IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

Project Acronym:	IRIS
Project Full Name:	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities
Grant Agreement:	No 774199
Project Duration:	5 ½ years (starting 1 October 2017)

Deliverable 6.9

Final report on Nice lighthouse demonstration activities

Work Package:	WP6: Nice Lighthouse City demonstration activities
Task:	T6.2 Coordination of Nice integration and demonstration activities
Lead Beneficiary:	NCA
Due Date:	30 November 2022 (M60)
Submission Date:	31 March 2023 (M66)
Deliverable Status:	Draft
Deliverable Style:	R
Dissemination Level:	PU
File Name:	D6.9 Final report on Nice lighthouse demonstration activities.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 774199

Authors

Surname	First Name	Beneficiary
CACCAVELLI	Dominique	CSTB
KEIM	Christian	EDF
COURAUD	Benoît	IMREDD
QUINARD	Honorat	IMREDD
DE CANSON	Sophie	ENGIE
VO	Toan	CSTB
CURTELIN	Guillaume	CAH
GINDRE	Céline	MNCA
BOUTILLIER	Jean-Baptiste	IN EXTENSO
COLON	François	VULOG

In case you want any additional information, or you want to consult with the authors of this document, please send your inquiries to: irissmartcities@gmail.com.

Reviewers

Surname	First Name	Beneficiary
COLON	François	VULOG
BOUTILLIER	Jean-Baptiste	IN EXTENSO

Version History

Version	Date	Modifications made by
1.0	31/03/2023	Final version for submission

Disclaimer

Executive Summary

The objective of this deliverable is to provide a detailed overview of the results of the Nice demonstration. This deliverable is intended for the following audiences:

- Stakeholders of the Nice ecosystem as it should provide a detailed overview of the solutions implemented by each of the partners,

- Stakeholders in the demonstration districts, as it should provide them with an overview of the solutions and how local stakeholders are involved,

- the project partners in the other flagship and follower cities,

- the general public, who are interested in the details of the demonstration.

This document will facilitate a common understanding of the demonstration activities and results. It will allow the project steering committee to assess the progress and compare it with what is stated in the IRIS Project Statement of Intent.

The beginning of the IRIS project was marked by several events that disrupted the progress of the demonstrators: the departure of the project manager within the Metropolis and of a partner, VEOLIA and the relocation of a measure outside the perimeter.

Despite these difficulties, the transition track 1 (TT1) demonstrators were successfully completed, the IMREDD and Palazzo buildings were built and were the site of experiments in the field of renewable energy and storage. The demonstrators on the Moulins towers and on the sewage network have made it possible to test innovative solutions for energy efficiency and energy savings.

For TT2, the late entry of MSE as a linked third party of the Metropolis has not prevented the progress of this measure. The geothermal network was delivered with its storage systems, the first buildings connected and the algorithms developed. Despite a connectivity problem for the second life battery, the flexibility scenarios via the EMS have been deployed on the IMREDD.

The TT3 was marked by the cessation of the auto-blue service which required a total reorganization of this part. The Metropolitan Council's car-sharing fleet was finally chosen to carry out the experiment. Despite a more limited scope and obsolete installations that had to be replaced, the demonstrator was deployed in V1G on 14 vehicles and 3 in V2G.

As part of the TT4, various data services have been developed. The 3D model of the neighborhood allows the monitoring of data related to the environment, energy, mobility and risks. The other demonstrators of this transition track are linked to measures deployed in the project.

Citizen engagement has also been taken into account, notably through the SCIC of IMREDD, where all the data will be available on dashboards, and will allow the dissemination of this information to the academic and industrial world. But also, by linking the environmental scenario and the actions carried out by Atmosud in the framework of T6.5. These services operate on data sets made available by the City Innovation Platform (CIP).

The TT5 related to civic engagement was particularly impacted by COVID 19 and the confinements. Thus, the measures initially planned in schools had to be cancelled and replaced by extracurricular activities. The air quality awareness campaign could only be carried out during the summer of 2022. Finally, the CAH portal measure had to be cancelled and replaced by a bicycle recycling demonstrator.

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

Abbreviation	Definition
EU	European Union
WP	Work Package
DHCN	District Heating and Cooling Network
EVCI	Electric Vehicle Charging Infrastructure
PV	Photovoltaic
BESS	Battery Energy storage System
EMS	Energy Management System
BEMS	Battery Energy Management System
ICT	Information and Communication Technology
IT	Information Technology
DA	Day Ahead
FCR	Frequency Control Reserves
TRL	Technological Readiness Level
DSM	Demand Side Management
EV	Electric Vehicles
V2G	Vehicle to Grid
REX	Return of Experience

1 Introduction

The IRIS project, in the Métropole Nice Côte d'Azur region, is being carried out on an experimental basis in partnership with industrials. The challenge around innovation is met with concrete productions and successful demonstrators. Focusing on the energy transition, the various solutions have updated new uses for the citizen in the fields of energy savings, energy efficiency and environmental awareness.

1.1 Scope and objectives

Objective of this deliverable is to provide a detailed overview of the preliminary results of the Nice demonstration. This deliverable is intended for the following audiences:

- Stakeholders in the Nice ecosystem as it should provide a detailed overview of the solutions that are implemented by each of the partners,
- Stakeholders in the demonstration districts as it should provide them with an overview of the solutions and on how local stakeholders are involved,
- Project partners in the other lighthouse and follower cities,
- Broader public, which is interested in the details of the demonstration.

This deliverable will facilitate the common understanding of the demonstration activities and the preliminary results. It will allow the Steering Committee of the project to assess the current status and compare with what is stated in the DoA and possibly provide feedback on the last period (M49-M66) of the IRIS project.

1.2 Lighthouse demonstration project

Nice, capital of the County of Nice and the French Riviera, is situated in a vast hilly cirque open to the Mediterranean, at the foot of the Alps, and is the natural outlet to the sea thanks to the valleys of the Var, its tributaries and the Paillon. This situation has always made it a strategic and political hub, disputed by many states.

Protected from the excesses of the climate by the Esterel to the west, the Mercantour to the north and the Ligurian Apennines to the east, the city is divided between a dense urban centre, with a historic core rich in a Baroque and Belle Epoque heritage unique in France, and gentle hills ideal for the joys of nature.

With a population of 348 556 inhabitants (in 2015) for a surface area of 7 192 hectares, it is also the central city of the Nice Côte d'Azur Metropolis. The perimeter of the latter is the result of a real desire to unite the 4 intercommunities of Nice Côte d'Azur, the Vésubie, the Tinée and the Mercantour resorts. It includes 51 municipalities and 553 305 inhabitants (in 2015), on a territory of 1,479.73 km^2.

For centuries, it has constituted a single living area. In the Alpes-Maritimes, the relationships between territories are organized according to a North-South vertical system. The valleys have few outlets to the north, they are closed by the summits and are turned towards the south and the sea. The Tinée and Vésubie valleys open out into the Var valley, which ends in Nice. It is this "vertical" space that constitutes the metropolitan living area.

The link between sea and mountains is very strong in many areas.

In summary, the Nice demonstration aims to address the following challenges:

1. Creating energy neutral neighbourhoods by developing renewable energies while optimizing their self-consumption through energy management and storage systems
2. For a high penetration of renewable electricity, it is essential to increase the flexibility of the electricity grid. Therefore, demand response management as well as the integration of storage capacity at district level are necessary solutions. This objective is also supported by the implementation of V2G charging stations within the metropolitan fleet.
3. Promote sustainable mobility, both in terms of electricity, with the optimization of vehicle recharging, but also with the provision of bicycle repair workshops or bicycles at very affordable prices for people in need or students
4. The deployment of the data platform which allows to store the data collected throughout the city and which serves as a real resource for the creation of intelligent services but also to raise awareness for all the actors of the territory
5. Improving the quality of life of the inhabitants by working on the improvement of the air quality but also by raising the awareness of the people of the social districts to energy to limit their expenses while optimising their comfort.

1.3 Structure of the deliverable

Chapters 2 to 6 of this document present in detail the demonstrators that have been developed within the Metropolis as well as the results and lessons learned from these experiments.

2 Results of Transition Track 1

2.1 Overview

Nice LH overall ambition is to drive **the Nice Eco Valley district** into a **Near Zero Energy district** that is livable, safe and socially inclusive, by integrating renewable and smart energy, electric mobility solutions, supported by meaningful information services thanks to open ICT**.** Transition Track #1 (TT#1) will contribute to this ambition by developing and integrating:

- A high share of locally produced and self-consumed solar energy in new buildings.
- Cost efficient energy saving measures adapted to the refurbishment of degraded and poorly efficient existing multifamily buildings.
- Smart information and communication technologies enabling to raise environmental awareness within the local community and among end users about the deployed energy solutions at the district level.

The technical measures that were demonstrated in the Nice LH have been classified in four different groups:

Measure 1: Collective self-consumption at building scale

Collective self-consumption at building scale is a new concept for commercial and residential customers in France while only a small number of projects have been done in Europe so far. This concept has been implemented and tested in Nice Méridia on two positive energy buildings constructed in 2019-2020 (PALAZZO MERIDIA and IMREDD buildings).

Measure 2: Optimization of heating load curve

A new smart control system has been implemented and tested in Les Moulins on two degraded high-rise buildings (132 apartments) enabling to adjust the heat supply to the individual demand in each apartment.

Measure 3: Commissioning process from the design to the operation

An innovative commissioning process has been tested to support the evaluation of the energy savings provided by the smart control system implemented in measure 2.

Measure 4: Dashboard providing real-time energy balance

The measure is based on the implementation and testing of a dashboard to raise environmental awareness of public local authority, customers or citizens about the deployed energy solutions at the district level, providing real time information and performance indicators.

The matching between technical measures and Integrated Solutions as defined in the GA is given Table 1 and illustrated in Figure 1.

Table 1 – Technical measures vs Integrated Solutions

Integrated Solutions	Measure number	Measure title
	Measure 1	Collective self-consumption at building scale (Palazzo Meridia)

IS 1.1 (Positive Energy Building)	Measure 1	Collective self-consumption at building scale (IMREDD)
IS 1.2 (Near zero energy retrofit)	Measure 2	Optimization of heating load curve
IS 1.2 (Near zero energy retrofit)	Measure 3	Commissioning process from the design to the operation
IS 1.3 (Symbiotic waste heat network)	Measure 4	Dashboard providing real-time energy balance

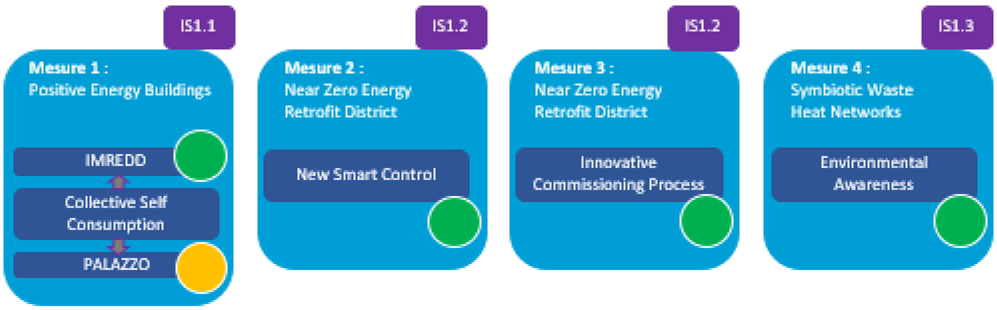


Figure 1. Schematisation of the relation and hierarchies among the chosen Use Cases and Sub Use Cases as by D6.3

The demonstration area for TT#1 is in the Nice Eco Valley district, a continuum of 3 homogeneous areas: Grand Arénas, Nice Méridia and Les Moulins (see Figure 2).

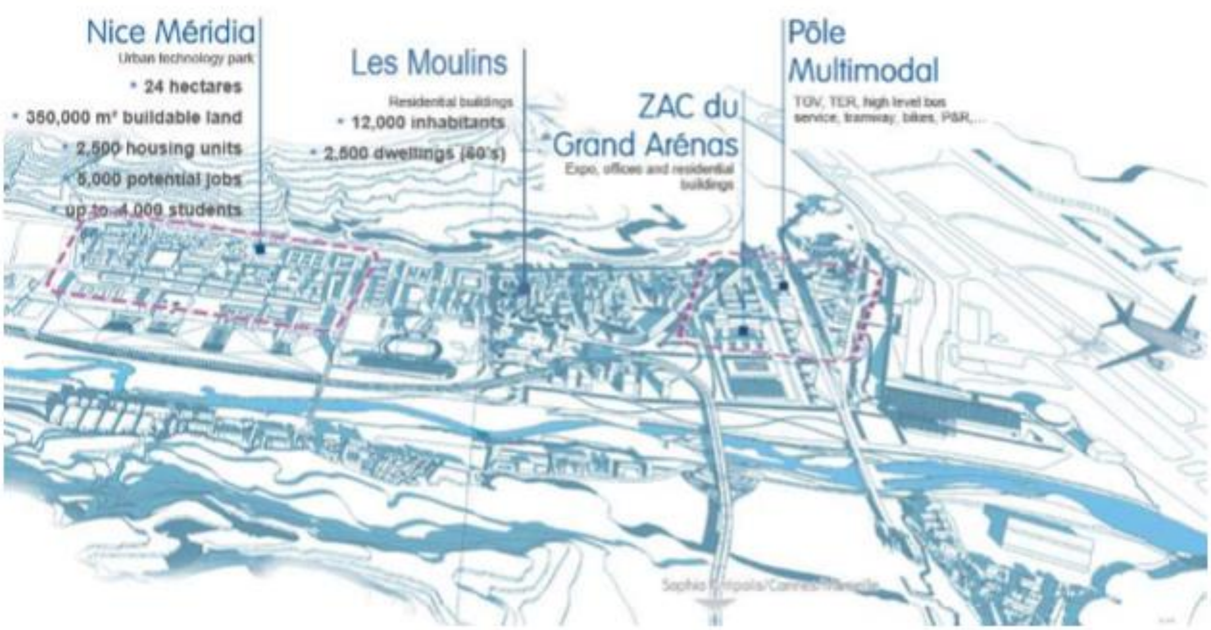


Figure 2 - Overview of the demonstration districts of Nice (source: MNCA)

__Les Moulins__

Nice Les Moulins is an income-deprived neighbourhood in the west part of Nice (2 969 social dwellings built during the 70's, around 12 000 inhabitants) with degraded mid-rise and high-rise buildings and a shared district heating.

Cote d’Azur Habitat, the social housing company in charge of Les Moulins together with the municipality of Nice and the National Agency for Urban Renewal launched an ambitious renovation program with general objectives to demonstrate the feasibility (technical, financial and social) of innovative low energy renovation processes for buildings.n*Started in 2011, the renovation program in Les Moulins is planned over 12 years, as a first step of a larger development in the Nice Eco Valley district, to be completed within 20 years (see Figure 3 and*

Figure 4*).*

Figure 3- Overview of Les Moulins area before renovation (source: MNCA)

Figure 4 - Les Moulins area after renovation *(source: MNCA)*

Grand Arénas

The new international business district of the Nice Côte d'Azur metropole will be that of the "Grand Arénas". The Grand Arénas represents a highly strategic sector, at the gateway to the city of Nice and in the immediate vicinity of Nice Côte d'Azur international airport. Its articulation with the international airport and the future multimodal exchange hub of Nice-Airport gives it exceptional accessibility and rapid connections with the whole of the Eco-Valley and the metropolitan area. To the existing tertiary site of 10 hectares, a complementary area of 49 hectares will be added, corresponding to potentially 700 000 m² of new floors-pace (see Figure 5).

Within the Eco-Valley, the goal of the Grand Arénas is to create a lively, innovative and eco-friendly neighbourhood, as the two driving principles of the new international business centres are urban diversity and eco-exemplarity. In addition to the offices and other facilities, a diversified housing offer is ensured (social mix), accompanied by services, shops, hotels or public facilities. The first development phase will be realized by 2021, achieving up to 140.000 m² of new mixed developments.

Figure 5 - Plan of the Nice Grand Arenas project (source: EPA plaine du Var)

Nice Méridia

High priority operation of the eco-valley, the technological pole of Nice Méridia will have a first development area of 24 ha or 537 000 m^2 of new mixed-use floor-area, with the objective to achieve 200 ha in the long term (see Figure 6).

Its location and its mixed used program will make it an outstanding eco-district, aiming at providing high quality living and working conditions. Its vocation is to be a catalyser of innovation, thanks to its dedicated R&D and educational spaces with a vocation to attract businesses and institutions dedicated to technology and services from the sustainability and health care branches. This target should be achieved by first attracting public and private R&D and innovative organizations which should self-reinforce themselves by speeding up the developments of incubators, start-ups, co-working spaces and business centres among other. Aiming at functioning as an «eco campus», the development program wants to enable short circuits between knowledge and innovation. With such aim, the IMREDD (a branch of UNS, IRIS partner) and the PALAZZO MERIDIA (owned by NEXITY, IRIS partner) buildings have been opened on site, promoting innovation and the creation of businesses related to the sustainable development and "green tech" (see Figure 7). The leitmotif of the land use and transport organization is "accessibility": this should enable to provide an integration of offices, shopping and housing areas among the districts, as well as access to services connected to the sport centre situated in the same perimeter.

Figure 6 - Land use plan of the Nice Méridia project - (D&A - Devillers et Associés)

Figure 7 : Overview of the demonstration districts of Nice Meridia (source: UNS/IMREDD - modifications by EDF)

2.2 Implementations

2.2.1 Measure 1: Collective self-consumption

Collective self-consumption at building scale is a new concept for commercial and residential customers in France while only a small number of projects have been done in Europe so far. This concept has been tested in Nice Meridia on two positive energy buildings constructed in 2019-2020. Table 1 lists the main features of the two positive energy buildings that host the use case.

Table 1. Main features of the two buildings supporting the demonstration

Building name	PALAZZO MERIDIA	IMREDD
Picture (project)		

Picture (construction stage)		
Building category	Office building	Educational building
Building owner	NEXITY (private)	Nice university (public)
End of construction	December 2019	January 2020
Total floor area (m²)	7860	4970
Total height (m)	34.75	15.66
Energy target	Positive energy building	Positive energy building
Energy system	District heating &cooling system	District heating &cooling system
PV surface (m²)	412 m² on roof top	858 m² on roof top
PV production characteristics	89 kW	180 kWc, 518 modules
Type of storage system	Electric battery	Electric battery (first and second life batteries) + V2G
Storage characteristics	66kW/90kWh	100kW/182kWh + 36kWh/10kW

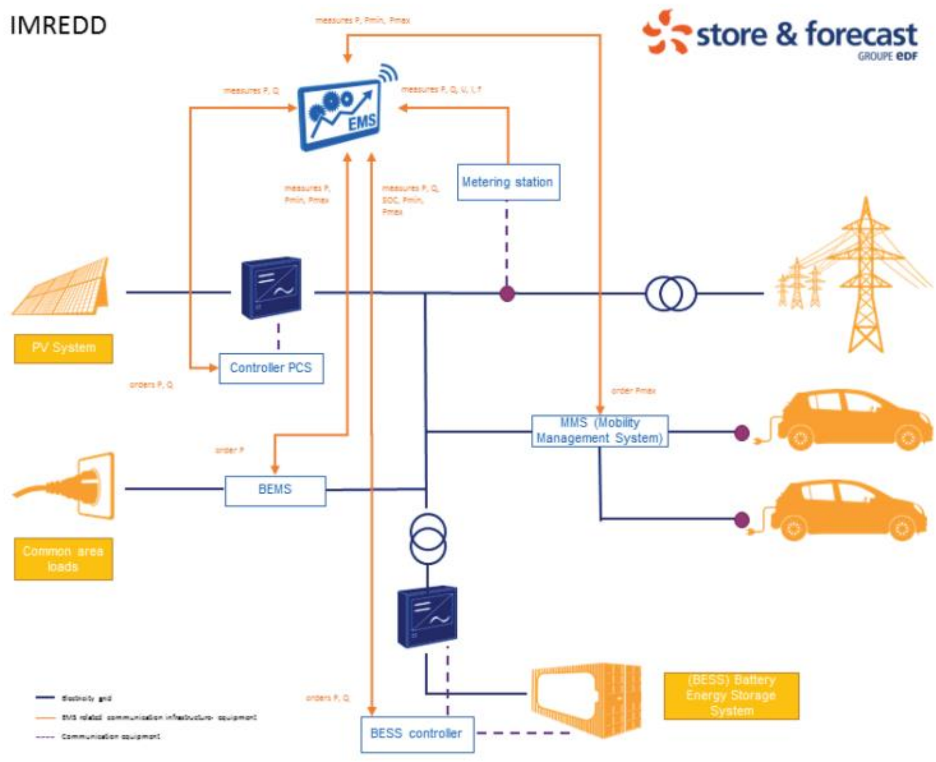
IMREDD

The IMREDD demonstrator for the measure 1 in TT#1, is fully operational since 2021. Indeed, the photovoltaic system and the lithium-ion battery pack have been installed during Q3 and Q4 2020. First tests involving the energy management system operated by EDF S&F, occurred during Q1 2021. IMREDD and EDF S&F have been working on the implementation of 2 main scenarios to control the flexible assets (batteries and V2G):

- Maximization of self consumption
- Procurement of grid support (Frequency Control).

Instead of being injected on the electrical network, the electricity produced by the photovoltaic pannels is consumed localy.

The simplified architecture of IMREDD building is proposed in Figure 8. The building is represented by the common area loads, on the left side of the figure, and by Electric Vehicles on the right side, that can charge on one of the 18th charging points located in the building. The building's loads are supplied by the solar PV system, but also by a battery and by the network. The control of the battery power is done by the Battery Energy Management System (BEMS) and the Battery Energy Storage System (BESS) based on the recommendations from the Energy Management System (EMS) provided by EDF SF.



© EDF Store & Forecast 2018

Figure 8 Imredd simplified architecture (source: EDF S&F)

In the case of self-consumption, the control decisions by the EMS to charge or discharge the battery are taken based on the local forecasted and current consumption and production but could also include the electricity price evolution. Therefore, in order to take the best decision, the EMS requires a knowledge of all the electrical quantities and power flows in real-time. This requires a strong IT infrastructure to connect all the devices together. Figure 9 shows the details of such an architecture, where the EMS is at the centre of the infrastructure, whereas IRIS' equipment's (solar PV, battery and other storage assets) are located at the bottom of the figure. As the EMS requires some services on the cloud, the above section of the graph displays all required cloud connections.

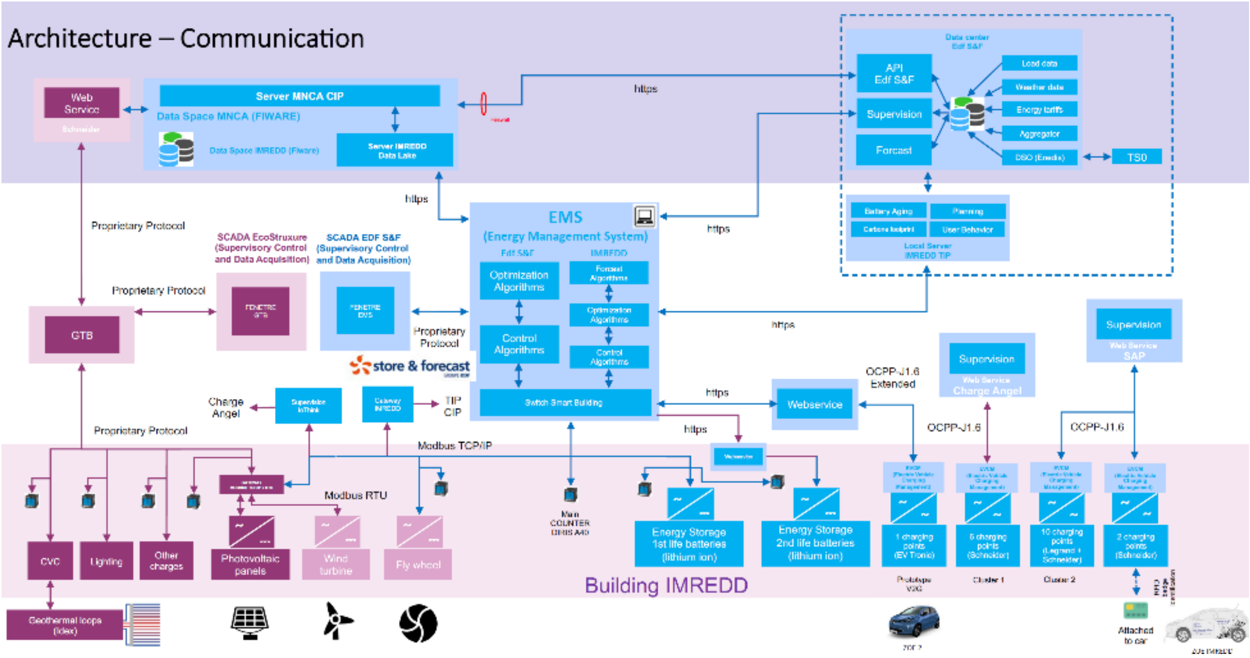


Figure 9. Detailed Infrastructure of IMREDD's building

To ensure self-consumption, IMREDD's building hosts a solar PV of 858m² that aggregates to 180kW of power production. Figure 10 displays a picture of the current installation.

Figure 10 : Photovoltaic system on IMREDD's rooftop.

The solar production can be fully consumed by the building in real time. However, the building consumption pattern corresponds to a standard tertiary building load curve, i.e. an increase of consumption starting around 8 AM, with a small reduction of power consumed around 12, an increase in early afternoon, and finally a reduction after 6PM every working day. This can be seen in Figure 11 that shows a whole week of consumption in blue, and the solar PV production.

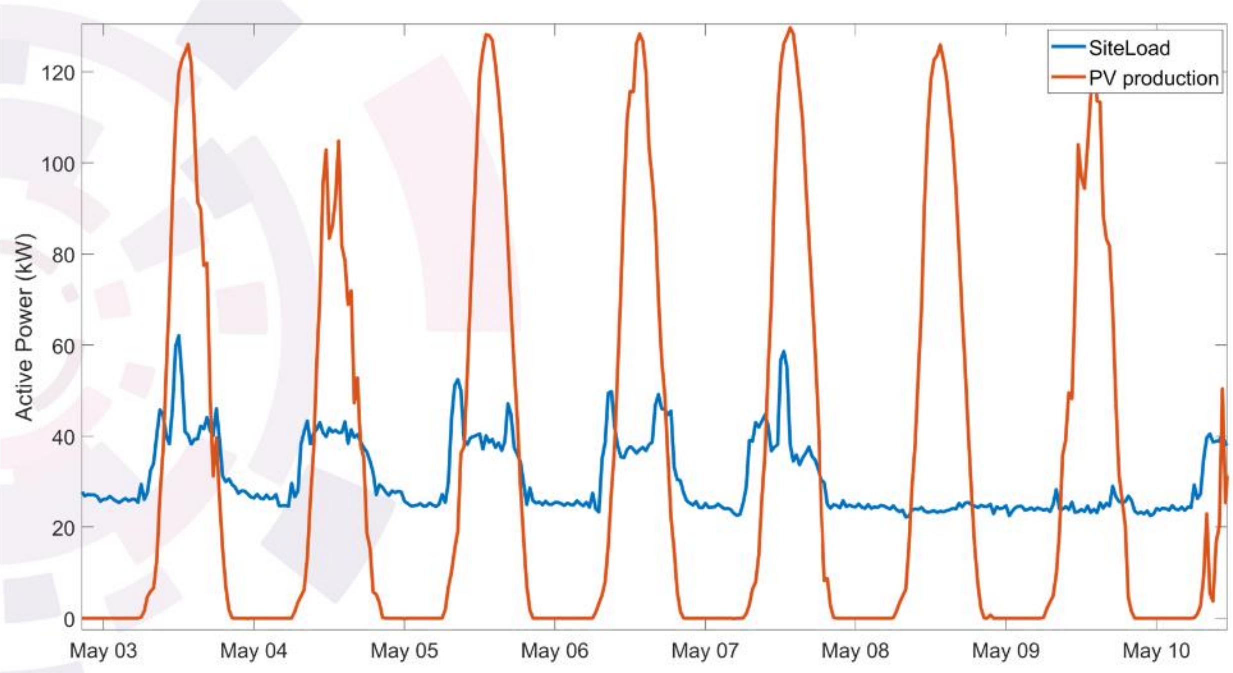


Figure 11. Imredd Building Load Curve and PV production

As one can see, solar PV assets were oversized in order to cover all the potential needs (Electric Vehicles (EV), high consumption equipment of the workshop) that may happen in the future. As, some consumption will still happen outside the times of PV production, storage assets such as lithium ion batteries were installed in the building. This contributes to the increase of the share of self consumed electricity in the building. Then, to increase the self-consumption rate, it is required to optimise the quantities of energy sent to the battery. For example, it might be optimal to not discharge the battery during the night to keep energy to supply the building in the morning.

The optimisation algorithm embedded in the EMS that controls the power that is sent to or drown from battery and the inverters are related to **TT#2 Measure 1 - Stationary storage deployment in buildings and local electric flexibility management.**

Figure 12. Lithium-ion battery system at IMREDD

As it is shown in Figure 9, many equipment have been installed to ensure good operation of the sel-consumption experiments. Figure 12 shows the battery storage enclosure and the inverters whereas Figure 13 displays the 6 inverters that convert the PV DC current into AC to supply the building, the network, or to feed the battery through the bidirectional inverters.

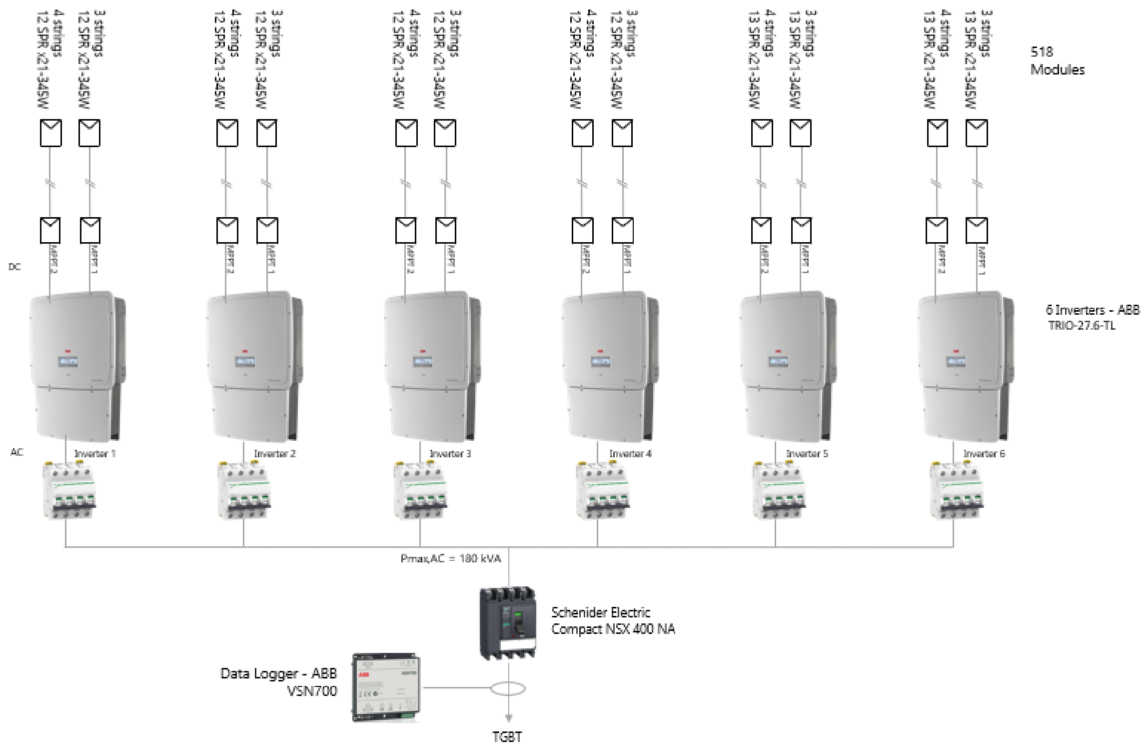


Figure 13. Architecture of the Photovoltaic system at IMREDD

For daily operations, all devices data need to be fed to the EMS. This requires to connect each equipment with a specific network dedicated to the energy operations, and to configure the data transfer to the EMS or to a storage facility (local or cloud based). An example to retrieve PV, bi-directionnal load monitoring and battery data is shown in Figure 14 using TCP modbus, all data from the PV data logger, the meter and the battery are sent to the EMS. The EMS then sends the data to EDF SF cloud. However, this data is not formatted in a standard way, and is not accessible to everyone. Therefore, within IRIS project, we retrieve this data through EDF SF API, convert the data into a Fiware NGSI v2 data format, and store it in the NICE City Innovation Platform in order to disseminate information of the IMREDD building and allow the calculation of KPIs in all TTs.

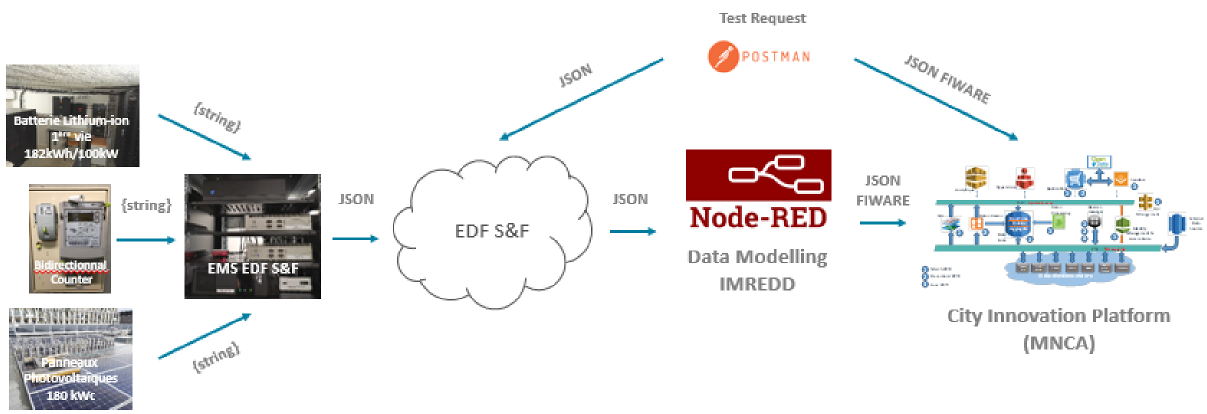


Figure 14. Data Acquisition and Data modelling concept

Table 2. Main variables for performance indicators computation

Variable name	Value (2022)
Delivered electrical energy from energy carrier (MWh)	**142.8**
Exported electrical energy to energy carrier (MWh)	**61.4**
CO2 coefficient from delivered electrical energy carrier (t CO2/MWh)	**0.057**
CO2 coefficient for exported electrical energy carrier (t CO2/MWh)	**0.04**
Building Area (m²)	**4970**
Electric energy consumption Reference (kWh/year)	**250 000**
Electric energy production by RES Baseline (kWh/year)	**180 000**
Storage capacity installed (kWh)	**182**

Storage capacity installed baseline (kWh)	**182**
investments for energy/CO2 related measures annualized (€)	**18 966**
annual costs related to energy/CO2 measures (€)	**30 000**
Thermal energy consumption (kWh/year)	**127 200**
Thermal energy consumption Reference (kWh/year)	**81 800**

PALAZZO MERIDIA

All the equipment needed for the experimentation in TT#1 have been installed and commissioned in 2020 and 2021 (Figure 15 and Figure 16). Data from the demonstrator are collected and transmitted to the Nice CIP following the process.

Figure 15 : Photovoltaic system in the PALAZZO building

Both the building management system and the energy management system are functional.

Figure 16 : Battery storage system and the EMS in the PALAZZO building

The battery is indeed used to optimise self-consumption of the common area of the building, which is then spread among the different co-owners of the building depending on their share of the building.

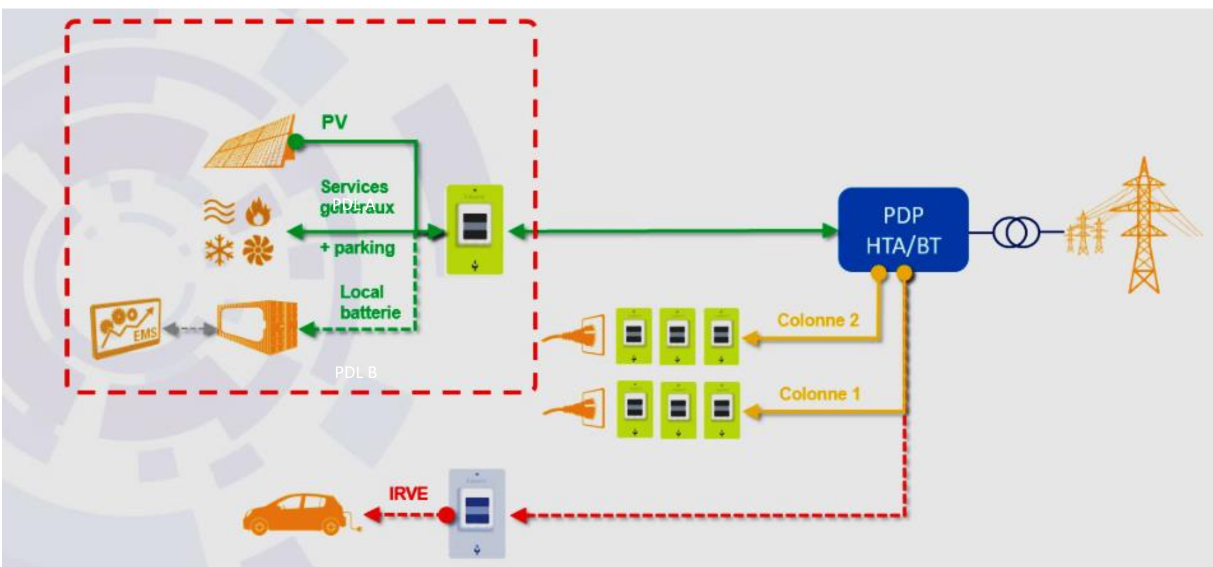


Figure 17 : Self-consumption concept in common area (Source: EDF)

Therefore, energy produced by photovoltaic panels is consumed either to charge the battery, or to meet the common area needs or injected on the distribution network. Unfortunately, due to legal and technical issues, the integration of EVSE was not possible in the self-consumption experiment as it required the installation of specific smart meters with specific electricity retail contracts.

2.2.2 Measure 2: Optimization of heating load curve

Context and goal

Renovation of existing buildings is generally limited to the refurbishment of the means of production or insulation of buildings. Heating control remains centralized according to a single heating law for the entire building, which depends only on an outside temperature and on an internal room measurement. Some houses are overheated while others are underheated, leading to an overconsumption of energy (overheating, opened-windows, …) and discomfort.

As part of the renovation of existing buildings, the aim of the project was to integrate an intelligent regulation within the district heating distribution, giving the possibility to adjust heating to the individual needs of each apartment according to their sun and wind exposures but also taking into account accurate temperature.

THE HEATING LAW: ADJUSTING A MODEL OF MODERN ENERGY DISTRIBUTION TO THE RENOVATION OF OLD HOUSING THAT IS TECHNICALLY AND ECONOMICALLY ACHIEVABLE

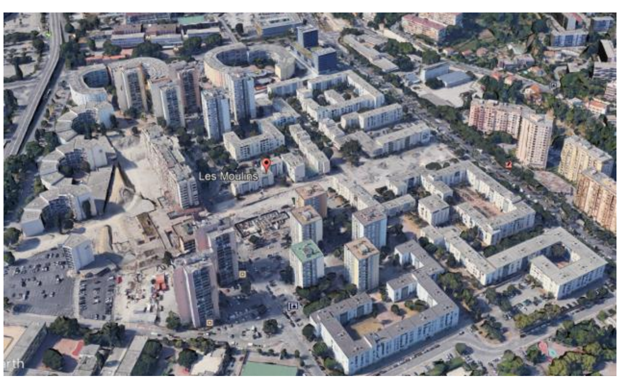
Description of the initial project

Measure 2 is divided into 3 solutions to adjust the different regulatory models and evaluate the profitability of the different investment stage.

- Solution 1: Separation within the sub-station of production from north and south distribution - analysis of the profits and establishment of reference consumptions data for the performance analysis of solution 2
- Solution 2: addition of regulators to solution 1, valves and thermal sensors per housing. Adjusting the distribution to individual needs, taking into account the actual temperature of each dwelling.
- Solution 3: technical and economical optimization of solution 2 - definition of the best performing individual control grid (housing / floor) according to technical and economic considerations.

The selected experimental area is located in the social housing area of Nice Saint Augustin in two neighboring buildings named 13 & 14. These buildings are equipped with underfloor heating (high inertia system) which will permit to test meteorological regulation within an optimal context.

In addition, different control algorithms will be tested simultaneously on the seventeen floors of each building in order to weigh the impact of each variable, and to test different sensor technologies.



Towers 13 and 14

- Date of construction: 1968
- Living area: 5342 + 5342 = 10,684 m2
- 17 stage-towers
- Total of 132 apartments (66 per tower)
- Collective heating connected to the “Moulins" heating network (one substation

Planning

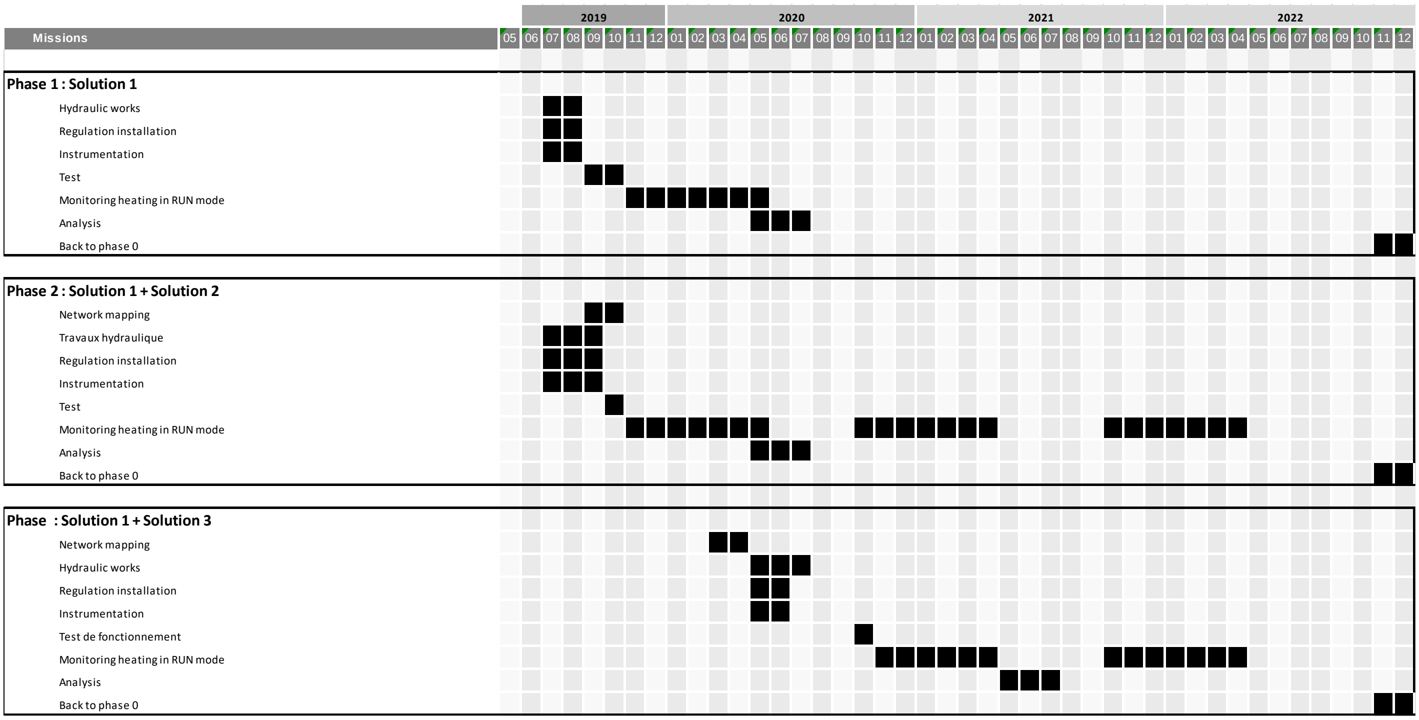


Figure 18 : Planning of implementation of the three solutions

Description of work

Solution 1

The work consists in applying an advanced regulation North/South on the two existing networks, considering the wind and solar exposures as well as the representative ambient temperature within the flats (temperature is being taken by sample).

Period and duration of works:

The solution 1 has been installed in tower 14 during summer 2019. Hydraulic works had to be realized out of heating season due to the obligation to drain the network in the substation.

Materials required:

- two variable flow pumps in the substation (one for each column outlet – north/south)
- an electronic regulator in the substation
- a LORA platform (gateway)
- Installation of sensors
    - Temperature on each heating departure and return (4 sensors) in the substation
    - 2 sunshine exposure sensors (North and South) on the façade : only on 1 building (bat 13)
    - 1 wind sensor on the roof (1 for the 2 buildings – put on building 13)

- 4 ambient temperature sensors in representative flats (north/south exposure, low/high level)

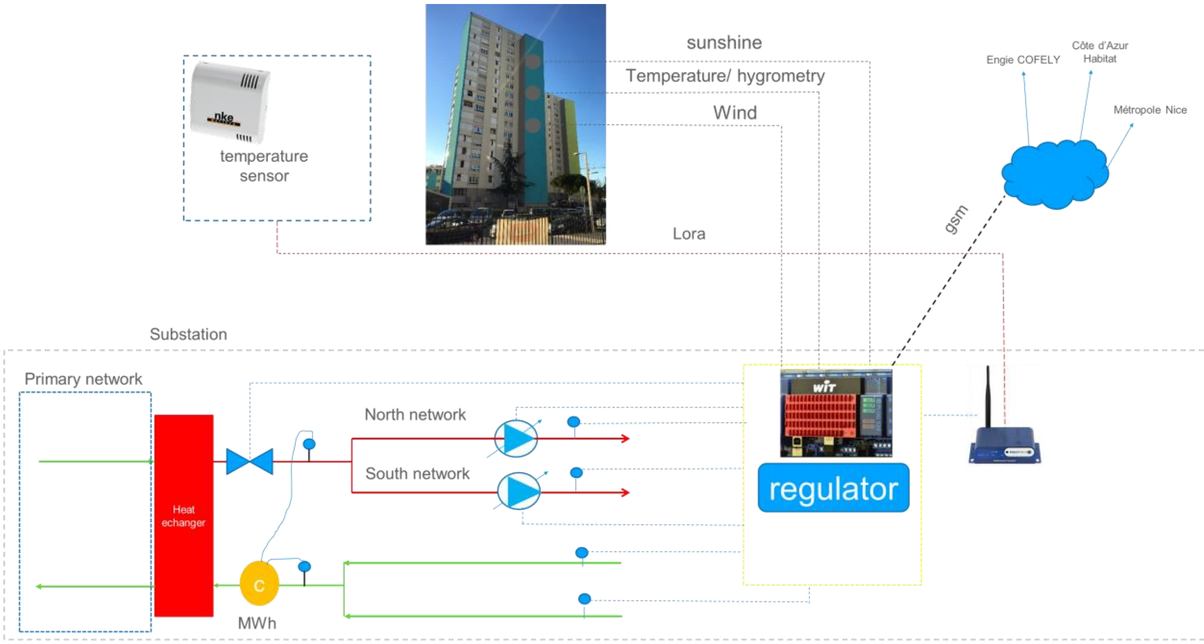


Figure 19 : Descriptive diagram of the operation of the solutions

The initial substation was not equipped with any regulation on the secondary network: heating brought by the primary network was adjusted thanks to a 3-way valve with an opening adjusted by the primary return temperature. The secondary network was equipped with two-constant flow pump, one for each north/south departure

Hydraulic works consisted in:

- Changing the existing 2 double pumps for 2 new variable speed ones with modification of the hydraulic circuit
- Adding the 4 thermal sensors required on the departure/return for the 2 networks

Insulation has been readjusted following the installation of new equipments.

Figure 21 : Existing pumps

Figure 20 : New pumps

A by-pass has been added on the top of the network to ensure a minimal flow on the network

Electrical works consisted in:

- Connection of pumps with change of fuses to adjust to new powers
- Installation of the regulator
- Connection of the 4 thermal sensors
- Connection between the regulator and equipments : pumps, departure and return temperature sensors, MWh counter

Regulation works consisted in:

- Installation of ambient temperature sensors in the flats: they have been installed in the living room at 1,5m high
- Installation of 1 wind sensor on the roof of the building 13 (wired-communication with the automaton)
- Installation of 2 sun-exposure sensors (North/South) on the façade of building 13 (wired-communication with the automaton)
  They have been installed in a place with a direct access by the roof, so as to facilitate the installation and eventually future troubleshooting without intervention within the flat
- Installation of the automaton in the substation (basement), near the substation electrical box
- Integration of the equipments for supervision :
  - information of the pump operating condition
  - information of pump default
  - departure and return temperature
  - Mbus connection to Mwh counter
  - primary network temperature

The commissioning has required the intervention of the pump manufacturer (Grundfos) simultaneously with WIT (the regulator manufacturer) so as to test and adjust each communication.

Solution 2

The work consists in applying an advanced regulation per flat, considering the wind and solar exposure as well as the ambient temperature in each flat. This solution requires the installation of solution 1

Period and duration of works:

The solution 2 has been installed in tower 13 during summer 2019 at the same time as solution 1. Hydraulic works had to be realized out of heating season due to the obligation to drain the network in all the building.

Materials required:

In addition to required materials for solution 1, following equipments had to be installed:

- one two-way valve on each departure network in technical closets (power supply 230V)
- 1 temperature IOT in each flat
- wired extension (power supply 230V) to the substation regulator from the electrical closet of each stage

Figure 22 : Wired extension

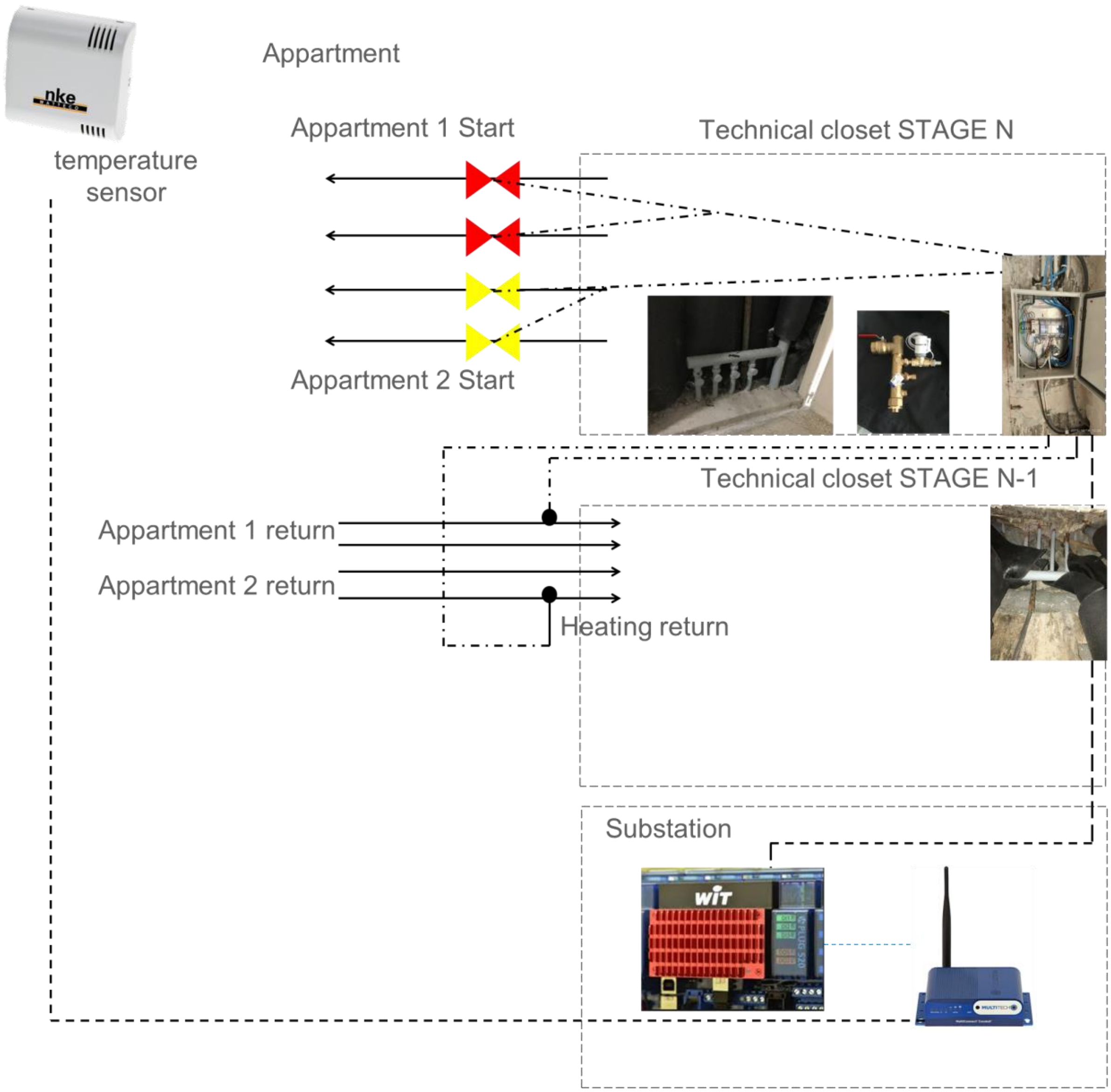


Figure 23 : Operation diagram of solution 2

Works: Return on experience (particular difficulties, advice, precaution)

H**ydraulic works** were conducted in each technical closet (2 closets per floor). We identified 2 heating networks per flat, requiring a double regulation per flat. Works consisted in:

- installing on each return (4 return in each technical closet) a hydraulic kit including a motorized 2-way valve with an upstream shut-off valve and a trap. Valves are installed upstream and downstream along the kits permitting an easy maintenance. The motorized valves are normally opened, permitting to heat by default, even in the case of a deficient ambient sensor or electrical default. The kit was installed just after the existing balancing valve so as to keep the balancing.
- Set-up of a downstream shut-off valve
- Set-up of a thermal captor on each return

Figure 24 : Hydraulic kit

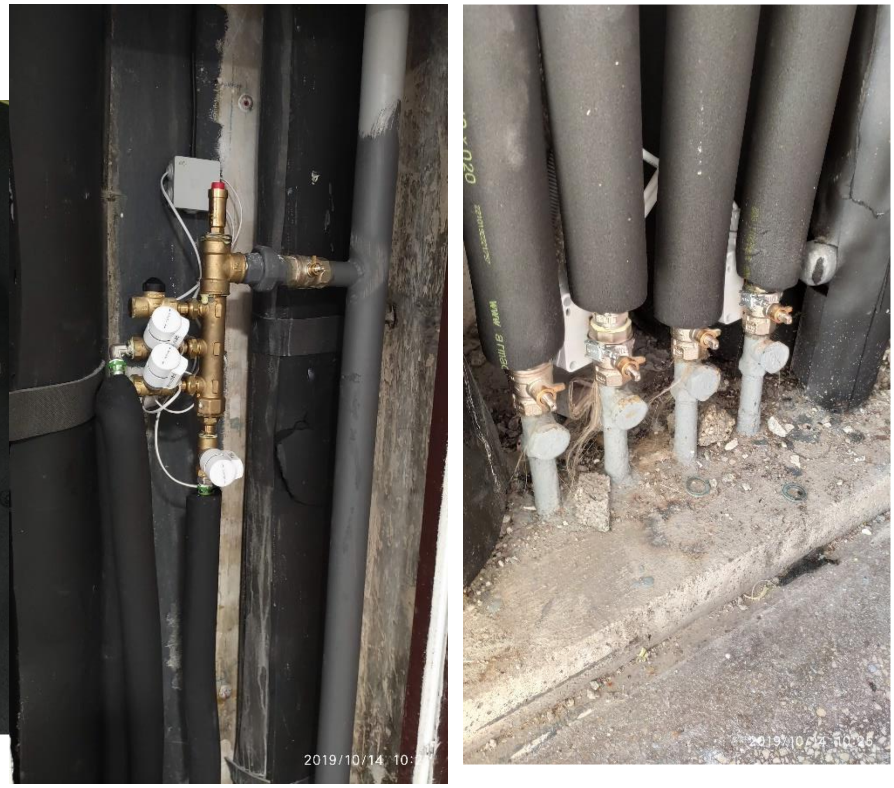


Figure 25: Heating departure

Insulation has been readjusted in each technical closet at the end.

Electrical works consist in:

- Installation of a regulator extension (1 per floor) – Bus communication with the automaton
- Connection of all the 2 way-valves to the regulator extension. The 2 way-valves of each flat are connected in series
- Connection of the temperature sensor on the heating network to the regulator extension

R**egulation works** consist in the:

- Installation of 1 ambient temperature sensors (IOT) in each flat : those have been installed in the living room at 1,5m high. Each IOT communicates with the underground automaton via Lora.
- Identification and assignment of each ambient sensor/ temperature heating network to the corresponding 2-way valves in the extension. The signal transmitted each hour to the automaton by the ambient temperature sensor permits to adjust simultaneously the 2 motorized valves of each flat.
- Study has been realized by a design office to take into account in the regulator, the shading of one building on the other one (ie annex)

Solution 3

The work consists in applying an advanced regulation per flat in the same configuration than Solution 2, but individual flat equipments are reduced per 2 to optimize the return on investment. Solution 3 is an intermediate solution between low costs investments of solution 1 with a minor efficiency performance and solution 2 with high investment level and a high-performance efficiency estimated.

Initial purpose was to install regulation with a scheme of one floor on two. The final decision has been taken to equip each flat on south exposure and to conserve solution 1 on the North face.

This choice has been taken for 2 reasons:

- South face can benefit more of regulation thanks to highest sun exposure during the day.
- The pumps for solution 1 are regulated via the return network temperature, while they are regulated on the network pressure for solution 2. Thus technically, mixing the 2 solutions in a same network is complicated.

Period and duration of works:

The solution 3 has been installed in tower 14 during summer 2020. Hydraulic works had to be realized out of heating season due to the obligation to drain the network in all the building.

Materials required:

The scheme is the same as solution 2 in terms of equipment installed. Only the quantities of 2-way valves and flat sensors are reduced.

- Installation of 1 ambient temperature sensors (IOT) in each flat: those have been installed in the living room at 1,5m high.
- Identification and assignment of each ambient sensor/ temperature network to the corresponding 2-way valve in the extension

2.2.3 Measure 3: Commissioning process from the design to the operation

Measure 3 is based on the REPERE service, a dedicated commissioning process elaborated to check from the design to the operation that energy efficient measures have been correctly implemented in refurbished apartment buildings. This service is based on monitoring and measurement data acquisition. Measurements are performed both before and after refurbishment operation.

During the IRIS project, the REPERE service has been applied on both building towers T13 and T14 to support the evaluation of the energy savings provided in measure 2.

136 sensors, measuring the behaviour of the T13 and T14 towers, were installed. They are classified into 10 categories measuring:

- Indoor Air Temperature,
- Outdoor Air Temperature,
- Water Temperature,
- Water Temperature Difference,
- Water Volume Flow,
- Water Volume Index,
- Energy Index,
- Power,
- Solar radiation,
- Outdoor wind speed.

Figure 26 shows the distribution of sensors. Nearly 75% of the installed sensors (101/136) measure indoor air temperature, followed by water temperature (12% or 16 sensors), energy index (5% or 6 sensors) and others.

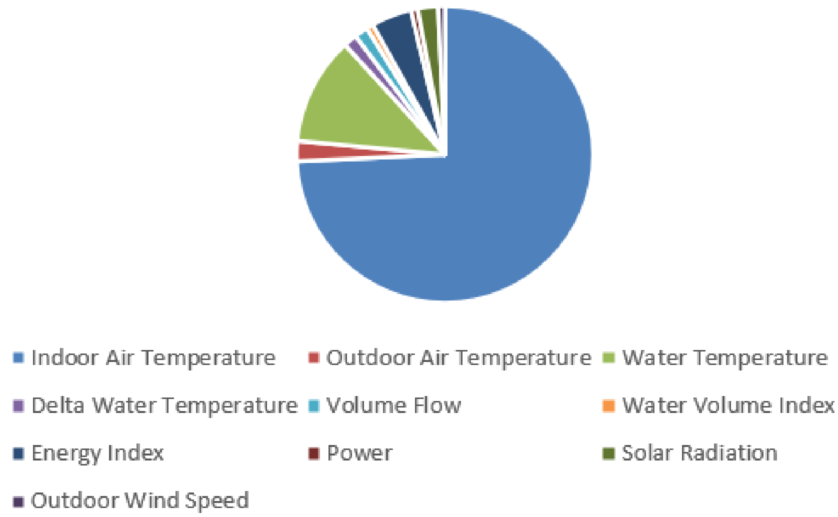


Figure 26 : Distribution of installed sensors

An example of the installation of temperature sensors is showed in *Figure 27*. The indoor air temperature sensor is installed behind the living room's door, at the height of 1,2 – 1,5m.

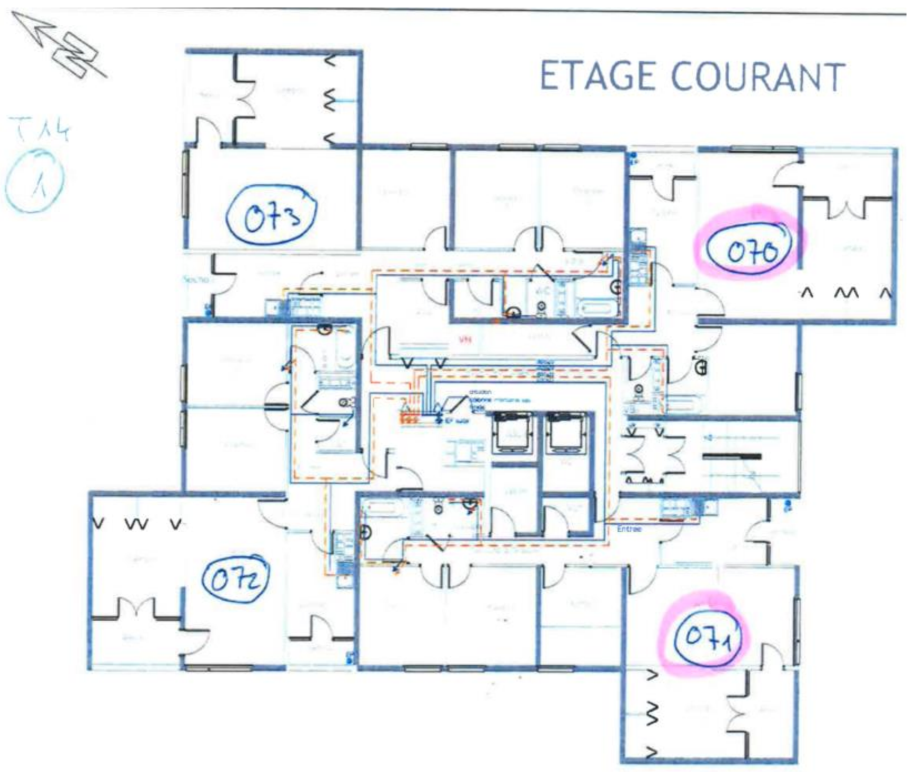


Figure 27 : Building plan of installed air temperature sensors

Installing sensors at both sites has been a real challenge due to pandemic-related restrictions. However, the entire configuration was finalized in November 2020. The REPERE service a monitoring script analysing the quality of the measured data and providing alert reports when the sensor measurement is not working properly - was launched at the beginning of the monitoring campaign. An example is shown in *Figure 28*.

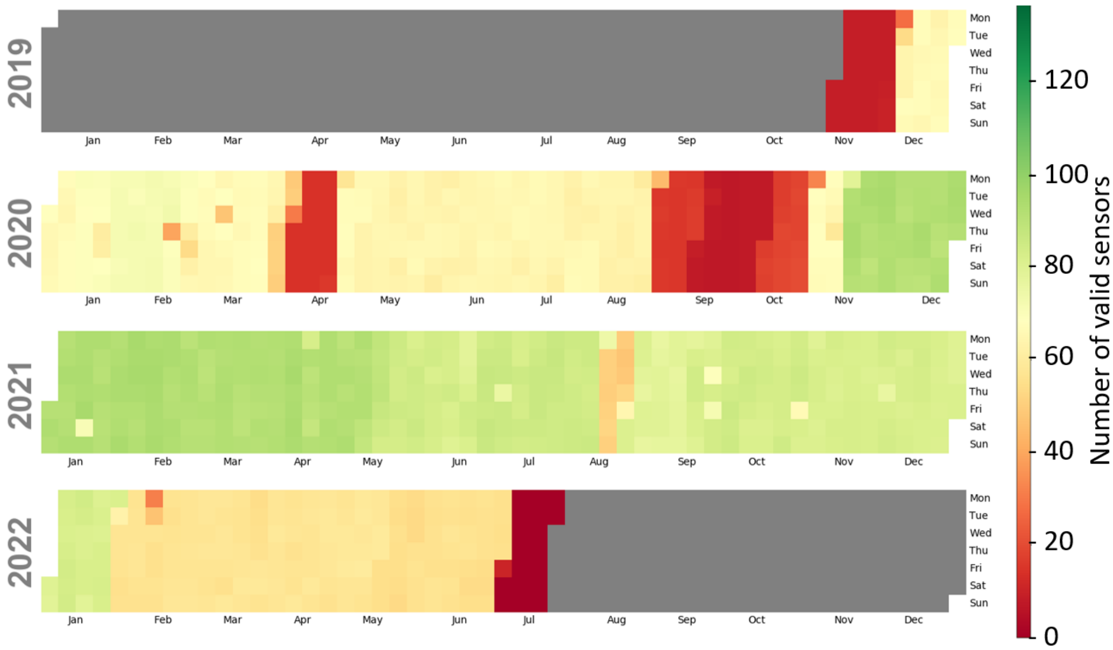


Figure 28 : REPERE - Global monitoring graph of sensor quality on the two sites

The above figure shows the number of valid sensors for 3 years measurement, with a colour indicator which turns from red (bad situation) to green (normal situation). Although officially launched in November 2019, the monitoring campaign only started in November 2020 when all the sensors were fully installed. After winter 2022, monitoring is complete. There is no more data transferred, which is represented by a red colour at the end of the measurement.

The REPERE service has been set up in a dedicated server where routines are installed to update the measurement data. It contains 4 steps as follows.

- Raw data collection: The raw data is collected from the ENGIE platform (https://www.engie-direct.com/Pages/fr-FR/index.html)
- Raw data verification: In these routine scripts, it is checked that sensors are transmitting well and meet their specification in terms of frequency of acquisition. Sensor derivative and value range are also checked to detect any anomaly.
- Data hole detection: The algorithms are developed to find out the lack of raw data during the measurement, from the installation until now. If the holes lack one measure, we use the algorithm as linear interpolation to fulfil the data. If the holes lack more than one measure, we cannot use the linear interpolation to fulfil the data and detect the anomaly.
- Sensor problem detection: After analysing raw data of each sensor, the sensor problem is diagnosed, for example, the sensor is working well, the sensor loses the recent data, the sensor does not work anymore, the sensor does not work from the installation, etc. Then, the data quality indicator is calculated. It is the ratio between the number of exploitable data and the number of all collected data, during the measurement.

The verification of sensors in the REPERE service is carried out monthly. Problems arising from sensor measurement, sensor drift, anomaly value range, etc., can be detected quickly and resolved so that monitoring takes place properly. If not possible, recommendations are done to overcome the problem.

2.2.4 Measure 4: Symbiotic waste heat networks

The implementation of the Dashboard has been kept within the ReUseHeat project and no costs have been declared for the action under the IRIS.

The action was targeting at replicating under IRIS, the Dashboard currently running on La Seyne sur Mer (LSSM) DHCN, on the Grand Arenas project. Nevertheless, following the latest official information on the project progress from MNCA and DALKIA (DHCN project owner), the DHCN despite being under construction, won't be commissioned before end 2023. This forces to keep the demonstration site in LSSM. The whole demonstration process has been achieved, user feed-back confirmed the acceptance and interest in the developed product and currently discussions are underway with DALKIA, in order to define and implement a common replication plan.

Extensive and periodic reporting have been done under ReUseHeat, and to avoid repetition, a summary is presented in the followings.

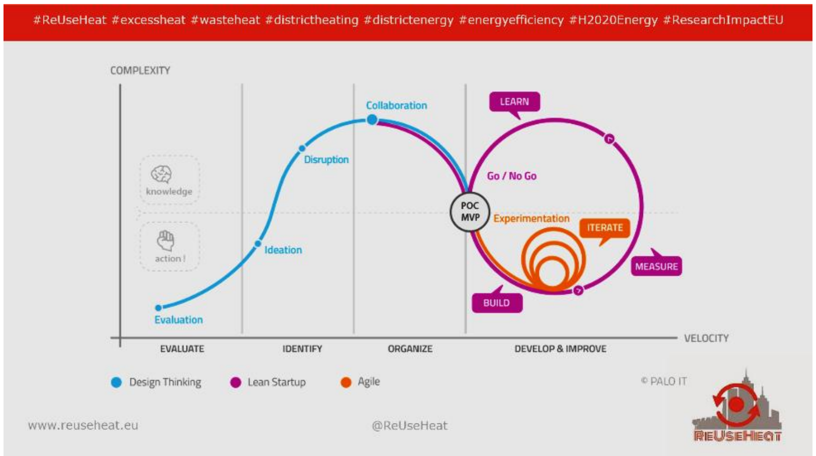


Figure 29 : Schematisation of the followed approach for the Dashboard ideation under ReUseHeat. (Source: EDF)

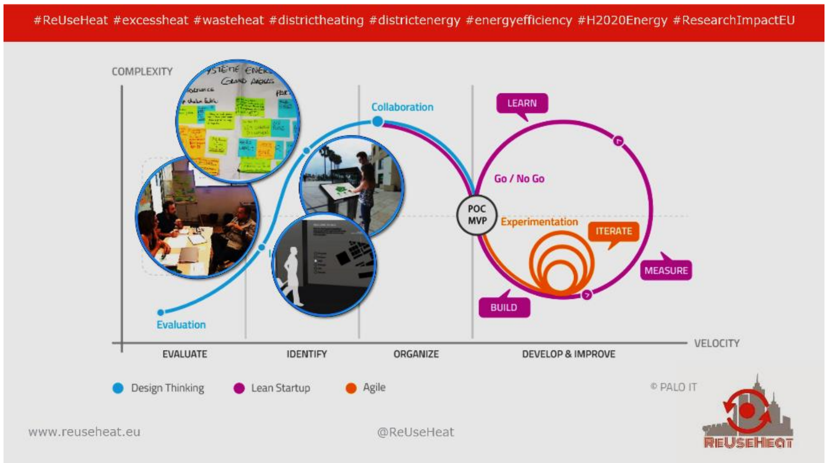


Figure 30 : schematisation of the achievements of the implemented Design Thinking approach. (Source: EDF)

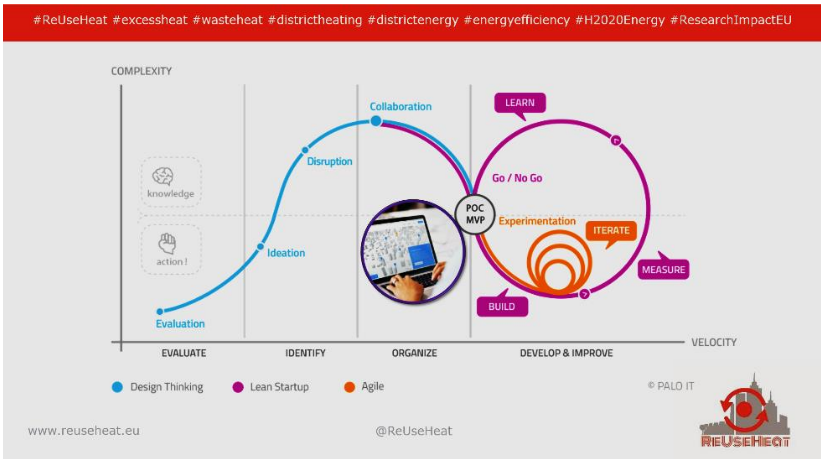


Figure 31 : Milestone of M30: MVP has been implemented and operational. (Source: EDF)

The first main milestone for the Dashboard implementation, has been the achievement of a fully functional Dashboard as MVP (Minimal Viable Product) resulting from the Design Thinking approach developed together with the R&D department of EDF, in M30. This has been firstly developed for Grand Arenas and subsequently adapted to the LSSM site.

Thanks to internal communication, interest has been awakened on the Dashboard and the management of the regional direction of EDF has agreed to dedicate resources from the "MedInLab" structure (dedicated structure in the regional trade direction of EDF, dedicated to the acceleration of innovation), to implement an Agile methodology to push the developments of the Dashboard. Rich user feedback has been achieved thanks to this work, which lead to a complete overhaul of the Dashboard design and content.

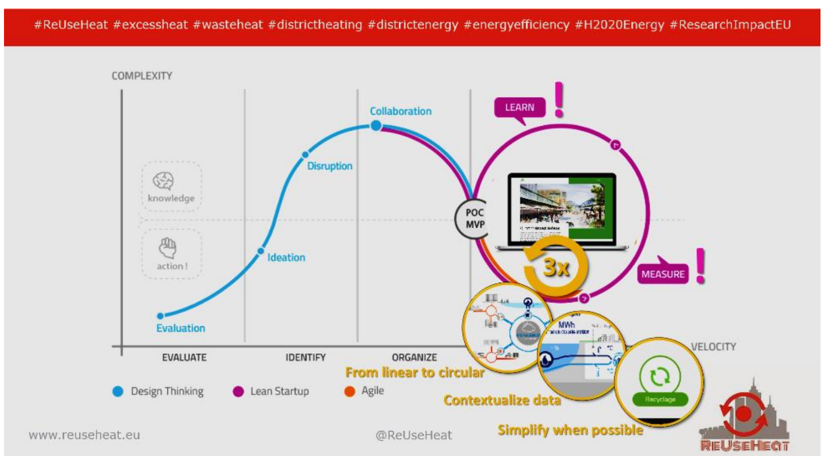


Figure 32 : Schematisation of the Agile methodology implemented thanks to the support of the MedInLab structure of EDF – three user feedback iteration have been possible – main learnings are schematised. Measure and learning phases are also closed, being able to qualify the demonstrator. (Source: EDF)

Since April 2021, the Dashboard is completed under the chosen stabilized form and publicly accessible under: https://reuseheat.dcrmed.fr/. Yet, data quality and consistency matters with the DHCN operator had to be dealt with: the DHCN of La Seyne sur Mer, has undergone extension and refurbishment works, which lead to continuous interventions on the local SCADA system, causing continuous changes in the data structure (i.e. naming, indexing and errors. Thanks to a new API instantiation, dataflows have been stabilized. Furthermore, the Dashboard has been developed in an additional English version to be able to address also the wider international community.

For achieving the final measure and validation phases, a dual approach has been implemented: first, for retrieving quantitative information to collect the needed KPIs to assess the acceptance of users of the developed product, an on-line questionnaire has been done in both English and French (with the collaboration of CARTIFF and IVL); second, for having more qualitative and in-depth answers, an interview guide has been developed together with the sociologist from EDF's R&D department.

The overall finding of the project have been condensed in a Handbook made publicly accessible under : https://smart-cities-marketplace.ec.europa.eu/news-and-events/news/2022/reuseheat-handbook

2.3 Key results

2.3.1 Measure 1: Collective self-consumption

The implementation of self-consumption in each building led to different results on how self-consumption can be increased at a larger scale. These results are described below for each building.

IMREDD

As explained, in the self-consumption scenario, IMREDD building's battery controlled by EDF SF aims to optimise the use of batteries to maximise the self-production rate. As a result, Figure 11 shows that the battery is charged when the solar PV production is greater than the building consumption, whereas it is discharging back to the building once there is not enough sun to supply the building. This allows for a reduction of power reinjection on the local grid, and a reduction of power supply from the grid. Indeed, the blue PoC curve, that represents the power seen by the electrical grid at the Point of Connection (PoC) is flat and close to zeros when t the battery can compensate an over or under production from PV.

