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Deliverable D7.2

Report on Smart Energy Microgrid Neighbourhood Installations

Martim Longo Pilot Site

Work Package:	WP7 - On-site Deployment and Pilot Installations
Task(s):	Task 7.2 Pilot Area Installation of Smart Energy Microgrid Neighbourhood Use Case
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Executive Summary

In this deliverable we report the various activities carried out in the implementation of the Pilot Area Installation of the Smart Energy Microgrid Neighbourhood Pilot Site in Martim Longo, Alcoutim, Portugal, with three sets of use cases and related Value-Added Services (VAS): Municipal Energy Efficiency and IEQ Services, UV for Citizens and Distributed Energy Assets Management.

For each of the services we used different types of equipment and sensors that necessitated a prior analysis of the needs, what existed locally and the expectations of the various stakeholders for each of the services to be implemented.

Based on the requirements identified, diverse IoT enabled devices were installed in municipal buildings for monitoring of IEQ and energy usage. A specific UV index sensor was installed in the weather station to provide data for the UV for Citizens service. Solar Radiations sensors were installed in the weather station to provide data for the Distributed Energy Assets Management service.

The sensor devices installed and the VAS developed are fully integrated with the VICINITY platform, and comprise several equipment brands and types of sensor devices to demonstrate VICINITY as an interoperability enabler for IoT systems.

Iterative upgrades and updates will be ongoing until the project ends to ensure device operation and to adjust the implemented solution to meet stakeholders' expectations and requirements.

There were no significant deviations from the planning done in WP5, considering the various phases of the project.

This deliverable was an important contribution to reaching MS 4 in the implementation of Work Package 7 within Task 7.2. The objective of the deliverable was to summarize the outcomes and results of the work on Task 7.2.

The goal of the deliverable was to install physical IoT devices (hardware), connect them to the VICINITY platform and implement VAS using the collected data.

The pilot project was split into three phases:

- Pre-installation Phase
- Installation phase
- Post-Installation phase

Planning, installations and implementations of hardware devices were completed and the expected objectives were achieved, with positive feedback from the stakeholders and potential for commercialisation, namely in VAS 1 and VAS 2, whilst VAS 3 still needs more maturity. An iterative development process with stakeholders is on-going.

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List of Definitions & Abbreviations

Abbreviation	Definition
API	Application Programming Interface
DER RES	Distributed Energy Resources – Renewable Energy Sources
EC	European Commission
EU	European Union
GDPR	General Data Protection Regulation
IEQ	Indoor Environment Quality
IoT	Internet of things
IT	Information Technologies
MCDI	Membrane Capacitive Deionization (a technology to deionize water)
MWp	Megawatt-peak
O&M	Operations and Maintenance
ppm	Parts per million
PV	Photovoltaics
UV	Ultraviolet Radiation
VAS	Value-Added Service(s)
VPS	Virtual Private Server

1. Introduction

The aim of this report is to outline the results of the installations performed at the demonstration site "Smart Energy Microgrid Neighbourhood" demonstration site in Martim Longo, Alcoutim, Portugal and focussing on the outcomes of Task 7.2. The report builds on the method and the plan outlined in the preceding Deliverable 7.1 to proceed with actions related to planning, installations, stakeholders engagement, deploying devices and integrating with the VICINITY platform.

Milestones set to meet the overall project milestone for installation in month 39 (March 2019) were achieved, while the overall scope of Value-Added Services (VAS) expanded as a result of the equipment installations and co-creation process.

The team installed sensors at 5 facilities exceeding the initial scope of installations and connected these devices to the VICINITY platform.

The team then proceeded to develop the architecture for the integration, data collection and analytics planning to integrate to VICINITY as well as develop VAS and further co-create with the internal and external stakeholders of the pilot site.

The project execution was split into three phases:

- The Pre-installation Phase focussing on the preparation stages for the development of the installation. Training employees, negotiating and analysing the equipment hardware and software, analysing API capabilities of the equipment, negotiating options with manufacturers as well as collaboration options.

- The Installation phase focussing on the actual installation activities and management of devices and the related infrastructures. Specific site limitations and alternative options and possibilities were taken into consideration. A number of modifications to the original plans were considered based on actual equipment performance on site.

- The Post-Installation phase focussing on continuous upgrades, coordination with on-site stakeholders and personnel performing tasks, testing, additional reconfigurations and adjustments to the equipment and the application. The stakeholders played an essential role in this phase, providing feedback, access to the installation, co-creation of the VAS.

Context within VICINITY

The results of the implementation are described based on the common methodology and plans specified in Task 7.1. The ENERC team installed and integrated VICINITY as described in Work Package 7, tested the solutions with internal and external operators and users.

The Martim Longo pilot site is connected to the VICINITY platform to generate user benefits in terms of new functionality, information and efficiencies. The renewable energy production, building level and various functional uses of buildings (school, retirement home, sports center and Solar Lab) allow for the cross leverage of the stakeholders´ input between the interlinked locations. The holistic approach to the solutions greatly enhances the chances of further exploitation both locally and through worldwide dissemination of results.

Objectives in Work Package 7 and Task 7.2

The objective of Work Package 7 is to plan, install and report the actions taken to have a Pilot Site running with devices using the VICINITY platform. The plan and methodology used is described in detail in Deliverable D7.1. This deliverable D 7.2 provides more detail and the results of the installations at Martim Longo, in Alcoutim, Portugal.

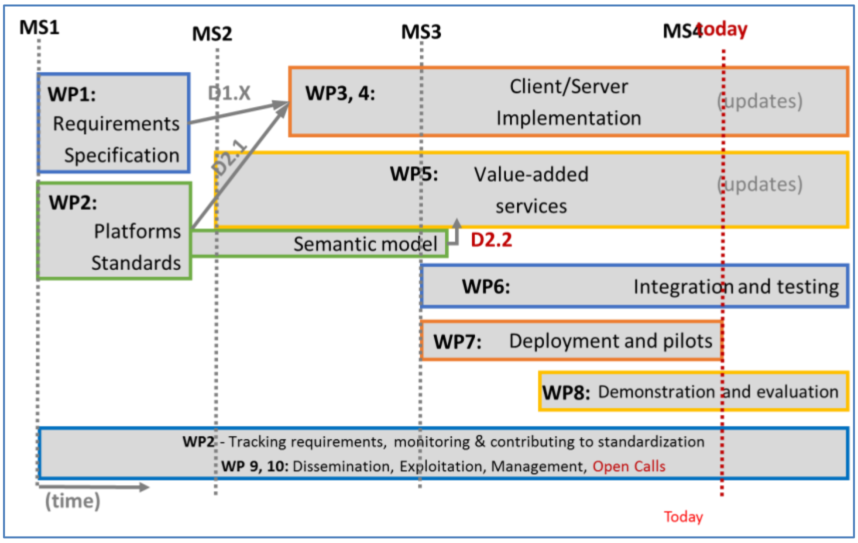

Figure 1 - Overall diagram showing the links between the different Work Packages

The interdependencies and continuity among the various work packages of the Vicinity project are illustrated in Figure 1. The initial Work Packages 1, 2, 3 and 4 have developed and established the VICINITY platform. Work Package 5 has been developed and implemented the VAS for each pilot site. In Task 7.1 the common and detailed planning has been described giving the pilot sites the necessary framework to install their hardware for pilot sites in Tasks 7.2 – 7.5. There is a strong link to WP8 and the Tasks are interdependent. These interdependencies are part of iterative development approach.

The objectives are listed in Table 1 (WP and Task Objectives).

