as if they were within the PEBs and that they were participating in the Dijon Metropole collective self-consumption. Thus, they will receive the instructions from the EMS as if they were really installed in the Fontaine d'Ouche district. The EMS will thus be able to simulate the gain in terms of collective self-consumption rate if the V2G charging points were really installed in the PEB. This still meets the objective of this demonstration phase.

We chose that all the V2G charging points will participate to the city self-consumption operation because there is more surplus of production in the city than in the other two zones (2 social landlords' zones: GDH and Orvitis), and to push the collective self-consumption rate which is lower in the Dijon city zone than in the other 2 zones.

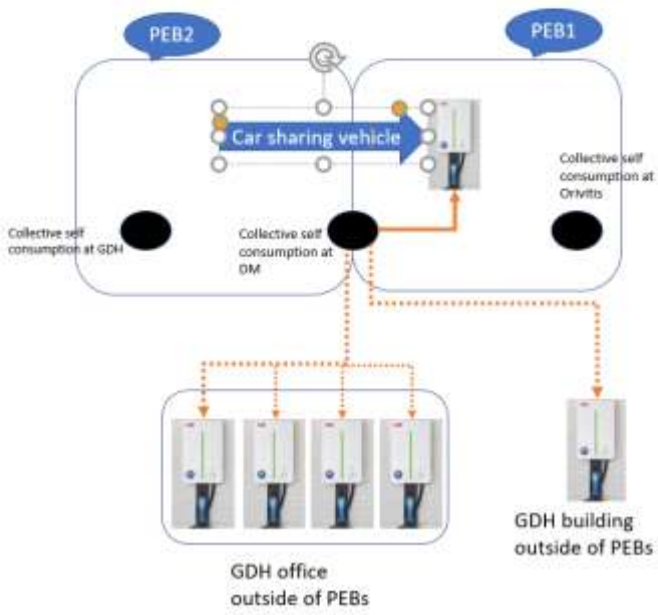

Figure 4 Schematic of suggested mitigation plan for Electric Vehicles

3.4.3.5 *Impact & summary*

Loss of V2G impacts the grid, as there will be just 1 of the 6 V2G which will be installed inside the PEBs. However, we will be able to measure their potential impact, just as if they were inside the PEBs (Table 15).

Table 16 Mitigation points for V2G stations: comparison of commitments and mitigation plan

Commitments in GA	Mitigation Plan
3 V2G charging points in the GDH area 3 V2G charging points in the Orvitis zone The 6 charging points to be installed inside the PEBs.	All charging points will participate in the DM collective self-consumption operation: - 1 charging point car sharing installed inside the PEB1. - 5 charging points outside PEBs belonging to the social landlord partner: GDH.

3.4.4 Update of risks

Some risks already detailed in D3.1 appear preeminent at the time of writing:

- The compatibility of only 2 vehicles with the V2G chargers (Peugeot iOn and Nissan Leaf) which has been considered and use cases have been found using such vehicles.
- The necessity of a car-sharing service was yet to be known, but further studies done by GDH showed that one car-sharing vehicle would be pertinent and justified the decision made in the mitigation plan.

Even though the mitigation plan detailed above answers the risk of the lack of use cases, some risks are still present, and new ones have appeared.

- First, we might have found concrete use cases, but it is only when the system is in place that we would see if it is used well enough to ensure expected performances and has a real impact on collective self-consumption.
- As mentioned in the mitigation plan, most of the charging points won't be inside the PEBs and thus won't be able to directly contribute to the self-consumption, and the solution proposed to simulate their participation could be more difficult than expected to realize.
- The risk of charging points being damaged (accident, fire, …) is real and raises the question of insurance. Therefore, it is more pertinent from this point of view that GDH buys the chargers, and it will thus induce a reallocation of the subsidies of which the details will come in a future amendment.

3.4.5 Lessons learned

This situation well illustrates the fact that issues regarding the implementation of innovative elements are not just technical but can also come from a lack of use case. V2G which is a relatively new technology, even though it is operational, is not widely deployed. Moreover, it relies on the near presence of electric vehicles which is still quite rare in social districts like Fontaine d'Ouche. And lastly, not all EVs are compatible with the standard chosen for the charging points (only 2: Nissan Leaf & Peugeot iOn). This shows the importance of focusing not only on what the project will provide by itself, but also on what it indirectly needs to perform as expected.