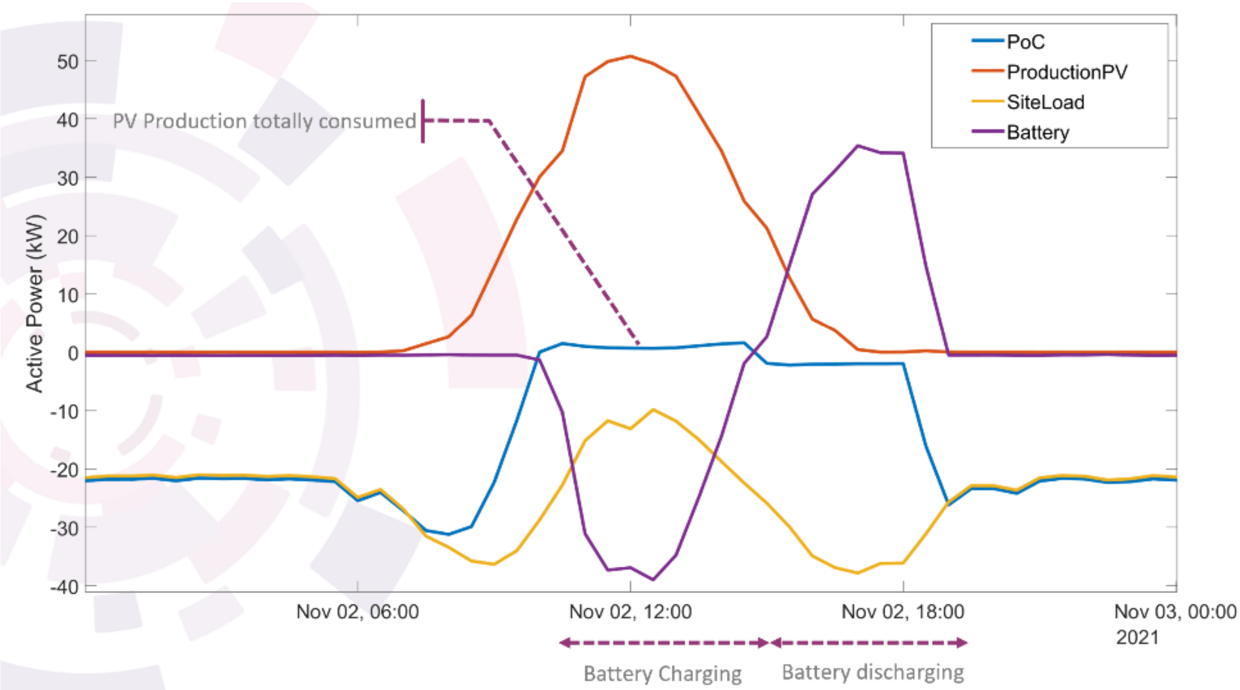


Figure 33.Typical load profiles in the self-consumption scenario in Winter

The load curves presented in Figure 33 correspond to the self-consumption scenario in winter, where the power from the sun is limited, which prevents the battery to charge enough and to supply the building for the whole evening. Therefore, Figure 34 shows how the battery can actually reduce the burden of the building's consumption on the grid. Indeed, we can see that the excess PV production is still used to fill the battery. However, this time, this self-consumption stops when the battery power is full, which happens in the early afternoon. At this stage, excess PV power 47 production can either be reinjected to the main grid, or just cut off by the inverters. In this experimentation, power was reinjected to the grid. When PV power production reduces, instead of starting to consume electricity from the grid to supply our extra consumption, the battery is then discharging to self-produce electricity to the building, in order to reduce the consumption from the grid. This lowers the burden to the grid, especially during the evening, until the battery State of Charge is below the acceptable value.

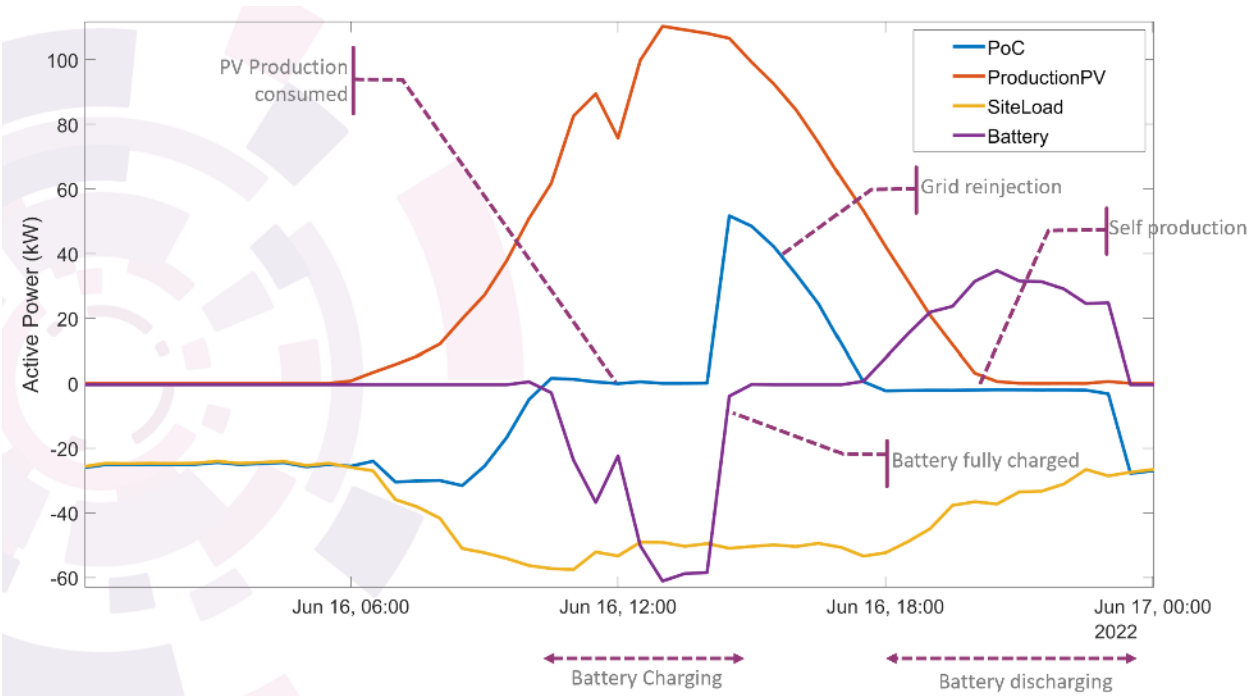


Figure 34. Typical load curve in Summer

In terms of self-consumption and production, we can differentiate two scenarios. In the first scenario, our building is only supplied by solar PV production, whereas in the second scenario, the building Is supplied by the battery as well. We can see in Table 3 that self-consumption and production rates are increased by 8%, which are not considerable values given the investment cost for this type of asset.

*Table 3. Self-consumption and production rates for **IMREDD** from the experimentation period between 2021 and 2O22*

	Building with PV only	Building with PV and battery
Self-consumption	**77.7%**	**88.7%**
Self-Production	**42.3%**	**48.1%**
% of time off grid	**20.5%**	**20.5%**

Similarly, we can highlight the percentage of time during which the building was fully supplied by its own equipments (PV and batteries). However, Table 3 shows that the battery was not able to increase the time off grid. This is mainly explained by the fact that during the experimentation phase, the battery was not always operational, or not always providing the service of self-consumption optimisation.

Also, we can highlight the evolution of the self-consumption and self-production rates with time, and with the use of different assets. Figure 35 and Figure 36 show the evolution of the self-consumption and production rates respectively. We can see that the addition of batteries increases self-consumption and production, although the size of the battery and of PV installation does not allow the storage system to fully self-consume and produce.

Following the increase of PV production in summer, the self-consumption rate reduces in summer compared to winter as PV production cannot be fully used locally as the battery is quickly full, as shown in Figure 34. Therefore, injection of PV production in the grid increases in summer.

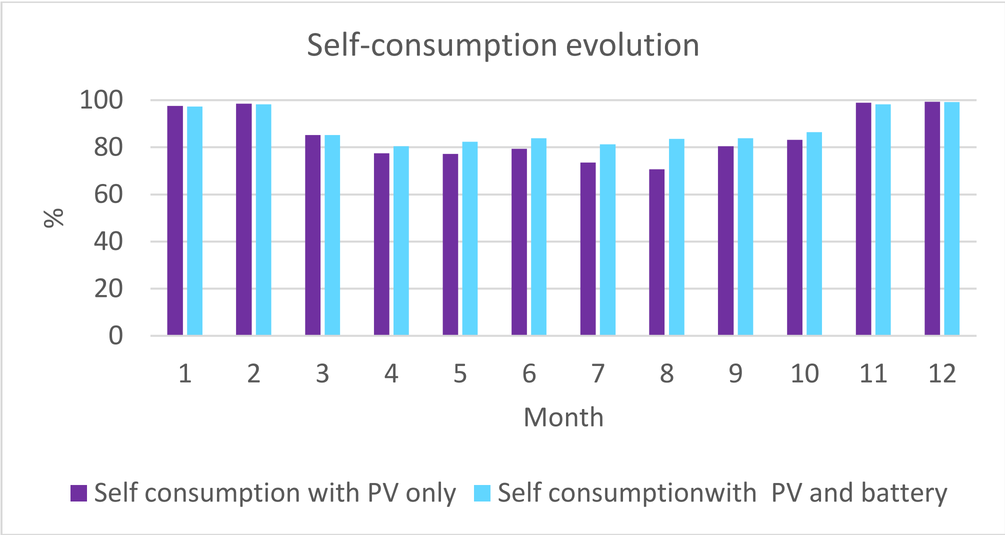


Figure 35. Self-consumption evolution with time of year

In the opposite, the self-production increases in summer as excess of PV production is used to supply the building consumption.

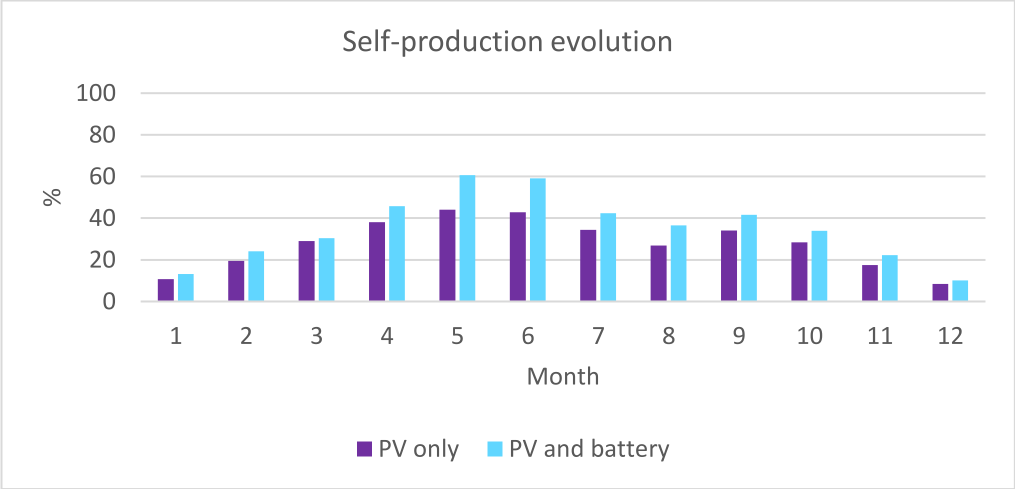


Figure 36. Self-production rate evolution with time of year

Finally, as it was shown in Table 3, the percentage of time when the building was considered off-grid is also following the seasonal trend, however, the battery as it was used during the experimentation phase did not allow the building to increase its capacity to be off-grid as shown in Figure 37. As it was discussed, the battery operations did not allow the building to increase this capacity, however, this is only due to the fact that battery was also used for other experiments from other TTs.

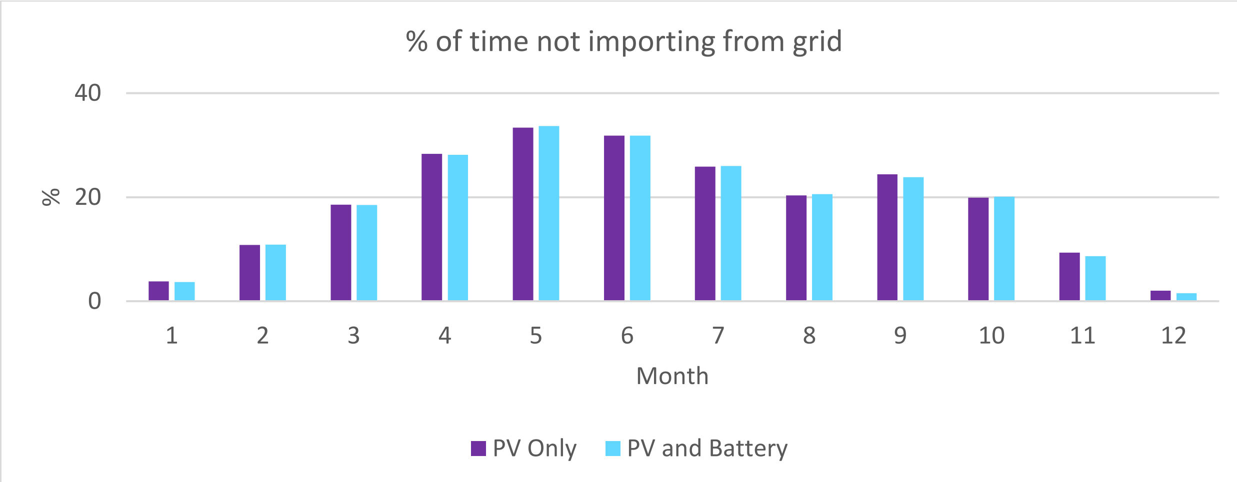


Figure 37. Percentage of time when the building was off-grid

Indeed, Figure 38 shows the battery profile when it is used to provide frequency control services. As we can see, the battery is solely used to follow the frequency evolution and does not provide any self-consumption services. As a result, all the excess generation from PV was injected on the grid. We see here that there is a need to optimise the control of flexible assets to provide multiple services at the same time, such as self-consumption maximisation and frequency control. Indeed, we can see that when PV production is greater than the building consumption, excess generation is sent to the grid regardless of the frequency state. Therefore, the battery is trying to follow the frequency evolution, however, in the same time, the building itself is re-injecting more than 30kW on the grid even when the frequency is above 50Hz, which requires the battery to recharge and to not discharge. This contradictory behaviour at the building scale should be taken care of by subscribing the whole building to regulation services, and not only batteries.

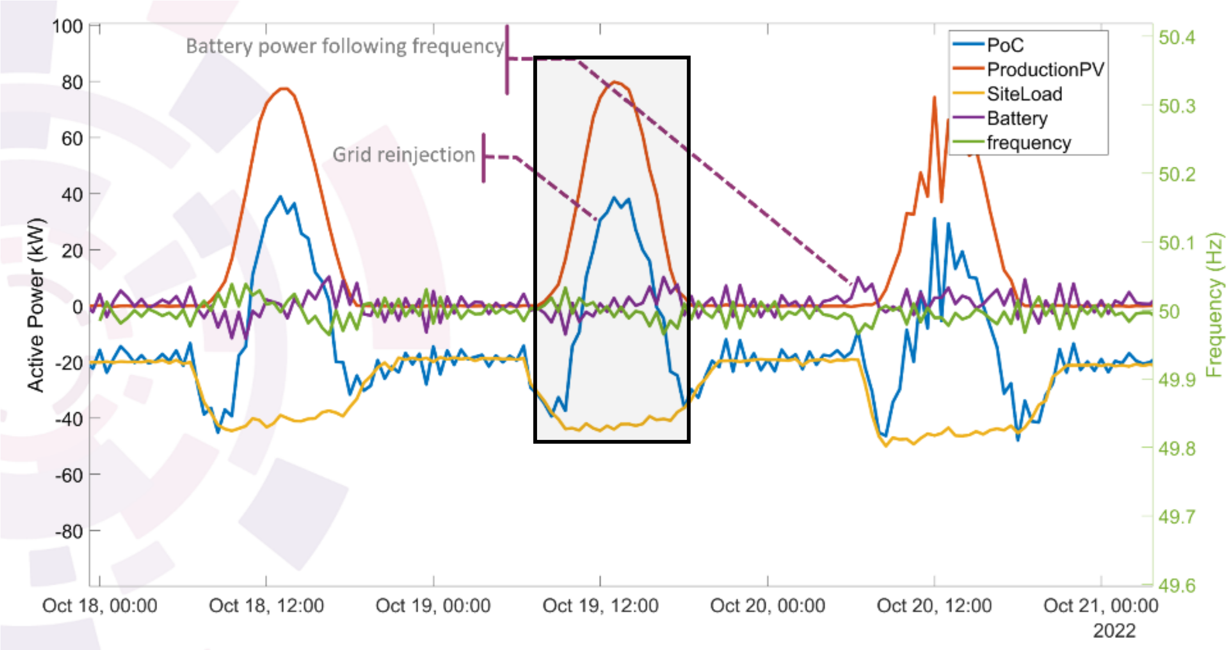


Figure 38. Example of load curves for other experiments

Finally, another explanation of the small increase in self-consumption and production rates comes from the fact that downtime of the battery was substantial during the experimentation phase. Indeed, Figure 39 shows that during four days, ICT issues prevented the EMS to control the battery as it was not able to detect any PV power production. This resulted in self production rate equal to zero for this period, which reduces the aggregated self-production rate given the frequency of such ICT issues events. This shows that optimal operation of assets can only be guaranteed by a strong and reliable ICT infrastructure, which requires considerable human effort to maintain the infrastructure.

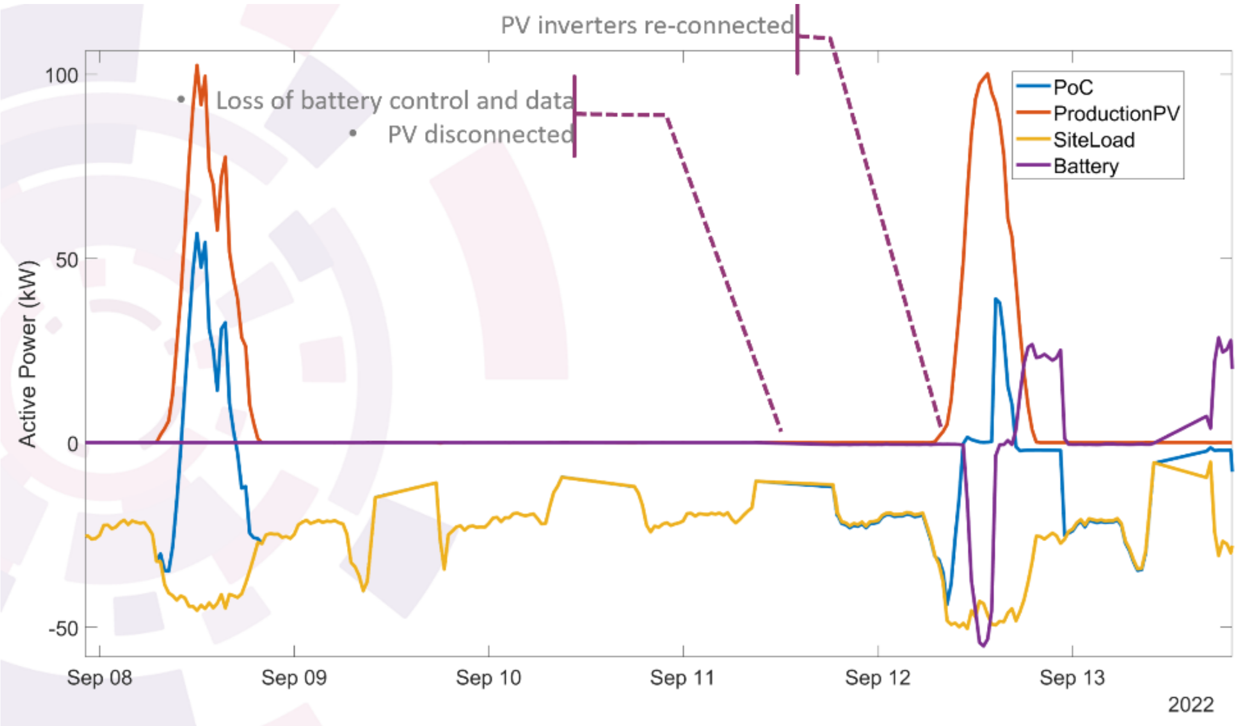


Figure 39. Downtime of the battery due to ICT issues

Finally, Figure 40 and Figure 41 show the annual evolution of the charging and discharging energy per month, and of the grid imports and exports respectively. Figure 18 shows that the battery is mostly used in summer when there is enough PV production to convert the instantaneous needs from the building and the charging of the battery. As it was shown in Figure 11, in Winter, this is less applicable as excess production is small and does not fully recharge the battery. Figure 18 also shows that the charging energy is well above the discharging energy, as the battery storage system has an efficiency around 75%. Finally, Figure 40 shows the impact of ICT and control issues in summer, where infrastructure downtimes in the months of July and August prevent the battery to work properly.

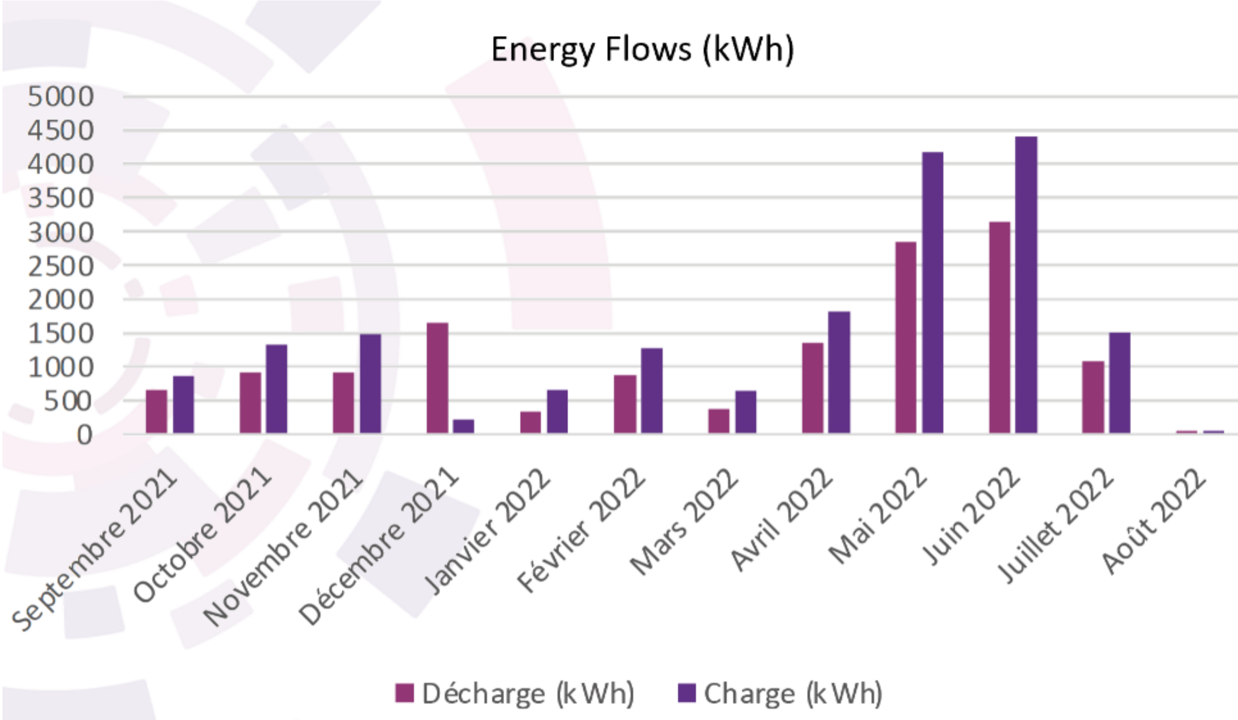


Figure 40. Evolution of energy flows in the battery

Finally, Figure 41 confirms that a grid connection will still be required, unless the production and storage assets are well oversized. Indeed, first, in winter, most of the power supply comes from the main grid, whereas in summer, even when there are not infrastructure issues (ICT) such as in June, grid imports are still substantial, especially during the night where the battery is discharged and that the base load must still be supplied, by the grid.

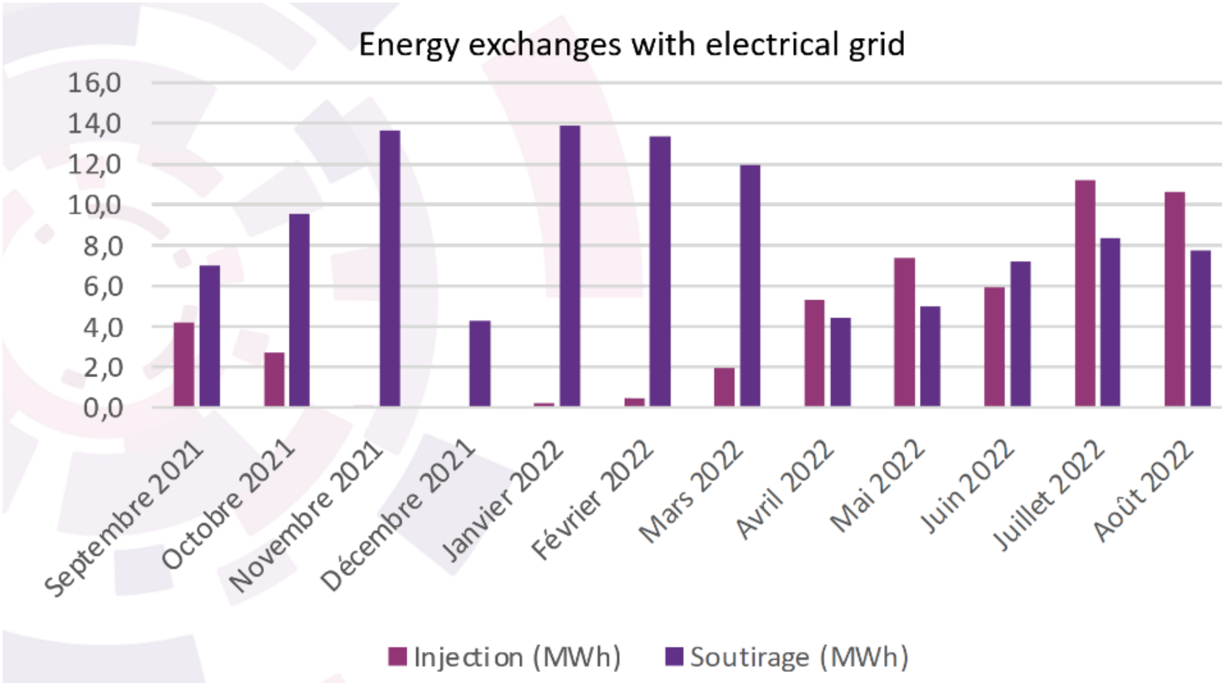


Figure 41. Evolution of Grid exports and imports

PALAZZO MERIDIA

The same conclusions apply to the Palazzo Building. Indeed, we can see in Figure 42 that the control of the battery was not consistent over the year. The battery seems to not have been used properly from January 2022, whereas no PV production was recorded during several months in 2022. As the control of the battery is based on local production and consumption, the fact that local production data was not available to the EMS prevented the control algorithm to use the battery properly.

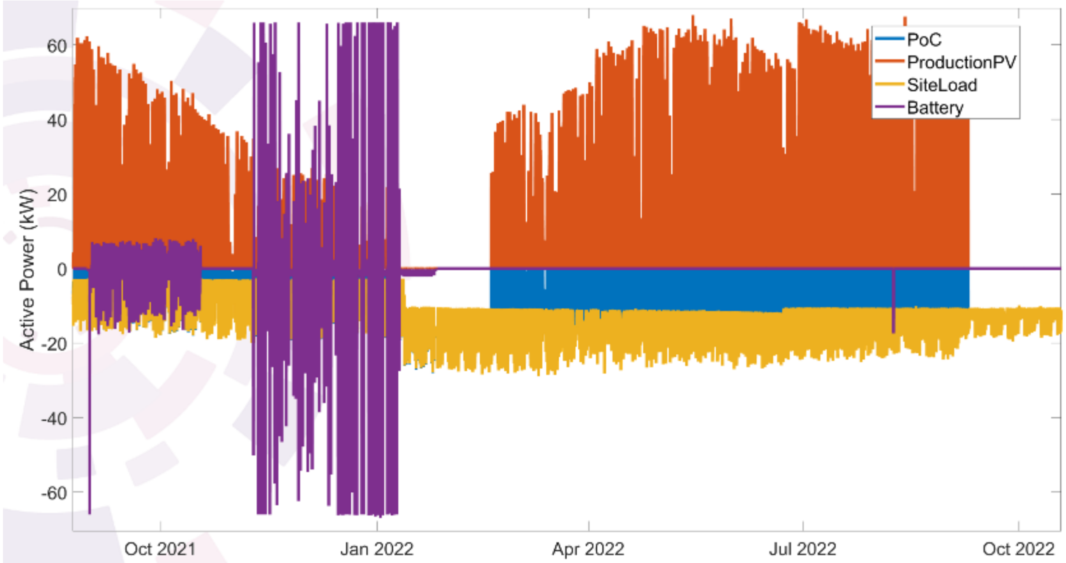


Figure 42. Annual overview of the different loads profiles, with PoC = Point of Connection

If we zoom in the period around October 2021, where the battery seems to be used at power ranges below 20kW, we can see in Figure 43 that the battery does not seem to be aiming at maximising the self-production rate. This is mostly due to the fact that the Palazzo building's experiment suffered from a lack of investment of manpower to investigate the relevance of the different assets load curves. This shows that given the current state of the art, investing in a building with solar PV and batteries for self-consumption might not be enough in custom implementation, and requires to have dedicated people in the building to ensure the best operations of the system.

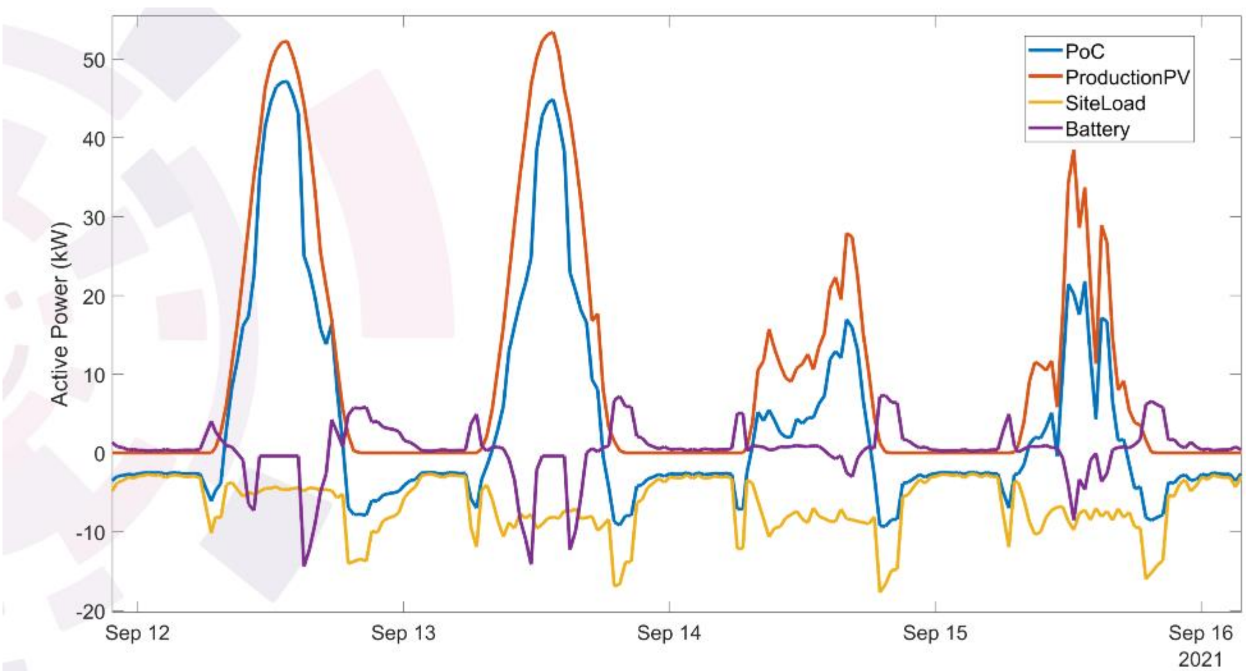


Figure 43. Zoom on the battery control of the Palazzo in the left side of Figure 20

The resulting key values are shown in the Figures below.

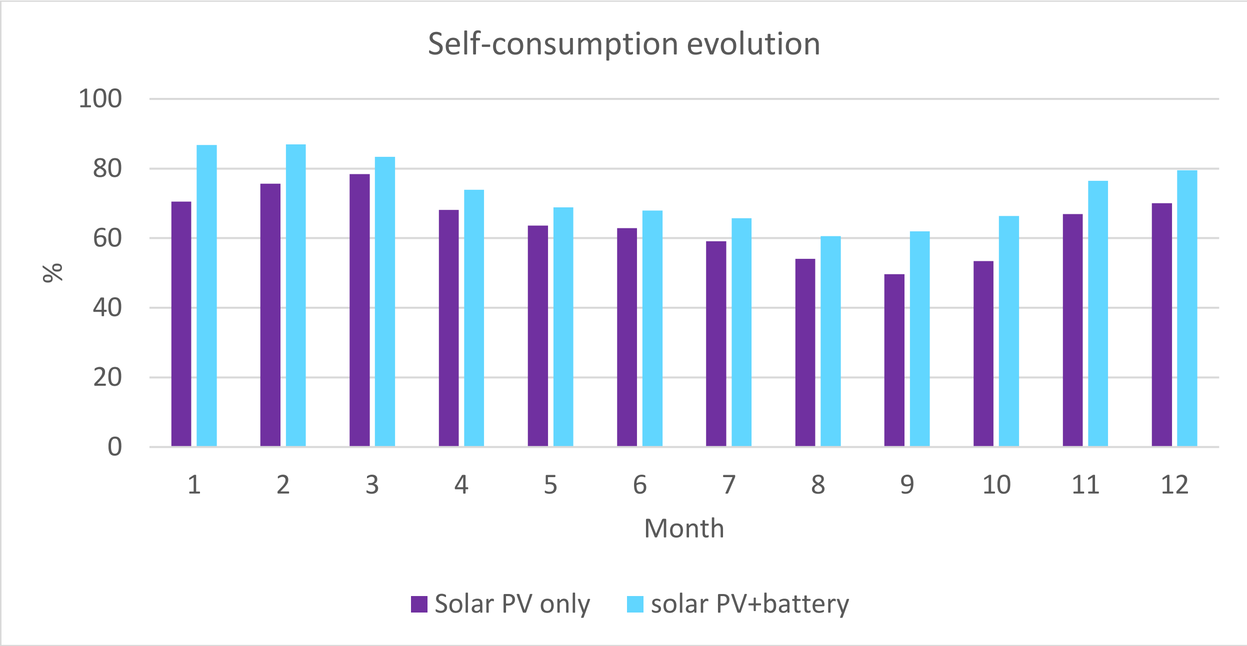


Figure 44. Self-consumption evolution for the Palazzo

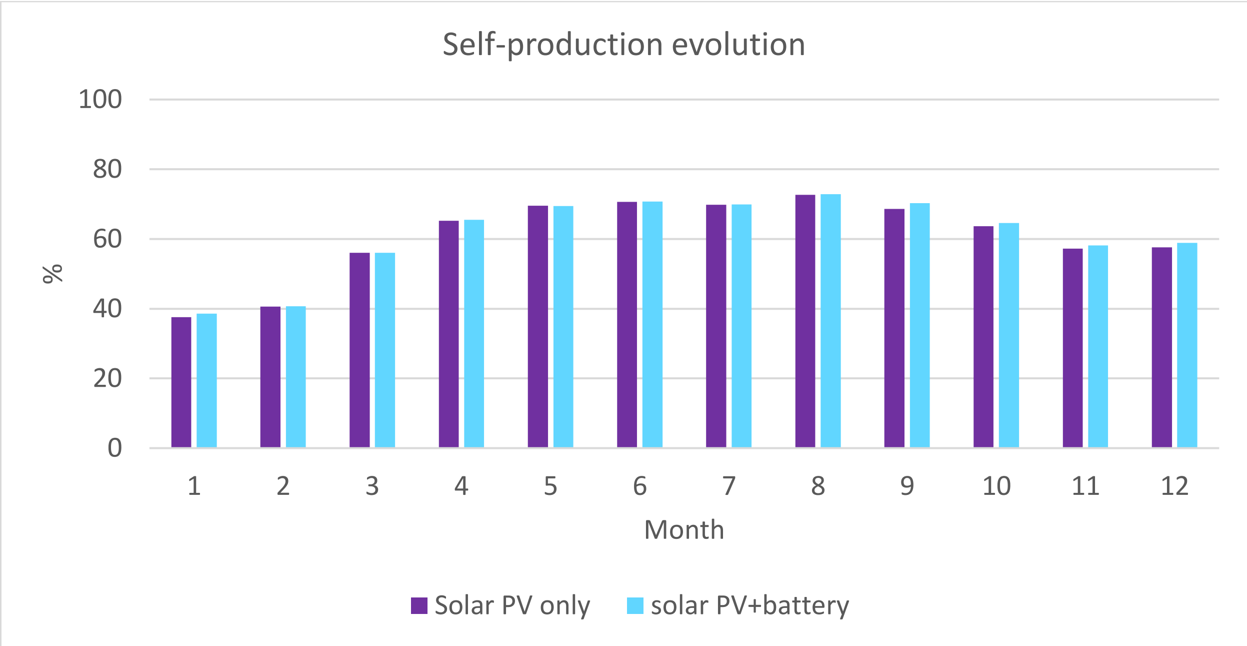


Figure 45. Self-production evolution for Palazzo building

Then, considering the percentage of time when the building was considered as off-grid, we can see in Figure 46 that the control of the battery did not improve the situation compared to a case without battery.

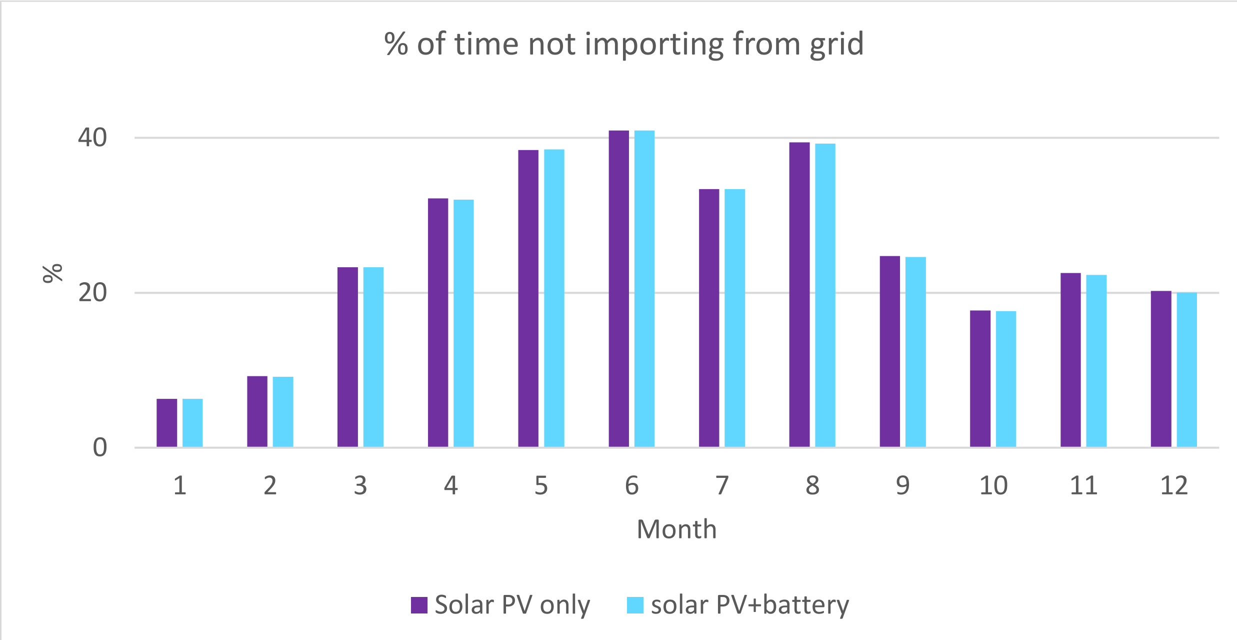


Figure 46. Percentage of time not importing from grid for the Palazzo

Because the battery was not really used for self-production, most of PV production was injected back to the grid. As a consequence, Figure 47 shows large amounts of power injection on the grid, whereas a normal behavior would have been to use this power production locally to charge the batteries, that would have been used to reduce the quantity of power imported.

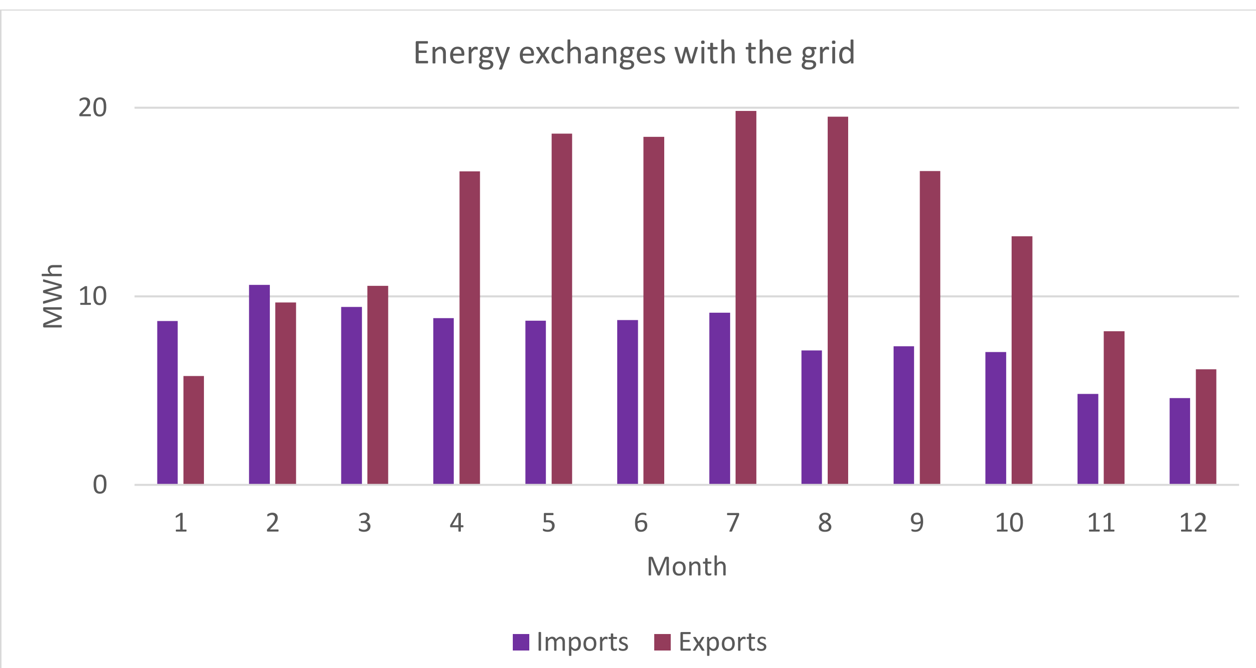


Figure 47. Summary of the energy exchanges with the grid for the Palazzo.

The annual main criteria (self-consumption, self-production, and % of time off-grid), are all summarized in Table 4.

*Table 4. Self-consumption and production rates for **Palazzo** from the experimentation period between 2021 and 2O22*

	Building with PV only	Building with PV and battery
Self-consumption	**62.2%**	**70.1%**
Self-Production	**65.2%**	**65.6%**
% of time off grid	**27.7%**	**27.8%**

This shows that batteries used to maximize self-consumption require a very robust system in order to ensure efficient operations without downtime. This requires the following:

- A strong ICT infrastructure without any downtime
- A local expertise to identify and solve potential issues of operation
- An integrated system instead of many different systems that are not supposed to work together
- A monitoring and alarm system to ensure quick notifications when the situation is not nominal

2.3.2 Measure 2: Optimization of heating load curve

Initial Gas price reference set at PGO 39.62€/MWH and PHO at 61.8€/MWH in 2019 have been updated to PGO 138,67€/MWH and PHO 216.3€/MWH in 2022.

All calculation (consumption, Effective day degree (DJR), 30y day degree (DJT), R) correspond to the heating season of the buildings, in average 190 days. 1 year of heating = 190 days which is more realistic than the initial scenario.

Energy consumption is linked to real Unified Day Degree (DJU)

Version 6	**11/07/2022**		Gas price reference € HT/MWH 2019
S=5342m2 X 2			PGO 39,62
17 etg			PHO 61,8
66 flats/building	T13&T14	**Nice Moulins**	

References			**T13**	**T14**	**Effective Day Degree (DJR) Weighted calculation reference**	**30y day degree (DJT) weighted calculation reference**
Effective Day Degre (DJR) zero	2018-2019		1088	1148	**1118**	**1257**
Reference zero consumption	2018-2019		465	410		

C	Gas price reference € HT/MWH 2022	01/07/2018 – 30/06/2019 = 39.62
3,5	PGO 138,67	01/07/2019 – 30/06/2020 = 30.77
estimate	PHO 216,3	01/07/2020 – 30/06/2021 = 23.86
1st June 2022		01/07/2021 – 30/06/2022 = 50.95

The Heating season 2020/2021 is the first season of adjustments and tests of the 3 solutions.

- **Tower 13 :**

Tower 13	Winter	Heating - Starting Date	Heating - Ending Date	Effective Consumption MWH	Effective Heating days	Standardized heating days	Effective Day Degree (DJR)	Corrected Effective Day Degree (DJR)	30y day degree (DJT)	Correted 30y day degree (DJT)	Corrected MWH consumption related to 190 days	Rigor over heating season
Reference	2018-2019	23/10/2018	14/05/2019	497	203	**190**	1162	**1118**	1281	**1257**	**465**	0,89
Solution 1+2 - T13	2019-2020	04/11/2019	07/05/2020	425	185	190	990	1002	1247	1257	436	0,80
Solution 1+2 - T13	2020-2021	02/11/2020	14/05/2021	361	193	190	1197	1175	1260	1257	355	0,94
Solution 1+2 - T13	2021-2022	02/11/2021	02/05/2022	385	181	190	1136	1192	1242	1257	404	0,95
				Average	191	190						

✓ Results on Tower 13 :

-Overconsumption registered due to regulation issues linked to the pump manufacturer, and communication issues.

-Thus, electronic changes were brought, updates of the firmware and algorithm modifications realized in parallel.

-The results have been improved thanks to the consideration of shading influence. Indeed, the south Part of Tower 13 is notably affected in winter time, by the shading of Tower 14; which has been confirmed by the study delivered by Axun (estimation 1.6°C), 50MvWH.

-A period of transition for the tenants regarding the contractual T°C to be accepted.

-More Equipment degradation on Tower 13 as the tenants are younger which has impacted the results.

=> Results stabilized at 19% MVWH savings

- **Tower 14 :**

Twoer 14	Winter	Heating - Starting Date	Heating - Ending Date	Effective Consumption MWH	Effective Heating days	Standardized heating days	Effective Day Degree (DJR)	Corrected Effective Day Degree	30y day degree (DJT)	Correted 30y day degree (DJT)	Corrected MWH consumption related to 190 days	Rigor over heating season
Reference	2018-2019	07/11/2018	14/05/2019	406	188	190	1136	**1118**	1234	**1257**	**410**	0,89
Solution 1 - T14	2019-2020	04/11/2019	14/05/2020	430	192	190	998	1002	1258	1257	426	0,80
Solution 1+3 T14	2020-2021	02/11/2020	14/05/2021	357	194	190	1197	1175	1260	1257	350	0,94
Solution 1+3 T14	2021-2022	02/11/2021	02/05/2022	347	181	190	1136	1192	1242	1257	364	0,95
				Average	189	190						

✓ Results on Tower 14 :

- Overconsumption registered due to regulation issues linked to the pump manufacturer, and communication issues.

- Thus, electronic changes were brought, updates of the firmware and algorithm modifications realized in parallel.

- Temperature sensors have been used as microphone by the tenants. Equipment Degradation

=> Results stabilized at 17% MVWH savings

2.3.3 Measure 3: Commissioning process from the design to the operation

The data collected during the monitoring campaign in towers 13 and 14 are analysed in this section. For each tower, the overall instrumentation quality of each category of sensor is presented, followed by a detailed analysis of each sensor during the monitoring campaign.

2.3.3.1 2.3.3.1 Tower 13

The data quality of sensors in **Tower 13** during the monitoring campaign from December 2019 until May 2022, is presented below.

Indoor air temperature

Figure 48 presents the data quality of sensor *1361364013_t_c_sonde_38* during the monitoring campaign. The blue line presents the raw data. The orange one present the analysed data. The green one presents the error type detection. If the detection value is lower 100, the error is minor and can be neglected. If the detection value is higher or equal to 100, the error is raised up.

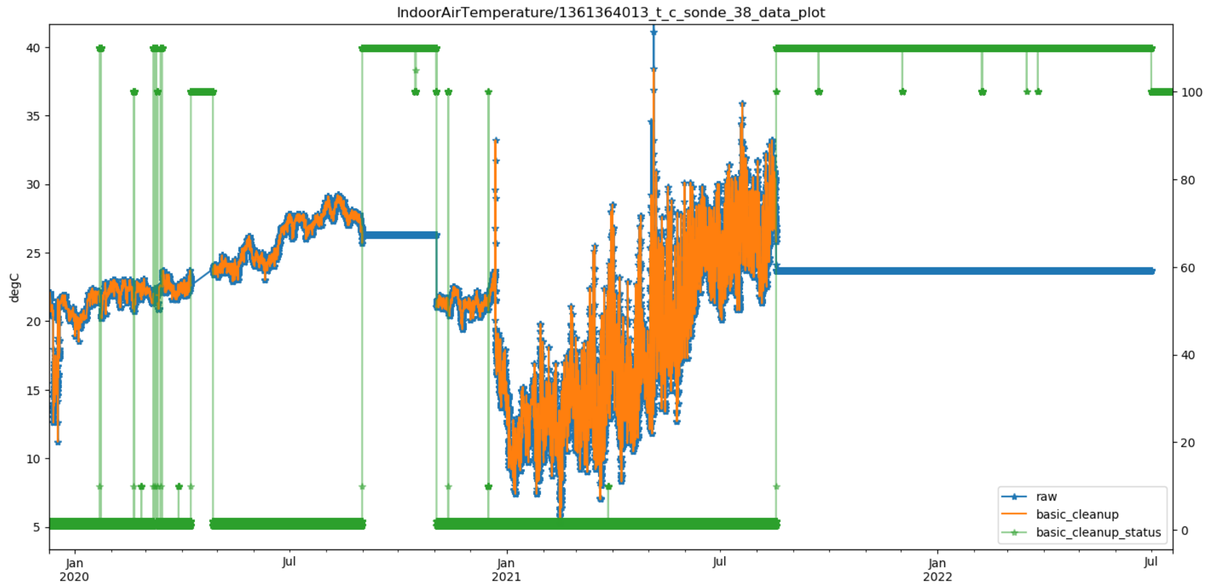


Figure 48 : Detection of data error of sensor 1361364013_t_c_sonde_38

The measurement was conducted from 1st December 2019 to May 2022. During this period, data is available only during two periods, winter 2019/2020 and winter 2020/2021. Their data quality is 92,7%, which mean the data can be used. However, the algorithms of detection of bad derivative shows a suspicious behaviour, for example occupants moved sensors outside, to force a maximum input of heating in their housing. As can be seen from Figure 48 between December 2020 and January 2021, the event was detected, and the subsequent temperature series measured the outdoor temperatures instead of indoor temperatures. Consequently, we cannot exploit these data. For 10 sensors having the same diagnostic, which are shown below, only data during winter 2019/2020 can be exploited correctly.

1361364013_t_c_sonde_13	1361364013_t_c_sonde_44
1361364013_t_c_sonde_22	1361364013_t_c_sonde_46
1361364013_t_c_sonde_31	1361364013_t_c_sonde_48
1361364013_t_c_sonde_36	1361364013_t_c_sonde_56
1361364013_t_c_sonde_38	1361364013_t_c_sonde_57

Figure 49 presents the data quality of sensor *1361364013_t_c_sonde_14* during the monitoring campaign. The measurement was conducted from 1st December 2019 to May 2022. During this period, there are some data holes. Where the holes lack more than one measure (for example during April, September and October 2021), we cannot use the linear interpolation to fulfil the data. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season.

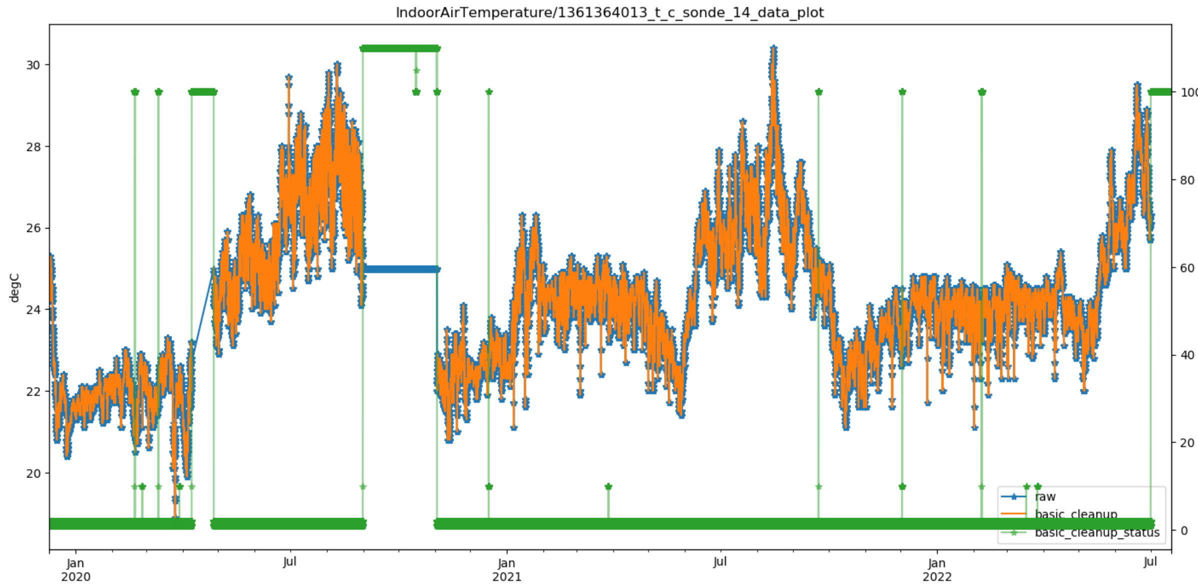


Figure 49 : Detection of data error of sensor 1361364013_t_c_sonde_14

The data quality of this sensor for 3 winters is 91,1%, and therefore the data can be exploited correctly. Indeed, 24 sensors have the same diagnostic, which are shown below.

1361364013_t_c_sonde_14	1361364013_t_c_sonde_29	1361364013_t_c_sonde_53
1361364013_t_c_sonde_15	1361364013_t_c_sonde_3	1361364013_t_c_sonde_54
1361364013_t_c_sonde_16	1361364013_t_c_sonde_30	1361364013_t_c_sonde_58
1361364013_t_c_sonde_17	1361364013_t_c_sonde_33	1361364013_t_c_sonde_59
1361364013_t_c_sonde_18	1361364013_t_c_sonde_34	1361364013_t_c_sonde_6
1361364013_t_c_sonde_19	1361364013_t_c_sonde_35	1361364013_t_c_sonde_61
1361364013_t_c_sonde_20	1361364013_t_c_sonde_37	1361364013_t_c_sonde_62
1361364013_t_c_sonde_21	1361364013_t_c_sonde_39	1361364013_t_c_sonde_63
1361364013_t_c_sonde_23	1361364013_t_c_sonde_45	1361364013_t_c_sonde_65
1361364013_t_c_sonde_24	1361364013_t_c_sonde_5	1361364013_t_c_sonde_66
1361364013_t_c_sonde_25	1361364013_t_c_sonde_50	1361364013_t_c_sonde_7
1361364013_t_c_sonde_26	1361364013_t_c_sonde_51	1361364013_t_c_sonde_8
1361364013_t_c_sonde_28	1361364013_t_c_sonde_52	1361364013_t_c_sonde_9

Outdoor air temperature

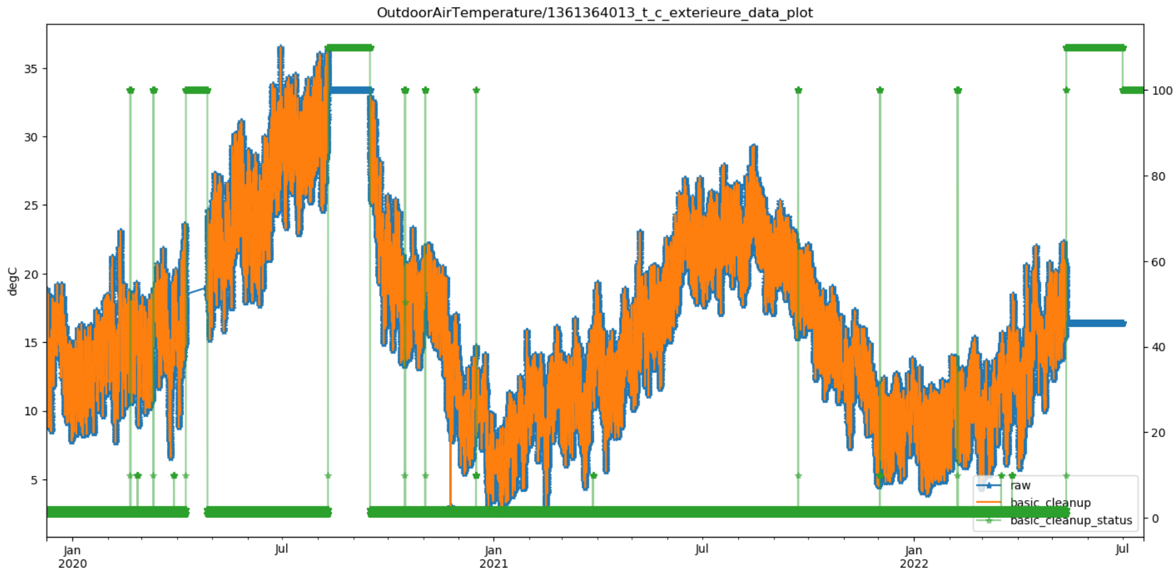


Figure 50 : Detection of data error of sensor 1361364013_t_c_exterieure

The measurement was conducted from 1st November 2019 until May 2022. During this period, there are some data holes, which lack more than one measure (during summer between August and September 2020), we cannot use the linear interpolation to fulfil the data. These data holes are therefore cannot fulfilled, which are presented as the green line, which has the detection value of 100 or over 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. The data quality of this sensor during the measurement is 93,3%, which means the data can be exploited correctly. The sensor *1361364013_temperature_ext* was out of service for 2 winters 2020/2021 and 2021/2022. Therefore, the CSTB recommended using the 1361364013_t_c_exterieure sensor data instead.

Water temperature

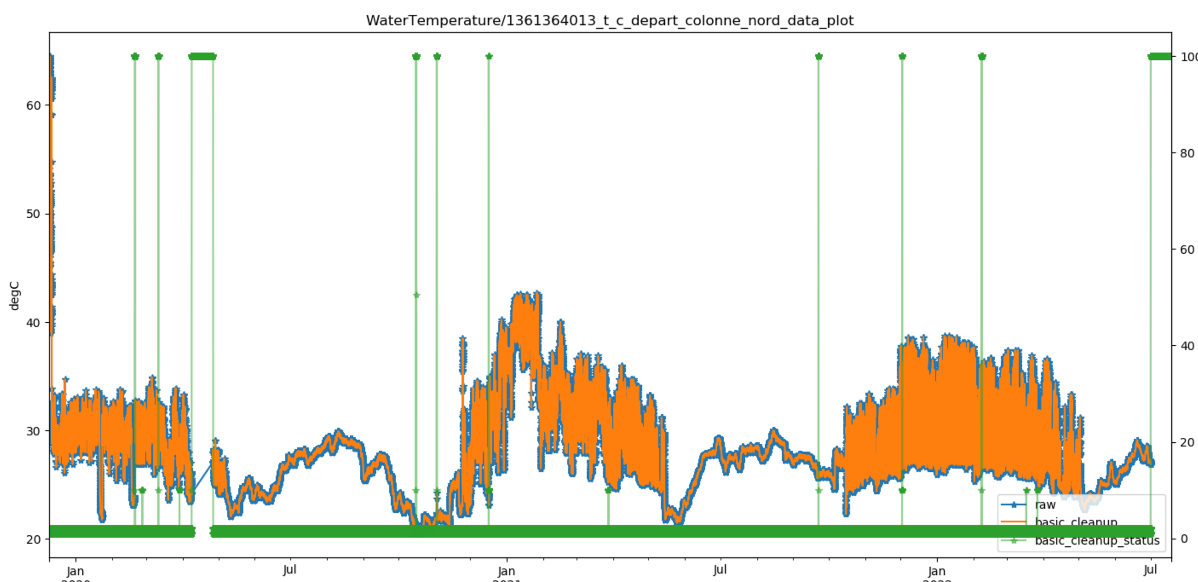


Figure 51 : Detection of data error of sensor 1361364013_t_c_depart_colonne_nord

The measurement was conducted from December 2019 until May 2022. During this period, there are some data holes (April 2020), which lack more than one measure. These data holes are presented as the green line, which has the detection value of 100. We cannot use the linear interpolation to fulfil the data. However, with the high data quality of this sensor during the measurement is 95,87%, the data can be exploited correctly, and we can neglect the data hole in April 2020. Indeed, 9 sensors have the same diagnostic, which are shown below.

1361364013_t_c_depart_colonne_nord	1361364013_t_c_retour_colonne_nord
1361364013_t_c_depart_colonne_sud	1361364013_t_c_retour_colonne_sud
1361364013_t_c_retour_12	1361364013_temperature_depart_chauffage
1361364013_t_c_retour_2	1361364013_temperature_depart_ecs
	1361364013_temperature_retour_ecs

Energy Index

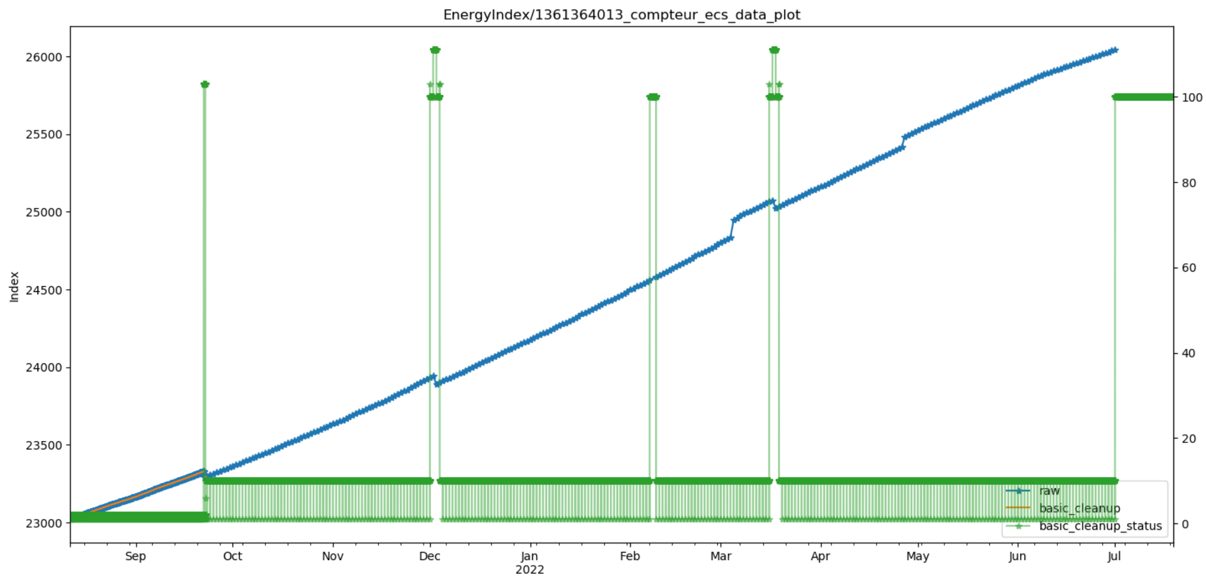


Figure 52 : Detection of data error of sensor 1361364013_compteur_ecs

The measurement was conducted from 1st August 2021 to May 2022. During this period, there are some data holes, which lack more than one measure (for example during December 2021, February and March 2022), we cannot use the linear interpolation to fulfil the data. These data holes are presented as the green horizontal line, which has the detection value of 100 or over 100. However, the graph shows a linear evolution of energy index, we can therefore fulfil the data by using the linear interpolation. The data quality of this sensor during the measurement is 97,43%, which means the data can be exploited correctly.

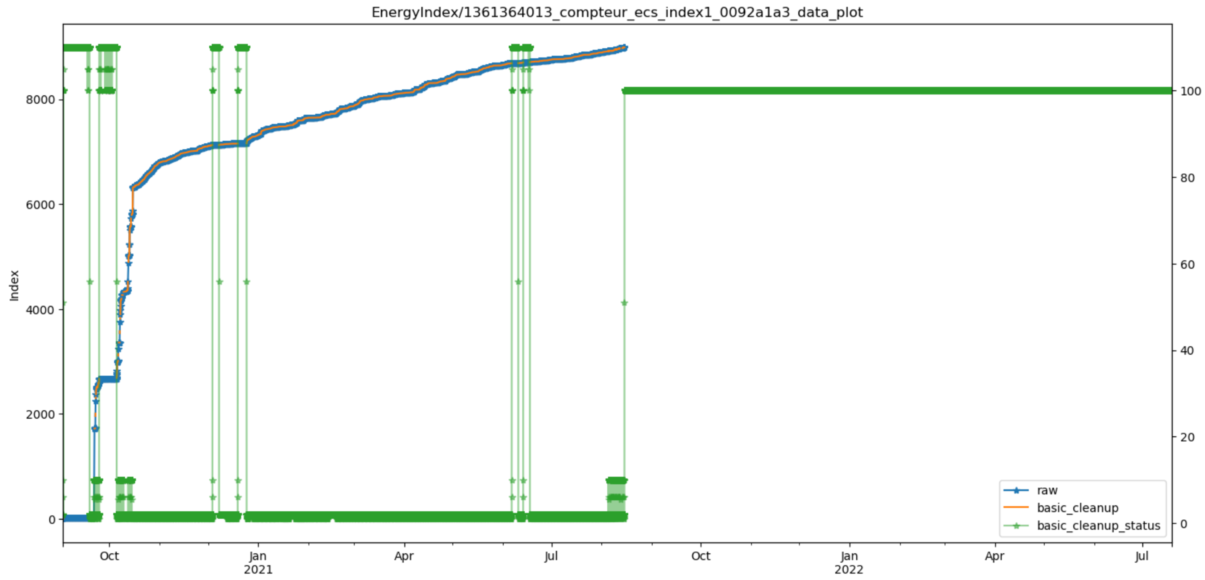


Figure 53 : Detection of data error of sensor 1361364013_compteur_ecs_index1_0092a1a3

The measurement was conducted during one full year from September 2020 to August 2021. During this period, there are some data holes, which lack more than one measure (for example during September and December 2020, August 2021), we cannot use the linear interpolation to fulfil the data. These data holes are presented as the green horizontal line, which has the detection value of 100 or over 100. The data quality of this sensor during the measurement is 82,82%, which means the data can be exploited correctly.

Note:

The sensor 1361364013_compteur_ecs_index2_0092a1a3 was out of service during all the monitoring campaign.

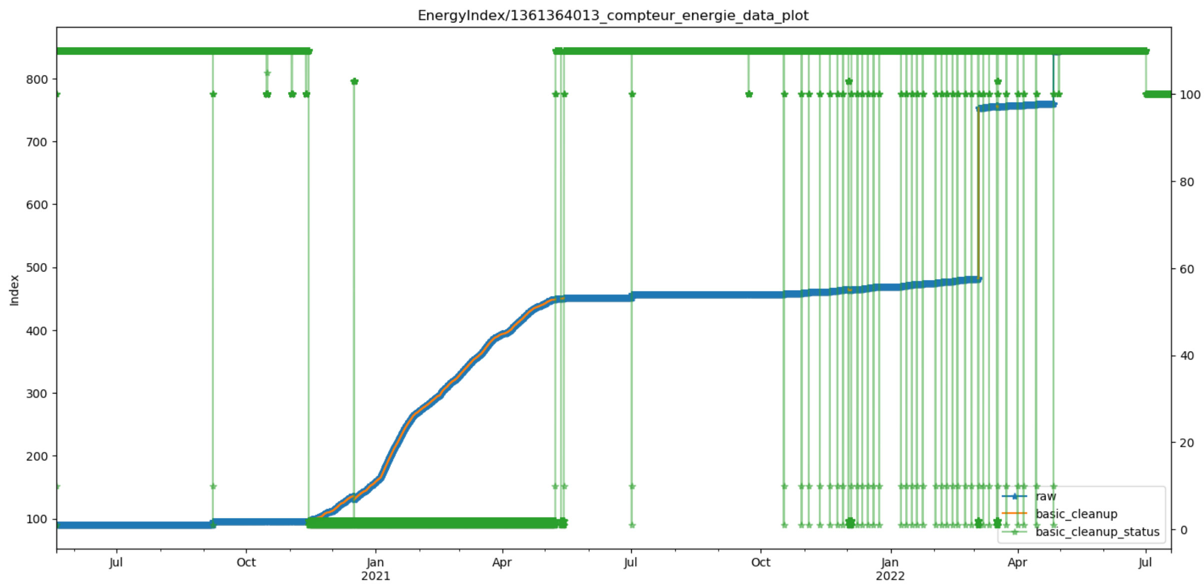


Figure 54 : Detection of data error of sensor 1361364013_compteur_energie

The measurement was conducted from May 2020 to May 2022. During this period, there are only a winter season from November 2021 to May 2022, where the data quality of this sensor is 83,5%. It means the data can be exploited correctly during this period. Out of this period, there are many data holes, which lack more than one measure. We cannot use the linear interpolation to fulfil the data.

Solar radiation

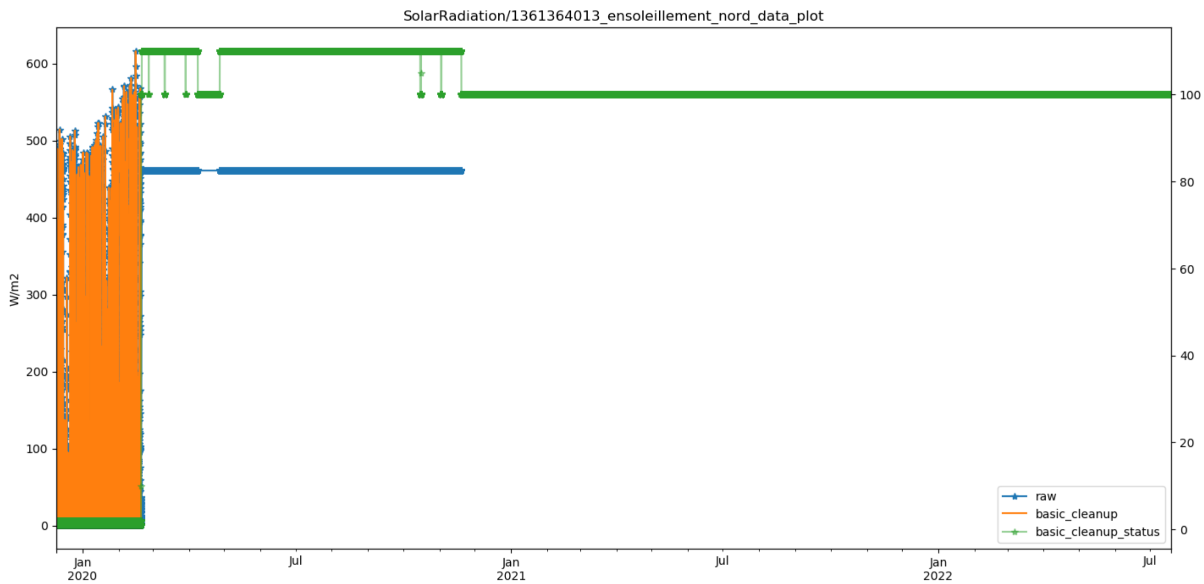


Figure 55 : Detection of data error of sensor 1361364013_ensoleillement_nord

The data can be collected during 2 months of January and February 2020. During this period, the data quality of this sensor is 88,51%, which means the data can be exploited. However, there is not enough data for the analysis. **CSTB recommended to use the solar radiation data from Météo France**.

In conclusion, the above analysis shows the global view of data quality of each sensor in Tower 13. The data quality (%) of a group of sensors is summarized in the next figure. The effective number of sensors is showed below the sensor category.

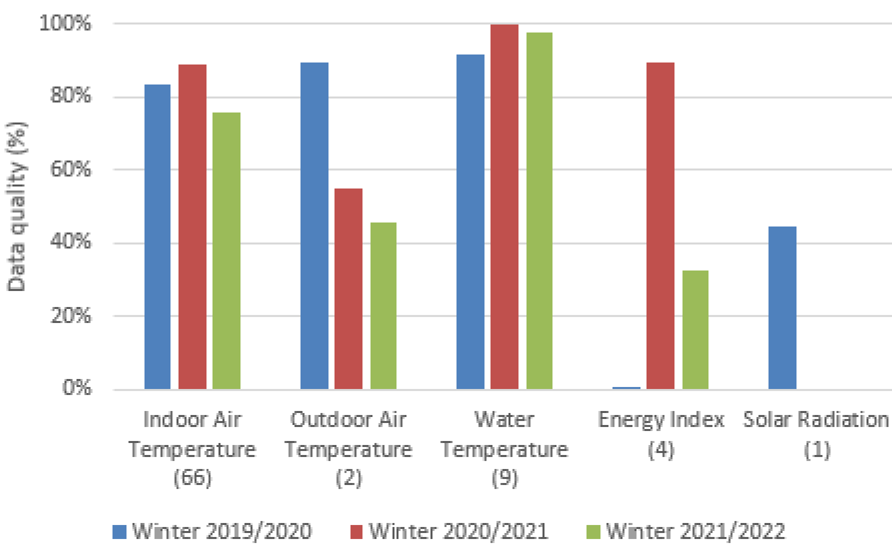


Figure 56 : Data quality of installed sensors in Tower 13

As mentioned in part 2.2.2 and 2.3.2, **only data measured from indoor air temperature and water temperature sensors are essential for energy saving calculation**. As can be seen, these two types of sensors show a good data quality, average of 83% and 96% respectively for 3 years measurement. These two sensors can be exploited correctly. The other types of sensors such as outdoor air temperature and solar radiation, show a lower quality. It is recommended to use the on-site data measured by Météo France. As the sensor **Energy Index** shows a lower quality, it is recommended to check with electricity invoices. For 3 winter periods from 2019/2020 to 2021/2022, the average reliabilities for all the sensors are 80%, 88% and 74% respectively. It is quite good to estimate the energy saving during these periods.

2.3.3.2 2.3.3.2 Tower 14

The data quality of sensors in **Tower 14** during the monitoring campaign from November 2020 until May 2022, is presented below.

Indoor air temperature

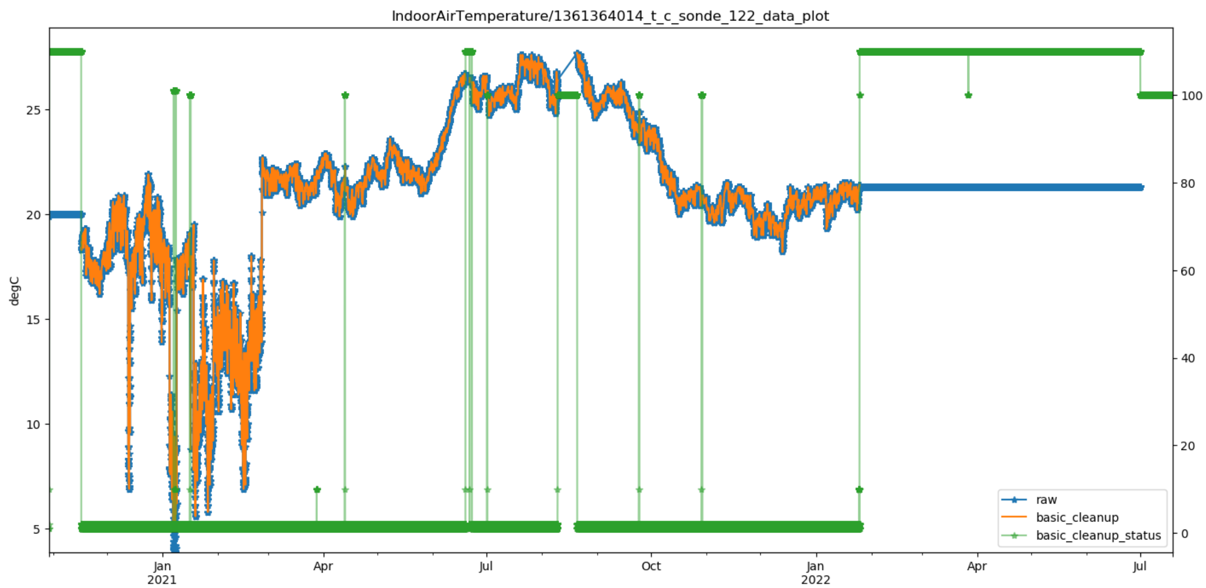


Figure 57 : Detection of data error of sensor 1361364014_t_c_sonde_122

Figure 57 presents the data quality of sensor *1361364014_t_c_sonde_122* during the monitoring campaign. The blue line presents the raw data. The orange one present the analysed data. The green one presents the error type detection. If the detection value is lower 100, the error is minor and can be neglected. If the detection value is higher or equal to 100, the error is raised up.

The measurement was conducted from November 2020 to February 2022. During this period, the data quality is 92%, which mean the data can be used. However, the algorithms of detection of bad derivative shows a suspicious behaviour, for example occupants moved sensors outside, to force a maximum input of heating in their housing. As can be seen from Figure 57, there are 3 periods that the event was detected, and the subsequent temperature series measured the outdoor temperatures, for example 8 December 2020, 3 January 2021 and 27 February 2021. Consequently, we cannot use these data during winter 2020/2021. Only data during winter 2021/2022 can be exploited properly.

