This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 691876
## Revision Chart and History Log

### Versions

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### Deliverable quality review

| Quality check       | Date       | Status | Comments                                              |
|---------------------|------------|--------|                                                      |
| Technical Manager   | 2018-07-13 | Ok     |                                                      |
| Quality Manager     | 2018-07-06 | Ok     |                                                      |
| Project Coordinator | 2018-07-23 | Ok     |                                                      |
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<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>B to C</td>
<td>Business to Consumer</td>
</tr>
<tr>
<td>BEMS</td>
<td>Building Energy Management System</td>
</tr>
<tr>
<td>CMS</td>
<td>Community Management System or Confluence Monitoring System</td>
</tr>
<tr>
<td>CNR</td>
<td>Compagnie Nationale du Rhône : producer of renewable energy</td>
</tr>
<tr>
<td>DNO</td>
<td>Distribution Network Operator</td>
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<tr>
<td>EC</td>
<td>European Commission</td>
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<tr>
<td>ETL</td>
<td>Extract Transfer Load software</td>
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<tr>
<td>EV</td>
<td>Electric vehicle</td>
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<tr>
<td>FME</td>
<td>ETL software edited by Safe</td>
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<td>GDPR</td>
<td>General Data Protection Regulation</td>
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<tr>
<td>IT</td>
<td>Information Technologies</td>
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<tr>
<td>JSON</td>
<td>JavaScript Object Notation (textual data format)</td>
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<tr>
<td>OGC</td>
<td>Open Geospatial Consortium</td>
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<tr>
<td>PV</td>
<td>Photovoltaic</td>
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<tr>
<td>SOS</td>
<td>Sensor Observation Service</td>
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<tr>
<td>WFS</td>
<td>Web Feature Service (OGC standard)</td>
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<td>WMS</td>
<td>Web Map Service (OGC standard)</td>
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# SMARTER TOGETHER BENEFICIARIES

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EXECUTIVE SUMMARY

Lyon Metropolis, which includes the Confluence district, is one of the three lighthouse territories involved in the Smarter Together project. Data collection, data publication, date re-use and interoperability are at the heart of the digital strategy of the metropolis. The development, within SMARTER TOGETHER, of the Community Management System (CMS), a digital solution based on data produced by various city stakeholders, is fully aligned with this strategy.

Deliverable scope

This document focuses first on the existing metropolitan data platform, which is an essential element in digital apps development on the territory. Functionalities, data access rules and technical architecture are detailed. Some examples of data sets published and services deployed on top of the data platform are given. It gives then a general overview of the objectives of the CMS, illustrated through the use cases covered. Data sources used, data flows and organisation are also presented at a macroscopic scale. A section is dedicated to the SOS format, the pivot format selected to support the publication of all data collected for the CMS.

The main section deals with the state of development of the CMS web application: after a description of the expectations regarding each of the use cases addressed by the tool, the technical architecture and the development methodology are presented. On the basis of screenshots of the software installed and running currently on metropolitan servers, the user interface is then detailed. An example of electricity consumption graph illustrates the kind of analysis made possible by the CMS. To conclude this section, future developments needed to improve the software and to expand its features and data perimeter are listed.

Key Achievements

- Stable technical and organisational integration with the existing data platform
- First running version of the CMS, based on a fully open-source and non-vendor-locked software architecture, with real data sources
- Control of the whole digital solution, from data collection to the CMS, by the Lyon Metropolis
- Road map established to proceed with the development of the CMS

This report reflects only the author’s view, neither the European Commission nor INEA is responsible for any use that may be made of the information it contains.
Introduction

1.1 Context

1.1.1 Work package 3: Lyon lighthouse project
The objective of WP3 is to deploy, in Lyon-Confluence area, low-tech and high-tech smart city solutions that have been identified and co-designed within WP1 and WP2 in order to reach the goals set in the WWF Sustainable action plan signed in 2010 to make this ambitious urban regeneration development carbon neutral.

1.1.2 Task 3.4: Integrated infrastructure and connected district
The main objective of this task is to deploy, based on the existing Data Platform operated by Grand-Lyon, an open, interoperable, non-vendor lock-in integrated and cross-cutting ICT solution called Community Management System (CMS). This solution collects data from many various sources:

- Smart power meters installed by the Distribution Network Operator (DNO),
- Smart heat meters of the district heating,
- Building Energy Management Systems (BEMS),
- Public infrastructures for weather and mobility data.

1.2 Objectives
CMS will help having a global understanding of energy flows of the district in order to improve the urban planning process and the planning, design and operation of public infrastructures.

1.3 Structure of the document
This document is structured as follows:

- Chapter 2 describes the existing data platform of Lyon Metropolis, which is a cornerstone of the CMS solution
- Chapter 3 gives a general overview of the solution, with the different use cases to be developed and the organisation established for the project
- Chapter 4 describes the CMS in its actual state of development: technical architecture, services provided, user interface
- Chapter 5 wraps up the document with a short summary of important points and a conclusion
2. The data platform

2.1 Context and objectives

2.1.1 History

The Greater Lyon data platform, www.data.grandlyon.com, has been launched in 2011. It was first of all focused on geospatial data and mobility data, and its scope is now extended to all aspects of urban life and activities.

