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HYDROUSA

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Water in the context of circular economy

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Update on integrated monitoring and controlling platform

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Brief Description	This document is an updated of Deliverable 5.7, containing information about the online monitoring and controlling platform, as well as information about the architecture and the functionalities of the developed platform. It also includes the modification based on sites operators' feedback.
Keywords	Online monitoring, control, Grafana

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1.3	12/03/2024	AGENSO	Revised according to final review comments

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EXECUTIVE SUMMARY

Deliverable 5.8 is and update of deliverable D5.7 "Integrated monitoring and controlling platform" and includes all the modifications implemented in the first version based on the experience and feedback provided by the operators of the demo cases (HYDROs). In order to visualize and monitor the readings from all sensors installed for the purposes of the HYDROUSA project, the Grafana platform was selected and installed on a dedicated server. It is an open-source platform, capable of receiving all the data from the data repository (see Deliverable 5.6 "Data repository"), visualizing and presenting them to the interested stakeholders in a presentable and intelligible way. This is realized with the use of dashboards, by combining various data through SQL queries and using fully customizable widgets (called "panels" in Grafana). Moreover, by employing functions within the database environment, calculations are carried out on data saved both offline and online, with the aim of estimating valuable quantities related to the environmental and economic performance of the systems. These results are also accessible via the Grafana platform and are presented in the following chapters.

Although effort has been made to enable automation control via the open-source platform, the sites feedback and the complication of some systems led to the necessity for implementation of additional dedicated tools for this purpose. Therefore, control of the irrigation systems of HYDROs 2-6 is performed by a specific controlling tool named ardeusi.gr (which has been developed by AGENSO), while for the control of the operation of the most complicated HYDRO systems (HYDROs 1, 4 and 5) separate automated control systems (PLCs, SCADA) have been implemented (see D5.5 "Design and Implementation of ICT infrastructure for data gathering and controlling).

This is an updated version of deliverable D5.7 "Integrated monitoring and controlling platform" containing all the latest updates in the implementation of the pilot sites in the platform. In the first chapter of this deliverable, there is a brief introduction on the scope of the work. The second chapter presents a quick overview of the Grafana platform, its features, and the specifications of the server where it's installed. In the third chapter, the creation of a dashboard in the Grafana platform is presented with screenshots of the process, while the fourth chapter presents indicatively the steps for the creation of HYDRO3 pilot dashboard. Chapter 5 presents the update works that were implemented in order to import off-line data (e.g. lab scale analysis) in the platform by illustrating the case of HYDRO1. Finally, chapters six to ten show the final result/dashboard for each of the HYDRO pilot sites.

HYDROUSA has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776643.

ABBREVIATIONS

ALv2	**Apache License Version 2**
CLA	**Contributor License Agreement**
CPU	**Central Processing Unit**
DR	**Data Repository**
IMEI	**International Mobile Equipment Identity**
MB	**Megabyte**
RAM	**Random Allocation Memory**
RPM	**Red Hat Package Manager**
SIEM	**Security information and event management**
SQL	**Structured Query Language**
UI	**User Interface**

1. INTRODUCTION

For visualizing and monitoring the readings from the sensors that have been installed in the demonstrator sites of the HYDROUSA project, the Grafana platform was selected – being an open-source choice – in order to be installed to a dedicated server, configured properly and used by the interested stakeholders.

In the following chapters, after a brief presentation of the Grafana platform, its features and technical specifications required, the step-by-step process of creating a dashboard is given. The process is then applied for creating a dashboard for the HYDRO3 pilot.

The dashboards of all HYDRO pilot sites are presented in detail, including all the following data:

- General information about the pilot (geolocation, pilot site overview of all process loops)
- Data from all the sensors that have been installed in each pilot site
- Data from the offline processes (chemical analysis at lab) that are being inserted manually
- Project environmental and economic assessment results (KPIs)

The present report is an updated version of deliverable D5.7 “Integrated monitoring and controlling platform” containing all the latest updates in the implementation of the pilot sites on the platform.

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2. ABOUT GRAFANA

Grafana[1] is a multi-platform open-source analytics and interactive visualization web application. It provides charts, graphs, and alerts for the web when connected to supported data sources. A licensed Grafana Enterprise version with additional capabilities is also available as a self-hosted installation or an account on the Grafana Labs cloud service. It is expandable through a plug-in system. End users can create complex monitoring dashboards using interactive query builders. Grafana is divided into a front end and back end, written in TypeScript and Go, respectively.

As a visualization tool, Grafana is a popular component in monitoring stacks, often used in combination with time series databases such as InfluxDB, Prometheus and Graphite; monitoring platforms such as Sensu, Icinga, Checkmk, Zabbix, Netdata, and PRTG; SIEMs such as Elasticsearch and Splunk; and other data sources. The Grafana user interface was originally based on version 3 of Kibana.

Figure 2.1 An example of a Grafana dashboard

Grafana was first released in 2014 by Torkel Ödegaard as an offshoot of a project at Orbitz. It targeted time series databases such as InfluxDB, OpenTSDB, and Prometheus, but evolved to support relational databases such as MySQL, PostgreSQL and Microsoft SQL Server.