Table 1 - WP and Task Objectives

Work Package/Task	Description
WP7	- Incorporates outcomes of WP6 (Integration & Lab testing); - Detailed planning for pilot installations on a larger scale at real world demonstration pilot sites, for evaluation and demonstration of the VICINITY framework: - Installation and integration of the identified IoT devices per Use Case to the VICINITY platform; - Deploy the VAS implemented in WP5. To establish the pilot test and evaluation infrastructures required for the most effective evaluation in WP8; - Integrate the VICINITY platform to operate correctly from a technical perspective for Pilot Area Installation of Smart Energy Microgrid Neighbourhood Use Cases at Martim Longo, Portugal.
Task 7.2	Task 7.2 "Pilot Area Installation of Smart Energy Microgrid Neighbourhood" Installation of the Pilot Area of the Microgrid Intelligent Energy Neighbourhood integrated with a set of Municipal buildings clustered together in the same area. These consist of a school, retirement home, sports pavilion and a swimming pool, that are about 1500m away from the Solar Demonstration Platform with 4MWp of installed power of photovoltaic systems and the SolarLab with a meteorological station and several solar radiation measurement equipments as described in WP1 (D1.3); In this ecosystem, we have several VAS that we intend to explore defined in WP5. Problems diagnosed during the on-site testing process are discussed and resolved through collaboration between different stakeholders to enhance and enrich the functionality of the VICINITY prototype.

Structure of the Deliverable

This deliverable is structured as follows. Chapter 2 presents the Methodology that the installation was based on. Chapter 3 gives a brief description of the Pilot Site, while Chapters 4, 5 and 6 present the work that has been carried out in each of the three installation phases that were described in Chapter 2. The conclusions are presented in Chapter 7.

2. Methodology

The installation was divided into three phases: Pre-installation, installation and post-installation.

Phase 1: Pre-installation

Preparations for the deployment of the hardware devices and software stacks and implemented a hardware catalogue in coordination with the responsible stakeholders. The team negotiated a collaboration with Kipp & Zonen equipment manufacturer, who are interested in the use case, its outcomes and further collaboration based on the results achieved.

Phase 2: Installation

Installation of the hardware devices and software deployment in accordance to the hardware catalogue.

At the Pilot Area Installation of Smart Energy Microgrid Neighbourhood, different types and brands of measurement and data collection equipment is used and integrated into the VICINITY platform through specifically developed adapters to overcome interoperability barriers.

A set of VAS was developed and deployed in Municipal buildings. Dynamic Building Audit measures energy consumption and indoor environment quality (IEQ). Smart School focuses on IEQ parameters relevant for school areas used by the students and teachers

For the general population with a special focus on students and the elderly, a UV monitoring service was developed, indicating the UV index in real time and recommending maximum time of exposure to the community to reduce possible skin cancer risks.

A tool to support photovoltaic (PV) parks Operation and Maintenance services was developed, namely, to assess the opportunity to manage the process planning of maintenance operations through washing photovoltaic modules for the PV parks that exist in the zone in order to increase the production efficiency and reduce operating costs and logistics. Smart Clean uses meteorological forecasts and measurements provided by SolarLab weather station, such as solar radiation.

Phase 3: Post-installation

The last phase was designed to test and verify the different devices and confirm that functionality meets the requirements. This activity will continue until the project ends to ensure the devices continue to operate and to adjust and upgrade VICINITY adapters and VAS applications.

3. Description of the Pilot Site

The Enercoutim pilot site at Martim Longo has three sets of use cases and related VAS as described in D5.2: Municipality Energy Efficiency and IEQ Services; Services for Citizens; and Distributed Energy assets management. Figure 2 shows the cluster of Municipal buildings and the private home where the equipment is installed, in addition to the SolarLab and the Solar Demonstration platform.

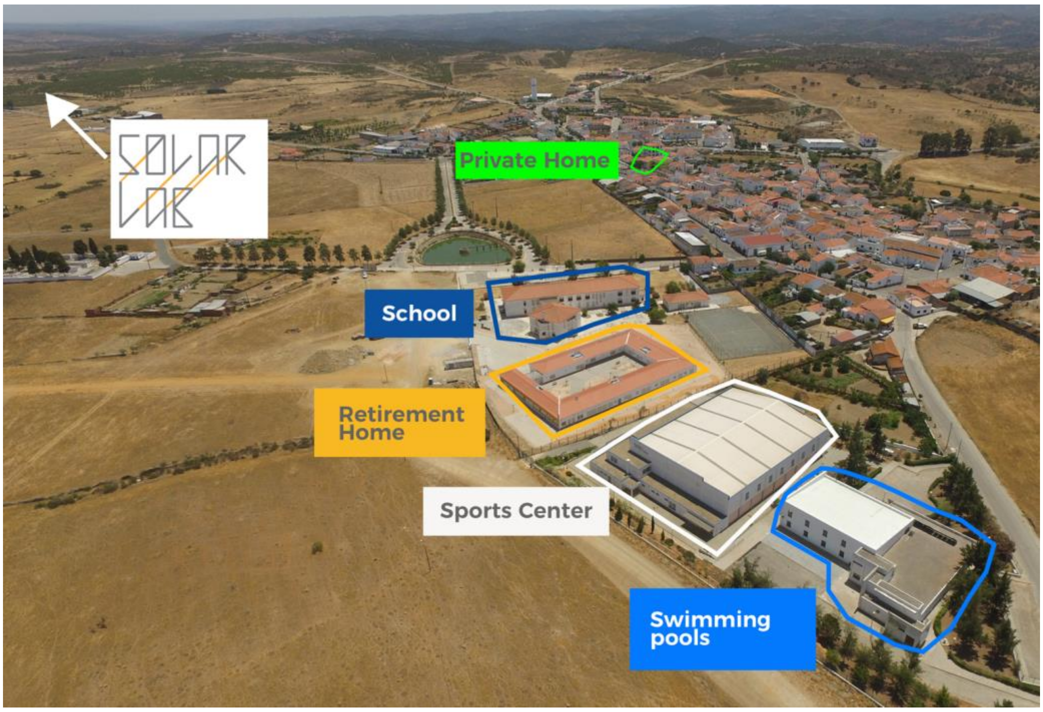

Figure 2 – Overview of buildings included in our Pilot site at Martim Longo Village

- **Municipality Energy Efficiency and IEQ Services**: Dynamic Audits, Flexibility and Smart School, which allows the users, the building manager and the maintenance operators to know at any time the current state of the Internal Environment Quality of the building, resources consumption and use of the facility;
- **Services for Citizens:** UV for Citizens which will provide useful information to the students, senior citizens and citizens in general about the UV level advisory for behaviour, outing planning and additional measures; the service is a model for the equipment usage and leverage for secondary use beyond primary function;
- **Distributed Energy assets management:** Platform Services, Distributed Energy Resources – Renewable Energy Sources (DER RES) production optimisation of operations and maintenance. The scope of the VAS is to help the operation and maintenance manager of the production plant to plan cleaning services of the concentrated photovoltaic modules at the Platform to increase energy production, reduce costs and plan the resources preparation and usage.
- In addition to the three services above, the team incorporated an Inventory management system for the installed devices (added to Figure 3 as IoT Inventory Management). The main impacts expected from each VAS are also identified in Figure 3.