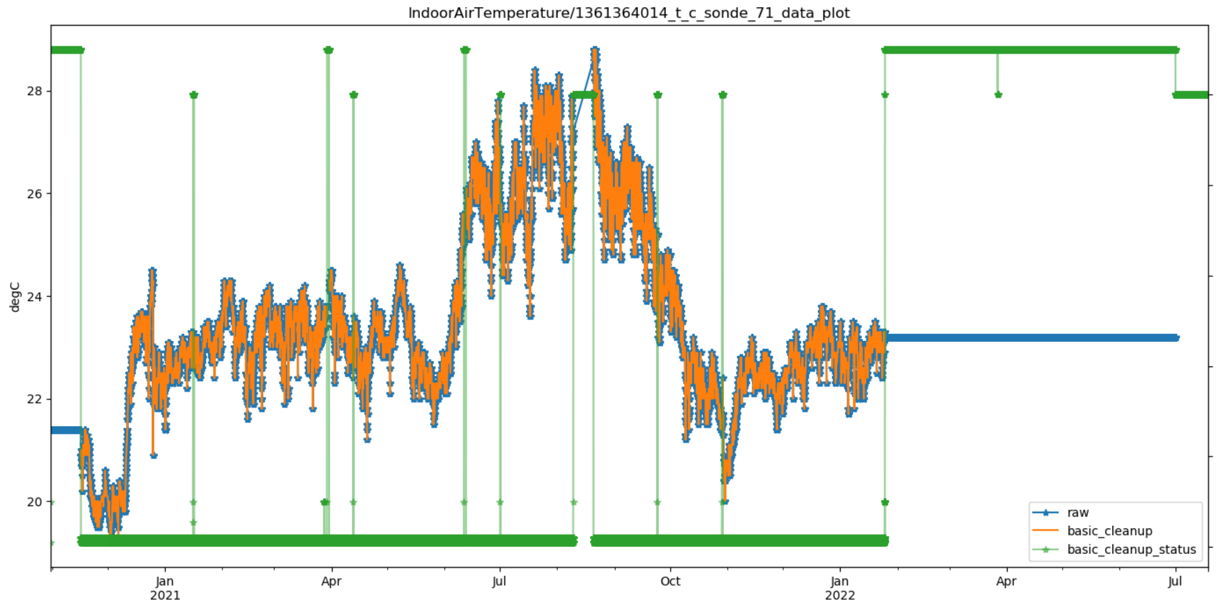


Figure 58 : Detection of data error of sensor 1361364014_t_c_sonde_71

The measurement was conducted from November 2020 to February 2022. During this period, there are some data holes. Where the holes lack more than one measure (for example between August and September 2021), we cannot use the linear interpolation to fulfil the data. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. During this period, the data quality is 96,7%, which mean the data can be used and correctly exploited. Indeed, 26 sensors have the same diagnostic, which are shown below.

1361364014_t_c_sonde_67	1361364014_t_c_sonde_87	1361364014_t_c_sonde_111
1361364014_t_c_sonde_71	1361364014_t_c_sonde_90	1361364014_t_c_sonde_114
1361364014_t_c_sonde_74	1361364014_t_c_sonde_91	1361364014_t_c_sonde_115
1361364014_t_c_sonde_75	1361364014_t_c_sonde_95	1361364014_t_c_sonde_118
1361364014_t_c_sonde_78	1361364014_t_c_sonde_98	1361364014_t_c_sonde_123
1361364014_t_c_sonde_79	1361364014_t_c_sonde_102	1361364014_t_c_sonde_126
1361364014_t_c_sonde_82	1361364014_t_c_sonde_103	1361364014_t_c_sonde_127
1361364014_t_c_sonde_83	1361364014_t_c_sonde_106	1361364014_t_c_sonde_130
1361364014_t_c_sonde_86	1361364014_t_c_sonde_110	

Outdoor temperature

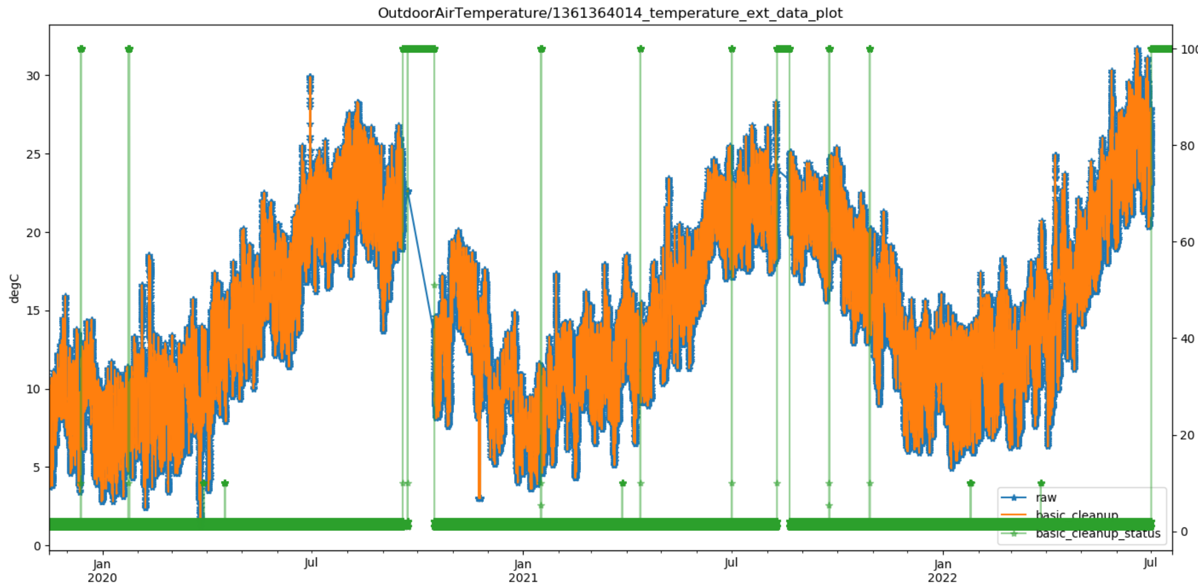


Figure 59 : Detection of data error of sensor 1361364014_temperature_ext

The measurement was conducted from 1st November 2019 until May 2022. However, we are only interested by winter 2020/2021 and winter 2021/2022 for calculation. During this period, there are some data holes. Where the holes lack only one measure, we can use the algorithm as linear interpolation to fulfil the data. Where the holes lack more than one measure (August 2021), we cannot use the linear interpolation to fulfil the data. These data holes are therefore cannot fulfilled, which are presented as the green line, which has the detection value of 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. For 2 winters, the data quality of this sensor during the measurement is 100%, which means the data can be exploited correctly.

Water temperature

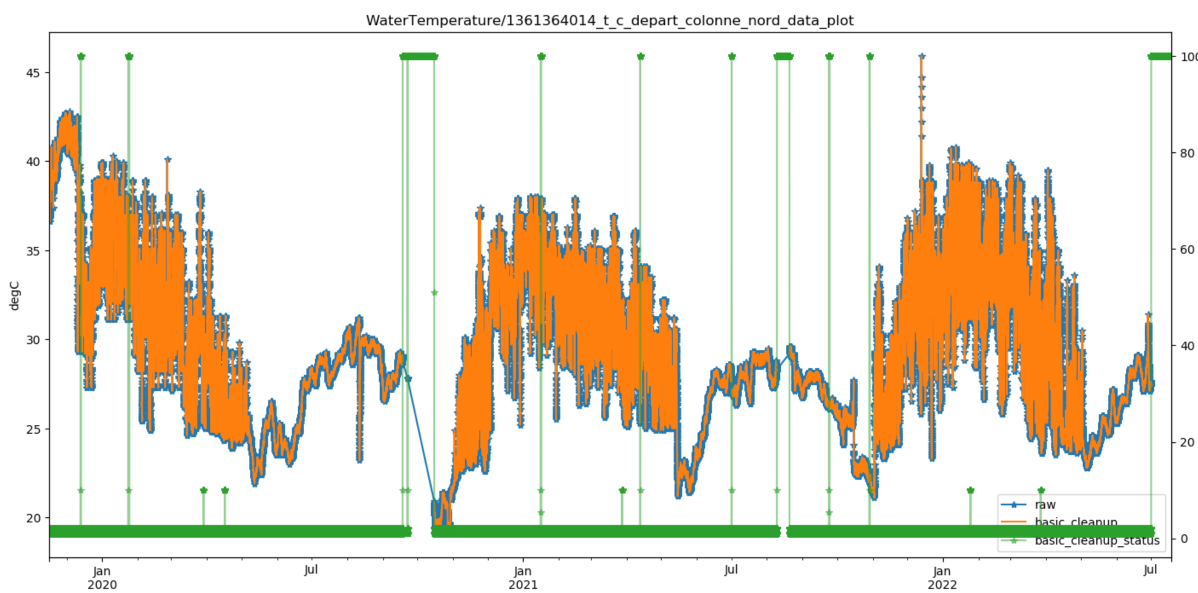


Figure 60 : Detection of data error of sensor 1361364014_t_c_depart_colonne_nord

The measurement was conducted from 1st November 2019 until May 2022. However, we are only interested by winter 2020/2021 and winter 2021/2022 for calculation. During this period, there are some data holes, which lack more than one measure (August 2021). We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. The data quality of this sensor during the measurement is 100%, which means the data can be exploited correctly. Indeed, 7 sensors have the same diagnostic, which are shown below.

1361364014_t_c_depart_colonne_nord	1361364014_temperature_depart_chauffage
1361364014_t_c_depart_colonne_sud	1361364014_temperature_depart_ecs
1361364014_t_c_retour_colonne_nord	1361364014_temperature_retour_ecs
1361364014_t_c_retour_colonne_sud	

Delta Water temperature

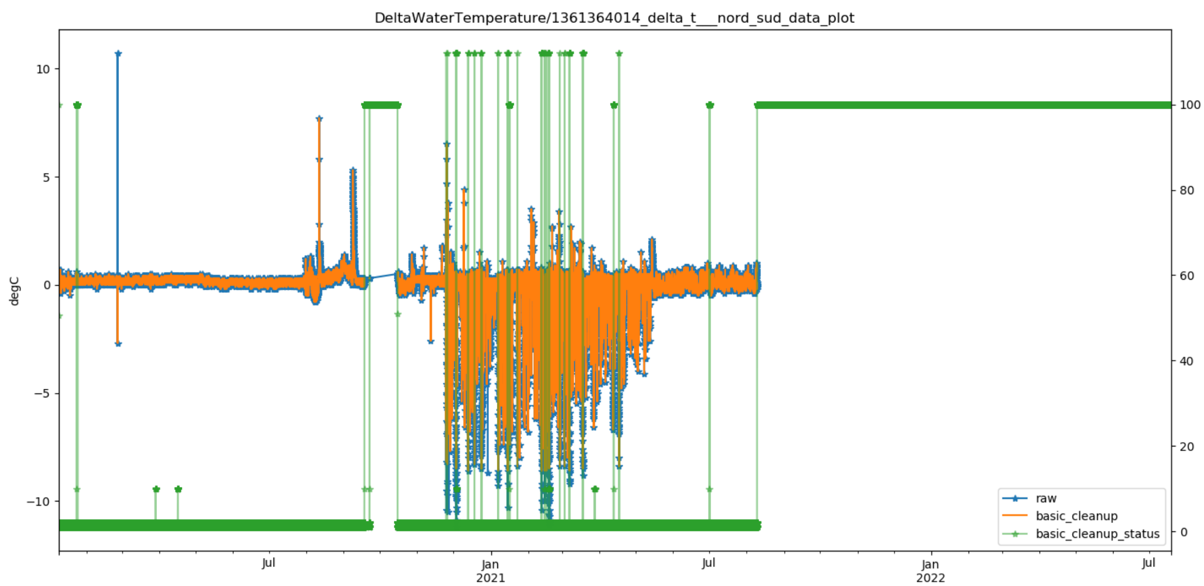


Figure 61 : Detection of data error of sensor 1361364014_t_c_depart_colonne_nord

The measurement was conducted from 1st January 2020 until 9 July 2021. During this period, there are some data holes, which lack more than one measure (September and October 2020). We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100 or over 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. The data quality of this sensor during the winter 2019/2020 and 2020/2021 is 95% and 99%, respectively. The data can be therefore exploited correctly. The sensor *1361364014_delta_t* has the same diagnostic.

Volume Flow

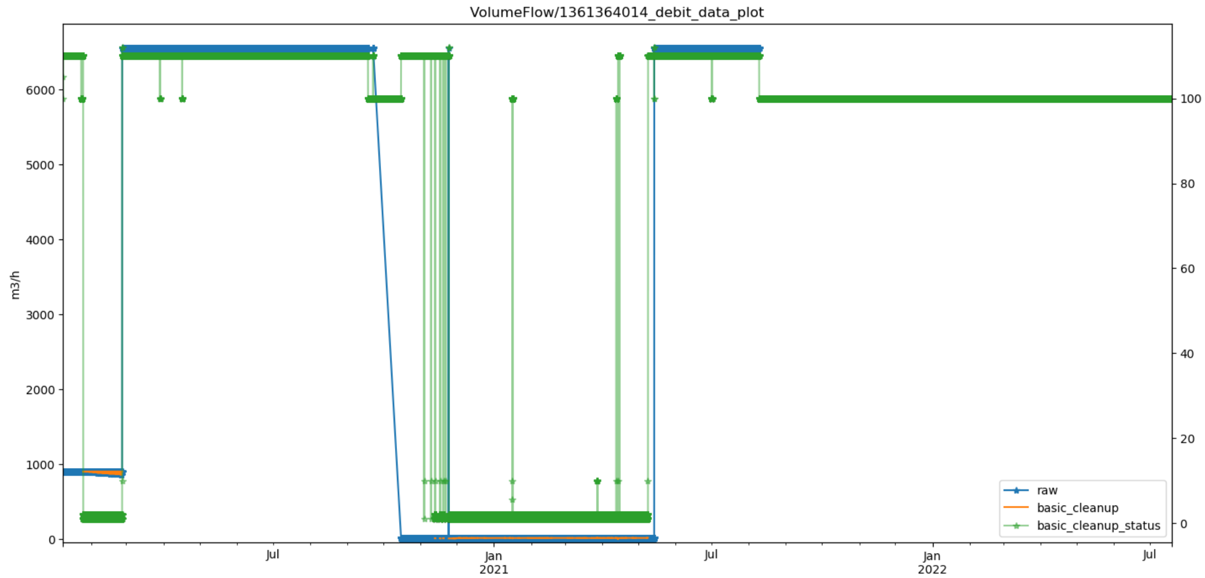


Figure 62 : Detection of data error of sensor 1361364014_debit

The measurement was conducted from 1st January 2020 until 9 May 2021. During this period (winter season 2020/2021), data quality is quite good (96,7%) and data can be exploited correctly. Out of this period, many measurements are lacked. We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100 or over 100.

Energy index

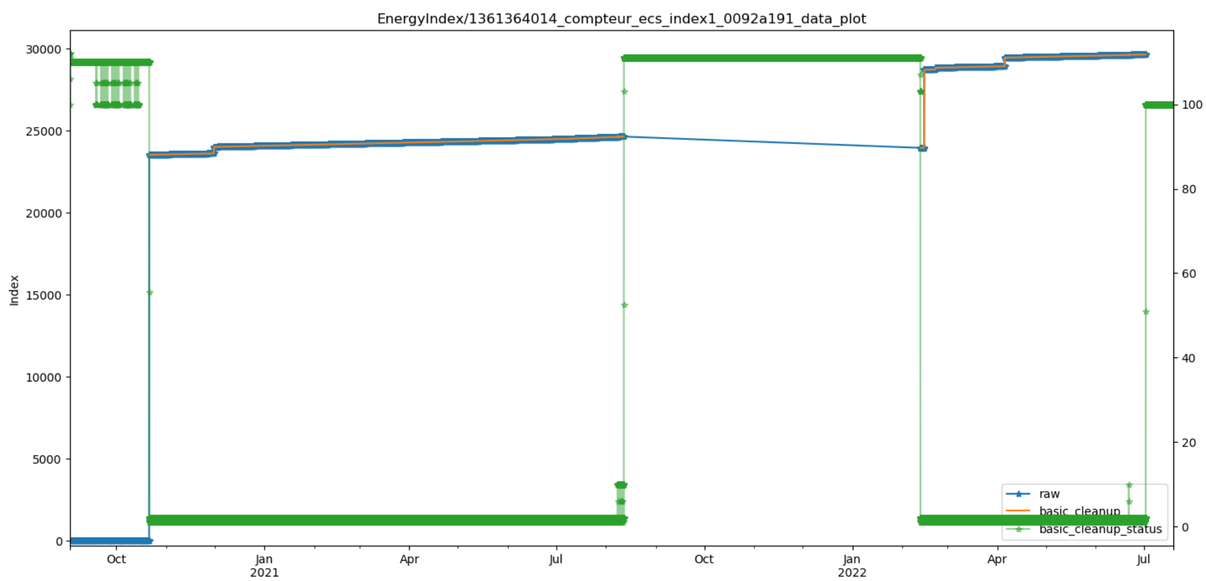


Figure 63 : Detection of data error of sensor 1361364014_compteur_ecs_index1_0092a191

The measurement was conducted from 1st September 2020 until May 2022. During this period, there is only one period of winter 2019/2020, where we can exploit the data. Its data quality is 100%. Out of this period, many data holes lack more than one measure. We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100 or over 100.

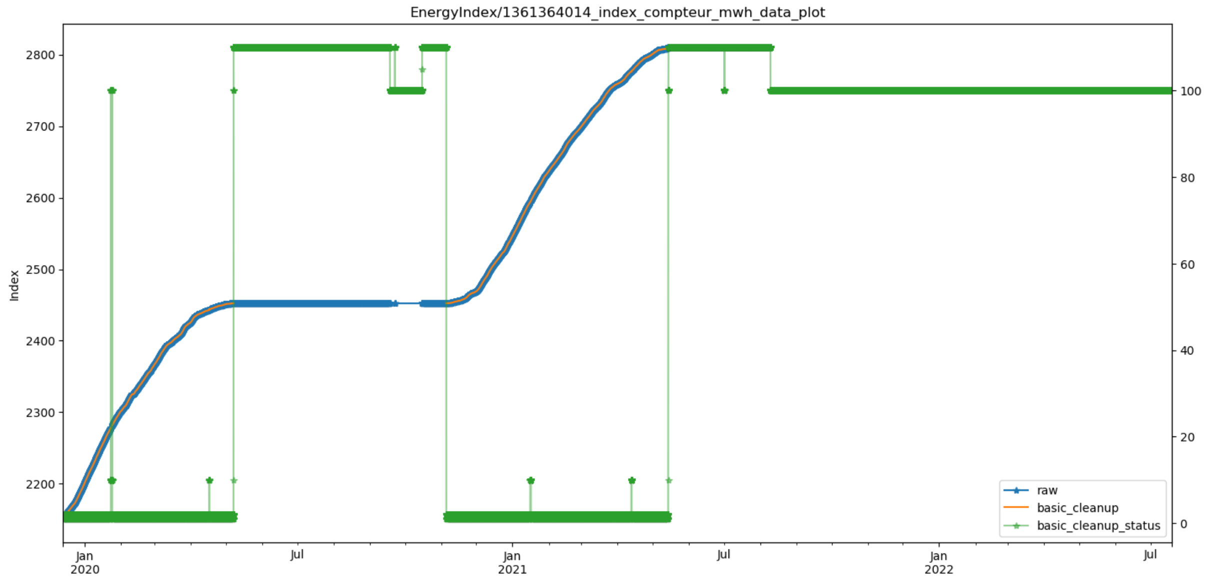


Figure 64 : Detection of data error of sensor 1361364014_compteur_ecs_index1_0092a191

The measurement was conducted from 1st December 2020 to 14 May 2021. During this period, there are some data holes, which lack more than one measure (May-October 2020). We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100 or over 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. The data quality of winter 2019/2020 and winter 2020/2021 is 87% and 90%, respectively. We can exploit the data correctly.

Power

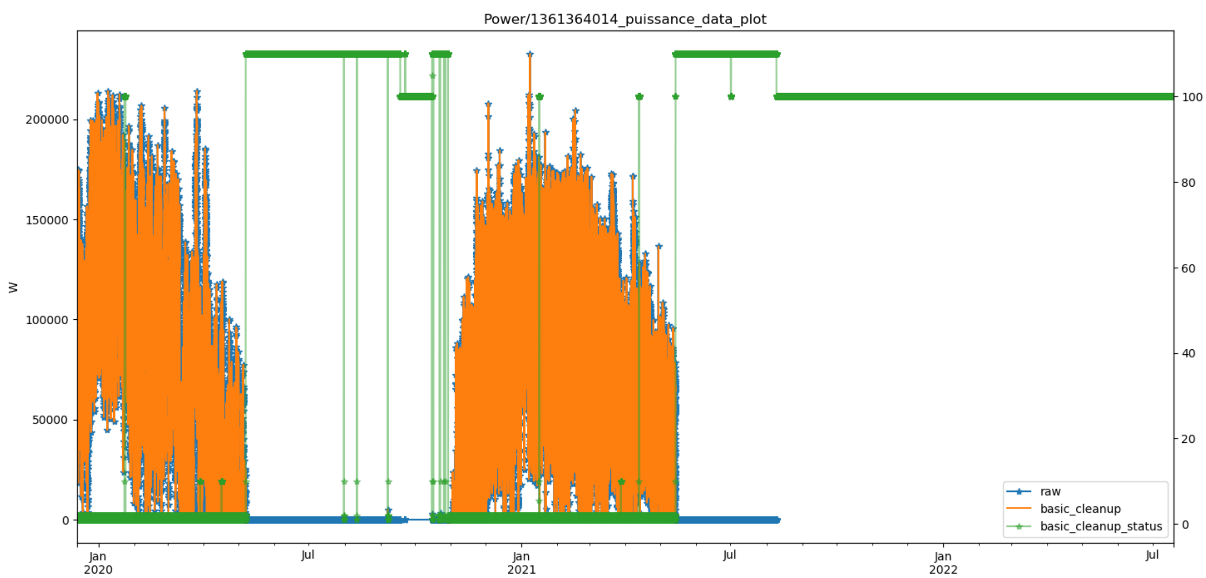


Figure 65 : Detection of data error of sensor 1361364014_puissance

The measurement was conducted from 1st December 2019 until 14 May 2021. During this period, there are some data holes, which lack more than one measure (May-October 2020). We cannot use the linear interpolation to fulfil the data. These data holes are presented as the green line, which has the detection value of 100 or over 100. However, these lacks do not impact on the data analysis because we only take into consideration the data during the winter season. The data quality of winter 2019/2020 and winter 2020/2021 is 86% and 91%, respectively. We can exploit the data correctly.

In conclusion, the data quality of sensors in **Tower 14** during the monitoring campaign from November 2020 until May 2022, is presented below.

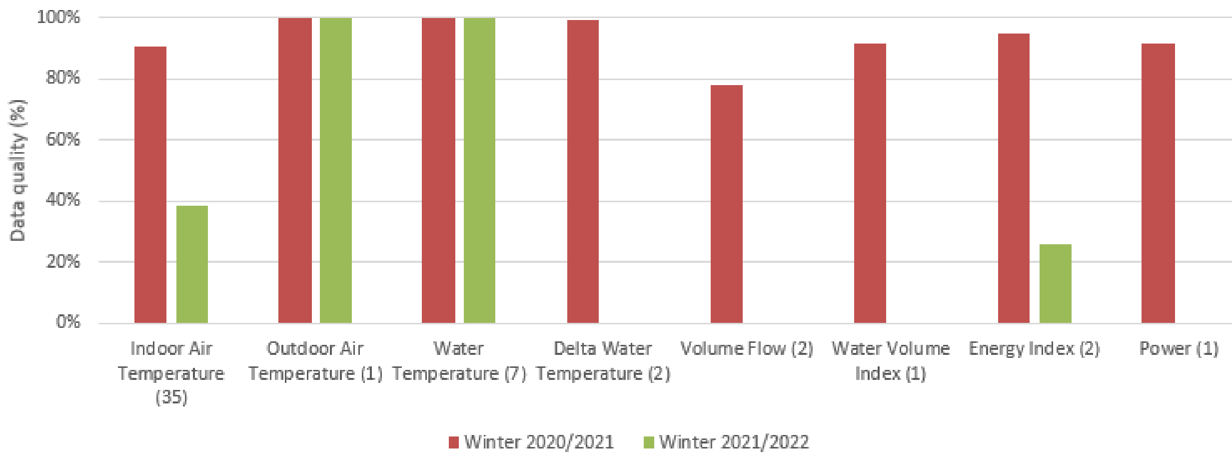


Figure 66 : Data quality of installed sensors in Tower 14

As can be seen, the measurement in winter 2021/2022 was available for only 4 categories of sensors, in which **only outdoor air temperature and water temperature sensors display a good data quality** (100%). Indoor air temperature and energy index sensors show a lower data quality (lower than 40%). The average reliability for all the sensors in winter 2021/2022 is 41%.

The CSTB recommended calculating energy savings for the period from November to December 2021 and estimating energy savings over the entire 2021/2022 heating season by interpolation. For the 2020/2021 heating season, all sensors display good data quality. The average reliability for all the sensors during this period is 86%. The energy saving can be correctly calculated from these data.

Based on these analyses and the available data, the energy savings for both buildings were calculated and are presented in the chapter on Measure 2: Optimization of the heating load curve.

2.3.4 Measure 4: Symbiotic waste heat networks

Once the development of the MVP was complete, it has undergone three main interactions through an Agile process (steered by the dedicated unit in EDF's Mediterranean Direction, called MedInLab). These interactions have enabled to obtain rapid end-user feedback and to implement meaningful feedbacks. This process gave input and support to adjust the Wireframe and its content. Feedback was the following: simplification, schematisation and contextualisation.

Simplification reflects a need to break down all technical wording and concepts towards common language and make information tangible for any kind of user. For example, “waste heat recovery” had to be simplified towards “energy recycling”, a word that made much more sense to all users providing feedback. This enabled to catch their interest and introduce the matter in a proper manner. Text needed to be largened to use longer periphrases and explanations as concepts could not be reduced to the technical wording used by “insiders” of the DHCN realm.

Schematisation was a consequence of simplification, as the whole system had to be explained based on its components. It was decided to enable, in the wireframe to move via schemes among the main DHCN components. These were source, distribution network, substation and additional concepts, as needed by the user or guided by his/her interest to know more about the technology. These sections were enriched with text, accompanied by video-animation, chosen by questioned users as their preferred mean of communication. Contextualisation refers to the need of users to understand what data relate to. The real-time data represented in curves or graphs at different scales of resolutions need to add value. Therefore, it was decided to overlay real time data on graphical representations of the source and substations, and from there, give the user the possibility to explore the displayed data more in detail.

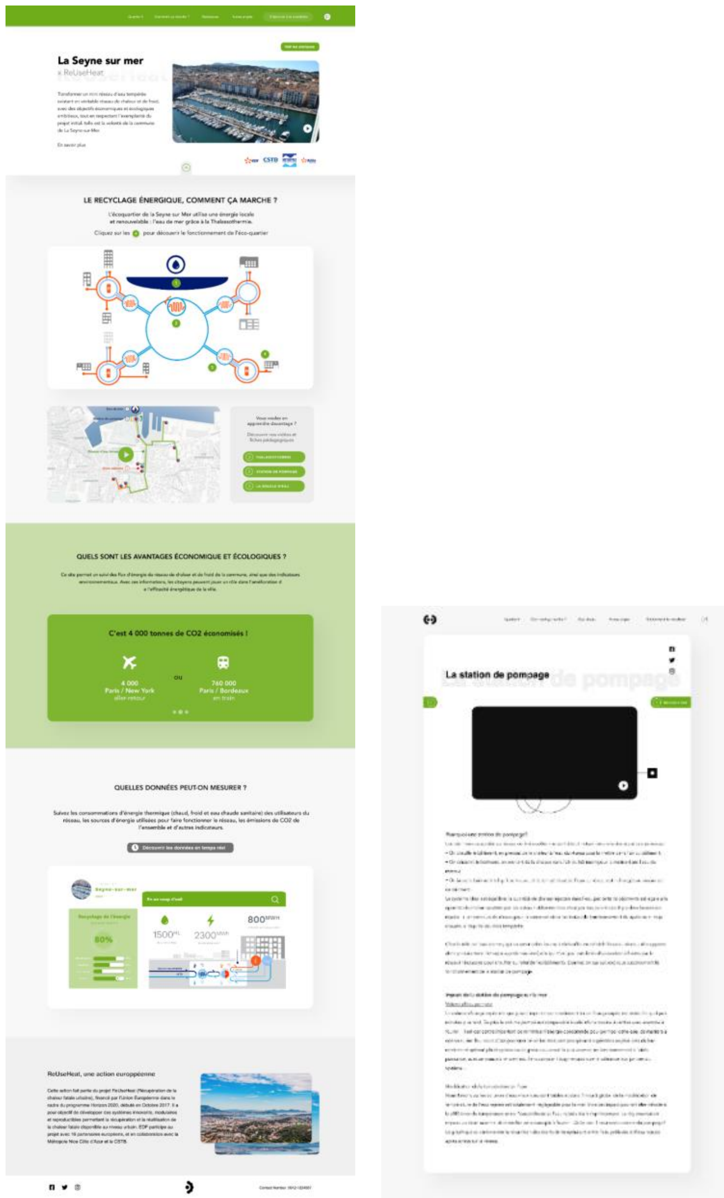


Figure 67 : new retained wireframe of the Dashboard – left : home page; right: one of the 3 newly added descriptive pages - here only the pumping station is visualized as the other pages are based on the exact same design. (Source: EDF)

2.4 Expected impacts and KPIs

2.4.1 Measure 1: Collective self-consumption

IMREDD

It was shown in section 2.3.1 that real life operational constraints during the experimentation phase prevented the building to achieve great KPIs, nor to demonstrate the relevance of the use of local storage assets. However, based on the results and load curves during the self-consumption experimentation phases, we can infer what would be the key results and KPIs when the battery is fully operational within the whole year. Therefore, annual self-consumption and production when the battery is fully operational and controlled to maximize self-consumption are given in Table 3, and show that the battery used at its full potential could increase self-consumption and self-production by 14.7% and 19.7% respectively. Similarly, an optimal battery control maintained during the whole year could double the time during which the building can be considered off-grid. This shows that it is necessary to maintain a high resilience of the ICT infrastructure to maintain optimal operations for the battery. Indeed, usual business models are designed using optimal behavior of the assets. Therefore, a gap in the way assets are operated can considerably increase the payback period.

*Table 5. Self-consumption and production rates from the period between 2021 and 2O22 for **IMREDD with battery fully used for self-consumption increase***

	Building with PV only	Building with PV and battery
Self-consumption	**77.7%**	**92.4%**
Self-Production	**42.3%**	**62%**
% of time off grid	**20.5%**	**43.7%**

Similarly, Figure 35, Figure 36 and Figure 37 show evolution of the time when the grid can be considered on grid, but also the self-consumption and self-production for a case where the battery is used for self-consumption for the whole time. We can see that an optimal control of the battery considerably impacts the main KPIs of the project.

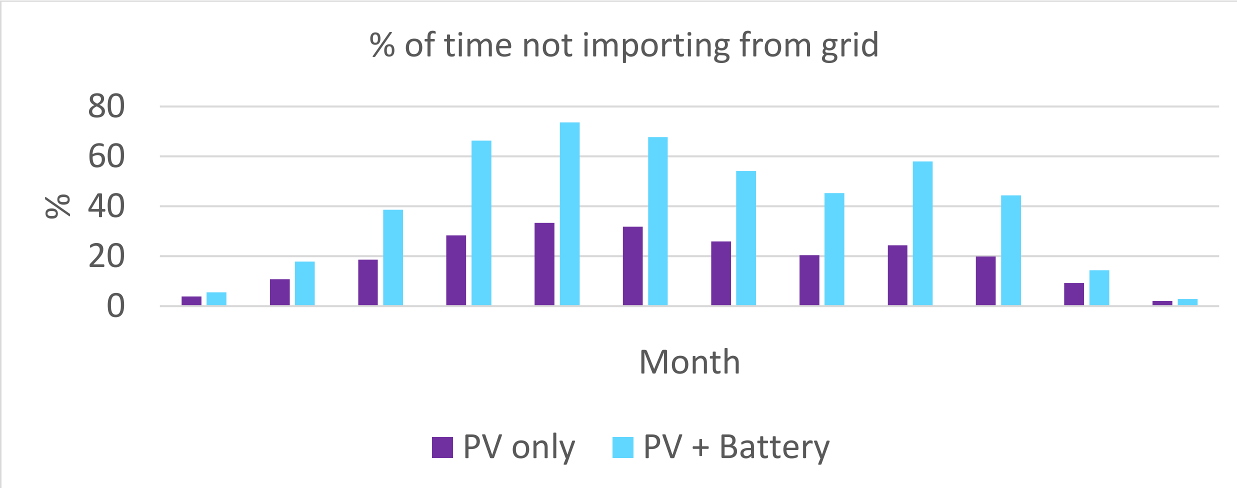


Figure 68. Percentage of time of grid when the battery is fully used for self-consumption

As one can see in Figure 70, the local production in summer is almost enough to supply the building's needs, as the self-production is close to 100%. However, Figure 68 shows that it is not enough for the building to be completely off-grid during these periods. Indeed, although the energy produced by PV is enough to cover the needs, ensuring instantaneous self-production requires to consider the power and not only energy. This first means that the battery should be well sized in order to ensure that daily production will cover the night needs. Figure 34 showed that in the case of the IMREDD's building, the battery cannot fully accept the local production, and is fully charged before the end of the daily PV production. Second, it means that the EMS should ensure each second that the building's production from PV and from the battery covers the building's consumption. Concretely, it requires to have a sub second monitoring and decision making capacity, that is usually not the case, especially when the assets come from different manufacturers with different requirements. As an example, solar PV installation used a specific data-logger that is feeding the EMS with the real time production of PV. However, this data is only available once every ten seconds at most in average. Therefore, the EMS could not go beyond a decision every 10 seconds.

Similarly, Figure 69 shows that thanks to the battery 100% of the local production is self-consumed during winter, which is due to the fact that the battery capacity is large enough to cover the winter production. However, it is not large enough to cover the summer's production, hence the need for the building to export or curtail during summer.

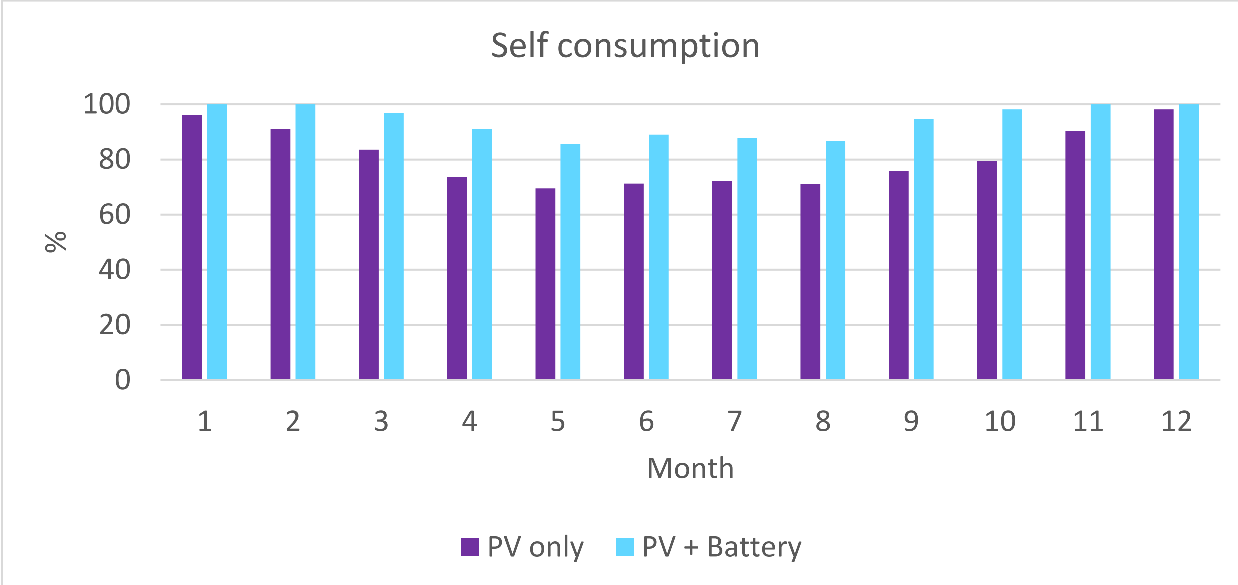


Figure 69. Self-consumption rate when the battery is fully used for self-consumption

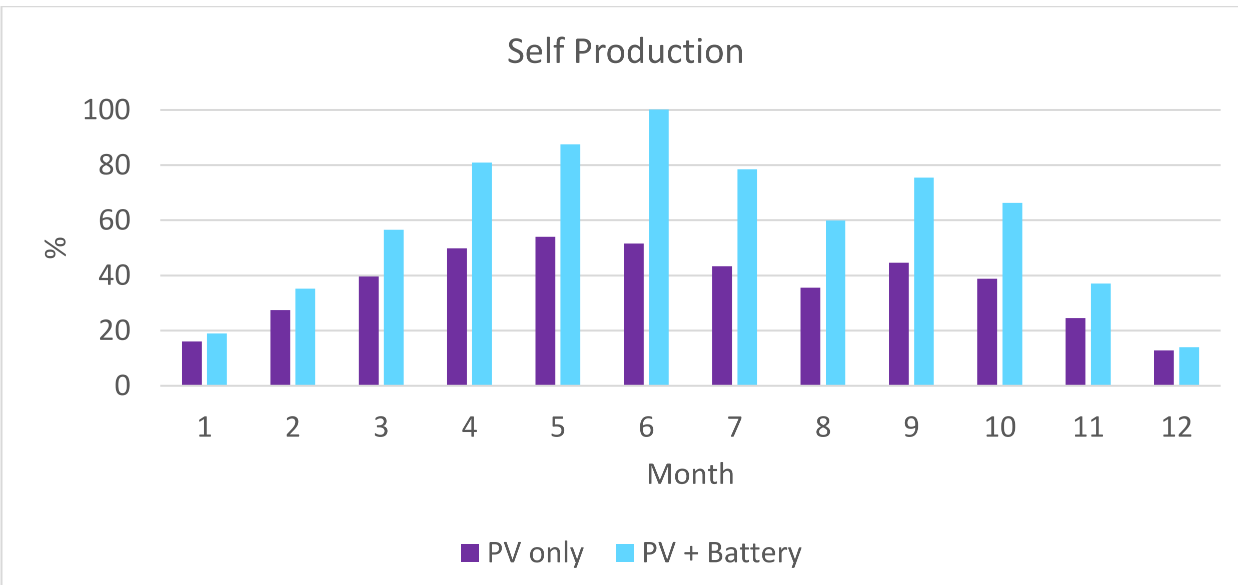


Figure 70. Self-production rate when the battery is fully used for self-consumption

PALAZZO

Similarly, the Palazzo's operations suffered from the same issue as IMREDD's building, which an inconsistent control of the battery that did not exploit the asset at its full potential. As a consequence, we propose here simulation results that show how much self-consumption and production could be expected if the battery had been used at its full capacity without any ICT issue.

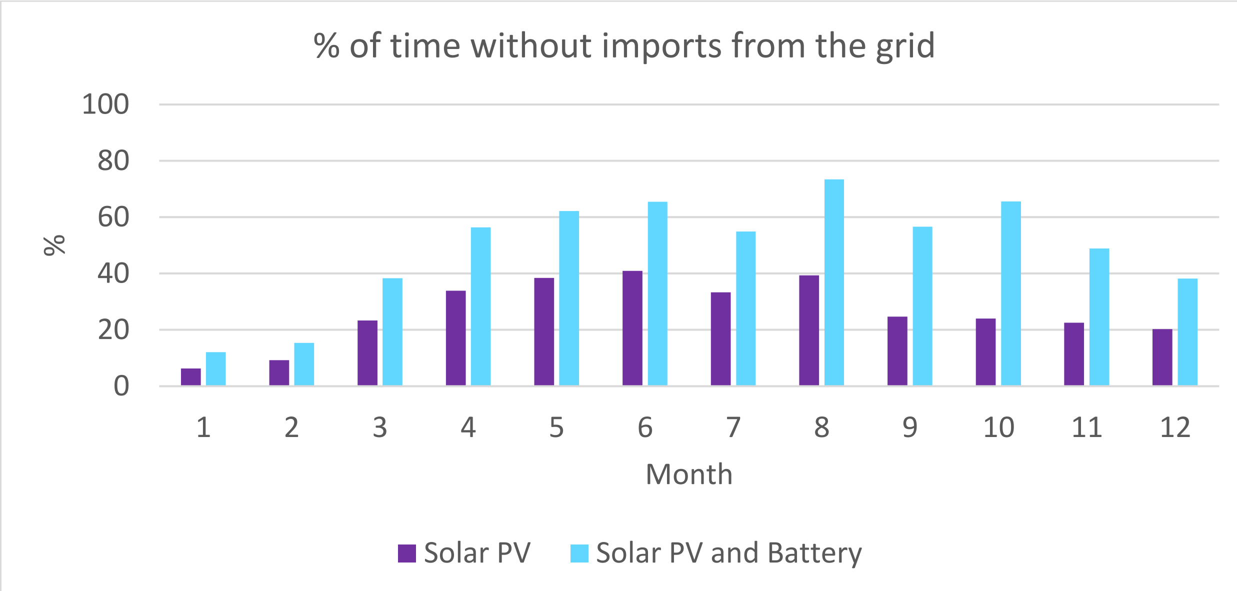


Figure 71. Percentage of time without imports from the grid when the battery is fully used for self-consumption

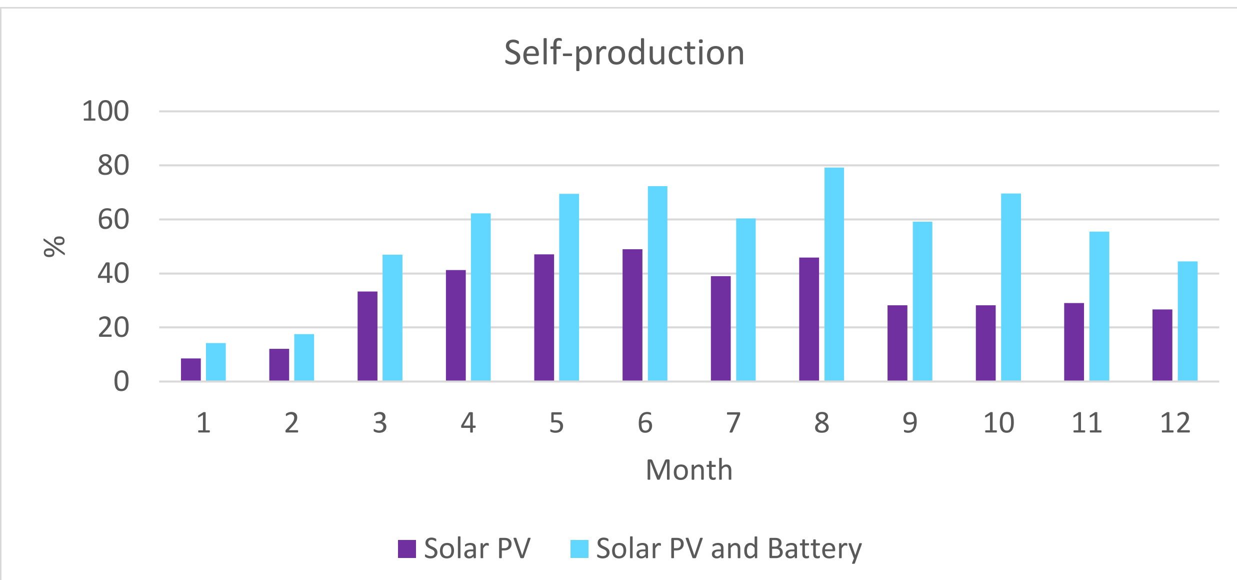


Figure 72. Self-production rate when the battery is used for self-consumption

Table 6. Self-consumption and production rates from the period between 2021 and 2O22 for ***the Palazzo with battery fully used for self-consumption increase***

	Building with PV only	Building with PV and battery
Self-consumption	**62.2%**	**82.7%**
Self-Production	**65.2%**	**81.4%**
% of time off grid	**27.7%**	**54.7%**

The gains that can be achieved by using the battery at its full potential for self-production are listed in Table 6, and show that the % of time off grid could almost be doubled. Although these results have not been obtained due to the fact that it is yet too soon in the experimentation phase, and that there were many ICT issues, they show that there is a potential for local flexibility to provide support to the local grid, and to reduce its dependency to other sources of power. The next subsections discuss the gains in terms of CO2 emissions, whereas section 2.5.1 discusses the financial considerations related to batteries.

CO2 emissions

Considering the CO_2 emissions that are avoided from the use of IRIS assets, we used the data from the French national grid operator, RTE[1], to assess the amount of $CO_{2,eq}$ avoided thanks to the local production. Table 7 shows the CO_2 emissions avoided for each of the buildings, depending on the asset considered. However, the numbers proposed in this table do not include the CO_2 emissions related to the manufacturing of the asset considered.

Table 7. Annual $CO_{2,eq}$ emissions avoided from the use of local assets for self-consumption

CO2,eq emissions avoided (tCO_2/year)	IMREDD		Palazzo	
	Use of PV only	PV with battery	Use of PV only	PV with battery
Real historical operations	**4851**	**5366**	**2251**	**2228**
Using battery to maximize self-consumption	**4910**	**7627**	**2251**	**3770**

The rest of the key performance indicators is displayed below.

Performance Indicators

[1] https://www.rte-france.com/eco2mix/synthese-des-donnees?type=co2#

The main key performance indicators listed below were filled with data from the year 2021-2022, considering only the results from the Nice experiment, measure 1 of the TT1.

Table 8. Key Performance Indicators for IMREDD and Palazzo buildings

KPI number	KPI name	Value for Imredd	**Value for Palazzo**
5	Carbon dioxide emission reduction	**7627 $kg_{CO2,eq}$**	**3770 $kg_{CO2,eq}$**
6	Carbon monoxide emission reduction		
10	Degree of energy self-supply by RES	**62 %**	**81.4 %**
15	Fine particulate matter emission reduction		
20	Increase in Local Renewable Energy production	**162 MWh/year**	**94.7 MWh/year**
21	Increased system flexibility for energy players/stakeholders	**110 kW/218 kWh**	**66 kW/90 kWh**
24	Nitrogen oxide emission reduction		
34	Reduced energy cost for customers	**22.7 k€/y**	**11.6 k€/y**
38	Reduction in car ownership among tenants		
39	Increased km by tenants and employees in the district		
42	Storage capacity installed	**218 kWh**	**90 kWh**
45	User engagement		
47	Quality of open data		
53	Storage Energy Losses	**2095 kWh/y**	**1380 kWh/y**

We can also compare the KPIs obtained against the forecasted ones.

Table 9. Key Performance Indicators comparison with initial values for IMREDD and Palazzo altogether

KPI name	**Target**	**Achieved value**
Local renewable energy production (MWh/year)	**360**	**250**
Carbon dioxide emission reduction	**24 tCO_2/year**	**11 tCO_2/year**
Degree of energy self-supply by RES	**80 %**	**72 %**
Storage capacity installed	**300 kWh**	**308 kWh**
Energy savings	**340 MWh/year**	**195 MWh/year**

As we can see, the local renewable energy production in 2022 achieved did not meet the target set at the beginning of the project. This is mostly due to the fact that the size of solar PV installed had to be reduced, but it is also due to the fact that solar panels did not produce as much as they should have in 2022. Reasons for this are multi-fold. First, the presence of excessive dust on solar panels that were installed horizontally. As an example, the presence of dust was responsible for an 8% decrease in production compared to the theoretical expectations. Also, another source of difference in production is related to shadings and weather. Different sources of shading (appliances on the roof, other building's construction) appeared after the construction of IMREDD's building, which affected the annual PV production compared to the theoretical values. Finally, weather was not as good as theoretical annual radiation. Altogether, it can explain parts of the difference between the KPI target and the achieved value. Also, it is important to highlight the face that solar PV data loggers experienced connectivity issues, resulting in the loss of some of the data from summer and end of the year. Therefore, the proposed number (250 MWh/year) is extrapolated (based on data from 2021 or computed from days within the same month for which data was available) to achieve an annual value. This might have some impact on the KPI difference as well.

This difference in solar PV annual generation also explains the low degree of energy self-supplied by RES, as this KPI consists in the Ratio of locally produced energy from RES and the energy consumption over a year. The local production was lower than expected.

Therefore, although the installed storage capacity exceeds the KPI target, the energy savings, computed as the annual total reduction of the building energy consumption after Measure 1 is implemented, were not as high as expected. Also, the energy savings target depends on the buildings initial consumption. In the case of IMREDD's building, the annual energy consumption is around 240 MWh/year, which is much less than the 600 MWh/year forecasted at the construction phase of the building. This explains the difficulty to reach this KPI, as the actual consumption values do not allow us to achieve such energy savings.

Although most of the KPIs are not met, some other important criteria are to be taken into consideration. First, the percentage of time off grid is also to be considered and went from 0% when no assets are installed to 24% when only solar panel are connected, and to 49.2% when the batteries are used to self-supply the buildings. Also, taken as percentages instead of absolute values, the grid import reduction went from 0% without assets to 35% when only solar PV is installed, and to 39% when batteries are added to the building's assets list. This also highlights the fact that KPIs targets would be better suited if they had considered relative values of impact reduction compared to a case without distributed energy resource. Indeed, as an example for energy savings, absolute values of energy reduction only make sense if this energy reduction is lower than the baseline energy consumption, which is hardly the case here.

Collective self-consumption

We have seen so far, the results from the Nice experiment that aimed to deploy two integrated energy systems in smart buildings. However, future energy systems will not be limited to a building and will leverage the concept of energy communities. This will allow buildings to exchange energy in order to maximize self-production at a more relevant scale, which is the scale of the neighborhood. This section highlights the expected impacts that could be reached in the case of an energy community constituted by the two buildings considered in this experiment, i.e., the Palazzo and Imredd's building.

First, considering only PV without the battery, we can see in Table 10 that self-consumption, self-production and the percentage of time when the two buildings together can be considered as off grid is not considerably increased.

Table 10. Self-consumption and production rates from the experimentation period between 2021 and 2O22 for the energy community constituted by the IMREDD and Palazzo buildings with current batteries (fully used for self-consumption increase

	Buildings with PV only	Building with PV and current batteries
Self-consumption	**76.8%**	**94.3%**
Self-Production	**42.8%**	**66.1%**
% of time off grid	**22.4%**	**52.2%**

The associated State of Charge of the battery of the community of (170+90 kWh) is shown in Figure 73, where we can see that during the winter period, the battery cannot be charged enough to increase self-production.

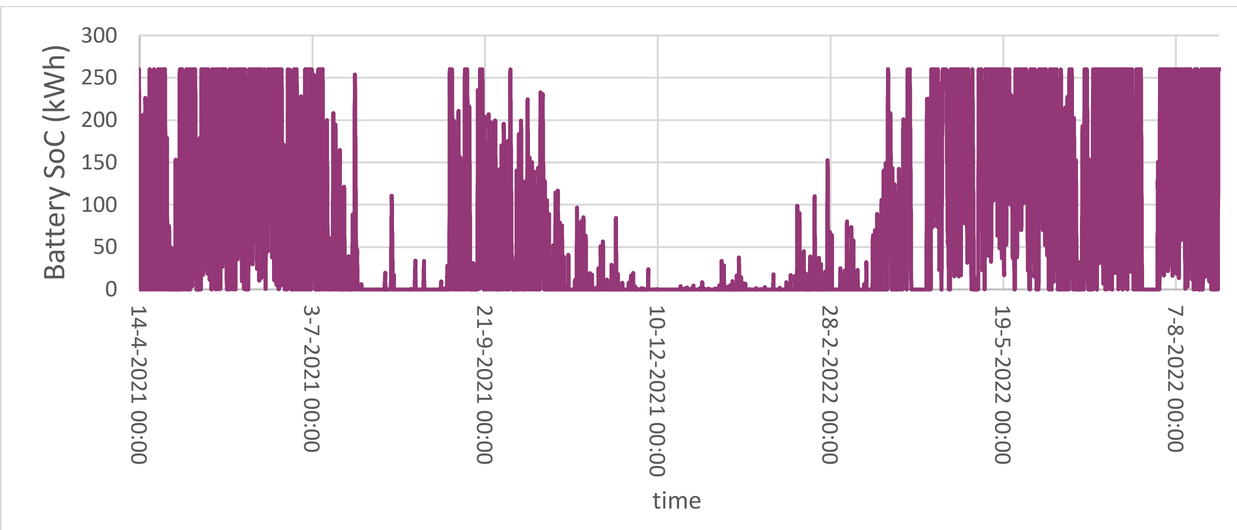


Figure 73. State of Charge of a community battery of 260kWh used as a flexibility asset for self-production at the community scale

Also, the small improvements for the main indicators compared to the case with two separate buildings is mostly due to the fact that the two buildings have the same type of production asset (solar PV), located at a very close location, and due to the fact that load curves are very similar, both typical from tertiary and commercial buildings, as shown in Figure 74. Therefore, the local PV production that is usually not consumed by a building will not be consumed by the other building as they have a similar load reduction at the same time.

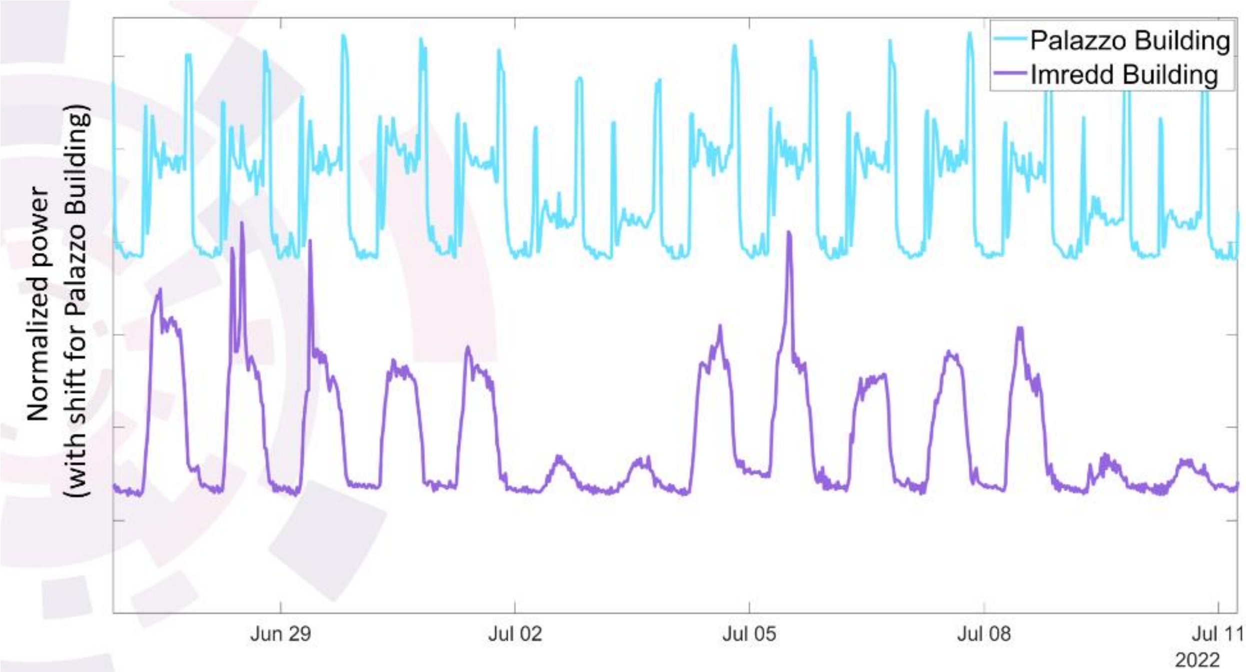


Figure 74. Normalized typical load curves for the Palazzo and Imredd building

However, weekends are different as there is a reduction of consumption from IMREDD's building. We could think that the extra production from IMREDD's building can supply the Palazzo building, but in reality, we can see from Figure 75 that the extra production from IMREDD's building does not really impact the self-consumption, self-production nor the time during which the Palazzo building can be considered as off grid. Therefore, due to the fact that both buildings have the same type of production and the same load curves, there is no considerable gains to constitute an energy community between both buildings if we only consider solar PV as the local production source.

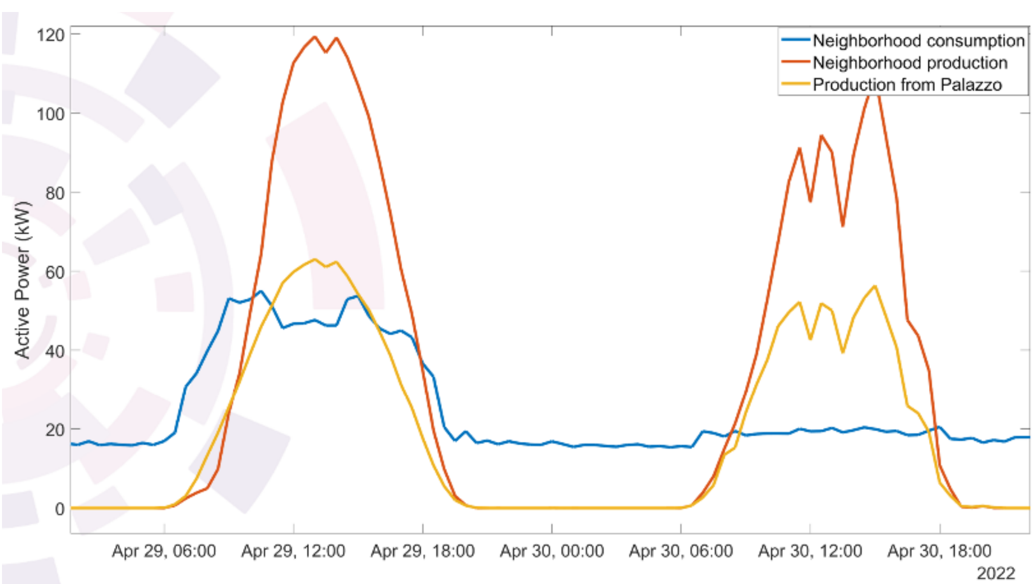


Figure 75. Zoom on week ends for the neighbourhood, with local production and consumption

Therefore, we will now consider a neighborhood with local storage to assess the impact on the main key indicators (self-production, % of time off grid, …). Figure 76 shows that small battery sizes provide good improvements, whereas if it was required to have the buildings off grid for the whole year, it would result in considerable sizes of storage assets, which is obviously unfeasible. The main question that remains is the optimal battery size to take and thus the maximum self-production rate that can be expected. This can be resolved by considering the simple payback period, the CO_2 emissions, but also by considering the grid requirements to ensure that the size chosen will be able to provide grid services when needed.

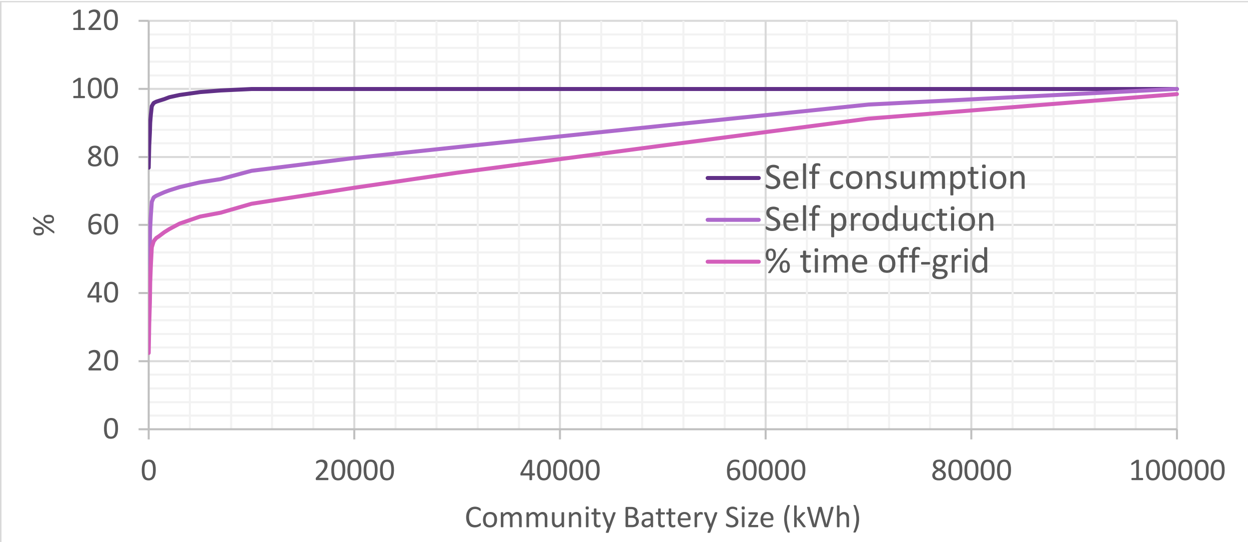


Figure 76. Impact of the community battery size on the main indicators

2.4.2 Measure 2: Optimization of heating load curve

As reminder as previously mentioned, Initial Gas price reference set at PGO 39.62€/MWH and PHO at 61.8€/MWH in 2019 have been updated to PGO 138,67€/MWH and PHO 216.3€/MWH in 2022.

All calculation (consumption, Effective day degree (DJR), 30y day degree (DJT), R) correspond to the heating season of the buildings, in average 190 days. 1 year of heating = 190 days which is more realistic than the initial scenario.

Energy consumption is linked to real Unified Day Degree (DJU)

Heating season 2020/2021 is the first season of adjustments and tests of the 3 solutions.

Version 6	11/07/2022		Gas price reference € HT/MWH 2019
S=5342m2 X 2			PGO 39,62
17 etg			PHO 61,8
66 flats/building	T13&T14	Nice Moulins	

References			T13	T14	Effective Day Degree (DJR) Weighted calculation reference	30y day degree (DJT) weighted calculation reference
Effective Day Degre (DJR) zero	2018-2019		1088	1148	1118	1257
Reference zero consumption	2018-2019		465	410		

C	Gas price reference € HT/MWH 2022	01/07/2018 – 30/06/2019 = 39.62
3,5	PGO 138,67	01/07/2019 – 30/06/2020 = 30.77
estimate	PHO 216,3	01/07/2020 – 30/06/2021 = 23.86
1st June 2022		01/07/2021 – 30/06/2022 = 50.95

All calculation (consumption, Effective day degree (DJR), 30y day degree (DJT), R) correspond to the heating season of the buildings, in average 190 days. 1 year of heating = 190 days

Energy consumption linked to real Unified Day Degree (DJU)

- **Tower 13 :**

									K	0,453
Energy savings									CO2 red	
E rt (MWh/M2* yearly adjusted reference consumption heating period)	T ec (MWh/M2* yearly observed consumption heating period)	E st (MWh) %	Target (MWh) %	MWh savings heating season	KWh savings heating season/m2	Price savings (€ PHO 2019)	Price savings (€ PHO 2022)	Price savings (€ PHO 2019-2022)	m CO2 (t eq C02)	Target m CO2 (t eq C02)
0,087	0,087	0	0	0	0	0	0	0	0	0
0,078	0,082	Inconclusive	20,0	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	45
0,092	0,067	27,3	20,0	97,2	18,2	6005	21016	13510	60,6	45
0,093	0,076	18,6	20,0	75,0	14,0	4635	16223	10429	41,7	45

As energy market is not stable in the current economic and geopolitical context, we have taken 3 references for gas market price.

Solution 1+2	Amount	Unit
Investment	208 827	€
MWh savings heating season	75	MWH
Maintenance (2% Investment)	2	%
m CO2 (t eq C02)	41,7	T
Estimation taxe CO2	80	€/T

* Market gas price (PEG NORD) = 50 €/MWH		Unit
* PGO Estimation	78,86	€/MWH
* Maintenance	4176,54	€
* Price savings	1737,96	€
* CO2 saving	3336	€
*Payback time ROI	41	Year

* Market gas price (PEG NORD) = 75 €/MWH		Unit
* PGO Estimation	108,95	€/MWH
* Maintenance	4176,54	€
* Price savings	8171,25	
* CO2 saving	3336	
*Payback time ROI	18	Year

* Market gas price (PEG NORD) = 115 €/MWH		Unit
* PGO Estimation	157	€/MWH
* Maintenance	4176,54	€
* Price savings	11775	€
* CO2 saving	3336	€
*Payback time ROI	14	Year

The solution 1+2 is positive after 14 years

- **<u>Tower 14 :</u>**

									K	0,453
Energy savings									CO2 red	
E rt (MWh/M2* yearly adjusted reference consumption heating period)	T ec (MWh/M2* yearly observed consumption heating period)	E st (MWh) %	Target (MWh) %	MWh savings heating season	KWh savings heating season/m2	Price savings (€ PHO 2019)	Price savings (€ PHO 2022)	Price savings (€ PHO 2019-2022)	m CO2 (t eq C02)	Target m CO2 (t eq C02)
0,077	0,077	0,0	0	0	0	0	0	0	0	0
0,069	0,080	Inconclusive	5	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	Inconclusive	9
0,081	0,065	19,0	15	66,3	12,4	4097	14338	9217	37,1	27
0,082	0,068	16,8	15	61,1	11,4	3778	13224	8501	33,3	27

Season 2021/2022, CO2 reduction of 33.3

Solution 1+3	Amount	Unit
Investment	158 141	€
MWh savings heating season	61,1	MWH
Maintenance (2% Investment)	2	%
m CO2 (t eq C02)	33,3	T
Estimation taxe CO2	80	€/T

* Market gas price (PEG NORD) = 50 €/MWH		Unit
* PGO Estimation	78,86	€/MWH
* Maintenance	3162,82	€
* Price savings	1655,526	€
* CO2 saving	2664	€
*Payback time ROI	37	Years

* Market gas price (PEG NORD) = 75€/MWH		
* PGO Estimation	108,95	€/MWH
* Maintenance	3162,82	€
* Price savings	6656,845	€
* CO2 saving	2664	€
*Payback time ROI	17	Year

* Market gas price (PEG NORD) = 115€/MWH		
* PGO Estimation	157	€/MWH
* Maintenance	3162,82	€
* Price savings	9592,7	€
* CO2 saving	2664	€
*Payback time ROI	13	Year

The solution 1+3 is positive after 13 years.

Data are issued for a heating period with 190 days in average.

The data collected over the period 01/01/2020-31/12/2020 is not considered as relevant due to the mix of different solutions. As mentioned previously, there were issues regarding the installation of temperature probes in the apartments and problems with the correct pump set-up.

2020-2021 period has been so far the period with the best energy savings 27% on T13 and 19% on T14, both superior to the fixed targets (20% and 15%).

We can consider that the two installations have been stabilized over 2021-2022 regarding equipment degradation, algorithm self-adaptation and technical adjustments.

The results for the last heating period are acceptable, keeping in mind that there was continuous degradation from the tenants. Target respected in overall.

The solution 1+3 on Tower 14 seems to be more attractive in an environment of social housing with energy savings stabilized around 17%.

NB : Engie's contract with Côte d'Azur Habitat ended on June 30th, 2022.

2.4.3 Measure 3: Commissioning process from the design to the operation

As shown in Section 2.3.3, there were problems during the monitoring campaign that prevented a very high level of quality in data collection from being achieved. In this section, we analyse the KPI **“Data loss prevention”**.

Besides, we analyse the KPI “**Advantages for end-users”** to qualify and quantify the impact of the integration of a smart control system (see measure 2) in the 2 monitored towers (T13 and T14) on the different stakeholders.

KPI “Data loss prevention”

This KPI is the ratio (expressed in %) between the number of lost data and the total number of collected data over the monitoring campaign. This ratio can also be calculated as:

KPI “Data loss prevention” = 100% – Data Quality Indicator (%)

where Data Quality Indicator (%) has been calculated in section 2.3.3.

The results for all sensors of the two monitored buildings are showed in the figures below:

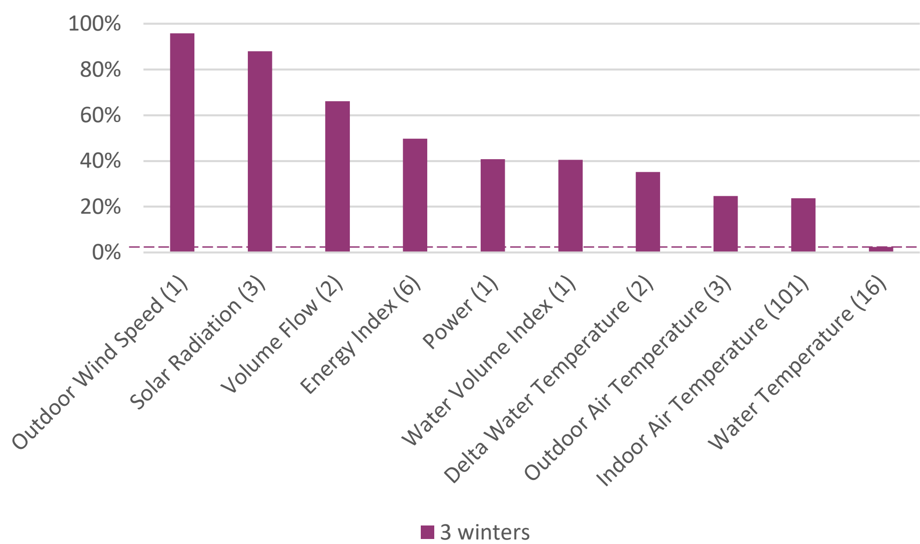


Figure 77 : Data loss prevention KPI of installed sensors in two buildings over the monitored period

The average KPI **“Data loss prevention”** for all sensors over the 3-years measurement period is 25%, which is higher than the KPI target of less than 2%. Several reasons can explain the gap:

- The sensor’s characteristics:
  - The sensitivity of the sensors decreases over the 3-years measurement period (ageing effect) which leads to a drift of the measured values
  - Some sensors are connected to electric batteries that have not been replaced over time
- Impact of other factors during the monitoring campaign:
  - Impact of outdoor environment on the sensor uses (wind, solar, etc.)
  - Impact of occupants (move the sensor to other places)

As mentioned in part 2.2.2 and 2.3.2, only data measured from indoor air temperature and water temperature sensors are essential for energy saving calculation. The data loss prevention ratio for water temperature has a KPI value of less than 2%, which achieves the goal. This is because water temperature sensors have less interaction with the external environment than other sensors. The measured values were sufficiently stable during the 3 years of measurement. Indoor air temperature sensors were more impacted by occupant behaviour (see explanation below). This is why the data loss prevention ratio for this category of sensors has a KPI value close to 23%, which is higher than what was expected for the demonstration.

As the other categories of sensors are less important for the demonstration, they were not prioritized when they had a problem. This may explain why the KPI values of these sensors are above 30%. For example, the sensors measuring outdoor conditions, such as outdoor wind speed and solar radiation have a KPI value higher than 80% meaning that these sensors are or have been (for some periods) out of service.

KPI “Advantages for end-users”

As mentioned before, measures 2 and 3 are strongly connected.

In Measure 2, the KPIs were calculated to assess the advantages and disadvantages of a new smart control system to offer tenants the opportunity to adapt the heat supply to their own comfort needs. This assessment was only carried out from a technical and economic point of view.

In Measure 3, we introduced an additional criterion based on the point of view of the end users on the solution developed in Measure 2. Three survey questionnaires were developed for three categories of stakeholders: the building owner, the building's energy manager and the building tenants. These 3 questionnaires are presented in Appendix 1. One-to-one questionnaire-based interviews were conducted with representatives of building owner (CAH) and building energy manager (ENGIE). An electronic version of the questionnaire was emailed to tenants. 25 of the 70 tenants (35%) contacted returned their completed questionnaires.

The results of the interviews and questionnaires were analysed against three main issues: cost savings, increased comfort, and improved stakeholder relationships.

Cost savings

The building owner indicated during the interview that he did not have a clear picture as to whether the solution promoted by Measure 2 has a positive or negative impact on the energy bill at the building level in particular during the period 2019-2021. The reasons for that are threefold:

First, the impact of the health crisis 2020/2021, such as containment and work from home disrupts normal occupancy cycles and consequently energy consumption values. On the one side, in some apartments, tenants stayed at home more during the Covid period, comparing to previous periods, for example 2019. Consequently, more energy was used in heating, ventilation, lighting, etc. and the energy bill tends to increase. On the other side, in some appartements, tenants have left their home during the Covid period. Consequently, less energy was used, and therefore, the energy bill decreased. Secondly, the impact of the 2022 energy crisis with the sharp increase in the price of energy (gas and electricity). Even if measure 3 provides significant energy savings, these saving are offset by the increase in energy prices. Finally, the different weather conditions encountered during the 3 years of the monitoring campaign make the assessment difficult.

The building energy manager is much more aware about the potential impact of measure 2 on cost savings (see section 2.4.2). However, he admits that the results measured on site were partly skewed by malicious actions. During the measurement campaign, some tenants understood that the temperature level in their home was influenced by the position of the indoor temperature sensor. These tenants moved the temperature sensor from one location to another to adapt their comfort level to their needs. For example, during the winter, some tenants who felt that the setpoint temperature of 19°C was not sufficient, moved the indoor temperature sensor outside. The heating system is then activated automatically, and the indoor air temperature of the apartment is increased. As a result, the energy bill is higher than expected. Aware of this malicious behaviour, ENGIE has modified some algorithms of its smart controller. Now the smart controller does not control anymore the indoor air temperature of each appartement but controls the average indoor temperature of a group of apartments (generally, all apartments on the same floor). If the average indoor temperature of this set of apartment decreases, the smart controller will increase the temperature to meet the setpoint temperature. If the temperature of an apartment is too different from that of the group, the controller does not control the temperature of that apartment. This keeps the temperature in each apartment in the building at a roughly identical level and then generates savings. The temperature in each apartment and in the common area is automatically controlled by ENGIE via the indoor temperature sensor, set at 19°C.

Along with the savings on the energy bill that occupants pay, Measure 2 also has a significant impact on care and maintenance costs because the monitored solution is easy to install, maintain and use, which meets the target of “**Advantages for end-users**” KPI.

Increased comfort

Before the installation of measure 2, the tenants of some apartments felt too hot, especially those closed to the South facade, because of solar gains. Implementation of measure 2 solved this problem. The splitting of the heat distribution network into 2 new distribution networks (one for south-facing apartments, the other for north-facing apartments) and the differentiated control of the heat supply of these 2 networks contributed to reduce overheating and decrease energy bills. In addition, the installation of a new smart controller maintaining the same temperature level in all apartments on the same floor is perceived favourably. However, during the work phase related to the upgrade of the heating system, some tenants (29%) felt bothered by noise, odours, ...

Although with the increase in energy prices, most residents are worried about their energy consumption and therefore their energy bill, 92% of tenants feel that a set temperature of 19°C is too low and 60% even answer that they feel uncomfortable. Indeed, some tenants have additional heating systems, for example electric radiator, to increase their comfort.

Overall, only 20% of tenants feel satisfied with their thermal comfort (which is lower than the target of 80% fixed for the demonstration) but this is not related to the implementation of Measure 2 but to the obligation to maintain the indoor temperature at 19°C set by the social landlord.

Improved relationships between tenants, building owner and building energy manager.

Information about the renovation of the heating system was announced to tenants via letters, stickers in the lobby and for some of them face-to-face discussions at the early stage of the experimental campaign. However, only 12% of tenants in both towers reported being informed of the planned work. This is lower than the target of 80% fixed for the demonstration. However, this data should be used with caution. Indeed, CSTB conducted the survey at the end of the experimental campaign. In the meantime, there have certainly been new tenants who have moved into the towers after the implementation of measure 2. These new tenants may not have been aware of the installation of a new heating control system.

Most tenants (90% on average on both towers) agreed to let the energy manager install a temperature sensor inside their apartment. Although explanations have been provided on the role of this sensor, some tenants have been afraid that this sensor will be used to spy on them in their homes. About 10% of tenants in whose homes the sensors were installed moved them away from their dedicated location or even threw them in the trash.

According to the maintenance contract, the energy manager must provide energy to maintain the indoor air temperature in each apartment at the setpoint temperature set by the social landlord. While tenants are not satisfied with this setpoint temperature, the rate of tenant complaints about thermal comfort did not exceed that recorded by the energy manager in the years prior to the implementation of Measure 2. It means that the implementation of Measure 2 does not affect the relationship between tenants, building owner and building energy manager.

2.4.4 Symbiotic waste heat network

Main outputs from the web-based questionnaire were that the Dashboard validated its main objective of awareness raising:

- 90% of the web survey respondents agree, to strongly agree, that after having consulted the Dashboard, their understanding of renewable district heating networks has increased,
- In terms of “completeness” of the tool, whilst most agree that the information already entailed is relevant and appropriated, half of the respondents considered that additional information could be integrated,
- Half of respondents answered that the Dashboard should be made accessible via “other media”.