The platform hosts data sets produced by business units of the metropolis, and data sets provided by partners of the territory: airport, railway operator, air quality agency, shared bikes operator...

2.1.2 Main objectives

- The objective is to provide an answer to the following Smart Metropolis strategic challenges:
  - Facilitate data exchange between the actors of the same territory
  - Promote the economic potential of public data and encourage:
    - Experimentation
    - Innovation
    - Services development
  - Foster citizen engagement by:
    - Transparency
    - Understanding of public policy

2.2 Main features

2.2.1 Overview of functionalities

Figure 1 presents the functionalities of the data platform. It must be outlined that the visible data platform, the data.grandlyon.com web site, is only one way to interact with the platform. A lot of other functionalities are offered by the platform:

- On data producers’ side: legal aspects of data integration (based on agreements with the data providers), technical integration of the data (format translation for instance), data normalization, data quality control, rights managements (definition of the license associated to the data set).
- On data consumers’ side: data publication under several formats (standard geographical formats validated by OGC, like WFS, WMS), authentication process of consumers when needed, metadata catalogue management
2.2.2 Focus on protocols and formats

The data platform is designed for integration of multiple data protocols and formats, and publication of data in various standard formats, mostly through APIs, via the HTTP protocol. This is illustrated by figure 2.

The different data formats accessible on the platform are described in a document available on the developer’s page of the data platform portal: http://rdata-grandlyon.readthedocs.io/en/latest/services.html.
2.2.3 Visibility of data and licenses

Depending on data sensitivity and on agreements signed with the data producer, there are three levels of data access:

- **Public access**
  - Data are available without any condition for their reuse
  - License is open
  - Example: availability of shared bikes (provider: JC Decaux)

- **Restricted access**
  - Authentication of user is mandatory
  - 2 different licenses
    - **Engaged license**
      - Purpose of reuse must be compatible with Greater Lyon policies
      - Example: real time road events (provider: Lyon Metropolis)
    - **Associated license**
      - Purpose of reuse must be compatible with Greater Lyon policies
      - Fee system can be activated in case of monopolistic situation/massive usage of data
      - Example: public transportation real stop times (provider: TCL)

- **Private access**
  - Data sets are not visible at all on the data platform web portal
  - Data are accessible to identified and authorized users or applications
  - Example: Bluely shared electric car service data (provider: Bolloré)

2.2.4 Data security

As explained in the previous section, there are different levels of access to data.

For restricted or private access to data, which is the most frequent case for data collected within the project, users or digital services have to use an account created on the data platform. This account is protected by a password with a minimal complexity controlled by the portal.

For the time being, the “basic auth” method is implemented for the authentication of users. This method will be soon replaced by the authentication layer “OpenID Connect”, which enables reinforced security mechanisms.
All the connections between a client and the data platform are encrypted thanks to the https protocol.

The middle-office, where partners’ data are stored, and the front-office of the data platform are both hosted by a European Internet service provider, in a data center located in France.

2.3 Access and use of data

2.3.1 Web portal and access to datasets

The data platform is accessible to everyone on Internet through a web portal: www.data.grandlyon.com

The main functionality of the portal is the search engine which makes it possible to find data sets on the basis of key words. Data sets are also classified under several topics.

In the example below, figure 3, the key word “traffic” gives 7 results. Among them data sets about road traffic, public transportation traffic, etc.
Once the user has found the data set he is looking for, he can access the complete data sheet, as shown on the figure 4.

The data sheet presents numerous information on data: description, formats available, download or access to the URLs of the APIs, extract of data, cartography...
2.3.2 Example of web application

The Onlymoov application, including a multimodal itinerary calculator, has been deployed by the metropolis. This application is based on a lot of data sets of the data platform.
Next figure illustrates how public or private initiatives can benefit from the data platform to deploy digital services.
2.4 Technical architecture

As shown on figure 7 the data platform is composed of 3 layers:

- **back office**: management of the data and metadata catalogue with the “Géosource” software, and collection of internal data sources
- **middle office**: external data integration with FME Extraction Transfer Loading (ETL) tool, storage of all the datasets, copy of the data catalogue, authentication API
- **front office**: replication of data, catalogue and authentication API, publication of data through APIs, and specific formats (MapServer, SOS).

Middle-office and front-office are hosted outside the IT infrastructure of the metropolis by an Internet service operator, ensuring a high availability and security.
2.5 The SOS format

2.5.1 What is SOS?


It can be defined as a web service interface which allows querying observations, sensor metadata, as well as representations of observed features.

![Diagram of SOS standard concepts](image)

2.5.2 SOS and Lyon metropolis data platform

This format is useful to provide georeferenced points of observation, with frequent variation of values over time. The SOS format has already been used for some data sets of the data platform:

- Data related to the sound sensors network deployed in the city https://data.grandlyon.com/environnement/rfseau-permanent-de-mesure-de-bruit-du-grand-lyon/
- Data related to the shared bikes historic of availability https://data.grandlyon.com/equipements/historique-des-disponibilites-des-stations-vflv/
2.6 A new version of the data platform

The product owner of the data platform is currently working on a new version of the data platform with an Agile approach. The development team is composed of two developers, an interface designer and a software architect.

