Achieving near Zero and Positive Energy Settlements
in Europe using Advanced Energy Technology
H2020 - 678407

Horizon 2020
European Union Funding
for Research & Innovation

# Design and implementation of a Web-GIS monitoring platform for zero energy settlements and districts

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**Technical University of Crete**

6th Jeffrey Cook Workshop in Desert Architecture // ZeroPlus Energy Settlements
25-26 November, 2019

# Design and Construction of 4 Zero Energy Settlements

## OBJECTIVES

- Regulated energy consumption up to **20kWh/m²/year**
- Renewable energy production at settlement level of at least **50kWh/m²/year**
- Investment **cost reduced by at least 16%** compared to current costs for single NZEBs

# Design and Construction of 4 Zero Energy Settlements

## York, UK

3 houses

- PV panels
- HIVE smart thermostat
- TESLA battery

## Voreppe, France

Apartment building

- DUALSUN solar panels, thermal and photovoltaic
- ANERDGY MRE C05
- Heat exchanger of the biomass urban heating network

## Granarolo dell' Emilia

2 villas

- Fibran insulation
- PV panels
- ABB React+

## Nicosia, Cyprus

Prefabricated demo house

- Fibran insulation
- HVAC FREESCOO
- FAE HCPV

A Web-GIS platform has been created in order to:

- To ***support effective monitoring*** of the case studies and ***collect all energy and environmental data*** regarding the performance of the four settlements.

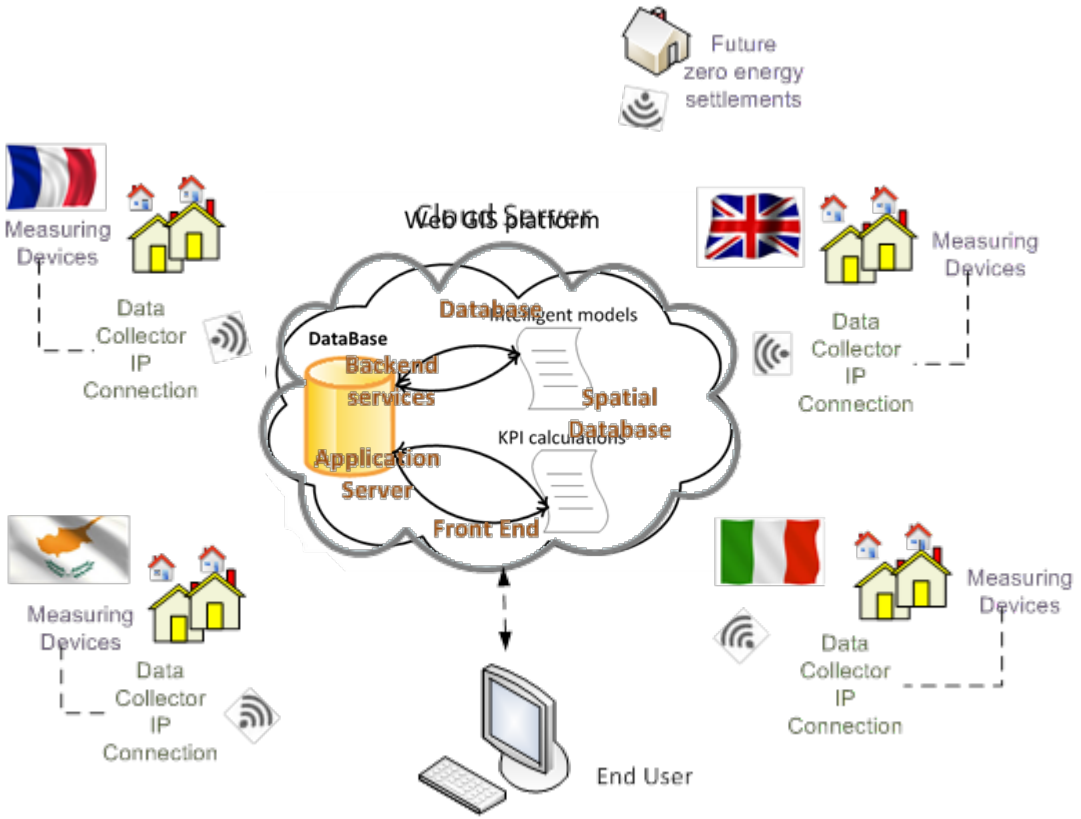
- To ***assess the performance*** of the involved systems and technologies and also the global energy and environmental performance of the settlements.

- To ***implement an optimised maintenance methodology*** for all systems and techniques in order to achieve the best possible performance and cost effective operation.

- To ***analyse*** in depth the results of the monitoring and generate proper technical information for future feasibility analyses and design.

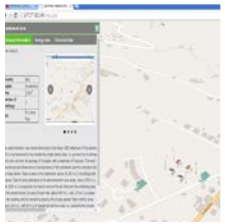
# Web-GIS Platform for Monitoring of ZERO PLUS

## OVERALL PLATFORM LAYOUT



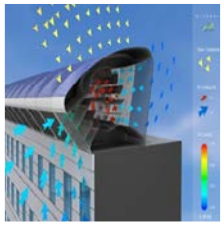
# Web-GIS Platform for Monitoring of ZERO PLUS

The Web-GIS platform is organized in 4 levels:



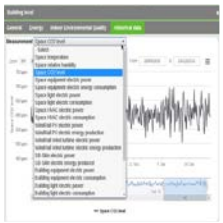
**Level 4:**
**The Web-GIS Dashboard**

**Level 3: Energy Production Technologies**



**Level 2: Energy demand profiles for buildings and districts**

**Level 1: Indoor Environmental Quality of Users**



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# Web-GIS Platform for Monitoring of ZERO PLUS

***Intelligent models*** have been created that support fault diagnosis and maintenance:

## MODELS FOR LEVEL 1 INDOOR AIR QUALITY

Real-time synchronisation of all indoor environmental quality indices

Extraction of PMV and PPD

Setting the indoor comfort set-points and requirements

Fault detection of the various sensors: Definition of acceptable range of measurements

## MODELS FOR LEVELS 2 AND 3 DEMAND AND PRODUCTION OF SETTLEMENTS

Statistical and probabilistic analysis of energy demand and energy production profiles

Prediction of energy demand and production 24 hours ahead: ANN

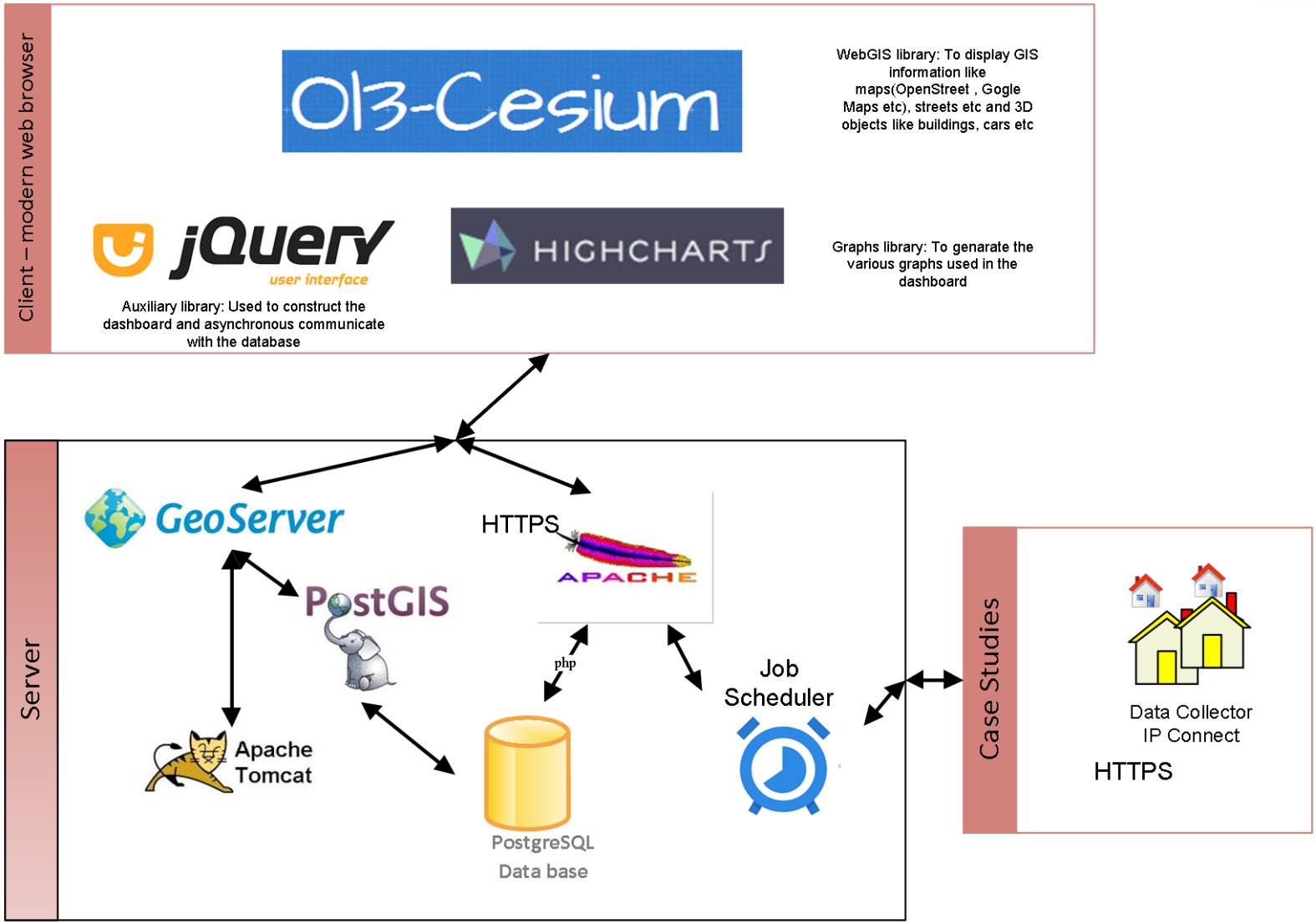
Linking of the energy demand and production profiles with specific subsystems to support maintenance: Error calculation for predicted and actual energy from the various RES.