For both DHCN operator and local authorities, the Dashboards needs additional communication actions to unlock its upper value, focusing on raising the awareness about such tool within a local community. Such a communication plan should focus on two channels:

- divulgate the access to the Dashboard via QR-Code for example, using local newspapers, public advertisement panels and possibly, door-to door flyers and last but not least, be integrated in the local authority’s webpage,
- secondly, target local educational institutions to present the Dashboard and use so the Dashboard as an educational tool.

This has been integrated in the replication plan in vision of a wider deployment of the service via EDF’s subsidiary DALKIA.

What also stands out, is that “public calls for tenders” for DHCN, should be the ideal manner to deploy the Dashboard. Being a rather innovative service, it could enable to the bidder to provide innovative and upper value to the overall offer. The value is thus on the awareness rising for the community via the chosen “playful” and simple format, and the transparency on the “green value” of the technology of such public-stakeholder lead projects.

These have been stated to become more and more “a must have” in the bidding process, where transparency in operation performances and accessibility of information via project specific webpages or other media, is expected. Such action becomes part of bidding requirements and thus, binding by contract. The driver for a public authority in doing this is also to boost the “collective awareness” of its citizens, which is yet not given. In addition, tertiary customers see a value to integrate such tools in their own communication actions concerning their own "social and environmental responsibility commitments", easing communication with own staff but also external parties (i.e. reporters).

These aspects give very valuable feedback on the improvement of the Dashboard in terms of indicators to display and channels to prioritize for the communication and replication plan, as this be part of the overall business model to be presented to the internal working group of EDF and DALKIA. Apart from developing and validating the operation of the dashboard itself, to increase awareness about low temperature DHC, the ReUseHeat partners had the opportunity to assess the performance of the DH&C network in LSSM thanks to the availability of data provided by the network owner DALKIA. The availability of data was for more than 1 year covering a complete reporting period it is shown in the table below. The dashboard was built with the intent to visualize the real time data and performance of low temperature waste heat solutions at district level. It was not built with the intent to, itself recovery waste heat, which makes it different from the other demonstrators in the project: it does not have any foreseen intended impact on the DHCN operation or automation, beyond the visualization needs for creating awareness for the general public.

Table 11 : Visualized numbers from the district energy system of La Seyne sur Mer (Source: EDF).

Demonstration case	Impact	Intended Result	Achieved based on real data during monitoring period
Seawater heat recovery (France)	Heat supply [MWh/yr]	Not apply*	1,190
	Cooling supply [MWh/yr]	Not apply*	1,416
	Energy recovered [MWh/yr]	Not apply*	For cooling: 1,745 For heating: 829
	Electrical consumption [MWh/yr]	Not apply*	1,074
	Primary energy saved [MWh/yr]	Not apply*	482
	CO_2 emissions saved [tonnes/yr]	Not apply*	271

2.5 Business models and exploitation

2.5.1 Measure 1: Collective self-consumption

The procurement of local energy resources allows the reduction of electricity supply cost. However, the high investment costs are usually considered as an obstacle to the deployment of distributed energy resources in the urban environment. Based on the results from the IRIS project, we have conducted an economic analysis on the potential bill reductions from the procurement of PV and of storage assets. Considering that there will be no feed in tariff in the near future, and considering a flat import tariff of 17c€/kWh for the use case of Nice, we obtain for IMREDD a simple payback period of 16 years for solar PV, and 14 years when the battery is used for self-production during the whole life time, without any down time (see Table 12). The large simple payback period for solar PV is explained by the fact that solar PV installation was oversized compared to the building needs, which results in solar PV surpluses that are not sold as the assumption was taken that there is no feed-in-tariff. Then, considering the 14 years for the battery compared to a lifetime between 10 and 15 years, it demonstrates that there is today little financial incentive for batteries used in the sole purpose of self-production, and shows that it is required to multiply the number of revenue sources to make batteries profitable. Among the revenue sources, there is the participation to wholesale energy markets, for portfolio balancing, the participation to frequency markets, or to new markets such as voltage regulation markets or local peer to peer.

Table 12. Simple payback period for the case of IMREDD when using a battery for self-production only

	Consumption only	Consumption with PV	Consumption with PV and experimental battery
Annual Bill (€)	40 269	25 625	17 522
ROI (years)	-	15.7	13.8

However, due to the experimental phase for the 2021-2022 period, the battery was not used for self-production most of the time. This resulted in different economic incentives. Indeed, based on the monitored data, the economic values from the last period are presented in Table 13, and show a return on investment above 47 years. This demonstrates the need for Energy Management System to be reliable, and to always operate in the proper way, to minimize the bill of the end-users.

Table 13. Simple payback period for the case of IMREDD with operations experienced between 2021 and 2022

	Consumption only	Consumption with PV	Consumption with PV and experimental battery
Annual Bill (€)	40 269	25 625	23 234
ROI (years)	-	15.7	46.8

In the case of the Palazzo building, the return on investment in the case of an optimal battery control are similar and shown in Table 14. The solar PV installation is better sized compared to the building consumption needs, which results in a lower payback period. However, when the battery is used for self-production, the time for return on investment is above 27 years, although the battery should be changed after 10 to 15 years. This demonstrates the difficulty to incentivize residentials to invest into flexible assets as it is difficult to make them profitable.

Table 14. Simple payback period for the case of Palazzo when using a battery for self-production only

	Consumption only	Consumption with PV	Consumption with PV and experimental battery
Annual Bill (€)	19 035	12 128	7 467
ROI (years)	-	11.1	13.6

2.5.2 Measure 2: Optimization of heating load curve

Investments launched for the three solutions represent important amounts. It includes equipment, subcontracting and installation costs.

Social housing with old buildings with very few energy consumption management has been considered as a good candidate for the project.

After implementing the tree solutions, the solution 1+3 appears as the best technical-cost optimization but with a payback only after 13 years (with a gas market price at 115€/Mwh)

As such, the potential customers who can duplicate the same solution have to consider important amounts of investment from the beginning. Initial studies need to be launched upfront in order to understand each building network and potentially save works expenses.

This type of project can be launched towards final customers who have a sensitivity to energy consumption, to avoid degradation as experienced in T13 and T14 during the works, monitoring and implementation phases.

2.5.3 Measure 3: Commissioning process from the design to the operation

Regarding measure 3, business model has been evaluated. REPERE service is positioned as a “bankable” business model. There are several issues to be tackled regarding the viability of the business model for this service.

First, instrumentation cost is expensive for only Measure and Verification application such as REPERE service alone. In this TT, however, measurement main goal is to provide input for housing temperature regulation and is part of the technical solution evaluated. Therefore, cost of measurement is imputed to the solution and not to the Measure & Verification application which make it much more viable economically. This example advocates on finding solutions where the instrumentation has another goal than being an input of REPERE service alone to mutualize instrumentation cost. REPERE service could be deployed as an additional service to a solution that has more direct control through sensors on the energy efficiency of the building.

Second, a potential issue regarding the cost of REPERE is the need of engineering time to configure the service, even if a lot of the process is automated there is still engineering time to adapt REPERE service to an existing instrumentation solution with its own API and workflow. This advocates for a more integrated approach on a standardize measurement solution to fully automate the process.

Last, economic value of the service provided. The evaluation of energy savings and the recommendation that are provided alongside this energy savings evaluation is hard to quantify properly now. How much a building owner is willing to pay for that information and how he will use it to reduce its energy consumption is hard to evaluate. For example, if the REPERE service conclude that energy savings can be gained by lowering temperature because they are too high in the building, maybe the owner will not be willing to trade off its occupants' comfort for energy savings and in this case the REPERE service value in terms of energy savings and economic gain will be null.

2.5.4 Measure 4: Symbiotic waste heat networks

The business model associated to the Dashboard has been extensively explained in the related deliverables of ReUseHeat and its associated KER (Key Exploitable Result). This is not repeated here.

In brief, the Dashboard should become a standard service for DALKIA as for any renewable DHCN network. The need to raise awareness and enlarge the communication scope to the local general public (and not clients) has been seen as a real need. It should thus be possibly internalized by the company and be designed to serve replication and scaling across France as a standard service. The costs for this should not be isolated in a single general offer or bidding of a DHCN project, but be spread across different projects, so that the remaining unitary costs can be absorbed within the overall busines plan of a DHCN.

2.6 Key recommendations

2.6.1 Measure 1: Collective self-consumption

The implementation of the two demonstrators (IMREDD/PALAZZO) was extremely interesting due to the different issues encountered during both the conception and the commissioning phases of the project.

Design of the system:

Sizing of the BESS :

In a new building like the IMREDD one, the battery sizing is based on the theorical production and consumption of the building which does not necessarily reflect the reality of the system. (Dust on the panels due to their positioning and shadows are not considered in the theorical production, added consumption due to new equipments). These points can lead to an over-sizing or under-sizing of the storage system.

Lack of regulations regarding the safety of the technical room hosting the BESS :

Regulation for securing stationary storage systems do not currently exist in Europe. Very few people in the construction industry have a good understanding about this type of technology including firefighters.

Lithium-ion could scare people when it comes to safety. But concretely, it is no more dangerous to have electric cars in your parking lot than a stationary storage battery.

Costs related to the technical room hosting the BESS :

Durring the initial techno-economical study, the cost associated to the construction and the security of the technical room dedicated to the BESS, were not taken into account. To be more exhaustive, the masonry, the fire door, the firestop ventilation valves, two redundant air conditionings, a fire detection sensor, an emergency stop outside the room to stop the battery power supply, a normal and emergency lighting, the creation of a specific electrical cabinet with dedicated breakers, a specific fire extinguisher for lithium-ion battery… Future stakeholders should pay attention to many things before starting the project.

System implementation in the technical room :

Generally, the ceiling height in the basement is limited and may not correspond to the height of on the shelf storage systems (height less than 2 meters). This was the case for IMREDD, SOCOMEC offered a tailor-made solution in order to adapt the height of its equipment to that constraints. Justifying the presence of a multitude of cabinets between the bidirectional inverter and the battery racks. It waw also necessary to raise the battery racks in order to avoid contact with water in case of flooding since the technical room is located underground.

Storage of BESS modules before the commissioning : the storage of the battery modules between the delivery and the commissioning is a very important step. Indeed, the temperature in the area must be controlled, no humidity, and a mechanical envelope to protect lithium-ion elements is needed. The installation of the modules in the racks can only be carried out by a qualified person. In the IMREDD case, modules remained on the ground for several months due to some delays in the planning.

Commissioning of the system:

Battery cycling. This step is mandatory before the final commissioning and must be done according a specific protocol given by the manufacturer.

IMREDD case :

The SOC of the battery is initially around 25% (storage and delivery initial condition).

1st stage → full discharge up to 5% (from 25% to 5%)

2nd stage → full charge of the system (from 5% to 95%)

3rd stage → full discharge (from 95% to 5%)

4th stage → charge up to 50% (from 5% to 50%)

Since the building is not fully operational, its regular consumption is relatively low around 30 kW, the battery has a charge/discharge rated power of 100kW. It will be necessary to inject a part of the energy into the distribution network to test the battery with its nominal rated power, which requires an authorization from the DSO. Another alternative is to use a resistive load bank to dissipate the excess of energy during the commissioning.

Delta of temperature between BESS modules:

If the air conditioning blows on the battery rack as illustrated in figure 42, modules on the top are going to be colder than the bottom ones. A warning appears when there is a difference of temperature between modules and when this difference goes beyond 10 ° C, the battery falls into a safety mode. Indeed, an important difference of temperature between modules implies an inhomogeneous aging of the BESS. It is imperative to pay attention to this type of constraint since, most of the time, technical rooms are small.

Figure 78 : Left /Air conditioning blowing directly on the battery – Right/Correct position

Supervision of the SOC after commissioning:

If the EMS is not functional after the commissioning of the storage system, it is necessary to upgrade the state of charge of the system manually at least once a month in order to compensate the self-discharge phenomenon.

Temperature and humidity:

The temperature and humidity in the BESS technical room must be maintained within an acceptable range, otherwise the battery will shut down. A probe is directly connected to the system in order to monitor these measurements.

As a temporary conclusion regarding the first experience on measures 1, we could say first that stakeholders like architects must pay a particular attention when studying the integration of renewable energy systems in future cities.

On the other side, end-users should not neglect and anticipate the maintenance time and cost of the implemented solutions.

Such simple recommendations could optimize the use of the energy produced locally and contribute to a better lifespan of the system.

Further results will probably lead to more precise conclusions about this kind of demonstrator.

Necessity to set up automatic alarm notifications:

The operation of the system can end up in outage that could either reduce the benefits from the local production and storage, or could even harm the assets (indeed, a battery that would be left without charge for several weeks could discharge too much and end up in a State of Charge outside the acceptable range, requiring to replace the entire battery cells.

Necessity to have a resilient, robust and fully operational ICT infrastructure:

As it was described above, all the operation operations of the energy system (EMS, battery control) require real-time data for proper and safe control. As it was shown in Figure 17, an ICT issue could lead in a failure of data collection, and therefore to a state where the EMS does not send any control request to the battery, which will automatically damage the battery by letting it discharge continuously until the State of Charge is below the acceptable range.

Give preference to all-in-one systems:

One of the main challenges faced by a local building energy system lies in the integration of different technologies that sometimes lack of compatibility and require middleware to ensure compatibility. It also increases the number of interfaces and of interlocutor which considerably increases the development and integration time. This also requires to develop several fields of expertise in order to ensure compatibility between assets, between ICT communication protocols, or between data types. This burden can be reduced by purchasing solutions that already ensure interoperability and that have all sub-systems integrated into one.

Diversification of revenue sources:

It was shown that current electricity prices make it difficult for local storage solutions to be profitable within the operational time of the assets. As a result, a common strategy to increase profitability of the assets is to diversify the source of revenue. Therefore, solar PV and batteries can be used in wholesale energy markets as assets owned by a balance responsible entity or can be used for frequency support in addition to increase local self-production. Also, local assets can be used to provide local flexibility, such as voltage regulation, or to decrease the electricity bill in a local community through local energy markets.

Incompatibility between long lifetime assets and short time considerations:

The Palazzo building was an interesting use case of collective ownership of a shared asset (solar PV and battery) in order to produce electricity that was then shared among the members of the community (of the building). The design phase was realized by the building developer and was considered by himself as a selling argument of the apartments. However, members of the community who bought apartments in this building were not convinced by the benefits of such assets and involuntarily inherited the assets instead of desired such energy solution. Then, once the developer of the building left the community (i.e. once the developer had sold all the apartments), the community did not really take over, and did not consider solar PV and batteries as critical assets that should be supervised on a daily basis. Indeed, the financial gains of these assets (that are spread among the community members following the size of their apartment) were considered to be too small to justify the burden of having a continuous monitoring infrastructure and dedicated people to maintain an operational system. As a consequence, the system was left without any human supervision for several months, which resulted in a large period of downtime of the battery that could have damaged the electrochemical cells and led to a need to replace the battery. Therefore, it is recommended to avoid using controllable assets in buildings owned by several members, unless the final members of the community are strongly convinced by the benefits of such assets. Similarly, it is strongly recommended to ensure or enforce that all operations of the assets will be supervised during the whole life time of these assets, which is usually difficult in jointly owned buildings where every decision requires the agreement from half of the building members, knowing that financial benefits are very limited, and thus to convince everyone of the benefits from these assets.

General feedback on solar PV design and exploitation

Then, as the demonstrator in TT1 is based on the integration of renewable energies in the urban area, it seems relevant to highlight a few points observed during the monitoring of solar PV systems and give feedback to future integrators, users regarding such systems. Indeed, we noted some unexpected phenomenon during the exploitation of the photovoltaic system due to shadings, dust, hot spots… as explained in the following subsections.

- PV production analysis for IMREDD building:

According to the preliminary study that was realized before the construction phase, the theorical production was estimated to 201 MWh/year. From the 2021-2022 period, the real energy production from the photovoltaic installation at IMREDD was equal to 161.9 MWh representing 80.5% of the theorical annual production.

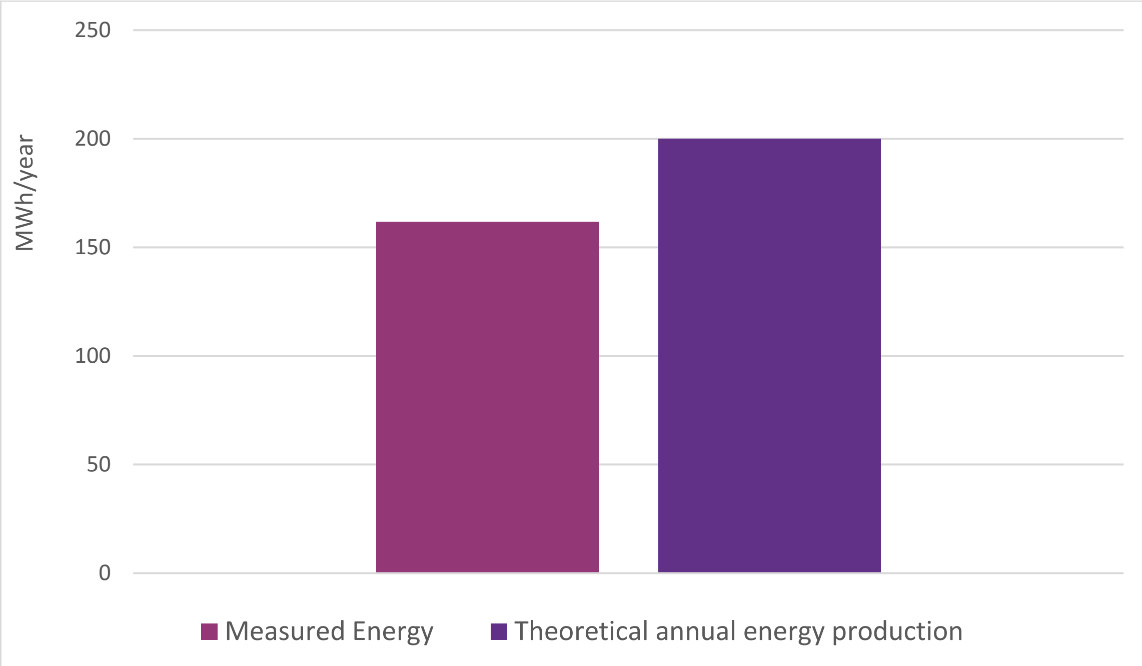


Figure 79. Cumulated energy produced by the photovoltaic installation from 2021 to 2022 at IMREDD

This difference between theoretical and measured annual production shows that it is important to consider large margins when designing a business model for solar PV installations, as it can increase the simple payback period by a few years.

The difference between real and theoretical production can be explained by several factors, such as meteorological aspects, but also by shadings and dust, that are not considered in theoretical analysis that consider nominal operation for the whole life of the assets.

- Impact of shadings from surrounding buildings

The photovoltaic electricity production is by nature affected by weather conditions. But shadings from the surrounding environment like buildings also impact the generation of renewable energy.

As example on Figure 80, the Palazzo building nearby the IMREDD one, has a strong influence on the annual PV production of IMREDD. According to the position of the panels on the roof, inverters begin to produce electricity later in the morning and impact by consequence the theorical production.

Figure 80 : Surrounding buildings (PALAZZO and Car Park) that bring shadings on the IMREDD rooftop

As illustrated in Figure 81, the production of inverters 4 and 6 is directly impacted by the surrounding environment especially in the morning.

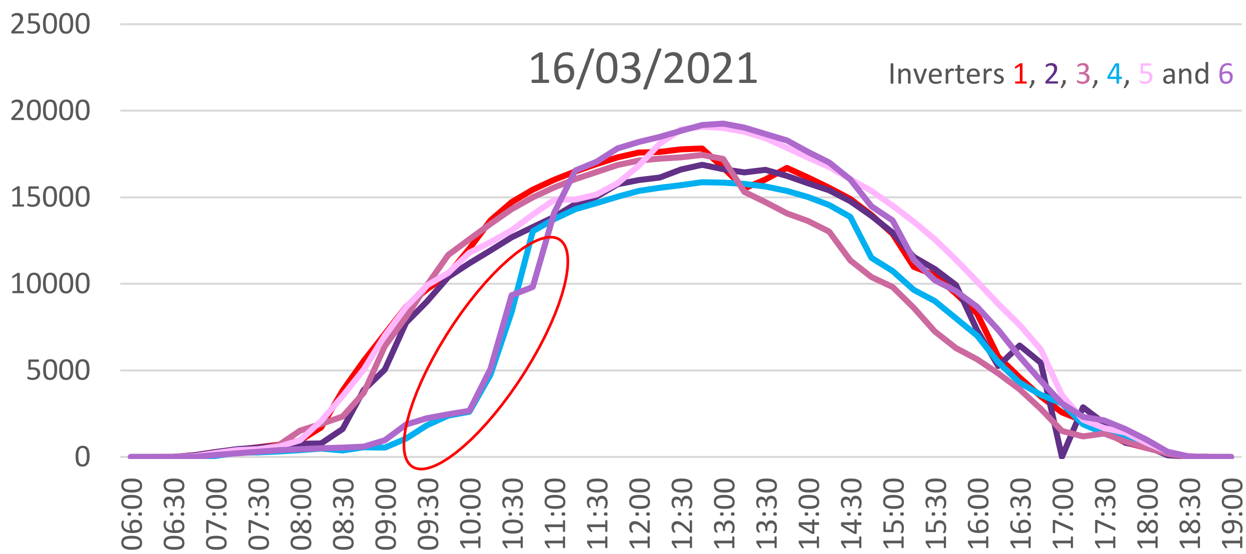


Figure 81 : Photovoltaic production from the different inverters at IMREDD

Figure 82 highlights the effects of shadings generated by the construction nearby IMREDD when located at the observation point situated on the green cross.

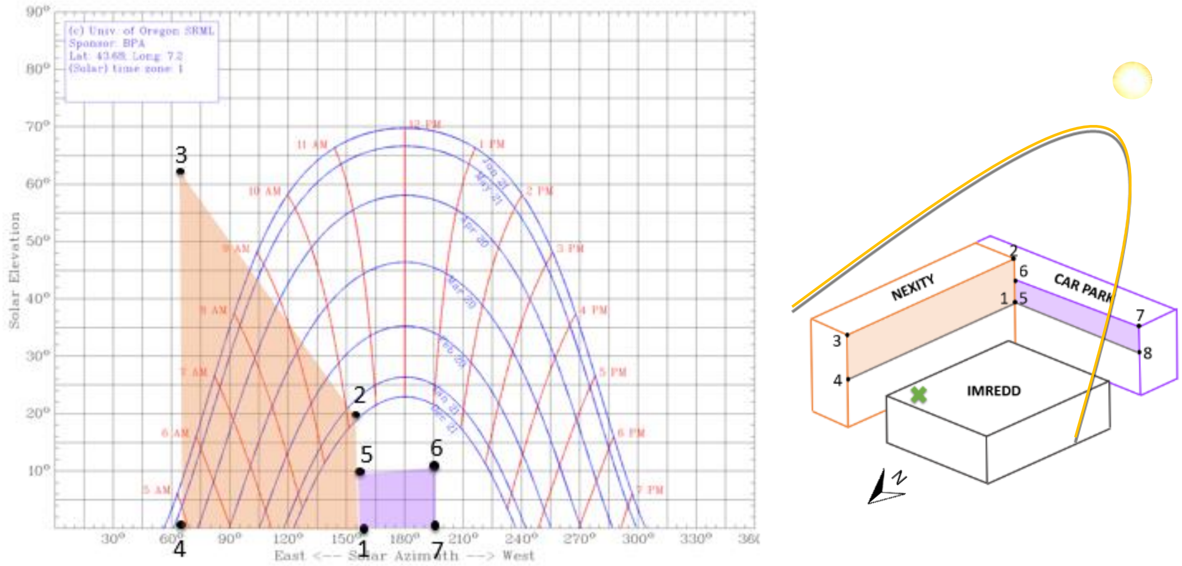


Figure 82 *: Impact of the shading brought by the PALAZZO and the Car Park on the annual irradiation of the IMREDD rooftop*

Such analysis must be done a priori and is justified in smart city projects where obstacles, in a near environment, are potentially everywhere.

- Impacts of shadings from IMREDD's own architectural elements

A fact that wasn't initially considered in the design of the IMREDD photovoltaic system is the shading brought by the different architectural elements of the IMREDD building itself.

Figure 83 *: Example of shadings on the photovoltaic panels of the IMREDD building*

That type of phenomenon has a direct impact on the production of individual panels or even cluster of panels usually identified as string. According how the panel is shaded, the production is impacted differently. As shown in Figure 84, a small shading could have a greater impact than a large one.

Figure 84 : Impact of a shade according to its position on the photovoltaic panel

In fact, it will depend on how the shading hides the panel, activating a given number of bypass diodes. N.B: Cells are connected in string and bypass diodes allow panels to supply power at a reduced voltage rather than no power at all when there is a shading.

Figure 85 : Another example of shadings induced by architectural elements

Architects must take into consideration such observations in order to optimize the photovoltaic production, increasing by consequence the return on investment of any building projects that incorporates renewable energy sources.

- Impact of dust on annual production

Panels are laid on the roof, side by side and without any slope. After few months of exploitation, it appeared that rainwater mixed with dust, could let traces on the top of the panel leading to a significative loss of photovoltaic production.

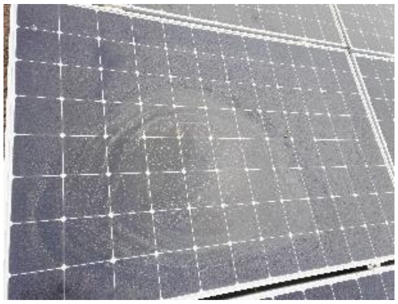


Figure 86 : Dust and evaporated rainwater on a photovoltaic panel

This dirt could increase locally the temperature of a panel as shown in Figure 87. The impact will be a loss of efficiency but also could involve an inhomogeneous ageing of the system.

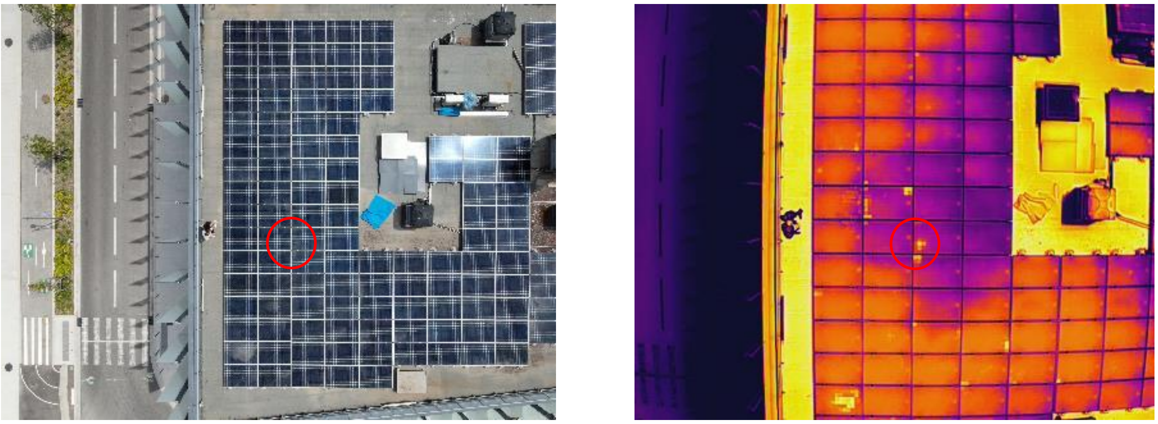


Figure 87 : Impact of dust and evaporated rainwater on a photovoltaic panel

The solution is to optimize the maintenance of the installation through a scheduled cleaning. Moreover, users and maintainers must note that a bad cleaning could be worse than no cleaning at all. Indeed, a bad cleaning could spread the dirt everywhere. Cleaning robots can be used as illustrated in Figure 88.

Figure 88 : Cleaning of the photovoltaic panels

- Hot spots

Another phenomenon that could appear in a photovoltaic plant is the so called “hot spot”. Thermography in Figure 87 can feature this kind of issue resulting most of the time from:

- Animal droppings
- Tree leaves
- Corrosion
- Dirt / dust
- Broken glass
- Internal problems of the cell

The destructive effect of hot-spot heating can be anticipated by a correct maintenance of the system through scheduled thermography and cleaning. IMREDD engineers identified in Figure 89, one hot spot during the annual maintenance of the installation.

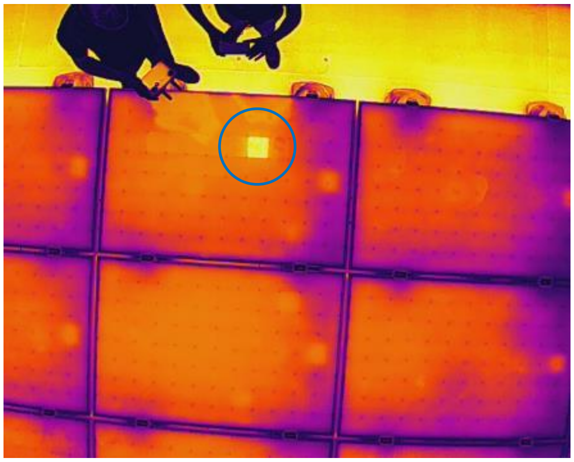


Figure 89 : Hot spot identification at IMREDD

As a conclusion regarding the measure 1 at IMREDD, stakeholders like architects should pay a particular attention when studying the integration of renewable energy systems. On the other side, end-users should not neglect and anticipate the maintenance time and cost. Such recommendations could optimize the use of the energy produced locally and contribute to a better lifespan of the system.

2.6.2 Measure 2: Optimization of heating load curve

Special feedback on Solutions 1

A first heating network tracking campaign has been led with the help of a thermal camera to establish the network mapping in all the building. This campaign has permitted to discover that the expected existing north/south distribution was not exactly the right one. Indeed, one network distributed the first 6 floors and the second one the last floors. A network modification has been realized to reassign the distribution properly.

A clear network mapping is required before starting any works.

Some equipments have been mutualized between the 2 towers to simplify the investment: solar and wind exposure sensors have been installed only in tower 13. Information is transmitted to the automaton of building 14 thanks to GSM communication between the 2 automatons. We observe some loss of data which penalize the regulation in building 14. Conclusion: a gateway (communication plateform) should have been installed on the top floor of the 2 buildings to secure the communication.

Special Feedback on Solutions 2 :

Special attention was paid to facilitate the works in a difficult social context :

Time in-situ has been shortened : The hydraulic kit has been made in a separate workshop to optimize the duration of the work on the floors and thus less disturb the tenants.

Particular attention was paid to the tenants by informing them: flyers were distributed before the work in their letter boxes and we put posters on all the floors with indication of the reasons for the work, the inconvenience caused. Besides, a telephone number was made available. => No setback was encountered.

TRAVAUX D'AMÉLIORATION DU CHAUFFAGE

ENGIE Cofely, prestataire pour Côte d'Azur Habitat, de la fourniture de chaleur et d'eau chaude sanitaire, travaille à l'optimisation de la performance énergétique des bâtiments pour améliorer votre confort et le chauffage dans vos logements.

A partir du **19 août**, le **bâtiment 13** fera l'objet de travaux de modernisation du réseau de distribution de chauffage. Des interventions sont prévues dans les placards techniques des paliers.

Nous nous excusons par avance de la gêne occasionnée.

*Besoin de renseignements complémentaires ? contactez nous au **06 33 13 78 36***
(numéro valable uniquement pendant la durée des travaux)

ENGIE Cofely

Installation of ambient sensors : flyers were distributed in the letter boxes to inform the date of intervention. Nevertheless 10% of tenants refused the sensor installation.

Communication made it possible to carry out the works without incivility

Ambient sensors have been all tested before installation and activated directly in-situ. Nevertheless, 3 of them are out of order as of to date. Test in "laboratory" is not sufficient to ensure the functionality. Choice has been taken in solution 3 to test the sensors in-situ. Due to COVID19, those sensors have not yet been changed.

After 1 year of operation, 24% of sensors are inoperant (total of non-installed, destroyed or moved by the tenants).

The exact analysis of failures due to technical or human origins is difficult to do. It will be interesting to analyze the origin of the failures after the removal of materials at the end of the experimentation.

During the commissioning, communication failures between the pump and the automaton and the tests that were realized led to several complaints from users of underheating. After the installation of solution 2, some tenants previously overheated saw the temperature of their housing decreased to the contractual temperature of 19 ° C.

As consequence, equipments has been degraded (sensors, 2way valves)

The implementation of energy performance requires a support to the users for their understanding, of the issues and the acceptance of commissioning setbacks.

In addition, the regulation at apartment level can reveal significant malfunctions of the distribution network: if the hydraulic imbalance is too important, the regulation by apartment may lead to underheating (vs previous scheme led to overheating)

Network balancing / sludge removal must be done first

Special feedback on Solution 3 :

Once again, some tenants refused the installation of the ambient sensors (22%). When installing the probes, we decided to activate them and test them in-situ in order to check the operating state.

Once the probes were installed, we noticed that 2 sensors located on the top floor did not have a stable radio coverage which leads us to conclude that it would have been better to position the GATEWAY LORA with an antenna on the roof rather than in the substation.

This solution could also have a GATEWAY (only 1 gateway on the roof of a building) and would improve the signal quality as well as the battery life given the proximity of the buildings.

We have also lost information (wind, sun) from a regulation extension located on the top floor which can be explained by the intervention of a service provider outside COFELY. As such, we have set up an alarm on the machine to remedy to the problem.

The position of the gateway is important to guarantee the quality of transmission and thus to guarantee the best regulation.

We recommend placing the Gateway on the roof, in an area away from intervention

Placing the probes in the living rooms (which benefits from internal contributions) penalizes the heating in the bedrooms which does not reach the contractual temperature. We decided to increase the deposit. This problem arises in periods when internal and external contributions are strong. It is therefore necessary to take it into account in relation to the regulation coefficient.

2.6.3 Measure 3: Commissioning process from the design to the operation

There are few lessons learned from the implementation of Measure 3.

- There is still a certain challenge in instrumenting residential buildings with sensors especially inside housings where the occupant can be sometimes reluctant to accept this intrusion in his privacy. The difficulty of this exercise has been increased much by the ongoing pandemic, making these operations much more difficult in times of lockdown. The information about the implementation of Measure 2 was announced to the tenants at the start of the monitoring campaign via newsletter, Intranet, email and SMS which is good but not enough. A steady and consistent communication with the tenants is essential to convince inhabitants to accept sensors in their home.

- Concerning the installed sensors, there are always unexpected problems during the measurement, which impact the collected data. The goal of KPI “Data loss prediction” should be realistic, where we can avoid or neglect the mentioned problems and reasonably accomplish the KPI. Many sensors have the problem of low battery during the monitoring campaign. It is better to know the lifespan of sensor in advance and prevent the unpleasant situation.
- Many sensors were installed with the objective of comparing the collected data with the one from other resources in need (electricity invoices, energy meter, water volume meter, etc.). In the objective of energy saving calculation, we do not need the above information. It is recommended to make a preliminary analysis about the essential sensors for the project. It helps us to save time and money.
- The algorithms designed to identify technical default on sensors have found an unexpected use of detecting occupants “cheating” intentionally with sensors. It is recommended to apply these algorithms in other project to detect the problems of sensors.
- Even if most of the process is automated regarding the computation of sensor data, there is still some time-consuming manual engineering process to be done especially on plugging the REPERE process to the existing instrumentation solution API. It is recommended to create a data collection process from different types of input of sensor (.xlsx, .csv, .json) and make a test before the installation of sensor.
- The high number of data holes during the monitoring campaign reduce the reliability of series of data. We should use the REPERE method more frequently, for example every week to check if there is any problem on the collected data. If yes, we can solve the problem as soon as possible (sensor lost, no more batteries of sensor, unexpected use of sensor, strange values of data, etc.), which helps us to have a good quality of data.
- Social surveys were conducted to collect the feedbacks of different stakeholders about the new smart heating control system. However, social surveys were only conducted at the end of project, with no baseline to compare results. It is recommended for a future operation to carry out social surveys also before the installation of the measure, to allow a statistical comparison of the results before and after the renovation.

2.6.4 Measure 4: Symbiotic waste heat networks

As reported under ReUSeHeat, the main lessons learned during the described implementation phases are the followings:

- “To create awareness for the general public (not familiar with the energy sector), information must be focused on making the technology understandable and to explain its advantages in the simplest way possible, in terms of language and form of used media.

- Data are not valuable if not contextualized via graphics or other contextual elements that a general user can relate to.

- Both need and interest in awareness raising on waste heat are identified nevertheless, general knowledge is low, if not absent, and the used communication channels must deal with this.

- The Design Thinking approach for building a suitable MVP, based on a Wireframe model, tested via an Agile method to gather end-users' feedback, and finally build the product and undergo the measuring and qualification of the products under real conditions, has been validated as an efficient methodology.

- The development of a dashboard system promoting the transparent reporting of real-time data, necessitates an in-depth review of the implemented data management process as for data consistency, quality and availability of the data generated from the local SCADA or O&M system. Additionally, the availability of dedicated APIs must be ensured, only mean to enable data transfer among IT systems.

- Through the exchanges in ReUseHeat, a cross fertilization has taken place between involved stakeholders, enabling the network operator to gain visibility and maturity on its operation and data management practices. Moreover, the developed dashboard has been identified as a missing service in the communication and commercialisation portfolio of the network operator, usually addressing more specifically customers (B2B) instead of end-users. This lead to the ongoing exchanges for developing and implementing a common replication plan between EDF and DALKIA. "

3 Results of Transition Track 2

The demonstration work under TT#2, more precisely under Measure 1, has put into light the yet early development stage of the BESS market, where the overall BM does not justify alone the technology adoption, and environmental concerns of innovators are yet the main driver. Similarly, yet much effort in terms of awareness raising and adoption of good practices is needed for market actors and end-users alike, to ensure a proper implementation of the technology. Despite 5 years passed since project start, no major regulatory improvement to foster local energy management system have emerged, nor on the asset level, nor on the market level.

These results push Partners involved in TT#2, to conclude that in the short- to mid-term, the most promising technology to develop PV together with DSM services in the urban tertiary sector, is Smart Charging technology (i.e. V2G). The technology yet needs improvements in terms of connectivity and accessibility nevertheless, the overall system implementation is less CAPEX and OPEX intensive and the technical capabilities comparable to BESS. Despite, the option of operating BESS for electricity market relevant ancillary services, has yet to be validated. So Smart Charging should represent the first choice for a tertiary real-estate development in urban areas to deploy an active DSM system.

KEY MESSAGE Include in the start of each Transition Track chapter a brief paragraph providing the key messages for the audience, e.g. on the key results, the key recommendations or key learnings that you would like to pass on. The key messages of each Transition Track could be used as well for the Executive Summary.

3.1 Overview

As to avoid any further misunderstandings between the nomenclature and articulation among “Measures” and “Integrated Solutions (IS)”, as has happened among different Deliverables in the Project (i.e. D11.4 and D6.4), a common agreement has been achieved among involved parties (EDF, EDF S&F, AGREGIO, MNCA, IMREDD, MSE). The matter has been discussed at Project Coordination level (Utrecht, CERTH) and the following articulation applies as by Grant Agreement (section “1.4 Ambition”) to TT#2:

1. **Measure 1 - Stationary storage deployment in buildings and local electric flexibility management:** corresponds to IS 2.1 and IS 2.3 respectively
2. **Measure 2 - Smart multi LEMs :** corresponds to IS 2.2

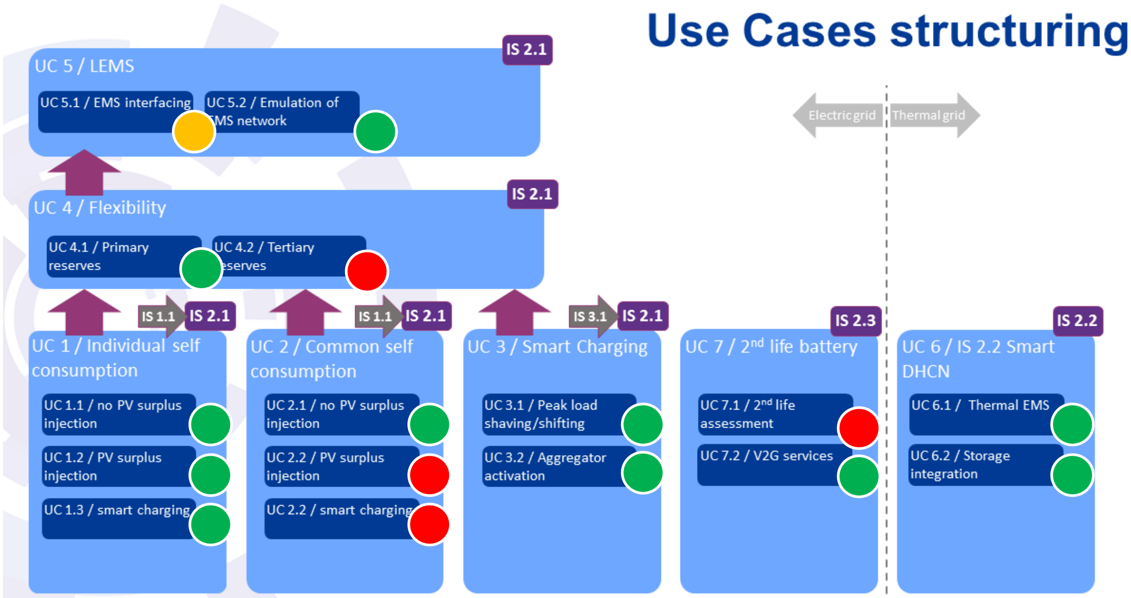


Figure 90: schematisation of the relation and hierarchies among the chosen Use Cases and sub Use Cases as by D6.4. The scheme specifies also the relation of UC with other TTs or ISs // Green: UC is achieved; Orange: not completely achieved; Red: UC not pursued (source: EDF)

In brief, most IS having been launched whilst, a general delay up to 12 month has to be accounted for due to the delayed delivery of the related buildings and specific assets. In the figure below, the overview of the district is given, with the identification of Nice Meridia by the dotted line.

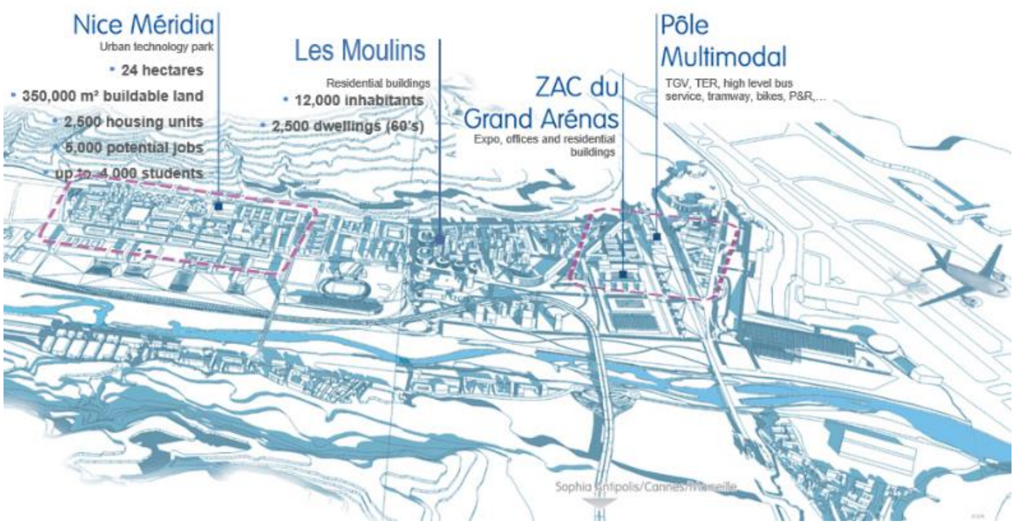


Figure 91 : Overview of the demonstration districts of Nice. Measures 1 and 2 will concentrate on Nice Meridia District – left dotted polygon (source: MNCA - modifications by EDF)

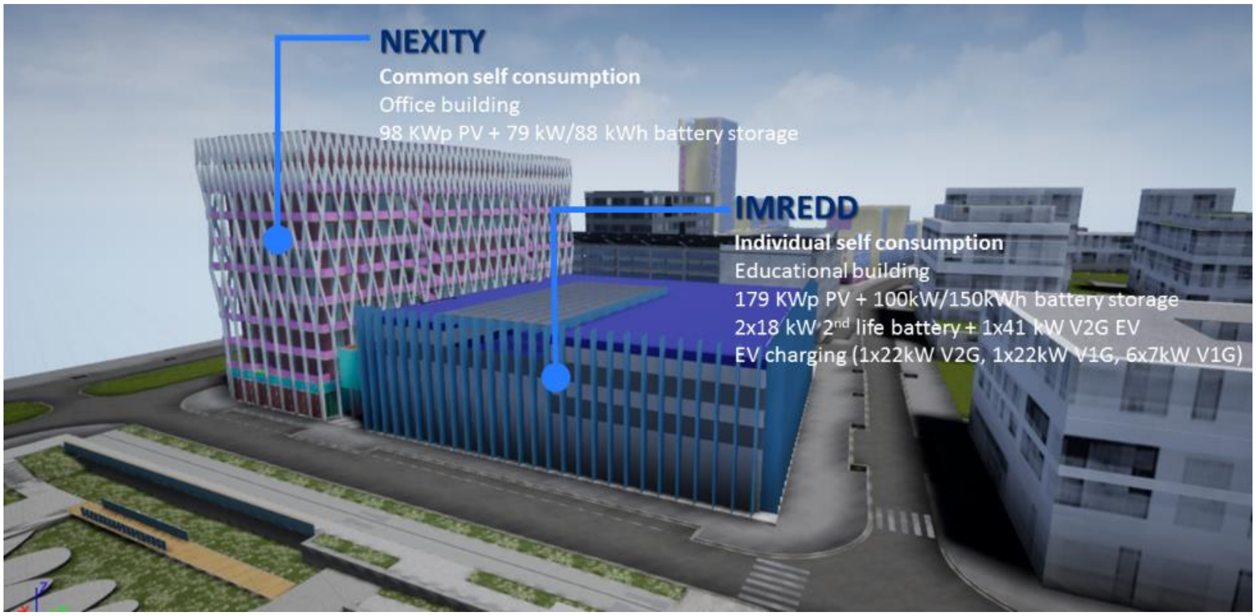


Figure 92 : rendering of the IMREDD and NEXITY case-study buildings for Measure 1 - S 2.1 and 2.3 with relevant technical details (source: UNS/IMREDD - modifications by EDF)

Figure 93 : photo of the NEXITY and IMREDD buildings as by 02/2020 (Photo credits : © Y. Bouvier for Nexity)

As for Measure 1, the status of the UCs are summarized as in Figure 90.

For the IMREDD demonstrator, all UCs have been implemented as planned however, part of it had to be done tacking into account deviation due to technical and regulatory aspects. Basically, all UC have been implemented: the BESS has been piloted under all foreseen scenarios (UC 1.1, 1.2, 1.3, 4.1), the V2G charging pole tests have been performed (UC 7.2), whilst the 2nd life BESS had yet not been implemented (UC 7.1), as hardware couldn't be nor sourced, nor commissioned, in time. This clearly hinders the comparison planned between UC 7.1 and UC 7.2, so the stationary application of 2nd life BESS compared to V2G smart charging. A dedicated SCADA has been set up for the demonstration and has been used for different dissemination action in relation to IMREDD, enabling to have a complete overview of the demonstrator.

The implementation of the NEXITY demonstrator has not been realized as planned, due to multiple technical and regulatory aspects that hindered a correct implementation. More explanation will follow in the next chapter. In brief, the BESS has only been possible to be piloted under the first UC 2.1, as the building owners didn't manage to regularise the PV installation as a self-consumption scheme to enable also grid injection so, neither the flexibility can be activated in legal terms. This hindered to EDF to implement the UC 2.2 and integrate the building in UC 4.1.

As for Measure 2, IS 2.2 is progressing as planned and achieved UC 6.1. The current DHCN development status is as follows:

- The following buildings (including IMREDD) have been connected to the heating and cooling production system and monitoring solutions:
  - Building Pléiade : parcel 2.1b
  - Building Odyssée : parcel 2.1b
  - Building Palazzo : parcel 1.1c
  - Building IMREDD : parcel 1.1b
    - Building Learning Campus : parcel 1.3B
    - Building Learning Campus : parcel 1.3A
  - Sous Station Habitat 06 - LF n°1 :
  - Sous Station Habitat 06 - RSJA n°2 :
  - Building Inphyni : parcel 1.7a
- The DHCN is fully operational with the activation of the geothermal production plant on December 2021. The objective of the Nice Meridia demosite is then to demonstrate that District Heating and Cooling networks can be an attractive solution, efficient, cost effective and relevant while combining heat and cool production, integrating a high share of renewable energies as geothermal coupled with heat pumps and thermal storages, therefore also supporting local renewable energy penetration into the electric grid.

Figure 94 : left - in violet, the perimeter of the DHCN operation under the PDS contract – IMREDD and NEXITY buildings are highlighted under the red rectangle in the centre upper area (Source: EPA Plain du Var, addition by EDF); Right - planned DHCN layout and overlay of existing buildings (source: https://www.google.com/maps/d/viewer?mid=1TkVPt5Z4ZgCFmPZZu81-RcsMxyv98VwH&ll=43.680735227580634%2C7.2003187737274175&z=16)

2018	2019-2020	2021-2022	2023-2024	2025-2026	2027-2028	> 2029
69 444 m²	106 097 m²	246 236 m²	304 131 m²	356 656 m²	447 284 m²	516 208 m²
	0,8	0,8	1,6	1,6	1,6	1,6
	2	3,2	3,4	4,3	5	5,7

Figure 95 : visualization and listing of Nice Meridia's mid-term planned connection phases. The extension of the constructed surface is highlighted in the coloured boxes (in square m² per period) and below the corresponding network length listed, divided in geothermal (line 2 in km per period) and hot/cold water (line 3 in km per period) pipelines (source: MNCA).

The related EMS called "hypervision" has been implemented over the connected buildings and to be to the production plant. It aims at providing a smart controller of the DHC production plant. This controller is defining the energy management strategies in order to minimise operational costs and to maximise the use of available renewable energy sources (thermal and electric). To do so, it aggregates all relevant information in real-time (measurements, predictions, etc.), computes energy management plans over a relevant prediction horizon (typically 24h), applies set points to the underlying systems, and monitors the realisation of planned operation to detect failures and deviations. This real-time monitoring is to be reinforced by DRL (Deep Reinforcement Learning) optimisation algorithm which will be implemented to improve first the Day Ahead operations and then will be used in Intraday and Hour to Hour orders.

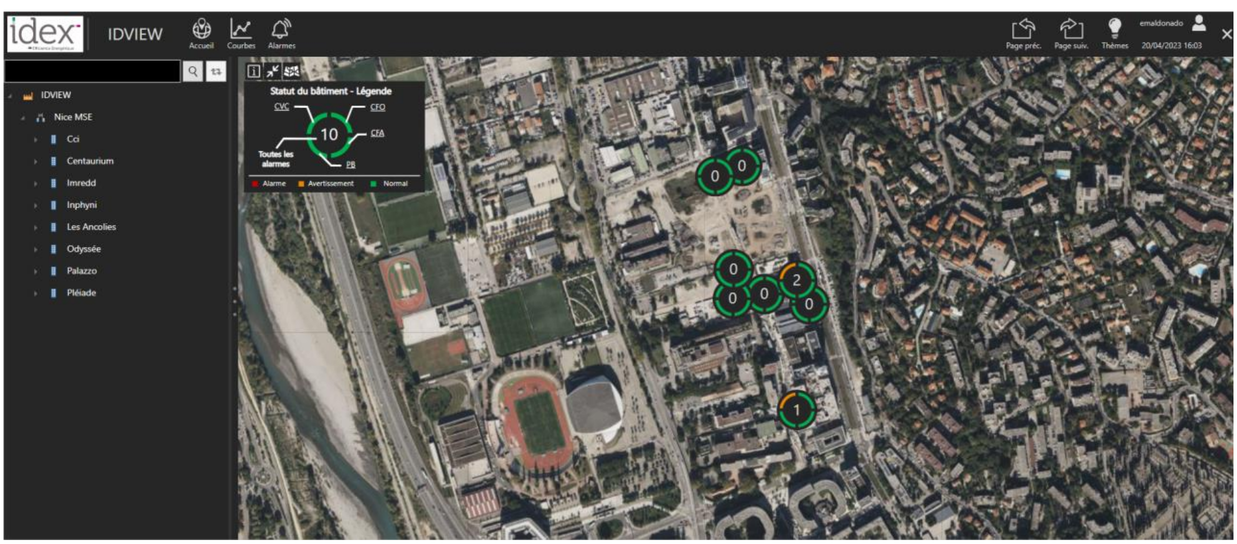


Figure 96 - Overview of the DHCN EMS ("Hypervision")

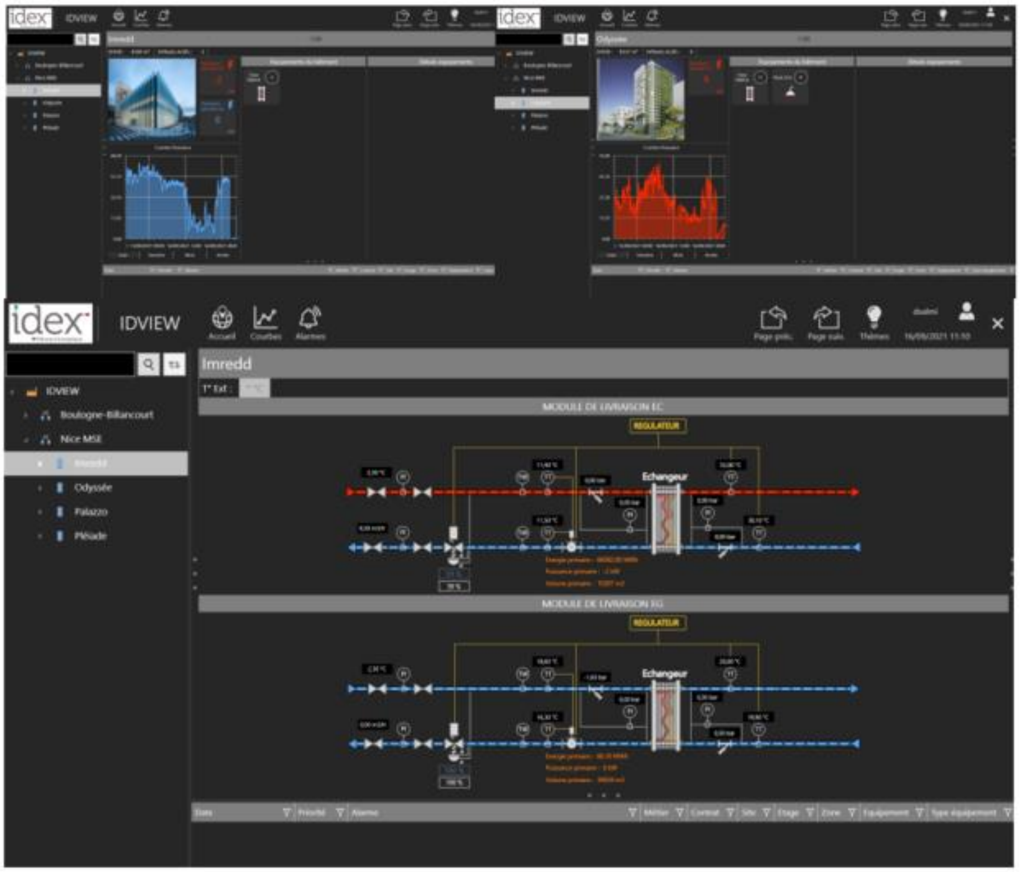


Figure 97 - Overview of the DHCN EMS ("Hypervision") supervising connected building

3.2 Implementations

3.2.1 Measure 1: Stationary storage deployment in buildings and local electric flexibility management

Implementation IMREDD Building

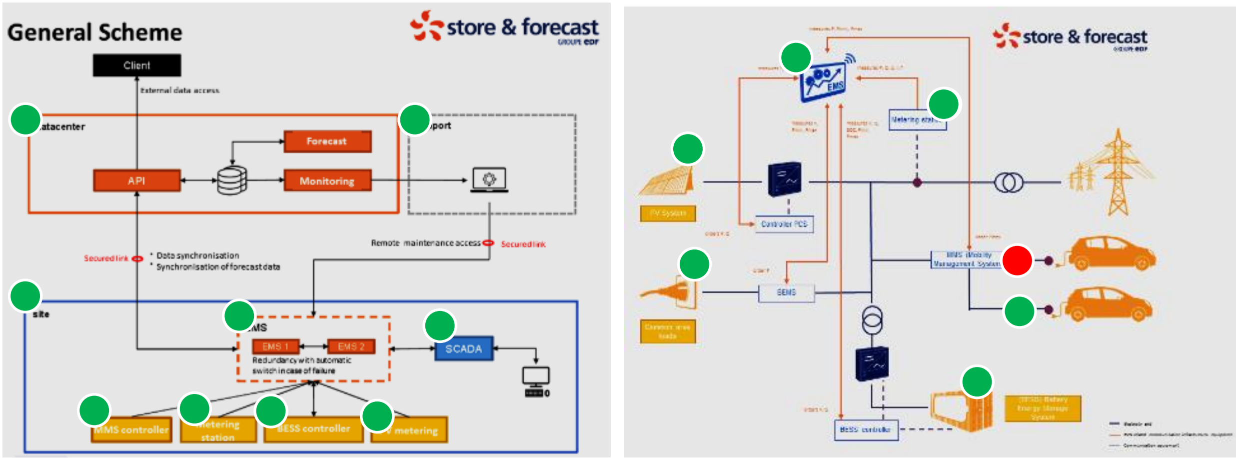


Figure 98 : IMREDD building // Left : overall EMS system conception as by D6.4 and as delivered today – "orange" flagged MMS controller: interfacing with V2G EVCI is yet not possible due to API problems // Right: overall communication and control infrastructure conception as D6.4 and as implemented today – "Red" flagged EVCI – the currently installed Mobility Management System does not allow any information exchange with any third party system, so neither the EMS (Source: EDF – EDF S&F)

The summary of the main implementations achieved as for Measure 1 – IS 2.1 (as by D6.4) in the IMREDD building are summarized in the figure above. In the followings, the main achievements and deviations are listed:

- The EMS's PC-stack has been in place since Q4 2020 and after first tests in Q1 2021, the EMS and SCADA have been commissioned in April 2021. Since, the EMS developed by EDF S&F actively collects data and operates the system as planned.
- UC 1.1 - Since, the main operation mode implemented is for maximisation of PV self-consumption. The BESS' cycling has not been only adapted to maximise the absorbed PV production, but additionally a daily optimized daily charging/discharging cycle to ameliorate the SOH and life-expectancy of a BESS has been developed and implemented (the EMS updates are done remotely).

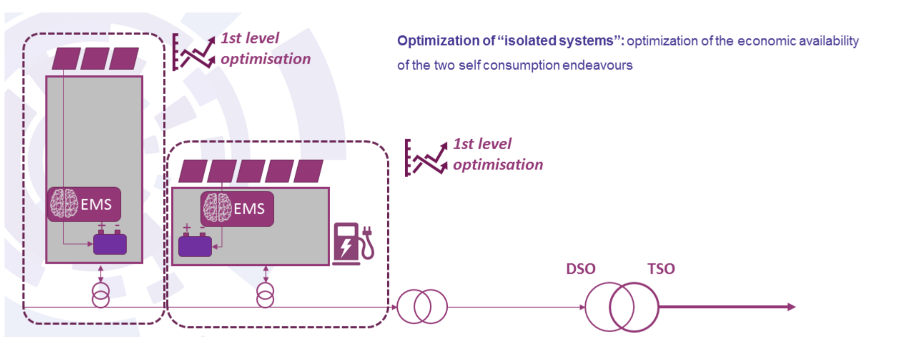


Figure 99: first level optimisation: the EMS ensures to fulfil all constrains imposed to each building (source: EDF).

- UC 1.2 – the main hurdle for the achieved of UC 1.2, was the regularisation of the PV injection and enable so to officially inject the PV surplus into the grid. In Q1 2021, the contract for a "balancing responsible party" could be achieved with AGREGIO. The acceptance to integrate an already commissioned and moreover, such small-scale installation, has been achieved thanks to the demonstration framework of IRIS. Indeed, the market for these types of activities are restricted to multi-MW installations. By any mean, both UC 1.1 and 1.2 could be taken up to TRL 8 thanks to the demonstration and results can be used to replicate the approach.

- UC 7.1 – The 2nd Life BESS has as been already said, not been commissioned yet, thus the UC has not been integrated yet. Below the scheme of the foreseen implementation under IS 2.3.

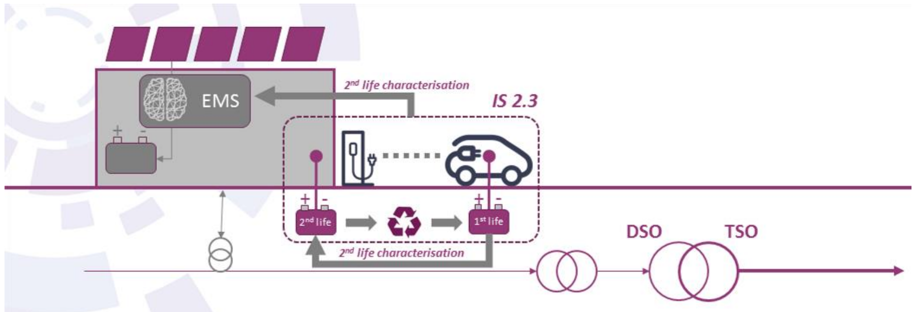


Figure 100: schematic representation of the experimentation principle of IS 2.3 (source: EDF – UNS/ IMREDD)

- UC 1.3 / 7.2 – the operation of the V2G experimentations was originally planned to start in Q3 2021 nevertheless, API issues made it not possible to pilot the installation before Q3 2022. The limitation on the delivered API by RENAULT, didn't enable to pilot the charging point as needed. The API has only been made available in Q2 2022. Since Q3 2022, the IC 1.3 could be implemented and will last until project end to gather much information as possible. The action led to an overall maturity of TRL 6.

- UC 4.1 – main needed developments in terms of algorithms (EMS/EDF S&F, VPP/AGREGIO) and API (between EMS and VPP) have been finalised in Q3 2022. The start of the demonstration was originally planned to happen in Q3 2021 but UC 1.3 was prioritized shifting UC 4.1. The downtimes of the BESS during Q2/Q3 2022 have forced to delay the demonstration start. Since Q4 2022, the experimentation has started and will last until project end to gather much information as possible for the BM assessment. The achieved TRL for this UC is of TRL 6 to 7, as more work is needed on the aggregation level for operating such distributed assets and more return of experience is needed to have a complete system qualification for achieving a TRL 8.

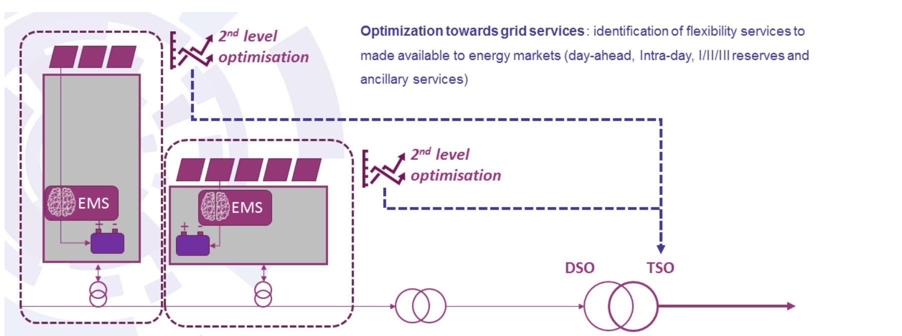


Figure 101 : second level optimisation: the EMS enables to communicate with an aggregator platform and provide flexibility services to the grid (TSO level) (source: EDF)

- UC 5.2 – the assessment of the district level has been done in anticipation of UC 4.1, as to identify the best implementation mode for UC 4.1. The assessment was done emulating 17 different clients and identify the most efficient control strategy among centralized, distributed, and decentralized operation modes. The distributed one has been chosen as the most efficient considering current technical availability and market design conditions under UC 5.2 and implemented under UC 4.1. The work is related as expected to a TRL of 5.

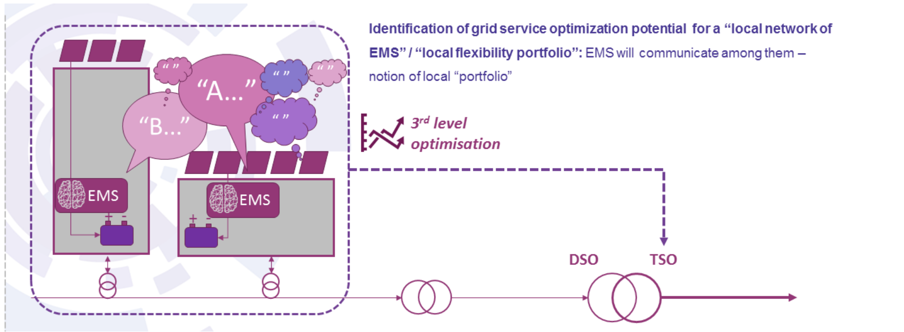


Figure 102 : third level optimisation: it is explored in how far, a local portfolio of assets could ameliorate the flexibility availability for the energy markets, as by integrating higher level optimization constrains and strategies, compared to the individual, distributed, optimization (source: EDF).

Implementation NEXITY Building

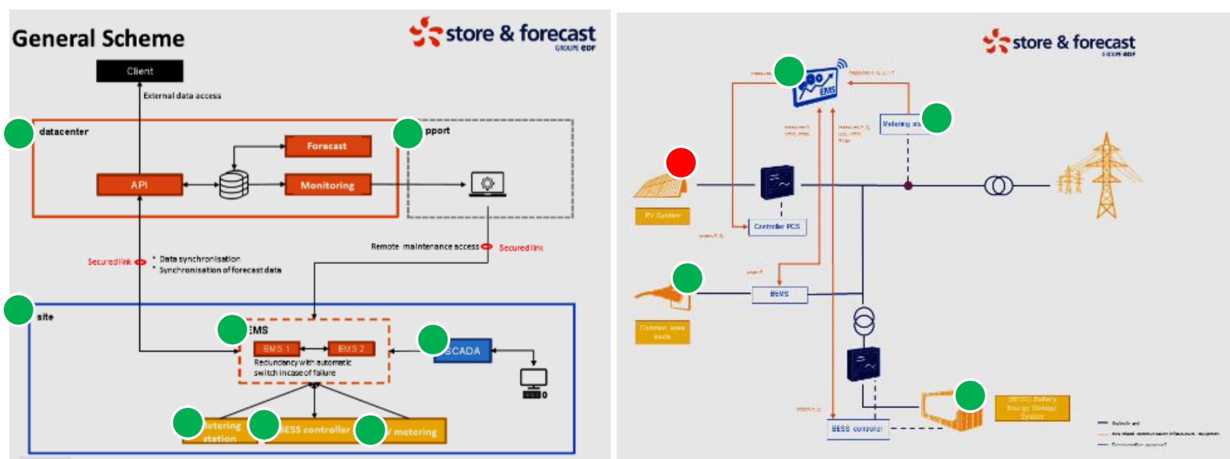


Figure 103 : NEXITY building // Left : overall EMS system conception as by D6.4 and as delivered today // Right: overall communication and control infrastructure conception as D6.4 and as implemented today – "Orange" flagged PV system – the installed converters can be metered and are connected to the EMS, but do not allow external orders making the PV system not controllable (Source: EDF – EDF S&F)

The summary of the main implementations achieved as for Measure 1 – IS 2.1 (as by D6.4) in the NEXITY building are summarized in the figure above. In the followings, the main achievements and deviations are listed:

- The EMS's PC-stack has been in place since Q4 2020 and after first tests in Q1 2021, the EMS and SCADA have been commissioned in April 2021. Since, the EMS developed by EDF S&F actively collects data and operates the system as planned.

- UC 2.1 – As for UC 1.1, the implemented operation mode is for maximisation of PV self-consumption with the forehead mentioned daily optimized daily charging/discharging cycle.
- UC 2.2 – Due to information asymmetry between the IRIS project and the real-estate project of the NEXITY building, the permitting procedure has not been done correctly, generating delays and regulatory obstacles which could not be overcome on-time. Similarly, awareness rising of the tenants/owners has suffered from information asymmetry leading to low acceptance (to not say refuse) of the demonstration. EDF has supported NEXITY to move the demonstrator from UC 2.1 to UC 2.2 by all his possible means. It provided support to NEXITY in clarifying the regulatory solutions to make PV injection possible and enable the building cooperative to decide for the most suitable solution to them. Despite being the original common self-consumption scheme not possible to be implemented technically (more explanations in the follow up chapter), neither the building cooperative agreed to pursue a common self-consumption schemes integrating their private areas, for economic reasons. Nevertheless, to make the efforts in vain, the building cooperative changed by 01/2022 the building operator from NEXITY PM to a third party. Therefore, no project Partners are anymore responsible for the demonstrator, only EDF S&F is still operating its EMS with obvious difficulties to ensure a correct exploitation of the BESS under such not obvious conditions.
- UC 2.3. – NEXITY did not implement any EVCI in the building and could thus not be integrated into the demonstration scope.
- UC 4.1 – it’s implementation is not possible as the building hasn’t yet regularized its status as a “production site” and can’t thus legally inject its surplus. EDF has thus stopped to pursue the integration of the NEXITY site into further UC stages.
- UC 5.1 – the planned endeavour to operate in a synchronized manner the two EMS has thus to be abandoned, as the NEXITY EMS could not advance in the UC maturity and the analysis would have been kept theoretical, with no added value to UC 5.2.

3.2.2 Measure 2: Smart multi LEMs

- **Implementation : development of the DHCN working as a multi-energy Smartgrid providing the Nice Meridia demosite with a high share of renewable energies**

The DHCN is fully operational since December 2021 :

- The 12 geothermal wells have been achieved
- All the DHCN distribution pipes have been laid considering the buildings yet to be built and connected over the 15 coming years
- 8 buildings (including IMREDD) have been connected to the provisional heating and cooling production system and 10 more will come by the end of 2024
- The production central (including the 5 thermo-frigorific pumps of 6.5 MW and heat 5.7 MW cool, a positive chiller of 2 MW, an ice storage system, and a negative “bi –regime” chiller of 850 kW dedicated to ice storage) is operational and will be activated by the end of September 2021 (M49).
- The year 2023 has seen two new energy storage:
    - Storage of heat developed with the CEA and Armines
    - Storage of electricity with a second life electric battery provided by Enedis

Figure 104 - Heating and cooling production systems implementation

Figure 105 - Geothermal well chamber

Figure 106 - Timelaps following the construction of DHCN energy production plant

Energy production plant

- **Implementation : development of energy storage opportunities**

The complexity of the operation of Nice Merida DHCN supervision has increase by the integration of energy storage in February 2023. The site is providing 3 types of storage opportunities designed, implemented and operated by Idex at a district level :

- Centralised ice-storage : by storing cooling energy under the form of ice, the storage could be operated in a peak-shaving mode, so charging at low demand period as at nigh time and discharge the stored energy during peak hours. The systems implemented and which is activated with the production plant resumes 140 m3 to deliver 7 MWh .

- Innovative heat storage : the design of the PCM large scale heat storage located in the heat and cold production plant has been completed in August 2021. The system that has been designed resumes a 600 kW peak power on discharge with a 1.2 MWh energy. It uses use high performance bio-sourced PCM with low melting temperature (considering the DHCN temperature range 35/65°C). Its implementation (including a well smart energy level measurement with reporting and control from the district multi energy supervision) has been completed by February 2023.

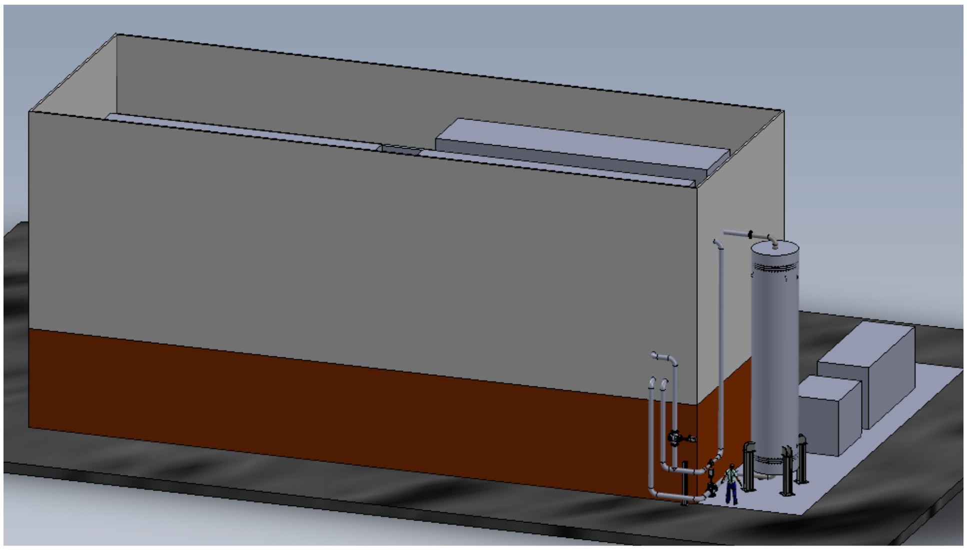


Figure 107 - PCM heat storage integration forseen within the production plant

- Centralized 2nd life electric battery : the DHCN operation team currently considers the opportunity of implementing a 1.2 MW (616 kWh energy) 2nd life electric battery used in a previous neadby location (Iles Sainte Marguerite by Cannes). This battery is planned to be installed at the production site by March 2022 to provide electrical energy services to the production plant and nearby buildings within Nice Meridia.

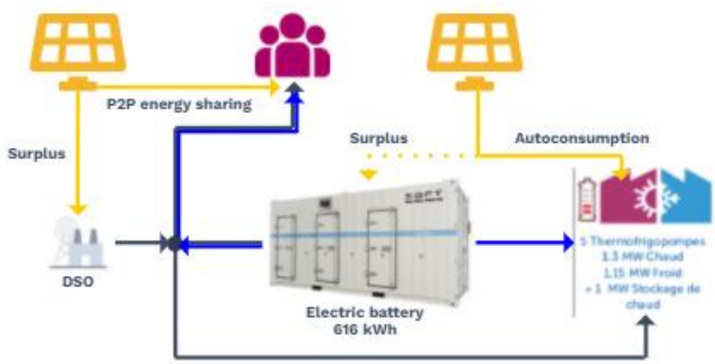


Figure 108 - Possible integration & use cas of the 2nd life centralized electric battery

Containers housing the battery and his power converter

All these storage assets should eventually allow the DHCN to get a 3-hour global autonomy (that could be valorized upon local flexibility markets) allowing an estimated heat and cold peak shedding of 20% to 25%.

- **Implementation : Multi energy networks modelling, simulation and operational optimization tools**

The multi energy supervision algorithms are currently trained on a first pool of customers, towards optimizing the thermal production and the network's hydraulic balance. Pumps and operating system (Heat Pumps – HP) are electrical grid clients and consumers. Consequently, they could provide by themselves flexibility to be integrated into the MSE supervision system.

The current demonstration aims at assessing the potential convergence of operational strategies for integrating the management of heating, cooling and power at district scale, thanks to the supervision system to be deployed over the DHCN :

- Data platform & Optimisation algorithms : a data platform collecting, aggregating, storing and communicating (while respecting data protection regulation) all local district data (consumptions, uses, productions, etc.) has been implemented. This data platform connection to the Nice City Data Platform is ongoing. From the monitored data collected by IDEX from its assets and from all the local actors (buildings properties, landlords, Nice City, local energy services companies…), we will support the post-treatment and analysis of the data to turn it into KPIs indicators. An evaluation of the smart controller performances will so be realised all along the monitoring period. Evaluation of the numerical model accuracy will be done in parallel. The first results obtained will provide advises for the optimisation of the management algorithms, and measures for the improvement of the whole system performances. In particular, with the support of the numerical simulator, an evaluation of a model-predictive control based on MILP approach will be compared to the smart controller implemented to evaluate its interest.
- Simulation & modelling (numerical twin) : a dynamic modelling of the local Nice Meridia DHCN have been designed. In parallel, the control platform ("hypervision") which will support the local smart controller over the DHCN has been implemented. In a second step, we will test and evaluate the smart controller proposed in the first place on the annual simulation platform thanks to the dynamic

model developed. Different kind of scenario and possibly control strategies will be investigated and sensibility studies will support the evaluation of the smart controller. In a third step, from the results obtains, pre optimisation on the control algorithms can be performed with iterative processes. This algorithm, using DRL (Deep Reinforcement Learning) method are developed since the end of 2022 and since then are learning from numerical twin simulations before being implemented with onsite operations.

- Smart controller ("hypervision") implementation : After validation and pre-optimization of the smart controller, its implementation has been performed on the local DH at block scale. A one year monitoring of the smart controller will be realized to evaluate its performance regarding the KPIs defined in WP2.

3.3 Key results

3.3.1 Measure 1: Stationary storage deployment in buildings and local electric flexibility management

3.3.1.1 Implementation: tailor-made SCADA for the IMREDD energy management system

Figure 109 : EMS hardware at IMREDD (source: IMREDD) and the showroom where the SCADA is displayed for communication and dissemination purposes. (source: IMREDD, EDF, respectively)

The optimization of energy systems relies mostly on the EMS that host algorithms used for the implementation of the different scenarios. Such systems require a monitoring interface or SCADA, allowing a supervision of the building and enables the operator to intervene in the operation mode of the EMS.