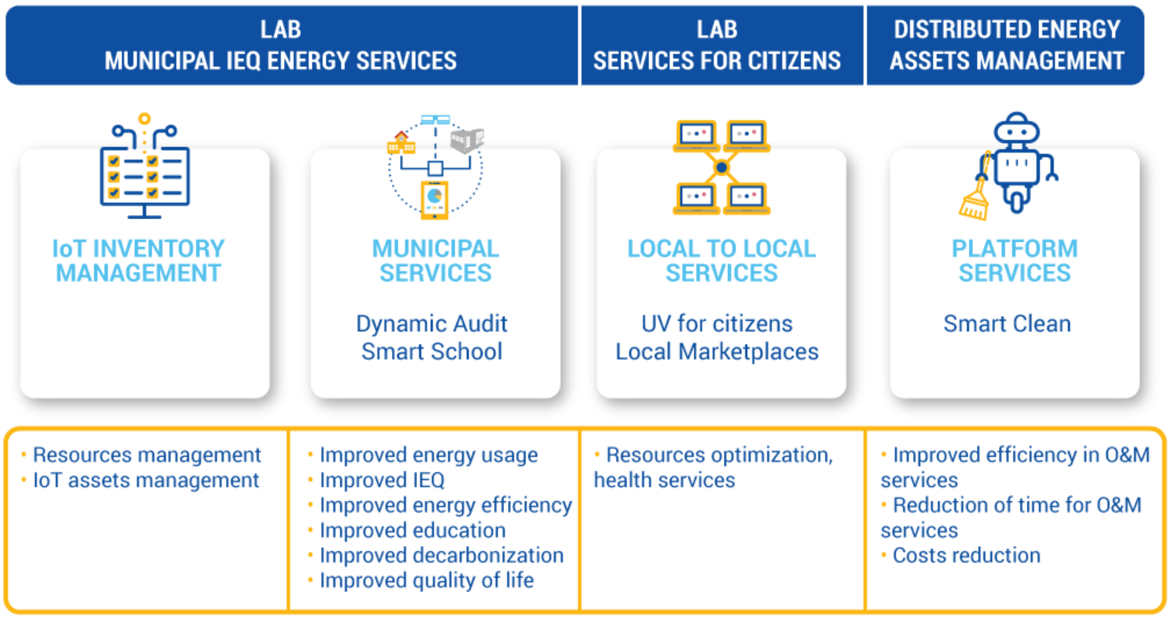

Figure 3 – Enercoutim Pilot site – VAS categories

The Pilot site team worked with internal stakeholders, such as the Operations and Management team, as well as with external stakeholders, such as students, building managers, municipal employees. Figure 4 provides an overview of stakeholders, sensors and appliances installed and VAS.

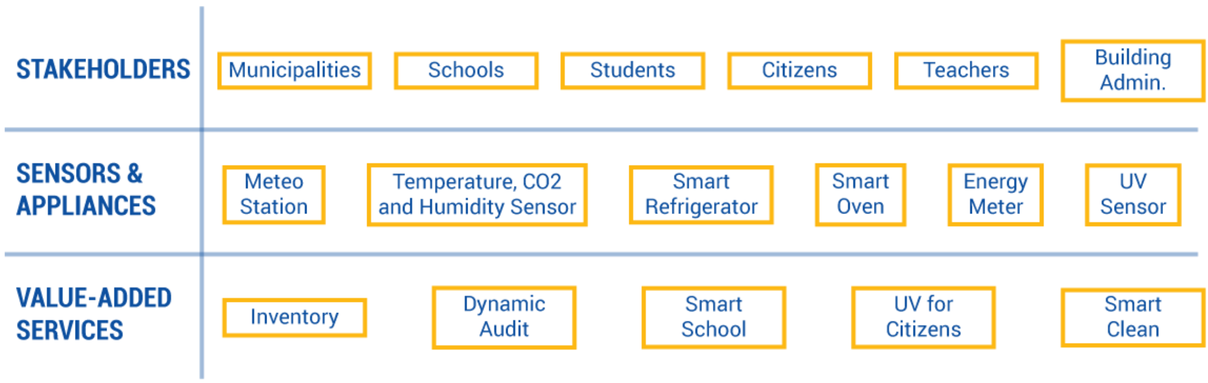

Figure 4 – Martim Longo pilot site context and structure

3.1. Use Cases 2.1, 2.2, 2.3, 2.4, 2.5, 2.8, 2.10, 2.11 (VAS1): Energy Efficiency and IEQ Management in Municipal Cluster of buildings – Municipal Services

Municipality Energy Efficiency and IEQ Services – Dynamic Building Audit, Flexibility and Smart School, allows the users, the building manager and the maintenance operators to know at any time the current state of the Internal Environment Quality of the building, resources consumption and usage of the facility.

Municipality Energy Efficiency and IEQ Services are deployed at the municipality cluster of buildings (School, Retirement Home, Gym and Swimming Pool) involving different stakeholders (Municipality, building administrators, teachers and students).

Different types of sensor devices are used to collect real-time information from the buildings, specifically: temperature, CO2, humidity, luminosity, noise, motion and energy consumption.

Dynamic Building Audit and Smart School VAS, process real-time values of sensor data and alert levels for monitoring and storing historical data for IEQ quality and energy efficiency analysis.

3.2. Use Case 2.9 (VAS 2): UV (Ultraviolet radiation) info services for Citizens and Tourists – Local to Local Services

Services for Citizens – UV for Citizens; provides useful information to the students, senior citizens and citizens in general about the UV level advisory for behaviour and outdoor activities planning. UV for Citizens VAS is also a model for equipment usage and leverage beyond primary function.

Services for Citizens is composed of UV (Ultraviolet radiation) info services for Citizens.

UV radiation is measured using a Kipp&Zonen UV sensor installed at SolarLab weather station.

UV for Citizens Value-Added Service, processes real-time values of the UV sensor and displays current UV index value and advisory information.

3.3. Use Case 2.6, 2.7 (VAS3) – Distributed Energy assets management – Platform Services

Distributed Energy assets management – Platform Services, DER RES production optimisation of operations and maintenance. The scope of these VAS is to help the operation and maintenance manager of the PV production plant to plan cleaning of the photovoltaic modules to increase energy production, reduce costs and plan resources allocation and usage.

Distributed Energy asset management services compare actual PV production against potential PV production. Potential PV production is estimated from PV equipment characteristics using Direct Solar Radiation measured with a specific sensor installed at the SolarLab weather station.

4. Pre-Installation Phase

The Pre-installation phase started during Task 7.1 and was completed during Task 7.2. The team started in November 2016 to perform an energy audit within the Municipal buildings described before, in order to obtain an overview of the “as-is” base case scenario, assess installation options and understand management and maintenance procedures (Figure 5). This process and the related outcomes are described in D1.3.

These audits of the facilities provided an overview of the local configurations. Information was collected using questionnaires and discussions with stakeholders. Based on the information obtained, the equipment was selected and mapped onto the buildings. The draft for IoT infrastructure and the related VAS was prepared. The retirement home was added to the cluster of the municipal buildings based on interest from the stakeholders coinciding with finishing of constructions of the facility.

Figure 5 – Screenshot of the results of the energy consumption in one of the Municipal buildings

The ENERC team was made responsible for installing and configuring the required equipment at the School, Municipal pool, Gym and the Retirement home. The stakeholders were offered training and assistance to handle day-to-day situations that might arise related to the equipment installed.

On the 24th of October 2017, ENERC conducted the first workshop with external stakeholders, involving the Municipality and the managers of each building (School, Retirement home, Gym and swimming pool). The project was presented and discussed, the next steps and expectations were set for the rollout phase to the stakeholders.

During Task 7.2, in October 2018, several deployment tests of software, including VICINITY Gateway and Agent, were performed on-site by ENERCOUTIM using the installed sensor devices and IT infrastructure.

On the 29th of November 2018, the team conducted another workshop with the stakeholders where initial results were presented and stakeholders’ expectations and suggestions were discussed. Compliance with the General Data Protection Regulation (GDPR) is critical to the Municipality, and so all data handling and storage must be carried out in accordance with the GDPR. Additional verifications of the authentication and data transfer encryption mechanisms were performed and the required improvements implemented.

Figure 6 provides a snapshot overview of the workshops, newsletter the ENERC team set for informing of the development of the pilot site stakeholders and presentation materials containing technical and other information about the VICINITY project and site-specific installations shared during the workshops.