With this new version, users will benefit from up-to-date technologies, access modes, user interfaces. The range of data managed by the platform will be extended. The new features of the platform are listed below.

2.6.1 Web portal

Various improvements and new functionalities are being developed on the portal side, for a better user experience:

- search engine allowing the search of both metadata and data
- editorialization: for instance articles on the production of data, their reuse...
- vector backgrounds maps
- interactive cartography, allowing user to compose their maps
- data visualization functionalities
- multilingual support
- questions & answers, animation of the community of users

2.6.2 Data storage

Two main topics regarding data storage are taken into account in the new version of the platform:

- data lake for real-time data logging
- storage and dissemination of sensitive data (encryption mechanisms)

2.6.3 Authentication and new data sets

New functions will also be developed regarding authentication and openness of the platform to users’ data:

- authentication via third-party digital identity providers (eg, Greater Lyon Connect)
- authentication of client applications (eg: OnlyMoov) via keys / access tokens
- crowdsourcing
3. General overview of the CMS solution

3.1 Context and use-cases

3.1.1 Sources of data

SMARTER TOGETHER aims at providing additional sets of data to the data platform of Lyon Metropolis. Figure 1 presents the main sources of data which will be gathered within SMARTER TOGETHER. Data will come from:

- Smart power meters installed by the Distribution Network Operator
- Smart heat meters of the district heating,
- Building Energy Management Systems (BEMS),
- Public infrastructures for data such as weather and mobility

The CMS needs therefore the cooperation of many different stakeholders (building owners, public operators, utilities, etc.) with their own constraints (regulation, market, privacy, etc.) in order to set up agreements for data exchange. Data stored in the data platform are then processed and presented by the CMS.

![Data sources for the CMS](image)

Figure 9 Data sources for the CMS
3.1.1 Use cases

The ICT solution has to handle five use cases or scenarios. They correspond to precise objectives and will be developed in the context of task 3.4 (see table 1).

<table>
<thead>
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<th>Scenario</th>
<th>Objective</th>
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<tr>
<td>1</td>
<td>Check the conformity of new buildings with the objectives of the specifications of SPL Lyon Confluence</td>
</tr>
<tr>
<td>2</td>
<td>Evaluate performance of energy renovation and of building operation</td>
</tr>
<tr>
<td>3</td>
<td>In eco-renovated buildings, provide information to inhabitants on the consumption of energy of their housing</td>
</tr>
<tr>
<td>4</td>
<td>Track consumption and energy production of Lyon-Confluence district and the respect of the zero objective carbon of the WWF Sustainable Action Plan</td>
</tr>
<tr>
<td>5</td>
<td>Track the level of use of electric vehicle systems (Navya, Bluely, CNR)</td>
</tr>
</tbody>
</table>

Table 1 ICT solutions scenarios

3.2 Global functional architecture

Figure 10 presents the main functional components and actors of the CMS solution:

- On the right, the different data providers: distribution network operators like ENEDIS, electric mobility operators like Bluely, real estate developers like Bouygues Immobilier. Each of those actors provides data sets in various formats (JSON, XML, CSV...) through various protocols (FTP, HTTP POST...)
- In the middle, the data platform: all data sets coming from different data providers are stored on the platform, in SOS (Sensor Observation Service) standard format/web service
- On the left, data clients: first of all, the Community Management System, a web application, but also users, like data scientists who could be allowed to access directly to raw data stored on the platform
3.3 Collaboration and partnership between the data producers and the Lyon Metropolis Data platform (and its Community Management System)

The development of a data-based visualisation tool like the CMS necessitates a strong collaboration between the Lyon Metropolis data platform, the SPL Lyon Confluence (urban developer of the demonstration area of Smarter Together) and the different data producers.

A data sharing agreement is signed between the Lyon Metropolis data platform and each data producer, before the effective data collection and visualisation through the CMS.

3.3.1 New buildings

The SPL Lyon Confluence, as urban developer of the Lyon Confluence area, sets the guidelines for the real estate developers for each new building. In the guidelines is featured the sharing of some of the energy data of the new buildings, with the Lyon Metropolis data platform. Based on this, the technical work can be realised with the contractors of the real estate developers, in order to submit to the approval of the owners (and the building manager) the signature of the data sharing agreement.
3.3.2 Photovoltaic production and district heating system
Since many years, the Lyon Confluence urban project has a strong focus on sustainable development, and among others, the local production of renewable energy. Different energy producers of photovoltaic installations are thus very keen to share their data with the city platform. The district heating system is implemented by the SPL Lyon Confluence. Therefore, all the substations are equipped with communication infrastructure allowing the data collection through the city platform and the Community Management System.