Fault detection of the subsystems: Definition of acceptable range of measurements

## MODELS FOR LEVEL 4 THE Web-GIS PLATFORM AND DASHBOARD

Supervisor models to manage the most complex functionalities, such as user interface, database components' interactions

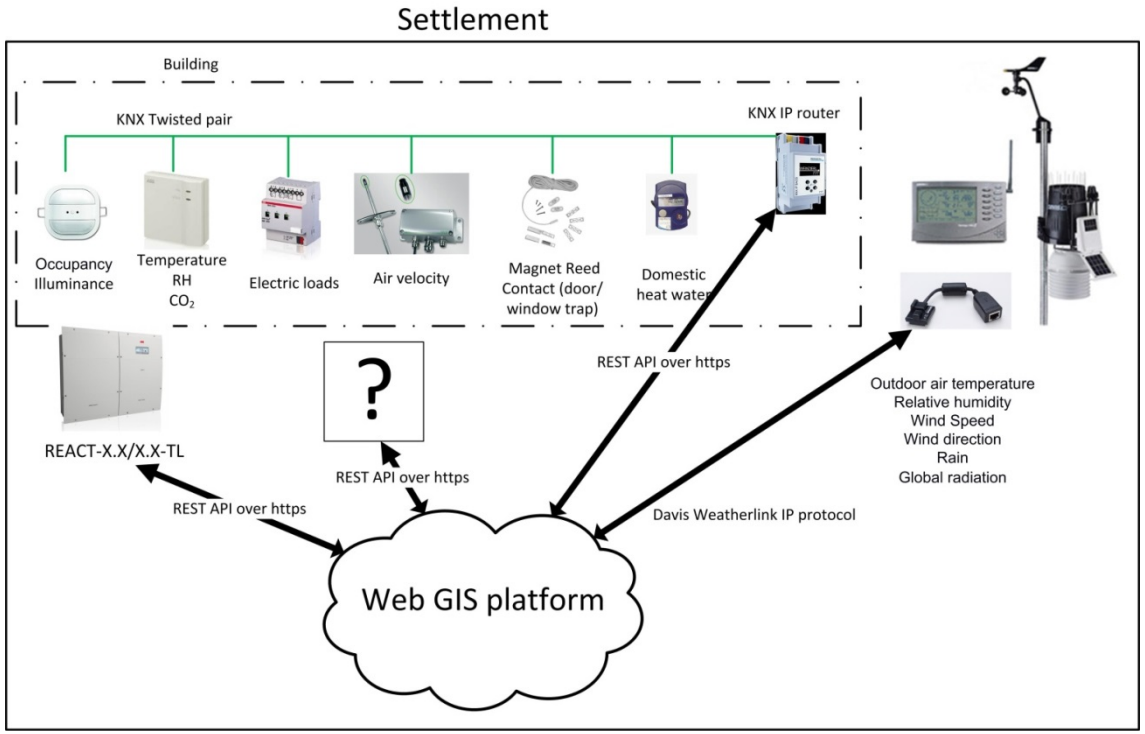
# Web-GIS Platform for Monitoring of ZERO PLUS



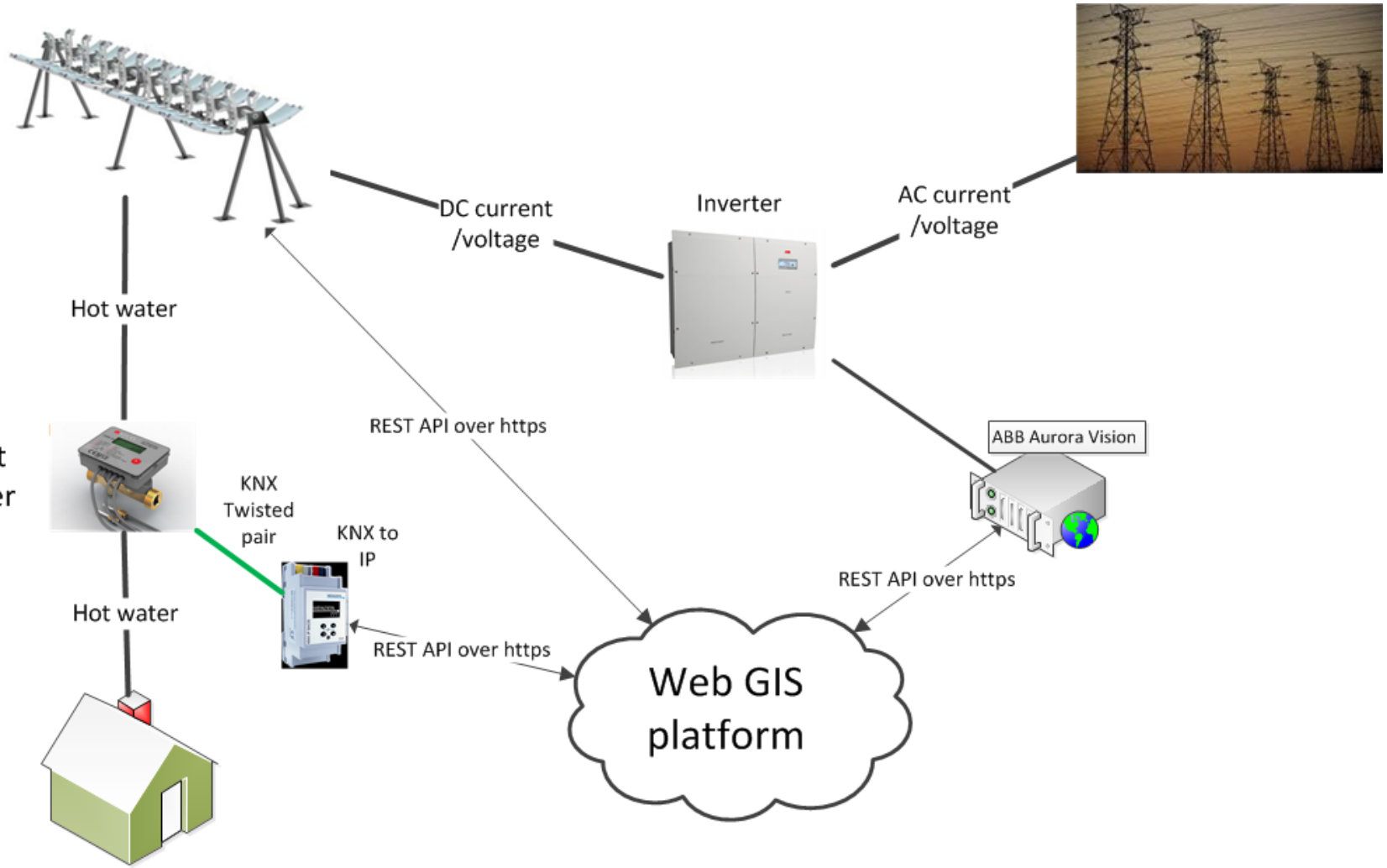
# Web-GIS Platform for Monitoring of ZERO PLUS

In the ZERO-PLUS buildings, a KNX IP router gathers the measurements from the various measuring equipment installed in the buildings using the KNX protocol. The KNX IP router transfers the measurements to the Web-GIS platform via a secured REST API