Grafana is widely used including in Wikipedia's infrastructure. Grafana has over 1,000 paying customers, including Bloomberg, JP Morgan Chase, eBay, PayPal, and Sony.

As of April 20, 2021, Grafana is licensed under an AGPLv3 license. Contributors to Grafana need to sign a CLA that gives Grafana Labs the right to relicense Grafana in the future. The CLA is based on The Apache Software Foundation Individual Contributor License Agreement.

[1] https://en.wikipedia.org/wiki/Grafana

Previously Grafana was licensed with an ALv2 license and used a CLA based on the Harmony Contributor Agreement.

2.1. Features of Grafana[2]

The most important features of Grafana are:

- Dashboard templating: it allows users to create a dashboard setup to suit their every need. These templates don't come with hardcoded values, which means that if someone has a test server and a production server, the same dashboard will work with both. Templating lets one examine data at every level from the macro to the micro, so one can start with a whole country, for example, then drill down to a particular region, and keep going as far as granularity allows. These dashboards are then shareable with everyone from teams throughout one's organization to the whole community.
- Provisioning: it may be easy enough to set up a single dashboard with some clicking, dragging, and dropping, but some users need even more simplicity in a way that scales. So, Grafana features provisioning so one can automate setup using a script. Anything can be scripted in Grafana. For instance, when one wants to create a new Kubernetes cluster, they can have Grafana automatically help with a script that already has the right server, IP address, and data sources set up and locked. This is also a way to control lots of dashboards.
- Annotations: this Grafana feature lets the user mark graphs, which is particularly helpful if they need to correlate data when something misbehaves. One can control-click and type on a graph to create the annotations manually, or data can be fetched from any source to populate them (an example of this can be seen in the way that Wikimedia uses annotations on its public Grafana dashboard). A good use case would be automatically creating annotations at the time of releases. If one was to start seeing errors a little while after a new release, they could go back to their annotations and check if the errors correlate. This kind of automation is possible with the Grafana HTTP API. Lots of Grafana's biggest customers use it for a wide range of tasks, with a common one being to set up databases and add users. This is an alternative to provisioning for automation, and there's more one can do with it. For instance, DigitalOcean's team used the API to include a snapshot feature that helps them to review dashboards.
- Kiosk mode and playlists: playlists are great for "rolling coverage". The user can select which Grafana dashboards they would like to display on a monitor or TV, and it can cycle through them throughout the day. Kiosk mode lets the user only show the UI elements that they need in view-only mode. Useful tip: The Grafana Kiosk utility handles logins, switching to kiosk mode, and opening a playlist, so if a TV the user wants to use has no keyboard they can still set it up without hassle.
- Custom plugins: the user can extend Grafana's functionality with plugins that offer extra tools, visualizations, and more. Popular examples include Worldmap Panel (which superimposes data on a map), Zabbix (which integrates with Zabbix metrics), and Influx Admin Panel (which enables database creation or lets one add users). These are just a couple of examples and there are many others besides them. The user can write a little code and Grafana can visualize anything that

[2] https://www.plesk.com/blog/various/grafana-monitoring-solution

produces a timestamp. Also, Grafana Enterprise customers can access additional plugins that facilitate integrations with Datadog, New Relic, Splunk, and others.

- Alerting and alert hooks: Grafana alerts can be sent through several different notifiers, including email, PagerDuty, or Slack or texts. If these aren't enough, it's very easy to code alert hooks that create different notifiers.
- Teams and permissions: where an organization has one instance of Grafana and several teams, they usually like to have the option to enforce some dashboard segregation. It used to be the case that this wasn't possible because Grafana automatically made everyone's dashboards accessible to everyone else. The later edition of multi-tenant mode meant that users could switch organizations but couldn't share dashboards. Some judicious hacks could enable both, so Grafana created an easier route to achieving this. It's now possible to create a team of users and then assign permissions on folders, Grafana dashboards, and so on, right down to the data source level for Grafana Enterprise users.
- SQL data sources: Grafana natively supports SQL, which helps the user to graph any kind of data that might be held in an SQL database. High-end users are doing lots of interesting things with SQL data sources, including building business dashboards that can appeal to the higher hierarchy personnel of a company.
- Monitoring the user's monitoring: if users take monitoring seriously enough to want to monitor their own monitoring, Grafana features its own Prometheus HTTP endpoint that can be scraped by Prometheus, making it fairly easy to get statistics and dashboards. Once the enterprise version is up and running the user will be able to get Google Analytics-style data access, so they can find out just how much CPU their Grafana is chewing through or how much time alerting takes.
- Authentication: Grafana supports LDAP and OA and other authentication styles, and lets one map users to organizations. With Grafana Enterprise, it's also possible to map users to teams: so if one's organization uses their own authentication system, Grafana lets them map teams in their in-house systems to teams in Grafana, which automatically gives team members access to their own designated Grafana dashboards.

2.2. Versions of Grafana

There are three different versions of Grafana, tailored to different categories users' needs.

The first one is the open-source self-managed version. Users can download, install, administer and maintain their own versions without any limitations.

Then there's the cloud version. It is offered as a fully managed service and is the fastest way to adopt Grafana. It includes a scalable, managed backend for metrics, logs, and traces and is managed and administered by Grafana Labs with free and paid options for individuals, teams and large enterprises. It includes a robust free tier with access to 10k metrics, 50GB logs, 50GB traces, 2 weeks data retention and 3 users.