For the sake of the IRIS project, IMREDD, EDF and EDF S&F worked together in order to create a human machine interface (HMI), according to all scenarios foreseen to be implemented during the lifetime of the experimentation and beyond. A strong interaction between both IMREDD and EDF S&F engineering team, lead to a first prototype and the clarification of the technical and functional requirements for the final implemented version.

The main page of the SCADA, as in the figure below, allows the user to have a global vision of the system in real time, especially regarding the power flow between the grid, the BESS and the RES installed. By clicking on different tags, users can visualise information as for e.g., the weather condition or the operation mode currently used. The setup of all the system is available and the different alarms related to the BESS are also monitored.

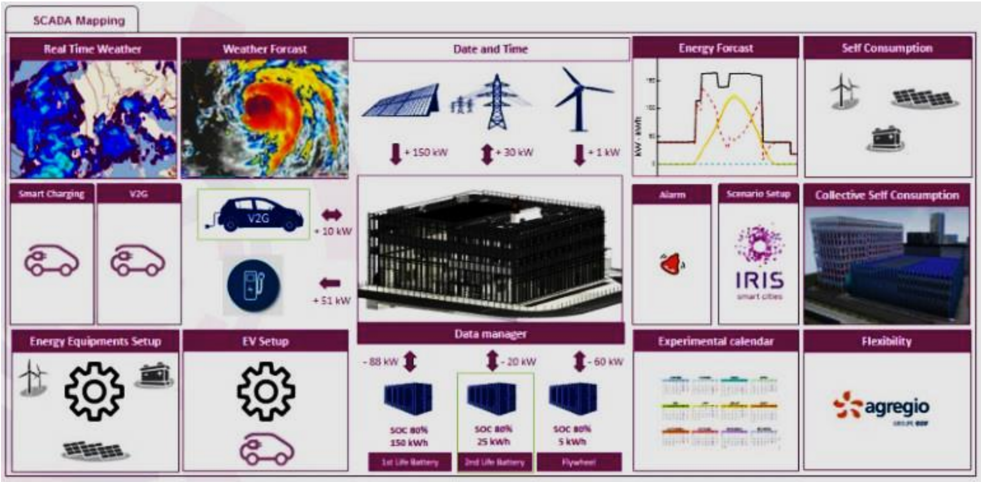


Figure 110 : Main page of the SCADA system project developed by EDF S&F and IMREDD (Source: IMREDD)

Figure 111 : Real time weather page of the SCADA system project developed by EDF S&F and IMREDD (Source: IMREDD)

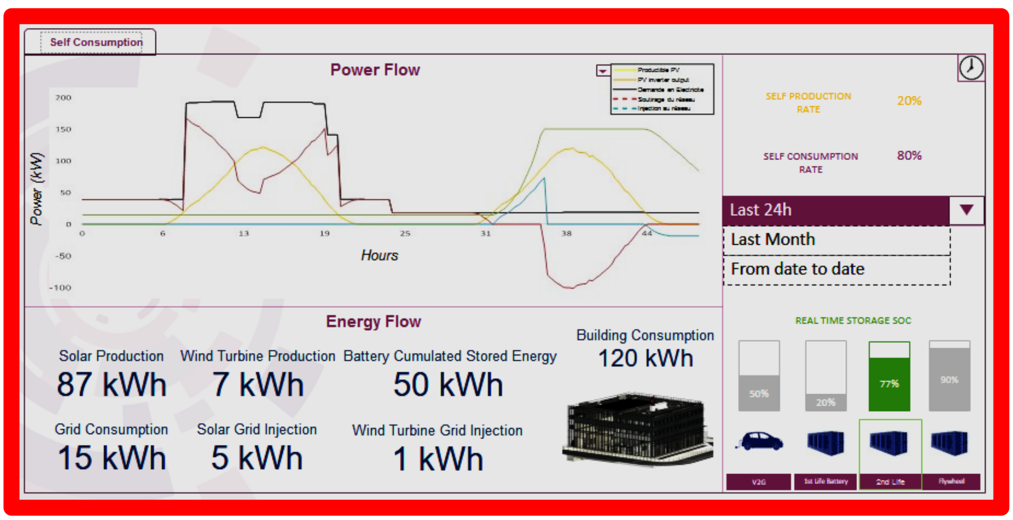


Figure 112: Self-consumption page of the SCADA system project developed by EDF S&F and IMREDD (Source: IMREDD)

Different energy storages or energy sources are available at IMREDD and all have been chosen to be connected and controllable by the developed SCADA. Indeed, users can select in the setup (**Fout! Verwijzingsbron niet gevonden.**), the storage that will be used for the experimentation. The system has provided a framework for all storage solution despite, not all such assets are operational. Connected are : the PV system, the BESS, the V2G charging pole. The 2nd life BESS will not be commissioned, as well as the flywheel. Since all the electricity produced on site can't be stored or directly used by the building, the operation mode can be chosen to enable, or not, to inject PV surplus into the grid. Further developments about EV (V1G) are planned but are not within the IRIS scope.

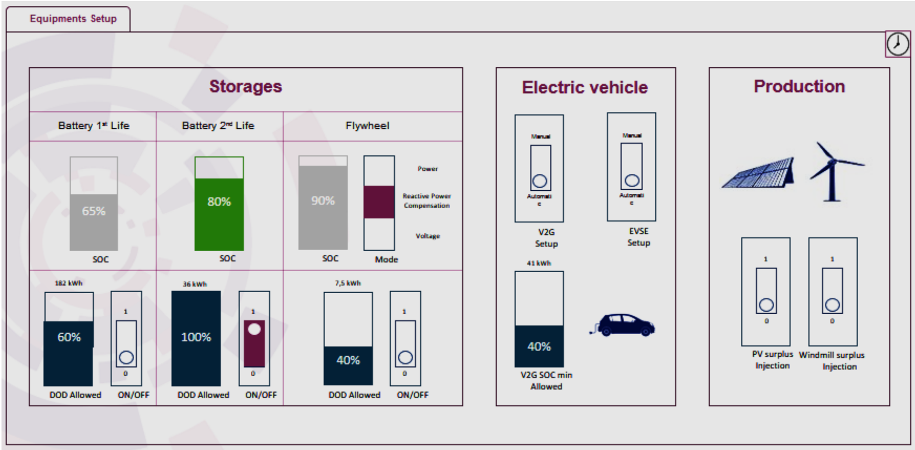


Figure 113 : Setup page of the SCADA system project developed by EDF S&F and IMREDD (Source: IMREDD)

Main result for Measure 1 is the launching of real-life demonstration activities on IS 2.1 and 2.3. In IS 2.1, both EMS are operational, data have been started to be streamed since April 2021 and monitoring is ongoing. The EMS's SCADA system streams monitored data accordingly.

Nevertheless, the road to the systems' commissioning what not easy at all: being a transversal task, the PV+BESS and the related ICT endowment, have seen misunderstandings in roles and responsibilities among addressed construction-task. Additional work coordination was necessary among different engineering and construction companies and high reactivity of involved partners were key to the successful implementation.

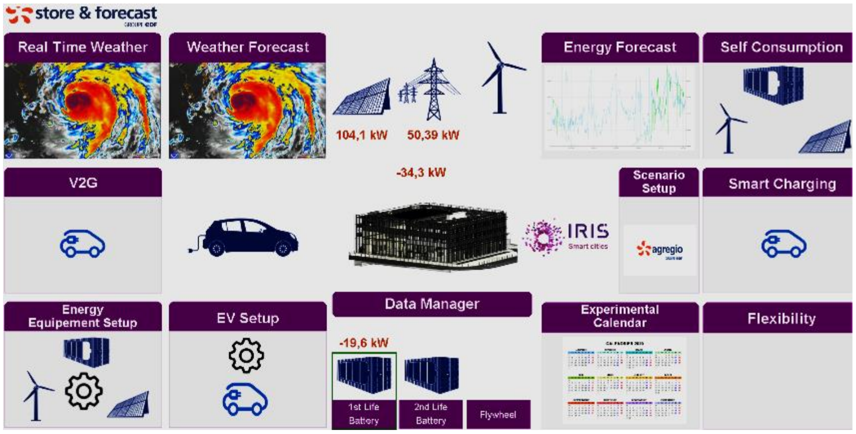


Figure 114 : Screenshots of the implemented SCADA system developed by EDF S&F for the IMREDD case (Source: IMREDD)

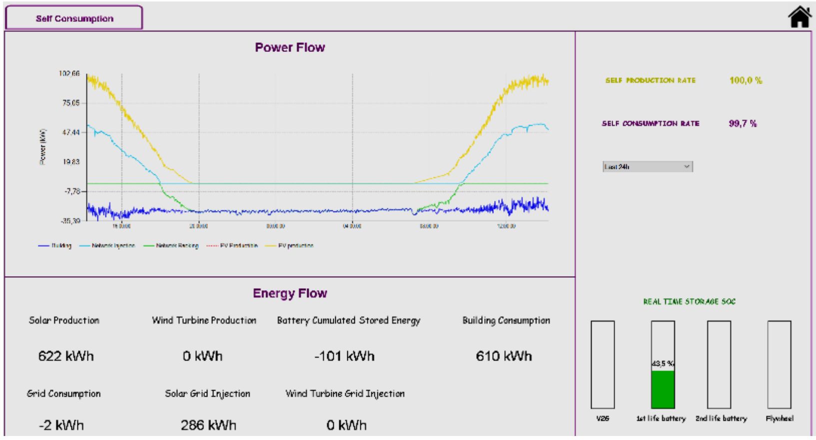


Figure 115 : Screenshots of the implemented SCADA system developed by EDF S&F for the IMREDD case (Source: IMREDD)

Regarding IS 2.3, the yet missing availability on the market of “standard” components for 2nd life BESS, demonstrates the early development stage of such technology. The sourcing and commissioning phase have been delayed due to the encountered difficulties to find adequate material, and experienced companies, for the needed BEMS (and power electronics) and inverter. Despite continuous promises for delivery of the BEMS from an identified third-party supplier, the Project Partners had to decide whether further delay the action or abandon it. Since Q2 2022, the involved partners agreed to abandon the action to ensure other UC are implemented correctly.

Figure 116 : IS 2.3, 2nd life batteries from Renault Kangoo – system ready to be connected to the BEMS and inverter (Source: EDF)

3.3.1.2 Implementation: UC 1.1 / 2.1 and UC 1.2 - the daily charging and discharging optimization cycles

Figure 117 : from left to right – IMREDD's two battery stacks, inverter, and view on the overall BESS room. (source: EDF)

When it comes to maximize the self-consumption of a building, a common and intuitive strategy for the EMS is to charge/discharge the BESS with the maximum power available. This strategy doesn't consider the ageing of the BESS. Indeed, the lifespan of the storage is strongly correlated to the number of charge/discharges cycles but also to the "C-rate". The C-rate indicates literally how fast the battery is filled or discharged. One could consider that the lowest is the C-rate, the longer will be the lifespan of the storage.

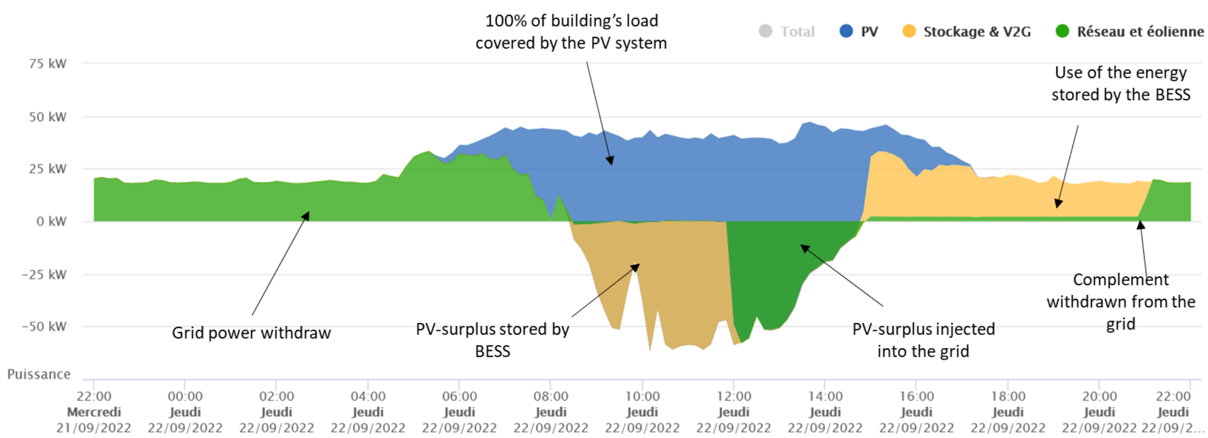


Figure 118 : typical daily charging/discharging cycle for the IMREDD building under UC 1.1 – here a September day 2022 is visualized. (source: IMREDD)

EDF S&F algorithm focuses on both maximizing the self-consumption rate and optimizing the daily charging/discharging cycles, to ameliorate the SOH and life-expectancy of a BESS. An illustration of this approach is shown in the figure above. The 104.1 kW from the PV installation is shared between the consumption of the building, the charge of the battery and the injection into the grid. The battery inverter has a 100-kW nominal power capacity. The charging power is, in this case, equal to 19.6 kW and the injection to the grid is equal to 50.39 kW. Instead of giving this amount of electricity to the DSO, it could be possible to charge the battery with an equivalent power of 69.99 kW (19.6 + 50.39), but it would not be necessarily SOH friendly and optimal over a day. In fact, it will depend on the daily PV production and building consumption forecast. Such strategy could enhance the use of lithium-ion batteries in future smart grids if the approach is scaled and replicated.

Lesson learnt : fire-safety and explosion containment requirement

As main return of experience for this UC, is as explained in the Lessons Learned section, the non-neglectable impact of regulation and additional technical reequipments due **to fire-safety and explosion containment measures** related to an in-door BESS application. In both IMREDD and NEXITY buildings, **extra costs are estimated as of about 50 000 EUR/building**, as for the following items:

- Masonry for wall reinforcement (≈ 10 000 EUR)
- Fire door (≈ 4 000 EUR)
- Fire stop ventilation valves
- Redundant air conditioning (≈ 15 000 EUR)
- Fire detection sensor
- Emergency-switch outside the room to cut power supply
- Normal and emergency lighting
- Power- plugs + dedicated electricity supply cables (all electrical installations ≈ 20 000 EUR)
- Specific fire extinguisher for Li-Ion batteries

These stringent fire-safety requirements are also reflected in the programming and threshold settings for the BESS alarms: the stringent requirements for avoiding fire or explosions does not only apply to the BESS's endowment, but also in the BESS operational settings so preferring to put the system in "security mode" rather than incurring any risk. This **increases significantly down-times of the BESS** (and consequently also of the EMS), reducing the availability of the BESS, beyond what was expected by the team at project start. Despite, safety and security must prime.

Lesson learnt: BESS and annexed assets commissioning duration

Here it must be pointed that the current market practice is rather inefficient for what concerns the "commission phase" of a BESS: in practice, it is defined as the connection of the BESS to the grid via a specific charging and discharging protocol (as explained in TT1). However, material non-reliability as experienced in **the project would point towards a 2-year commissioning phase for the system**. Indeed, in both the IMREDD and NEXITY case, in 2 years' time, all battery racks had to be changed as well as the inverter. This clearly make an analysis of the SOH and related battery degradation rate as aimed by the IS, not possible. The monitoring of the assets should thus ensure at least 3 to 5 years to have meaningful results and ensure to overcome technical issues and default during the first 2 years after commissioning.

Lesson learnt: "one stop-shop" solution for BESS sourcing and operation

Additionally, a major learning emerged from this case: the advice to choose a **"single solution provider" (a "one stop-shop" solution), so to opt for one company for sourcing and operation of assets**. This reduces consistently the exploitation complexity of such rather unstable asset. In both IMREDD and NEXITY cases, both IMREDD and EDF teams and engineers, have ensured the early detection and treatment of alarms and technical issues far beyond their "official" scope. Nevertheless, in case the battery operator had to intervene, whilst communication could last several days for informing and assessing the issues, the treatment delays of severe issues could add up to several weeks or month. This means (as in the case of the experienced material defaults) during which nor BESS, nor EMS, are operational and demonstration activity has to be delayed, impacting exploitation results.

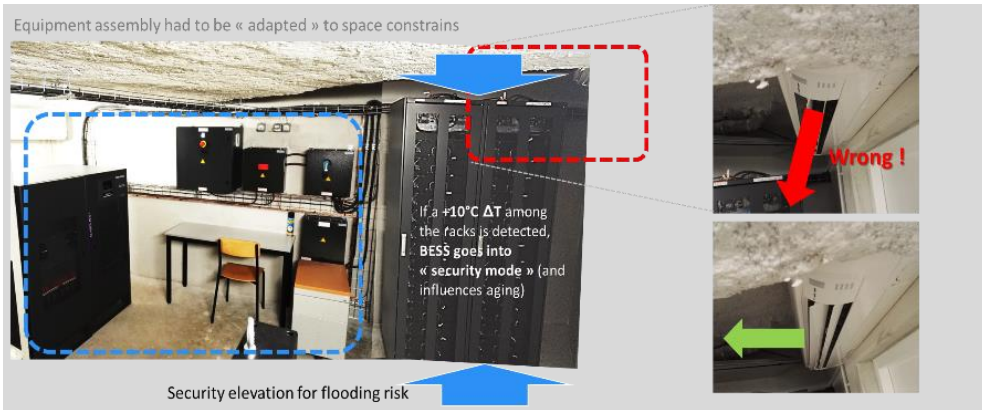


Figure 119 : example of encountered issues – the need to adapt equipment to the very limited space available while respecting i.e. flood risk elevation requirements; the setting of the cooling system can interfere in the BESS operation, as a too high vertical temperature differential are not tolerated by the BESS and causing the triggering of the security mode and so downtimes. (source: IMREDD)

Lesson learnt: information asymmetry among H2020 projects and real-estate implementations

A very particular but rich return of experience comes from the implication of this UC in the NEXITY demonstrator: concerning social awareness and acceptance on one side and permitting and regulation on the other.

A general background problem that should be pointed out, is the **planning asymmetry between the real estate project and the IRIS project**, which is not negligible. Basically, all work done within the IRIS framework, had to have to be implemented as "modificatory technical sheets" to the existing (and closed) design documentation. This happened at all stages as simply the IRIS project started too late in the advancement of the real estate project. This created additional coordination needs for the TT#2 leader and team, but also has strong repercussions on the leading role of NEXITY and IMREDD in their respective private projects. Additionally, as being modifications, they've sometimes not been implemented in time to enable to subcontractors to order and implement material as wished (i.e. PV inverters with only one access port have been installed in the Palazzo Meridia).

Lesson learnt: industry stakeholders need more awareness raising

This kind of issue has also affected the IMREDD construction project, but the availability of own skilled and available stuff, has significantly reduced the impact of such asymmetry. Most of the installation could be realized by mobilizing own staff, enabling to keep iteration with subcontractors less impacting. To point out is that beyond this information asymmetry, **subcontractors involved in both real-estate project refused to install the BESS and V2G charging poles,** as they were not ready to take any responsibility on the matter, being the new requirements "new land" for them, not familiarized at all with these types of assets/technology. The Project had thus to step up on these aspects and **without IRIS, with its resources and skills, such endeavour would not have been achieved**. This underlines the innovativeness of the proposed UCs, going beyond initial expectations.

Lesson learnt: end-user acceptance needs awareness raising

Given this situation, communication and sensibilisation towards the new owners and tenants of the NEXITY building couldn't be achieved as would have been necessary. In other words, owner and tenants were almost unaware of the assets implemented in the building and their implication in contractual matters for the housing community, as the commercialisation happened in parallel of the IRIS solutions related design process. Indeed, at commissioning of the installation (PV+BESS+EMS), the existing multi-energy and multi-system Energy Performance Contract (EPC) in place did not include in its perimeter the BESS-rooms nor the IT-room (BESS' EMS + Building EMS). Neither the implication of their operation was included in the EPC. This had financial repercussion on the common charges and the role and responsibility of the operator, which enlarged in scope. This **created a general discontent from the building community. The financial aspect had more weight than the environmental impact of the building.**

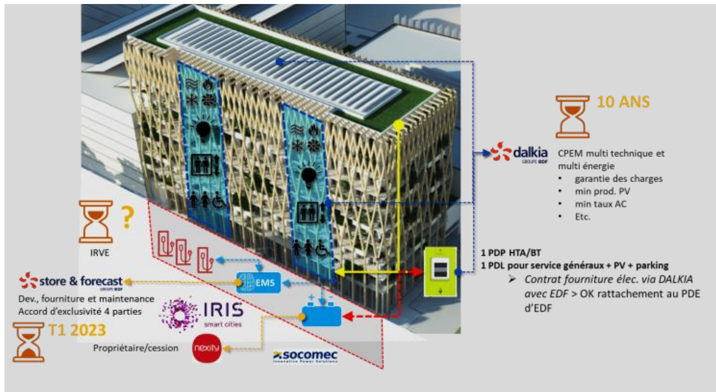


Figure 120 : schematisation of the situation of the NEXITY building – explication of integrated assets and meters, and highlight involved stakeholders and related contract (i.e. EPC) as well as still open questions (i.e. EVCI). (Source: EDF)

Lesson learnt: commissioning does not tolerate any deviations and regulation is yet as an obstacle

Information asymmetry among real estate project and the IRIS project, has also created a non-negligible impact on the TT#2 foreseen activity: the PV system was regularized as a "100% self-consuming" system, awaiting to implement a "commons self-consumptions scheme". Despite EDF alerting since the early design stage that, following latest received design documents done by the responsible engineering company, the sole solution would be a "individual self-consumption" scheme. This is due, due to regulatory constrains based on the system design approved: the common areas of the building have been all connected to a sole electricity meter, meaning that the notion of common self-consumption could not apply as the minimal requirement is 2 meters.

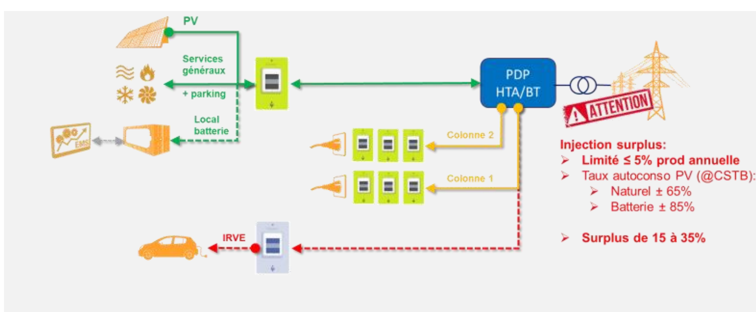


Figure 121 : schematisation of the current situation of the NEXITY building – a 100% self-consuming installation with surplus injection into the grid.

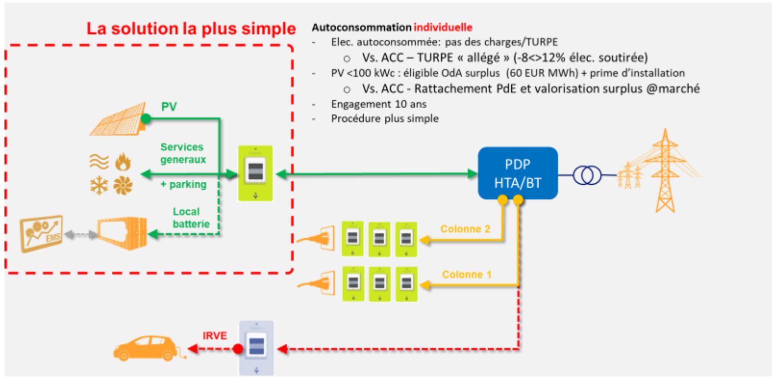


Figure 122 : schematisation of the simplest solution, individual self-consumption on the "common" meter. (Source: EDF)

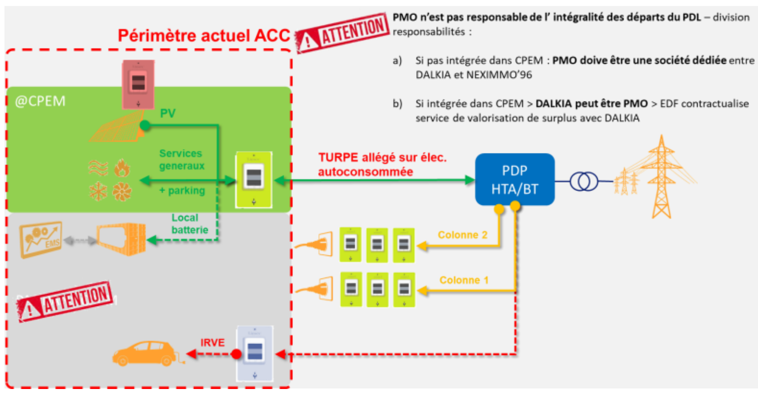


Figure 123 : the originally proposed common self-consumption scheme: it not legally possible still another meter is considered in the contract's perimeter (min. 2 meters). Listing of the implication for the definition of the legal responsible party. (Source: EDF)

NEXITY asked the help of EDF to clarify the current contractual matter as well as give an overview of the regulatory and financial implication of the different possible implementation schemes. First, EDF held several meetings to raise awareness on the matter with all involved parties and staff and ensure all have a good enough understanding of the situation and possible solutions. NEXITY staff understood the non-feasibility of their intention under the current constrains and that the launched contract with the DSO would not be possible to be signed, till a second meter would be commissioned and integrated in the contract (as in the figure above). For this, EDF offered to NEXITY and the building community, to enlarge the project ambition and develop with the building community a real common self-consumption endeavour by also integrating the individual private areas (and meters) of the office space owners. The scheme is shown in the figure below. The ambition was to enable to all tenants to leverage from the produced PV and not only the common areas.

The agreed way forward for the Partners, was to present the whole matter in the general assembly of the building community and put the solutions at vote. The common self-consumption endeavour was refused. In other words, **tenants were not accepting to have any raise in the common charges against the possibility to leverage individually from the produced PV energy** (integrating their individual meters within the common self-consumption's contract perimeter). Indeed, **under current market regulation, such self-consumption schemes are yet not economically competitive in a general urban set-up** (with no specific grid constrains or limitations) **and thus, not attractive**.

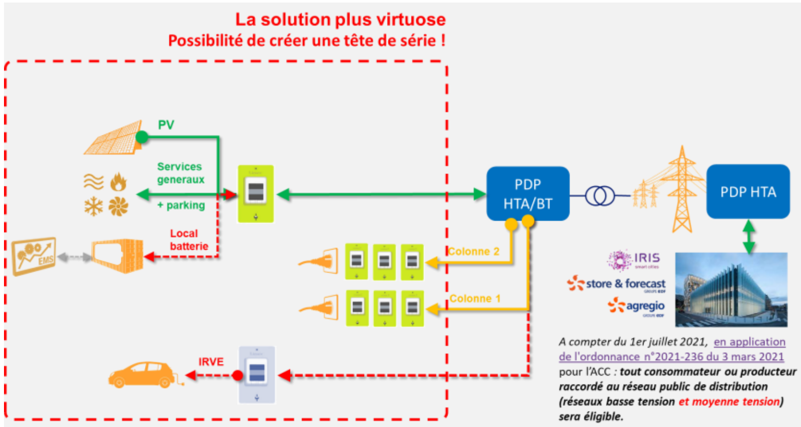


Figure 124 : proposition of EDF to NEXITY and its chousing community: deploy a common self-consumption scheme by integrating voluntary customers in the contract perimeter – the proposal has been rejected by the building community. (source: EDF).

Once all these aspects have been solved, EDF also provided support to NEXITY to identify alternative solutions to implement and gave also support to identify who could implements the needed next steps (PV injection regularisation with a Balancing Responsible Party). Despite, to EDF's best knowledge, the matter of the PV surplus injection has yet not been solved. Since 01/2022 the building operator has been changed and since, no exchanges have been held with the new owners and project Partners.

The REX for this first "permitting" relevant phase for the IMREDD building was similar: the regularisation of the PV+BESS endeavour and the achievement of a Balancing Responsible Party took 14 months of work and subcontractor refused to take-over or provide support (against retribution) in such "a-posteriori" permitting process. Indeed, it must be understood that the PV-industry does not provide usually any further "after sales services" on such regulatory items beyond a system's commissioning phase (well known for their complexity and duration). **So, there is almost no space for errors in these regards in a PV system's commissioning phase and after buildings' commissioning, almost no change is possible.** What could be achieved for the IMREDD building couldn't be achieved for the NEXITY building, as in the first case, the whole work has been done by own staff, without external support and this, also at an earlier development stage. NEXITY did not have such choice and had to ask, in vain, support to its operator and subcontractors on the market.

3.3.1.3 Implementation: UC 1.3 – V2G smart charging or IS 2.3/UC 7.2

Figure 125 : RENAULT ZOE V2G AC prototype and the related charging pole – installation as set-up in the IMREDD building (source: IMREDD)

The smart charging activity has been implemented leaning on IS 2.3 and the availability of the V2G prototype installation provided by RENAULT. The measure has been implemented nevertheless, with 1 year delay as the connectivity and communication protocol of such experimental assets were not at the needed maturity level. Due to this, first non-foreseen protocol development had to be engaged by IMREDD, until RENAULT did share a more suitable one, and finally enabled to unlock the possibility to pilot the charging pole via the EMS in Q3 2022.

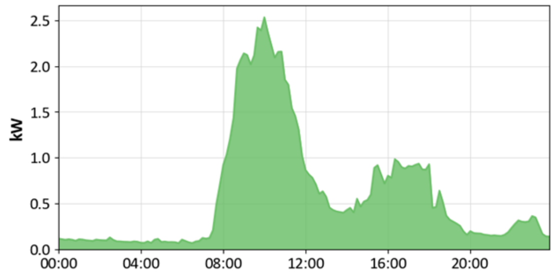


Figure 126 : typical EV-charging load curve for the IMREDD building – metered data are shown - the main peak is located in the morning at 9:00 and the second one, less important, at 16:00. (Source: IMREDD)

In general terms, the "prototype" nature of the car did not influence only the connectivity of the V2G pole, but also the overall use of the car and so its availability for charging and discharging cycling. Because of the stringent insurance policy limitations towards a free use of the car, it has not been openly used for daily commuting needs. This clearly influences the car availability and comes with rather low charging requirements for the demonstration activity. Consequently, the IMREDD team used the car in relation with the EMS experimentation calendar, so to have a rather realistic SOC of the car. The specific load of the V2G does therefore not follow the typical charging behaviour observed at the IMREDD building, as shown in the figure above.

Coming to the V2G experimentation, the first main obstacle is the connectivity of the asset, needing additional development to enable to integrate it in the IP-network of IMREDD on one hand, and a more developed protocol to enable control of the charging/discharging power setting from the EMS on the other. As said, IMREDD initially engaged in the development of the protocol however, achieved to retrieve an updated code by RENAULT by Q2 2022. This enabled the EDF S&F team to adapt the interface between the EMS and the V2G charging pole and integrate the first tests to identify the asset's operation boundaries (i.e. min/max charge or discharge power or order refreshing frequency). Thanks to these first results, the smart charging operation strategy could be adapted to the asset at hand and start the second test campaign phase in Q4 2022. The V2G car is officially available for testing on site till end 2022, when the contract among IMREDD and RENAULT takes end. However, the project team is confident that the car will stay available until project end and enable to extend the test campaign and retrieve additional results. More results will be added in M66 once data are available and evaluated.

Lesson learnt: in tertiary sector, Smart Charging comes first, before any BESS in-door application

The experimentation under IS 2.1 (UC 1.3) regarding smart charging has been done also to feed IS 2.3 (UC 7.2) as to enable the comparison of the pros and cons of the V2G charging with a 2nd life BESS application. As the 2nd life BESS could not be commissioned, IS 7.1 could not be realized and the objectives of IS 2.3 not quantified. However, it could be argued that despite the early development stage of both technologies, V2G technology sees less difficulties for a short- to mid-term market penetration than 2nd life BESS. Surely both technologies do yet need support for R&D but, pushing V2G technology can have a much higher short-term impact in the industry.

Furthermore, arguing from an investors or real-estate developers' point of view (as i.e. NEXITY), a 2nd life BESS is, as for any BESS, an additional asset with consequent additional investment needs and space requirements (both not negligible for a real-estate developer). Whereas EVCI is already mandatory in new real-estate projects and, if V2G technology is implemented with a rather negligible over-costs compared to the mandatory V1G technology, it represents a cost competitive solution for providing charging/discharging capacity to an EMS and building, compared to any indoor BESS solution. **From a purely qualitative analysis and return of experience of the experienced sourcing, commissioning, and implementation phases for both technologies thanks to the IRIS demonstration, it can be assessed that from a market readiness point of view, Smart charging or V2G technology should be prioritized**. **This is also the REX that NEXITY provided to the project, aiming at replicating Smart Charging models for their future real-estate projects, but not engaging anymore in BESS investment under current regulatory and market conditions**.

However, **the REX from the V2G implementation in the IMREDD demonstrator, shows similar challenges as for a BESS for the permitting phase:** given the low awareness of the industry on the technology and also from stakeholder as several local fire-departments, makes permitting processes complicated and companies/subcontractors are reluctant under such conditions to take any initiative or responsibility. IMREDD had to provide the local fire-department with a benchmark concerning explosion risk of V2G cars in indoor applications, before accepting the V2G charging pole installation. Despite such benchmark, showing the almost negligible explosion risk of EV under stationary charging conditions, the fire department was reluctant to allow the experimentation. V2G and V1G fast charging poles see yet regulatory obstacles for indoor applications and regulation is yet an obstacle to their deployment. This is accompanied by a general unawareness of the industry about these specific technologies and associated risks.

3.3.1.4 Implementation 4: UC 4.1 – Flexibility provision – Primary reserves

UC 4.1 is directly nourishing the KER and related BM and is thus key towards the validation of the proposed model. Indeed, the learning from the previous UC are important for the return of experience generated from the design to the exploitation phases despite, this UC feeds the BM with the needed values for its validation. To recall, the objective of the UC is to prove the value creation via operating a PV+BESS for FCR (Frequency Control Reserves). The proposed set up is the local optimisation via the EMS provided by EDF S&F and its interfacing with the aggregator platform from AGREGIO. Following the analysis done in the early stage of the project the hypothesis has been formulated, that the FCR service provided by a BESS could probably be enough to rebalance the overall BM (business model) and lead to a positive NPV (Net Present Value).

The main developments towards the implementation of the UC were the identification of the technical and functional specifications the overall system had to satisfy and the interfaces between the two parties (aggregator + EMS). Moving from a centralized towards a distributed approach (see next section - UC 5.1), the API development between AGREGIO and EDF S&F moved from the aggregator to the EMS side. Main issue to be solved where the synchronisation of the platforms and ensure stable and reliable information exchange on the whole chain. For the IMREDD demonstration, AGREGIO set up a dedicated pool to be run in parallel of its market bids, enabling the demonstrator to participate to the bidding phase in the day-ahead primary reserves market and test the implementation of the service by the EMS. For the latter, the optimisation of the FCR service is done locally, exchanging with the aggregator its availability in terms of power over the defined bidding period and in case of flexibility activation, provide real-time monitoring of the operation.

The overall set-up has been completed by Q3 2022 and since the first communication tests have been achieved. The EMS has been kept under a continuous operation mode with the objective function to follow the grid frequency, waiting to finalize the VPP and EMS interconnection. This gives already valuable results on the availability of the battery for FCR services in terms of activation capacity and duration. Additional test will be performed until project end and a final extrapolation over a whole year of operation be assessed thanks to the demonstration data. More information will be provided by M66.

Lesson learnt: the energy flexibility market is yet constrained to big consumers

From the implemented work, what came to light is the yet early development stage of the flexibility market. The flexibility pools integrated into the spot electricity market are yet mainly individual customers able to provide each the needed minimal trading requirement (+1 MW). Additionally, some of such clients are reluctant to share the risk with other customers, to avoid being affected by the non-availability of a third-party asset putting at stake the whole pool. The market is recently moving towards pools with customers of lesser capacities, yet not achieving the size of the single assets as integrated in IRIS.

Lesson learnt: commercialisation efforts and contractual arrangements are yet an obstacle

Besides the technical aspects exposed above and in the next chapter, commercial and contractual aspects are yet hindering a faster development of the market. **Commercialisation efforts are high, as awareness of customers is rather absent** and thus, much effort has to be put into bringing this rather “complicated” service to the market, which yet has no structural/endogenous demand for the service. **The contractual arrangements are also yet in early development for this market segment**, as revenues, but also risk and potential penalties make the definition of **clear boundaries among parties not straightforward**, making operators reluctant to engage in the market. On the other hand, customers are rather reluctant too, given the little if not absent familiarity with this specific market segment and with new and rather unknown tariffication. Moreover, for what concerns possible fine due to non-reliability of the service is a risk, that in principles should be taken as much as possible by the aggregator or service provider. The challenge is to integrate such aspects in a rather “simple” contract and tariff scheme, that can be easily understood by the client, which in turn should not be affected by penalties.

Moreover, current regulation from the TSO on the FCR market imposes is that each and every pool has to be assessed and validated against its reliability before being able to integrate and participate to the ancillary reserves’ market. This makes the **sourcing of a larger pool of smaller assets also more time consuming and less attracting for involved parties**. A market design enabling more flexible definition and validation of a reserve pool, whilst still ensuring its reliability, could facilitate to bring such distributed resources, as those demonstrated in IRIS, to the flexibility spot market.

3.3.1.5 Implementation 5: UC 5.1 – EMS emulation

The aim of the study is to identify the most suitable optimisation strategy for a pool management for FCR (Frequency Control Reserves) and local peak shaving, so a pool of EMS beyond that available in IRIS.

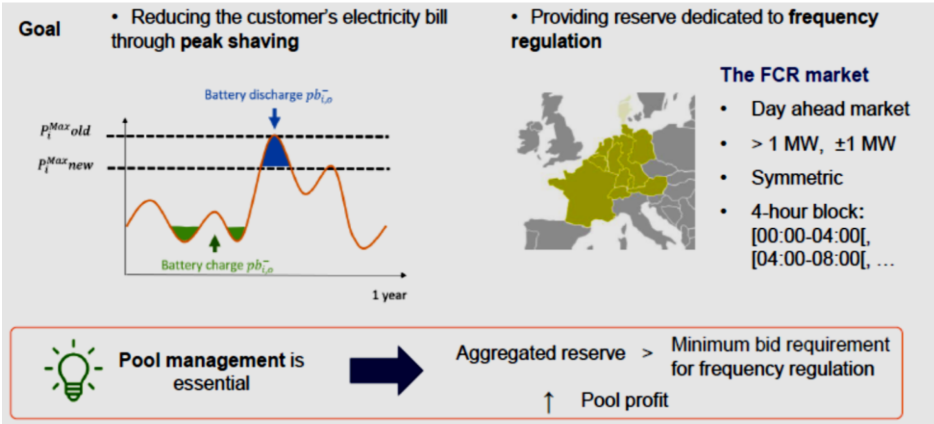


Figure 127 : schematisation of two objective functions: left the local peak shaving aiming at reducing a customer's bill and right, the FCT market, aiming at increasing the pool's profit.

The considered pool for the study is composed of batteries installed behind the meter of industrial and commercial sites, as the analysis and simulation work has been done based on a pool of 3,8 MW or 17 batteries or customers (these have been taken among EDF S&F's portfolio). The objective function is to reduce the customer's electricity bill through peak shaving, while providing reserve dedicated to frequency regulation.

The challenge is here to identify the best strategy to ensure an optimized solution for both services. Indeed, the two objectives can be in conflict: on one hand the "local objective" maximizing peak shaving and on the other hand, the "pool objective" maximizing FCR bid and response. The optimal solution must maximize profit from the combination of those two services to compute the optimal solution, while several strategies can be used as a centralized, distributed, or decentralized approach. The work has thus analysed how such different approaches are implemented, their implications in terms of computation time and optimisation quality, exploring their respective pros and cons.

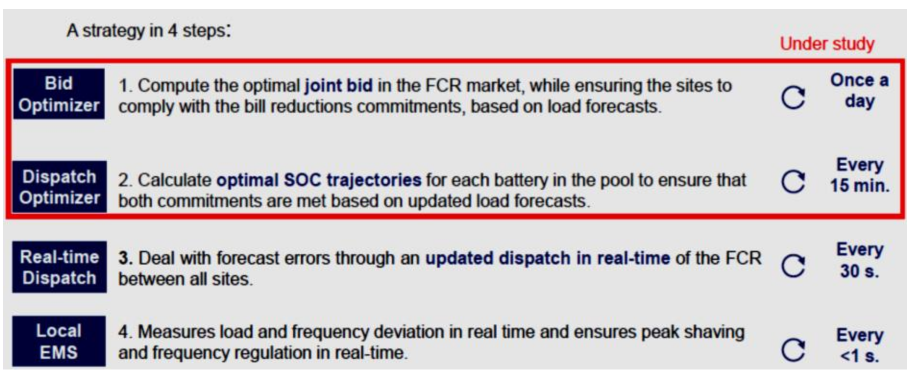


Figure 128 : the workflow is implemented in 4 main steps, whereas the study focuses on the first two steps, essential for the optimisation problem, as the other two steps are more related to operational ICT issues (source: EDF S&F).

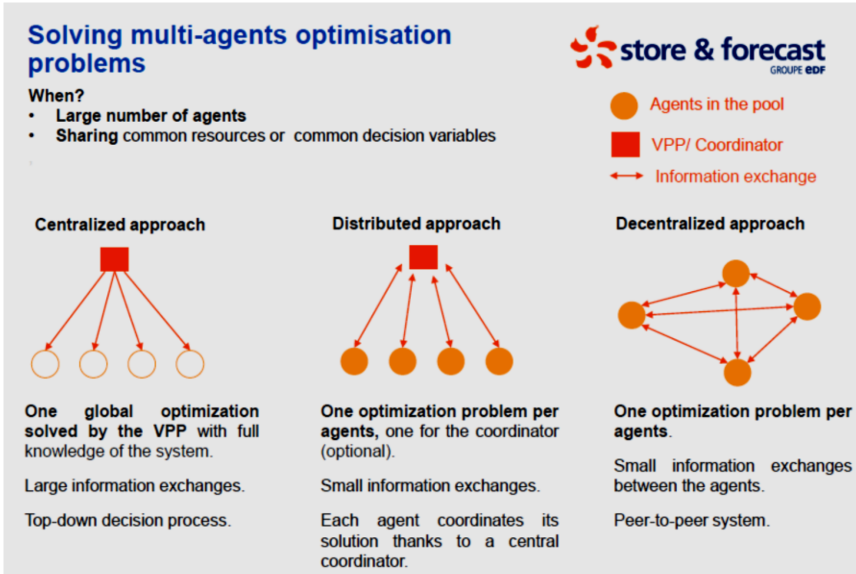


Figure 129 : schematisation of the 3 different approaches considered – centralized, distributed and decentralized (source: EDF S&F)

As can be evinced from the schemes above, the same problem can be approached through different levels of decentralisation of information and decision share among the “agents” within the considered system. The centralized system is an organisation which corresponds to an aggregator controlling the whole system via a VPP (Virtual Power Plant): he needs the full knowledge of the system, so each and every agent shares almost all information, leading to a large information exchange and rather large optimization problem. On the opposite, the decentralized approach in completely based on Peer-to-Peer (P2P) exchanges, locating the optimization problem at the agent level, without any coordinator.

Indeed, the latter despite being interesting for research purposes, it does yet not reflect existing market conditions, where the market agent – aggregator - is unavoidable. For this, the distributed approach has been implemented in UC 4.1 and the decentralized one, not further deepened for the demonstrator: the pool optimization is yet coordinated by a central coordinator, the aggregator and the sole market agent; however, the optimization problem is located at the agent level and exchanging much less information than through a VPP approach. In other words, the EMS optimizes its own assets and exchanges with the aggregator its availability for flexibility services. It’s then up to the aggregator to optimize the dispatching of the connected agents and up to them, to control their assets accordingly.

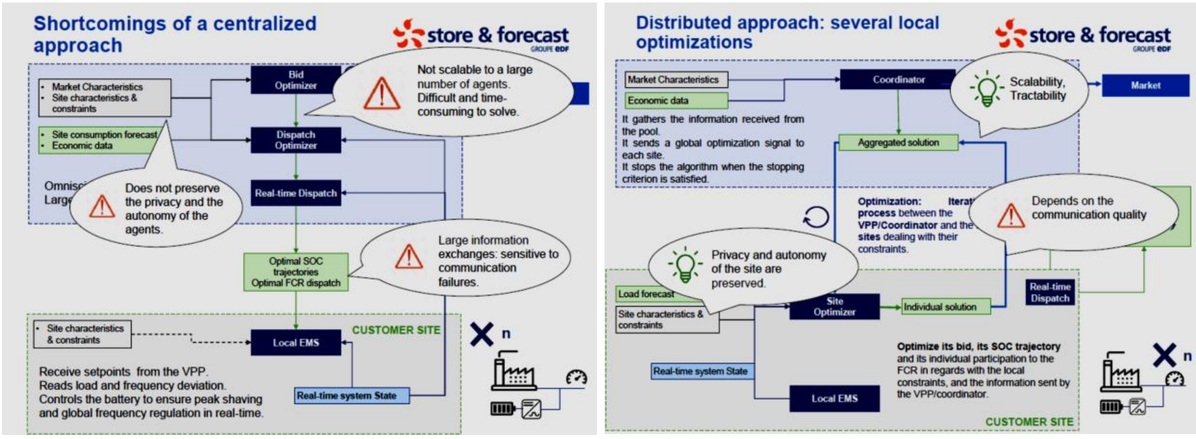


Figure 130 : comparison of the overall information and optimisation flow between a centralized (left) and distributed (right) approach. (source: EDF S&F)

The results from the comparison brings to light **the main advantage of a distributed approach so, its scalability due to the lesser needs of data exchange and computation time, which does not increase linearly with the connected assets as in the centralized approach.** Indeed, the distributed approach needs additional computation for iterating among agents and converge to the optima nevertheless, this becomes negligeable while scaling the system. The threshold is estimated to be of about 250 agents or sites.

Work done and case studies

store & forecast GROUPE EDF

- ✔ The **centralized approach** is implemented, simulations were performed and some degraded modes were studied.
- A **distributed approach** is under study with 17 sites.

		Centralized approach (global)	Distributed approach (local)	
Case study set up		Gold standard.	Perfect communication 365 days and 17 sites.	Communication delays and losses with 17 sites and 3 days. Protocol in case of communication failure.
Result	Optimality gap	\	Acceptable solutions found with a **few tens of iterations (optimality gap < 0,5 %).**	**Consensus** between all agents reached despite communication uncertainties (the optimality gap remains acceptable).
	Scalability and computation time	Computation time scales linearly with the number of sites.	Runtime does not depend on the number of batteries but one the slowest site's optimization runtime and need in peak shaving. Expected to be significantly **faster than a centralized approach** with 250 sites or more.	**Slower convergence** since the number of iteration and the time per iteration are increased. Depends on **the communication quality** between the batteries and the coordinator.

Figure 131 : synthesis of the quantitative comparison of a centralized and distributed approach. (source: EDF S&F).

Takeaways

store & forecast GROUPE EDF

	Centralized approach (global)	Distributed approach (local)
Structure	One global optimization.	Several local optimizations.
Privacy	✗ The VPP has full knowledge of the system.	✓ Local data are kept private, small information exchanges.
Scalability	✗ Not scalable to a large number of agents. Difficult and time consuming to compute.	✓ Highly scalable to a large number of agents. Small optimisation problems solved in parallel.
Optimum	✓ No optimality gap.	✗ Small optimality gap, depends on the tolerance.
Communication quality	✗ Large information exchanges, sensitive to communication failure.	✗ Iterative process. The algorithm runtime depends on communication quality. Development of a protocol to limit the impact of communication delays and losses.
Complexity to implement	✓ Similar complexity than implementing a single optimizer if the communication is reliable	? Not existing in operation (to our best knowledge)

Figure 132 : synthesis of the main outcomes of the centralized and decentralized optimisation strategy. (source: EDF S&F)

A smaller shortcoming from the distributed approach is the deviation in the identified optimal solution, due to the sensibility to local optima. However, the deviation stays in acceptable tolerance as below 1%. What stand out, is the need to define a protocol to deal with ICT related aspects of the information exchange among EMS and aggregator, as downtimes in communication means is part of the exploitation reality of these systems, where 100% asset availability can't be unsured. Despite this, is seems that such **a distributed approach is yet not common in the market and aggregators yet work more often with a centralized, VPP based approach**. More demonstration activity and knowledge share are needed among the community in order to leverage from this approach and see un uptake of a distributed approach in the flexibility market, believed to be key to enable the uptake of decentralized flexibility operators under current market design conditions.

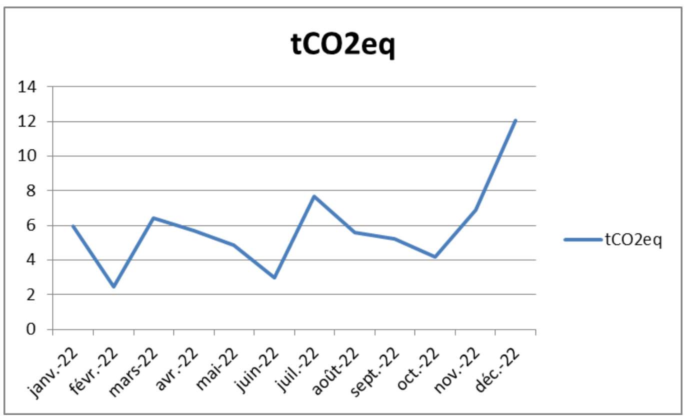
3.3.2 Measure 2: Smart multi LEMs

The first significant results regarding Measure 2 have been analyzed after 1 year of exploitation at nominal use of the DHCN. It will have been operated with an advanced controller of the DHC production plant to minimize operational costs and to maximize the use of available renewable energy sources (thermal and electric).

Due to various equipment defaults throughout the period the data is not 100% accurate:

- Data feedback inventory
  - The overall electricity consumption of the plant is reliable
  - The overall electricity consumption of geothermal energy is reliable
  - The reports of the electrical consumption of the auxiliaries are not reliable to date
- Exchange table not reliable, modification in progress, no history therefore in 2022
  - The two geothermal energy meters out of order: pending supply / replacement
  - Energy meter Heating network flow OK
  - Energy meter Cold network outgoing out of order: pending supply / replacement

Key results for environmental and energetic impact



Mois		01/2022	02/2022	03/2022	04/2022	05/2022	06/2022	07/2022	08/2022	09/2022	10/2022	11/2022	12/2022	TOTAL
Conso Elec Prod.	MWhe.	114,21	32,44	127,20	92,14	71,77	0,00	132,35	86,88	84,90	73,84	121,49	232,42	**1169,64**
Conso Elec Géothermie	MWhe.	14,58	20,39	11,32	30,87	33,55	64,18	33,80	33,64	28,11	16,31	28,18	28,18	**343,11**
tCO2eq	tCO2eq	5,95	2,44	6,40	5,68	4,87	2,97	7,68	5,57	5,22	4,16	6,91	12,04	**69,89**

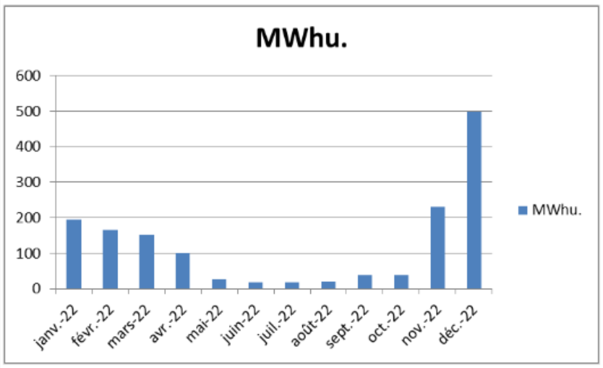
Data feedback inventory:

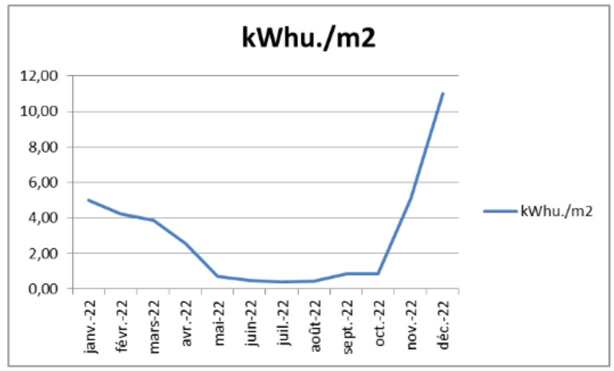
- No full operation and maintenance of the secondary distribution in building. The lack of communication between primary and secondary energy distribution system makes the data analysis less accurate. Indeed the precision to distinguish heating and sanitary use of the energy is very important. The feedback allows us now to work hand in hand with the building operator. This will give us and them a full vision of the energy consumption and environmental impact.
- The DHCN us geothermal energy and electricity as primary energy, no fossil energy is used. The environmental impact is reduced and only 69t CO2 equivalent has been calculated related to the use of electricity.

Key results for energy efficiency

Energy consumption for heating:

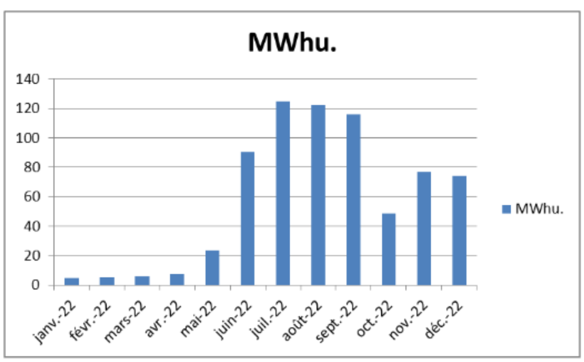
Mois		01/2022	02/2022	03/2022	04/2022	05/2022	06/2022	07/2022	08/2022	09/2022	10/2022	11/2022	12/2022	TOTAL
DJC18	DJU	259,30	197,20	194,40	117,00	17,90	0,00	0,00	0,00	3,90	9,80	102,00	214,60	**1116,10**
Ventes Chaleur	MWhu.	194,55	165,44	151,20	100,19	27,56	18,18	18,22	20,73	38,57	38,83	230,11	497,76	**1501,34**
m² abonnés livrés	m²	39 104	39 104	39 104	39 104	39 104	39 104	45 254	45 254	45 254	45 254	45 254	45 254	
kWhu./m2	kWhu./m2	4,98	4,23	3,87	2,56	0,7	0,46	0,4	0,46	0,85	0,86	5,08	11	

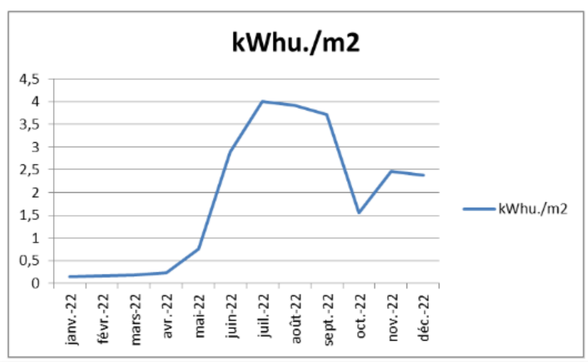




Energy consumption for cooling

Mois		01/2022	02/2022	03/2022	04/2022	05/2022	06/2022	07/2022	08/2022	09/2022	10/2022	11/2022	12/2022	TOTAL
DJF18	DJU	0,00	0,20	0,80	8,50	71,50	184,10	282,20	263,90	144,50	57,90	7,60	0,10	**1021,30**
Ventes Froid	MWhu.	4,72	5,20	5,61	7,10	23,61	90,09	124,53	122,24	116,06	48,39	76,72	74,02	**698,29**
m² abonnés livrés (PS > 0)	m²	31 159	31 159	31 159	31 159	31 159	31 159	31 159	31 159	31 159	31 159	31 159	31 159	
kWhu./m2	kWhu./m2	0,15	0,17	0,18	0,23	0,76	2,89	4,00	3,92	3,72	1,55	2,46	2,38	





In 2022, 4 new buildings has been connected to the DHCS, therefore there is a significant increase in the need of heating and sanitary use. The analysis of the data and consumption show a use of the energy throughout the year with very low variation during winter. In fact the power's peak is low but the consumption is high. The regulation of the temperature needs to correlate the set point of the secondary and primary energy distribution. The result shows a difference between the two set points and a low efficiency between the DHCS and inside the building distribution. 2023 will be a year dedicated to optimize the regulation of the buildings.

3.4 Expected impacts and KPIs

3.4.1 Measure 1: Stationary storage deployment in buildings and local electric flexibility management

As had been stated in the GA, aim of the measure is: "in case of bankable business model, development and test of a LEMS on one of two areas: Nice Meridia or Grand Arenas". The scope has been thus set on Nice Meridia, as delays in the Grand Arenas represented a too high risk, potentially putting at stake the whole TT#2 activity. Indeed, the decision was consistent with the current announced commissioning of the Grand Arenas DHCN project beyond the IRIS project's end. As explained in the previous sections, an incremental UC-based approach has been implemented for ensuring to hedge against permitting risk as well as asset delivery delays and ensure to cope with regulatory and thus also potential bankability requirements.

In terms of expected actions under Measure 1 and their realization, this can be resumed as follows:

1) ***energy consumption/bill reduction, DSM (to reduce peak demand)* => achieved** – both demonstration buildings have an operational system composed of PV+BESS+EMS and operated under different UC as listed above.
2) ***implementation and management of self-consumption at building and district scales* => partially achieved** – no district level self-consumption scheme or energy community has been implemented by the concerned Project Partners within the Project's framework, due to regulatory and financial constraints. UC 5.1 however, enabled to explore the matter, going beyond self-consumption only and integrating flexibility management at a larger pool than the considered district.
3) ***the injection of PV surplus power into the grid properly remunerated* => achieved** – demonstrated in the IMREDD building via AGREGIO and operated under UC 2.2; not achieved in the NEXITY building due to the given explanations.
4) ***the management of EV charging ports (w/o peak shaving for DSO)* => achieved** – demonstrated in the IMREDD building via the implemented EMS under UC 1.3; NEXITY has not implemented any EVCI.
5) ***deployment of a strategy to aggregate flexibilities to be valued on energy markets or through DSOs to release grid constraints and energy storage managements*." => achieved** – implementation in IMREDD via the implemented EMS and Market Platform to provide FCR to DA Primary Reserves Market under UC 4.1- waiting for validation of the BM.

In terms of KPIs, the measure of success relative to Measure 1 was the deployment of a "***storage capacity of 2 120 kWh (2.1 MWh) in the 2 demonstration and replication areas (Stationary battery storage)".*** Today, less than 0,4 MWh of stationary storage capacity are deployed within Measure 1's scope as part of the demonstration project. An additional BESS of 616 MWh capacity has been installed in the DHCN site under Measure 2. No parallel take-off of the technology can yet be observed by 2022, nor locally, nor nationally. The overall unfavorable market conditions for the technology have been shown above. More demonstration activity and clearer regulation are necessary to raise awareness and confidence in the market. Without public funding, and public tendering, no large-scale take-off of the technology is foreseen at the time being. Indeed, the project REX is to prioritize Smart Charging as additional storage capacity can be mobilized, i.e. under TT3 additional 1MWh have been operated.

The KPIs chosen to be reported under WP9 for the demonstration activity concerning Measure 1 are listed in the followings. Where appropriated, additional information have been added for the sake of completeness.

- **Storage capacity installed:**
  - 92.3 kWh stationary BESS in NEXITY +
  - 182.6 kWh stationary BESS in IMREDD +
  - 41 kWh RENAULT ZOE V2G in IMREDD +
  - NO 2nd LIFE BESS +
  - NO FLY WHEEL =
  - ---
  - **315,9 kWh** => reference = no BESS at all in other sites rather than big industrial sites

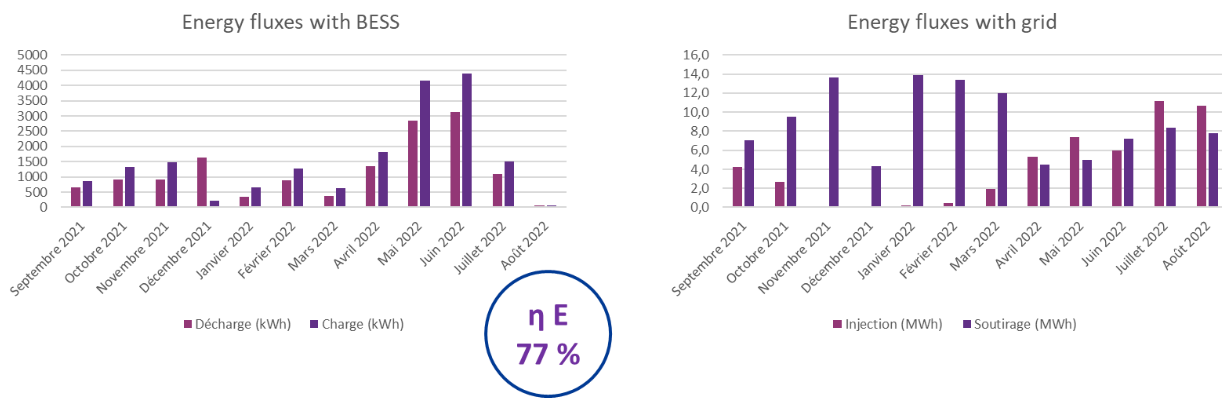


Figure 133 : visualisation of two-way fluxes among the IMREDD building and the BESS on the left and with the distribution grid on the right. (source: IMREDD)

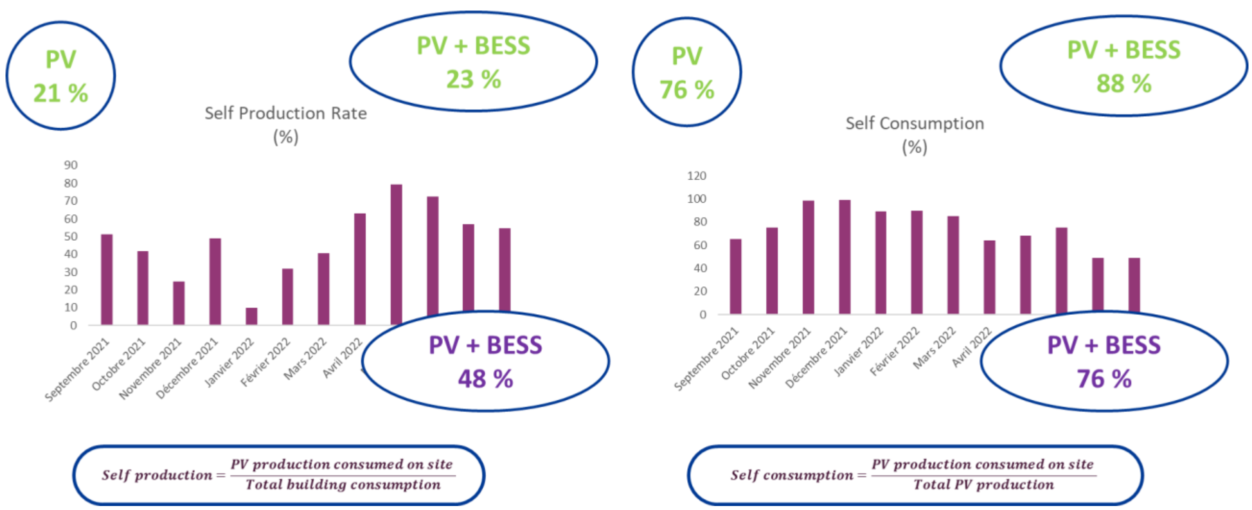


Figure 134 : visualisation of planned (green) and achieved (violet) self-production rate (left) and self-consumption rate indicators under UC 1.1 and UC 2.2 for 1 year operation. (Source: IMREDD).

In the figures above, a summary of the data from the IMREDD building from the last operation year is shown, more precisely the energy fluxes generated by the operation among the BESS and the grid. What can be evinced, is that the BESS is operated with an overall yearly COP of about 77%. The main usable monthly discharge power achieved with the BESS is of 3 MWh during May and June 2022 (due to material default, data for July and August are not meaningful), whilst is less than half for the winter months.

Globally speaking, the expected self-consumption rate of the PV+BESS endeavour in the IMREDD demonstrator has been largely underestimated in the design phase, as the experimentation data show a rate of 48% compared to the expected 23%. Whilst the self-consumption rate was slightly overestimated to 88%, while experimentation has achieved 76%. These results must be interpreted carefully, as has been explained before, the system has experienced longer period of down-times of metering and the PV+BESS+EMS.

- **Battery degradation rate:**

As has been mentioned the 1st life BESS's equipment has had full replacement of the cells so no meaningful measure can be evinced as all battery cells are brand new. The SOH (State Of Health) has been screened since commissioning and showed as expected, no noticeable variation. Similarly, the case for the V2G relevant cycling could not be achieved for a long enough duration due to the explained deviations. The related assessment of the degradation rate of the 2nd life BESS could not be achieved, as the asset has not been made operational. The indicator has thus to be abandoned. By any mean, after the REX from the implemented actions, it is suggested that a period of at least 3 to 5 years operation should be taken as minimal timeframe for evincing meaningful data on this matter.

- **Increased system flexibility:**

As explained in the previous paragraphs, the indicator only concerns the IMREDD case, as the NEXITY demonstrator has not been able to move to the 2.2 UC and thus, nor PV surplus injection nor flexibility services can be exchanged with the grid.

In the case of the IMREDD building, seen the current market conditions, priority has been given in the demonstration to the Primary Reserves Market, more precisely to the FCR (Frequency Control Reserves). No tertiary reserves are targeted, as estimated to potentially generate far less revenues.

- Number of activations per year = to be defined // waiting test campaign and evaluation
- Average Power flexibility [kW] = to be defined // Probably in the range of 80% of 182.6 kWh ≈ 146 kW
- Average Energy flexibility [kWh] = to be defined // Probably zero as FCR (+/-) usually have net zero voltage
- Average activation duration = to be defined // Probably 4h

- **Energy costs reduction:**

Energy cost reduction is related to the previous indicator, so to the revenues achieved by the FCR operation mode and additionally to the revenues achieved by the sale of PV surplus.

- Income PV injection [EUR] + = to be defined // waiting annual bill to be emitted
- Income energy services [EUR] = to be defined // waiting test campaign and evaluation
- % of Expenses electricity [EUR] = to be defined

- Annual energy consumption : **676 MWh** Mean energy buying price : 5 c€/kWh
- Investment costs (PV panels price, battery price,…) are not taken into account
- Energy selling price : 7 c€/kWh
- Self consumption bonus (CRE) : 10€/MWh

Scenario	Energy bought (€)	Energy sold (€)	Costs (€)
No PV no battery	96 974	0	96 974
PV + battery	77 673	3 062	74 611

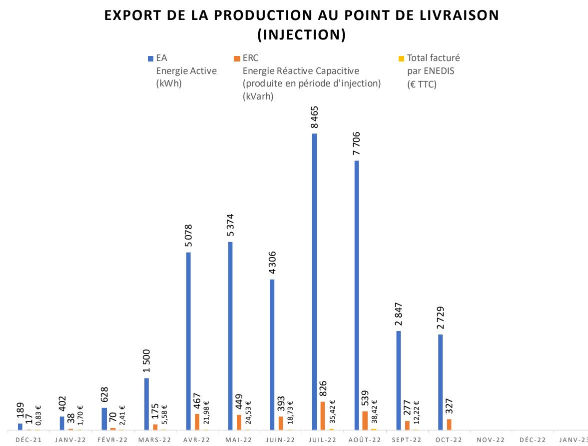


Figure 135 : left – estimated generated revenues from the PV-surplus sold under UC 1.2; right – metered exports at the DSO interface: blue – active energy or PV-surplus; orange- reactive energy; yellow – monthly DSO related costs in EUR (Source: IMREDD)

Moving from UC 1.1 to 1.2 was stringently needed, as this firstly enabled to inject the PV-surplus without risks of fines or other persecution from the DSO, surplus which is unavoidable seen the systems sizing, but also to be able to leverage from current market mechanisms and generate possibly additional revenues for the surplus PV. The bill is emitted once a year and is therefore currently not available as covering the 2021 period only. What is expected, is that the overall operation under PV self-consumption optimization, leaves not enough surplus to be sold to generate significative revenue in the overall energy bill. The market is not designed to foster such type of installations (small or decentralized PV), as once connected to a balance responsible party, the full produced PV should be sold on the market to ensure the maximum of the generated PV is sold. As said before, such market is designed yet for multi-MW installations.

3.4.2 Measure 2 Smart multi LEMs

<u>Expected results within the PCM hot storage operational since February 2023.</u>

- Measure the performances of an innovative PCM hot storage in real operating condition.
  - Improve the system efficiency by coupling the heat pump to four kinds of storages (geothermal, heating, cooling and electricity storage systems).
  - Assess the performances of a district heating and cooling system based on low temperature heat pumps.
- Implement smart energy management systems to jointly optimize the operation of heating, cooling and electricity generation, consumption, distribution and storage systems.
  - Experiment a state-of-the-art AI-based optimal control method for these smart energy management systems in real operating conditions.

Picture/Map (eye catcher)

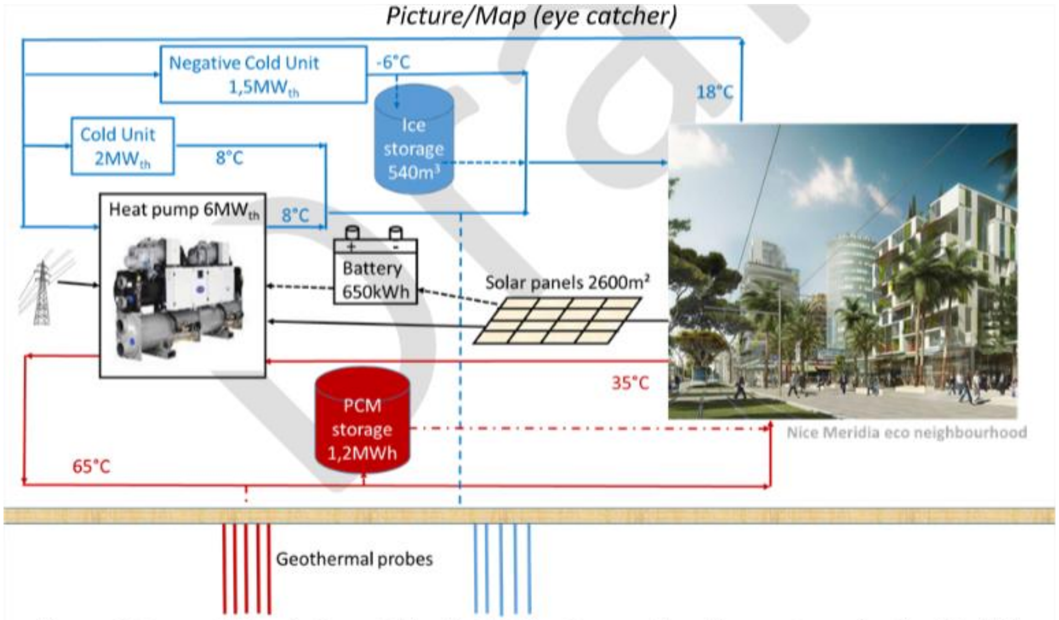


Figure 1 General description of the district heating and cooling systems for the Meridia eco-district

Selected KPI are:

Nom	Reference	Frequence	Unité	Définition
Thermal energy consumption	ThermalEnergyConsumption	Annual	kWh	Aggregated Consumption data by year corresponding to the net consumption used by the network (kWh/year)
Building Area	BuildingArea	Annual	m2	Building Area of the network
Delivered thermal energy from energy carrier	ThermalEnergyDelivery	Monthly	MWh	Aggregated delivered data by month corresponding to the net delivered energy injected to the network (MWh)

The CO2 coefficient from delivered thermal energy carrier	ThermalEnergyCO2	Monthly	t CO2 / MWh	Aggregated CO2 emission data by month corresponding to the CO2 emission exported by the thermal energy carrier (tCO2 /MWh)
Peak Power	PeakPower	Weekly	kW	Maximum Peak power aggregated by hour (kW)
Thermal energy production by RES	ThermalEnergyProductionRES	Monthly	kWh	Aggregated production data by month corresponding to the net production energy RES only injected to the network (kWh)
Heating price	HeatingPrice	Monthly	€	Heating price P1+P2+P3 (€)
Heating price baseline	HeatingPriceBaseline	Monthly	€	Heating price baseline (€)

3.5 Business models and exploitation

3.5.1 Business model canvas – Measure 1: Stationary storage deployment in buildings and local electric flexibility management

3.5.1.1 Key Partners

- organizations within the EDF Group (LTP to EDF)
- real-estate and construction companies
- building owners or association
- engineering companies
- operation companies
- public entities

3.5.1.2 Key Activities

- The activity is directly linked to the willingness of customers to integrate renewable energy sources in the actual context of energy transition
- Distribution channels are developed within EDF group and its subsidiaries
- The revenue stream will be generated in a near future by the activation of flexibility services via a BESS in the tertiary sector under operation conditions, in addition to the EMS and BESS O&M services.

3.5.1.3 Value Proposition

- Expertise and dedicated companies on the whole value chain > ability to accompany the client on all phases
- Reduction of overall system sizing thanks to operational performances
- Security of service supply and quality – data and evidence driven
- Make PV+BESS systems viable under current market conditions, thanks to a valorisation service offered, coupling PV+BESS+EMS O&M with flexibility services via an Aggregator. Respective platforms will be able to communicate and exchange information and orders, providing a seamless service to the customer.

3.5.1.4 Customer Relationships

- The service commercialization will lean on the existing network and channels of the EDF Group.
- The service will have most probably be developed on both public or private tendering market and direct B2B commercialization.
- Due to the diversity and complexity of building projects, contractual forms will have to be addressed on a case-by-case manner, depending on the Group’s perimeter of implication and project stage/maturity.
- The service will come in addition to the existing service portfolio addressed to clients, with the (hopefully validated) promise to make PV+BESS integration economically viable.

3.5.1.5 Customer Segments

- Client is an owner, constructor/developer or operator of any tertiary sector building: offices, education, and commerce.
- He has strong environmental ambitions and is not against investing in a PV+BESS system.

- He has or will launch a tendering procedure related to his real-estate project (independently if green- or brown-field project).

3.5.1.6 Key Resources

- All key resources are entailed in the EDF Group, from commercial staff, advanced data analytics engineering to exploitation personnel.
- ICT infrastructure is adapted accordingly (EMS + Aggregation platforms)
- Integration of the service in the offer-list of commercial staff and the related “training” for correctly setting up and negotiating commercial propositions
- Billing via existing means.

3.5.1.7 Channels

- The Group can leverage from its existing commercialization and communication channels, addressing real-estate related clients as principal customer.
- Evidence and data-based communication.
- Public and private tendering will have to be screened and used to develop and push the offer to the market.

3.5.1.8 Cost structure

- The biggest costs are on the CAPEX side, for investing in the PV and BESS.
- The overall exploitation service, mostly linked to the O&M of the system and licensing of the EMS and Aggregation, will have to be in accordance with the revenue streams that can be created by their operation, so to have at least, a win-win solution for the involved parties - reach an acceptable IRR for the contracts or assets’ lifetime.

3.5.1.9 Revenue streams

- The revenue streams for the company are mostly related to engineering and O&M fees (also for licensing of the EMS+aggregation system)
- Additional revenues generated by the aggregator, will have to be split among involved parties.
- Particular attention must be paid in case EPC (Energy performance Contracting) model is adopted in the exploitation phase, as revenues will be more or less directly related to the exploitation performances of the system or parts of it. This service has thus to be accounted for and integrated in the contract accordingly.

3.5.1.10 Bankable business model

- The business model is believed to be bankable nevertheless, the demonstration has to be attended to better evaluate the order of magnitude of the savings/revenues that can be achieved for the customer (to be updated in M66).

3.5.1.11 Recommendations to cities that want to replicate this result

3.5.1.12 List the most important factors to enhance replicability

- Develop a low-carbon energy system strategy for their territory, with a focus on three main aspects:
    - availability and accessibility of local RES for energy production at building level (PV mostly) and assess the interest of constraining building projects to adopt minimal requirements in terms of RES share > BESS are only of interest if PV or other variable RES are integrated in the system in a considerable manner (+30%).

    - Integrate the notion of RES based low to neutral temperature district heating and cooling networks, so with heating/cooling assets (Heat Pumps) located at building level > expand the possibility of a DHCN operator to offer building O&M services in link with the network and thus, leverage from bi-later energy storage/production.
    - Integrate in the strategy that the existing market for energy flexibility is yet constrained in the TSO level > avoid addressing a local level, which will most probably not enable a viable BM to any involved party. Instead, ensure tendering integrate as requirement that consortia have to entail aggregators (registered ones) in case BESS are through to be deployed.
- Develop the dedicated tendering on their own building stock, identifying “forerunner building” which can become a reference for the industry and thus, favour the adoption of the technology/solutions.

3.5.1.13 How can your company support cities wanting to replicate this solution?

- Dedicated WS and communication and dissemination campaign
- Participation to call for tenders
- Integrate service in commercial offers of the EDF Group and integration in its common network and channels.