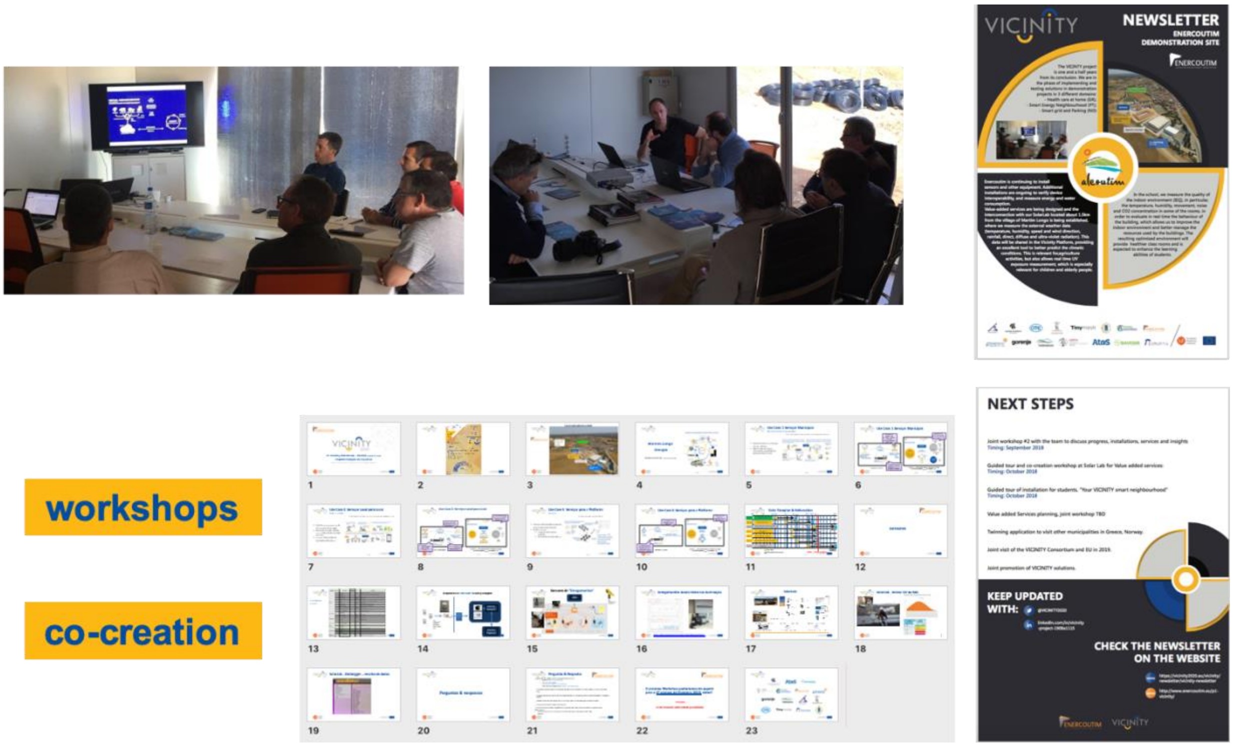

Figure 6 – Workshop events, materials produced, such as PP and newsletters

Figure 7 summarises main expected benefits of VASes at the Municipal cluster pilot site based on the Dynamic Audit use case. These goals were extended during the development process.

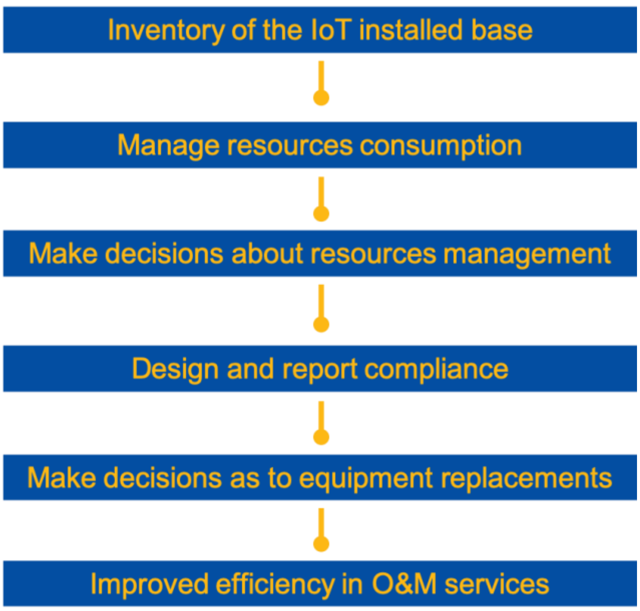

Figure 7 – Main goals of VAS

5. Installation Phase

The methodology of the installation work defined in Task 7.1 has been used for Smart Energy Micro Grid Neighbourhood Installations at the Martim Longo Pilot Site.

IEQ sensor devices from SERINUS and IEQ and Energy sensor devices from ENERGOMONITOR were installed at the Municipality cluster of buildings and connected to the VICINITY cloud using specifically developed VICINITY adapters that interface with VICINITY Gateway and Agent.

Gorenje appliances, fridge and oven, were connected to the Gorenje Cloud using a wi-fi connection to the Internet and made available to the Dynamic Building Audit VAS over the VICINITY Cloud using a VICINITY Contract.

Weather station sensors were connected to the VICINITY Cloud using a VICINITY adapter that connects locally to the weather station datalogger.

During October 2018, several deployment tests of software, including VICINITY Gateway and Agent, were performed on-site by ENERCOUTIM using the installed sensor devices and IT infrastructure.

VAS were implemented and deployed as a web application with a responsive layout suitable for usage in mobile and desktop browsers. Initial versions of the VAS started experimental operation at the end of October 2018.

Core VAS logic, server services for the web application and database storage, were deployed to a Cloud VPS server enabling the low latency connectivity required to provide adequate responsiveness at the user interface.

Figure 8 provides an overview of achieved integration of the devices and services at the Pilot site.

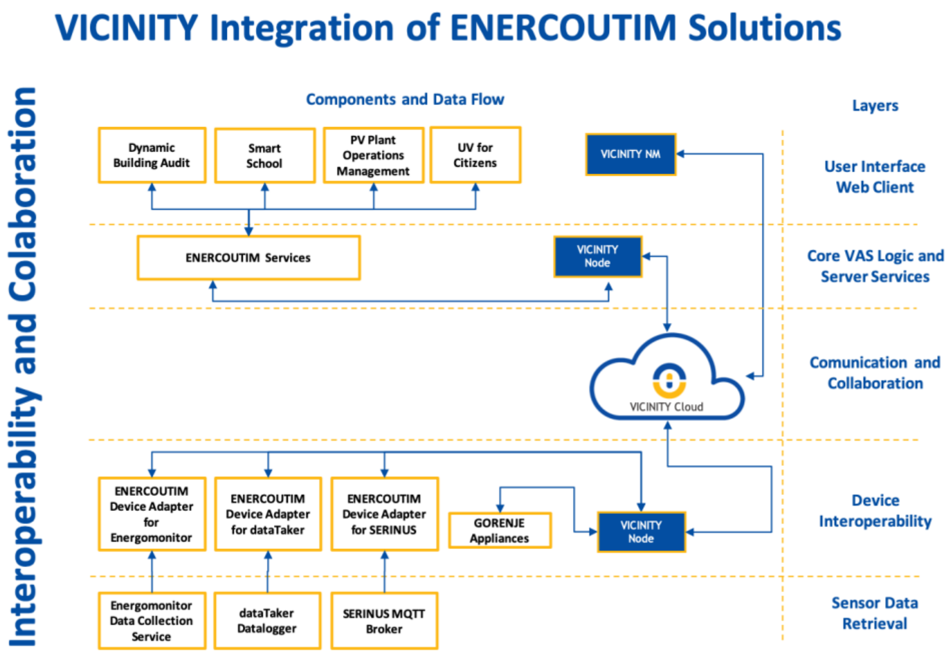

Figure 8 - VICINITY integration

5.1. Hardware Installation

IEQ and Energy sensor devices and Gorenje appliances installations occurred mainly between April and July 2018. IT infrastructure adjustments, including the installation of additional routers, occurred mainly in September and October 2018, as some issues resulting from unanticipated connectivity requirements were detected. The installed hardware according to the catalogue presented in D7.1, including connectivity related IT infrastructure adjustment, is shown in Table 2.