Finally, there's the enterprise version. It is enhanced with access to Enterprise data source plugins and built-in collaboration features. There's also a self-managed option for organizations that have special requirements around data localization and privacy.

2.3. Grafana for the purposes of the HYDROUSA project

The version of choice of Grafana for the purposes of the HYDROUSA project, was the open-source self-managed one.

The requirements for the installation of Grafana are as follows:

- Supported operating systems
  - Debian / Ubuntu
  - RPM-based Linux (CentOS, Fedora, OpenSuse, RedHat)
  - macOS
  - Windows
- Minimum recommended RAM[3]: 255MB
- Minimum recommended CPU[3]: one (1)
- Supported databases
  - SQLite
  - MySQL
  - PostgresSQL
- Supported web browsers[4][5]
  - Chrome/Chromium
  - Firefox
  - Safari
  - Microsoft Edge
  - Internet Explorer 11[6]

The chose version of Grafana was downloaded from the designated download location and installed on a dedicated server.

The server's specifications are:

- CPU: Intel(R) Core(TM) i7-4930K CPU @ 3.40GHz
- RAM: 14.4GB DDR3 ECC
- HDD: 1x 1TB SATA II
- Operating system: Ubuntu 18.04 (64-bit)
- Monthly bandwidth: 32TB traffic, unlimited incoming

It is obvious that the server more than satisfies the requirements of the Grafana software.

3 Some features, such as server rendering of images, alerting and data source proxy might require more RAM or CPUs
4 Older versions of the aforementioned browsers might not be supported, therefore an update is recommended
5 JavaScript should always be enabled in the user's browser, as running Grafana without JavaScript enabled is not supported
6 Fully supported only in Grafana versions prior to v6.0

3. CREATING A DASHBOARD AT GRAFANA

In this chapter, the steps to create a dashboard at Grafana is presented.

Once the chosen version of the Grafana has been properly installed and configured, users can login by navigating to the servers URL, pointing at port 3000 (the default port where Grafana is installed).

As soon as the page loads, users will be prompted to enter their credentials to login (Figure 3.1).

During the first login, the user will be asked to change their password for security purposes.

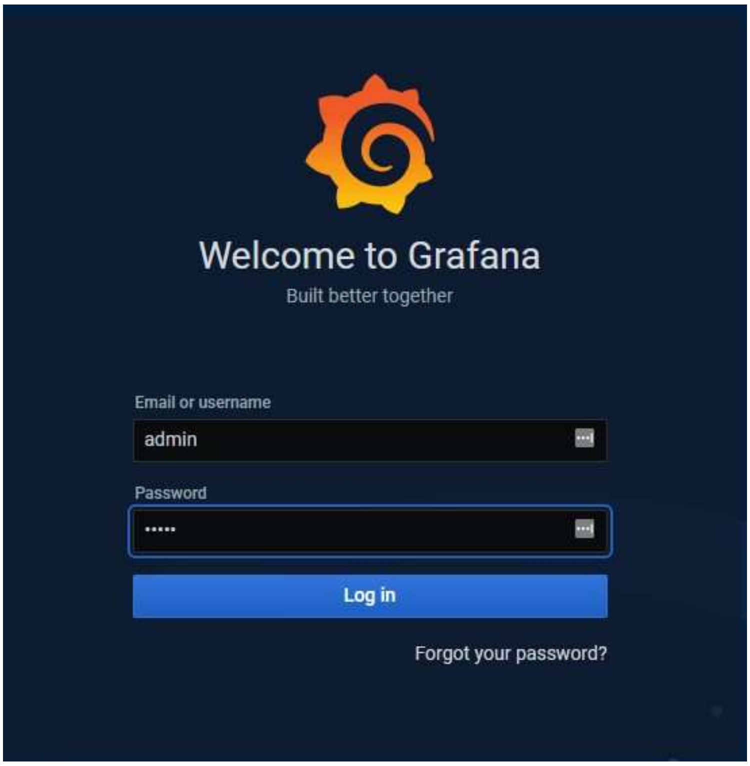

Figure 3.1 Grafana login screen

After successfully logging in with their credentials, the user is greeted with the welcome screen of Grafana (Figure 3.2), where all the available options appear. It should be noted that in the example presented in this report, the screens are of a user with administrative privileges – normal users have less choices available and the environment appears slightly different.