3.6 Key recommendations

3.6.1 Measure 1: Stationary storage deployment in buildings and local electric flexibility management

What the work has shown and highlighted in the Key Barriers as in D2.1, can be resumed in following key recommendation:

- ***Implementation via UC-phasing according to regulatory requirements – permitting gives no space for errors***
    - The articulation of the UC and sub-UC has proven to be effective as enabling to isolate demonstrators and individual assets towards the different regulatory and permitting requirements. Technical and regulatory barriers have been identified in the early stage and implemented in the sub-UC structuring accordingly, considering so aspects related to commissioning of single assets and permitting (i.e. PV surplus injection or common self-consumption).
    - The permitting related to a PV+BESS+V2G is yet relatively complex, and the industry has little awareness about it. A **BESS or V2G EVCI come with specific requirements when designed for in-door applications,** which have large impacts on engineering requirements and overall CAPEX/OPEX, due to fire safety requirements. Local fire safety departments might ask for additional proof of concept or securities. Additionally, the whole electric system has a specific permitting procedure that must be accomplished before system commissioning. In particular**, the PV installation itself, should be commissioned with the final chosen implementation scheme** (self-consumption Vs. injection) as rarely, a BESS is sized to absorb all PV surplus in urban applications and PV-subcontractors, provide active service for supporting the implementation of different self-consumption endeavours (individual Vs. common w/o retribution) only at the commissioning stage and not in an "after sales" manner. The process takes months to be accomplished, up to more than a year if not done correctly, and rather complex. Operators are thus reluctant to engage a-posteriori in such endeavours.

- ***BESS+EMS solutions – choose insider companies and one-stop shop solutions***
    - The overall level of knowledge on system design, delivery and operation requirements of BESS or V2G indoor installation in the real-estate or building sector is very limited, if not absent, as solutions didn't reach yet significant enough market penetration.
    - **Knowledge about technical, permitting and regulatory constraints is limited to a very few "insiders" companies**, having already implemented first R&D/industrial demonstrators. Official guidance for indoor application in buildings is missing, and more particularly for what concerns local fire-safety requirements, a specific regulation is not given.
    - Indeed, indoor BESS come along with added (even obligatory) additional efforts, some with a non-negligible financial impact:
        - Allocation of a dedicated space - it's a rare resource once the functional plans/zoning are settled in real estate projects whilst **BESS are usually underestimated, being rather heavy** (≈ 1t x 100 kWh) **and voluminous** (HxWxL ≈

2,5x2x1m), meaning exceeding minimal floor-charge requirements in certain buildings of 500 kg/m². Static engineering must ensure the conformity of the construction for hosting such heavy assets. To consider that for 2nd life BESS, the mentioned weight and size do double.

        - **BESS are considered as an "explosive asset"** and treated as such by the entitled fire department - the allocated space must respect stringent fire-safety and explosion containment measures. This does not however mean that local firefighters might be aware on procedures or regulations to be followed. Such requirements' costs are not negligeable and should be integrate in the early BM of a PV+BESS/V2G endeavour

    - The exploitation complexity should be considered when defining the exact scope of suppliers and service providers around such systems, mostly in the first years of operation of such assets. In these regards, **a "one stop-shop" solutions, or single integrated service provider should be targeted.** The unreliability of the physical and digital assets needs constant monitoring and almost weekly interventions (remote or physical) in the first couple of years of exploitation. Reducing the actors in the value chain, can ensure a fast detection and solving of alarms and related causes, as delays related to downtimes significantly impacts exploitation efficiency and costs, even more if related to an EPC. **The proposed ideal solution should be to choose a single provider for the sourcing and operation of the BESS and related EMS.** This should ensure clear definition of responsibilities and reduce contractual interfaces between the BESS operator and the building operator.

- ***Target self-consumption or TSO level flexibility markets***
    - Given the current **absence of a DSO level market** and the current public and private electric system design and operation practices (concerning provision security and service quality), little incentive is left to pro-sumers to organise for trading and exchanges of RES electricity (PV) at the local urban/district scale or to adopt complementary assets as BESS or other storage solutions. **The flexibility market is yet strictly restrained to the TSO** (transmission system operator) **and aggregators are yet the most effective** (if not only) **manner to provide bankable services to the grid.**
    - This enforces the chosen approach which with IS 2.1 (UC 4), targets Primary Reserves as main mean to provide flexibility to the grid and hopefully, provide enough revenue streams to balance the overall BM.

- ***Dedicate special attention to the ICT endowment of buildings***
    - Depending on the foreseen operation mode, but it's most likely to be the case, a dedicated management system and high-level ICT endowment is needed. This can become complicated – and expensive - in terms of equipment (measures/controllers), communication and interfacing protocols (wirings, APIs with other systems) and this is often neglected. Not integrating them in a dedicated IT- project/task following all phases of a real estate project can lead to large delays and extra costs.
    - **Too often, proprietary systems and platforms multiply supervision and reporting interfaces for building owners and operators alike.** Built to serve "silos" among building exploitation tasks/businesses, share of data and information among them is limited and

often, not even possible without (costly – from about 15 000 EUR onwards) interventions of the system provider or software developers (ad-hoc API and IT architectures development – if possible, at all). The situation can be defined as "spaghetti ware**": as many APIs must be created as there are services and underlying metering/IoT/management systems and platforms.** Project implementation costs and more importantly, that of delivery and exploitation phase, are driven by the development of such "ad-hoc" APIs. The situation on the demonstration site was unfortunately not much different. Main downside of so designed systems is that any change at any interface is costly and time consuming, as so that usually such system does not undergo any evolution during a building's lifetime.

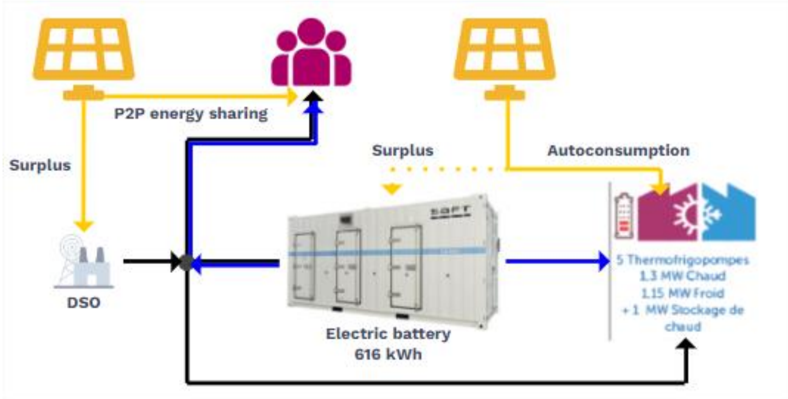
- These aspects converge towards the Smart Building guidance proposed by the SBA (Smart Building Alliance) as for their R2S (Ready-to-Service) Label, which the demonstration partners endorse after the achieved experience: first, the construction process should **integrate an "IT/Smart Task" (as an electricity, fluids or civil-works task) in the work assignment**. Responsibility of the task must be clearly assigned, and objective should be the **harmonisation and avoidance of inconsistencies and overlaps among information and exploitation systems/infrastructures**. This is however nowadays not the case and seldom implemented. Secondly, the solutions should further thrive towards the implementation of a **unique BIS (Building Information Systems) and the data exchange orchestrated by a middleware, a BOS (Building Operating System).** Such technology, yet at the early development stage, seems promising in real-time operation applications as for e.g., that implemented in the Nice demonstrators, so to increase overall system reliability and ensuring its capacity to evolve, whilst reducing CAPEX and OPEX of the overall ICT endowment.

3.6.2 Measure 2: Smart multi LEMs

The first year of operation and maintenance of the DHCS shows a continuous production of renewable energy throughout the year for the use of heating and cooling of the building. But the overall efficiency depends on the control of the regulation of all points of usage. This means the smart multi energy needs to operate with one single operator from the primary energy production to the secondary energy distribution in the buildings to allow a full vision on all the consumption.

We are now focusing our work on the flexibility in the network by using the major production equipments in the power plant (heat pumps, energy storage ...) and the buildings services and equipments.

Therefore Smart Multi LEM can only be fully efficient by targeting a customer engagement strategy to create loyalty and trust towards the customer. The goal is to attract decentralise energy producer (such as photovoltaic electrical production) in a micro grid system. The Energy Manager of the DHCS can offer purchase agreements for the sale of surplus energy that consumer produce.



<u>Medium-term objectives:</u>

Flexibility operator for the eco-district

- Increase in price differentiation with the implementation of dynamic price
- Diffuse flexibility offer within the framework of the energy community
- Partnership with Enedis
  - Emergency backup in the event of source substation failure (near police station, school, tramway)
  - Voltage regulation in the event of local overproduction of renewable energy

4 Results of Transition Track 3

The main results concerning Measure 1, will be update in the follow up version M66.

KEY MESSAGE

- Early EVCI adopters, are today in a difficult situation due to the asymmetry among building's refurbishment speed and EV+EVCI development speed: changing or improving their EVCI, has strong repercussions on the associated electric (reinforcement) and ICT endowments (adapt to new standards and protocols) and might also incur civil-works. Such repercussions are considerable in terms of CAPEX and OPEX and might exceed the cost of the sole EVCI and associated services themselves.
- Tendering definition responsible parties should consider this and provide accurate information on the existing situation after having performed audits on the concerned sites. Targeted consortia should thus not only be able to provide Smart Charging, but also ensure the needed works on the peripheral infrastructure of the EVCI.
- Developing Smart Charging, means having not only a clear visibility on the targeted EVCI and services, but also on the available and/or planned EV-fleet and related standards. The choice on charging capacities of charging poles as well as charging technology to implement (i.e. V1G and/or V2G) is limited by a pool's EVs. If these aspects are not treated in the early stage, the EVCI can't be correctly sized and adapted to a client's needs, resulting in oversized or underperforming EVCI and services.
- To ensure all aspects cited above are considered, would mean in the ideal case that a company or local authority targeting such development, has ensured a transversal cooperation among the related departments (i.e. building-, EV-fleet-, transport-, and IT-departments), sharing common objectives and related budgets. Nevertheless, this is not usual in the actual market and such coordination work should not be neglected, possibly impacting the work implementation with strong delays, till such multiple involved stakeholders or decision-makers reach common agreement on the work scope and budget.
- A Smart Charging plan can be implemented in a seamless manner for end-users if the interfacing with an EV-fleet management platform can be achieved as done under TT#3. The communication among the systems ensures the Smart Charging platform can be fed with the needed mobility constrains imposed by users, enabling a flawless customer journey. Nevertheless, any such action should ensure awareness raising actions have been implemented for end-users and concerned service operators, to ensure acceptance on one-hand, and a more efficient implementation on the other.

4.1 Overview

The demonstration activities of TT3 are structured along the two integrated solutions IS 3.1 and IS 3.2. Each IS is translated into "measures" or "use cases" (UC) forming the demonstration activities and described in D6.5.

IS 3.1 measure addresses the deployment of a “smart charging infrastructure”. Smart charging aims basically at optimizing the balance between EV charging needs and its availability for providing energy services. By monitoring a large pool of charging stations equipped with fast charging points, belonging to both public and private networks, it is expected to provide more flexibility to the public electricity grid not only by implementing power-shaving and shifting (V1G) but also other energy services such as i.e. primary reserves by reverse power transfer from the battery to the grid (V2G). The smart integration of such strategies should lead to the optimization of the overall energy expenses, and possibly generate a new savings/income stream for EVCI operators and/or owners.

At the time being, it seems that thanks to IRIS, the LH Nice could become the first (or one of the first) public authorities in France to be able to test V1G and/or V2G smart charging services on their EVCI and EV fleet. Key aspect of the work is also the interfacing of the platforms among IS3.1 and 3.2 and leverage from the developed API and information exchange to ameliorate the customer journey on one side, and service provision on the other.

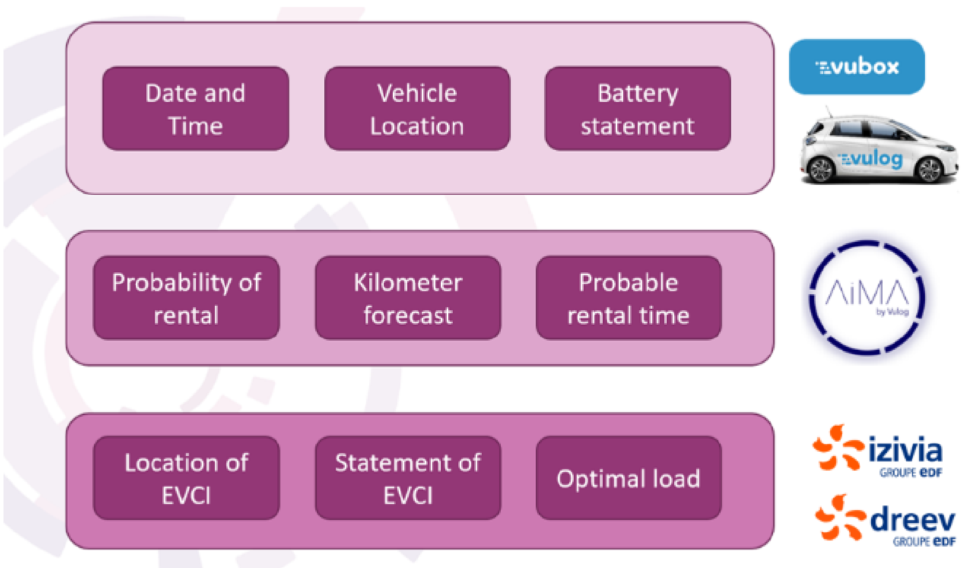


Figure 136 : Source of data useful for prediction

IS 3.2 measure, focuses on fleet management of public shared EVs, expected to pave the way to a new mobility paradigm where end users can benefit from a flexible solution for daily trips within the city instead of using their personal car. This approach is consistent with the ambition of the city of Nice to set up new means of transport (e.g. electric buses, bicycles, scooters) and to promote environmentally friendly solutions. Nice city has been an early adopter of EV mobility public service in France and intends to test EVCI load optimization and shared mobility solutions utilizing its own EV fleet and involving its public officials. Linking the booking forecasts combined with other contextual data to the availability of shared EV located at the right place and with the right battery load should lead to increase significantly the utilization rate of shared EV. To achieve that, it is required to gather data from both VULOG car sharing platform and the EVCI operation platform.

As part of the IRIS project, the vehicle fleet is that of the metropolis of Nice and the users are the employees of the metropolis.

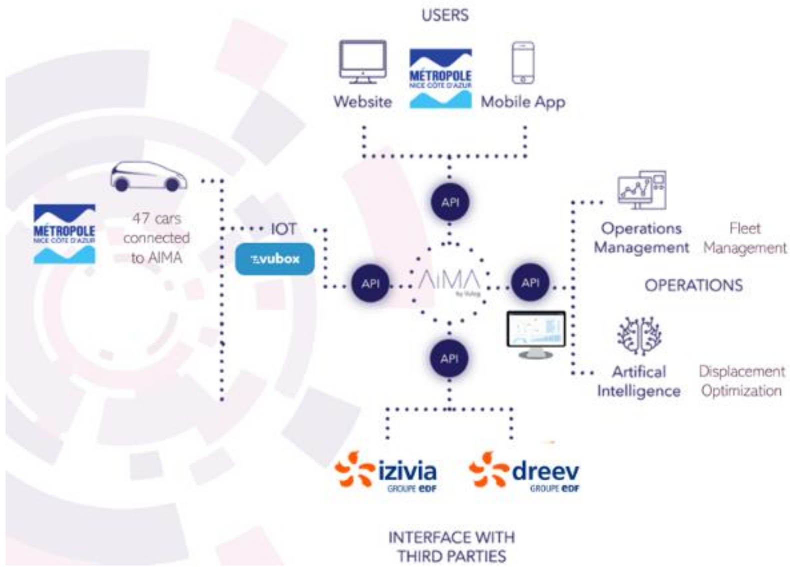


Figure 137 : AIMA platform interaction

Since the change of scope reported in the previous deliverables and the related amendments, a first main work has been focused on the feasibility assessment on the different sites proposed by MNCA and the scope has been set on 2 demonstration sites for the V1G Smart Charging demonstration as presented in the followings. One additional site is documented for the project, including a V2G project but lead under a private contract under MNCA and IZIVIA. Following stages have been achieved since on the sites:

- ***IS 3.1 – Smart Charging - Test V1G offer on the private fleet of MNCA:*** 17 EVs to be used by MNCA employees equipped and monitored by VULOG. Technical prerequisites have been validated. IZIVIA has thus installed his energy management equipment on 2 sites: *Immeuble Connexio* and *Parking Corvésy*. IZIVIA's existing real-time smart charging algorithms have been adapted to take into account the data provided by VULOG's EV fleet management platform in order to establish charging schedules: estimated energy amount, departure time, vehicle model, current state of charge. A dedicated API has been set up for this purpose. The final technical assessment has led to retaining two out of three possible sites:
  - *Immeuble Connexio : 12 EV charging points - 22 kW* (Schneider EVLINK SMART WALLBOX) in the parking > works have been terminated to solve the power limitations (3 kVA maximum power) and charging points are connected in parallel, and needed ICT equipment is installed and operational.
  - *Parking Corvésy : 5 EV charging points - 7 kW* (Schneider EVLINK PARKING) > 4 charging points have been replaced and needed ICT equipment installed and operational.
  - *Face immeuble le Plaza: site has not been retained* - 14 EV charging points (Legrand GREEN'UP T2P3) on public street > EVCI not compatible with smart charging and work would impact public space: the needed budget for works exceeds largely the upper value for the demonstration.
  - *Original planning and achieved implementation:*
    - Start of works – 01/09/2020 (signature of amendment to public O&M contract) // target achieved
    - Approval amendment to GA – Q4 2021 // At Q4 2022, the LTP has yet not accessed to the project with evident impacts on work delay.

        - Solution development and equipment delivery – Q4 2021 // equipment has been delivered in Q2 2022 and the software solution finalized in Q3 2022.
        - Metering/control test – Q4 2021/Q1 2022 // test have been deployed in Q3 2022.
        - Test of Smart Charging offer – from Q1 2022 onwards // to be started in Q4 2022/Q1 2023.

- ***IS 3.1 – Smart Charging - Test V2G offer on 3 V2G vehicles of the private fleet of MNCA:*** 3 V2G chargers based on DREEV's V2G solution have been installed for serving 3 cars used for public/official events of the Metropolitan's authority. Technical prerequisites have been validated (i.e. historic usage data to ensure compatible usage profile). The contract falls outside of the project's scope as being a commercial agreement among MNCA and IZIVIA. However, what was planned to be part of the project as in the V1G use case, is the interfacing of the service with the system provided by VULOG. A dedicated API was foreseen for this use. However, this action had been delayed, as the platform proposed by VULOG could, by contract, not cover MNCA's department in charge of the addressed carpool. Instead, the complete application provided by IZIVIA (based on the technology of DREEV), has been provided to ensure car reservation and definition for the EV-charging preferences and ensure the endeavour is achieved. The API has been developed and completed in Q4 2022. The equipped site is as follows:
    - *45 rue Gioffredo: 3 11 kW* charging points for 3 Nissan Leaf within the parking > on site audit done to define work requirements for the electric and ICT installation > works are finished and the EVCI operational since Q4 2021.
    - *Provisional planning and achieved implementations:*
        - Works and commissioning of equipment – Q4 2021 // achieved as planned
        - Start of V2G service – Q1 2022 // to be confirmed
        - Interfacing with VULOG platform – after mid 2022 // delayed and replaced by the DREEV application since Q1 2022 – API set-up has been achieved in Q4 2022.

- ***IS 3.2 - Smart charging combined with free floating test :*** As of today, VULOG car sharing platform is enabling the booking of vehicle as soon as the battery load is above a specific threshold (enough for achieving a trip). Moreover, the platform is computing multiple historical data to determine the most optimal locations as well as time periods for a car to be booked within Nice area. This functionality could be used to maximize the turnover of shared vehicles. Therefore, an adaptation should be considered to address the sharing model of a private carpool instead of a public car sharing fleet.

  Additional work shall be done to correlate data related to the load of the vehicle battery to the likeliness of rent of a vehicle when available. This issue is strongly related to IS 3.1 demonstrator focusing on smart management of an EVCI. Thus, IS 3.2 aims at establishing a car sharing management combined to smart charging in order to forecast an optimal battery charge for a vehicle at one time at one location. To achieve that goal, VULOG intends to develop a relocation process of vehicles from any free location to a charging station by involving end-users themselves and by offering incentives.

4.2 Implementations

4.2.1 Measure 1: Smart Charging

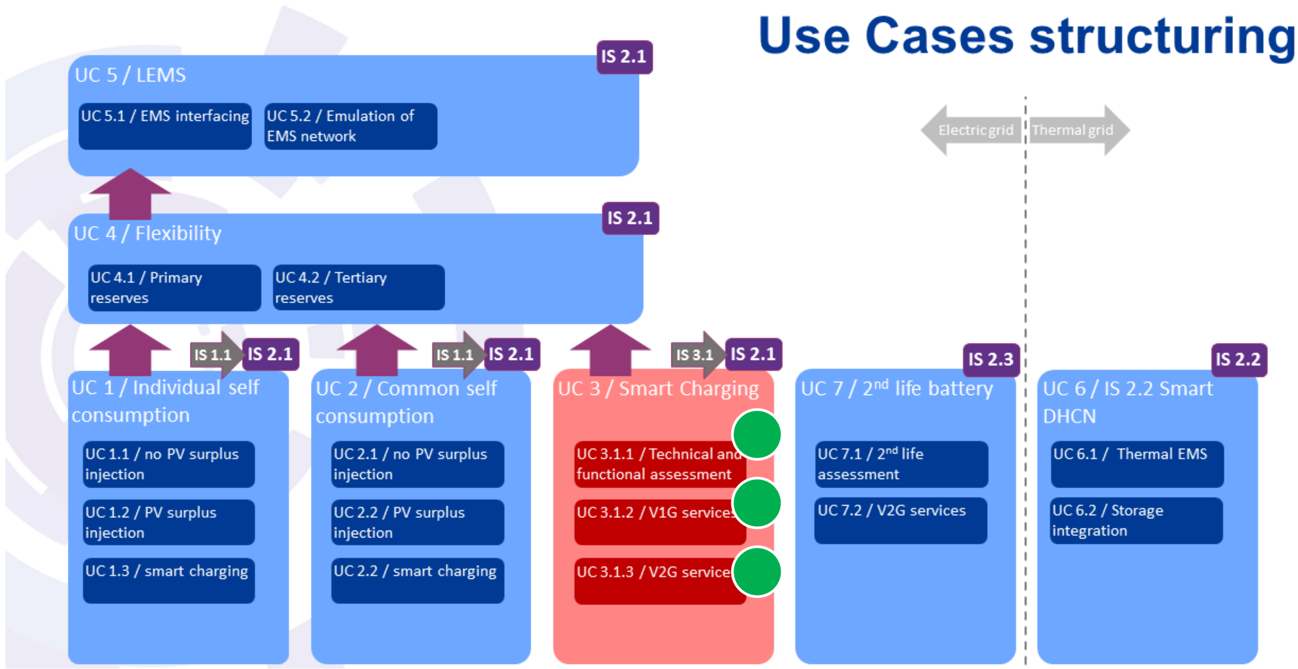


Figure 138 : UC structuring of IS. 2.1. In red, the UC related to TT#3 is highlighted – Green circle: UC has been implemented; Orange: UC on halt or not started yet

As by D6.5, IS 3.1 or UC 3, has been initiated as planned. The technical assessment for the 3 sites has been completed whilst with several month delay. The functional assessment of the API specifications to interface the V1G service with the platform provided by VULOG has been completed, and the API finalised since Q4 2022. To this end, since Q4 2020, MNCA, EDF, IZIVIA and VULOG have held at a monthly basis, information exchange, progress sharing and decision-making meetings. This, accompanied by on-site visits and audits and sharing of MNCA of historic data, has enabled to achieve a detailed knowledge of the retained sites and define associated interventions and budgets, while ensuring the right pre-requisites are given for both for both V1G and V2G related actions.

To point out at this stage, is that this task was very resource and time consuming, as transversal cooperation among departments and on innovative themes, is not part of the usual workflow. The coordination of the decision-making process has thus been complex and generated several months of delay nevertheless, the demonstration has been achieved and implemented despite all difficulties. What should be put in light is that IZIVIA agreed to take the risk and started its work, despite not being yet officially integrated into the GA as by date 12/2022.

IZIVIA has realized engineering and equipment installation works on the sites for the retained sites and ensure the needed software and algorithms development. For IS 3.1, the work has consisted of following actions:

- provision and operation of the needed on-site equipment (automation system – local energy management system for 2 sites and 17 charging points and additional ICT equipment/services),

- monitoring of the charging behaviours and define, develop and implement control strategies for activating flexibility for the EVCI,
- develop the needed algorithm to calculate charging schedules based on mobility needs expressed by VULOG. A heuristic approach has already been specified by IZIVIA and has been tested based on available data,
- develop the needed API(s) for the interfacing of IZIVIA's, DREEV's and VULOG's platforms and
- collect information about V2G EVCI implemented with MNCA; ensure an application to enable vehicle reservation and charging preference setting for end-users.

Missing is yet the extrapolation over 1 year operation and assessment of the replication potential from the achieved REX and feed through expertise and information the TT#2 activities.

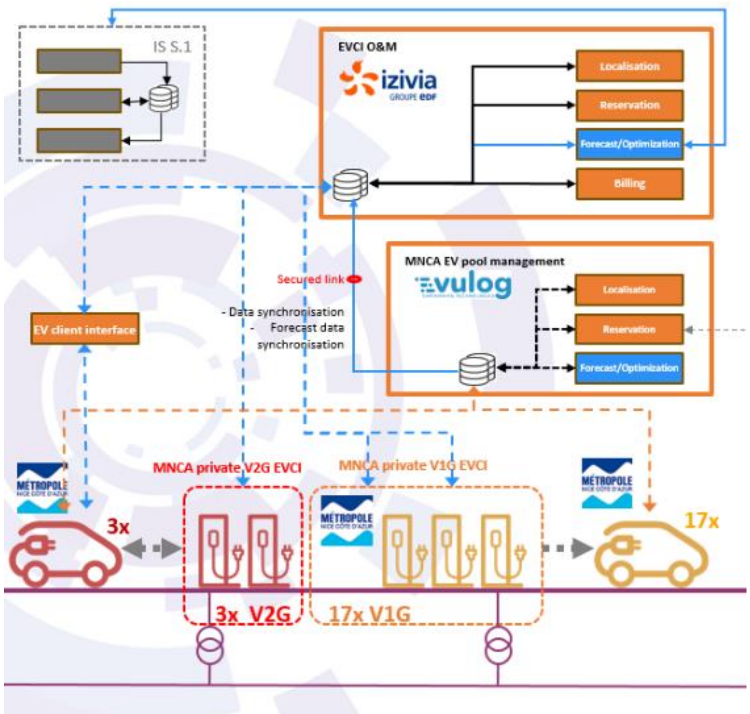


Figure 139 : General system interconnection between the different platforms directly impacted by the smart charging to be implemented in IS 3.1 – the highlighted blue rectangles, corresponding to forecast and optimization layers, are those focused on by IS 3.1; dotted lines correspond to additional interconnections to be done

4.2.2 Measure 2: Free floating EV car sharing system

The data from AIMA has been correctly provided and provided since the implementation of the car sharing service. Thus, VULOG was able to build a database to know:

- The identifier of the race,
- The driver's identifier,
- The “departure” date of the reservation,
- The “end” date of the reservation,
- The identifier of the starting station of the race,
- The name of the departure station,
- Distance travelled.

It is possible to access the data since the year 2018.

Within the framework of the IRIS project, only the **Connexio** (V1G), **Corvésy** (V1G) and **Gioffredo** (V2G) stations are studied. In addition, it was planned that IZIVIA, DREEV and VULOG link their databases in order to correlate the use of car sharing with energy management:

IZIVIA and DREEV put forward their booking data needs:

- Time,
- Which vehicle will leave and when,
- It would really take trips / km,
- Need to have the car's initial state of charge,
- hypothesis on the battery level.

The purpose of these data is to obtain a forecast of the departure time and the charging point in order to make a planning schedule from battery capacity. For this, several hypotheses have been put forward by VULOG and IZIVIA:

- Either the car has been reserved or it is on site.
- Delay sanctioned; arrival time known.
- As for the reservation, the vehicle must return to its point of departure.

IZIVIA and VULOG have started implementing the connection between the respective platforms of the two companies. Badges have been considered to identify vehicles. However, the Nice metropolis (NCA) has confirmed that each vehicle is associated with a terminal, thereby simplifying the correspondence at this level.

VULOG expressed the need for certain types of data, namely:

- Departure times,
- Energy requirement,
- Vehicle model,
- Vehicle site,
- State of initial charges.

For each reservation created on the VULOG platform and related to a station managed by IZIVIA, an energy requirement is automatically sent to the IZIVIA platform with:

- the planned departure time,
- the planned return time.

Likewise, when a reservation is updated on the VULOG platform (departure or return date updated for ex.), the energy requirement is automatically updated (deleted + created with the new values) on the IZIVIA platform.

If the reservation is cancelled, the energy requirement is automatically deleted on the IZIVIA platform.

These automatic processes are based on core VULOG system features to trigger action based on the system activity, and the IZIVIA API to create and delete energy requirements.

as matter stands, some issues still remain concerning the needs in terms of vehicle load. It is possible to be aware of the booking as well as its, but not the actual load of the vehicle. IZIVIA can only get an estimate of this load.

The load estimate will have to depend on the vehicle, the model. VULOG and IZIVIA must, as a first step, succeed in exchanging information. The idea is to make occasional requests on the charge level but if the vehicle is not in use, to preserve the battery of the box, the VULOG box, the VUBOX, must be put on standby. We can then only know the load value punctually. The wake-up frequency is configurable.

DREEV and VULOG have also started implementing the connection between the respective platforms of the two companies.

For each reservation created on the VULOG platform and related to a station managed by DREEV, an energy requirement is automatically sent to the DREEV platform with:

- the charge start time,
- the charge end time,
- the wanted SoC.

Likewise, when a reservation is updated on the VULOG platform (departure or return date updated for ex.), the energy requirement is automatically updated (deleted + created with the new values) on the DREEV platform.

If the reservation is cancelled, the energy requirement is automatically deleted on the DREEV platform.

These automatic processes are based the same VULOG system features used for IZIVIA integration, and the DREEV API to create and delete energy requirements.

As matter stands, it is not possible for the VULOG system to know the SoC required for the reservation. Indeed, the VULOG system only knows the planned reservation duration, which is not enough to estimate the required SoC (the distance, the average speed, … should be taken into account).

4.3 Key results

4.3.1 Measure 1: Smart Charging

The work so far done, has put into light:

- how existing EVCI upgrade is costly as costs needed for upgrading the related overall electric and ICT system is considerable, if not predominant. The latter is a too often underestimated factor, as clients are largely unaware on the impact that EV and its EVCI have on their electric system.
- Moreover, clients have seldom a clear vision on the deployment of E-mobility among their own or operated vehicle fleet. This is however the main determinant for defining the perimeter of possible V1G or V2G services yet bounded to the deployed EV-fleet and associated charging and communication technology.
- In terms of public administration, such projects are complicated to implement, as different parts of the smart charging system, affects different departments of the administration. Buildings' electric endowment and EVCI are part of the building department, energy contracts are managed by the energy department, the private EV fleet is part of the logistics department, while the public fleet falls under the transport department, and last but not least, any IT platform affects the IT department. These interfaces must be coordinated as well as the associated decision-making process accompanied, as these departments have seldom the chance to work in such a transversal manner. Long information exchange and negotiation processes are unavoidable, incurring serious delays in the project realization of any optimistic or pessimistic planning.
- The overall proposed services under TT#3 are seemingly encountering user interest and the proposed user-experience adapted to their needs: VULOG's platform will be in front-end to end-users for the vehicle management whilst, the V1G Smart Charging services will stay in back-end, prioritizing EVs' availability and their batteries' SOC. By any mean, the proposed services go beyond current software and processes in place within public authorities and it is believed that the information exchange among platforms can raise the overall exploitation performance and end-user acceptance and provide new flexibility levers to the electricity grid. The encountered discussions with the different involved parties, have so far confirmed the interest in the proposed solution.
- Finally, since Q4 2022, the API specifications between VULOG and IZIVIA are settled and implemented. Smart Charging operation should start by Q1 2023 and will be kept operation till project end.

Lesson learnt: asymmetry between technological and urban development

- In general terms, the "technological obsolesce/lock-in" is a common situation for early adopters of an EV-fleet and which has to be dealt with some urgency, as the situation described previously, is partly true for a wide range of local authorities.

Lesson learnt: the revamping of the peripherical systems of an EVCI can be more costly than the EVCI itself

- As explained above, the existing EVCI upgrade is as costly as a complete replacement. Whilst slow charging was the standard, fast charging is becoming more and more popular and accessible in terms of investment and operation costs. Nevertheless, in upgrading the EVCI, the costs for upgrading the overall electric and ICT system are considerable, if not predominant. The latter is yet a too often underestimated factor, and accordingly, public and private tendering are missing a clear analysis of status-quo and underestimating such costs. Moreover, clients have seldom a clear vision on the deployment of E-mobility among their own or operated vehicle fleet, or local specific e-mobility needs, which should be the departure point for defining the pool structure of the EVCI among the different charging capacities and technologies.

Lesson learnt: Smart Charging needs the cooperation of multiple departments not used to collaborate

- In terms of governance, current practice needs the integration of different departments of a local authorities or companies to realize such endeavours, needing inter-department competencies. These are usually driven by different strategic plans or objectives and rarely are enabled to work in a transversal manner and converge on common interests in such endeavours (as for e.g., on financing relevant matters or concerning exploitation responsibilities). The governance and coordination of interfaces and the associated decision-making processes is a difficult task and should not be underestimated in terms of impact on a project's planning.

4.3.2 Measure 2: Free floating EV car sharing system

The VULOG system is connected to the IZIVIA and DREEV systems and can manage (create, update, delete) energy requirements related to reservations made by the end user (who will use the vehicle) in order to optimize and plan the right battery SoC.

But the heterogeneity of the IZIVIA and DREEV solution complicates the integration. Indeed, the data required by both systems are not the same, the authorization protocol used by both systems are not the same… A convergence could simplify the integration. Use "standard" (like OAuth for the authorization protocol) or a common API could be an option but define the core features and data could be enough.

In addition, it's not easy to estimate the optimal battery charge because it depends on the route the user will choose, and the only data the VULOG system has are the reservation duration. At list the distance should be asked to the end user.

4.4 Expected impacts and KPIs

The originally targeted objectives are the followings:

- Number of EV: 2 000,
- Number of EV charging stations: 1 000,
- Number of Free Floating : 100 000,
- 300 <> 1 829 ton CO2 reduction/year,
- NO2 reduction/year: 7 %,
- PM10 reduction/year: 6%,
- PM2,5 reduction/year: 6%,
- 15 300 000 km yearly travelled with *V2G cars,*
- Peak shaving: 3,1 MW

Activities carried out on TT#3 on smart e-mobility were supposed to try to demonstrate that electric mobility could be boosted by the implementation of a 2nd generation of EV car sharing system: Free Floating. Indeed, as has been described in the introduction to the chapter, TT#3's scope has been amended and is reduced to the 3 mentioned sites and their EV pool, reduced to totally 20 EV, 3 of them are V2G cars. A free-floating scheme could apparently not be implemented by MNCA due to different reasons and is thus yet organized via round-trip mode, associating 1 EV to 1 charging point.

4.4.1 Measure 1: Smart Charging

In terms of expected actions under TT#3 and their realization status, this can be resumed as follows:

- ***Developing and testing tools for positioning and operate rapid charge to optimize fleet rotation.* => partially achieved** – 2 tools for Smart Charging have been put in place for the private fleet of MNCA: one concerning V2G (implemented and operational) and the one concerning V1G is under finalization. Automation equipment has been installed and set-up for operation.
- ***Developing a dynamic charge plan and car/charger interface* => partially achieved** – in the scope of the activity, a V1G Smart Charging test campaign is on the point to start. The V1G Smart Charging foresees to implement dynamic charge plans, whereas end users will access the service via the VULOG interface. In the case of the V2G Smart Charging, end users are actively using the provided end-user interface from DREEV, enabling to input reservation preferences as time, duration and expected trip length. The dynamic charge plan is defined accordingly to end-users constrains.

The KPIs chosen to be reported under WP9 for the demonstration activity concerning Measure 1 are listed in the followings. Where appropriated, additional information have been added for sake of completeness.

- **Peak load reduction:**

The KPI is computed vie the Smart Charging platform, as activating peak shaving or shifting in a dynamic manner, is part of the optimization problem. The delta between realized charging cycles and the theoretical one will be traced and fed into this indicator. Extrapolation for having a yearly assessment is foreseen.

  - To be updated at the end of project.

- **Installed storage capacity:**
  - 20 cars x 50 kWh (average EV battery capacity) = 1 MWh

The storage capacity of an average EV is of 50 MWh. The metering of the Smart Charging platform might give more precise information, and this will be updated accordingly if need by M66.

- **Supervised fast charging poles:**
  - 20 => 17 V1G poles and 3 V2G poles

These charging poles are regrouped as explained before, under 3 different sites.

- **Increased system flexibility:**

The KPI is constructed vie the Smart Charging platform, activating peak shaving or shifting in a dynamic manner, tracing the displaced volumes and power of energy and thus accounting for the needed statistics. Extrapolation for having a yearly assessment is foreseen. To be updated at M66 when more information will be available.

4.4.2 Measure 2: Free floating EV car sharing system

The KPIs relating to measures related to car sharing have been changed during the life of the project, in particular in connection with the departure of Autoblue. The news KPIs are:

Yearly km made through the e-car sharing system					
KPI Description	The key element of a car-sharing system is the usage of the system, not only in terms of users but in terms of kilometres. This indicator will assess the number of kilometres done using the car-sharing service				
KPI Formula	Number of kilometres done by the car-sharing fleet				
Measurement procedure	1. Data collection				
Unit of Measurement	km		**Threshold/ Target**		
Object of assessment	Building	X	**Stakeholders**	DSO	
	Set of Buildings	X		TSP	
	Energy Supply Unit			End-Users	X
	Set of Energy Supply Units			Governance	
	Neighbourhood	X		Citizens	
	City	X		Representative Citizen Groups	
				Citizen Ambassadors	
Responsible Partner for KPI Data Collection			UTR, NCA, GOT		

Access to vehicle sharing solutions municipality					
KPI Description	This KPI makes it possible to judge whether all the employees of a Municipality that has implemented a car sharing solution have access to the service.				
KPI Formula	Number of different users / Number of employees				
Measurement procedure	1. Data collection 2. KPI calculation				
Unit of Measurement	%		**Threshold/ Target**		
Object of assessment	Building		**Stakeholders**	DSO	
	Set of Buildings	X		TSP	
	Energy Supply Unit			End-Users	
	Set of Energy Supply Units			Governance	X
	Neighbourhood			Citizens	
	City	X		Representative Citizen Groups	
				Citizen Ambassadors	
Responsible Partner for KPI Data Collection			VULOG		

Number of trips in a free-floating car-sharing system					
KPI Description	The successful implementation of a free-floating car-sharing system mostly depends on the use of the vehicles, which is highly related to the service subscribers. In case that the system is used by an organisation the number of users is constant as only the employees have access to the service. Therefore, the KPI "Number of free-floating subscribers" is not suitable to assess the use of the service. Instead, the number of trips will better assess the increase in the use of the system.				
KPI Formula	Number of trips done by the car-sharing fleet				
Measurement procedure	1. Data collection				
Unit of Measurement	#		**Threshold/ Target**		
Object of assessment	Building		**Stakeholders**	DSO	
	Set of Buildings	X		TSP	
	Energy Supply Unit			End-Users	
	Set of Energy Supply Units			Governance	X
	Neighbourhood			Citizens	

	City	X		Representative Citizen Groups	
				Citizen Ambassadors	
Responsible Partner for KPI Data Collection			VULOG		

The data could thus be collected by the AIMA platform, with the help of the metropolis of Nice. Thus, VULOG has the data set, namely the number of trips, the distance travelled and the rate of use, per month and per station. These data are attached.

Figure 140 : Location of Connexio, Corvsy and Gioffredo in Nice

Thus, with regard to the kilometres travelled, the following synthetic evolution is observed:

Building	Connexio (V1G)	Corvésy (V1G)	Gioffredo (V2G)	Total
Year (YYYY)	**377 014**	**200 601**	**5 859**	**583 475**
2018	0	39 589	0	39 589
2019	0	41 089	0	41 089
2020	92 696	32 276	0	124 972
2021	135 098	44 899	2 304	182 301
2022	149 220	42 749	3 555	195 524

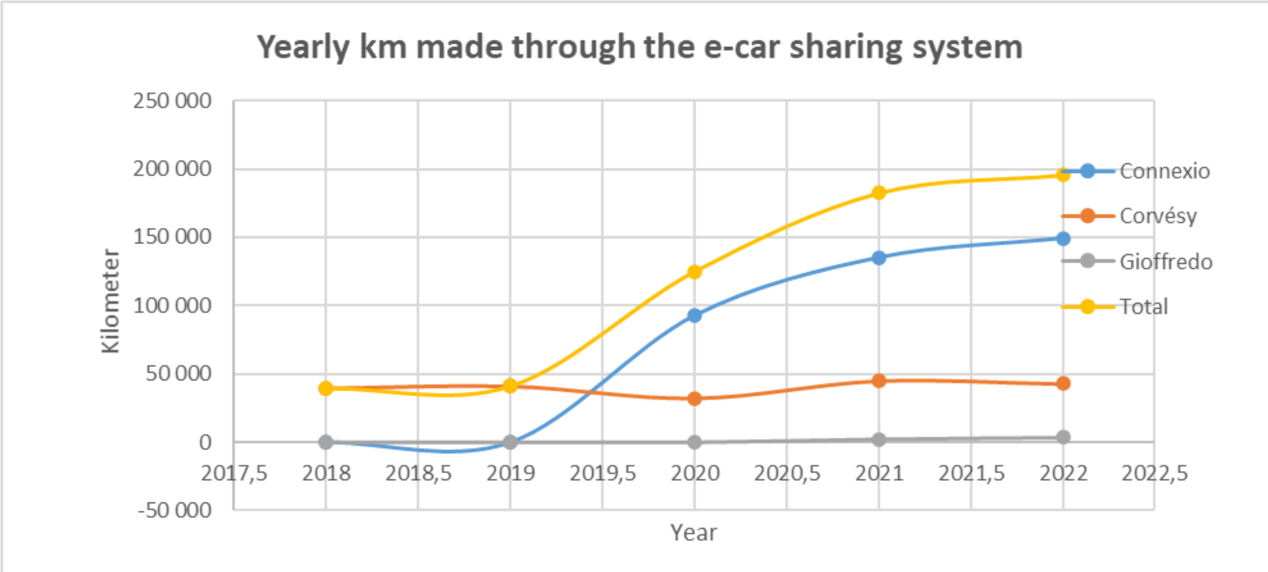


Figure 141 : Yearly km made by car sharing service for the MNCA

There has been a continuous increase in the total number of kilometres travelled by the car sharing service, despite the crisis at COVID 19. We also note that this increase is only valid for the "Connexio" access point, the other points, namely "Corvésy" and "Gioffredo", have only stagnated. Thus, it is important to study the curves with a monthly granularity:

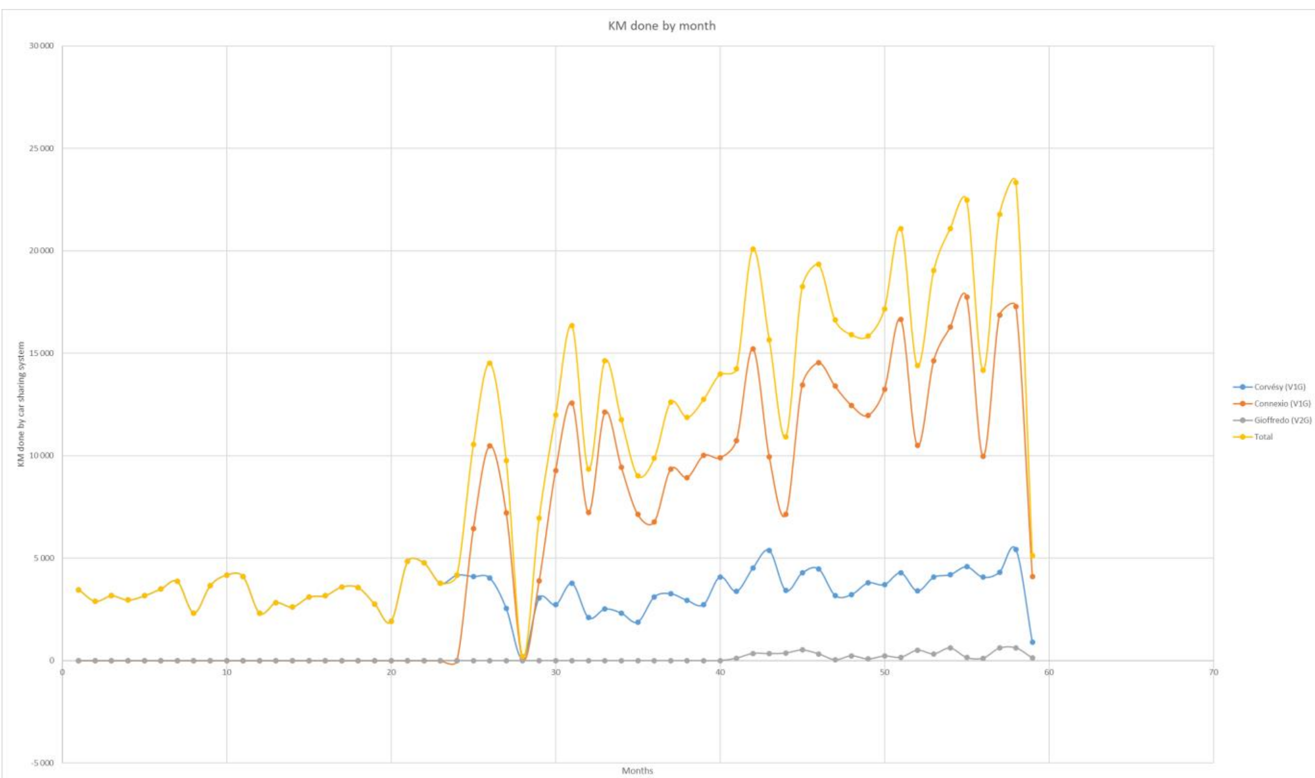


Figure 142 : KM done by car sharing system, month by month, with the MNCA's fleet

In this figure, the "Connexio" terminal is in red. Moreover, it is clear that until 2019 (M24), the total and "Corvésy" kilometres are merged. On this curve, we can clearly see a drop in the kilometres "covered" during the successive confinements in France, namely those that took place at M27 and M28 as well as at M35 and M40. It can also be noted that the containment of the M40 had little impact on the service:

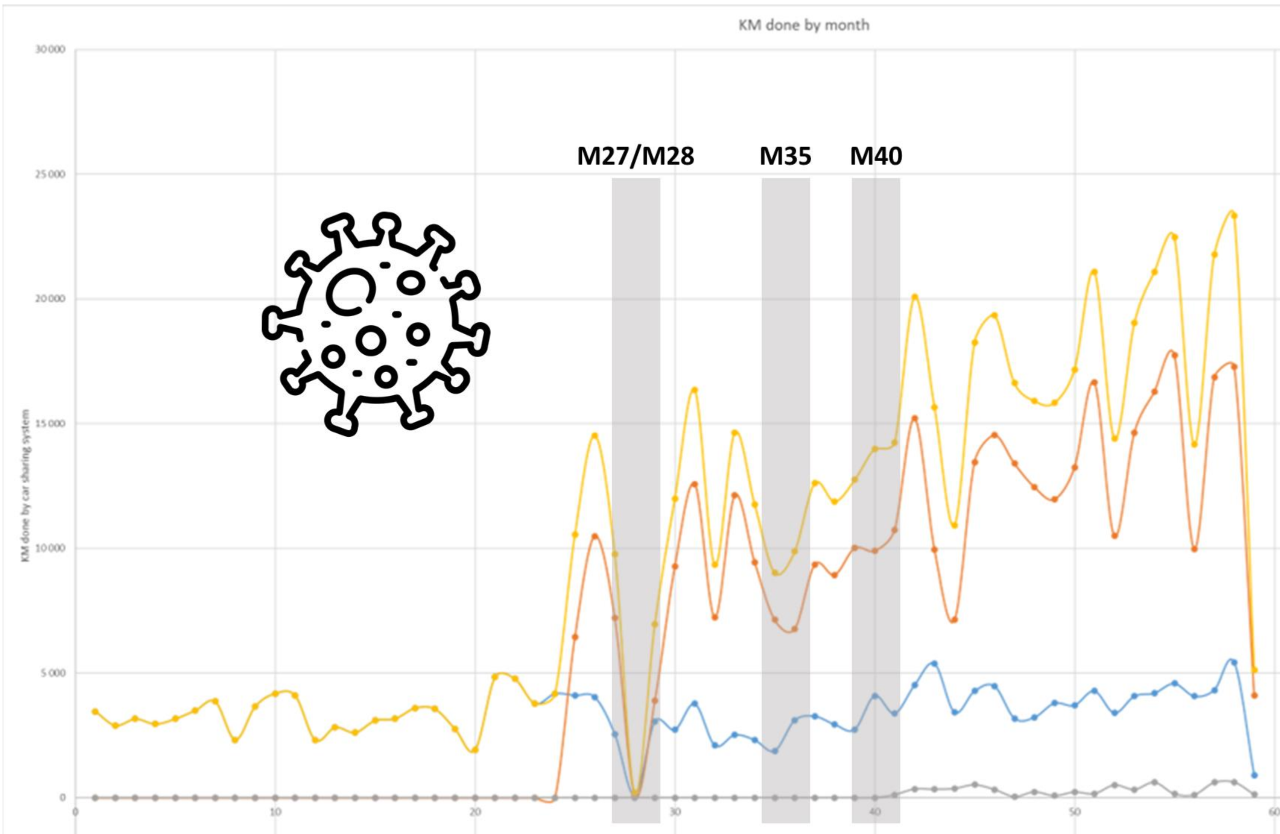


Figure 143 : Effect of the Coronavirus on KM done by car sharing system

Indeed, we observe that from the confinement of M27/M28, the average value of the service drops, and we observe a change in the trends. There is obviously a drop to 0 in service during the strict confinement that occurred in France, but there are also marked drops during the seasonal holiday periods (July and August) that are observed in M32, M44 and M56:

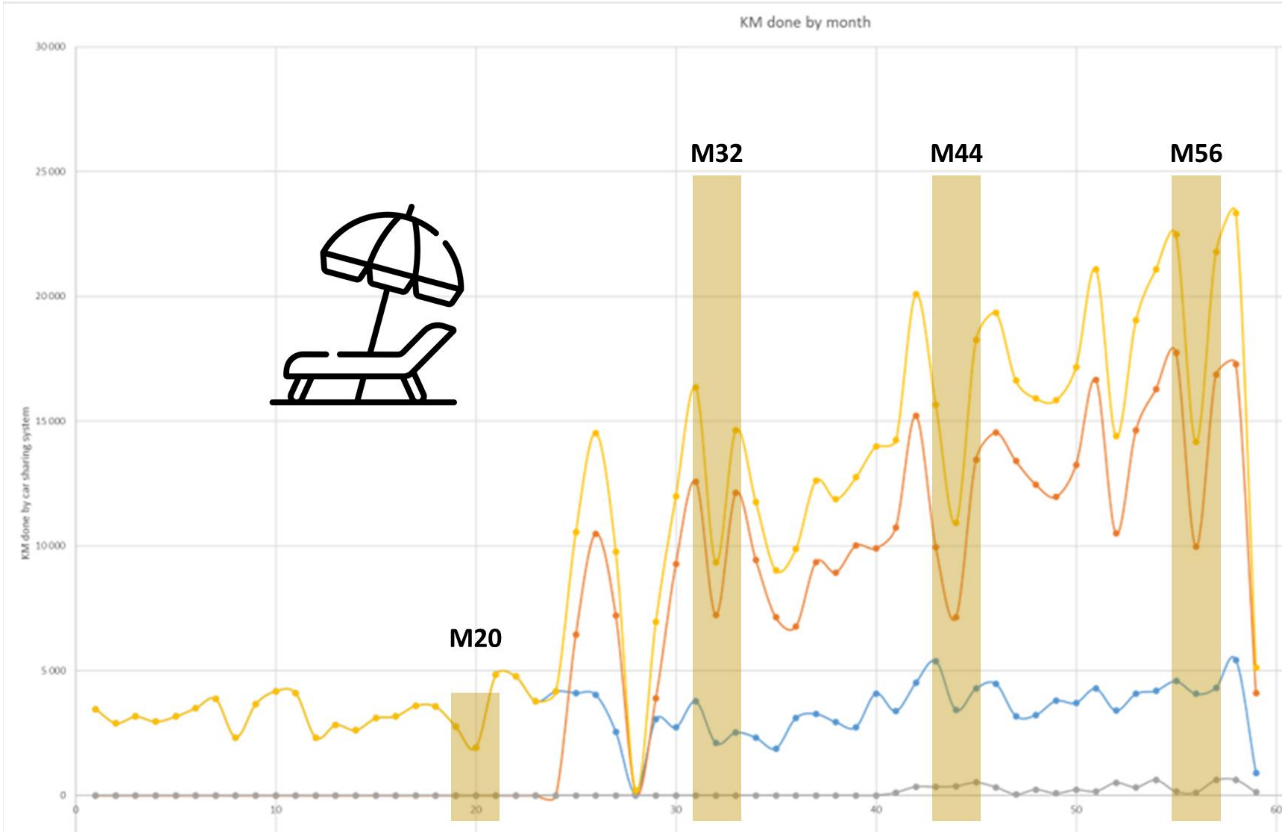


Figure 144 : Effect of the summer vacation on KM done by car sharing system

The reason for this drop is that in France, during the month of August, the economy as a whole is slowing down. For the economy as well as for politics, it is the lowest month of the year. The whole country is slowing down, except of course for tourism. In August the French economy traditionally takes its summer holidays. Reduced workforces, orders put on hold, closed workshops, Airbus factories sparser than usual... French activity is put in brackets during the lowest month of the year. Thus, there is no need to use a professional vehicle not only because the customers are not working but also because the employees themselves are not working.

Slight decreases also occur in the months M49 (see M48), M50 and M52. This corresponds to the summer holiday months in France (in the Nice area, zone B), namely the Christmas, February and April (Easter) holidays. This influx is all the more marked as the ski resorts have not reopened, since the COVID, until 2021:

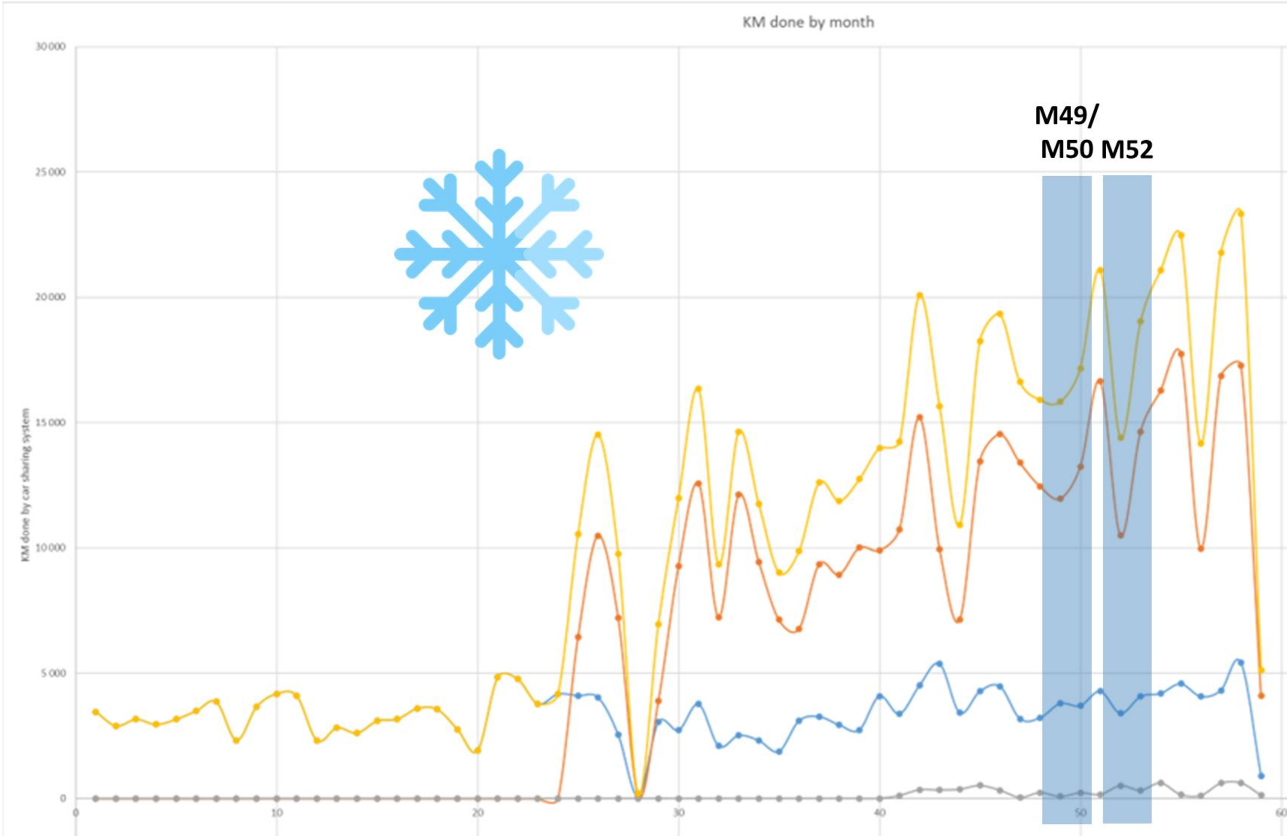


Figure 145 : Effect of the winter vacation on KM done by car sharing system

In conclusion, all peaks are explained:

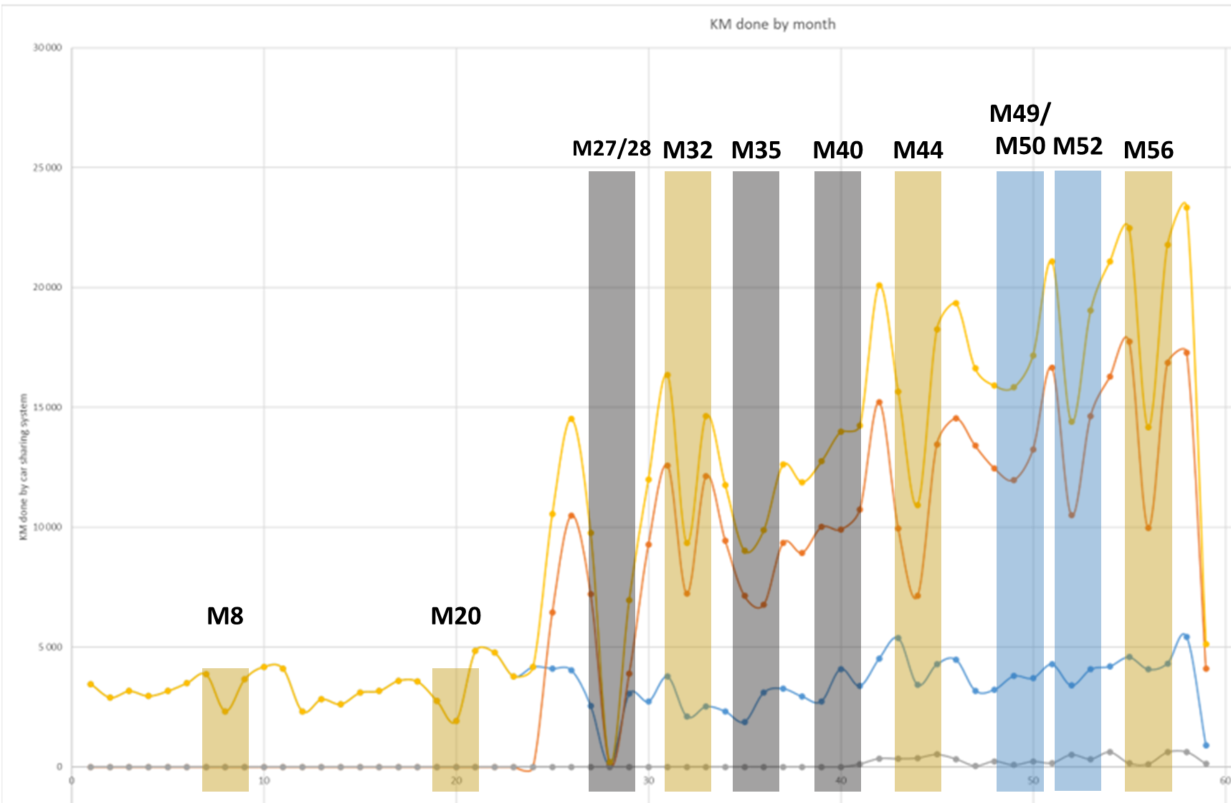


Figure 146 : Multi effect on KM done by car sharing system

It should be noted that the last value, M60, is not to be taken into account, as the data set for December 2022 is not available. In addition, there has been a clear increase in the number of kilometres travelled over the years, despite the successive crises. It is now necessary to correlate these kilometres travelled with the overall use of the service.

Thus, with regard to the number of trips made, the following synthetic evolution is observed:

Building	**Connexio (V1G)**	**Corvésy (V1G)**	**Gioffredo (V2G)**	**Total**
Year (YYYY)	**7 970**	**7 395**	**225**	**15 590**
2018	0	1 881	0	1881
2019	0	1 666	0	1666
2020	2 169	1 091	0	3260
2021	2 811	1 320	91	4222
2022	2 990	1 437	134	4561

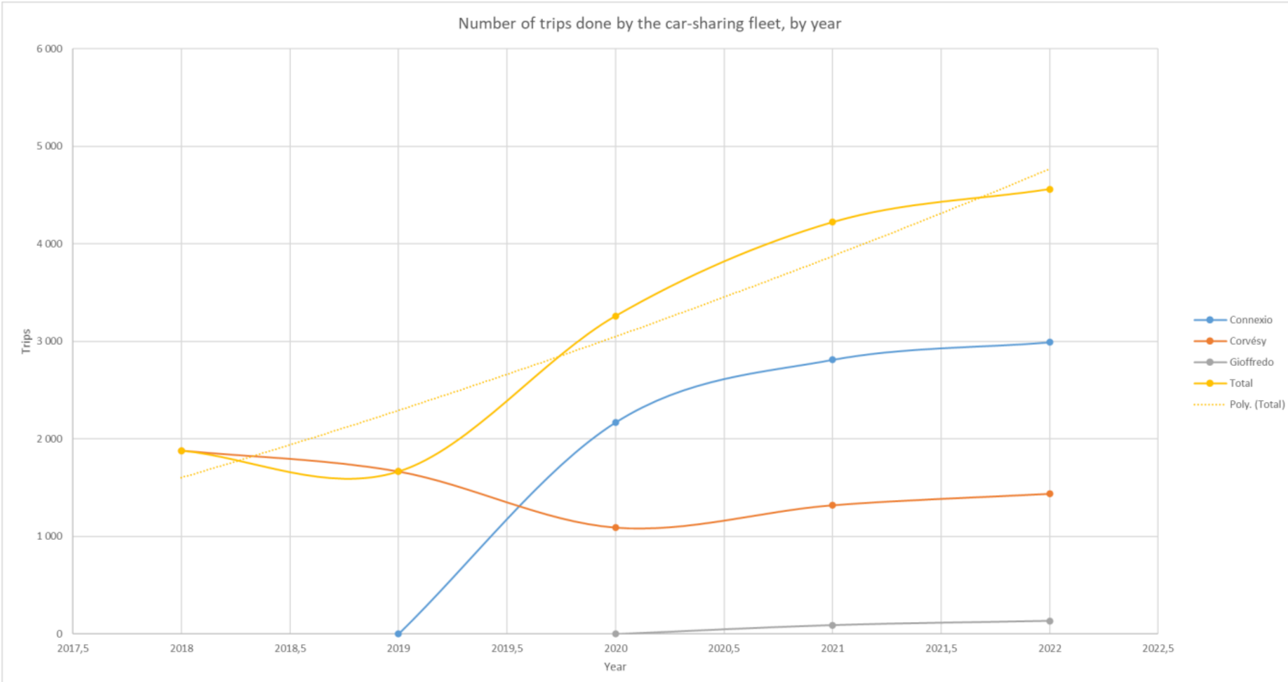


Figure 147 : Number of trips done by the car sharing system, with the MNCA's fleet, year by year

This figure shows the different curves relating to the number of "trips" (the number of reservations) made by the car sharing service. These curves have been constructed per load point and per year.

Once again, a macroscopic analysis, i.e. with a yearly granularity, does not allow us to draw any conclusions about the use of the service. There is only an increase in the number of trips.

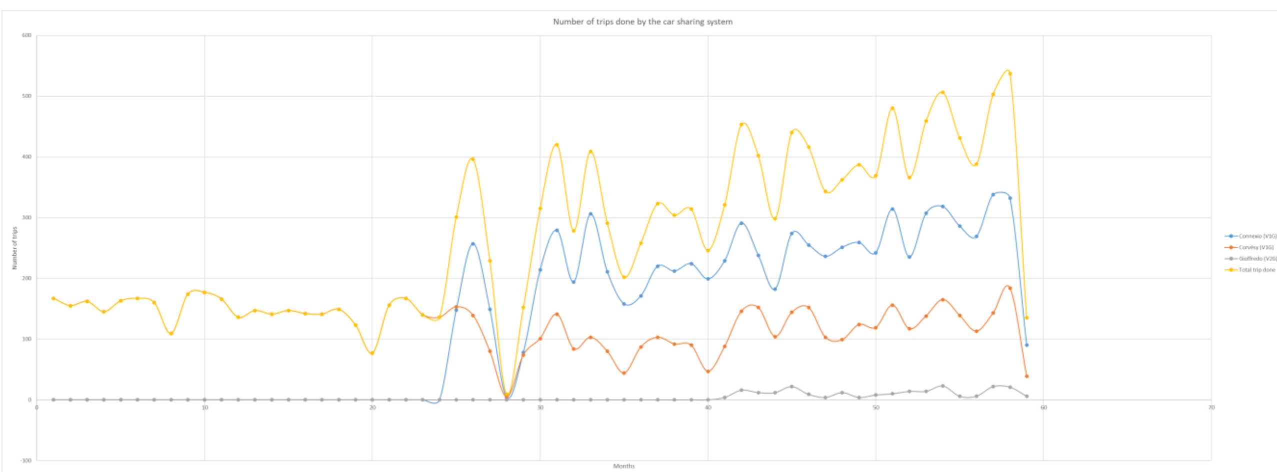


Figure 148 : Number of trips done by the car sharing system, with the MNCA's fleet, month by month

This figure shows the different curves relating to the number of "trips" (the number of reservations) made by the car sharing service. These curves have been constructed per load point and per month. Once again, there is a great disparity between the different months. The trends are similar between "Corvesy" and "Connexio" and are repeated on the sum of the trips. For Gioffredo, the data is too sparse to draw a trend.

Thus, by superimposing with the events detected in the previous paragraph, we observe :

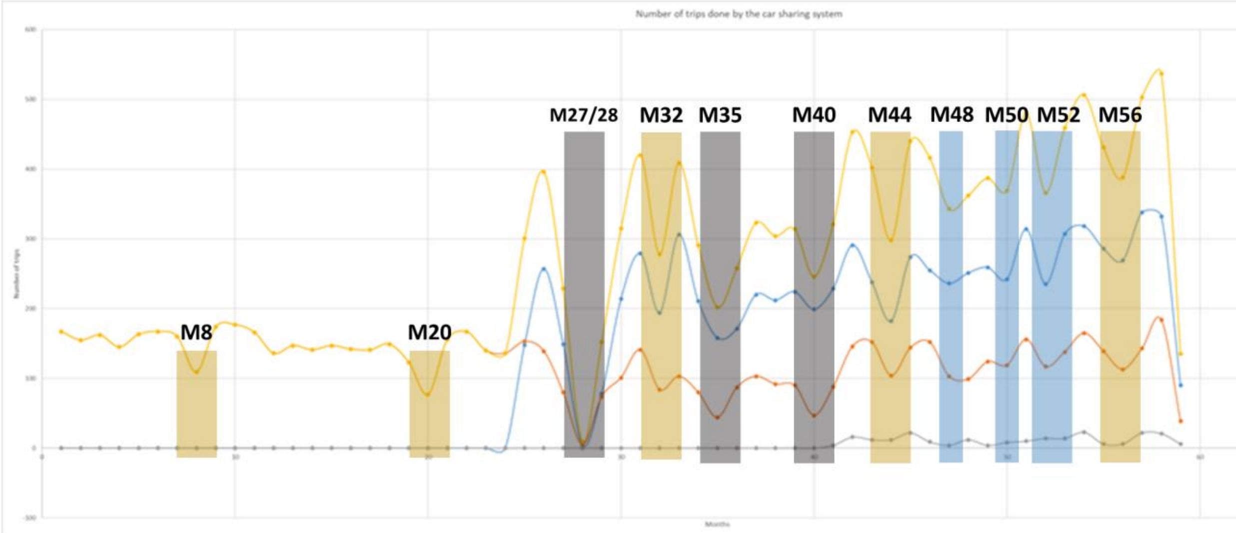


Figure 149 : Multi effect on number of trips done by the car sharing system

It can be seen that the explanations between the kilometres travelled and the number of trips are similar. However, we note that the decrease in service is more marked in months 47 to 50, marking more clearly the differentiation between Christmas and the February holidays. It can also be seen that the number of trips indicator allows for a better display of "peaks" and "drops" in use: it is a better marker than the number of kilometres travelled.

We also notice, as seen on the macroscopic curve, that the number of trips increases over time, showing that car sharing is becoming more democratic. However, this increase is less marked than the number of kilometres travelled. It can be concluded that car sharing in Nice is difficult to convince, but that if users do take the plunge, they tend to use the service more. We will check this with the last KPI.

We then observe the following rate of use:

Building	Connexio (V1G)	Corvésy (V1G)	Gioffredo (V2G)	Global
Year (YYYY)	/	/	/	/
2018	0,00%	10,87%	0,00%	10,87%
2019	0,00%	9,78%	0,00%	9,78%
2020	11,39%	9,46%	0,00%	20,85%
2021	13,55%	8,52%	2,62%	24,69%
2022	15,39%	9,51%	3,48%	28,38%

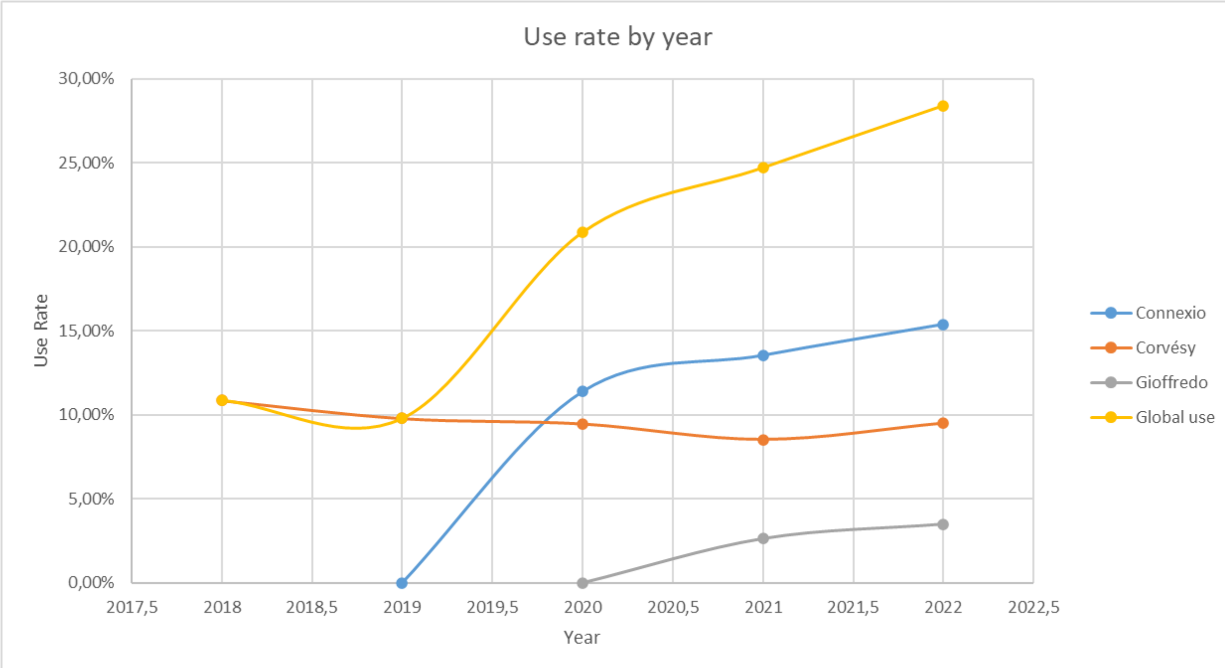


Figure 150 : Use rate of car sharing service by MNCA's employees, year by year from 2018

This figure shows the different curves for the "utilisation rate" (the number of actual users/the number of possible users) of the car sharing service. These curves have been constructed per load point and per year. We can clearly see that this rate has increased significantly from 10 to 30% in 4 years. Let us look at the evolution of this rate month by month:

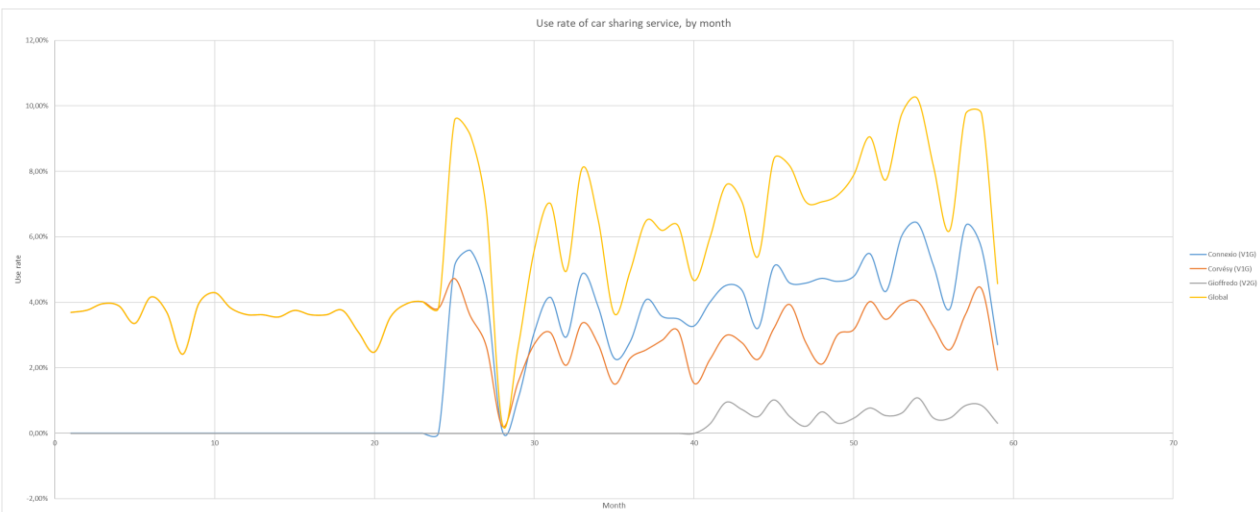


Figure 151 : Use rate of car sharing service by MNCA's employees, month by month from 2018

This figure shows the different curves relating to the number of "usage rates" of the car sharing service. These curves have been constructed per load point and per month. Once again, there is a great disparity between the different months. The trends are similar between all the curves. We can also see that Gioffredo follows the trend of the other curves! Thus, by superimposing with the events detected in the previous paragraph, we observe:

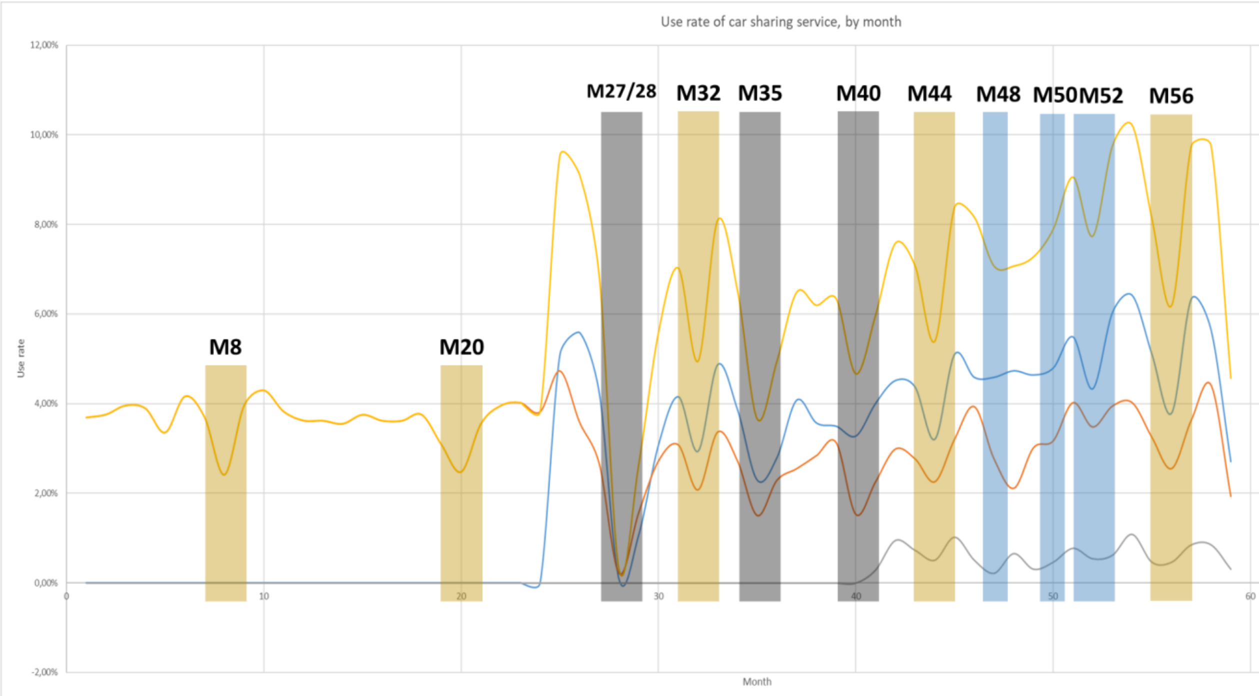


Figure 152 : Multi effect on use rate of car sharing service by MNCA's employees

Once again, the elements are perfectly superimposed on this curve with, however, several remarks:

- The utilisation rate of the M26, i.e. before COVID, was not exceeded until the M54. It can be deduced from this that COVID slowed down the acceptance of car sharing by two years in terms of utilisation rates. This "brake" was not observed before. It is therefore likely that the other indicators would have been much more important without the COVID crisis.
- The M50 is smoother than the other indicators, showing that although the other indicators show a drop during the February holidays, this is not relevant for the utilisation rate. This statement is qualified by the fact that only the Gioffredo terminal shows growth.
- The usage rate indicator could be improved by including the holiday dates of each user in the possible users. At present, it is not known whether this drop is due to the fact that staff do not use the service because they are on holiday or whether holidays lead to less traffic and therefore encourage personal use of the car.