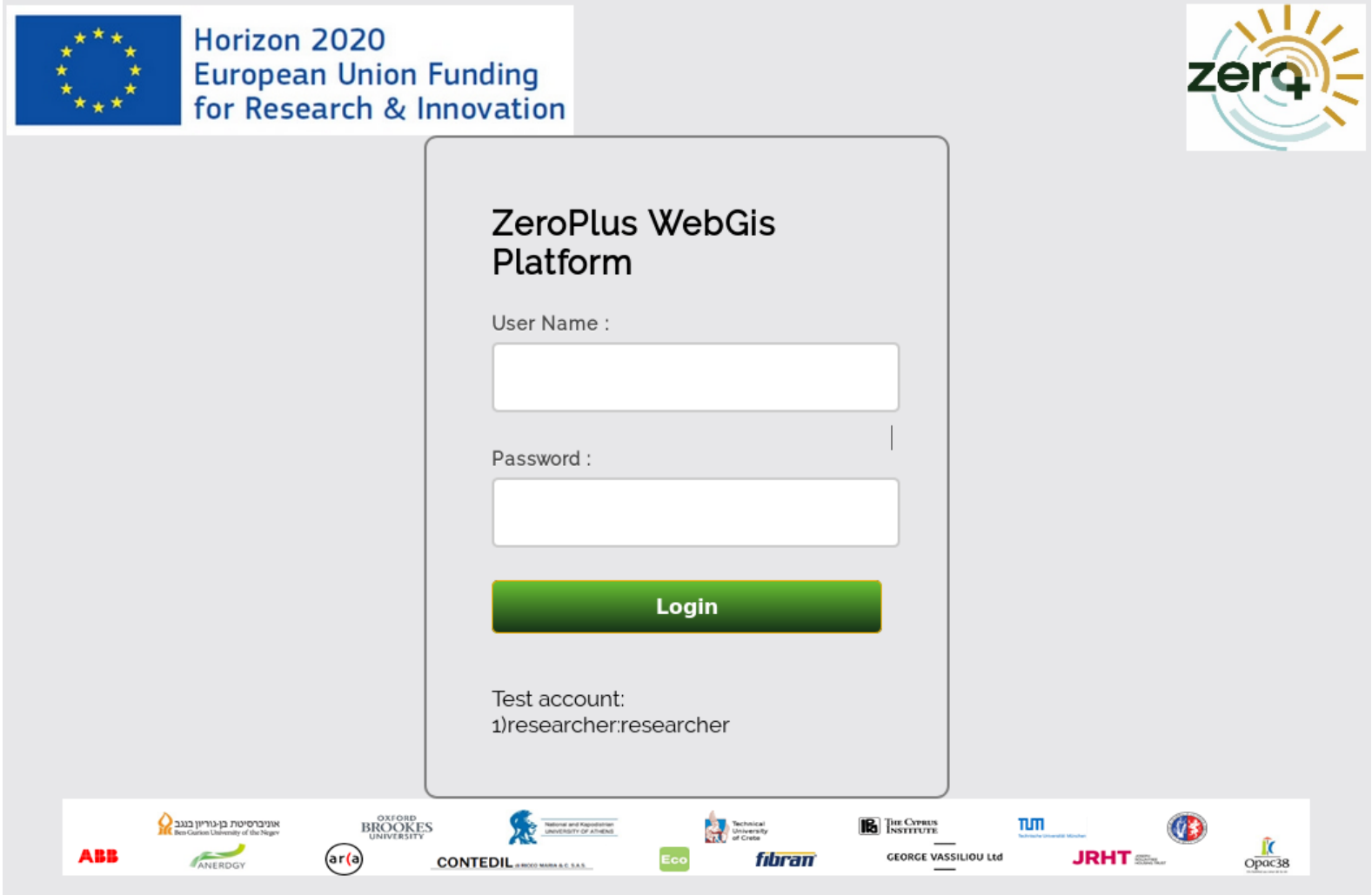
Schematic representation of the monitoring devices and data acquisition units at building and settlement level along with their interconnection to the Web-GIS platform:



# Measurements gathering

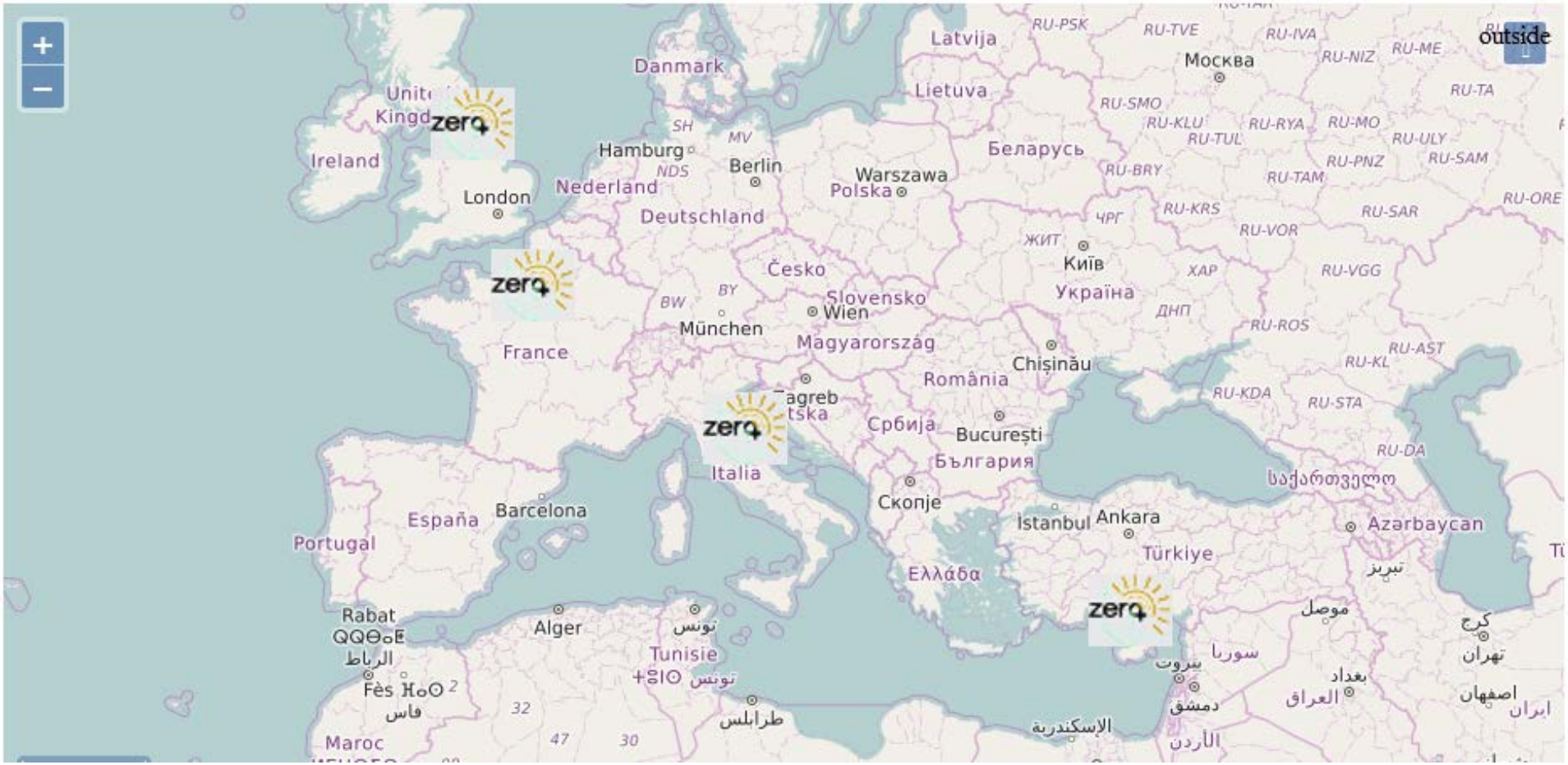


# Web-GIS platform walkthrough




AETHERIA HEIGHTS

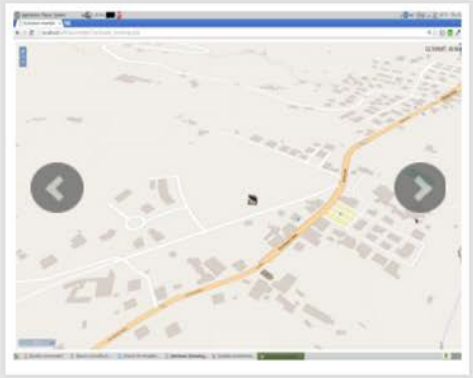
# Web-GIS platform walkthrough



# Web-GIS platform walkthrough

Italian settlment, Novafeltria

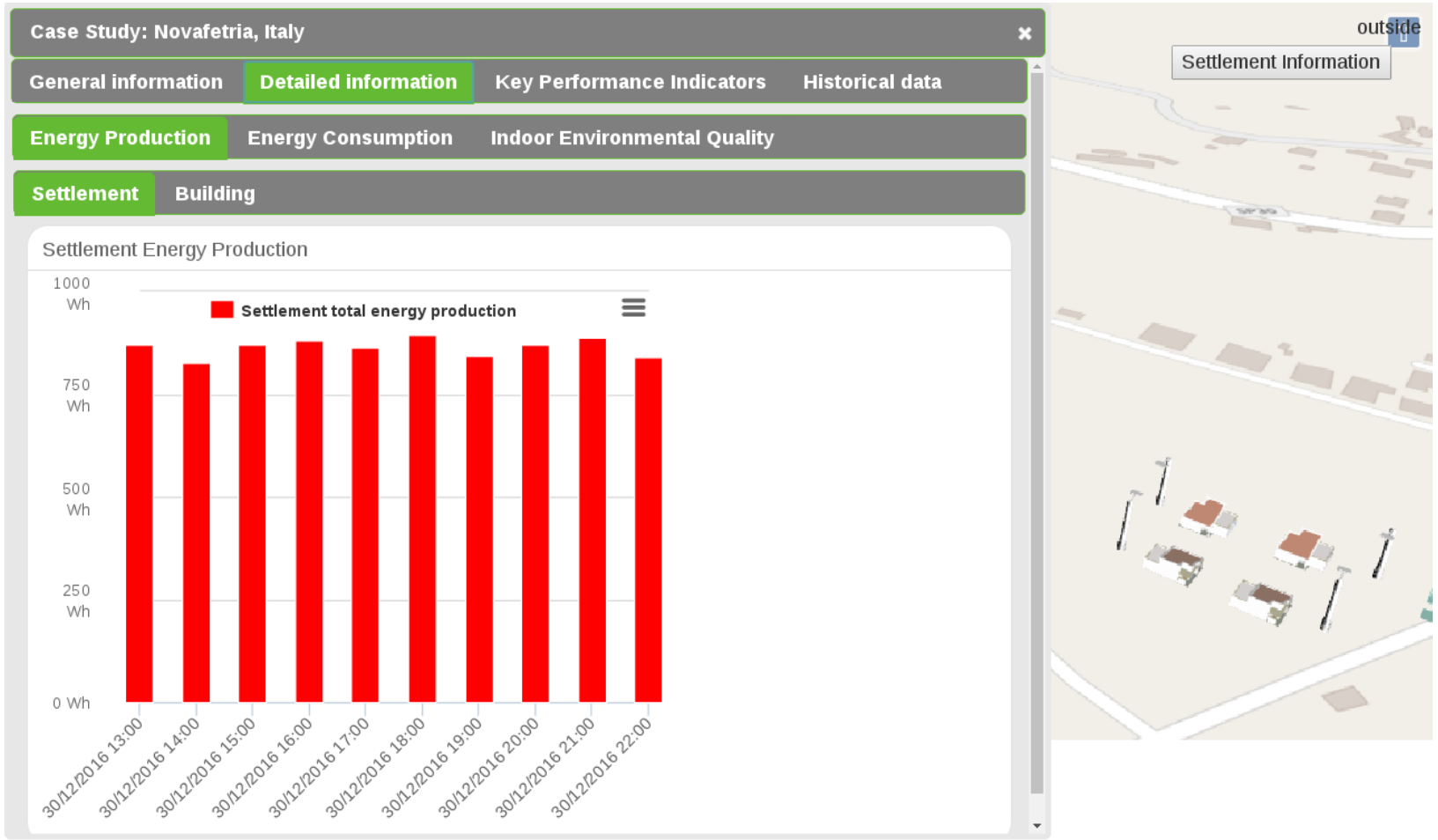
General information | Detailed information | Key Performance Indicators | Historical data



| | |
|---|---|
| **Country** | Italy |
| **Region** | Novafeltria |
| **Net floor area** | 4000m$^2$ |
| **Number of buildings** | 4 |
| **RES** | Wind Rail, SBSkin |

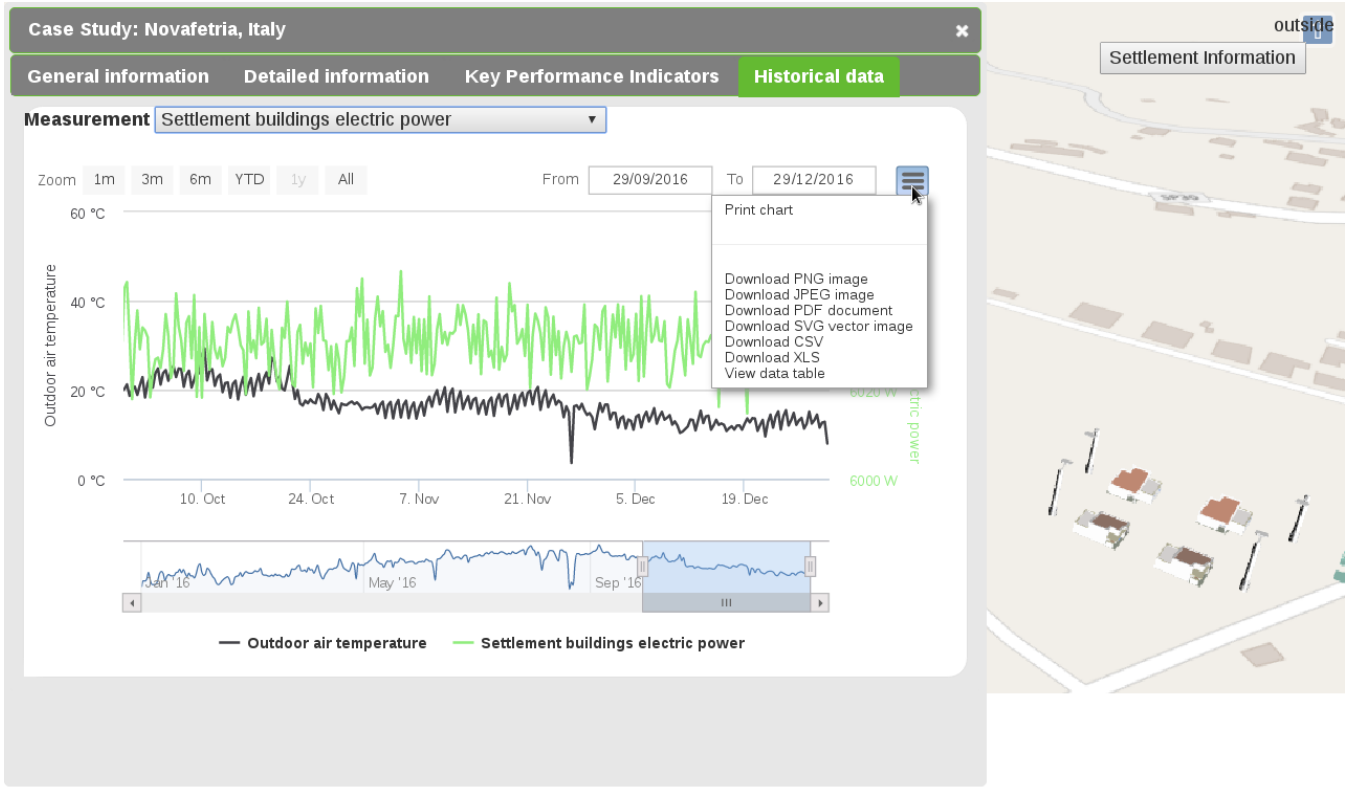
The demonstration case study belonging to the Italian NZE settlement of Novafeltria (RN) is represented by four residential single-family villas, i.e. ground floor buildings. Each villa can host an average of 3 people, with a maximum of 5 people. The main geometrical and dimensional characteristics of the settlement and the standard villa are listed below. Total lot area of the settlement: about 30.150 m$^2$ (including public spaces) Total lot area dedicated to the demonstration case study: about 2500 m 2 , with 1600 m 2 occupied by the total lot area of the all villas and the remaining area by the private street Lot area of each villa: about 400 m$^2$<, with 130 m$^2$ occupied by the building and the remaining area by the private garden Total net floor area: about 100 m $^2$, with 80 m$^2$ of residential net floor area (i.e. excluding the private garage)