3.3.3 Electric consumption
Enedis (formerly known as ERDF), electric grid operator, is a beneficiary of Smarter Together. They were willing to join this experimentation since the proposal stage to complement the development of electric smart meters in the Lyon Confluence area (part of a national rollout plan) with development of new data-based services with city and public bodies. The signature of a data-sharing agreement with the Lyon Metropolis, in compliance with the national regulation of data privacy, was already planned in the grant agreement.

3.3.4 Eco-refurbished buildings
The owners of the buildings eco-refurbished in Lyon Confluence, within Smarter Together, have integrated in their program of works the installation of smart meters and sensors connected to the city platform (and validated the signature of a data sharing agreement Indeed). It was a condition given by the project coordination of the Lyon Lighthouse project to the building owners, before confirming the integration of their eco-refurbished buildings in Smarter Together.

3.3.5 Electro mobility operators
The three providers of shared-electric mobility services (the autonomous shuttle Navly, the car-sharing stations and electric vehicles Bluely, and the car-charging station CNR) are part of the strategy of the Lyon Metropolis to develop low-carbon transportations. Therefore, the discussions were more focused on the identification on the right type of data to be shared with the city platform, than on convincing them to agree on the principle of data sharing.
3.4 Data producers and legal aspects

In order to define how each set of data can be used, Metropolis of Lyon has to sign an agreement with each data supplier. The table below show the state of progress of this legal process at the time of writing of this document.

3.4.1 Agreements signed or in progress

<table>
<thead>
<tr>
<th>Name of the data supplier</th>
<th>Type of data supplied</th>
<th>Type of licence</th>
<th>State of progress of the contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPICES Energie PV production data Public access and restricted access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Générale du Solaire PV production data of Gymnase Chanfray building Public access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERL PV production data of Amplia building Public access Under signature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enedis Power consumption data Private access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navly Distance covered by the electric shuttle - Energy consumed - Location of the shuttle lines and stops Public access and restricted access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bluely Location of the carsharing stations - Availability of cars and parking spaces Private access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNR Availability of the electric charging spots Private access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5 (refurbished building) Detailed electric consumption of the C5 building Public access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>District heating Energy delivered by each of the substations Public access and restricted access Under signature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Météo France Weather informations - Heating degree-days Private access Signed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Summary of the legal process with data suppliers
### 3.4.2 Upcoming agreements

Legal and technical discussions have started in the past months with other partners who could provide data.

**New buildings**

<table>
<thead>
<tr>
<th>Name of the data supplier</th>
<th>Type of data supplied</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hikari</td>
<td>Heating</td>
<td>Data of the common areas: technical development in progress. Data of the dwellings: need of a complementary technical deployment, in progress.</td>
</tr>
<tr>
<td></td>
<td>Domestic hot water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electric consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Ilôt G</td>
<td>Heating</td>
<td>Feasibility of data exchange validated with the data providers (companies Ista, Urmet)</td>
</tr>
<tr>
<td></td>
<td>Domestic hot water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor temperature</td>
<td></td>
</tr>
<tr>
<td>Ilôt A3</td>
<td>Heating</td>
<td>Principle of a data exchange agreement validated by the condominium</td>
</tr>
<tr>
<td></td>
<td>Domestic hot water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electric consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Photovoltaic production</td>
<td>Technical exchanges to come before finalizing the data sharing agreement</td>
</tr>
<tr>
<td>Ilôt A2</td>
<td>Heating</td>
<td>Technical exchanges to come before finalizing the data sharing agreement</td>
</tr>
<tr>
<td></td>
<td>Domestic hot water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electric consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Photovoltaic production</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Future data suppliers: new buildings
Refurbished buildings

<table>
<thead>
<tr>
<th>Name of the data supplier</th>
<th>Type of data supplied</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cité Perrache</td>
<td>Heating Domestic hot water Electric consumption</td>
<td>Instrumentation and data concentrator to be deployed</td>
</tr>
<tr>
<td>Cité Mignot</td>
<td>Heating Domestic hot water Electric consumption Internal temperatures</td>
<td>Instrumentation &amp; data concentrator to be deployed</td>
</tr>
<tr>
<td>Condominium 35 rue Smith</td>
<td>Heating Domestic hot water Electric consumption Internal temperatures</td>
<td>Instrumentation &amp; data concentrator to be deployed</td>
</tr>
<tr>
<td>Condominium 61 rue Delandine</td>
<td>Heating Domestic hot water Electric consumption Internal temperatures</td>
<td>Instrumentation &amp; data concentrator to be deployed</td>
</tr>
<tr>
<td>French Tech</td>
<td>Heating Domestic hot water Electric consumption Others</td>
<td>Technical exchanges to come</td>
</tr>
<tr>
<td>King Charles</td>
<td>Heating Domestic hot water Electric consumption Others</td>
<td>Technical exchanges to come</td>
</tr>
</tbody>
</table>

Table 4 Future data suppliers: refurbished buildings

3.5 Challenges in data collection process

3.5.1 Technical challenges

For the time being, in the district of Confluence, there is no common standard in matter of energy or building information.