Thus, although these three indicators show the same variations month by month, they are each important for analysing the approval of the service and the importance of the service for the city. It can be concluded that the service is being used more and more, although the COVID has strongly degraded the growth.

However, the question arises as to the frequency of the "dips"/"peaks", whether they are due to frequent holidays by employees or whether they are due to a tendency for staff to use their own cars during holiday periods?

4.5 Business models and exploitation

4.5.1 Smart Charging services (V1G/V2G) for local authorities' private EV-fleets

4.5.1.1 The business model - is it a public business case?

The business model is bankable nevertheless, it is less clear, how much savings can be achieved for the customer and so, clarify the customer promise associated with the service. This will partially influence the commercial offer and its associated costs.

4.5.1.2 Key Partners

- Technology providers – EVCI, ICT
- Engineering companies – works and cabling
- Consultants – design and engineering

4.5.1.3 Key Activities

- Active commercial offerings – address public authorities across FR
- Tendering screening – identify key call for tenders enabling to valorise/integrate the service

4.5.1.4 Value Proposition

- First, and only, smart charging service in France addressing both V1G and V2G technologies for local authorities
- Expertise and dedicated companies on the whole value chain > ability to accompany the client on all phases
- Reduction of overall system sizing thanks to operational performances
- Interfacing with existing/planned EV fleet platform
- Security of service supply and quality

4.5.1.5 Customer Relationships

- Commercial force to publicize the capacity of the EDF group's to provide Smart Charging services among its customer portfolio
- Integrate Smart Charging as differentiation from competitors in the tendering process.

4.5.1.6 Customer Segments

- Existing customer segments:
  - B2G - Local authorities – mid to big size cities and metropolitan areas,
  - B2B - private companies with large real-estate park/EV-fleet.

4.5.1.7 Key Resources

- Key resources are available in the related companies.
- ICT infrastructure is adapted accordingly
- Integration of the Smart Charging service in the offer-list of commercial staff and the related "training" for correctly setting up and negotiating commercial propositions
- Billing via existing means.

4.5.1.8 Channels

- Use of existing commercial channels of the Group.

- Integration of Smart Charging will be an additive but, distinctive element from the competition as well as the capacity to interface EV-fleet management platforms

4.5.1.9 Cost structure

- Strategy is the automation of the service, no needing additional resources
- The needed automation equipment is becoming mainstream and has low impact in terms of budget and can thus be considered as not representing an “additional cost”.
- The costs structure of the service will be defined, once results will be retrieved – if saving are considerable, benefit share could be thought of however, it is more probable that the saving achieved form the service will equilibrate the overall additional cost for the customer – win-win approach
- In the case of V2G technology, the revenues are shared with the customer, comparable to the annual charging costs – already part of the commercial offer.
- Customers will be able to choose as already given today, different service levels and billing schemes for end-users.

4.5.1.10 Revenue streams

- Integration in traditional contracts
- The service will be an additional item that will be integrated in existing revenue model.

4.5.1.11 Bankable business model

The business model is believed to be bankable nevertheless, the demonstration has to be attended to better evaluate the order of magnitude of the saving that can be achieved via Smart Charging for the customer.

4.5.1.12 Recommendations to cities that want to replicate this result

- Elaborate a comprehensive low carbon transport and mobility strategy, addressing E-mobility
- Assess in a detailed manner the status-quo of the building park and associated EVCI to have an accurate vision on additional works and equipment to achieve the set development strategy – equilibrate ambition with investment (and operation) capacity
- Articulate the tendering against the main costs: building renovation works compared to EVCI sourcing and O&M.
- Keep simple cost structures for end-users, hiding the service complexity.

4.5.1.13 How can your company support cities wanting to replicate this solution?

- Dedicated WS and communication and dissemination campaign
- Participation to call for tenders
- Integrate service in commercial offers of the EDF Group and integration in its common network and channels.

4.6 Business models and exploitation

4.6.1 Smart Charging services (V1G/V2G) for local authorities' private EV-fleets

4.6.1.1 The business model - is it a public business case?

The business model is bankable nevertheless, it is less clear, how much savings can be achieved for the customer and so, clarify the customer promise associated with the service. This will partially influence the commercial offer and its associated costs.

4.6.1.2 Key Partners

- Technology providers – EVCI, ICT
- Engineering companies – works and cabling
- Consultants – design and engineering

4.6.1.3 Key Activities

- Active commercial offerings – address public authorities across FR
- Tendering screening – identify key call for tenders enabling to valorise/integrate the service

4.6.1.4 Value Proposition

- First, and only, smart charging service in France addressing both V1G and V2G technologies for local authorities
- Expertise and dedicated companies on the whole value chain > ability to accompany the client on all phases
- Reduction of overall system sizing thanks to operational performances
- Interfacing with existing/planned EV fleet platform
- Security of service supply and quality

4.6.1.5 Customer Relationships

- Commercial force to publicize the capacity of the EDF group's to provide Smart Charging services among its customer portfolio
- Integrate Smart Charging as differentiation from competitors in the tendering process.

4.6.1.6 Customer Segments

- Existing customer segments:
    - B2G - Local authorities – mid to big size cities and metropolitan areas;
    - B2B - private companies with large real-estate park/EV-fleet.

4.6.1.7 Key Resources

- Key resources are available in the related companies.
- ICT infrastructure is adapted accordingly
- Integration of the Smart Charging service in the offer-list of commercial staff and the related "training" for correctly setting up and negotiating commercial propositions
- Billing via existing means.

4.6.1.8 Channels

- Use of existing commercial channels of the Group.

- Integration of Smart Charging will be an additive but, distinctive element from the competition as well as the capacity to interface EV-fleet management platforms

4.6.1.9 Cost structure

- Strategy is the automation of the service, no needing additional resources
- The needed automation equipment is becoming mainstream and has low impact in terms of budget and can thus be considered as not representing an “additional cost”.
- The costs structure of the service will be defined, once results will be retrieved – if saving are considerable, benefit share could be thought of however, it is more probable that the saving achieved form the service will equilibrate the overall additional cost for the customer – win-win approach
- In the case of V2G technology, the revenues are shared with the customer, comparable to the annual charging costs – already part of the commercial offer.
- Customers will be able to choose as already given today, different service levels and billing schemes for end-users.

4.6.1.10 Revenue streams

- Integration in traditional contracts
- The service will be an additional item that will be integrated in existing revenue model.

4.6.1.11 Bankable business model

The business model is believed to be bankable nevertheless, the demonstration has to be attended to better evaluate the order of magnitude of the saving that can be achieved via Smart Charging for the customer.

4.6.1.12 Recommendations to cities that want to replicate this result

- Elaborate a comprehensive low carbon transport and mobility strategy, addressing E-mobility
- Assess in a detailed manner the status-quo of the building park and associated EVCI to have an accurate vision on additional works and equipment to achieve the set development strategy – equilibrate ambition with investment (and operation) capacity
- Articulate the tendering against the main costs: building renovation works compared to EVCI sourcing and O&M.
- Keep simple cost structures for end-users, hiding the service complexity.

4.6.1.13 How can your company support cities wanting to replicate this solution?

- Dedicated WS and communication and dissemination campaign
- Participation to call for tenders
- Integrate service in commercial offers of the EDF Group and integration in its common network and channels.

4.7 Key recommendations

4.7.1 Measure 1: Smart Charging

EVCI upgrade - Audit the existing installations and associated infrastructure first

- As has been highlighted before, cities are suffering from an aging and obsolete EVCI, as EV charging capacity needs are raising rapidly and therefore, also the demand for fast charging infrastructure. However, as highlighted by the work done under Measure 1, whilst the EVCI cost itself is easily accountable and relatively accessible, the main cost of such an endeavour relies in the revamping of the peripheral infrastructure of the EVCI: electric grid and ICT endowment and reliability of connectivity. All these aspects have costly repercussions on the overall endeavour. It is therefore recommended, to perform a careful audit of the existing infrastructure and evaluate the additional needs in terms of buildings or sites specific electric system reinforcements and ensure connectivity via W-Lan/4G or other ICT infrastructure, plan associated potential civil works, and last but not least, the overall hardware and software endowment should be ensured to work with common protocols (at best with open and documented APIS).
- What has not to be forgotten, is to clearly define the existing and foreseen EV pool that is targeted together with the roll-out of an EVCI. EVs are yet not developed under common charging standards and yet, different car manufacturers use different technological solutions for EV-charging. Charging might need DC and/or AC charging; EVs might have internal converters limiting charging capacity (so careful to not oversize the EVCI); different end-users (as i.e. on-site intervention commuting or home-work place commuting) might be targeted having different mobility or service needs; in the case of V2G EVCI, it has to be ensured the availability of V2G compatible EV in a pool. All these aspects must be considered before starting delineating what EVCI should be developed, where, and with which technical and functional specifications.

V2G Smart Charging – assess car usage and availability first

- Coming back to V2G smart charging, attention must be put on fire-safety requirements for indoor applications, as local fire department might need to approve an indoor installation.
- Nevertheless, the main question behind V2G is the nature of the V2G compatible cars, which are and should be part of an EV pool. This influences the charging standard to be deployed. Still the Japanese standard prevails, but a common European wide standard is on the way to be defined.
- At the time being, the BM behind the V2G smart charging is the service provision of Primary Reserves to the Energy Market. This means, the EV must be made available a minimal average time per day of about 8h. This involves assessing the parking or user behaviour of the involved pool and ensure that the EV do not have a too high daily turnover, as to ensure enough availability to provide grid services and ensure to balance the overall BM.

Raise stakeholder and end-user awareness before implementing a Smart Charging plan

- As has be evinced from the lessons learned, the implementation of such an endeavour, needs the coordination of different agencies of a local authority, which might not be used to collaborate on such a relatively new endeavour. As in the case of this demonstration, all involved stakeholders need to gain awareness on the expectation in terms of performances and impact of the targeted solution. In a second step, the scope and the related roles and responsibilities of each department must clarify and coordinated. This in crucial, as if a consensus among such stakeholders can't be achieved from the early beginning, long delays have to be expected for the project implementation.

- Similarly, end user expectations and needs should be considered in the early stage and a related awareness raising campaign can enhance their acceptance. As all innovation, Smart Charging needs awareness raising to ensure end-users acceptance of the proposed tools and their influence on their habits. In case the latter is not tolerable, the tool has to be adapted to the expected end-user experience. In the case for the proposed V1G smart charging demonstration, the service has been kept “behind the scenes” and end-users should not be affected by the smart charging during their user experience, as the service has as main objective, to ensure a recharged car for the end-user at any needed time. Their only interaction is via the interface provided by VULOG. In the case of the V2G Smart Charging demonstration, as the service is in direct contact with the end-user, early setting problems had been experienced, where errors in the operation of the interface by the end-users lead to not satisfactory charging of the EV. This has been solved, by informing end-users about the working principle of the application.

4.7.2 Measure 2: Free floating EV car sharing system

As recommended, the last indicator should be reworked by taking into account the fact that staff are on leave in the probable use of the service. It is not normal for this indicator to behave in the same way as the other two, given that it is based on a rate. Indeed, it should be smoothed.

In fact, compared to the first two indicators, this one should not be predictable in the same way as the kilometres travelled and the number of trips.

5 Preliminary Results of Transition Track 4

Measure#1 enable to improve air quality data and support citizen engagement. Air data will be retrieved thanks to sensors and stations measurements; traffic data collected on the CIP and on other sources.

Measure#2 provide a dashboard including the digital modelling of the IMREDD building and the building data collection available on the CIP.

Measure#3 provide a Smart Charging management platform that directly communicate with the energy aggregator platform which will trade flexibility services on the energy market.

Measure#4 provide a new tool, the SMART CITY INNOVATION CENT (SCIC) that allow to see in real time the impact of the different energy scenarios on the building.

5.1 Overview

As reminder, demonstration activities within the **T**ransition **T**rack **4** (**TT1**) are organized around 4 measures that initially referred to IS-4.

Measures are now divided as following:

- **Measure 1** Sensors data collection in air quality
- **Measure 2** BIM/CIM data display
- **Measure 3** Data control and monitoring for Smart e-mobility
- **Measure 4** Services for grid flexibility

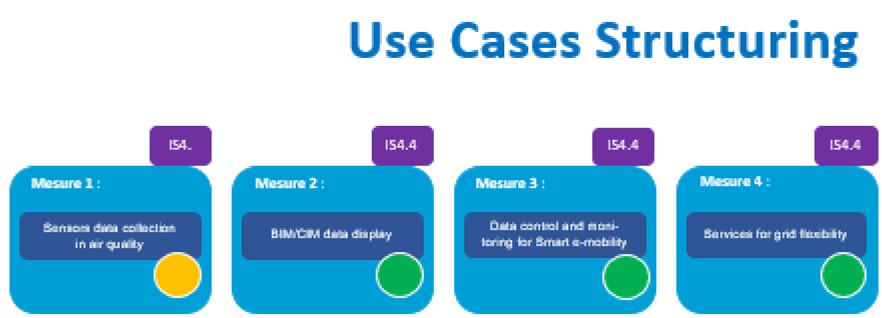


Figure 153 : schematisation of the relation and hierarchies among the chosen Use Cases and sub–Use Cases as by D6.6. Green: UC is started or under operation; Orange: not yet implemented; Red: UC not pursued anymore

All measures have been started but some of them are still pending.

5.2 Implementations

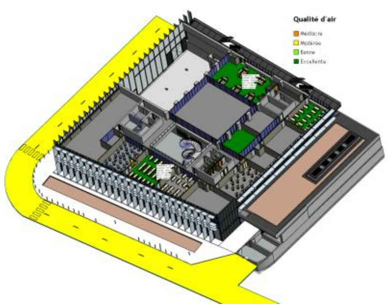
5.2.1 Measure 1: Sensors data collection in air quality – Sensors in IMREDD building

As part of the experimentation in measure 1, IMREDD has equipped its building with two external air quality sensors. The first one is located on the roof and the other one is beside the road, near the traffic jam. These two sensors can measure a lot of parameters (temperature, humidity, atmospheric pressure, VOC, PM1 - PM2,5 - PM10, NO2, O3).

Figure 154 : Outdoor air quality sensors at IMREDD

Data from IMREDD sensors will be pushed to the CIP and crossed with data already owned by MNCA in order to enhance the awareness of citizen in the Meridia district.

The air quality from the inside of the building is also available and monitored locally at IMREDD. In a near future, such measurements could be corelated with the pollution outside the building and constitute a new indicator for the wellbeing of citizens.



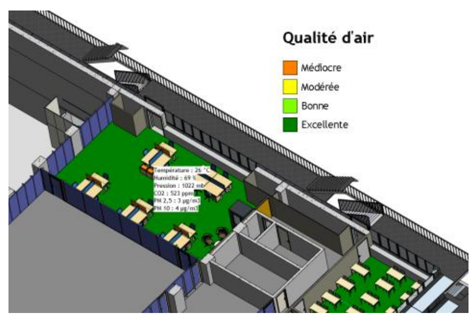


Figure 155 : Real time air quality visualization at IMREDD

5.2.2 Measure 1: Sensors data collection in air quality – Use of microsensors

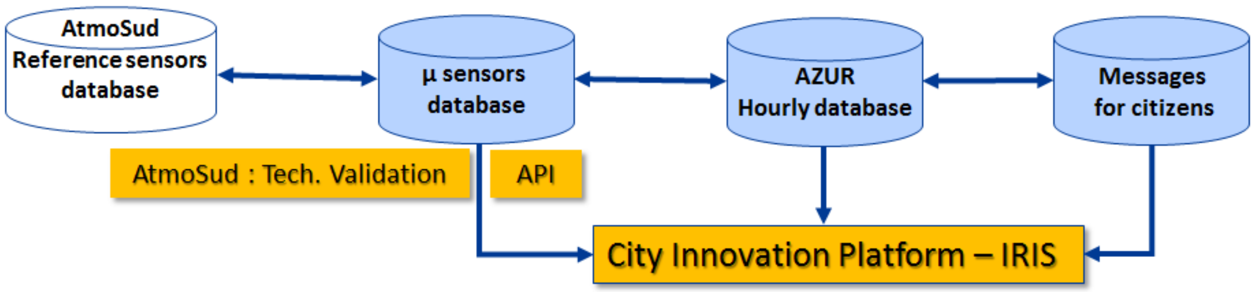


Figure 156 : Data service schema

AtmoSud's contribution to Task #4 consists of sharing data with the City innovation Platform (feed with air quality data and exploit existing traffic data). The data will afterward be used to create citizen engagement demonstrators.

This achievement relies on two actions:

- Improve the air quality measurements with micro sensors
- Upgrade the AZUR air quality mapping model with hourly forecast and real time information. This service will be fed by micro sensors' measurements and traffic data.

Current Status

AZUR is the forecast air quality platform developed by AtmoSud to provide information at very high resolution. This platform already provides daily forecasts for several pollutants: PM_{10}, $PM_{2.5}$, NO_2 and O_3. AtmoSud, with the contribution of its modelling and innovation team, has designed this platform with a great agility. IRIS project allowed to develop the hourly module and to provide a near "real-time" air quality information using AZUR methodology (Morgan et al. 2022) .

Currently, the only real-time input is observations from AtmoSud monitoring network. Over Nice city, this network regroups 4 stations: Nice Airport, Nice Arson, Nice Magnan and Nice NCA port. To provide high spatial and temporal resolution information, AZUR platform needs an update of the monitoring network with micro sensors over the demonstration area and to use real-time traffic data. 20 microsensors have been installed in the Nice metropole (7 have been bought because of IRIS project). These microsensors can work properly during one year. After they have to be uninstalled.

AtmoSud had worked with CIP administrators in order to push daily AZUR on the CIP. This joint work helps to collect the CIP's traffic data as well.

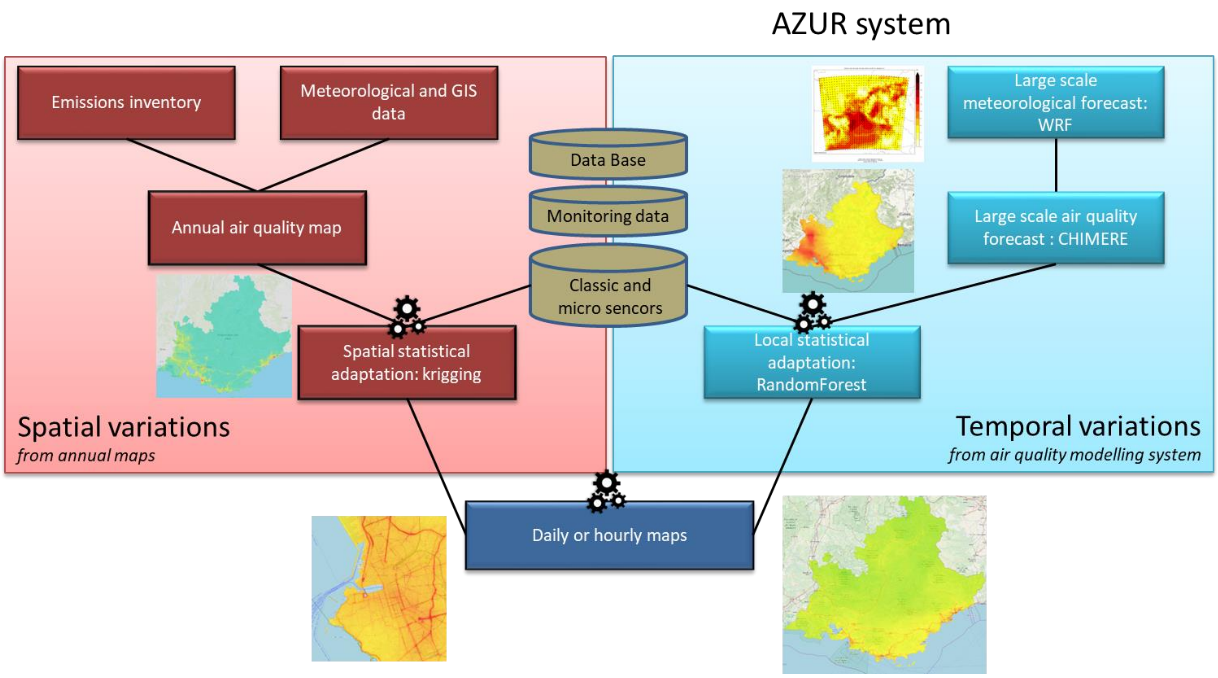


Figure 157 : AZUR system concept

5.2.2.1 Procurement of equipment and/or services

Air quality data

Air quality data will be collected from several sources:

- ***Micro sensors***

7 micro sensors have been installed in Nice Meridia and Eco Valley by AtmoSud after a call for tender. Data provided have used for AZUR compliance at high resolution.

- ***Air quality measurement network***

AtmoSud already owns a measurement network composed of numerous non-stop operating air quality stations. These continuous measurements are used to check the proper functioning of micro sensors.

- ***AZUR***

This hourly data model have been developed. Developments have been done with open source software. For its operation a server have been purchased. The results are already one the web site of www.atmosud.org. with Logos IRIS and Europe.

Traffic data

- ***City Innovation Platform***

After several audit , the CIP does not contain any traffic data.

- ***IMREDD*** *has no traffic data.*

Faced with these difficulties ATMOSUD has developed a new method adapted

5.2.2.2 A new adapted method : Notion of neighbourhood: background pollution situation

For all pollutants, the maps are calculated from measuring stations. This calculation is then transposed into their zone of influence called "neighborhood"[1]. The latter are defined so that all the measuring stations cover the whole regional area. The background sites cover up to 100 km. The maps are obtained by aggregating the estimates of each neighborhood by inverse distance. The area of influence of each station is thus limited by the neighboring stations (Figure 3).

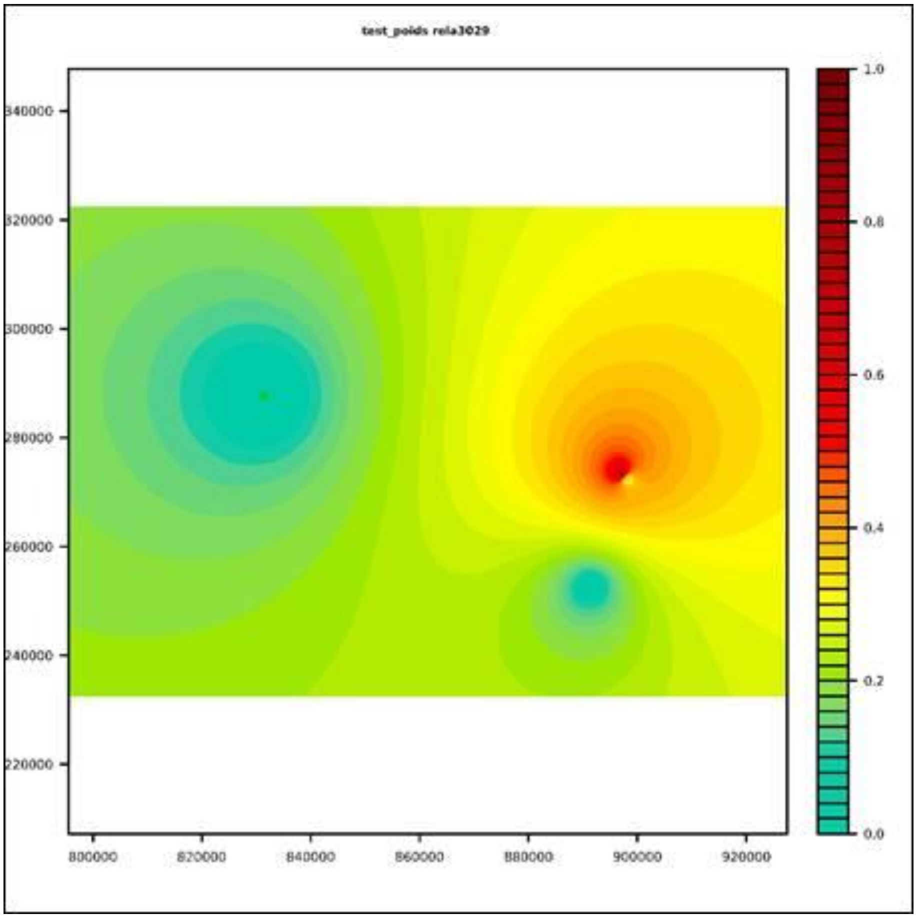


Figure 158 : Relative weight of a measurement site (Aix Art point in blue) in relation with the proximity of three others (points in black) whose traffic

5.2.2.3 Concept of neighborhood: influence of road traffic

The sites under the influence of road traffic are taken into account by means of a neighborhood based on the linearity of the nearby roads. The weights are calculated as a function of the distance between the station and the mesh points in the following way:

- Linear decay on the axis between 0 and 1
- Transverse: exponential decay between 0 and 1 (degree 2)

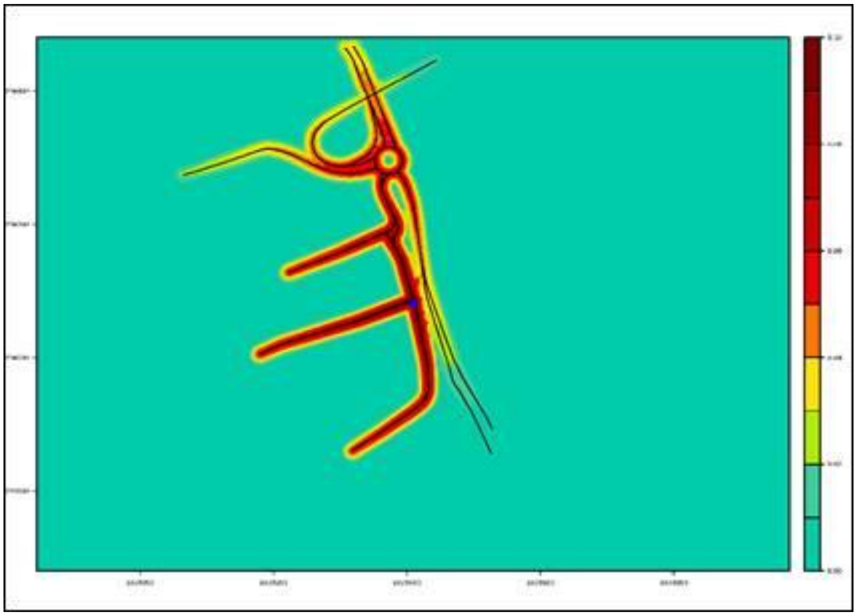


Figure 159 : example of weight in the vicinity of a traffic site

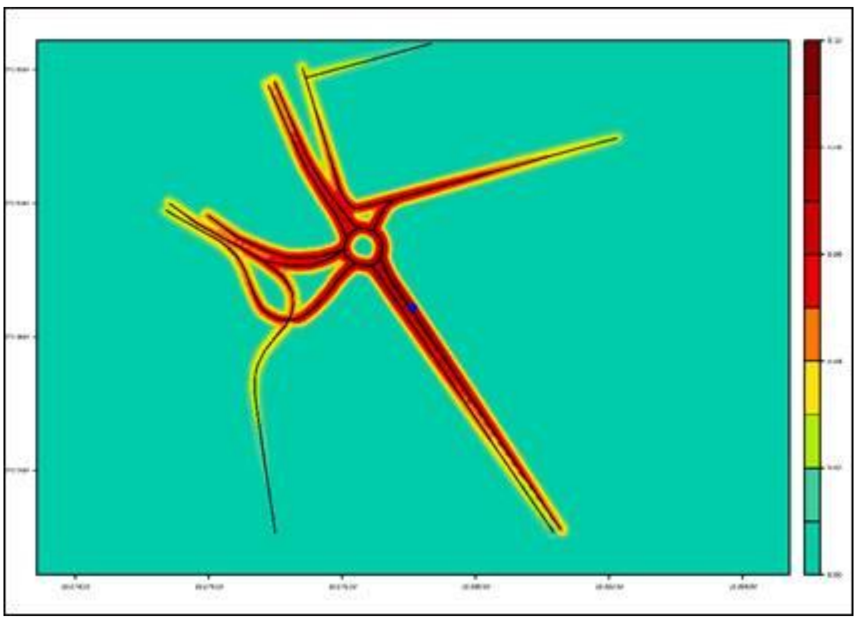


Figure 160 : example of weight in the vicinity of a traffic site

5.2.2.4 Consideration of micro-sensors

The micro-sensors are taken into account in the post-processing of the Azur maps. Each sensor is associated with a neighborhood as defined above. This one defines the limits of the zone to be modified on the Azure map as well as the weight of this modification. The concentration to be added or subtracted is given by the difference between the value measured at the sensor and the value estimated by the Azure map. This difference is then weighted in inverse distance in the vicinity of the sensor.
In order to consider the uncertainty of the measurements on this type of device, a confidence index is taken into account using a coefficient that lowers the weights in the vicinity of the sensor.

About the calculation grid :
- Work on 5 m grid
- Re interpolation of weights on the departmental grid at 25 m

The calculation of the maps:
- Calculation of the mes-mod deviation
- Multiplication of the weights/sensor by the deviation.
- Addition to the Azur map

Note: the sensor correction grid is not saved. The modifications of the raw map are made sensor by sensor.

5.2.2.5 Final result

After taking into account the background pollution, the proximity to the traffic axes and the pollution of the micro sensors, it is possible to obtain a mapping of the concentrations (NO2, particles) for each hour of the day.

Today, Azur run every hour and is fully operational. The new homepage of www.atmosud.org is published. Logos of IRIS and Europe have been enclosed. Animation is available for the last 24 hours and the next 24 hours.

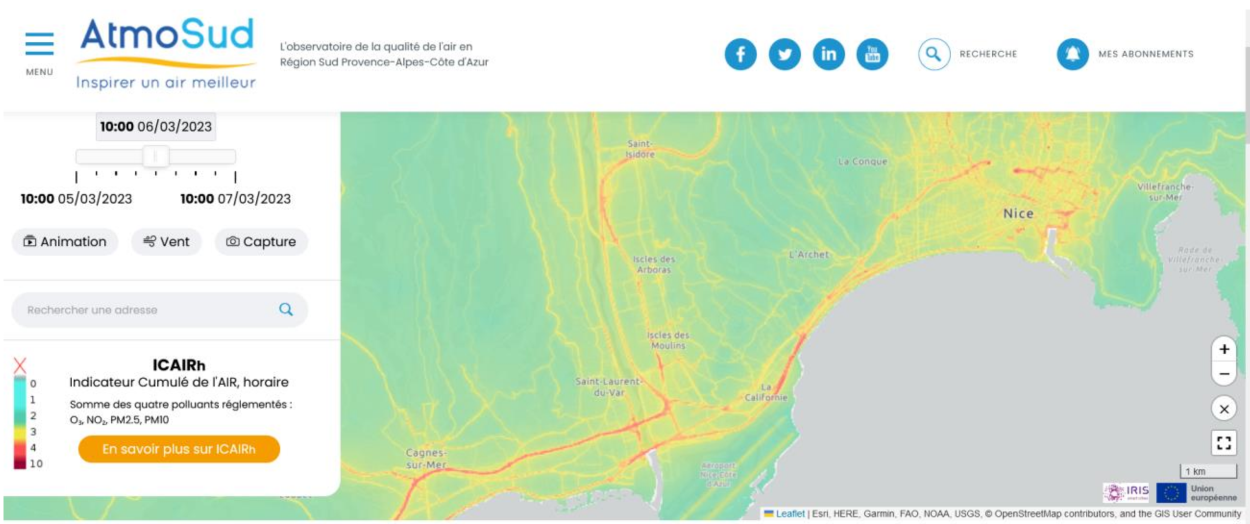


Figure 161 : AtmoSud Homepage website, the focus on Nice area

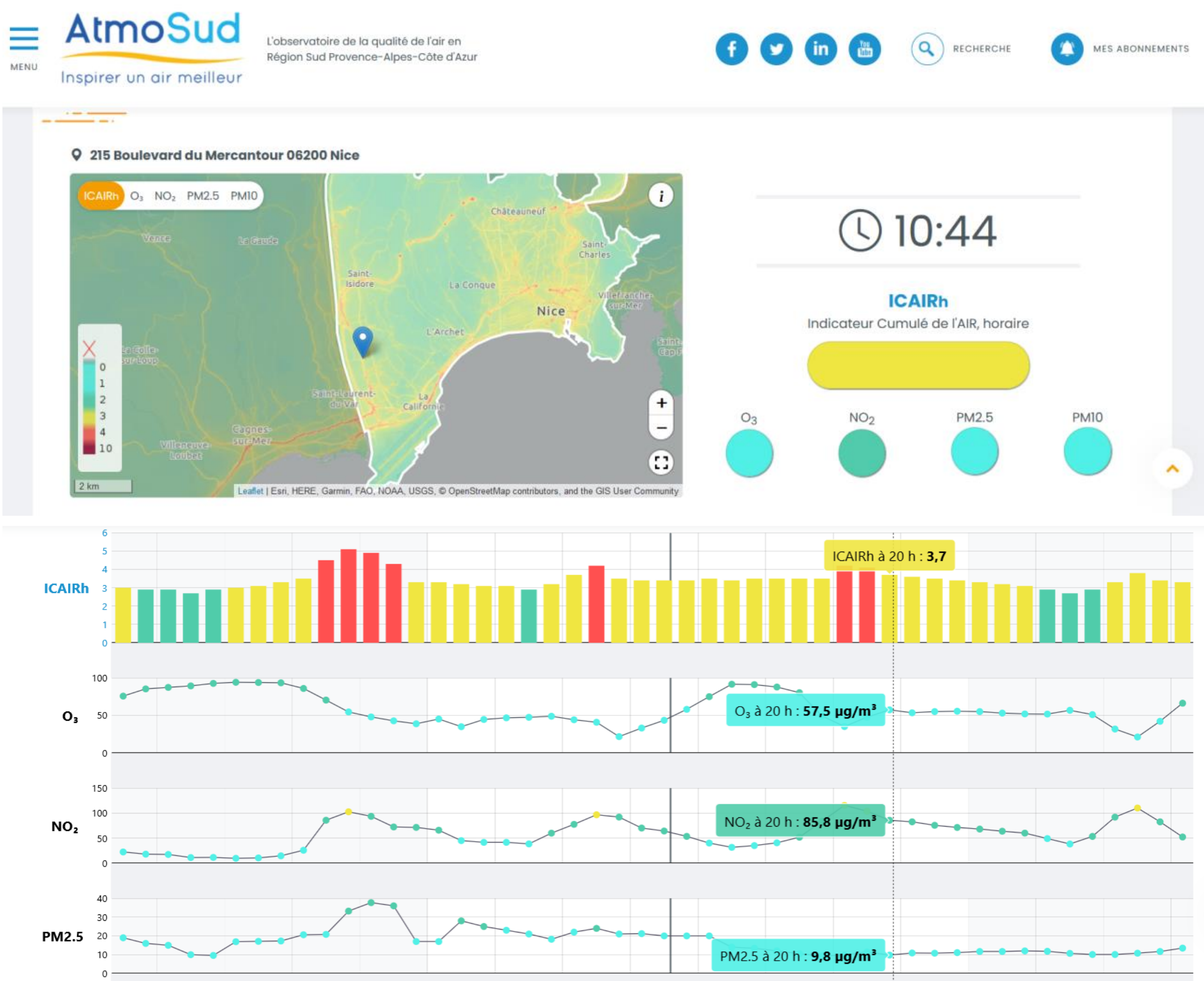


Figure 162 : AtmoSud website, "l'air de ma commune" Nice

This new fully operational tool have been presented in January 2023 (24th of January), AtmoSud's 50th anniversary conference. (see below, TT5).

5.2.3 Measure 2: BIM/CIM data display

The main goal of the measure 2, is to demonstrate the capacity of the multi-scale BIM and its ability to integrate real-time "hot" data from the CIP at the urban and building scale. The project is naturally divided into three distinct steps. The first one regards the conception of the 3D model of the IMREDD building as shown in figure 3.

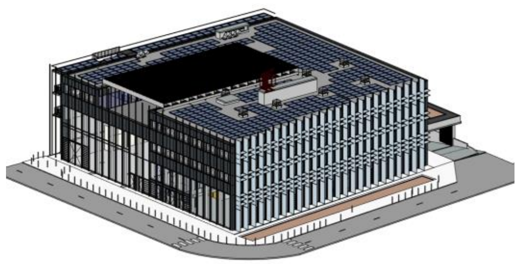


Figure 163 : 3D model of the IMREDD building

In a second time, live data coming from different equipment are displayed. An example of the irradiation and the atmospheric pressure measurement is given in Figure 164.

Figure 164 : Irradiation and atmospheric pressure real time visualisation at IMREDD

Those first two tasks have been already completed by the IMREDD engineering team and transferred to IRIS partners for further developments. Finally, the model in Figure 163 will be integrated at the neighbourhood scale, providing an adding building block to the BIM/CIM data display.

5.2.4 Measure 3: Data control and monitoring for Smart e-mobility

This measure is related to the TT#3 demonstration activity in Nice which is focusing on building and optimally coupling systems operating both EVCIs and electric carsharing fleets over a city, aiming at implementing a "Smart Charging" management and testing various related use cases.

The private EVCI network of NCA is from now on controlled by a supervision platform provided by EDF partner. The EVCI supervision platform interface with the Smart Charging management platform to support an optimal charging plan in accordance with the operating requirements of the carsharing of the e-fleet and the instructions from the energy aggregator platform to comply with flexibility energy ser-vices such as peak shaving and shifting and tertiary energy reserve.

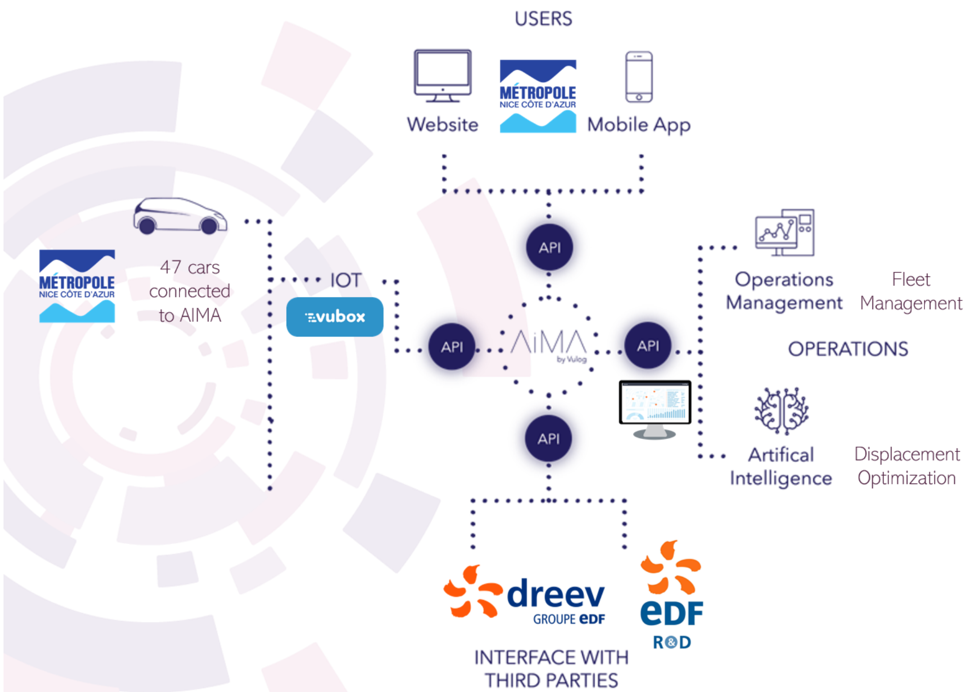


Figure 165 : Data flow diagram for the car-sharing platform "AIMA"

5.2.5 Measure 4: Services for grid flexibility

Local energy data at IMREDD from the energy system like the lithium-ion battery, photovoltaic panels, EV charging infrastructure are gathered into the CIP and contribute to the creation of a new tool, the SMART CITY INNOVATION CENT (SCIC) will allow to see in real time the impact of the different energy scenarios on the building. The SCIC will also play an educational role and will raise the awareness of the various actors of the territory to energy.

On a technical point of view, data are pushed to the CIP using Node Red flows as illustrated in Figure 166. Data mainly come from the energy management system that gathers data especially from the IMREDD energy devices. Then, data are available through EDF S&F API's.

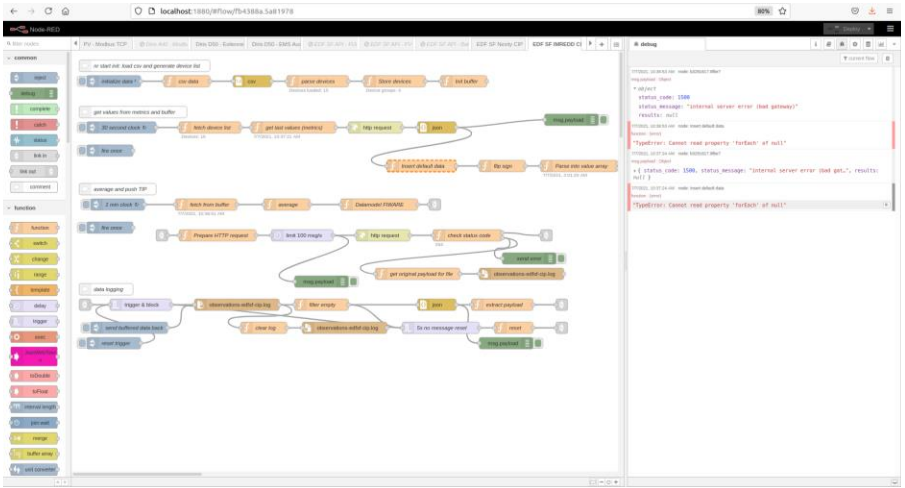


Figure 166 : Node Red flow hosted at IMREDD that recover data from EDF S&F cloud to the CIP

The creation of dashboards using real data is still under development with already few realizations as shown in Figure 167. Another part of the work is to imagine new scenarios by crossing data together.

Figure 167 : An example of energy data streaming at IMREDD SCIC's

5.3 Preliminary results

The BIM modelling associated to the IMREDD building is already presented in the SCIC. Visitors have the possibility to visualize “hot” data through different screens. International delegations are also invited to visit the showroom and share a unique experience based on innovation.

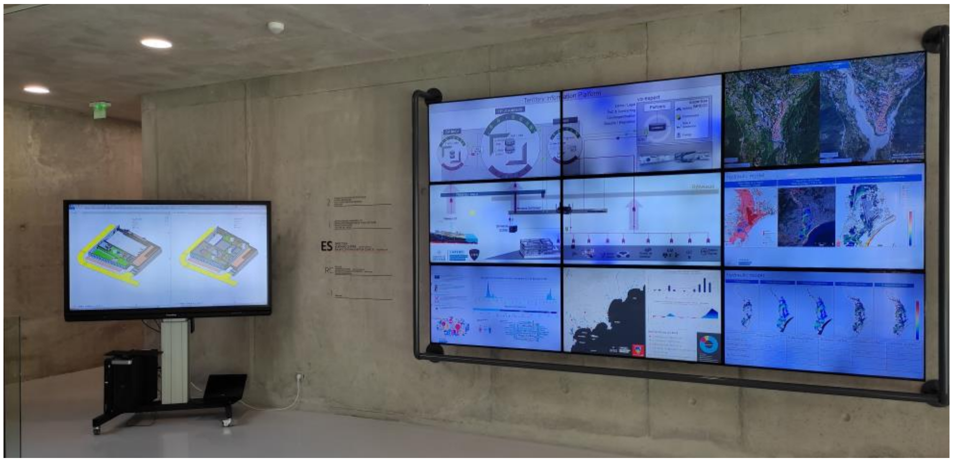


Figure 168 : An example of energy data streaming at IMREDD

6 Results of Transition track 5

6.1 Overview

As explain previously, several technical measures have been implemented to Nice LH with ambition to drive the Nice Eco Valley district into a Near Zero Energy district.

In addition to these technical measures and to increase the social inclusion of the project, Nice LH has implemented citizen engagement actions broken down into three measures.

Measure 1: Public awareness campaign Air Quality :

corresponds to IS 5.1 Co creating the energy transition in your everyday life

Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family :

corresponds to IS 5.1 Co creating the energy transition in your everyday life

Measure 3: Citizens individual engagement - IOT invoices :

corresponds to IS 5.4 Apps and interfaces for Energy efficient behaviour

Table 15 : TT5 measures and expected impact

Demonstrator	In a nutshell
#1 Public awareness campaign Air Quality	Brief summary: Three solutions will be implemented: urban awareness campaign, students training project and commuting to work by air quality measurement to develop car-sharing.
	Expected impact: raise the awareness of various targets about the air quality: general audience, white collars, and young people to change the habits of mobility
#2 Public awareness campaign Energy – School & Collège; Youth & Family	Brief summary: The objective is to increase general knowledge of the world of energy and/or their environment in order to raise the awareness of different audiences and encourage them to change their behaviour.
	Expected impact: More acquaintance by children with the subject of sustainability, a positive vibe within youngsters about the IRIS-initiatives who will involve and help their parents.
#3 Citizens individual engagement – IOT **Replaced by the measurement below**	Brief summary: Integrate in the same IOT application the energy consumption of each tenant from different sources and deliver relevant messages related to their behaviour.
	Expected impact: Increase understanding of the link between individual behaviour and its impact on personal energy bills.
#3 bis - Citizens engagement: waste	Brief summary: The aim of this measure is to collect used bicycles so that they can be repaired and sold to students and/or people in need

Demonstrator	In a nutshell
reduction and sustainable mobility	Expected impact: Reduce waste and enable people to adopt a soft mode of travel

The demonstration area for TT#5 is in the Nice Eco Valley district, a continuum of 3 homogeneous areas: Grand Arenas, Nice Méridia and Les Moulins (see).

The TT#5 measures will be implemented in different scale of area:

- For #1: The actions will be implemented in the city of Nice into the tramway & in the Grand Arenas city affair quarter and the Moulin's Area.
- For #2: The actions will be implemented in the Moulin's Area situated in the west of Nice near the airport.
- The measure #3 was to be deployed in the same area as the measure #2.

The city of Nice and the neighbouring area Les Moulins and Grand Arenas are showed in the next figure.

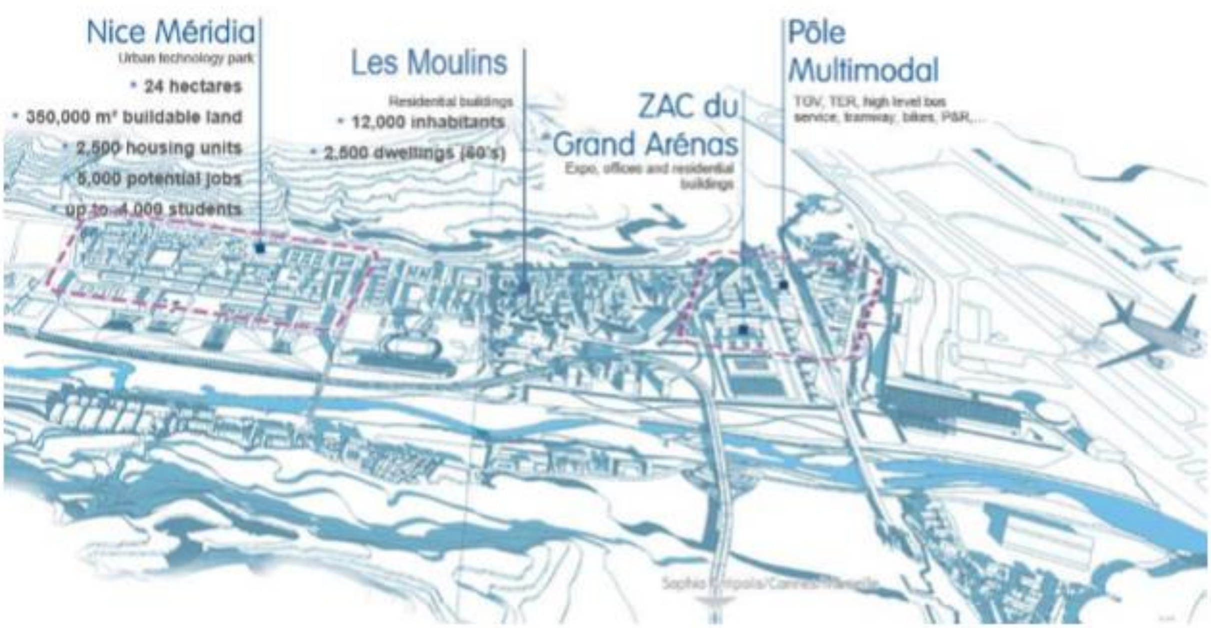


Figure 169 : Overview of the demonstration districts of Nice

<u>**Les Moulins**</u>

Nice Les Moulins is an income-deprived neighbourhood in the west part of Nice (2 969 social dwellings built during the 70's, around 12 000 inhabitants) with degraded mid-rise and high-rise buildings and a shared district heating.

Cote d'Azur Habitat, the social housing company in charge of Les Moulins together with the municipality of Nice and the National Agency for Urban Renewal launched an ambitious renovation program with general objectives to demonstrate the feasibility (technical, financial and social) of innovative low energy renovation processes for buildings.

Started in 2011, the renovation program in Les Moulins is planned over 12 years, as a first step of a larger development in the Nice Eco Valley district, to be completed within 20 years (see Figure 170 and Figure

171).

Figure 170 : Overview of Les Moulins area before renovation

Figure 171 : Les Moulins area after renovation

6.2 Implementations

6.2.1 Measure 1: Public awareness campaign Air Quality

AtmoSud's contribution to citizen engagement with innovation about the air quality consisted in three steps:

- Improvement of air quality measurements
- Upgrade of the AZUR air quality model with hourly forecast and real time information
- Release of concrete citizen engagement solutions linked with technical innovations

The data provided by AZUR and measured are the cornerstone of the citizen engagement solutions. Since they are local and real time data, they will play a significant role in supporting citizen engagement in the district. Therefore, they underlie all of the solutions for every target mentioned hereinafter.

Data exploitation

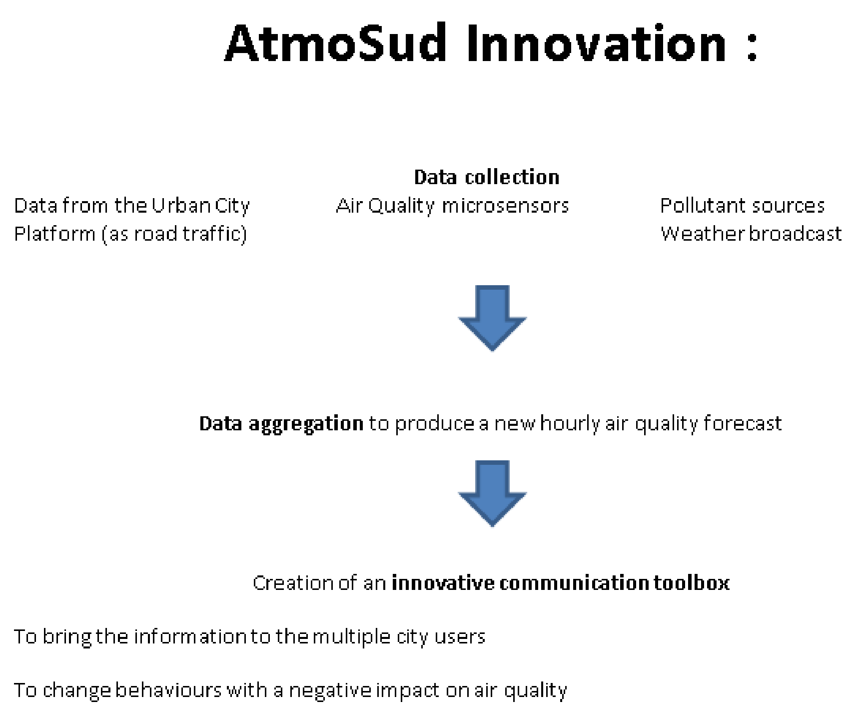


Figure 172 : AtmoSud's innovation strategy in the framework of the IRIS project

Target segmentation

To offset the heterogeneous features of Nice Eco Valley District, the chosen strategy is to divide the audience into target groups. Depending on its characteristics, each group will be reached with a specific communication to generate citizen engagement.

By analyzing the population, several groups stood out: city dwellers, low-income and disadvantaged households, children, teenagers and students, professionals etc. After discussing with ENGIE Cofely, it was decided to distribute the targets between Engie and AtmoSud.

AtmoSud's initiative would target:

White collars

Target are employees and head of companies working in the Arena business area. Most of them are using their car daily to reach their workplace. the chosen approach for this target is to raise awareness about the air quality and specially the negative impact of road transport by **promoting soft mobility during commuting trips to and from work.**

Due to the high density of companies, the business district The Arenas is a relevant geographic testing area which would be our use case for this measure.

University students and high schools

The approaches planned with high schools are **awareness sessions with our dedicated program "Air and me",** an interactive pedagogical slideshow to raise awareness**.** By obtaining an education about sustainability issues young people will act accordingly as adults. Reaching teenagers through education is a long term investment, but they are also able to change their habits at their own level, and to influence adults' behaviors. More information about the "Air and me program" here.

Concerning university students, the selected use case involve students with a sustainable development major, so it will be an easier audience to reach. If they share the values related to the environment, they are not obviously engaged into concrete actions. The project was to help them to **convert their convictions into commitment**. Of course, some of them might already act upon their values, then, the project was to provide them knowledges to become more qualified **ambassadors for their peers and relatives**.

Students were to be be committed into a **training project** part of their classes. This training aims at creating an awareness action to help changing behaviors, based on the context of the IRIS project. By working on a practical project, they **gain a useful "professionalizing" experience** to highlight in their future professional life.

General public

The chosen approach for this target **is an urban awareness campaign.**

A vast and very heterogeneous target from a demographic perspective. Therefore, the chosen media to reach them would be mass media. However, in the framework of the IRIS project, the goal is to reach locals from the city or the investigation area. Consequently, mass media enabling geographic segmentation would be selected such as local urban screens (in public transports and on the road).

Target 1 the white collars

The aim of the initiative in the business area was to **help white-collars to change their commuting behavior, by choosing public transports or other alternatives to the individual car**. Nearby, a plethoric offer is available, going from public transports (buses, train, and tramway), to a car-sharing device established by the district itself and city blue vehicles (bicycles and electric bicycles etc.).

The data collected thanks to local measurements and the AZUR model, would play a crucial role to raise awareness about the air quality in the business district. To spread these data to the target audience, several **pedagogic communication tools** are considered: air quality condition, road congestion index, local traffic information, itineraries solutions, etc. These tools would **be displayed on several media within the business district**, which are currently being discussed (intranet, pedagogic display panel, etc.). In addition, the Arenas was at the time working on how to accompany internally with communication (lever of motivation, ludification, etc.).

On the one hand, the tools' features would depend on the possibilities offered by both air quality and traffic data collected. On the other hand, **a survey would be carried out to produce a relevant and useful pedagogical service.** Estimate the targets' needs, expectations, and journeys, unveil the mobility determinants, are the best ways to **rightly highlight soft mobility and car-sharing assets**. This co creation of tools through surveys and interviews would lead to reach a higher level of the engagement ladder. **The survey can be collectively conducted by partners of IRIS** (AtmoSud and IMREDD) by involving students majoring in sustainable development in the process.

Concerning the business district, the link was established through the CEO club, in charge of the area management. The co-design phase unveiled the context features to rely on, such as an existing car sharing device in the district, and other mobility alternatives.

During the exchanges, the club asked AtmoSud for more details about the air quality status in the area.

During 2020 we had a few meeting and we proposed a model of questionnaire, different messages to address to the users and we studied the possibilities of using their internal digital displays to communicate.

We delivered a 12 pages note on the subject, but with Covid crisis the relationship with the Arena CEO club stopped and it has been impossible to implement the solutions considered

Figure 173 : AtmoSud recommendations for the Arenas Business Center

Target 2 University students

AtmoSud carried out a co-construction process with Master students from Nice Sophia Antipolis University. Two groups of MASTER students (MASTER COMEDD and MASTER DISTIC) realized a work on the citizen commitment in connection with the air quality.

MASTER DISTIC (https://univ-cotedazur.fr/offre-de-formation/distic-digital-studies-information-et-communication)

We have been working since 2020 with the Master DISTICC. It is now the third year of these collaboration born with the IRIS project. The productions of the student are displayed on this dedicated website:

https://atmosudiris.wordpress.com/

The collaboration with MASTER COMEDD consisted mainly in a work of sensibilization and they began to develop a game on air quality.

With the teachers and the students of MASTER DISTIC we developed a more intense collaboration. They were asked to develop ideas to raise air quality awareness among their fellows and they were given microsensors to test their use and their potential utility ton engage student on air quality issues.

They also run a survey among students (https://docs.google.com/forms/d/e/1FAIpQLScK6pgaejhZu9dmE-84EqDyW8Pd-1azB0D3ResYV37cX--zoA/viewform) .

Survey: This anonymous questionnaire was completed by nearly **100 students** in order to extract representative statistics. Our objective, beyond this data collection, was to perceive the degree of awareness and commitment of students regarding air pollution. The survey lasted 5 minutes (about 10 questions) and was proposed online via the Google Form tool. It was relayed on the student messaging system and on student Facebook pages. We obtained results from all horizons, as many men as women, first year students as well as fifth year students. We notice that a majority of students are concerned about the environment, without always really knowing how to do it. According to them, it is mainly the industries and the automobile which pollute. Finally, we note that they generally do not know AtmoSud.

Air pollution awareness work requires, as stated in the SWOT analysis, online awareness campaigns, but

An aborted attempt for a fully digital campaign index based

AtmoSud has scheduled an important awareness campaign for Air Quality for the city of Nice. Digital panels have been identified. Why digital numerical panel? Digital signage is a communication tool that allows you to display any kind of content on a screen: text, images, videos, rich content.

Our brain understands, identifies and remembers visual elements more easily than text or sound elements. Studies by the American psychologist Jerome Bruner lead to the following figures: we retain 10% of what we hear, 20% of what we read and 80% of what we see and do. It is therefore images, videos and interactive content that have the best chance of being remembered. If static displays can display images, only digital signage screens can display videos or rich content.

- 75% of people remember a dynamic display
- 44% remember a static display

Compared to other broadcasting channels, digital signage also shows excellent performance. A message broadcast on the radio has a recall rate of 27% and a static outdoor display a recall rate of 30%. A message broadcast on television reaches 32% and 52% for a message broadcast on dynamic display screens. Thanks to the animation of the contents, but also to the possibility of precisely targeting a place or an audience, digital signage is extremely effective. 47% of people who have seen advertising on a digital billboard still remember it precisely 30 days later.

Digital signage is also a very attractive tool: 70% of people look at the displays on outdoor digital panels, compared to 43% of advertising content on the Internet, and 41% on Facebook. In addition to its attractiveness, induced by the possibility to animate the displays and the strong luminosity of the panels, this type of display is also appreciated by consumers and passers-by. Indeed, they can access up-to-date information (compared to posters), interact with the screens and get the information they want.

The city of Nice is equipped with 40 digital panels allowing a dynamic digital display. These panels are dedicated to general interest and advertising. The Metropolis of Nice Cote d'Azur has agreed to display information messages on air quality. AtmoSud prepared various messages to communicate on air quality according to the level of pollution and the type of the main pollutant measured in the air.

Thématiques	Messages	Niveau de la Qualité de l'air			Type de panneau			
		Bon	Moyen	Mauvais	routiers	tramway	bus	ARENAS
Air	AtmoSud vous informe de la qualité de l’air au quotidien	x			x	x	x	x
	Je m'informe et j'adapte mes comportements pour limiter ma pollution et préserver ma santé		x		x	x	x	x
Covoiturage	Pensez au covoiturage		x	x	x			x
	Covoiturage : - polluant - cher		x	x	x			x
	1 voiture = 5 places!		x	x	x			x
	Bouchon ? Stress au volant ? Je covoiture, économique, écologique et convivial	x	x		x			
	Pour me déplacer sur mon lieu de travail, je pense covoiturage !		x	x	x			x
	Seulement 1,2 passagers par voiture en moyenne!		x	x	x			x
	Inscrivez-vous sur notre plateforme de covoiturage Klaxit!		x	x				x
Ecoconduite	Ne pas pousser le moteur = 20 % de carburant économisé		x		x			
	Ne pas pousser le moteur = 20 % d’émissions en moins		x		x			
	Je coupe mon moteur lorsque je stationne		x		x			
	Je conduis en souplesse et j’économise jusqu'à 40 % de carburant.		x		x			
	J'entretiens mon véhicule pour moins polluer et éviter 25 % de surconsommation de carburant.		x		x			
	Obtenez des conseils éco-conduite personalisés avec Geco-Air!		x	x	x			x
	Découvrez votre score écoconduite avec l'appli Geco Air!		x		x			x
Mobilité douce	Ca bouchonne? Plus vite à vélo pour les petits trajets !	x	x		x			x
	A pied ou à vélo pour les petits trajets!	x	x		x			x
	L'achat d'un vélo équivaut entre 2 et 4 pleins d'essence	x	x	x	x			x
	Je vais au travail à vélo 1 à 2 fois par semaine !	x	x	x	x			x
	En ville, sur une distance de moins de 6 km, je vais plus vite en vélo		x	x	x			x
	En ville, je me déplace autrement qu'en voiture, car c’est le mode de transport le plus cher		x		x	x	x	x
	3 stations vélos bleus à - de 600m. Testez les!		x	x				x
	Je marche 1h/jour = - 0.5 tonne de CO2 par an	x	x		x			
	Je marche 1h/jour = économie de 160 L de carburant par an	x	x		x			x
Traffic routier	Avez-vous vraiment besoin de votre véhicule pour ce déplacement ?			x	x			
	Se déplacer sans voiture, c'est possible			x	x	x	x	x
	Je limite mes déplacements sur les grands axes routiers et à leurs abords, aux périodes de pointe (7 h-10 h / 17 h-20 h)			x	x	x	x	x
	40% des trajets en voiture font moins de 2 km		x		x			x
	Limitez vos déplacements en voiture			x	x			x
	Une prom sans voiture = un air meilleur	x	x		x	x	x	x
Impact Tramway	3 lignes de tramway = - 40% de CO2 sur l'Avenue de la Californie	x	x		x	x		x
	3 lignes de tramway = - 35% de particules fines sur l'Avenue de la Californie	x	x		x	x		x
	3 lignes de tramway = - 54% d'oxydes d'azote sur l'Avenue de la Californie	x	x		x	x		x
	Envion 15% de pollution en moins sur la Promenade des Anglais grâce au tram !	x	x		x	x		x
	Le tram c'est 17% de gaz à effet de serre sur la Promenade des anglais	x	x		x	x		x
	Lorsque vous prenez le tramway, vous préservez l'air et le climat	x			x	x		x
Covid-19	Covid-19 à Nice: -70% de pollution routière	x	x		x			x
	Grâce au confinement: - 70% de pollution routière sur la Prom	x	x		x			x

Figure 174 : Air quality messages according to the level of air pollution

We also forecast the potential occurrences of the different level of pollution to reassure political authorities.

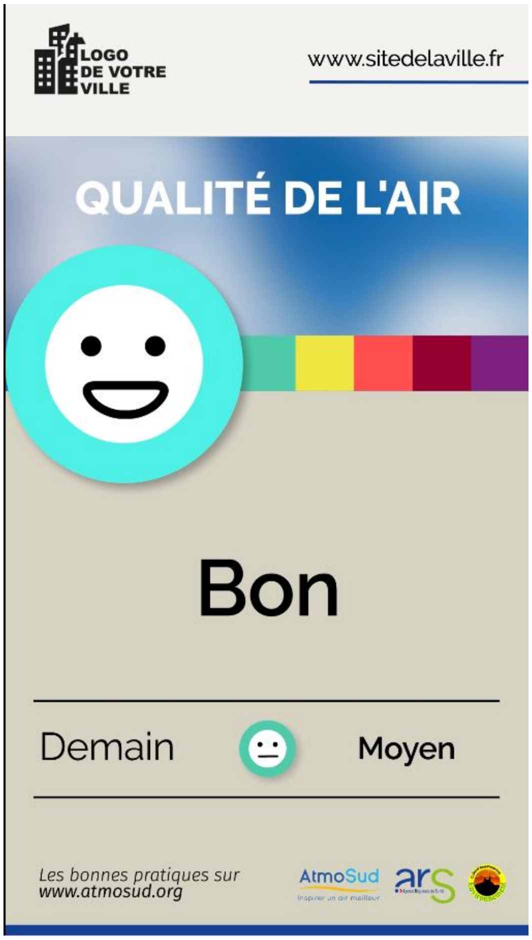
Frequencies of the various level index of pollution on the Nice area

During the 243 days of modelised and measured index available in Nice between 2019 and 2020, the statistics are:

• 1 day « Good »
• 64% « Fair »
• 33% « Moderate »
• 2% « Poor »

A major campaign was planned for June 2021. The French regional elections in June 2021 have postponed the planned information campaign until the end of 2021.

The city of Nice had planned a digital information campaign called "RESPIRE"/ “Breathe”. It deals with 3 specific themes: nature in the city, soft mobility, energy savings. These themes may be related to air quality information. It is therefore proposed that there be a synergy between the IRIS citizen information campaign and the "RESPIRE" information campaign. The digital panels are managed by a subcontractor: Jean Claude Decaux. Examples of animations have been developed and allow to display 2 pieces of information: the air quality index and a citizen commitment message. (see figures below). The logos would be logo IRIS + Europe + logo NCA and the contents validated by the communication service of Nice Cote d'Azur. The citizen engagement messages were prepared by AtmoSud and communicated to NCA.



5 seconds **5 seconds**

"When there is a pollution peak I reduce my speed by 20 km/h"

Figure 175 : Air quality digital campaign proposal on Decaux's displays

Once the information, awareness and citizen engagement campaign is underway, the number of people reached can be estimated (KPI). In parallel, surveys on citizen engagement will be conducted to verify the impact of the IRIS communication campaign on air quality.

Several thousand citizens of NCA should be aware and should be able to receive messages about their civic commitment to act.

But finally, the communication consultants of the NCA authority thought that a potential fair or moderate air quality index would be counter productive with the "Respire/Breathe" campaign.

And it was decided to base the campaign only on recommendations and not on live data.

The RESPIRE/ BREATH campaign

3 messages to encourage Soft Mobility and improve air quality in Nice had been chosen:

1. Use of the bicycle => "By bicycle, I act for the planet"
2. Carpooling => "I load up with friends in my car to go to work"
3. Use of public transport => "Monday to Friday, the tram I prefer"

The goals were to :
1) Create a link between air quality and our daily movements
2) Educate the public by broadcasting an inciting message
3) Speak up without blaming the user and valuing "good" behavior
4) Evaluate the impact of messages on user behavior by carrying out a survey with a priori and a posteriori interviews

Bicycle message

Figure 176 : Breathe Air quality awareness campaign "By bicycle, I act for the planet"

Covering tram L1 and L2
=> From June 27 to July 4
A3 display in tramway (approx. 500 copies)
=> From June 28 to July 4
Vélo Bleu digital campaign
=> From June 27 to July 4
Display behind Bus
=> From June 28 to July 4
Tram digital screens
=> From June 28 to July 4
Town hall screen (10 places)
=> From June 27 to July 4
Social Networks NCA

Figure 177 : Breathe Air quality awareness campaign Carpooling message

Saleya exit parking display
=> From June 28
Covering tram L1 and L2
=> From June 27 to July 4
A3 display in tramway (approx. 500 copies)
=> From June 28 to July 4
Vélo Bleu digital campaign
=> From June 27 to July 4
Display behind Bus
=> From June 28 to July 4
Tram digital screens
=> From June 28 to July 4

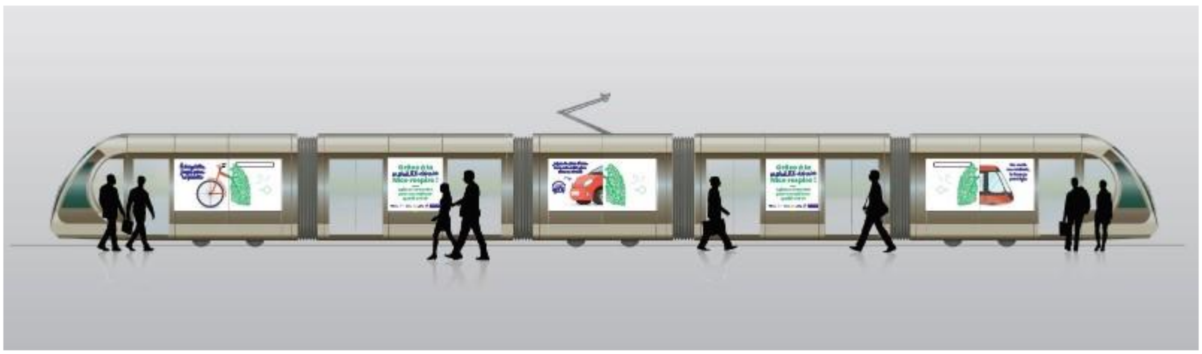
Town hall screen (10 places)
=> From June 27 to July 4
Social Networks NCA

Public transport message

Figure 178 : Breathe Air quality awareness campaign Public transport message

Carpooling message
Covering tram L1 and L2
=> From June 27 to July 4
A3 display in tramway (approx. 500 copies)
=> From June 28 to July 4

Vélo Bleu digital campaign
=> From June 27 to July 4
Display behind Bus
=> From June 28 to July 4
Tram digital screens
=> From June 28 to July 4
Town hall screen (10 places)
=> From June 27 to July 4
Social Networks NCA



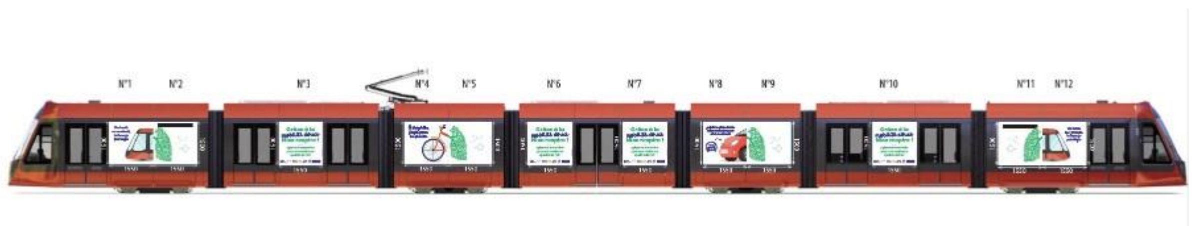


Figure 179 : Breathe Air quality awareness campaign the streetcar displays

AtmoSud communication campaign on the new index: ICAIRh

The ICAIR indicator takes into account the cumulation of the 4 pollutants PM10, PM2.5, O_3 and NO_2, to calculate a single value for assessing air quality. This choice to consider the sum of the 4 pollutants makes it possible to properly assess the exposure of each to pollution.
For example: On the diagram opposite the curves of ozone (O_3) (1), nitrogen oxide (NO_2) (3) and fine particulate matters (PM10 and PM2.5) (2) represent a fictitious summer day. Ozone is generally the highest, with a lower level in cities than in the outskirts and countryside. If we consider the only majority pollutant, the city could appear less polluted than peri-urban areas, or countryside.
With ICAIRh, each pollutant concentration will be taken into account in the assessment of the final level of air quality. And by making a curve that combines the three pollutions, we realize that urban areas are actually more polluted than peri-urban areas. ICAIRh represents the "multi-exposure" of populations.

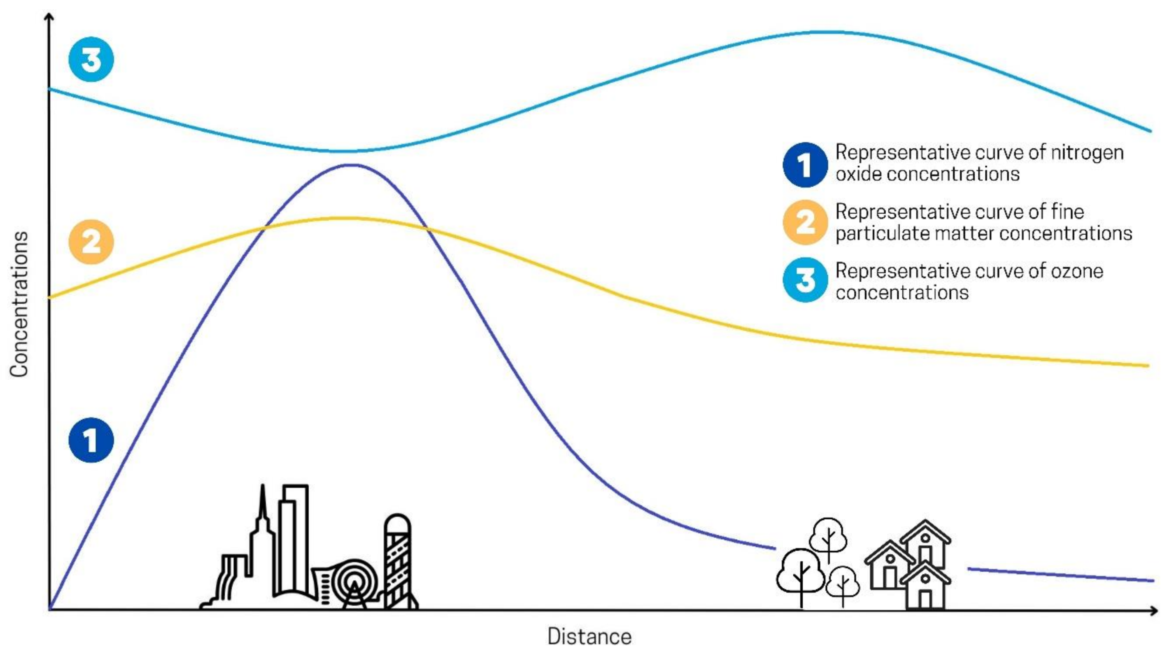


Figure 180 : Representative curves of air pollutants in town and in rural areas

The IRIS project enabled AtmoSud to set up an hourly mapping system for air quality, called the AZUR model. It is a high-resolution model is calibrated using micro-sensors implanted on the city of Nice. Based on this model, AtmoSud has developed a new very high resolution hourly indicator (spatial resolution of 25 meters), called cumulative air index or ICAIR-h, which is based on the thresholds of the European index. It thus provides dynamic information at street level during the day, depending on the fluctuation of pollutant concentrations in the air. distance

This new indicator combines the concentrations of 4 regulated pollutants (nitrogen dioxide, ozone and PM10 and PM2.5 particles). It is in particular this consideration of the cumulative effects of different pollutants that is innovative and makes it possible to highlight areas with multiple exposure.

This hourly indicator is produced in anticipation for the next 24 hours and is updated every hour for the next 24 hours: it is therefore both in real time and forecast. AtmoSud's engineering teams have also worked to integrate the territory's activity data when it is available: thus, the indicator will evolve and will be fed by the territory's real-time data, through the City Plateform .

You can see on this video the 24 h air quality evolution of a summer day: https://www.youtube.com/watch?v=L_E897qdp8g

The indicator has a double interest: by providing air quality information in near real time, it allows everyone to adapt their behaviour and reduce their exposure to air pollution. It is therefore an innovative and effective communication and awareness tool. It is also a decision-making tool to identify local phenomena impacting air quality.

