TRANSFORM PROJECT EXPERIMENTATIONS: ENERGY-CONSUMPTION DIAGNOSTIC OF A FRENCH CBD DISTRICT IN ORDER TO SUPPORT THE CITY'S ENERGY TRANSITION

Aurélie FERRAGE
Maxence BOCQUEL
ERDF – France
aurelie.ferrage@erdf.fr

Béatrice COUTURIER
Grand Lyon – France
becouturier@grandlyon.org

Flavia BARONE
Grand Lyon - France
fbarone@grandlyon.org

ABSTRACT

Through the TRANSFORM project, six major European cities, including Grand Lyon, are experimenting processes and innovative ideas to become a Smart Energy City. Good energy planning, including energy grids planning, appears to be one of the key factors of success to become a smarter city. ERDF, France's main electricity DSO, is working as a partner of Grand Lyon on this project to help the city's energy planning.

In Lyon, the business district of Part Dieu has been chosen as the experimental area. Indeed there is currently a big urban development project in Part Dieu aiming at doubling the available building surface by 2030 while keeping the 2010 energy consumption level.

This paper presents how ERDF and Grand Lyon managed to do an electricity-consumption diagnosis of the Part Dieu district in respecting the confidentiality regulations.

INTRODUCTION

Getting a reliable vision of the Part Dieu energy consumption was crucial for Grand Lyon. This diagnostic is the base of all further energy study of the area. The energy audit requires crossing energy and urban data in order to get useful indicators such as energy consumption per square meter or energy consumption by activity.

Regarding electricity data, as the electricity DSO in the Lyon area, ERDF is the only actor with access to consumption data of all customers regardless of their electricity supplier.

ERDF already provide some data services to local governments in order to support their energy policymaking processes. Yet, most of the time these data are aggregated at city scale. The work that have been done by ERDF in the Transform project is quite different as the level of details needed for the Part Dieu energy diagnosis is very high.

1. COLLABORATION BETWEEN GRAND LYON AND ERDF

1.1. Convention

Publication of data by ERDF is strongly regulated. ERDF is not allowed to communicate any data that could be considered as commercially sensitive information (CIS) or as personal information [1]. For that reason ERDF cannot give individual consumption data to Grand Lyon. The data have to be aggregated in a way that respects statistical confidentiality rules.

Thus ERDF and Grand Lyon had to work together on this project to find the right aggregation meshing, which respects the confidentiality rules.

Therefore a convention has been established to define the data exchanges among stakeholders and their engagements.

1.2. Grand Lyon Data's collection

Creating an energy diagnosis of the Part Dieu district required an important work on urban data collection from Grand Lyon. The necessary building and planning data did not exist in an already usable form.

The main source of data describing the existing situation of Part Dieu came from the "*Urban and landscape atlas of the Part Dieu district*". This document, created in 2012 by the Lyon Urban Planning Agency describes most of the Part Dieu district in terms of total surface area, construction year and building specificities.

This database had to be completed by data coming from MAJIC files (local tax databases). Indeed these files have information on surface area per usage (housing, professionals or dependencies). Finally the 3D files were used to get the buildings' height

Figure 1 represents main source of data used to characterise each building block.

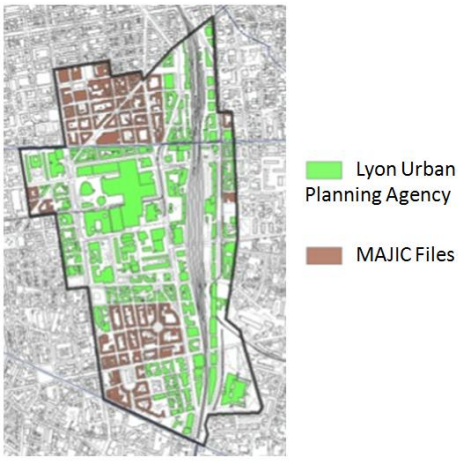

Figure 1 - Data used for building blocks' characteristics

As this energy diagnosis will be used as the base for all energy studies on the Part Dieu 2030 project, the urban database made by Grand Lyon had to integrate information on the project.
This information was given by Mission Part Dieu, a branch of Grand Lyon, and AUC, the architecture and town planning company in charge of the project design.