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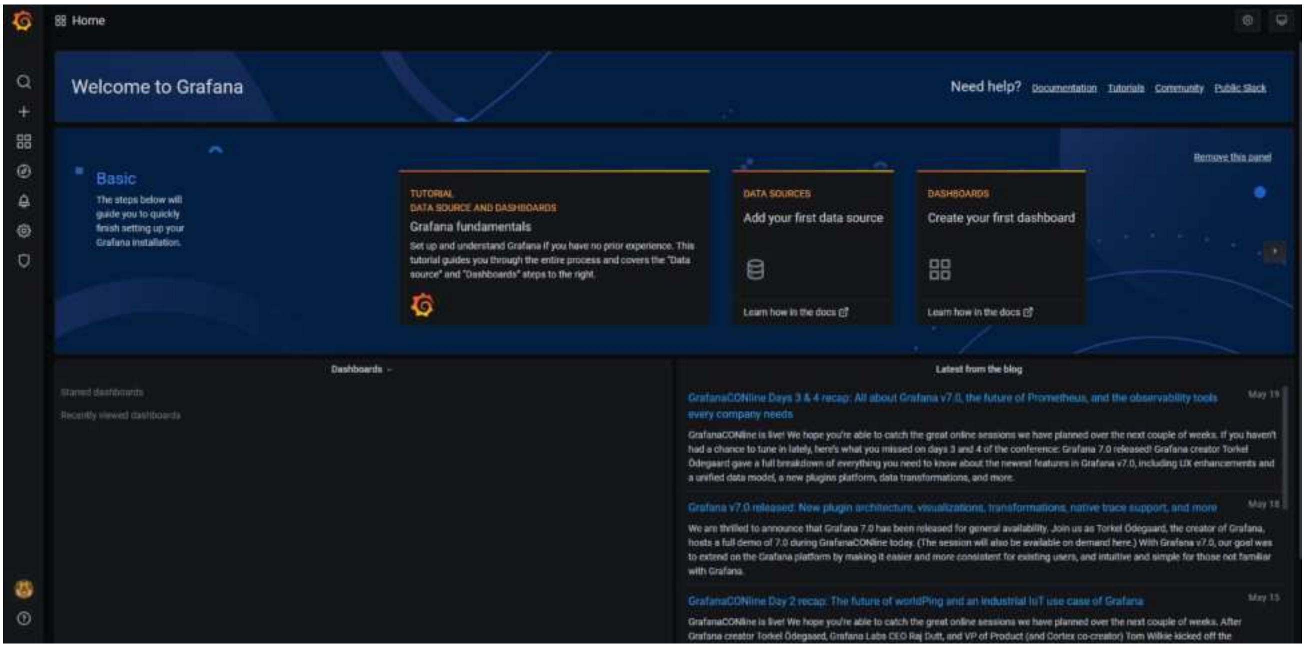

Figure 3.2 Grafana dashboard overview

The first step for the creation of a dashboard, is to connect the Grafana installation with a data source from which the data will be fetched. In this example, the data will be fetched from the data repository's database (Deliverable 5.6).

This is done by clicking on "Add your first data source" at the "DATA SOURCES" tile (Figure 3.3).

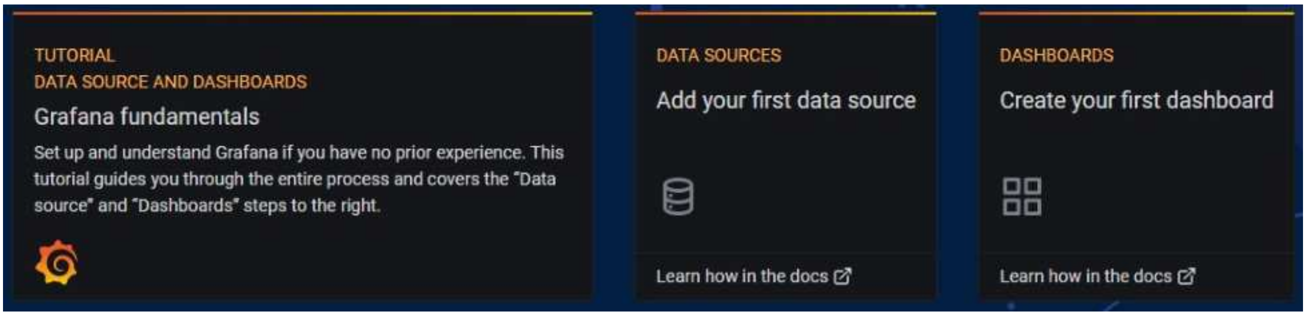

Figure 3.3 Adding a data source.

The user is redirected to the "Add Data Sources" page, where they can add a data source from several available options.

In this example, the option to be chosen is the "MySQL" one, under the SQL category (Figure 3.4). The user can then proceed by clicking on the "Select" button.