# Web-GIS platform walkthrough




localhost/ol3CesiumHightChart/public_html/map.php#tabsGI-2

# Web-GIS platform walkthrough

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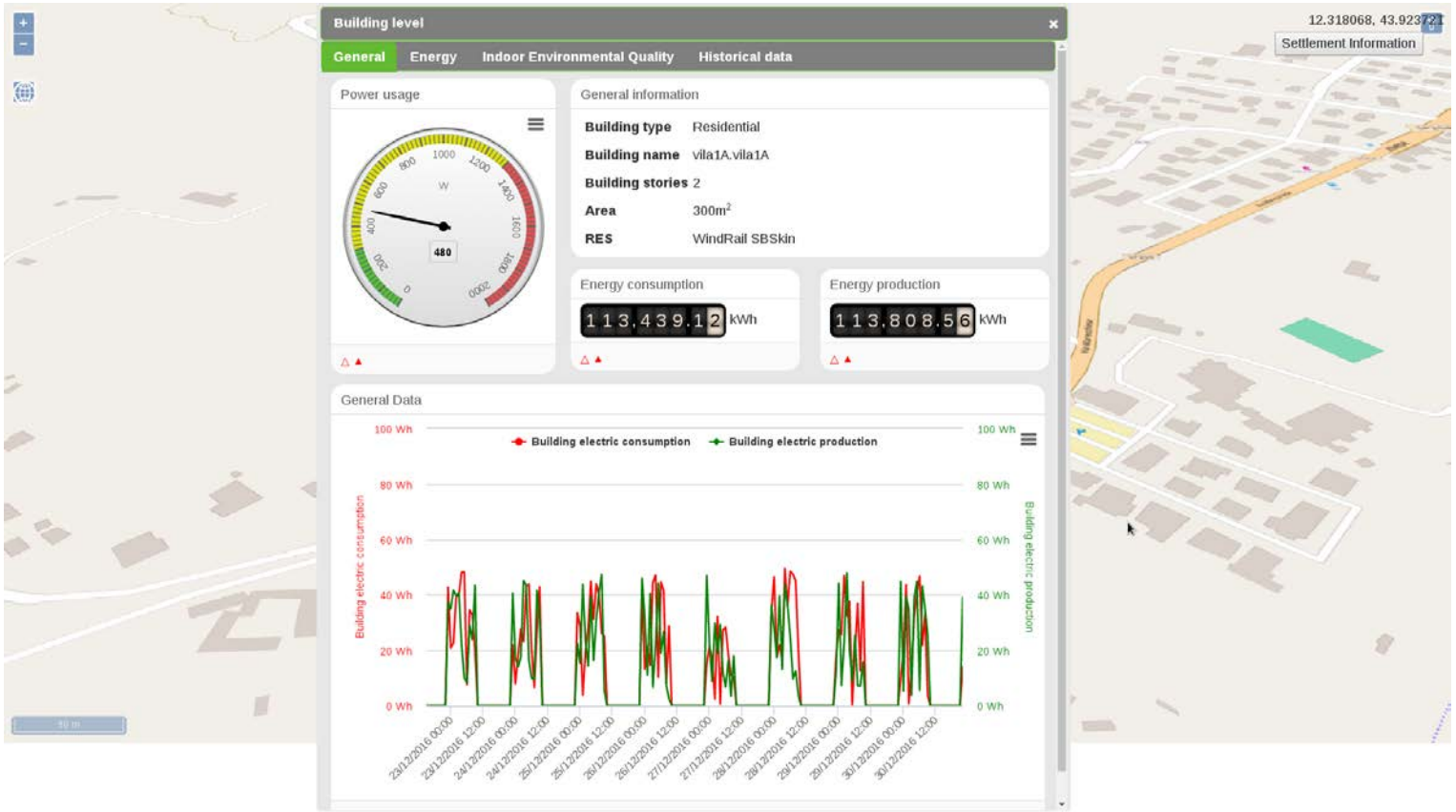


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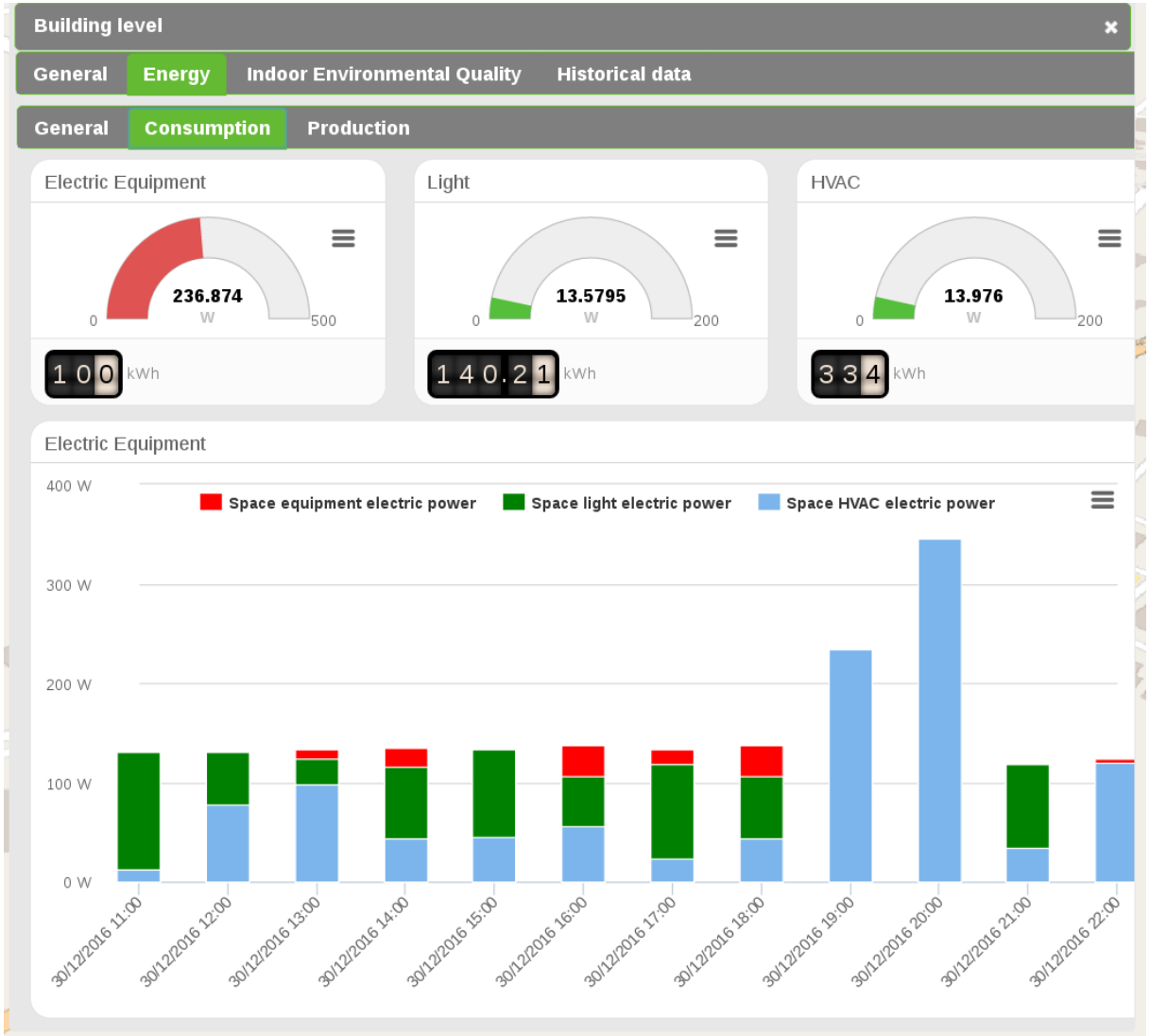


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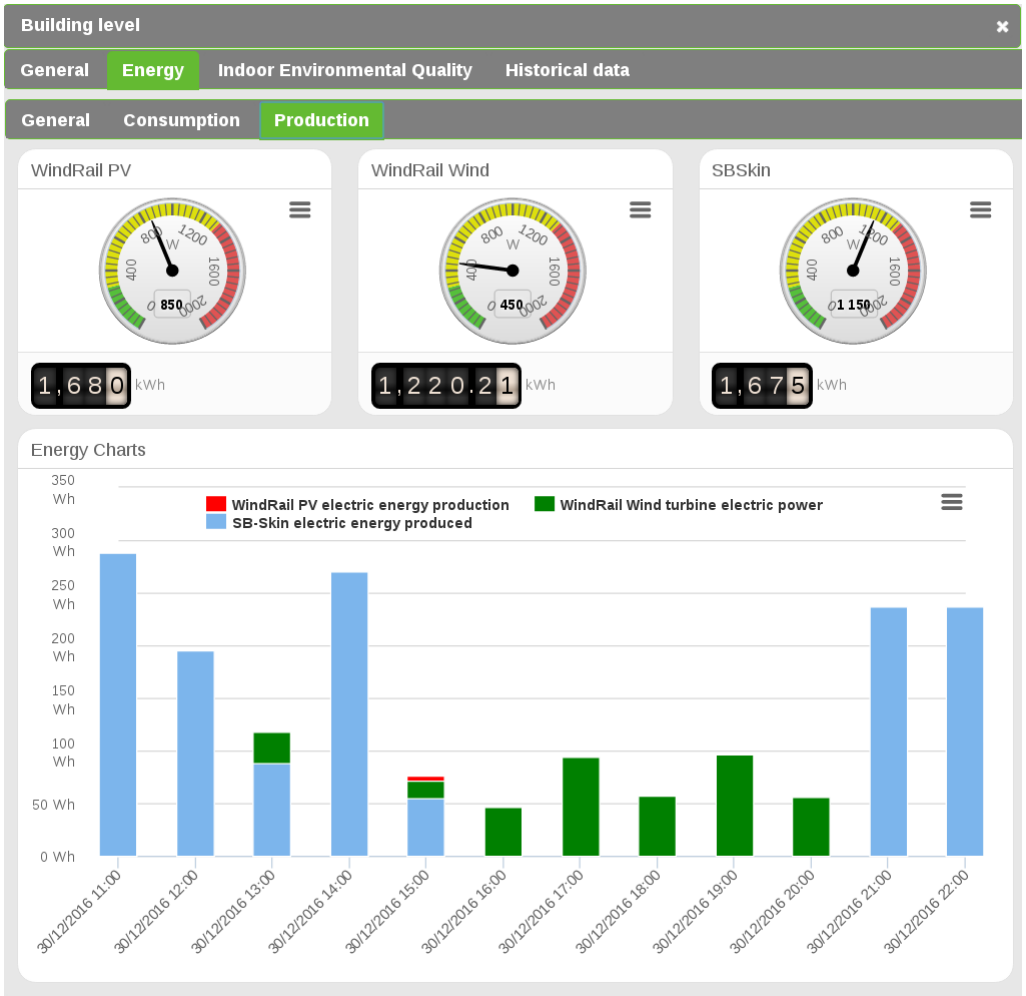