Table 2 - Hardware Catalogue

Type and vendor	*Functionality*	*Nr. of units*	*Communication*	*Use Case*	*VAS*	*Location*
IEQ Sensor Device (SERINUS)	Measurement of temperature, humidity, CO2, light, noise and movement detection	14	Connected to local SERINUS gateway using Tiny Mesh radio protocol.	UC 2.2, 2.5, 2.10	VAS1	Municipal Cluster of Buildings (School, Retirement Home, Sports Centre and Swimming Pool) and SolarLab
Gateway for Sensor Devices (SERINUS)	Collect and route sensor data to cloud based MQTT broker	2	Connected to VICINITY cloud using a remote VICINITY gateway and adapter	UC 2.2, 2.5, 2.10	VAS1	Municipal Cluster of Buildings (Retirement Home) and SolarLab
Weather Station UV Sensor (Kipp&Zonen)	UV Index measurement	1	Connected to Weather Station Datalogger	UC 2.9	VAS2	SolarLab
Weather Station Radiation Sensors (Kipp&Zonen)	Measurement of direct solar radiation, global solar radiation and atmospheric long wave radiation.	3	Connected to Weather Station Datalogger	U.C 2.2, 2.6, 2.7	VAS1,3	SolarLab
Weather Station Standard Sensors (Thies and Pronamic)	Measurement of temperature, humidity, precipitation, atmospheric pressure, wind speed and wind direction	5	Connected to Weather Station Datalogger	UC 2.1, 2.2, 2.3, 2.5, 2.10	VAS1, 3	SolarLab
Weather Station Datalogger (dataTaker)	Collect and store weather station sensor data	1	Connected to VICINITY cloud using a local VICINITY gateway and adapter	All	VAS1, 2, 3	SolarLab

Table 2 Hardware Catalogue (cont.)

Type and vendor	***Functionality***	***Nr of units***	***Communication***	***Use Case***	***VAS***	***Location***
Refrigerator and Freezer (Gorenje)	Refrigeration	3	Connected to VICINITY cloud using a remote VICINITY gateway and adapter	UC 2.11	VAS 1	Retirement Home, SolarLab and private house
Oven (Gorenje)	Cooking	3	Connected to VICINITY cloud using a remote VICINITY gateway and adapter	UC 2.11	VAS 1	Retirement Home, SolarLab and private house
IEQ Sensor Device (Energomonitor)	Measurement of temperature, humidity and CO2	3	Connected to Energomonitor Homebase using Energomonitor radio protocol.	UC 2.2, 2.5, 2.10	VAS 1	School
Electricity Meter (Energomonitor)	Measures electricity consumption	2	Connected to Energomonitor Homebase using Energomonitor radio protocol.	U.C 2.2, 2.3, 2.4	VAS 1	School
Water Meter (Energomonitor)	Measures water consumption	2	Connected to Energomonitor Homebase using Energomonitor radio protocol.	UC 2.2	VAS 1	SolarLab
Homebase for Sensor Devices	Collect and route sensor data to Energomonitor cloud	2	Connected to VICINITY cloud using a remote VICINITY gateway and adapter	All	VAS 1, 2, 3	Municipal Cluster of Buildings (School) and SolarLab
Raspberry Pi (Raspberry Pi Foundation)	Generic Linux system used to operate VICINITY gateways and adapters	2	Connected to the Internet using LAN.	All	VAS 1, 2, 3	Municipal Cluster of Buildings (School) and SolarLab
4G Routers (TP-LINK)	4G Internet gateway with wi-fi and wired LAN connections	2	Connected to the Internet.	All	VAS 1, 2, 3	Municipal Cluster of Buildings (School) and SolarLab

Figure 9 - Different types of sensors and equipment installed

The pictures above give an overview of the installed devices. Gorenje appliances installations, IEQ sensors of two types from two manufactures, optic sensors to measure resources consumption, such as electricity and water, meteo station equipment, datalogger, gateway devices and the displays are demonstrated in the pictures above, taken in various facilities of the demo sites.

5.2. Value-Added Services and VICINITY Components Deployment

Deployment of applications providing VAS and the required VICINITY components took place mainly between October and November 2018. The currently installed versions of each VAS are listed in Table 3 (Deployed VAS) and the related VICINITY components are listed in Table 4 (Deployed VICINITY Components).

Table 3 - Deployed Value-Added Services

Ref.	Value-Added Service Name	Version	Deployment
VAS 1	Dynamic Building Audit and SmartSchool	0.7	Deployed on ENERC VPS server
VAS 2	UV for Citizens	0.7	Deployed on ENERC VPS server
VAS 3	PV Plant Operations Management and SmartClean	0.7	Deployed on ENERC VPS server

ENERCOUTIM services layer (Figure 8) of VAS applications, consisting of a single JAVA EE Grizzly based web server with three modules (Dynamic Building Audit and SmartSchool; UV for Citizens; and PV Plant Operations Management and SmartClean), were deployed on ENERC VPS Server and are currently operating at https://dba.enercoutim.eu.

Table 4 - Deployed VICINITY Components

VICINITY Component Name	Version	Deployment
VICINITY Gateway	0.6.3.1	Deployed on ENERC VPS server and Raspberry Pi
VICINITY Agent	0.6.3.1	Deployed on ENERC VPS server and Raspberry Pi
ENERCOUTIM Device Adapter for Energomonitor (VICINITY Adapter)	0.7	Deployed on ENERC VPS server and Raspberry Pi
ENERCOUTIM Device Adapter for dataTaker (VICINITY Adapter)	0.7	Deployed on Raspberry Pi
ENERCOUTIM Device Adapter for SERINUS (VICINITY Adapter)	0.7	Deployed on ENERC VPS server and Raspberry Pi

5.3. VAS 1: Municipal Energy Efficiency and IEQ Services – Dynamic Building Audit and Smart School

Dynamic Building Audit application consists of a web-based environment dashboard and analytics including real-time display of sensor data; real-time display of alert levels; display of historical sensor data; display of the location of measured values on building plan; and status maps. Figure 10 displays the login page for the on line application of the VAS.

Figure 10 - Martim Longo Municipal buildings cluster

After successful login, the user is presented with a list of all the building views (Figure 10) included in the user profile and an informative overview with aggregated values of sensor data for each of the referenced buildings (Figure 11).

The Figures below show some aspects of the user interface.

Figure 11 - Municipal information overview

The inventory of sensors and appliances page (Figure 12), identifies each sensor device and Gorenje appliance installed (Figure 13, values blurred for privacy) and its current measurements or anomaly warnings, allowing for detection of possible anomalies.