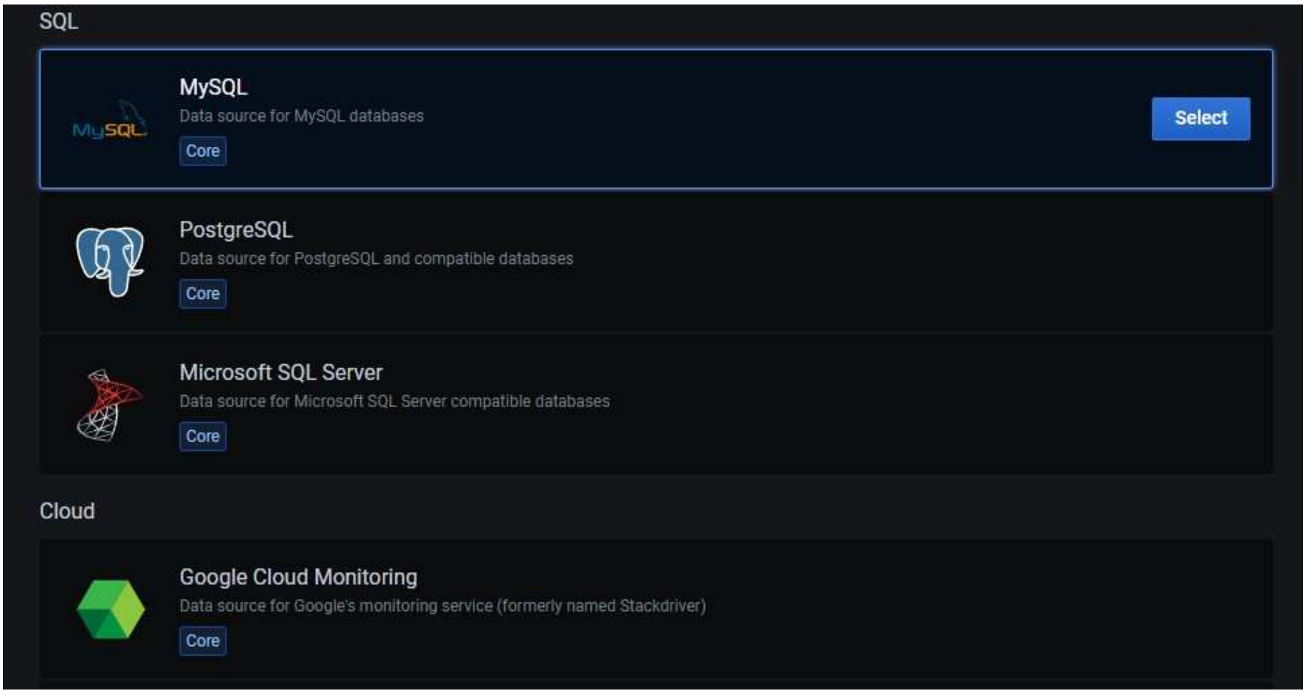

Figure 3.4 Selection of a MySQL database

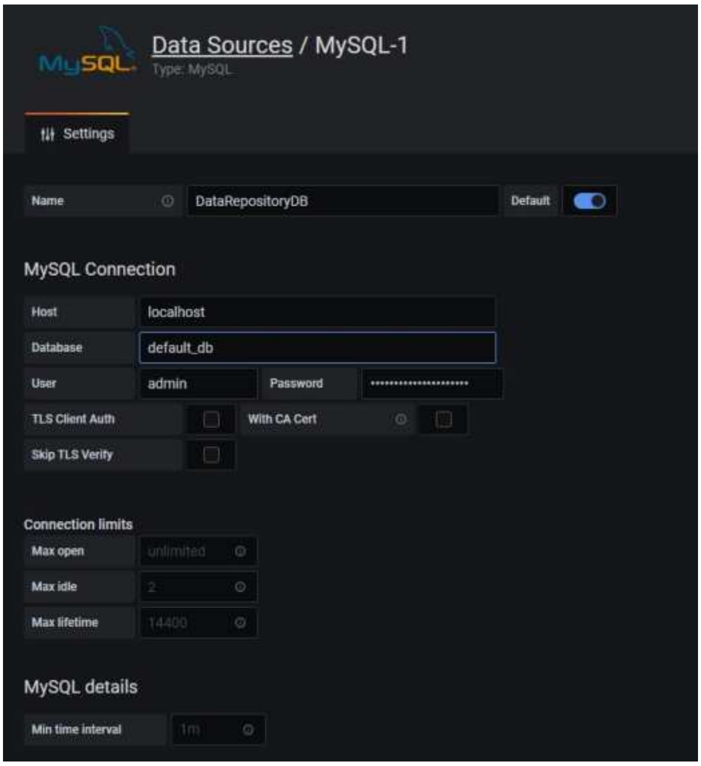

Figure 3.5 Settings for connecting to a MySQL database

If the connection parameters with MySQL (Figure 3.5) are correct and the connection is successful, the notification shown in Figure 3.6 appears.

Figure 3.6 Successful connection to database

As soon as the data source has been added successfully, the user can proceed with creating the dashboard. One left panel, the user needs to click on the plus (+) sign and then select “Dashboard” (Figure 3.7).