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# Data sources for the four case studies

- Italy
  - IEQ (T, RH $CO_{2,}$), energy consumption (KNX IP router)
  - Heating/cooling set Point (HVAC controller, Rotex G1)
  - PV energy production and battery storage (ABB Aurora Vision)
  - Outside meteorological conditions (Vantage Pro2™ Plus with 24-Hr Fan Aspirated Radiation Shield)
- France
  - IEQ (T, RH $CO_2$), energy consumption, energy production (PV, hot water) (KNX IP router)
  - Outside meteorological conditions (Vantage Pro2™ Plus with 24-Hr Fan Aspirated Radiation Shield)
- UK
  - IEQ (T, RH, $CO_2$), energy consumption (Orsisenergize)
  - T, heating set point (Hive)
  - Energy production  and battery storage (Telsa Power Wall)
  - Outside meteorological conditions (Vantage Pro2™ Plus with 24-Hr Fan Aspirated Radiation Shield)
- Cyprus
  - IEQ (T, RH $CO_2$), energy consumption (KNX IP router)
  - Energy production (electrical, hot water), Heating/cooling set point, HVAC consumption (Frescoo and FAE industrial controller)
  - Outside meteorological conditions (Vantage Pro2™ Plus with 24-Hr Fan Aspirated Radiation Shield)

# High Quality Datasets

Design and Implementation of procedures to ensure collection of high quality datasets

Correction of equipment/sensor failure

- Every new measurement is checked with fault detection function. If fault found then:
  - Email to the **Rescue Person** to resolve issue
  - Automatically create a entry on Google Sheets for the specific case study for having Error Log.

Correction of electrical power disruption

- Every 15 min is checked if all measurements for each one of the case study are inserted on the webGIS. If not:
  - Email to the **Rescue Person** to resolve issue
  - Automatically create a entry on Google Sheets for the specific case study for having Error Log.

# High Quality Datasets

Design and Implementation of procedures to ensure collection of high quality datasets

Correction of errors at data transfer

- On every data logger the local history for measurements is enabled if exist. When internet connection is restored the measurements will be transmitted to the webGIS platform
  - Email to the **Rescue Person** to resolve issue
  - Automatically create a entry on Google Sheets for the specific case study for having Error Log.

Correction of Problems on WebGIS platform

- External service (uptimerobot) checks every 5 min of WebGIS platform is up and running. If no:
  - Email and SMS to TUC to investigate and solve the issue
- Every 15 min is checked if all measurements for each one of the case study have correct time
  - Email and SMS to TUC to investigate and solve the issue

# Web-GIS Platform for Monitoring of ZERO PLUS

Web-GIS platform ***accessibility***

The communication protocol between the Front End and the end user is performed via Internet using secure transfer protocols. The various end user categories have specific privileges for security purposes:

**Administrator:** ***access to all available data*** form all settlements and ***capability to modify the database.***

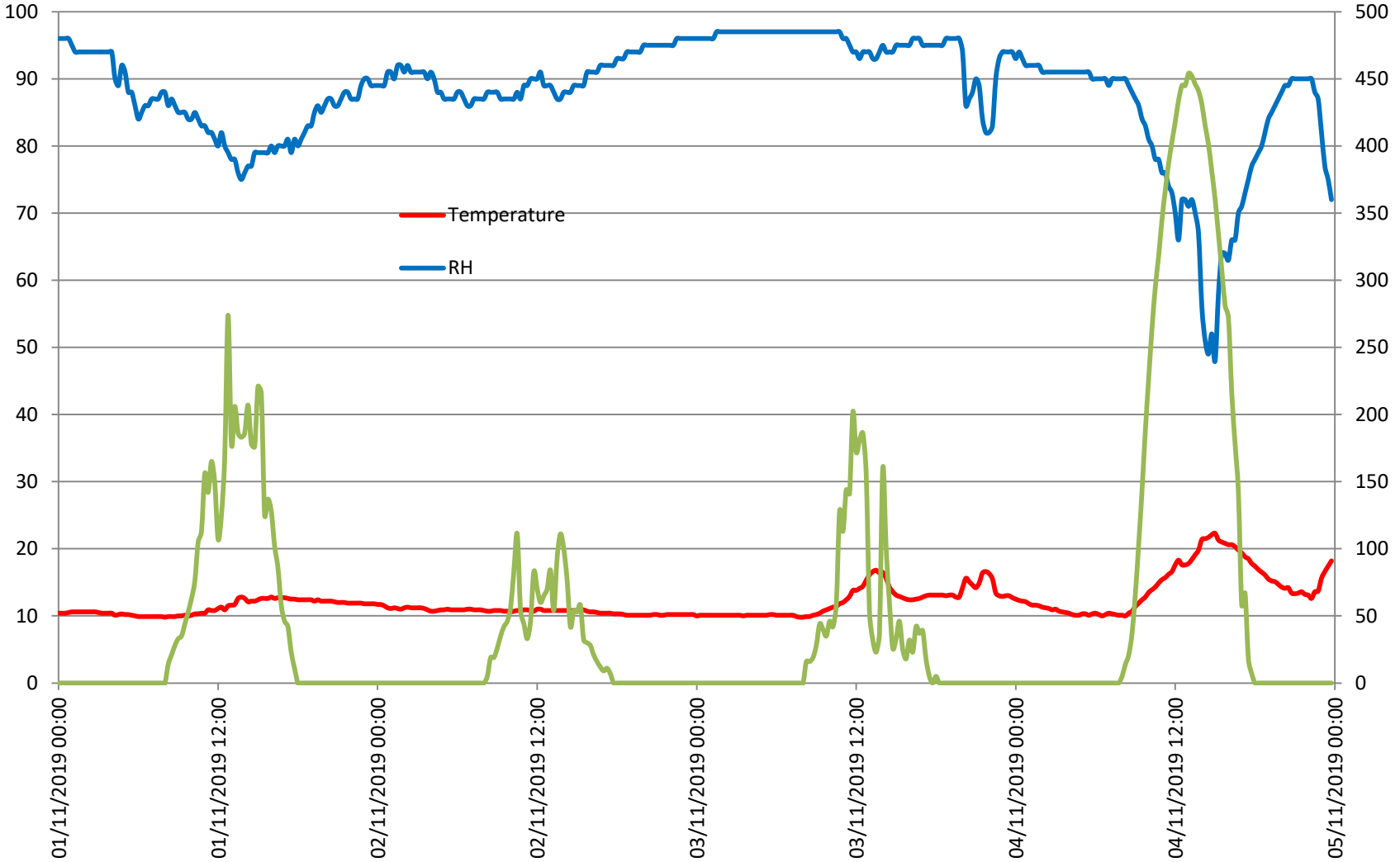
**Researchers:** will have ***only read access to all available data*** from all settlements.

**Building owners:** The building users have access to ***their own building data.***

Web-GIS platform ***security***

- All the data transfer between the platform and the outside word is encrypted (SSL/TLS for the website and REST API).
- All password are stored in an encrypted form
- Each component of the platform have access only to the minimum amount of data ie. Gathering data component for Italy case study can only write data to specific table on database and unique username/password