ENERCOUTIM Dynamic Building Audit Services

www.enercoutim.eu

Building	Device Id	Device	Location	Sensor Id	Sensor	Unit	Value
Retirement Home	148	Serinus	Single rooms 22	148-C	Carbon Dioxide	ppm	
				148-H	Humidity	%	
				148-T	Temperature	C	
	18	Serinus	Triple rooms 10	18-C	Carbon Dioxide	ppm	
				18-H	Humidity	%	
				18-T	Temperature	C	
	188	Serinus	Living room	188-C	Carbon Dioxide	ppm	
				188-H	Humidity	%	
				188-T	Temperature	C	
	28	Serinus	Double rooms 30	28-C	Carbon Dioxide	ppm	
				28-H	Humidity	%	
				28-T	Temperature	C	
	FZ2	Gorenje Freezer	Kitchen	FZ2-T	Temperature	C	
	OV2	Gorenje Oven	Kitchen	OV2-T	Temperature	C	
	RF2	Gorenje Refrigerator	Kitchen	RF2-T	Temperature	C	
	118	Serinus	Refectory room	118-C	Carbon Dioxide	ppm	
				118-H	Humidity	%	
				118-T	Temperature	C	
	168	Serinus	Library	168-C	Carbon Dioxide	ppm	
				168-H	Humidity	%	
				168-T	Temperature	C	
	178	Serinus	Teacher s room	178-C	Carbon Dioxide	ppm	
				178-H	Humidity	%	
				178-T	Temperature	C	
	238	Serinus	Entrance hall	238-C	Carbon Dioxide	ppm	
				238-H	Humidity	%	

Figure 12 - Inventory of sensors and appliances

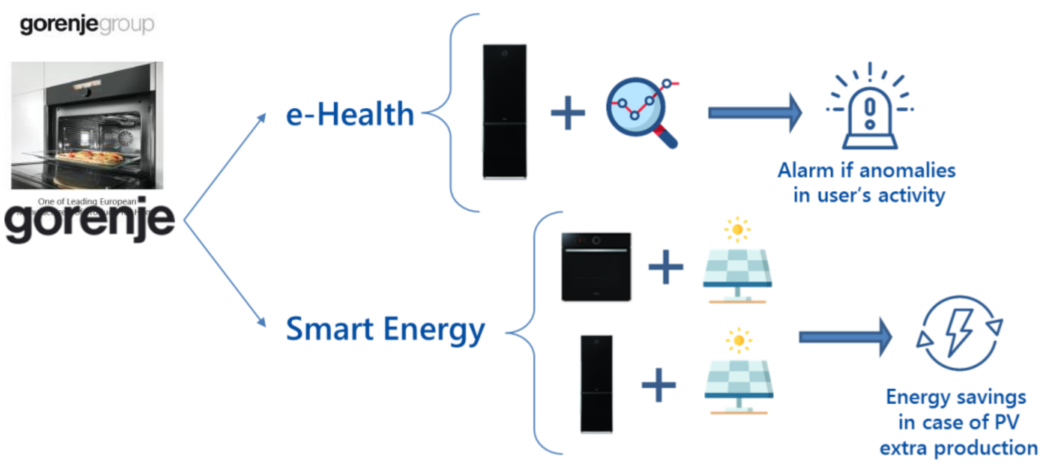

Figure 13 - VAS usage of Gorenje appliances

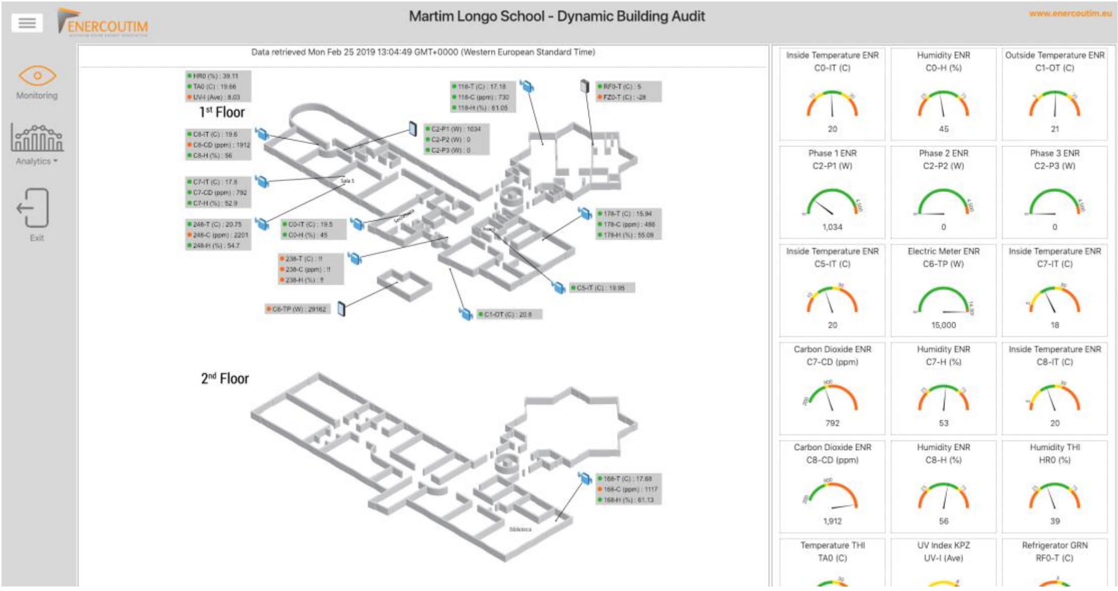

Figure 14 - Sensor readings of Martim Longo School in Monitoring page

Following the link for a specific building view, users are presented with the Monitoring page (Figure 14) that links to multiple analytics pages: last 2 hours measurements graphs; last 48 hours hourly average graphs; customizable time-series graphs; export and download data; and carbon dioxide status map (Figure 15).

Historical sensor data and related analytics are critical for understanding most IEQ and Energy processes since some relevant thresholds are established for periods of several hours or days (e.g., there is a CO2 legal limit considering an 8-hour average) and there is usually a daily cycle inherent to IEQ and Energy parameters. Historical sensor data is stored in a PostgreSQL database integrated with the Dynamic Building Audit and Smart School application.

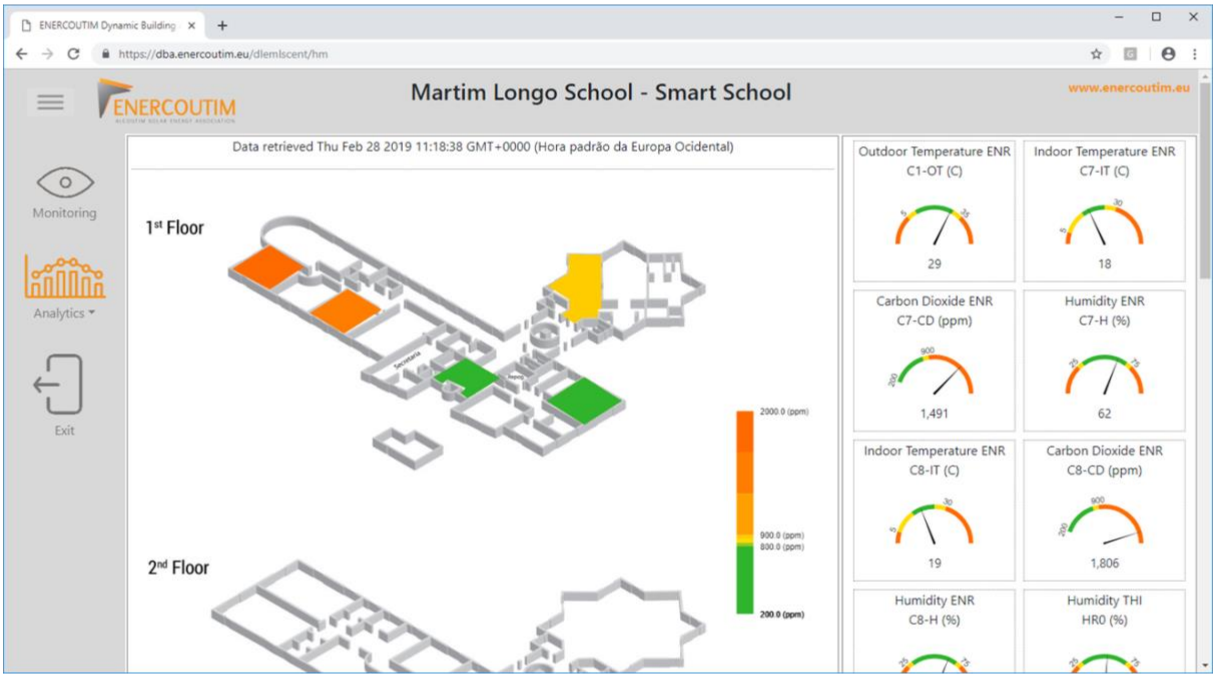

Figure 15 - CO2 status map of Martim Longo School in Analytics - Carbon Dioxide Status page

5.4. VAS2: Services for Citizens – UV for Citizens

The UV for Citizens VAS provides information about UV index and advise on the maximum time of exposure to the sun to avoid skin problems to citizens, namely the students, teachers and the retirement home managers.