A long process of consolidation of the data was then necessary to improve their reliability. Finally Grand Lyon was able to make a database with the following information for all the Part Dieu building blocks:

- Usable area by major type of use (housing, shops, offices, hotels, equipment),
- Oldest and newest construction year of the blocks' buildings,
- Evolution of the blocks with the Part Dieu project (surface demolished, surface refurbished, surface build with the provisional delivery year)

This database had to be completed with historical energy consumption data (electricity, gas, district heating and cooling). To facilitate the collection of these data by the DSOs, Grand Lyon and the Urban Planning agency created a document that associates each building's address with its building block. This document was used by ERDF as an input for the electricity consumption data collection and aggregation.

1.3. ERDF Data's collection

The main challenge that ERDF had to face was to extract the necessary data from its current Information System (IS), which has not been designed for this type of service. With the time frame and budget of the Transform project, it wasn't possible to directly make any important modification of ERDF's IS.

Finding the area's customers
The first step of the data collection was to identify all the customers of the area. The feasibility of few solutions has been investigated. The first solution consisted in extracting from ERDF's IS (clients database) data on all customers of the 3rd and 6th district of Lyon and then use their addresses to keep only those in the TRANSFORM area. This solution requires extracting a very big quantity of unnecessary data and is therefore not ideal. The second possible solution was work with ERDF's Geographic Information System (GIS). Indeed the GIS has information on all types of customers including the geographic position of their grid connection point. Therefore, it was possible to extract the list of customers located in the Part Dieu district using Smallworld™ GeoSpatial Analysis (GSA), a software recently developed by General Electric and adapted to ERDF's GIS.

Assign each customer to their aggregation block
Once the customers of the area had been identified, they had to be associated to their building block. This step was important because the consumption data of the customers would be aggregated by block. This phase turned out to be quite difficult. Indeed, the customers are located in the GIS by the position of their grid connection point and therefore appear to be in the street instead of in their building.
The only way to assign customers to the correct building block is then to compare their address with the list of addresses given by Grand Lyon. ERDF has already normalised residential customers' addresses in its database. It was therefore quite easy to match residential clients with their building blocks. However, not all non-residential customers' addresses are yet normalised in ERDF's IS and their comparison with Grand Lyon's document addresses is very difficult. To facilitate this step, we have developed an algorithm able to standardise addresses and compare them with Grand Lyon's address document. This algorithm is completed with a manual verification of the result. Indeed it's necessary to make sure that the customers not assigned to a building block are really outside of the district limits and don't have spelling mistakes in their address.

Electricity Consumption data
Getting the electricity consumption data is very easy for the clients that have a Linky Smart Meter as ERDF's IS receives their consumption index every day. Thus ERDF can easily get the monthly or annual energy consumption figure of these clients. Yet, at the moment Linky is only in its demonstration phase and only a small portion of the Part Dieu area is equipped with these meters.
For all other customers, ERDF has a database named SIDECAR used to centralise all data on electricity provision. This database possesses the annual quantity of electricity billed to each customer. In most cases, this figure equals the quantity of electricity consumed. However, there can be a difference between the two values if a customer has been overcharged one year, indeed to compensate this overcharging they will have a negative billing for the next year.
For the TRANSFORM project, we have used the annual billing values (from 2010 to 2013) of the customers present in the Part Dieu area. Out of the 19,000 customers identified in the area, 4% had negative billing data. In these cases, to solve the problem of overbilling, electricity consumption figures have been estimated as the mean of the quantity billed over a 3 year period.