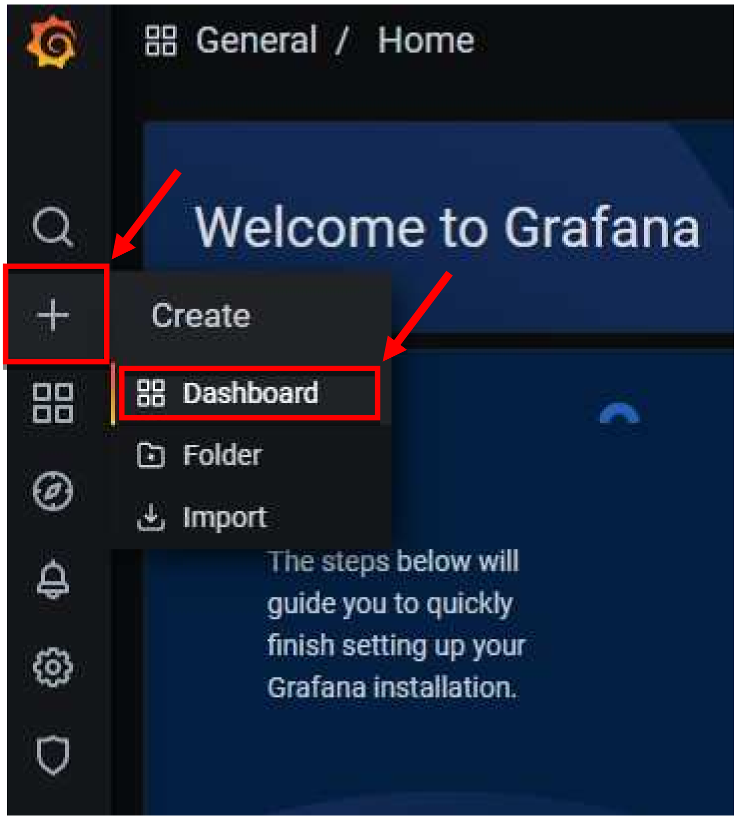

Figure 3.7 Creation of a new dashboard

Each dashboard can be comprised of panels and rows. To add the first panel, the user needs to click on the “+ Add new panel” button, at the screen that appears after the dashboard creation (Figure 3.8).

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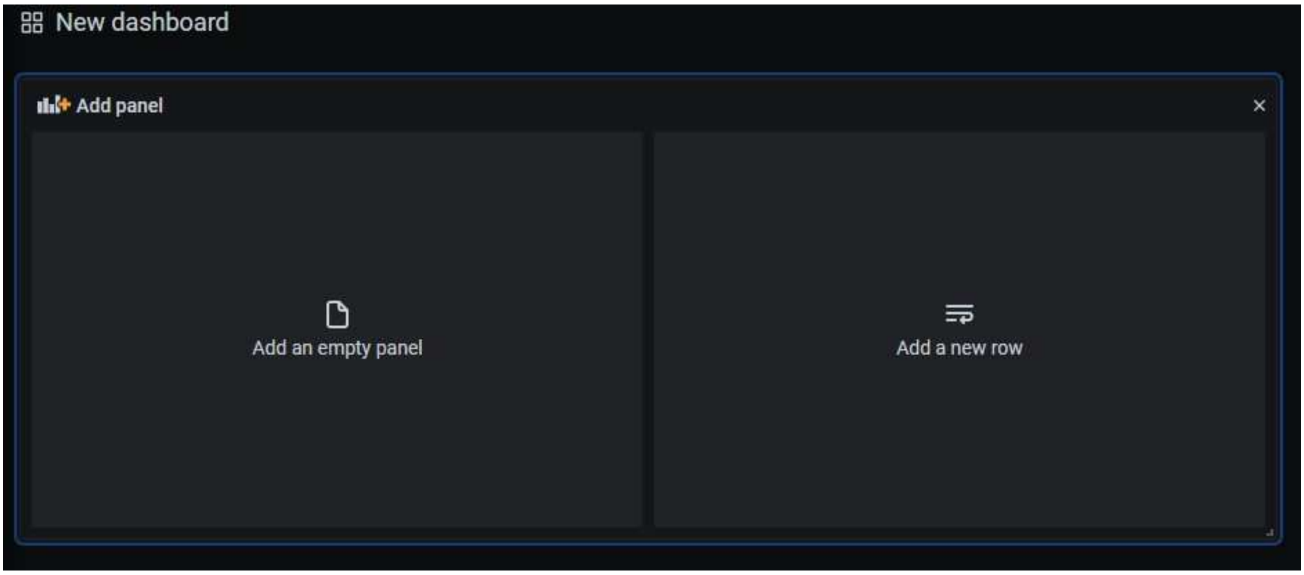

Figure 3.8 Adding a new panel to the dashboard.

A new default panel will appear on the newly created dashboard, containing an empty dataset (Figure 3.9).

To change that, the user needs to change the data source and select the data repository database as the panel's data source.