# Weather data from Italian Case Study





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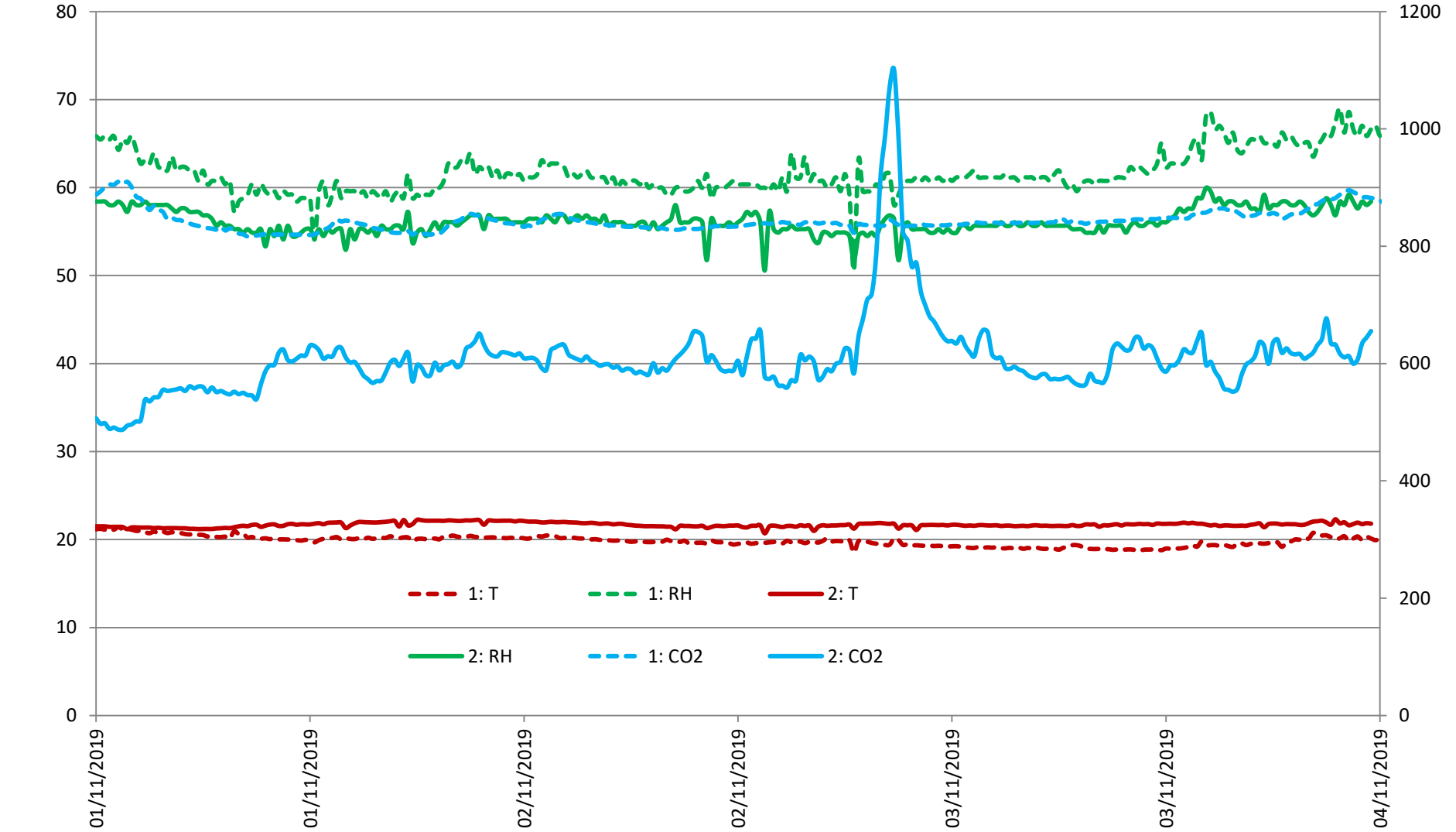
# IEQ from Italian Case Study





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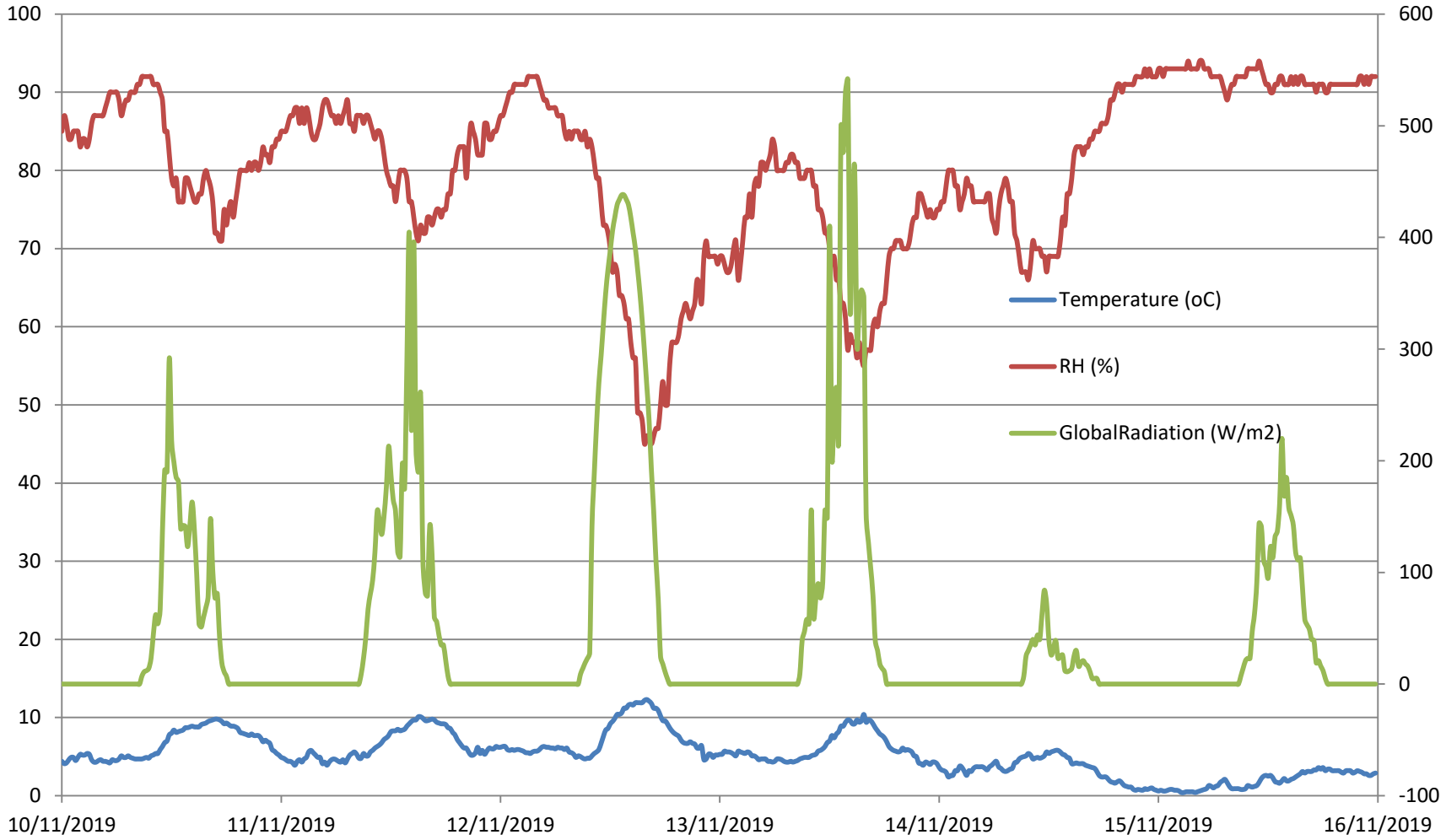
# Weather data from France Case Study





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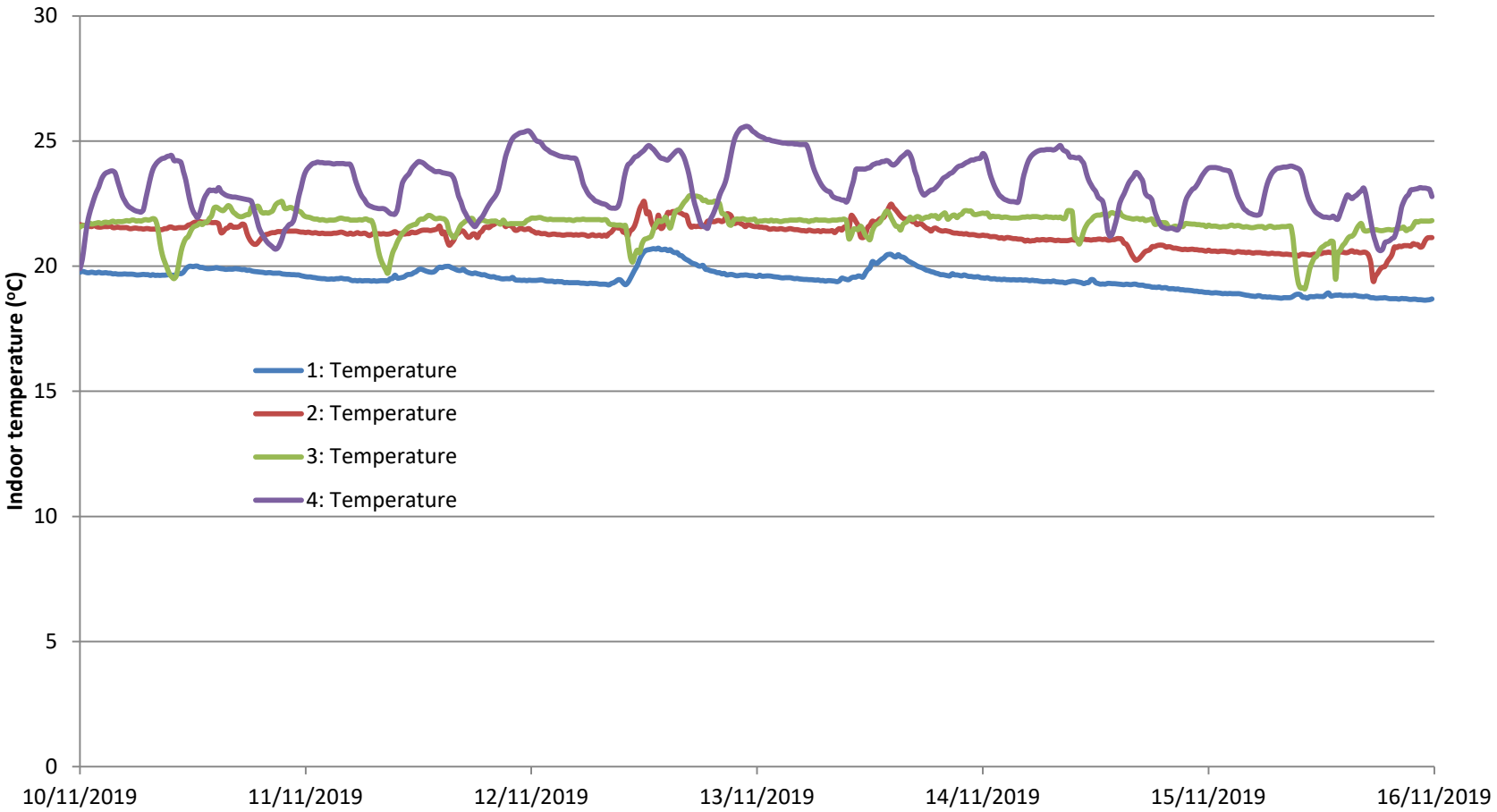