For each new partner involved in the process of data collection, we have to understand and import new formats and new data models.

As a matter of example, we have several sources of data for electric consumption and production. We present below two of these sources: the Linky smart meters and the Spoony data loggers.
Our partner Enedis has set up a solution to provide data collected by the Linky smartmeters installed in the buildings of the district:

Figure 11 An ENEDIS Linky smartmeter

Data is provided through JSON data files following the EU-MED standard, based on the Common Information Model (CIM):

Figure 12 Data collection: EU-MED Enedis data model

For the same category of data, electric consumption, we also collect data directly from data loggers provided by a company called Dotvision:
Data is embedded in a JSON file. This is an extract of the format chosen by Dotvision:

### 3. Data format

The DataChunks sent by spoony are organized as follow:

<table>
<thead>
<tr>
<th>Field name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;from&quot;</td>
<td>DataChunkSource (see below)</td>
<td>Source of DataChunk, identify source device and internal unit.</td>
</tr>
<tr>
<td>&quot;t&quot;</td>
<td>Date</td>
<td>Timestamp of DataChunk, Date at which the DataChunk was sent from the device, ISO 8601 format.</td>
</tr>
<tr>
<td>&quot;count&quot;</td>
<td>Integer</td>
<td>Number of items in the following array &quot;elements&quot;.</td>
</tr>
<tr>
<td>&quot;elements&quot;</td>
<td>DataPointChunk[] (see below)</td>
<td>Array containing sampled data, regrouped by DataPoint.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;devcid&quot;</td>
<td>String</td>
<td>Source device identifier. As configured on device. User is responsible for unity of devices</td>
</tr>
<tr>
<td>&quot;unit&quot;</td>
<td>String</td>
<td>Source of data within the device (Service name). Always ODM/DataChunk in current devices revisions. Subject to change without notification.</td>
</tr>
</tbody>
</table>
When comparing the two JSON files, for one point of active energy measure, it appears clearly that the same kind of information is provided in two totally different ways:

<table>
<thead>
<tr>
<th>ENEDIS</th>
<th>DOTVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;UsagePoint&quot;: {</td>
<td>{</td>
</tr>
<tr>
<td>&quot;id&quot;: &quot;12345678901234&quot;,</td>
<td>&quot;from&quot;: {</td>
</tr>
<tr>
<td>&quot;category&quot;: &quot;FDL&quot;</td>
<td>&quot;deviceId&quot;: &quot;SpoonyDotVisionDev&quot;,</td>
</tr>
<tr>
<td>},</td>
<td>&quot;unit&quot;: &quot;ODMDataChunk&quot;</td>
</tr>
<tr>
<td>&quot;IntervalBlock&quot;: {</td>
<td>},</td>
</tr>
<tr>
<td>&quot;refUP&quot;: &quot;12345678901234&quot;,</td>
<td>[</td>
</tr>
<tr>
<td>&quot;refRT&quot;: &quot;1&quot;,</td>
<td>{</td>
</tr>
<tr>
<td>&quot;interval&quot;: [</td>
<td>&quot;from&quot;: {</td>
</tr>
<tr>
<td>&quot;begin&quot;: &quot;2018-05-02&quot;,</td>
<td>&quot;device&quot;: &quot;SpoonyDotVisionDev&quot;,</td>
</tr>
<tr>
<td>&quot;end&quot;: &quot;2018-05-03&quot;</td>
<td>&quot;unit&quot;: &quot;ODMDataChunk&quot;</td>
</tr>
<tr>
<td>],</td>
<td>}</td>
</tr>
<tr>
<td>&quot;IntervalReading&quot;: {</td>
<td>},</td>
</tr>
<tr>
<td>&quot;rank&quot;: &quot;1&quot;,</td>
<td>[</td>
</tr>
<tr>
<td>&quot;value&quot;: {</td>
<td>{</td>
</tr>
<tr>
<td>&quot;value&quot;: &quot;26618&quot;</td>
<td>&quot;t&quot;: &quot;2016-07-05T15:13:51.013Z&quot;,</td>
</tr>
<tr>
<td>}</td>
<td>&quot;count&quot;: 29,</td>
</tr>
<tr>
<td>},</td>
<td>&quot;elements&quot;: [</td>
</tr>
<tr>
<td>&quot;ReadingType&quot;: {</td>
<td>{</td>
</tr>
<tr>
<td>&quot;id&quot;: &quot;1&quot;,</td>
<td>&quot;n&quot;: &quot;KMATHEB&quot;,</td>
</tr>
<tr>
<td>&quot;intervalLength&quot;: {</td>
<td>&quot;count&quot;: 1,</td>
</tr>
<tr>
<td>&quot;value&quot;: &quot;1&quot;,</td>
<td>&quot;records&quot;: [</td>
</tr>
<tr>
<td>&quot;unitSymbol&quot;: &quot;day&quot;</td>
<td>&quot;i&quot;: 2068,</td>
</tr>
<tr>
<td>},</td>
<td>&quot;t&quot;: &quot;2016-07-05T15:13:53.9983&quot;,</td>
</tr>
<tr>
<td>&quot;unitSymbol&quot;: &quot;kWh&quot;,</td>
<td>&quot;q&quot;: &quot;good&quot;,</td>
</tr>
<tr>
<td>&quot;kind&quot;: &quot;active energy&quot;,</td>
<td>&quot;r&quot;: 887.71948</td>
</tr>
<tr>
<td>&quot;flowDirection&quot;: &quot;CONS&quot;</td>
<td>}</td>
</tr>
</tbody>
</table>