Figure 16 - UV radiation sensor installation at SolarLab

UV Index is measured using a UV radiation sensor installed at SolarLab weather station (Figure 17).

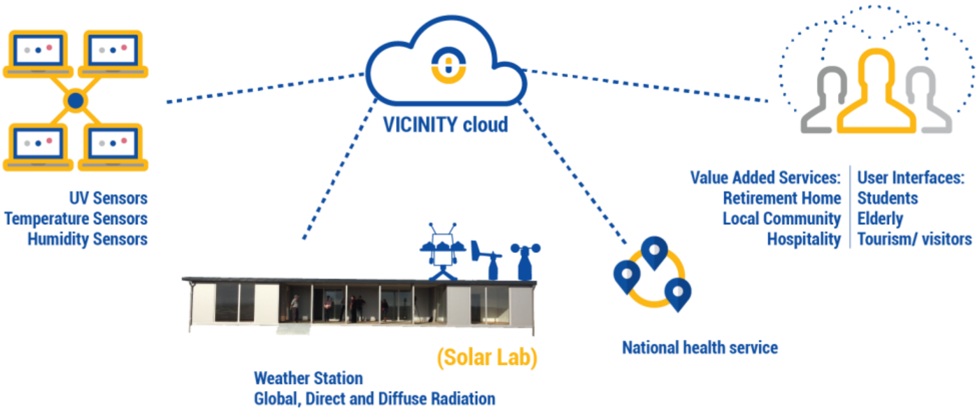

Figure 17 - VAS 2 design overview

Figure 18 shows the colour coded information display used to yield information on the UV radiation and recommend maximum time exposure. The information display is being co-created with the stakeholders, taken their feedback into consideration during workshops.

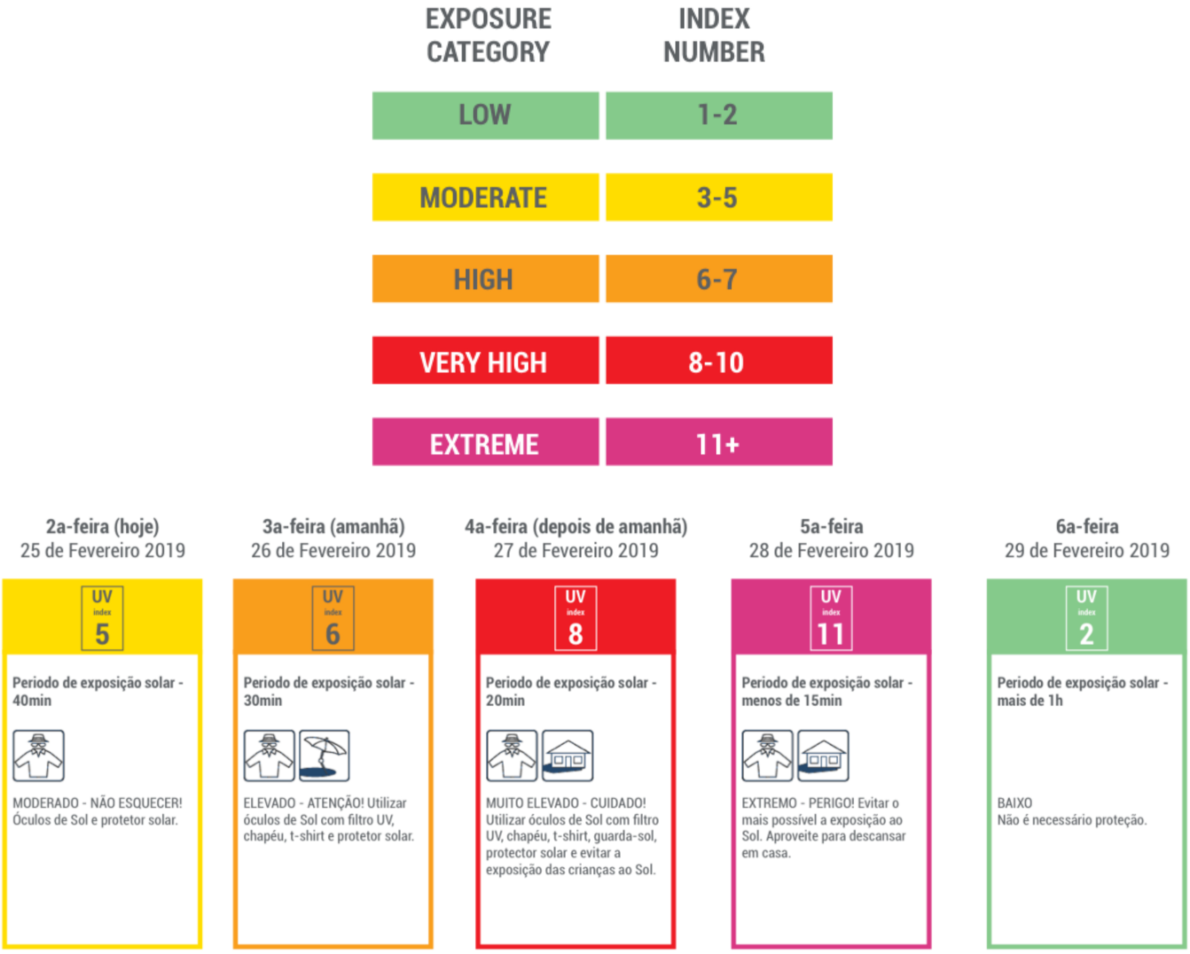

Figure 18 - Screenshots of the display of UV for citizens

5.5. VAS3: Distributed Energy Assets Management and Smart Clean Services

Distributed Energy Assets Management-and Smart Clean service depicted in (Figure 19) consists of a web-based dashboard (Figure 20) and analytics, designed to compare potential PV production with actual PV production to assess the efficiency and the schedule of maintenance services taken the holistic approach to condition monitoring, resources availability and the production resource performance.