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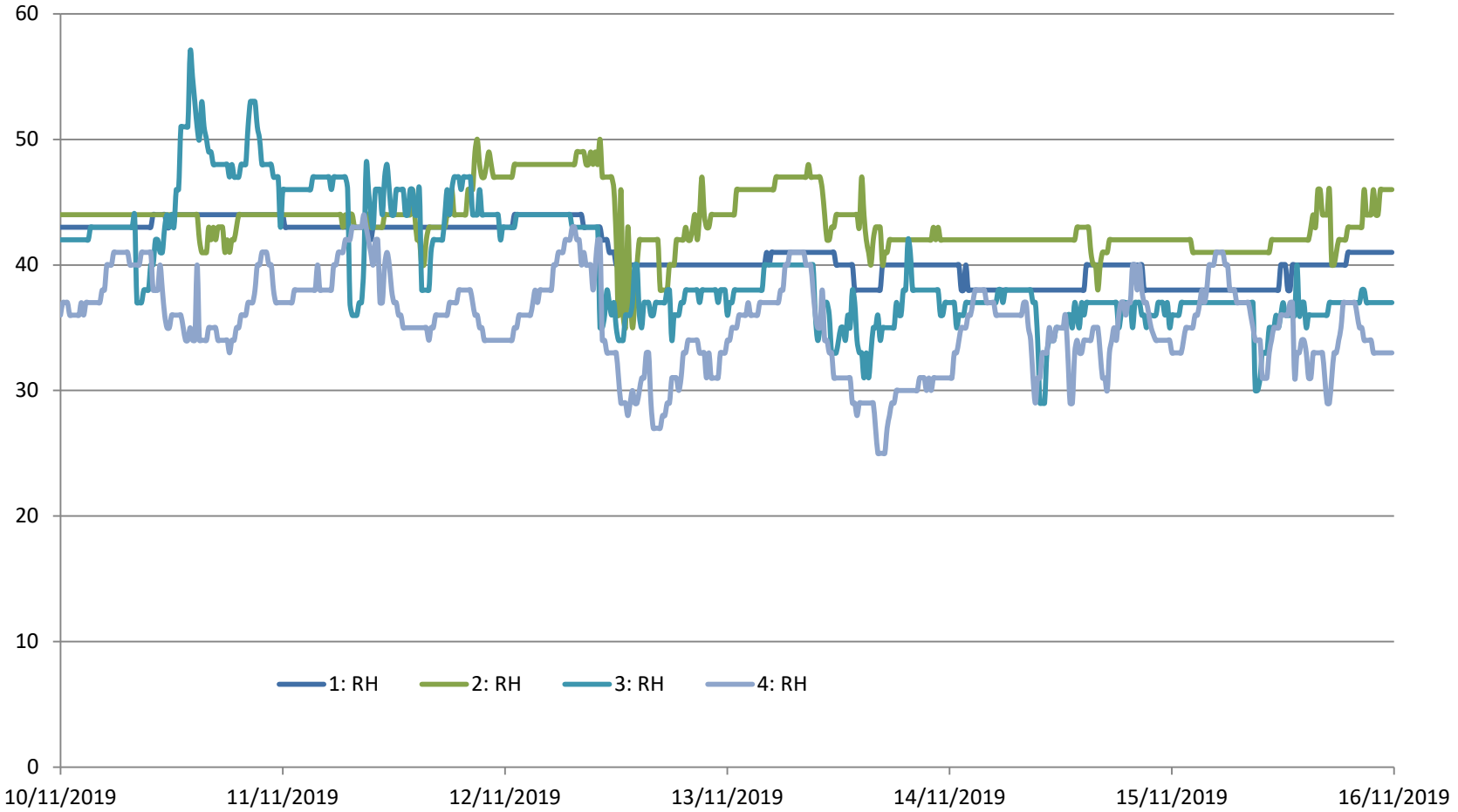

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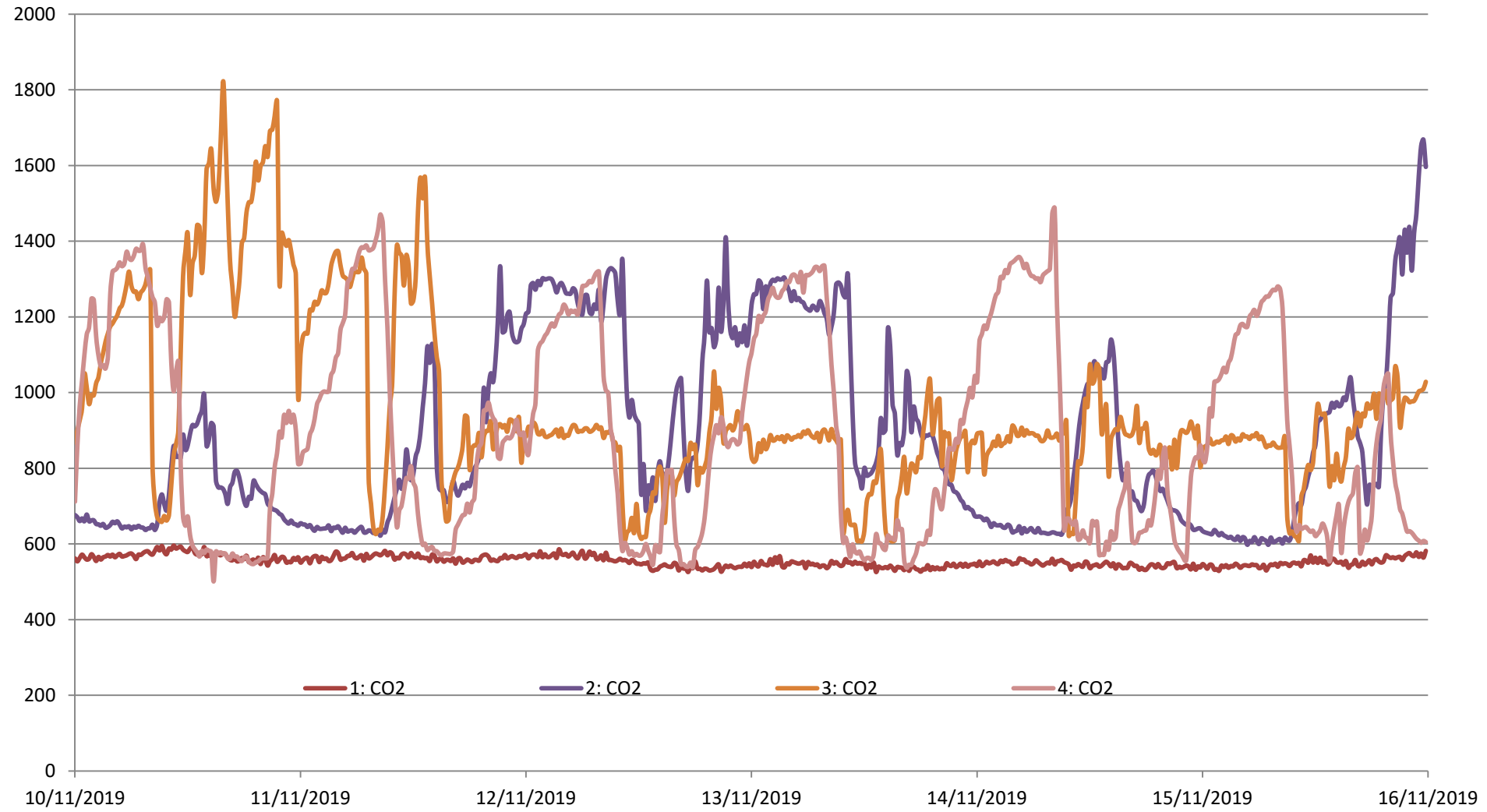



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WEB-GIS PLATFORM

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