To overcome the difference of naming and organisation of information in the various sources of data, a process of normalisation is applied when data is published in SOS format (presented in chapter 2 of this document). For instance, in SOS the naming of the active energy measure will be “activeEnergy” for all data sources.
3.5.2 Legal challenges

As already mentioned in this document, the Metropolis of Lyon has to sign an agreement with each data supplier.

Several difficulties have to be overcome when preparing the agreements, like:

- Multiple actors and organisation. In the case of CNR charging station for instance, three parties have to sign the agreement which increases the complexity of tuning and signature of the agreement:
  - The Metropolis: as responsible of the data platform where data are stored
  - CNR (Compagnie Nationale du Rhône): as owner of the charging station
  - GIREVE: as “B to C” responsible of the digital intermediation platform between customers and charging station owners. GIREVE manages the server and APIs enabling data collection by the Metropolis

- GDPR compliancy. In the case of ENEDIS, data collection has to respect privacy and different rules are implemented:
  - Aggregated data can be collected from a building for the CMS usage only if there are more than 10 dwellings in the building
  - Under 11 dwellings, the consent of each dwelling inhabitant must be obtained

3.6 Roles and organisation

The core team dedicated to the development of the CMS is composed of:

- The Lyon Metropolis team:
  - a project manager
  - a data platform expert
  - a technical integrator
  - a business analyst / functional designer
  - one or two web developers

- The product owners:
  - SPL Lyon Confluence WP3 manager
  - Hespul energy management expert
4. The community management system

4.1 Scope of the CMS

The IT solution developed within SMARTER TOGETHER has to support the five scenarios listed in Table 1. Nevertheless, two different solutions, both of them based on data stored by the data platform, can be distinguished:

- The Community Management System itself, a web application which covers the 4 scenarios oriented toward the stakeholders of the district
- The web application dedicated to the inhabitants, which covers the scenario n°3, the visualisation of energy and water consumption in the dwellings

It had been envisaged to regroup all the scenarios in a unique application with different access level and data access authorisations. But it appears that there is a specific challenge on applications to be used by inhabitants: user experience and user interface cannot be designed in the same way. The first application is oriented toward experts and professionals, with numerous options and features, whereas the second one is oriented toward “the man on the street” and has to be simple and ready-to-use.

In the next sections of this document, features, architecture and state of development of the CMS, the web application that covers scenarios 1, 2, 4 and 5, are described. But as these scenarios have been first described in French, pictures and graphs displayed in this section contain text written in French that has not been translated into English. The design and development of the second application for scenario 3 has not yet begun and will be described in a future document.

4.2 Services and features to be provided by the CMS

4.2.1 Scenario 1: new buildings

The objective of the scenario is to check that new buildings are in conformity with specifications established by the SPL Lyon Confluence for the real estate developers. In the specific case of positive energy buildings, the annual balance between energy consumption and energy production must be a negative value (more production than consumption).

The software enables the visualisation of the following data for each building:
- Energy production for each period of time considered
- Energy consumption for each period of time considered
- With display options:
  - Final energy or primary energy values. The measured values, provided by the smart meters, sensors and other devices are final energy values. The primary energy is calculated by applying specific coefficients for each type of energy and source of production. For instance, final value of electricity consumption must be multiplied by 3.2 to obtain the primary energy consumption.
  - Aggregation of energy values:
    - by category of energy produced or consumed (example: photovoltaic production)
    - by destination: dwellings, offices, stores
  - Application of a climatic correction factor for the heating consumption
  - Visualisation of data at different scales: year, month, day.
- Value of the yearly balance between consumption and production

![Consommation tous usages et production en énergie primaire](image)
4.2.2 Scenario 2: refurbished buildings

The objective of the scenario is to check that refurbished buildings are in conformity with the guidelines set within SMARTER TOGETHER concerning refurbished buildings: a primary energy consumption under 96 kWh/m²/year.

The following usages of energy have to be considered:

- Heating
- Cooling
- Ventilation
- Auxiliary heating
- Hotwater
- Lighting of common areas

The software enables visualisation of following data for each building:

- Energy consumption for each period of time considered
- (Energy production: unusual for refurbished buildings)
- With display options:
  - Final energy or primary energy values. Coefficients applied to calculate primary energy are based on the national public regulation RT2012.
  - Application of a climatic correction factor for the heating consumption
  - Visualisation of data at different scales: year, month, day.
- Curve of the cumulative primary energy consumption by square meter by year. The total living area of the building is considered to calculate the monthly values of this curve.
4.2.3 Scenario 4: consumption and energy production of Lyon-Confluence district

The objective of the scenario is to track energy production and energy consumption at the level of the whole district of Confluence.