Aggregation

ERDF has adopted the following rules to ensure that aggregated data respect statistical confidentiality:

- The aggregated data is made of at least three elementary data

- None of the elementary data represents more than 80% of the aggregated data.

When we first aggregated the individual data using Grand Lyon's addresses document, out of the 154 building blocks, 25 were CIS. This is due to the fact that Part Dieu is a business district and quite often the same company uses an entire building block. Grand Lyon had three options to deal with this issue:

- Accepting not to get the CIS data
- Getting the data owner's approval to get his consumption data
- Grouping building blocks together so the aggregated data respects confidentiality rules.

The third option was the easiest to implement. Therefore Grand Lyon defined new aggregation distributions by grouping buildings blocks until there were no CIS data left.
This work required many exchanges between Grand Lyon and ERDF. Publishing consumption data respecting confidentiality regulations is a lot trickier than it looks.

2. RESULTS

2.1. Results for Grand Lyon:

The first objective of Grand Lyon was to produce an energy diagnosis in GIS format for the Part-Dieu district on the three energy vectors (electricity, gas, district heating and cooling) to know and measure precisely the district's current consumption levels.

The energy diagnosis thus produced is presented in map form and provides the following data:

- Type of building,
- Heat recovery potential in the Part-Dieu district,
- Consumption by energy vector (see Figure 2 for the electricity consumption),
- Buildings connected to the district heating and cooling network,
- District heat and cold consumption,
- Location of the different grids (electricity, gas, district heating and cooling),
- Total primary energy consumption,
- Total final energy consumption,
- Energy efficiency of buildings with regard to primary energy,
- Energy efficiency of buildings with regard to final energy.

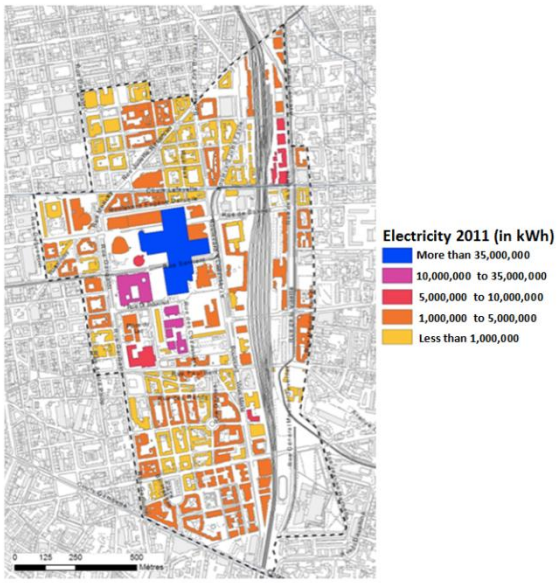

Figure 2 - Electricity consumption diagnosis for 2011

The Part Dieu 2030 project has an ambitious energy objective. The project aimed at maintaining the overall primary energy consumption of 2010 while doubling the buildings' surface area [2].
To test whether or not this objective is achievable at the 2030 horizon (date of completion of the urban project), it's necessary to simulate the evolution of the area.

This energy diagnosis is used as an input data for two simulation methods aiming at simulating the evolution of the area. One of them has been developed by HESPUL (a not-for-profit organization specialized in rational use of energy and renewable energy) and focuses on energy. It aims at evaluating the future energy consumption of the area per usage (heating, electrical appliances etc.) and energy vector. The second method developed by ERDF focuses on electrical power behaviour and estimates the future electrical load curve of the area [3].

Thanks to the work done in TRANSFORM, Grand Lyon is able to know the level of energy performance to reach for new and rehabilitated buildings. This way, Grand Lyon will support developers in the implementation of this objective. Grand Lyon will also play a guiding role in choosing the different energy carriers in 2030.