Another thing to keep in mind when thinking about installing V2G stations is the load curve of the installation we are working on. This is because the whole purpose of V2G is to limit the power absorbed by the installation and having too much storage through V2G can be useless (and thus a potential waste of money). In our specific case, having more than 4 V2G chargers at GDH headquarters would not increase the gains in energy. This shows that V2G is pertinent for structures which have a large fleet of EV and sites which have a relatively high minimum consumption, especially as energy prices rise.

3.5 Support to urban planning: Positioning of EV charging points (IE 4.2.2 & 4.2.3)

3.5.1.1 Objectives & users

Electric vehicles are now technically state of the art: their production is massive; they are produced with characteristics in line with the needs of a large proportion of Europe inhabitants. European regulation is pushing new vehicles toward low-carbon emissions vehicles, in particular with the announced end of new combustion engine cars by 2035, including then electric vehicles. Beyond acceptability by the car users, two main barriers to the development of EV are identified:

- Bootstrapping effect: electric vehicles can be used beyond standard house/work commuting patterns if there is a network of charging stations, as the average kilometres range is still considered as low compared to combustion engine cars. Innovations dependant to network effects (such as phone networks, instant messaging systems, social networking tools) are difficult to kick off, as every individual would need an infrastructure to exist according to its immediate needs, whilst the infrastructure is developed according to the current (low) demand. Though local authorities are responsible for organizing electrical mobility deployment on their territories, no national enforcement is yet described in the law. Financial incentives can be dedicated so that local authorities should reach the European recommendation of one charging station for 10 electric vehicles (computed considering an estimated forecast of the fleet in the coming years).. Electric vehicles are still under dissemination, thus about 180 charging stations were deployed in the DM territory in 2020 for its 254,000 inhabitants, the vast majority being set up and operated by private compagnies with public access and only 10 exploited with a public status.
- Local policy-makers who manage the usage of public space in a city, and have the power to promote, facilitate, restrain or forbid the deployment of charging stations. Decision-makers for urban planning have a clear picture of the current demand (which is low at this stage of diffusion of the technology) but also need scenarios of the potential demand for electric vehicles, and visibility about the potential costs/profitability and potential deployment plans.

The goal of the "Electric Mobility Tooling and Studies" functional group is (i) to anticipate the needs of Charging Stations for Electric Mobility on a territory, (ii) to propose potential deployment locations to match this demand, and (iii) to deliver this information in a visualisation tool which facilitate their appropriation by decision-makers. Two Innovative Elements tackle this goal:

- IE4.2.2 Smart-charging infrastructure deployment planning tool: an existing model is upgraded to assess the demand for charging stations over space in the context of the use case (traffic and availability of electrical network), and a study is driven to apply this model and method on the territory of Dijon Metropolis. In addition, a joined prospective tool is used by researchers to produce scenarios of electric vehicles demand, and propose locations of charging stations in interaction with the city.
- IE4.2.3 Geographic visualization tool for enhanced decision-making: based on the results of the study, a presentation of results is organized in an interactive dashboard, and is presented to decision makers, in order to support their analysis of the needs.

3.5.1.2 infrastructure deployment tool (IE 4.2.2): activities and progress

EIFER developed a chain of tools to support decision making for the implantation of charging stations:

- A tool to estimate the demand for electric vehicles at the scale of communes based on the demographic characteristics (based on census data) and hypothesis on regulation and interest by the population. This tool produces a demand for electric vehicles for various communes.
- A second tool is dedicated to the positioning of a given number of charging stations in a given territory. It takes the results of the first as an input, then proposes scenarios for the deployment of the charging stations over space according to available space, parking lots, activities (businesses, shops, residential…). The result is a list of stations positioned over space.

In the frame of RESPONSE, this tool is upgraded to match better the demand in cities having PEB, and to tackle scalability and replicability:

- Take into account the shape of the electric network, and the power available in the network for consumption and injection, so the charging stations are positioned in places where the electric network is capable of providing the necessary power.
- Take into account the traffic in the city, so the positioning also takes into account the flow of vehicles going through each potential location

These two upgrades of the model are added to the multi criteria function which governs the interest for every charging station.

The pre-existing material and the methodologies were described with more detail in D3.1. We report in Table 17 the activities which took place since the beginning of this task.