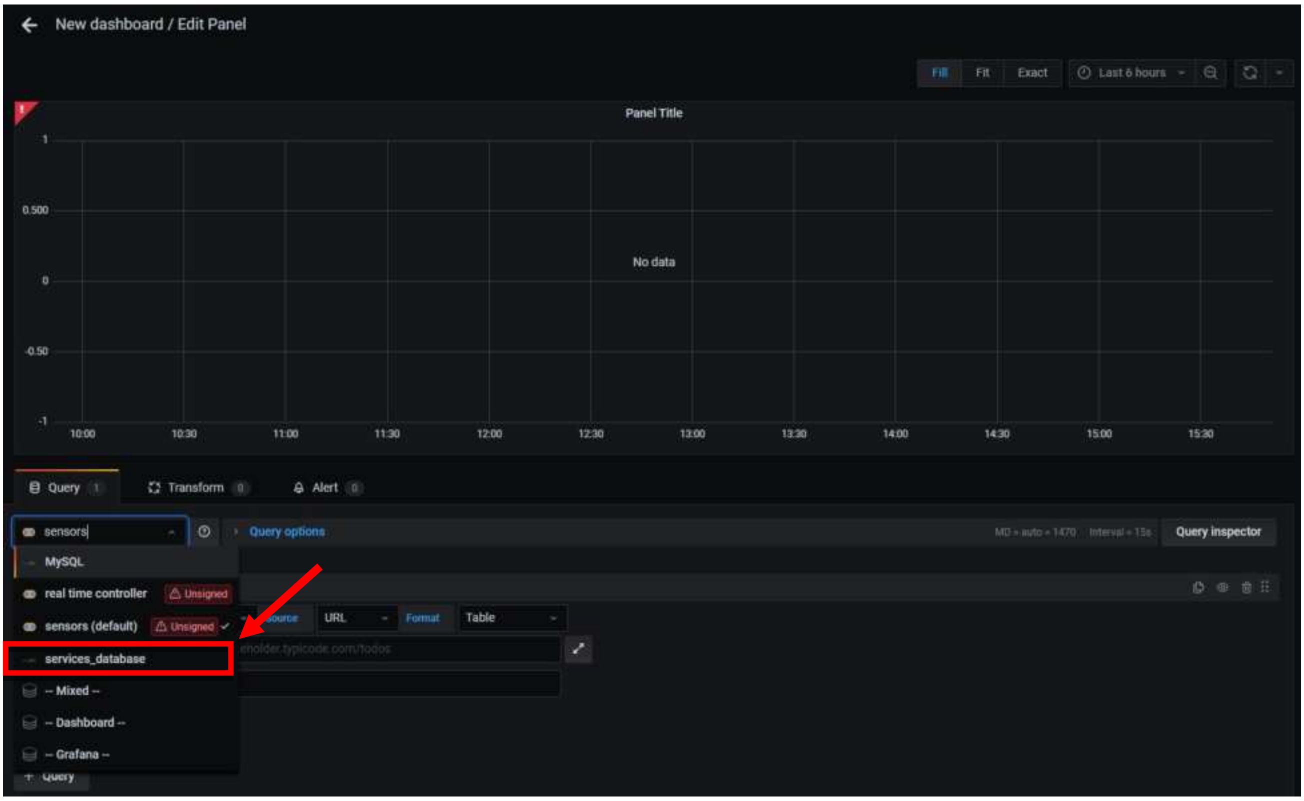

Figure 3.9 Changing the data source.

When the data source is changed, the chart will start appearing empty, because there is yet to be specified a query to fetch the data. After a query has been written (as shown at the text box below) to fetch the appropriate data, a graph will be generated (Figure 3.10).

```
SELECT
    timestamp AS "time",
    temperature, humidity
FROM sensor_data
WHERE
    $__unixEpochFilter(timestamp) AND
    imei = 'xxxxxxxxxxxxxxx'
ORDER BY timestamp
```

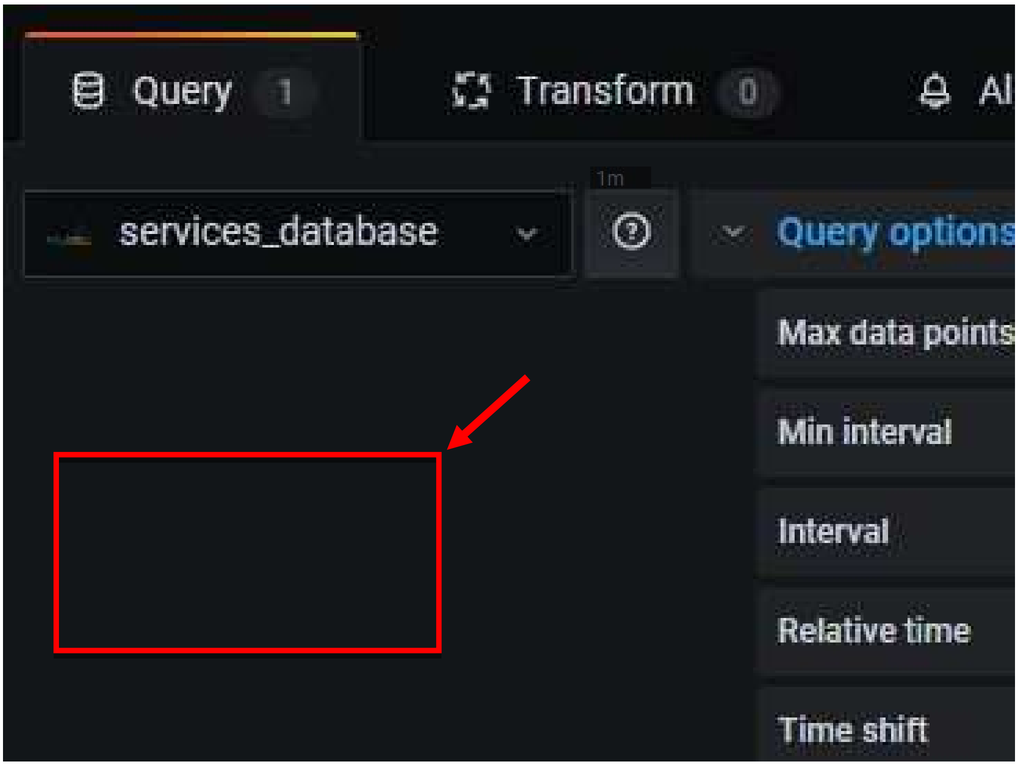

Figure 3.10 Grafana query example

After the query is executed, the panel looks like Figure 3.11.