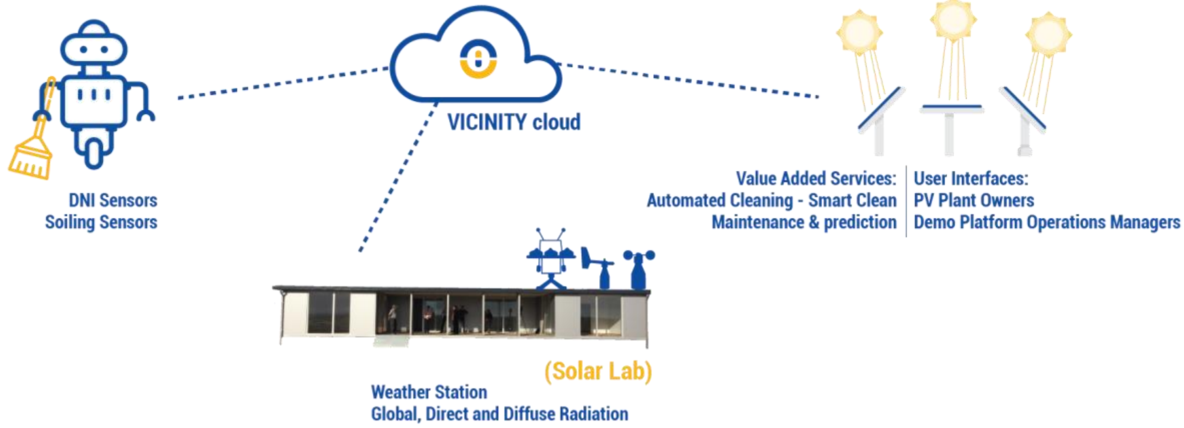

Figure 19 - VAS 3 design overview

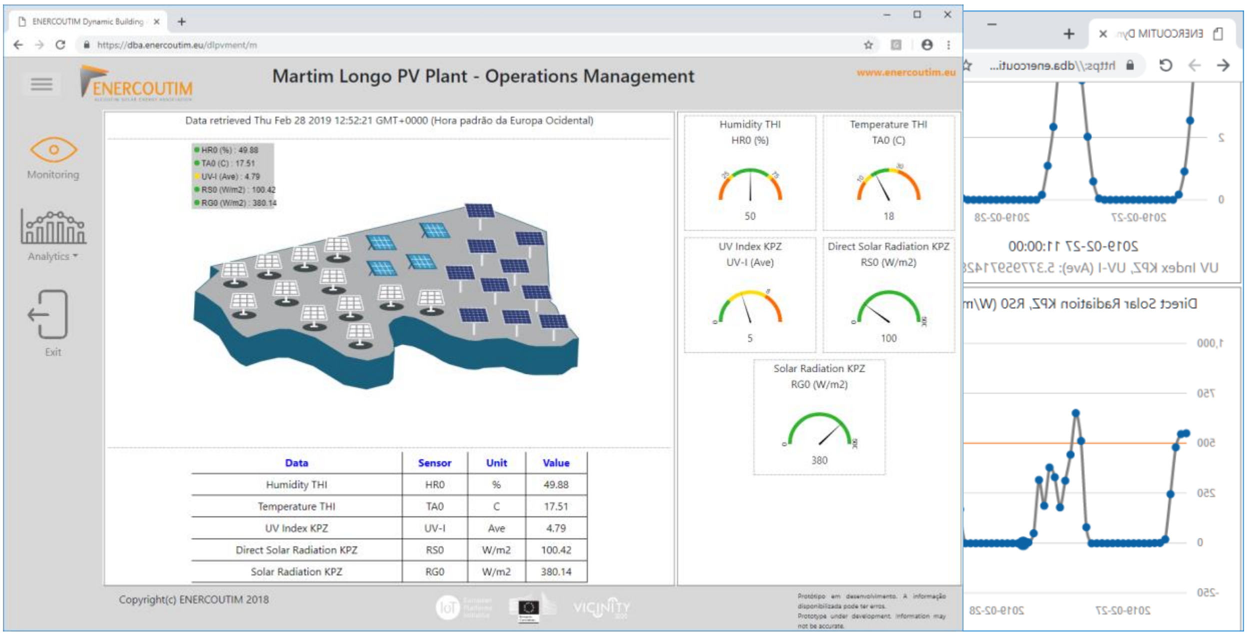

Figure 20 - Screenshot of the VICINITY platform display of operation management for Smart Clean at Martim Longo PV Platform

A water treatment machine, using the Membrane Capacitive Deionization (MCDI) technology by VOLTEA, was installed to use in the water for cleaning. However, the equipment manufacturer has not finalised APIs; hence the equipment cannot be connected to the VICINITY platform and operation is not being managed using the VAS application as initially planned.

5.6. VAS problems and opportunities identified

On this VAS the following problems were identified:

- Internet connectivity issues due to IT security restriction in different buildings, that required specific configurations and additional routers for some of the sensor devices gateways;
- No possibility to integrate existing metering equipment such as water meters due to the lack of sensors fitting the equipment;
- Lack of developed APIs for the water purification equipment;

- Two Energomonitor water meters (cold and hot), to measure the water consumption at the SolarLab were added in addition to the planned integration and connected to the VICINITY Cloud;
- Production of the Dust measuring equipment was delayed and the specific sensor that was envisioned for the system was not delivered on time. Another solution had to be implemented instead.

It could be deducted that the issues above stem from the industry maturity level transitioning towards greater connectivity and digitalisation.

On this VAS the following opportunities identified:

There is a need to understand buildings performance not only from technical managers standpoint but from the users' standpoint. Interest in this is clearly demonstrated by stakeholders, given their engagement and interest in the observable relationships between IEQ and daily building usage patterns and operations.

Equipment manufacturers are in the process of fine-tuning equipment performance and technical parameters, such as energy consumption use, reliability, scope of services definition, security compliance. Performance expectations as to the parameters listed above for services delivery on applications level are of essence to further commercialisation of solutions. The feedback provided to the manufacturers of equipment is another beneficial by-product of such collaboration, contributing to device improvements and scope of services extension.

Equipment manufacturers are interested in the extension of services and functionalities and value creation from equipment and ENERC is exploring possibilities of such collaborations with manufacturers, for example, a wider roll-out of UV for citizens services based on installed equipment at solar energy production sites of the manufacturer.

6. Post-Installation Phase

The pilot site is now in the post-installation phase. The operations and the development team are supporting the operation of the devices and continue implementing adjustments and upgrades related to the VICINITY adapters and VAS further improvements at the application level as part of iterative process.

The recent workshop with stakeholders highlighted inherent relationships between IEQ and daily building usage patterns and operations. Also, some suggestions were made to improve the user experience, for example, labelling of sensors as well as improvement of notifications.

The expected results for the VAS are being realised and further co-developed and discussed with the stakeholders. Bug fixes and also specific improvements as PV soiling losses assessment, are being implemented as an iterative process of system updates and upgrades.

7. Conclusions

The pilot site achieved the objectives for WP7. Various types of equipment and sensors were deployed to demonstrate three use cases and VAS. The overall scope of the pilot has exceeded the original plans. The installed devices have been integrated into the VICINITY platform, the VAS are being demonstrated and are enabling further co-creation with internal and external stakeholders.

VAS 1 - Dynamic Building Audit and Smart School

This VAS provides IEQ and energy sensor readings for monitoring and historical data for analytics, enabling improved indoor environmental quality and energy usage efficiency.

With further development of the services and data refining the team is striving to obtain commercial value in the future.

The feedback of the pilot stakeholders is an import signal for the success of the project and its feedback was extremely positive. The stakeholders demonstrated a clear willingness to implement actions to improve the functioning of their spaces based on the information made available to them from this service.

They also started thinking about types of measures that could be of relevance to improve the IEQ, the energy efficiency and not least the potential of using of the information to convey knowledge to students at school through practical demonstrations.

VAS 2 – UV for Citizens

The collected data gives the Citizens, namely the students, teachers and the Retirement Home managers, information on the current and forecast UV index, and the maximum time of exposure to the Sun to avoid lasting health effects, including skin problems.

This VAS is extremely important to all stakeholders involved, especially in a region where the UV index is usually high in large coastal areas around the Mediterranean region. Not everyone is aware of the dangers of exposure to ultraviolet rays, and only an index is a limited indicator of the duration and other necessary behavioural suggestion aimed at preventative measures. As climate change and environmental exposure to dangerous elements are becoming more and more of a public safety issue, tools such as UV for citizens that leverage installed equipment for additional data provision for public safety will deliver towards such needs.

VAS 3- Distributed Energy Assets Management-and Smart Clean

The collected data allows for the start of predictive maintenance and smart cleaning assessment. Online and offline processing of resources management are necessary to develop a full service for a first phase of regional roll-out. This will be the focus of further VAS development by the team. The industry is at the early stages of automating the process and implementing advanced analytics related to the process. There is both a need as well as scope for further development.

8. References

[1] Project VICINITY http://www.vicinity-h2020.eu, namely deliverables D7.1, D5.1 and D 5.2.

[2] ICT 30 – 2015: Internet of Things and Platforms for Connected Smart Objects: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/914-ict-30-2015.html

[3] General Data Protection Regulation: https://ec.europa.eu/info/law/law-topic/data-protection_en

[4] PostgreSQL: https://www.postgresql.org/

[5] Kipp & Zonen: https://www.kippzonen.com/

[6] VOLTEA Membrane Capacitive Deionizaion technology : http://voltea.com/tag/membrane-capacitive-deionization/