Table 17 Activities and progress for the EV positioning tool

IE4.2.2	Task	Progress
Software upgrade	Enrich the tool to position charging stations according to the electric network shape and available power.	done in first semester 2022
	Enrich the tool to position charging stations according to the traffic	done in first semester 2022

Data collection	Data on the current shape of the electric network, and the available power on every branch of the network for consumption or demand,	was collected from ENEDIS with the support of EDF and DM. Data is delivered under strict conditions due to guarantee free competition. Data is also only delivered for usage in a limited time frame (4 weeks) because the power available in the network evolves quickly with the demands for connection of PV or residential demand.
	Data on the traffic of streets in the city	Data was provided by ATMO with the support of DM. This data comes from simulation models.
Case study	Test the methodology on a small area	Tested on 2nd semester 2021
	Define the area for the case study	EIFER agreed with DM to the study of the "Toison d'Or" District
	Agree on scenarios and hypothesis for estimation of demand	Agreed on two scenarios of deployment (2022)
Restitution	Restitution of the case study to several interlocutors of the city	Done in June 2022 with the support of DM. (Transportation department, Urbanism department, Urban ecology + Elected person in charge of these topics)

At the time of writing this report (M24), the tool dedicated to the positioning of charging stations was upgraded to include the availability and location of the energy network. This also led to the identification of an organizational way for the DSO (Enedis) to produce and communicate this data to an external partner. These results are parts of the Innovative Element which can be replicated elsewhere.

This tool was tested at the scale of a district, then at the scale of the Metropolis, and its results were presented to the city. This study would run one more time with new data on traffic, in order to provide results with more insights.

3.5.1.3 Geographic visualization tool: activities and progress

EIFER developed in the past several tools to support urban planning, including tools which allow the user to start and compare simulations, or tools dedicated to the comparison of several scenarios. These tools facilitate the exploration of the results of a study for decision-makers, by varying several hypotheses, and projecting themselves in potential scenarios of deployment over time.

The development of this tool is starting now, based on the results of IE 4.2.2.

Table 18 First activities for the geographic visualization of the deployment of charging stations

IE4.2.3	Task	Progress
Definition of scenarios	From IE 4.2.2 results	Restitution of scenarios analysis in June 2022
Definition of technical solutions	Define needs of DM regarding indicators and visualization of the resulting deployment plan for charging stations	Planned for 2nd semester of 2022
	Choose the technical solution to produce the dashboard	A standard solution is to deploy a dashboard produced with solutions from the ESRI company. The resulting dashboards are intuitive and can be rapidly produced. Yet they are most of the time used in a one-shot way. As a consequence, we consider the possibility to develop this tool instead as part of the energy-climate dashboard. This would ensure the knowledge and usage of the results, and would provide the possibility to update the scenarios over time.

3.5.1.4 Update of risks

On the one hand, the risks for these two Innovative Elements relied on the availability and the quality of the data: if not available, traffic and electrical network shapefiles couldn't have been integrated into the activity, reducing the quality of the results. Therefore, it may have been necessary to extrapolate data from other sources. Fortunately, data were obtained and exploited, under an agreement.

On the other hand, technical difficulties may have occurred (e.g., servers' troubles or lack of human resources for developing new features in the pre-existing tool). This risk still remains for IE4.2.3 as it encompasses an online visualization.

3.5.1.5 Lessons learned

This experimentation led to a shift in the maturity of the partners to exchange this nature of data.

For a Data point of view, the collection of our sets was obtained for limited time and their updates showed significant evolutions. Although data are often time dependent, the development of the new features of the tool couldn't have been achieved without their obtention in first place for the small area case study (tests and developments). The agreement for Data exchange could be enhanced with a proposal for automated update when the extrapolation to the global territory is performed.

Besides, the technical aspects of these activities are now considered as efficient, from local expert feedback.

However, local context has been highlighted as a significant driver in the scenarios for charging station locations. A slight modification in parameters can influence results markedly. The inclusion of local experts during the development of scenarios and for calibrating parameters of the model has to be considered for providing efficient and useful analysis to the DM.

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Chapter 4

Replication potential

Chapter 4 – Replication potential

4. Replication potential of T3.3 Innovative Elements

The potential for replication in FC was first discussed in D3.1, and will be analyzed with FC in T3.6. We present here a first assessment of replication potential and conditions based on the activities and risks we reported in this document at M24.

4.1 Overview of replication potential

Based on the feedback, barriers and risks identified earlier, a first assessment of the replication potential of the IE developed in T3.3 is provided here. Due to the barriers or risks identified during demonstration, two different potentials appear for replication in the territory of demonstration (France) and in other European countries. It appears that the solutions related to data are strongly related to the regulation framework, but also the maturity of the energy providers who collect and process data (Table 18).