The software enables the visualisation of the following data at the global level of the district and for each block of the district:

- Aggregated values of energy consumption by:
  - destination: dwellings, offices, stores
  - vector of energy: electricity, heat...
- Aggregated values of energy production
- Standardisation of consumption values by square meter of living area of the buildings and display of the result on each block with a scale of colors

The software presents also other global indicators:

- % of renewable energy on the global electricity consumption
- % of renewable energy on the global heat consumption
- Amount of CO₂ emitted by the district

The energy data available in this scenario depend on the category of block:
- Non-refurbished block
- Partially refurbished block
- Fully refurbished block
- Block belonging to “ZAC1” (1st phase of the Lyon-Confluence urban project) or “ZAC2” (2nd phase) with new buildings
- Etc.

Figure 16 Scenario 4: example of representation (EC funded Transform project)
4.2.4 Scenario 5: level of use of electric vehicle systems

The objective of the scenario is to calculate the amount of CO\(_2\) saved thanks to the three electrical mobility services deployed in the district:

- Bluely: shared electric cars
- CNR: charging stations for electric cars
- Navly: electric public transportation (autonomous shuttle)

The following method is applied to calculate the amount of CO\(_2\) saved:

- Measure of the electric consumption of the 3 services. Calculation of the corresponding CO\(_2\) emission, based on the European electricity mix of 430 g of CO\(_2\)/kWh.
- Estimation of the distance covered by the various services. Calculation of the CO\(_2\) emission based on a vehicle emitting 90g of CO\(_2\)/km.
- Calculation of the amount CO\(_2\) saved.

4.3 Technical architecture

4.3.1 Overview of the CMS architecture

The CMS is a web application and the technical solution is based on two major components:

- The data platform: in charge of data formatting, integration and publication
- The CMS software:
  - divided into two parts, the back-end (data storage and computation) and the front-end (user interface)
  - in charge of data specific computation (use cases oriented), data visualisation, data export
4.3.2 Focus on the data platform

- Data coming from the data producers are processed by FME (https://www.safe.com/), the only vendor locked component of the solution, which is used historically to integrate data.
- Data are stored in a PostGIS database and accessible via the 52 North SOS server.

Data collected in the context of the CMS are mainly georeferenced and with a variation over time. In order to provide a standard access to data, all data sets collected for the CMS are stored and published through SOS on the data platform. This format can be considered as a pivot format between original format provided by data producer and the format of data as visualised or exported in the CMS.

As explained in this document, the CMS is oriented toward specific scenarios and may not use all the data provided by the different data sources, or may transform (i.e. sum, aggregate...) data.

The SOS format of data will be always available to visualise or extract detailed data or data which would not be visible in the CMS. Open source visualisation and analysis software like Grafana (https://grafana.com/) can fit this expectation.

Figure 19 is a screenshot of the graph of measures of power in the C5 building: there is a value every 10 minutes, for each data logger deployed, and for each electrical phase.
4.3.3 **Focus on the back-end**

- Data are stored in a **mongoDB database**, with a **use-cases optimised structure of views/tables**
- **Node.js** is used to code applicative modules on the server side

4.3.4 **Focus on the front-end**

- Following components are used to code the web pages of the application:
  - **Angular**: to develop the specific web pages of the CMS
  - **Bootstrap**: a free and open-source front-end library for designing websites and web applications
  - **Leaflet**: a widely used open source JavaScript library used to build web mapping applications
  - **Chart.js**: a powerful data visualisation library used to include charts and graphs in the web pages of the application
4.3.5 **Data flow between the CMS and the back-end**

Data are transferred between the data platform and the front-end database thanks to scheduled scripts coded in Python language.

4.4 **Methodology and software tools**

4.4.1 **An iterative development**

Data collection and development of the CMS are two parallel tasks. Agreements with data producers and interface developments are still going on. For that reason, most of the scenarios could not be implemented at the beginning of the development of the CMS.

Until now the Metropolis structured the development of the CMS as follows:

- First version of the CMS (achieved): 3 iterations with the internal team, the SPL and the support of two external technical profiles, an IT architect and a developer.
  - Set up of the technical architecture
  - Set up of the User Interface
  - Development of the first scenario, with “dummy” data

- Suspension of the development and intensive work on data integration (achieved, but data integration is still in progress)

- Second version of the CMS (in progress): several iterations to be defined with the internal team, the SPL and the support of two external profiles, a business analyst and a developer

4.4.2 **IceScrum**

IceScrum is the software used to establish the road map of improvements and next development iterations of the CMS, in a collaborative way.
4.4.3 GitLab

GitLab is the software used to manage the source files and versions of the CMS, it is also used to track bugs.
4.5 Software solution developed

4.5.1 Scope of the actual application
The application developed so far covers mainly scenarios 1 and 2.

4.5.2 Application login
For the time being, only one profile has been defined on the app. It’s the administrator’s profile. An identifier and a password are requested by the web navigator when the app is launched.