2.2. A step for ERDF to evolve towards new data services

Thanks to this experimentation with Grand Lyon ERDF now has an experimental tool able to respond to Grand Lyon's needs. However to industrialise this tool for the rest of France, more investments are needed to change the data history information system.
Even with the tool developed for the TRANSFORM project, providing this type of service is very time

consuming. Indeed, due to the high level of detail necessary for such a precise diagnosis, the risk of getting CSI aggregated data is very high. Treating these data to make sure that there is no CSI left takes a long time and requires a lot of communication between ERDF and the local government.

ERDF is aware that more and more local governments are interested in having accurate data on electricity consumption. Recent reforms, like the creation of Metropoles, give more power to local governments to deal with energy issues. Thus, more and more French cities are interested in getting localised energy consumption data (Paris and Bordeaux for example). The work done in the TRANSFORM project will be used to develop an industrial software that will be able to rapidly and automatically provide this type of service.

As this work is in progress, nothing is yet decided regarding the final tool. Yet two levels of services will probably be available:

- A custom made level providing consumption data with a very high detail level like what has been done in the TRANSFORM project
- A classic level providing consumption data aggregated at the IRIS scale (see example in figure 3).

IRIS areas are used in France in many statistics databases. It's a level of aggregation created by the INSEE (National Institute of Statistic and Economy) to represent the neighbourhood scale. They include around 2000 inhabitants or employees (for business areas). Using IRIS areas for aggregating consumption data has two main interests. First, considering the size of an IRIS area, there is very little chance that the aggregated data will be commercially sensitive information. Secondly, as this level of aggregation is used in many INSEE databases, the energy consumption data can be cross-referenced with other data like incomes of the inhabitants, age of the buildings, etc.

As an energy data manager, ERDF contributes to value creation by providing basic data adapted to the different users in terms of level of aggregation and possible enrichment.

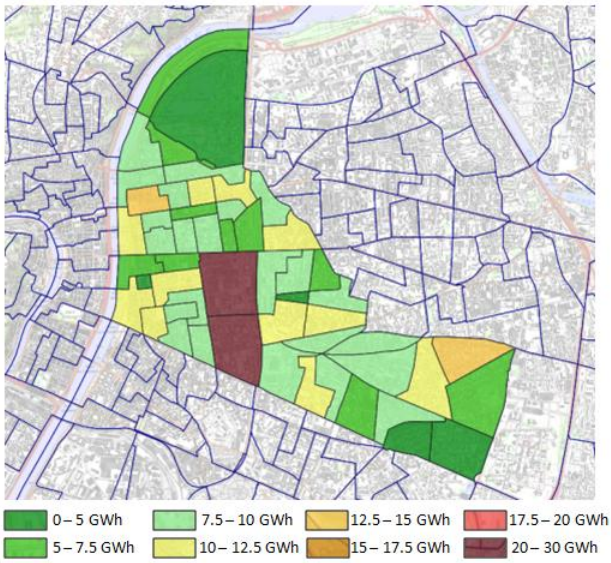

Figure 3 - Energy consumption of the 3rd and 6th district of Lyon in 2013 using IRIS areas

CONCLUSION AND PROSPECTS

This experiment met ERDF and Grand Lyon's objectives. Indeed they managed to create together a new model of data exchange, governed by a structured convention. This is the best way to provide Grand Lyon with reliable and custom-made data while respecting French regulation.

For Grand Lyon, this experiment and the following energy studies are essential steps for the creation of their Transformation Agenda towards a smart energy city.

ERDF was able to communicate to Grand Lyon electricity consumption data of each aggregation block of the area; this process is now replicable in any other city. With the deployment of the Linky smart meter in all of France, this data service will improve and become more dynamic.

This type of diagnostic can be done at the scale of an entire city and helps the local government to plan its energy efficiency policies and actions. It can also be used as an indicator to monitor the benefits of the city's policies and projects each year.

Through this type of project, ERDF shows that DSO's have a major role to play in helping cities' energy transitions.

ACKNOWLEDGMENTS

This project has only been possible through collaboration between Grand Lyon, ERDF and HESPUL.

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