Table 19 Assessment of replication potential of the IE in IS4.1 and IS4.2

IS	Functional group	IE	IE title	Replication potential
IS4.1	PEB monitoring and operation	IE4.1.3	PEB Multi-Energy Dashboard	**Fast replication possible** The tool is an evolution of a commercial product. Its replication in France is straightforward (same energy providers, same regulation, business already operated in the territory). Its replication in another European country would require the negotiation of access to data streams and the development of adapters.
		IE4.1.1	Genesys tunnelling solution	**Fast replication possible** The tool is an evolution of product used in an industrial setting. Its replication in France is straightforward (quality of security is in line with the recommandations of the national agency ANSSI). We identified no barrier to the replication to another European country. The platform is developed for an easy integration of new protocols and assets.

	Energy Climate Platform	IE4.1.2	Shared datalake	**Reuse methodology and feedback.** The methodology and return on experience can be reused to build a similar data hub in the French context (same regulatory framework, same national energy players). The replication in another country requires a local analysis of the national regulation and of the maturity of energy network providers. The replication requires a political motivation of the city to manage its territory data.
		IE4.1.4	Advanced indicators: temperature, air quality, energy & GHG, Hybrid AI	Regarding temperature, air quality, energy and GHG indicators, the tools developed, or the methodology, might be replicated to another territory. The replication potential depends on the availability of sensors or data sources.
		IE4.1.5	Energy Climate Dashboard	**Replication easy in France**, The energy-climate dashboard is replicable
4.2	Preparation and deployment of V2G charging stations	IE4.2.1	4.2.1 EV charging points with PV, shading and battery featuring smart-charging and V2G operation	**Fast replication possible** if usage exists. The main barriers for replication is the demand in electric vehicles in the PEB or area for replication. If the target local contains a car pool (from a company or public institution), deploying a V2G station is straightforward.
	Support to urban planning: Positioning of EV charging points	IE4.2.2	Smart-charging infrastructure deployment planning tool	**Fast replication possible**
		IE4.2.3	Geographic visualization tool for enhanced decision-making	**Fast replication possible**

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Chapter 5

Conclusions

Chapter 5 - Conclusions

The D3.3 describes the progress of activities hosted in T3.3. The analysis of the progress of IE and their potential for replication highlights the heterogeneity in their maturity: solutions based on commercial products (IE4.1.1, IE4.1.3) have a high replicability potential; solutions tackling methodological, technical or organizational challenges (IE4.1.2, IE4.1.4) have a high variability in their progress; solutions based on data collection, which are highly innovative in their organizational aspect (stakeholders are not yet used to transmit this type of data), are delayed.

This report also describes the reality of the demonstration activities by listing the activities led by every technology provider. This enables to monitor the progress of the demonstration, but also to share the difficulties, challenges, or steps which facilitate or limit the replication of these solutions. The key barriers common to these IEs are the access to data (identified for PEB monitoring and remote command, for territory-scale energy data, and to gather network data necessary for the positioning of charging stations). It appears that the strength of the barriers for data access were underestimated. The question is not only legal (the analysis of the regulation barriers and levers was done in T3.2), but also organizational: every entity responsible of sharing data has to appropriate in his own organization the risks and regulation, to determine a doctrine on the granularity of data it accepts to share, to agree on data agreements, etc. In this process, the role of the Light House City is central as it weights in the negotiation to access data related to its territory. This also means an important benefit of the demonstrations of RESPONSE is organizational; many actors (the LHC, the energy providers, the partners in charge of data manipulation) evolve their organization and infrastructure to be able to process, anonymize and share data. Further replication of the IE with the same national actors would later be facilitated by this organizational progress.

Three deviations were identified:

- The difficulty to find the usage for the V2G charging stations (IE4.2.1) led to a mitigation plan which was already accepted by the Project Officer and is integrated in an amendment.
- The access to territory data (negotiation for data access, procurement of the shared datalake) is slower to obtain than expected. This suggest a mitigation plan which ensures the delivery of flows of data for project monitoring on time, and an extension of the task to allow the full development of the Advanced indicators and Energy Climate Dashboard.
- The subcontracting scheme defined for the Energy-Climate Dashboard appear unrealistic, and requires a different organization for software development.

This report on M24 is the first version of T3.3 focused on ongoing work, with feedback on progress and activities. The final version at M36 will include more details on the final states of IE and on the lessons learned compared to the initial plans. A feedback on the usage of the solutions will be partly delivered with the other work packages of the RESPONSE project dedicated to the monitoring of solutions.

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