4.5.3 User interface: general description and navigation principles
The user interface is divided into 4 main parts:

- Title bar
- Left menu
- Map
- Graphs

Figure 21 CMS: user interface, global screenshot
The left menu allows the choice of a scenario. For each scenario the different buildings, blocks or areas participating to the scenario can be clicked either in the left menu or directly in the map to display the corresponding graph.

### 4.5.4 User interface: title bar

On the left side of the title bar, the menu icon switches on or off the display of the scenarios' menu.

On the right side of the title bar, two icons are dedicated to the general settings, like the choice of a language, and other global features.

![Figure 22 CMS: general settings](image)

### 4.5.5 User interface: left menu

The menu lists the scenario and for each scenario the buildings, blocks, areas of the district which can be focused on and displayed in the graph area.
4.5.6 User interface: map

The map displays points or areas corresponding to buildings, blocks or areas of the district. Information on the item appears in a pop-up window when the item is clicked, with the name and picture of the item.
4.5.7 User interface: graphs

The graphs section, on the right of the screen, is composed of the title and description of the current scenario. The graphs are displayed one below the other, with a title and a description for each graph (for instance the name of the building for scenario 1), and the section can be scrolled to visualise the different graphs.

On top of each graph, coloured rectangles specify the correspondence between the colours of the bars and the represented energy consumption and production.

Two curves are displayed: the first one represents the difference between energy consumption and energy production for the period of each bar. The second one represents the difference between energy consumption and energy production cumulated for the whole period of the graph: for a one year period displayed, the...
value of the curve in December will show if production of energy has been above or under energy consumption for the considered year.

A toolbar is available for each graph.

On the left, the first icon toggles between “observed property” mode (values aggregated by source/type of energy) and “destination” mode (values aggregated by category of place: house, office, store). The other icons modify the current period of time displayed, a click on the arrows displays the previous or the next period.
On the right, 6 icons are available:

1. Definition of a customised period of time to be displayed
2. Toggle between “multi bar” graph and “stacked bar” graph
3. Download a PDF or CSV version of the graph or data of the graph
4. Set the aggregation mode: Day, Month, Year
5. Toggle between final and primary values of energy
6. Toggle between full screen and not full screen

Figure 28 CMS: graph, display options, second group

Figure 29 CMS: graph, display in multi bar mode
Bars and curves can be hidden or displayed by clicking on the coloured rectangle on top of the graph.

![Figure 30 CMS: graph, bars and curves in hidden mode](image)

### 4.6 Data analysis: an example

The graph on figure 29 displays the electric consumption of the C5 building (refurbished buildings: offices of the SPL Lyon Confluence), for a period of one month.

It can be easily observed that weekends are periods of low consumption whereas Mondays are always days where electricity consumption is at its highest for the week.
4.7 Future developments

A new round of development is currently in progress. The user interface presented in the previous section is going to be deeply modified and the database and software architecture will evolve in order to make it easier to add new buildings and data sets in the CMS.

Moreover the next version of the software will focus on the following topics:

- Integration of new data sets in the data platform and in the CMS, mainly:
  - Electric vehicles usage: autonomous electric shuttle Navly, charging station CNR, shared electric vehicle Bluely
  - Photovoltaic production: virtual (C5 building) and real (Gymnase Chanfray, Amplia, ...)
  - Electricity production and consumption from the Linky Smart Meters
  - Data from the energy management system of each new and recently built blocks (Hikari and others)
  - Data from the District Heating network
  - Data from eco-refurbished buildings

- Specification and implementation of the scenario-oriented tables of the database
- Scenario 4: implementation of the various levels above buildings, blocks, areas
- Development of administration features: new buildings, links between data sets available and graphs in the application
- New navigation and search engine as illustrated by the picture below:

Figure 32 CMS: user navigation
5. Conclusion

As shown in this document, the Community Management System development cannot be reduced to a software development. Various technical, legal and organisational tasks have to be achieved in order to make the CMS a really relevant tool:

- **Technical aspects:**
  - storage of energy data in SOS format, with the 52°North server, has still to be consolidated and documented
  - quality of coding has to be checked and documented thanks to softwares like SonarQube
  - technical documentation has to be improved in the perspective of replication

- **Legal aspects:**
  - clarification of responsibility in data agreements between the Metropolis and the co-owners of buildings or between the Metropolis and the data providers
  - compliance of data collection and usage with privacy (GDPR applying since May 2018): for instance in the case of temperature measurement inside the dwellings

- **Organisational aspects:**
  - maintenance of the solution on the long-term
  - definition of a standard format and information structure for the new buildings or eco-renovated buildings providing data

Nevertheless at this stage we have reached a good level of maturity in different fields of the CMS development:

- Data collection, relations with data producers
- Data storage and link with Grand Lyon data platform, expertise on SOS format
- Software development, stability of technical architecture

In the coming months we will consolidate the lessons learned during the first phase of development to develop a new version of the web application and we will take advantage of the integration of many new data sets in the data platform and in the CMS database.