Beyond this new indicator, AtmoSud, with Nice metropolitan authority NCA, has set up communication and citizen engagement actions on the issue of air and the promotion of soft mobility. Eventually, communication campaigns integrating the ICAIR-h index could emerge to make air quality accessible to all. It is the smart city as a whole, integrating measurement by micro sensors, engineering and expertise for modeling, up to the communication of information, which is the heart of AtmoSud's action within the framework of IRIS.

And finally the 24th of January AtmoSud launched ICAIRh index on his website homepage, and everyone in the area can have access to this information.

You can choose you exact location and time (within the past 3 hours and the next 24 hours), to see it on the map

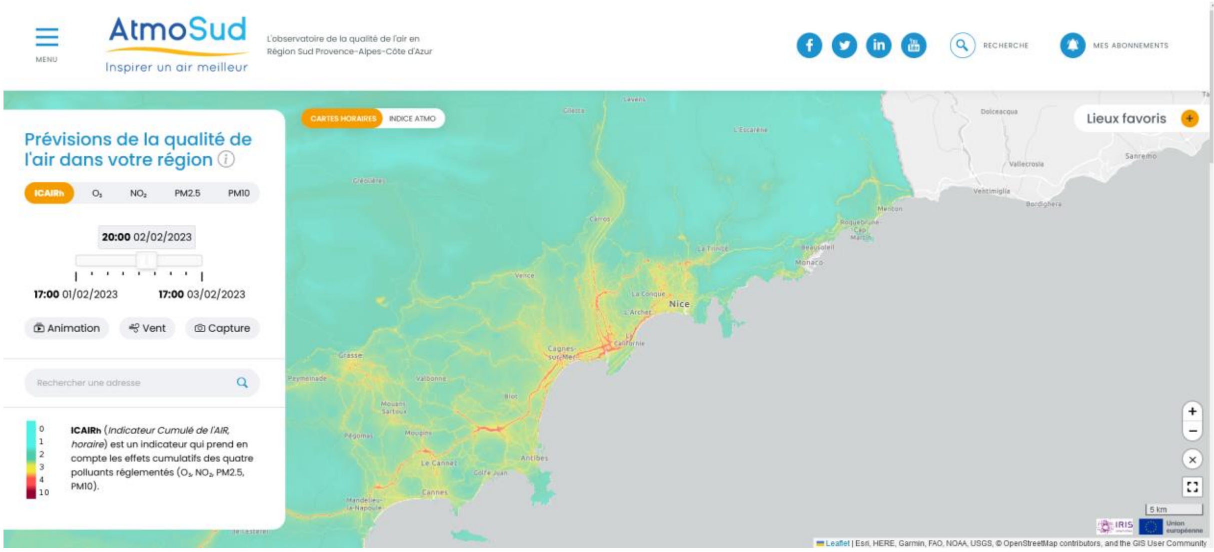


Figure 181 : AtmoSud website air quality map of Nice area

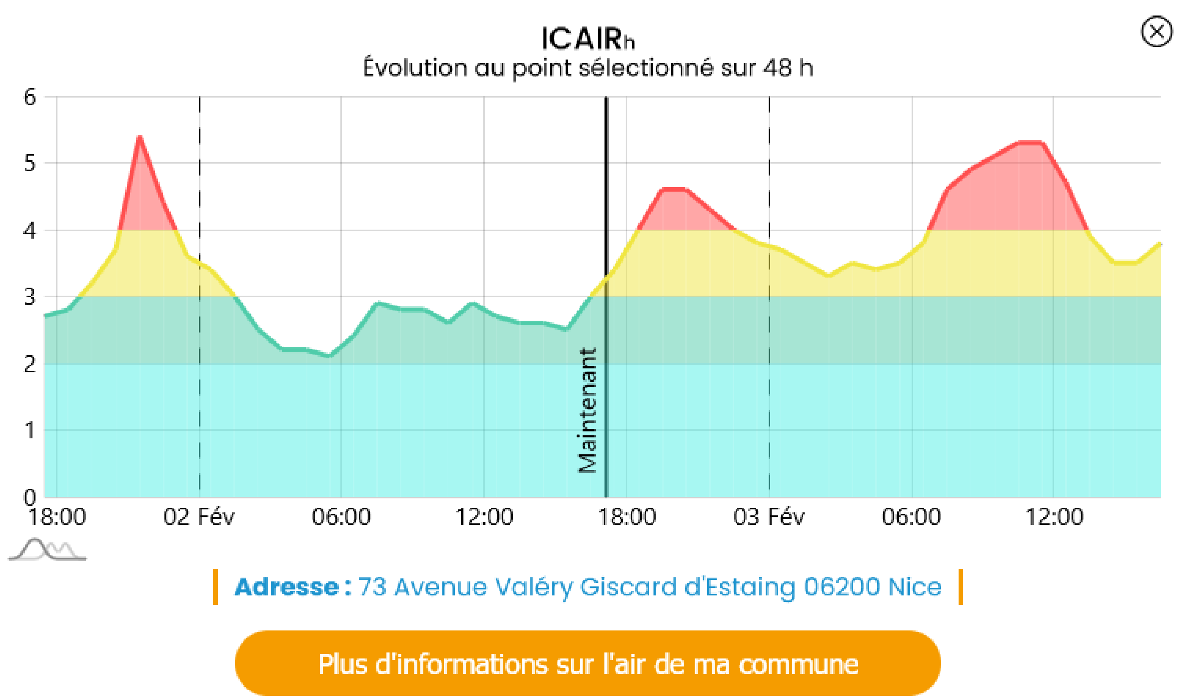


Figure 182 : New hourly air quality index on a curve

In this example, one can easily see that the 2nf of February it is better at this address to do sport before 6pm.

AtmoSud launched this communication campaign the day of the celebration of its 50th anniversary. The new index was introduced to all AtmoSud Partners, including of course NCA, and the media had been invited.

From the 19th December 2022 to 31st January 2023, AtmoSud produced 11 posts dedicated to the anniversary and to the coming of the new index on LinkedIn, Twitter and Facebook.

Figure 183 : Post on social network to publicize AtmoSud 50'th anniversary and the coming of the air quality index-1

Figure 184 : Post on social network to publicize AtmoSud 50'th anniversary and the coming of the air quality index-2

We made 3 news on our website:
https://www.atmosud.org/actualite/le-cinquantieme-anniversaire-datmosud
https://www.atmosud.org/publications/50-ans-atmosud-programme-du-24-janvier-2023
https://www.atmosud.org/actualite/atmosud-fete-ses-50-ans-le-24-janvier-2023

And we made a webpage dedicated to the explanation of the index:
https://www.atmosud.org/article/icair-lindicateur-cumule-de-lair
and we put the index on our website homepage:
https://www.atmosud.org/
with the logo IRIS, of course

Afficher dans le navigateur

AtmoSud
Inspirer un air meilleur

INVITATION PRESSE
Mardi 24 janvier 2023 à 12h30
Palais du Pharo, 55 boulevard Livon, 13007 Marseille

50 ans de surveillance de la qualité de l'air en Région Sud Provence-Alpes-Côte d'Azur

AtmoSud réunit tous les acteurs engagés du territoire – adhérents et partenaires - pour se projeter ensemble dans les **futurs enjeux de la qualité de l'air et du climat.**

>>> À l'occasion d'**une visite presse qui vous fera voyager dans l'air et le temps**, du passé au futur de la surveillance de la qualité de l'air et du climat, vous pourrez **visiter notre exposition et interroger nos experts de l'air, adhérents et partenaires d'AtmoSud** (associations, collectivités, acteurs économiques…).

En exclusivité

Présentation de **l'indicateur ICAIRh**, **nouveau service cartographique HD** pour **adapter son activité heure par heure en fonction du cumul des polluants.**

VOYAGEZ À TRAVERS 50 ANS D'HISTOIRE DE L'AIR ET DU CLIMAT

La visite presse - introduite par **Pierre-Charles Maria**, Président d'AtmoSud, et **Claire Pitollat**, Députée des Bouches-du-Rhône, avec la présence de **Amapola Ventron**, Vice-présidente de la Métropole Aix-Marseille et **Anne Claudius-Petit**, Conseillère régionale Provence-Alpes-Côte d'Azur - vous emmènera **au cœur des travaux d'AtmoSud, ceux d'hier, d'aujourd'hui et de demain.**

Dominique Robin, Directeur d'AtmoSud, sera votre guide tout au long de cette exposition dédiée aux métiers de l'air.

L'INNOVATION, AU CŒUR DU FUTUR D'AtmoSud

Cette exposition vous permettra de **découvrir le tout nouvel indicateur ICAIRh conçu par AtmoSud, les analyseurs d'hier et d'aujourd'hui** avec un compteur en direct de particules ultrafines et **les mesures de demain avec des microcapteurs et un drone.**

Figure 185 Press conference invitation to AtmoSud 50'th anniversary and the coming of the air quality index-

6.2.2 Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family

This measure consists of mobilizing citizens living in the area of the experiment on environmental issues related to energy.

To this end, and in order to intensify the potential for success, we have chosen to develop specific actions for different audiences: children, adolescents, families and adults.

In France, the health crisis due to COVID made impossible the implementation of the initial project, in the schools. The schools were closed for 4 months (march2020/july2020). Then, at the start of the 2020/2021 school year, the restrictions on interventions in schools did not allow the project to be implemented.

So the project was reoriented towards children coming to the ADAM leisure center in the Moulins area and around the creation of flyers and advertising posters on energy savings.

5.1.1.1. LEISURE CENTER – CHILDRENS – ENERGY FLYER :

The schedule of this action is :

DATE	ATELIERS
28/10/2020	**Workshop 1** : Project presentation, Brainstorming to find a name for the project, prepare the micro-sidewalk
29/10/2020	**Workshop 2 :** Visit of the boiler room, Micro-sidewalk, shared meal with JALE animation and sorting of the questions listed
04/11/2020	**Workshop 3 :** Answers to the questions identified during the micro-sidewalk with ENGIE technicians
02/12/2020	**Workshop 4 :** Reflection on the construction of the booklet
21/12/2020	**Workshop 5 :** Realization of the booklet
Janvier 2021	**Workshop 6 :** Editing of the booklet based on the ideas and drawings of the teens
February 2021	Validation of the booklet by the Engie & CAH
September 2021	Printing of the booklet
20/10/2021	**Workshop 7 :** Presentation by teenagers of the booklet produced to partners
29/10/2021	**Workshop 8 :** Distribution of the booklet in all CAH residences
3/11/2021	**Workshop 9 :** Distribution of the booklet in all CAH residences
24/11/2021	**Workshop 10 :** Assessment with the inhabitants to know their feelings about the booklet (micro-sidewalk)
TOTAL	**Beneficiaries : 2 417 flats**

At the end of the project, the young people were very proud of their achievement and of the impact that the flyer could have on their environment and their neighbourhood and their relations and friends.

Their self-image had evolved positively well beyond the strict aspect of the project.

5.1.1.2. LEISURE CENTER – CHILDRENS – Energy saving Poster

This action took shape following the health crisis and to complement the actions carried out within the IRIS project with young children.

The initial idea was to remind residents of simple energy-saving measures during a period when they were mainly at home.

To do this, we thanked distributed awareness-raising posters to the residents, putting them up in the halls of the buildings in the neighbourhood.

Then, when discussing with the children who come to the leisure centre, it became clear that they were very interested in these subjects.

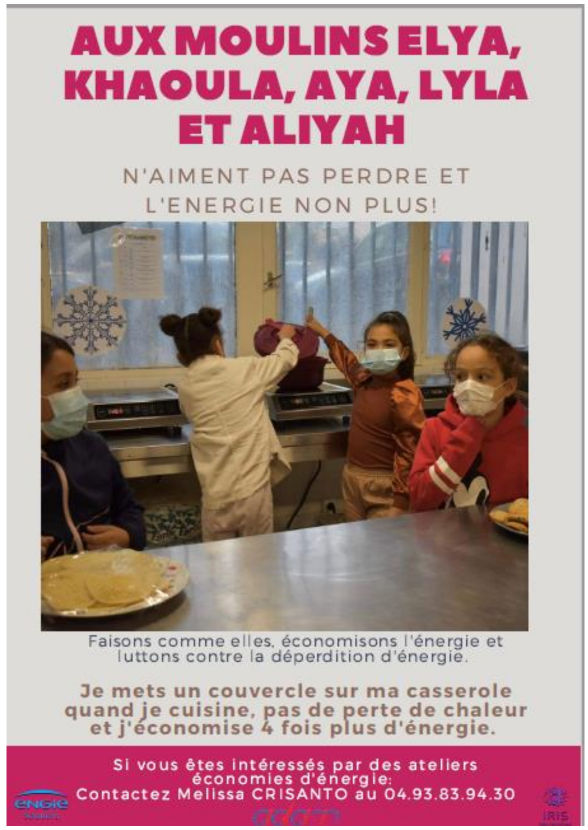
The idea was born to get them involved and more than that, to make them the real actors of this action.

- 8 posters were created.

The schedule of this action is:

Date	Workshops
15/09/2021	Presentation of the project, Animation I'm learning about energy Smartchef “la maison toquée”. Definitions (energy saving, energy waste etc...)
13/10/2021	Break the ice and get to know the children, in order to learn more about their daily habits and give them an Ecogesture
10/11/2021	Continue group work, think about the presentation of the posters and the assigned eco-actions
01/12/2021	Setting the scene, taking photos and designing posters
08/12/2021	Setting the scene, taking photos and designing posters
12/01/2022	Presentation of the posters to the children and facilitators
08/02/2022	Presentation of the posters to the parents concerned for validation of the distribution
16/02/2022	Retouching of posters after advice and discussion with children and families
23/02/2022	Display of posters in the leisure centre
16/03/2022	Assessment of the action, feedback from children and families
TOTAL	**10 Workshops – 21 family beneficiaries** **2417 beneficiaries with dissemination**


AUX MOULINS KELVIN, INAYA,ILEF,LINA ET ELISSA
SE COUCHENT TÔT ET LEUR TÉLÉ AUSSI
Faisons comme eux, économisons l'énergie, éteignons nos appareils électriques.
Je ne laisse pas mes appareils électriques en veille, je les débranche et j'économise 80 euros/an.
Si vous êtes intéressés par des ateliers économies d'énergie:
Contactez Melissa CRISANTO au 04.93.83.94.30


AUX MOULINS ELYA, KHAOULA, AYA, LYLA ET ALIYAH
N'AIMENT PAS PERDRE ET L'ENERGIE NON PLUS!
Faisons comme elles, économisons l'énergie et luttons contre la déperdition d'énergie.
Je mets un couvercle sur ma casserole quand je cuisine, pas de perte de chaleur et j'économise 4 fois plus d'énergie.
Si vous êtes intéressés par des ateliers économies d'énergie:
Contactez Melissa CRISANTO au 04.93.83.94.30


AUX MOULINS YANIS, RIAD ET ADEM
ADORENT LE SPORT DONC ILS SE DÉPLACENT À PIED OU À VÉLO
Faisons comme eux, économisons l'énergie, optons pour des modes de déplacement doux !
Je ne prends pas la voiture pour les petits trajets. J'économise 650Kg de CO2/an.
Si vous êtes intéressés par des ateliers économies d'énergie :
contactez Melissa CRISANTO au 04.93.83.94.30


AUX MOULINS ALADIN, NOLAN, ET ISMAEL
ADORENT LES CERISES MAIS SEULEMENT EN ÉTÉ!
Faisons comme eux, économisons l'énergie, mangeons des fruits et légumes de saison.
Je respecte le calendrier des fruits et légumes de saison et je réduis mon impact carbone.
Si vous êtes intéressés par des ateliers économies d'énergie :
Contactez Melissa CRISANTO au 04.93.83.94.30

5.1.1.3. ADULTS AND FAMILY: SMART FLAT – SOCIAL GROCERY STORE

The aim of these workshops for families was to raise awareness of energy, its challenges and opportunities in the context of energy transition.

The people who attended these workshops initially came via the ADAM association, in particular families registered with the social grocery shop or members of the social mediation and access to rights programme who were having difficulty paying their energy bills.

A third group of people joined the other two spontaneously following the article in the Les Moulins newspaper and the distribution of the booklet produced by the adolescents.

It was necessary to adapt the workshops according to the audience present. For people who speak little or no French or who are very poor, the discourse was simple and fun, based essentially on diagrams, figures, quizzes etc.

For those who were more comfortable, the workshop took the form of a Power Point and more technical points were addressed.

It was important to adapt the discourse so as not to lose anyone and to raise the awareness of a maximum number of beneficiaries, even if it meant making the workshops a little childish.

The schedule of this action is:

Date	**Workshops**
16/01/2020	Energy transition
30/01/2020	Energy transition
26/05/2021	Water a rare energy
09/06/2021	Water a rare energy
15/07/2021	The energy cost of food waste
22/07/2021	The energy cost of food waste
16/09/2021	The Electrical consumption at home
28/10/2021	The energy cost of food waste
18/11/2021	Energy efficiency: identifying energy-using appliances
06/12/2021	Energy saving and festive season
13/01/2022	Water, a rare energy
07/02/2022	Energy efficiency: identifying energy-using appliances
17/03/2022	The energy voucher: how does it work?
TOTAL	**13 Workshops – 60 beneficiaries**

Figure 186 : Workshops with citizens

5.1.1.4. YOUTH – 15 -18 years old – I like my substation

The advantage of this project is that in addition to the theoretical side of the workshops and actions described above, it also combined a practical side with site visits.

Several groups of teenagers had the chance to visit the main boiler room of the heating network that supplies the buildings in the neighbourhood and the sub-stations at the subground of the buildings.

The visits are built in several stages:

- Appointment at the ADAM association
- Distribution of a questionnaire to the teenagers whose answers will be given during the site visit. This encourages them to be attentive
- Everyone is equipped with individual safety equipment, which makes the teenagers feel responsible and privileged to have access to this usually closed place.
- Visit and technical explanation, observation of the operation of the boiler burners.
- Return to the association with debriefing of the questionnaires
- Shared meal with the technical staff and ADAM.

DATE	Workshop	Number / Age
18/02/2020	Site visit / workshop with youth (usage of Time's up energy)	12 adolescents / 12-17 ans

09/07/2020	Site visit / Burner ignition procedure/ Boiler room questionnaire understand network specificities	10 adolescents / 12-17 ans
07/10/2020	Site visit / Burner ignition procedure/ Boiler room questionnaire understand network specificities	16 enfants / 6 - 11ans
29/10/2020	Site visit / Burner ignition procedure/ Boiler room questionnaire understand network specificities	19 adolescents / 12-17 ans
TOTAL	**4 visits**	**57 Beneficiaries**

Figure 187 : Visit in the frame of "I like my substation" with young people

6.2.3 Measure 3: Citizens individual engagement - IOT invoices – NEW MEASURE :

Unfortunately, this measure could not be implemented. Several factors led us to abandon this action, in particular the termination at the 30/06/2022 of the operation and maintenance contract between CAH and ENGIE for the residences initially involved in the measurement.

However, before the end of the operating contract, we had underestimated the implementation difficulties that became apparent during the project:

- **Identification of an appropriate residence within the perimeter of the experiment (Les Moulins) with the appropriate criteria to measure the effectiveness of the measure:**
  Individual electricity consumption, statement of m3 DHW consumed per dwelling, possibility to regulate heating individually
  The configuration of the collective underfloor heating system, over which the tenants have no control, did not make the experiment appropriate for the residence initially identified.
  We tried to change residence while staying in the experimental area, but the decision process within CAH was very long and the constraint of staying in the area created an additional difficulty. After several attempts, we decided to stay in the original residence, even though this was not the most convincing choice.

- **Measuring the impact of awareness campaigns:**
  The awareness campaign, via the CAH website, was to focus on "eco-actions" that tenants are expected to implement and whose impact is measurable via their individual heating, DHW and electricity bills.
  For heating, given the way it works (collective underfloor heating), few individual energy saving actions have a direct impact on tenants' consumption.
  On the other hand, the messages concerning electricity or domestic hot water were relevant.

- **CAH's billing method for heating :**
  CAH's method of billing for heating consists of invoicing zones grouping together several buildings in a global manner and then by dwelling according to the the surface area of the dwelling. This method does not allow the savings linked to individual actions by tenants to save energy and reduce their consumption to be passed on to individual heating bills.
  It is almost impossible to establish a correlation between awareness campaigns and actual savings.

- **Integration of individual consumption of all energies in the CAH WEB portal :**

  This action consists of collecting the consent of the tenants to give access to their data from their electricity bills in order to integrate them into the CAH WEB portal.

  Several steps are necessary to get ENEDIS to sign the protocol for access to individual data and then provide us with the data.

In a context of suspicion linked to COVID, the public information meetings for tenants could not be held. Door-to-door visits are essential to explain the situation to each tenant and to obtain their agreement.

In view of the time limits and the delay in this measure, we have decided to stop the experiment. In its place, in agreement with the project manager, we have proposed a new citizen engagement action described below.

6.2.4 Measure 3 - NEW MEASURE : Citizens engagement: waste reduction and sustainable mobility

This action is implemented in the Moulins district and more precisely in the recycling centre. It is carried out in partnership with the Cyclotrope association.

The aim of the recycling centre is to:

- limit illegal dumping and improve the cleanliness of the neighbourhood by offering a local collection point for the use of residents and a door-to-door collection of waste. to be used by the inhabitants and a door-to-door collection,

- raise awareness among users and residents of eco-actions and offer a place focused on education and education on selective sorting, waste prevention, composting and sustainable development,

- implement a recycling centre and ensure the operation of a solidarity shop which will and offer for sale reused objects while promoting professional integration in the sector integration in the sector,

- to federate and actively involve the existing associations in the Nice les Moulins district around the project Nice les Moulins, and to create a dynamic to improve the living environment and social relations.

In 2021, the recycling centre won the Eurocities Awards in the zero-pollution category.

As part of our action, the bicycles collected by the bulky goods department are repaired and resold by the recycling centre. Free workshops to learn how to repair and maintain your bike are also offered regularly by the Cyclotrope association.

Figure 188 : Flyer of the activities of recycling center – Bicycle workshop

6.3 Key results

6.3.1 Measure 1: Public awareness campaign Air Quality

The collaboration with students have been very interesting. The objectives were:

- to carry out a process of co-creation on the theme of the citizen commitment for the protection of the quality of the air with 2 MASTERS of the university of Nice (COMEDD & DISTIC)
- To carry out a survey near the university public

Due to COVID context and lockdown: many difficulties to implement the actions.

The Masters internships related to the IRIS project took place with 2 groups of students. The reports were returned and the defenses carried out. The operation had been repeated the following year, and again this year.

Realizations :

- Reports
- Many new ideas with IRIS project valorization (coming soon on the AtmoSud Website)
- Survey on the behaviour changes: more than 100 students involved

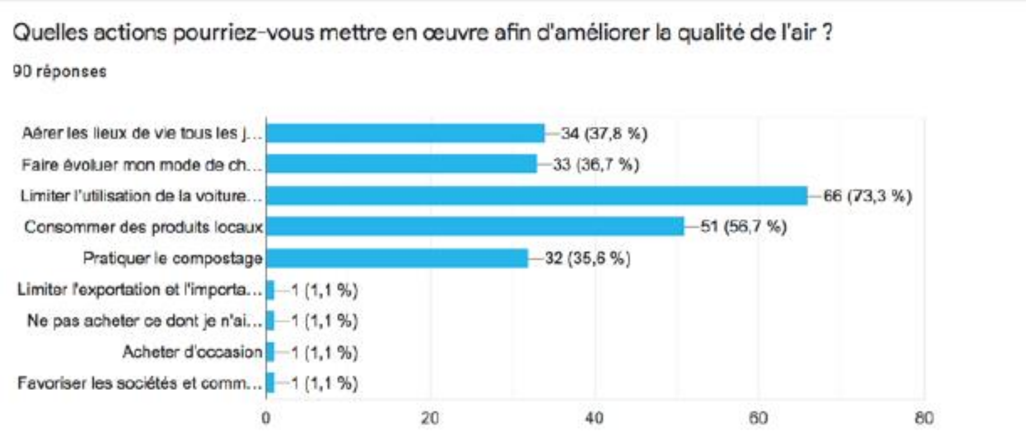


Figure 189 : Results of the survey lead by the students on behavior changes

The survey on the RESPIRE campaign

To evaluate the impact of the communication campaign two surveys had been conducted by IFOP, a well-known society specialized on surveys, before and after the campaign
The survey was conducted with a sample of 608 people, representative of the population of the municipality of Nice aged 18 years and over.
The representativeness of the sample was ensured by the quota method (gender, age, profession of the respondent) after stratification by district

The interviews were conducted by telephone from July 6 to 11, 2022.

MAIN LESSONS
Home- work travel modes
Among the inhabitants of the city of Nice, the employed workers work for the most part more than 10 kilometers from home (37%, with a relatively balanced distribution with lower distances) for an average journey of 10 to 20 minutes (for 42%)
To get to work, the people of Nice mainly use private gasoline cars (43%), ahead of public transport in common (34%) and walking (18%). Quite logically, the use of the car increases with the distance: one in two people whose work is located more than 10 kilometers from his home cites the car as the main means of transport; walking being cited by 63% of working people having to travel less than 5 kilometers.
Among employed workers who favor public transport, economic (48%, compared to 31% on average) and ecological criteria (39%, against 23%) appear to be the most cited to explain their choice of mode of transport to get to work. The walkers also strongly highlight these aspects (40% cite the economic aspect, 44% for the ecological) while evoking mainly the fact that walking is good for your health (51%, against 15% on average). Proponents of the individual car citing the fact that their vehicle is a work tool or part of their job (28%, compared to 18% on average).
Air quality and mobility
Asked about air quality, a very clear majority of the people of Nice (62%) consider that road traffic constitutes the main source of pollution on the territory of the Metropolis, far ahead from air traffic (19%) or maritime traffic (5%). Walking is the transport mode in which the people of Nice believe that they are the most exposed to air pollution (34%), ahead of the bicycle (24%) and the car (20%)… which is the correct answer! Invited to project themselves into a situation where the air quality would be temporarily degraded, seven out of ten Nice people say they are ready to adapt their modes of transport by preferring soft mobility (70%). Conversely, among employed workers, only a minority (36%) say they will plan to adjust their working hours to switch to teleworking, a score down 9 points between June and July 2022! Among employed workers who are unwilling to adjust their working conditions in the event of deterioration in air quality, nearly half say that their company would not allow it (48%), more than personal organization concerns (24%) or lack of envy (13%).

In terms of information, 52% of the people of Nice now say they are well informed about the air quality in their daily environment, i.e. an increase of 5 points since June 2022. In detail, it is mainly the oldest (66% among people aged 65 and over).

Concerning the vectors of information on air quality, the weather on television (49%, +6 points since June, perhaps due to the heat waves) and on the radio (35%, +7) appear to be the channels preferred in practice by those who consider themselves well informed.

Among the less informed, these same vectors are in high demand (46% for the weather forecast on the phone, 40% for the television weather forecast at home), in addition to public posters (34%).

Finally, 12% of the people of Nice claim to have already calculated the carbon impact of their trips, compared to 32% who have not yet done so, but would like to do so, and 55% who are not considering this approach, this rate rising to 67% among those aged 65 and over, i.e. the public traditionally the most hermetic to environmental issues, both locally and nationally.

The “Nice breathes” campaign

Carried out the day after the “Nice breathes” campaign, this survey shows that 9% see precisely what it is about, and that 6% do have only a vague idea, i.e. a total of 15% of Nice people who have been exposed to the campaign enough to remember it. The memory of the campaign appears to be much stronger than on average in the heart of the city (23%), but weaker in the Three hills district (9%) and the West coastline (10%).

Among people exposed to the campaign and who remember it, three quarters (73%) declare that this “Nice breathes” campaign has rained, a sign of a high approval rate. However, the impact on behavior is more limited: only 31% of these people declare as well as the campaign pushed them to change their daily behavior, including 12% “a lot”.

So if the impact of the campaign has been real, a two weeks campaign did not change the behavior of all the population targeted but it corroborated the interest of the population for air quality.

So AtmoSud decided to launch a second campaign, at a regional scale, using the tool developed through the IRIS project.

The new index ICAIR

The press conference we hold the 24th of January was centered on the new index and the media fall outs were good on local media:

Atmosud, une histoire toujours dans l'air
La Provence - 25/01/2023

AtmoSud lance un nouvel indicateur de pollution de l’air dans la région
Nice Matin Nice - Nice - 25/01/2023

Atmosud célèbre 50 ans d’engagement pour un air respirable
La Marseillaise BDR Marseille - BDR Marseille - 25/01/2023

Bonne qualité de l’air et de la respiration démocratique à Toulon
La Marseillaise BDR Marseille - BDR Marseille - 27/01/2023

One of the local tv channel made an interview about this new index:

https://www.bfmtv.com/cote-d-azur/replay-emissions/bonsoir-cote-d-azur/atmo-sud-un-nouvel-indicateur-de-la-qualite-de-l-air_VN-202301250583.html

Figure 190 : Presentation of the new air quality index on local TV (BFMTV Nice)

Another press conference is scheduled the 1st of march to promote this new tool for behavioral change build with the support of the IRIS project.

AtmoSud

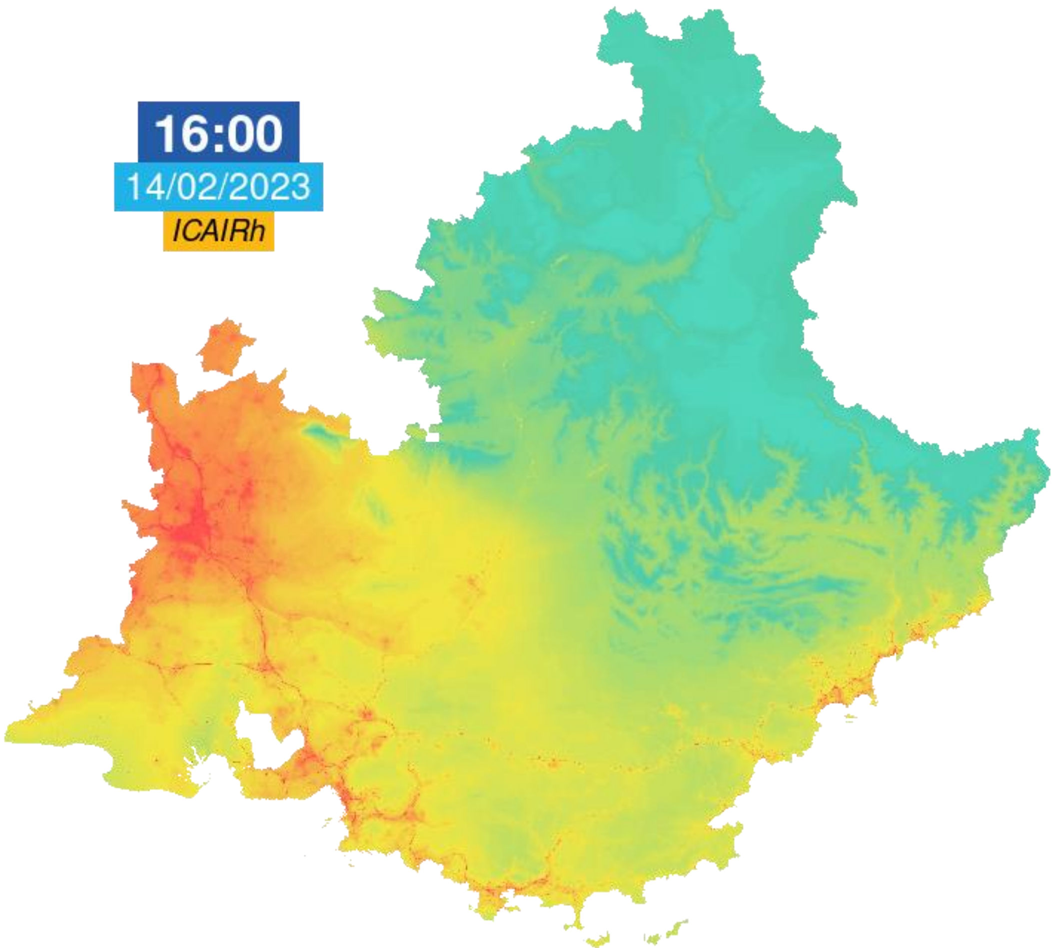
Inspirer un air meilleur

INVITATION PRESSE

Mercredi 1er mars 2023 à 11h30

Le Noilly Paradis - 146 rue Paradis - 13006 Marseille

ICAIRh indicator, a new service to adapt its activity hour by hour and better preserve the air around us



La carte ICAIRh ci-dessus représente l'évolution de la qualité de l'air des 14 et 15 février (épisode de pollution - procédures préfectorales du 12 au 16 février 2023).

The ICAIRh map above represents the evolution of air quality on February 14 and 15 (pollution episode - prefectural procedures from February 12 to 16, 2023).

ICAIR is the new AtmoSud indicator intended to better take into account the four main regulated pollutants (NO_2, O_3, PM2.5, PM10) with a spatial visualization of 25 meters over the entire region (HD modeling with assimilation of measurements).

It is available in two versions:

- hourly: with a 24-hour forecast, it is ICAIRh.
- annual: for an overall view, it's ICAIR365.

This new indicator, which takes into account the cumulative effects of different pollutants, highlights areas of multiple exposure.

To know :

In its hourly version, it is based on the thresholds of the European index. In its annual version, it uses WHO guidelines.

Air quality changes throughout the day with the intensity of pollution sources (road traffic during the day, residential wood heating in the evening, etc.) and depending on weather conditions. ICAIR in its hourly version makes it possible to adapt its activities according to the evolution of pollutants.

DISCOVER your geolocated ICAIRh by flashing this QR code

Figure 191 : Second press conference invitation to publicize the new air quality index-1

As a result many articles have been produced on the new index on French local media:

AtmoSud
Inspirer un air meilleur

Difficultés à visualiser ? Cliquer ici

Veille Media

Jeudi 02 Mars 2023

12 articles

12:01:00 Pollution : nouvel outil pour alerter.

FRANCE 3 PROVENCE ALPES - 12-13 provence-alpes - 01/03/2023 - Ecouter / Rega

12:01:00 Pollution : nouvel outil pour alerter. 12:01:22 Reportage de F. Renard sur la qualité de l'air. 12:01:36 Interview de Stéphan Castel, responsable de communication AtmoSud. 12:02:13 Interview de Dominique Robin, directeur AtmoSud. 100 000 voitures par jour empruntent l'autoroute Nord autant pour l' autoroute est. 12:02:38

Temps d'écoute : 1 min 38 sec

19:06:03 Pollution du port de Marseille : plainte

FRANCE 3 PROVENCE ALPES - 19-20 provence-alpes - 01/03/2023 - Ecouter / Rega

19:06:03 Pollution du port de Marseille : plainte collective au pénal. La procédure pénale est lancée pour mise en danger de la vie d'autrui et préjudice écologique. 19:06:22 Interview de Marie Prost Coletta, présidente Cap au Nord. 19:07:05 Qualité de l'air en région PACA : nouvel outil pour alerter. 19:07:18 Reportage de Frédéric Renard. 19:07:35 Interview de Stéphane Castel, responsable de communication AtmoSud.

Temps d'écoute : 2 min 46 sec

Atmosud affine son évaluation de la qualité de l'air

MarsActu.fr - 01/03/2023

Addition Bref le 1 Mar 2023 1 Dans la région, la qualité de l'air est mesurée par Atmosud. Ce mardi l'association indépendante a présenté lors d'une conférence de presse un nouvel indicateur "plus précis" accessible à tous, baptisé "ICAIRh". Deux nouveautés : les polluants sont additionnés et une prévision heure par heure est proposée sur le site internet d'Atmosud.

Temps de lecture : 1 min

La qualité de l'air provençal en temps réel à portée de clic

La Provence Aix En Provence - 02/03/2023

Guénaël Lemouee Icair. Ce nom ne dit encore rien à personne. Il ne devrait pas tarder à faire parler de lui et représente à la fois une avancée majeure dans l'information sur la pollution atmosphérique et une véritable innovation provençale sur laquelle Atmosud, l'observatoire régional de la qualité de l'air, planche depuis dix ans.

Temps de lecture : 2 min

Pollution maritime à Marseille : des habitants et des associations portent plainte

Lemonde.fr - 01/03/2023

Pour la première fois, une requête collective est déposée devant les juges spécialisés du pôle de santé publique pour « mise en danger de la vie d'autrui » et « pollution des eaux ». En cause, notamment, les émissions des bateaux de croisière. C'est une première à Marseille.

Temps de lecture : 4 min

Pollution : ce nouvel indicateur qui permet de connaître la qualité de l'air à… 25 mètres près !

LaProvence.com - 02/03/2023

La Provence Et s' il était possible de connaître en temps et en heure, la propagation des polluants dans l'air de Marseille. Après 10 années de recherches, Atmo Sud offre aujourd'hui cette possibilité, pour la seconde ville la plus polluée de France. Cet observatoire de la qualité de l'air de la Région Sud Provence-Alpes-Côte d'Azur a mis au point un indicateur de pollution sans précédent.

Temps de lecture : 2 min

Un outil grand public pour mesurer la pollution

La Marseillaise BDR Marseille - 02/03/2023

région L'observatoire de surveillance de la qualité de l'air de la région Paca (AtmoSud) a présenté l'Icair, son nouvel indicateur destiné au grand public. Un outil grand public pour mesurer la pollution région L'observatoire de surveillance de la qualité de l'air de la région Paca (AtmoSud) a présenté l'Icair, son nouvel indicateur destiné au grand public.

Temps de lecture : 2 min

Vidéo : en Provence, un nouvel indicateur permet de connaître la qualité de l'air à… 25 mètres près !

LaProvence.com - 01/03/2023

Par La Provence Et s'il était possible de connaître en temps et en heure, la propagation des polluants dans l'air de Marseille ? Après 10 années de recherches, Atmosud offre aujourd'hui cette possibilité, pour la seconde ville la plus polluée de France. Cet observatoire de la qualité de l'air de la Région Sud Provence-Alpes-Côte d'Azur a mis au point un indicateur de pollution sans précédent.

Temps de lecture : 2 min

Vous voulez savoir quel air vous respirez ? Il existe un outil pour ça

Var Matin - 02/03/2023

Prendre en compte les effets cumulatifs des différents polluants. Voilà la démarche du nouvel outil d'AtmoSud. Baptisé ICAIR, il permet au grand public d'avoir un accès direct aux données par heure des quatre polluants réglementés : ozone (03), oxyde d'azote (NO2), particules fines PM2, 5 et PM10. Une mesure plus précise permettant de repérer les " zones à exposition multiples ".

Temps de lecture : 1 min

Vous voulez savoir quel air vous respirez? Il y a un outil pour ça

Nicematin.com - 01/03/2023

AtmoSud lance son outil ICAIR permettant d'avoir accès aux données des quatre grands polluants réglementés. Avec, en plus, une option prévision. Prendre en compte les effets cumulatifs des différents polluants. Voilà la démarche du nouvel outil d'AtmoSud. Baptisé ICAIR, il permet au grand public d'avoir un accès direct aux données par heure des quatre polluants réglementés : ozone (03), oxyde d'azote (NO2), particules fines PM2, 5 et PM10.

Temps de lecture : 1 min

Figure 192 : List of media fallout after the second Press conference on the new air quality index

The new index will also be presented the during the JTA (technical days about air) which is a meeting bringing together all the associations in charge of air quality monitoring: https://jta2023.atmo-grandest.eu/

6.3.2 Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family

5.1.1.5. Heating Flyer :

The eco-citizen is aware that he or she belongs to an earth that guarantees his or her existence, which implies rights and duties with regard to the environment.

But in the priority neighbourhoods where unemployment, insecurity and precariousness are the watchwords, environmental issues are not the concern of young people, they do not really feel they have a role to play. And this booklet project proved them wrong, hence their investment and the impact it had on them and their families.

This booklet project was born from the observation that there was a lack of communication between the inhabitants and the actors in charge of energy in the neighbourhood. The young people wanted to act as a bridge between the residents and the institutions in order to re-establish dialogue and enable all residents to reduce their energy bills. They therefore created this booklet based on the questions of the residents and the answers of the institutions.

They felt that they were being useful and contributing to these environmental issues. In order to get them interested, it was only necessary to show them that they could be actors of an improvement in their neighbourhood, they were not aware of it. For them, only the "rich" had the power to change things and therefore a role to play in environmental matters. They couldn't imagine that without money one could set up ecological projects with a serious impact.

When they saw that their booklet had an impact on 2417 houses and that their tips for saving energy had been read by more than 2400 people, they realised their power as small eco-citizens. They understood that individual actions can have a collective impact.

5.1.1.6. Energy saving Poster :

The preservation of resources and the environment concerns not only the older children but also the younger ones, who are not the least informed on the subject. In fact, schools are playing the game and giving pride of place to environmental issues for the new generations.

Some children were already practising everyday gestures to watch their energy consumption. These children interested in the environment had more or less the same profile, coming from a modest and small family (1 or 2 children), with two working parents.

On the other hand, the children least interested in environmental issues were those from single-parent families or very large families (5 to 7 children) and those living in very precarious conditions.

This lack of interest in these causes can be explained by the fact that they are confronted with more "basic" daily problems such as food, clothing etc.

In order to re-establish a balance between these children and to arouse everyone's interest in these environmental issues, the subject is approached through games: stories, comics, games on the platform I learn about energy etc. ....This works and allows all the children to adhere to the project. They all got involved in this "Display your ecogest" action by finding an ecogest that suits them according to their hobbies or simply their daily life.

At the end of this project, even the most reluctant, assimilate some ecogestures and take pleasure in staging their shots for the construction of the posters.

During the presentation of the posters to the 100 families of the leisure centre, the children are proud of their creation and explain in their own words the ecogestures in question. Nolan can be heard telling his mother "Mum must only eat fruit and vegetables in season because it costs a lot of energy to bring in fruit that is not in season and it damages the planet".

This intervention by the 8 year old boy suggests that these workshops have had an impact on these children and indirectly on their families with approximately 300 beneficiaries.

5.1.1.7. ADULTS AND FAMILY : SMART FLAT – SOCIAL GROCERY STORE

This double awareness raising by sensitising parents on the one hand and children on the other has borne fruit. During the workshops, mothers told me that their children called them to order when they left the television on without watching it or when they left the water running for nothing. These workshops have had an impact and have worked well since several workshops have been set up at the request of the inhabitants, such as the energy voucher workshops, food wastage or the ecogestures to be implemented during the end-of-year celebrations.

Participants also contributed to the development of new workshops by proposing their own themes.

6.3.3 Measure 3: Citizens individual engagement - IOT invoices – NEW MEASURE : Citizens engagement: waste reduction and sustainable mobility

The year 2021 was again impacted by the health crisis. Thus, the Recyclerie closed its doors to the public in April and for 1 month.

Several BASE bike mechanics courses were also given by the Cyclotrope association at the Recyclerie des Moulins.

The objective of this training is to learn how to repair your bike yourself with few tools at hand.

On the programme:

- To be able to diagnose the state of the bike and know how to identify the repairs to be made;
- Know how to adjust your brakes, change a brake pad and even a cable
- Be able to repair a puncture with a patch
- Adjust your derailleur & change a chain

All participants were able to leave with a certificate of participation and a multi-tool.

Figures to remember for 2021

Collection and sorting :

- 357 tonnes of bulky items collected in the Les Moulins district (+6.5% compared to 2020)
- 2,491 voluntary collectors (2,101 in 2020) for nearly 46 tonnes (30 tonnes in 2020)
- 77 home collections (+48% compared to 2020) for 12 tonnes
- 347 tonnes sorted and redirected to the outlets (Avenir Recyclage and Simone Veil waste collection centre)
- 38 tonnes of WEEE redirected to Ecosystème (compared to 34 tonnes last year)

More than 416 tonnes collected (+39 tonnes versus 2020)

Recovery/sale :

- Nearly 32 tonnes of items were given a second life by being resold via our solidarity shop (16 tonnes in 2020)
- 239 items recycled and upcycled (162 in 2020)
- 10 541 baskets in comparison to 6 363 baskets in 2020 (year with 3 months of closure)
- 34,577.93 € turnover for the year against 15,773.76 € in 2020 (9 months of opening)

6.4 Expected impacts and KPIs

6.4.1 Measure 1: Public awareness campaign Air Quality

KPI number	Unit	Details	Object of assessment
10.32 **People reached**	Number	• Number of people reached in public transports (tramway, bus) • Number of students/high schools pupils participating in the project • Number of persons interviewed during polls	Urban awareness campaign Commuting to work Student training
10.19 **Increased environmental awareness**	Likert scale (no unit)	• Questionnaires/Interview/Polls • Emissions and air quality indicators variation • Travelled kilometers on car sharing devices in the Business district (before/after awareness campaign) • Number of users of car sharing devices in the Business district (before/after awareness campaign)	Urban awareness campaign Commuting to work Student training

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	10.19-INCREASED ENVIRONMENTAL AWARENESS
2	Transition Track Number	TT 5
3	Measure Number *As it is stated in the measure tracker*	M#1 - Public awareness campaign on air quality
4	KPI *KPI('s) that are related to the data*	10-19-INCREASED ENVIRONMENTAL AWARENESS
5	Units of measurement *i.e. KWh, Euro, etc.*	Likert scale (no unit)
6	Baseline (of data variable)	NC

	e.g. relating to BaU or previous performance data	
7	Meter *i.e. smart meter, survey, energy bill, etc.*	Polls/Interview Air quality AZUR maps
8	Location of measurement *Where the measurements take place*	Business district Public transports managed by NCA
9	Data accuracy *How accurate is the measurement*	Medium
10	Collection interval *How often the data is recorded*	NC
11	Start of measurements *i.e. 1-1-2019, 0:00CET*	NC
12	End of measurements *i.e. 31-12-2020, 24:00CET*	NC
13	Expected availability *i.e. open data, public, confidential, no data available*	- Open data for air quality measures and polls - Privately owned data for the car sharing device
14	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	1) Online without access constraints
15	Data format *i.e. csv file, json…*	NC
16	Data owner *i.e. the name of the company that will give access to data*	AtmoSud
17	Comments *Further info*	-

The evaluation of the impact of the actions on “INCREASED ENVIRONMENTAL AWARENESS” are complex to evaluate , and at the same time real and concrete, the results of the survey showed that the campaign had a positive impact:

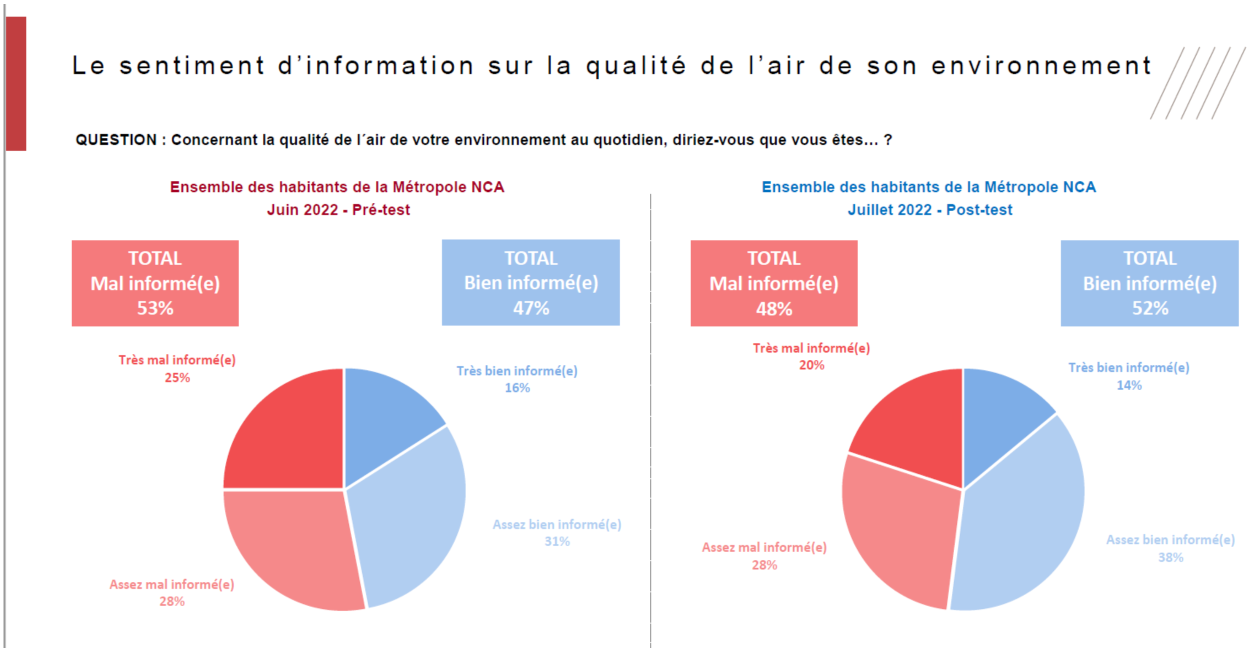


Figure 193 : Results of the survey made after the Nice Air quality awareness campaign "Breathe"

One can observe an augmentation of well-informed persons by 5%. During the two years of work with students, we also have observed a real change of awareness of the student involved. The limit is the number of person involved.

The interest is growing and after the press conferences , we had 17 articles on various local media, and the new index made the contribution of IRIS project seems to have real success on media, and we hope it also will on the public

No	Parameter	Value
1	Data Variable Name *i.e. Thermal energy consumption, locally produced electrical energy, etc.*	10.32- PEOPLE REACHED
2	Transition Track Number	TT 5
3	Measure Number *As it is stated in the measure tracker*	M#1 - Public awareness campaign on air quality
4	KPI *KPI('s) that are related to the data*	10.32- PEOPLE REACHED
5	Units of measurement *i.e. KWh, Euro, etc.*	Percentage
6	Baseline (of data variable)	NC

	e.g. relating to BaU or previous performance data	
7	Meter *i.e. smart meter, survey, energy bill, etc.*	**Number of people using trams and buses during the Air Quality communication campaign.** **affluence statistics** (number of people reached in public transportation; tramways, bus) **Counting** (number of students/high schools pupils participating in the project, number of persons interviewed during polls) **Car sharing** device statistics (Business Center : Arenas)
8	Location of measurement *Where the measurements take place*	Public transports managed by NCA University and high schools
9	Data accuracy *How accurate is the measurement*	Medium
10	Collection interval *How often the data is recorded*	NC
11	Start of measurements *i.e. 1-1-2019, 0:00CET*	NC
12	End of measurements *i.e. 31-12-2020, 24:00CET*	NC
13	Expected availability *i.e. open data, public, confidential, no data available*	Open data
14	Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline*	1) Online without access constraints
15	Data format *i.e. csv file, json…*	NC
16	Data owner *i.e. the name of the company that will give access to data*	AtmoSud
17	Comments	-

	Further info	

Concerning the Nice campaign, we can estimate that more the 500 000 people were reached considering the number of displays :

Nb digital panel+Tram+Bus * Nb person * Nb day

[(40 * 2000 * 7) -10%] ~ 250000 *2 ~ **500 000** people

Considering the 2 press conferences:

After the press conference of the the 24th of January 2023, our contractor Onclusive found 27 press articles and estimated that 2.42 million persons read or watched or listened the articles:

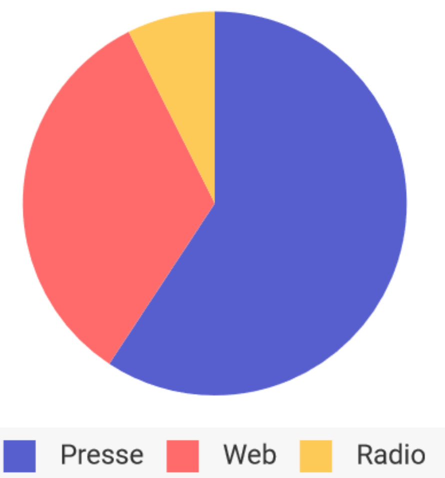


Figure 194 : Breakdown of media coverage by type of media

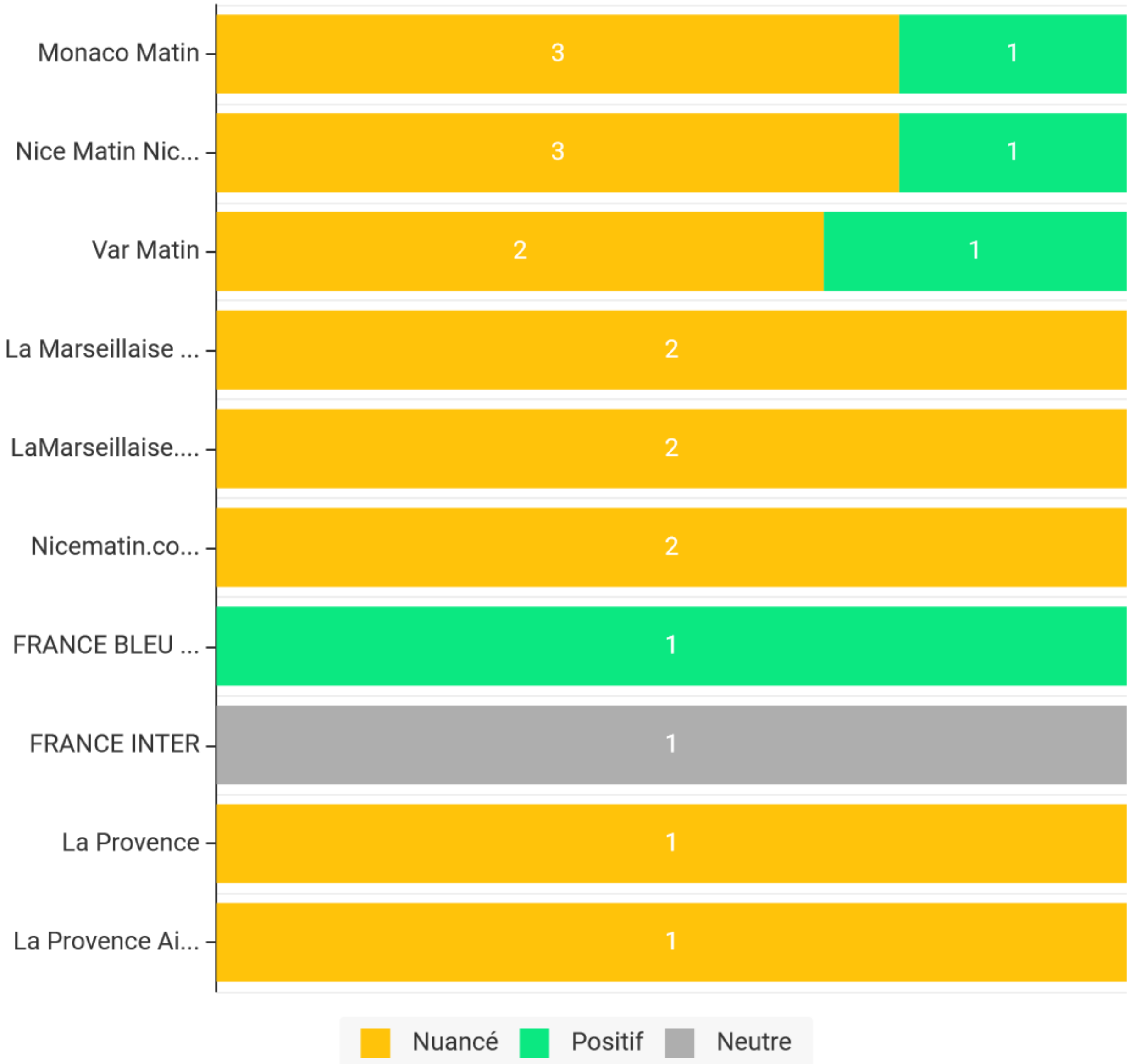


Figure 195 : Breakdown of media coverage by media and tone

After the press conference of the 1st of march 2023 about the new index ICAIR: 13 articles had been found on the subject with an impact of 1.78 million persons (results received the 2nd of march)

6.4.2 Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family

The KPis results for these actions are :

City	Nice	Nice	Nice	Nice	Nice
TT	TT5	TT5	TT5	TT5	TT5
Solution	5.2	5.2	5.2	5.2	5.2
mesure 2	All	All	All	All	All
KPI	17: Increased awareness of energy usage	17: Increased awareness of energy usage	17: Increased awareness of energy usage	17: Increased awareness of energy usage	17: Increased awareness of energy usage
Option	None answers	Little answers	Somewhat answers	Significant answers	High answers
Year					
2020/2021 - Actions 1.2.1 - LEISURE CENTER – CHILDRENS – ENERGY FLYER	0	5	5	48	52
2020 - Actions 1.2.4 - YOUTH – 15 -18 years old – I like my substation	0	5	6	12	37
2020 - Actions 1.2.3 - SOCIAL GROCERY STORE	0	0	0	2	8
2021 - Actions 1.2.3 - SOCIAL GROCERY STORE	0	0	4	15	25
2022 - Actions 1.2.3 - SOCIAL GROCERY STORE	0	0	0	3	3
2021/2022 - Actions 1.2.2 - LEISURE CENTER – CHILDRENS – Energy saving Poster	0	0	5	5	11

6.4.3 Measure 3: Citizens individual engagement - IOT invoices– NEW MEASURE

KPIs related to this measure are currently being developed. Indeed, the replacement of this measure is recent, and the indicators have therefore not been extracted from the data set in our possession.

6.5 Business models and exploitation

6.5.1 Measure 1: Public awareness campaign Air Quality

AtmoSud is a non profit organization, and we do not have the expertise for a business model evaluation of our work. We do not sell our productions as we are bound by the law to publicize all our works.

6.5.2 Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family

Given that we cannot measure the financial impact of these measure in terms of savings, we are not in a position to establish a business model.

6.5.3 Measure 3: Citizens individual engagement - IOT invoices– NEW MEASURE

Given that we cannot measure the financial impact of these measure in terms of savings, we are not in a position to establish a business model.

6.6 Key recommendations

6.6.1 Measure 1: Public awareness campaign Air Quality

The weight of political context as an obstacle

Taking into account the political context and the political agenda is absolutely necessary especially when your partner is a local authority. In election time air quality issues are becoming very tense. It is a good thing to raise awareness (tense subjects means they are debated and present in the media) but at the same time local authorities are more afraid of the subject. Even though the mayor, the president of NCA is involved in air quality improvement (with more bicycle path, developing tramcar), the communication counsellors prevent the use of the live data on air quality fearing that a day with a poor index would have a bad impact on the communication campaign.

The weight of media as a booster

Once you have got a good story with technological innovation, you can bring the media to relay your messages.

With the story of European program, the use of microsensors (media love new technologies and innovation), a new index (media love what is new), you focus your story on the uses with a concrete example (when and where it will be better for your health to jog). Then you have media interest and their communication is much more efficient than your own communication campaign.

With a good coverage of the subject, you can the come back to your local authority and be more welcome to work on how they will display the new index.

The impact of sensibilisation to raise a deeper awareness as a painstaking work

To work with student was very interesting, most of them has been very engaged in the project. They bring more radical ideas (improve air quality or die) and it is refreshing. They open your focuses and a different view of issues. And we think, they have change, they are more aware of air quality issues and solutions. But if you consider the time you have spent and the number of person impacted, the balance is in favor of working on a training for teachers that can be relay of your messages and knowledges.

6.6.2 Measure 2: Public awareness campaign Energy – School & Collège; Youth & Family

The main lessons learned during the described implementation phases are the followings:

- In a sanitary context normal, we must work well in advance with all stakeholders to gain their support and build the project together.

At the start of the project, the stakeholders are Directors of school, Coordinator “REP+ Educational Area”, Teachers, Parents, Childrens…

- The administration is quite difficult to convince and it takes time.

- Working with associative organizations has allowed us to implement actions much faster and to reach like even a large number of children and adolescents.

This project has had a real impact on the neighbourhood and the families, it has popularised the environmental discourse by making it accessible to everyone and above all by showing that we all have a role to play in the energy transition, children, teenagers, adults etc...

Raising awareness among children remains the best way to address these environmental issues because they are the future and their concerns will be decisive for the planet.

In conclusion, despite a difficult context, it is possible to talk about the environment in priority neighbourhoods.

6.6.3 Measure 3: Citizens individual engagement - IOT invoices– NEW MEASURE

The implementation of this measure is recent, we cannot draw any lessons from it at present. An update will be made before the end of the project.

7 Result and impact at Lighthouse city level

7.1 Introduction

7.1.1 Nice innovation

MNCA has set up several tools on its territory in order to instil innovation in all the fields for which it is responsible and thus ensure the support of local elected representatives, companies and universities.

MNCA has set up on its territory a "Centre Européen d'Entreprises et d'Innovation" (CEEI) which is a support organisation for SMEs and innovative entrepreneurs. The CEEI also ensures interaction between the companies and the actors of the territory: universities, research centres, incubators, competitiveness clusters, creation partners, international relays, financial networks, mutualised resource centres, consular networks...

MNCA also has a department for innovation and the intelligent city, to which the IRIS project is attached. The missions of this department are:

- Supporting elected officials in determining policy directions related to digital and smart city
- Steering and monitoring the deployment of network infrastructures for citizens and businesses
- Experimenting, with the business departments, with technological solutions in anticipation of future deployments, and testing new uses in real situations
- Determining the measures to be taken to support citizens in this digital transformation
- Ensuring a technological watch well upstream of industrial offers and anticipating their use within the framework of metropolitan competences

7.1.2 Nice strategies

Digital policy and Smart City MNCA have a new positioning.

Over time, digital technology has become established in the metropolitan area to help improve the public service provided to its citizens. Sometimes exploited in a logic of pure innovation, digital technology in the territory is now tending towards greater meaning and efficiency, supported by an administration that has been able to evolve in contact with its environment.

A step has now been taken by the metropolis, which is rethinking its Smart City strategy around convictions and priorities specific to the territory. The aim is to improve the quality of life and health, to achieve the climate and ecological transition, to secure and develop the territory, and to ensure equity and solidarity in the territory.

The intelligent city thus becomes a peaceful metropolis, which places people at the centre of its concerns, using current and future digital resources for the common good of the entire metropolitan territory, demonstrating agility in the transformation of space and public services.

7.2 Impact at the Lighthouse city level

The impacts of the IRIS project on the territory or the organisation of the Metropolis cannot be assessed at present because the project has just been completed and public policies take a long time to put in place. However, two examples can be cited to illustrate this beginning of change.

7.2.1 Open data and IOT

The Metropolis of Nice Côte d'Azur continues to develop and implement the CIP which collects data from the demonstrators in the framework of the IRIS project. For this purpose, it has set up the open data portal.

The shared Open Data portal of Nice Côte d'Azur and its partners is part of a wider project for an interconnected and sustainable Metropolis. Nice Côte d'Azur is a metropolis with a strong dynamism, a vision and a recognized experience in the adoption of innovative technologies.

In just a few years, it has become one of the leaders in the world of these new information and communication technologies.

By making their data available on the shared Open Data portal, the Nice Côte d'Azur Metropolis and its partners want to encourage experimentation, innovation and the creation of services on their territory.

The idea is simple: to allow third parties, and in particular developers and entrepreneurs, to exploit certain data in order to imagine new ways of using and enhancing them by creating new mobile services and applications.

The main challenges of Open Data for Nice Côte d'Azur :

- Promoting the smart and sustainable metropolis
- To release public data useful to citizens, tourists, students, people with reduced mobility, elderly people (article of the law of 10 July 1978 "on various measures to improve relations between the administration and the public and various administrative, social and fiscal provisions" commonly known as the CADA law)
- Valuing the work of local start-ups that could develop numerous applications thanks to data and real-time data flows
- To be a showcase referencing the different websites of the partners and the applications created by the developers
- Accelerate the appropriation of new uses linked to ICTs by the inhabitants, tourists and businesses of the Metropolis
- Improve the quality of public services offered to citizens.

The particularities of the Nice Côte d'Azur Open Data project :

First of all, the Nice Côte d'Azur Metropolis is a member of the OPENDATAFRANCE association, which brings together several local authorities involved in projects to open up their data, and shares its objectives of pooling good practices around Open Data.

Indeed, particularly at the technical level, the Nice Côte d'Azur Metropolis respects the international European standard DCAT (Data Vocabulary Catalog) allowing interoperability between data publication platforms and facilitating their harvesting.

The Metropolis has favoured development through open source tools (DRUPAL, CKAN, PIWIK) to support the collaborative movement.

At the legal level, Nice Côte d'Azur proposes to use the Etalab Open Licence, drafted by the French government and facilitating the re-use of data.

The Metropolis has also signed partnership agreements with its member municipalities as well as with the institutional partners that you will find on the portal in order to define the role of each one in this great project.

It should also be pointed out that the Metropolis has already carried out several actions to promote open data on its territory (workshops in cyber-spaces, awareness-raising for all business departments, legal clauses aimed at the re-use of data, thematic groups, etc.).

Finally, Nice Côte d'Azur offers innovative and participative functionalities on its portal such as animated and customisable datavisualisation of the majority of data sets, or self-suggested search, as well as the distribution of unique API keys for registered developers allowing them to easily play with our data in real time.

Data is currently published according to its availability and the estimated interest of its producer, but it is likely that you will want additional data.

To conclude, the key words for Open Data in Nice Côte d'Azur are :

- Sharing
- Innovation
- Interoperability
- Reuse

7.2.2 E-Mobility

The initial objective of the IRIS project was to develop a smart charging service based on the car-sharing service autobleue. Following the closure of this company, the demonstrator was finally implemented on the Metropole's car-sharing fleet.

Sustainable mobility is a subject that is dealt with by several departments of the Metropolis:

- the car fleet department, which manages the reservation platform

- the buildings department, which installs the charging stations

- the mobility department, which is in charge of the strategy for deploying charging stations within the territory

The implementation of this measure was initially complex because there were technical problems to solve and several departments to contact. The latter were not used to working together.

The IRIS project thus made it possible to bring together all the actors of the Metropolis involved in this field and thus to show that more consultation and joint work was necessary to set up a real strategy.

7.3 Results at the Lighthouse city level

7.3.1 Self-consumption and storage

In the two IRIS demonstrators set up on the IMREDD building and on the Palazzo building, self-consumption and storage energy solutions were demonstrated. It is expected that the need for flexibility will increase in France to manage a higher share of renewable energy and, at the same time, an increased energy demand due to the electrification of the industry and the mobility sector. Interest in flexible energy solutions also increased last year due to high energy prices in Europe.

The results showed that a change in the current regulations was necessary to make these solutions viable by creating energy communities to exchange electricity between buildings.

This has recently been implemented and an energy community is expected to be set up between the IMREDD building, other buildings in the area and the geothermal network.

7.3.2 Citizen engagement

The various measures implemented in the Moulins district have shown that residents are interested in and receptive to energy-saving awareness-raising activities.

The work carried out by the young people during the extracurricular time was beyond the initial expectations. The young people proved to be driving forces and became ambassadors of the key messages to their parents and neighbours.

The measure deployed at the Moulins recycling centre to replace the one initially planned for the CAH web portal came late in the project. It will be continued over time and could be replicated on other sites in the Metropolis.

7.3.3 IRIS visibility

During the IRIS project, the metropolis has developed various partnerships to increase visibility within the territory. We can mention in particular the Flexgrid label, which is a programme for the deployment of optimised energy systems.During the event which took place in Nice from 2 to 30 September 2022, we participated in the Transition Forum

During the event that took place in Nice from 28 to 30 September 2022, we took part in the Transition Forum, with which we established a partnership within the framework of IRIS.

7.3.4 IRIS communication

The experience of the project has also taught us that at the level of the local ecosystem, communication could be improved. In particular on the following points:

- Communication towards the general public to be developed, to promote the action and to mobilize citizens

- Internal communication to be developed, to mobilize staff
- Successful communication with professionals, to be continued

7.4 Next steps

The City of Nice has ambitious objectives in the different transition tracks that IRIS has been leading for the last 5 and a half years. The Climate, Air and Energy Plan, the Europe and Digital strategy contribute to this goal. The IRIS project can, with its lessons learned, serve as a basis for further experimentation in these and related areas.

Integrated solutions are urgently needed to move towards the ambition of becoming a climate-neutral city and doubling its production of renewable energy. The focus will also be on geothermal networks, which must be intensified and accompanied by the expected expansion of solar installations and the first hydrogen stations.

A local network of renewable energies intended to meet the heating and cooling needs of the future Grand Arénas eco-neighborhood by relying on a carbon-free solution: the thermal energy of the water treated by the Haliotis wastewater treatment plant should see the light of day in 2024.

The electrification of a large part of the city's own vehicle fleets, the extension of recharging infrastructures for public and commercial fleets as well as work on the theme of the last mile will be a major area of work in the years to come. come. The experiment set up on Smart Charging is a cornerstone for this deployment.

The flexibility of buildings initiated with IMREDD and the Palazzo will continue in the Nice Méridia district where a specific urban planning policy has been put in place.

On the Nice Méridia urban technology park, which constitutes a mixed district of 350,000 m² (tertiary sector, shops, teaching premises and 1,600 housing units), the Nice Côte d'Azur Metropolis and the EPA Plaine du Var aim to deploy a large-scale application nature of a Smart Grid on the scale of an urban district, an unprecedented experience until now.

The district's energy mix includes at least 75% local renewable energy. For this, geothermal energy will cover 100% of heating, cooling and domestic hot water needs. Solar will cover approximately 20% of electricity needs for lighting buildings and public lighting, ventilation, specific uses and charging electric vehicles. Several storage technologies (building inertial, thermal, electrical), associated with load management, will optimize the sizing and operation of the district's multi-energy loop (heat - cold - electricity - gas).

An innovative contractual model will be used: a public service delegation with a range of services, in particular energy efficiency services with appropriate pricing.

The balance of energy networks will be ensured at a territorial level thanks to new digital tools and new energy market levers.

7.5 Conclusion

To build on the results and successes of the IRIS project, the city of Nice will

• Implement the co-creation strategies and approaches developed and tested during the IRIS project. Approach initiated with the launch of numerous collaborations

• Use the results of the IRIS project for the next calls for European projects

• Disseminate the results of the IRIS project to other cities and communities, in order to encourage the adoption of similar co-creation approaches and to facilitate the sharing of best practices and knowledge.

• Build on the partnerships and networks established during the IRIS project to continue collaborating with other cities, research institutes and other stakeholders on sustainable urban development initiatives.

• Consider continuing the experiments carried out within the framework of IRIS during a future European or other project

8 Annex

8.1 Social surveys

8.1.1 Landlord (CAH: social housing company)

This survey is carried out as part of the IRIS project on the perspective of the proposed heating solution, which was carried out in tower 13 and tower 14, "Cité de Moulin". We kindly ask you to answer the following questions.

This survey will take you about 3 minutes to complete.

GENERAL INFORMATIONS

Regarding the implementation of the solution, how was it perceived by the tenants, by the landlord?

COST SAVING

Have you observed a significant decrease in the energy bill in two towers T13 and T14?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Has the proposed solution increased the value of two towers?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

INCREASED COMFORT

Has the level of thermal comfort of tenants improved?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

What is the satisfaction level of tenant in general?

☐ Unsatisfied ☐ Somewhat unsatisfied ☐ Neutral ☐ Somewhat satisfied ☐ Satisfied

IMPROVED RELATIONSHIPS BETWEEN STAKEHOLDERS

Have you noticed a decrease in the number of complaints from tenants, about to the temperature of their apartments?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

If the project had to be redone, what aspects would you like to change or evolve?

8.1.2 Energy manager (ENGIE)

This survey is carried out as part of the IRIS project on the perspective of the proposed heating solution, which was carried out in tower 13 and tower 14, "Cité de Moulin". We kindly ask you to answer the following questions.

This survey will take you about 3 minutes to complete.

COST SAVING

Was the proposed solution easy to implement?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Was the proposed solution easy to maintain?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Was the proposed solution easy to use (e.g., meter reading)??

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Is the solution cost-effective with the obtained results?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

INCREASED COMFORT

Is the measured temperature in each dwelling in accordance with the setpoint temperature?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

What is the satisfaction level of tenant in general?

☐ Unsatisfied ☐ Somewhat unsatisfied ☐ Neutral ☐ Somewhat satisfied ☐ Satisfied

IMPROVED RELATIONSHIPS BETWEEN STAKEHOLDERS

With the proposed solution, has a number of interventions increased or decreased?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

In the event of a complaint from tenants (cold/hot), how quickly can you intervene to manage this complaint?

Do you plan to reapply this solution to other sites? Why?

If the project had to be redone, what aspects would you like to change or evolve?

8.1.3 Tenants

We are interested in your opinion on the work carried out on the heating system!

New heating systems are installed in your tower, which allows you to save energy on heating and better control the temperature of your home.

This survey is carried out as part of the IRIS project on the perspective of the proposed heating solution, which was carried out in tower 13 and tower 14, "Cité de Moulin". We kindly ask you to answer the following questions.

This questionnaire will take you about 3 minutes to complete.

GENERAL INFORMATIONS

Have you been informed of the installation of the heating system before the work began?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

How has the work been explained to you?

To what extent were you bothered (noise, odors, ...) by the installation work?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Is the sensor in your home a problem for you?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

INCREASED COMFORT

Is the temperature of your apartment comfortable in winter?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Do you feel that the temperature of your home is sometimes too low?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

If so, during what period was the temperature of your home too low?

In general, are you satisfied with the work done on the installation of the heating system?

☐ Unsatisfied ☐ Somewhat unsatisfied ☐ Neutral ☐ Somewhat satisfied ☐ Satisfied

IMPROVED RELATIONSHIPS BETWEEN STAKEHOLDERS

To what extent would you recommend this solution for other towers of “La cite de Moulin”?

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

8.2 Nice Air Quality awareness campaign “Breathe”

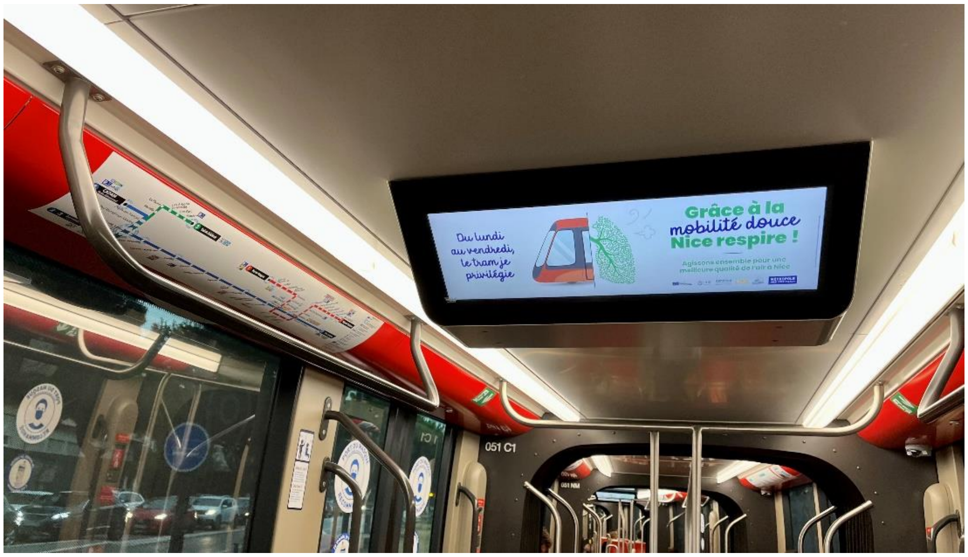


Figure 196 : Digital display in a streetcar (central display)

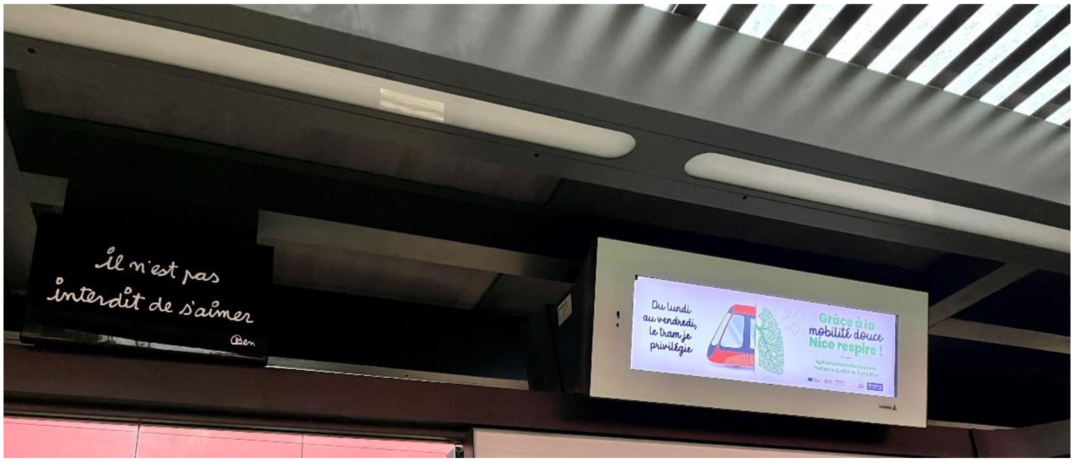


Figure 197 : Digital display in a streetcar (lateral display)

Figure 198 : Digital display in a streetcar (display in between two wagons)

Figure 199 : Digital display in a street car station

Figure 200 : Digital display at Saleya exit parking

Figure 201 : Displays at the back of buses

Figure 202 : Digital display in public area 1

Figure 203 : Digital display in public area 2

Figure 204 : Digital display in public area 3

Figure 205 : Digital display in public area 4