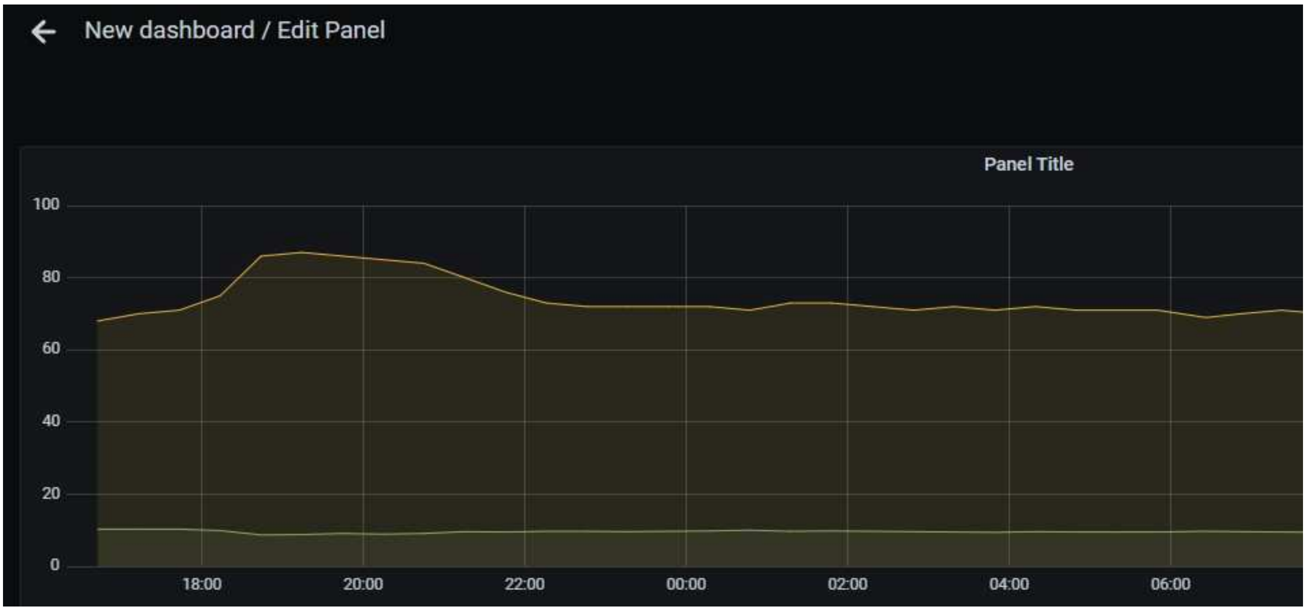

Figure 3.11 Time series panel

Additionally, the user can change several options of the graph, such as the display, the series overrides, the aces, the legend, the thresholds, the time regions, the links, and the repeat options (Figure 3.12).

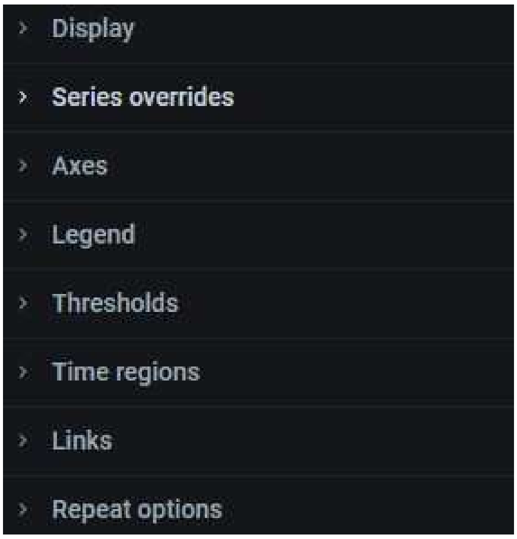

Figure 3.12 Graph options

As mentioned before, a dashboard can be comprised of several rows and panels. Each of these panels can be configured separately, something that increases the dashboard's flexibility.

The types of panels that the user can choose from are presented in the Figure 3.13 below.

Figure 3.13 Visualization types

4. IMPLEMENTATION IN HYDROUSA PROJECT: THE CASE OF CREATING DASHBOARD FOR HYDRO3 PILOT SYSTEM

In this chapter, the creation of the Grafana dashboard for one of the HYDRO sites (HYDRO3) will be presented as an example.

The HYDRO3 Pilot is an innovative sub-surface rainwater harvesting system, located in a remote area in the island of Mykonos, Greece.

The pilot is comprised of the following components for monitoring and controlling its operation:

- Two water tanks which are used for storing the water harvested from the rainwater collection system
- Two water level (distance) sensors for measuring the water quantity in each one of the two tanks
- Two temperature sensors for measuring water temperature in each tank
- Two pH sensors in the two tanks
- One weather station for monitoring environmental parameters of HYDRO3 PILOT (e.g., precipitation, light intensity etc.)
- Nine soil moisture sensors for monitoring the moisture in each one of the nine plots of the oregano field located on the same area.
- Nine electro valves for automated irrigation at each plot separately
- One relay for turning on the pump when irrigation in one of the plots is needed.

The data transmitted from the pilot, can be summarized as follows:

- Location (coordinates)
- Water quantity (2 tanks)
- Water temperature (2 tanks)
- Water pH (2 tanks)
- Water TDS (1 tank)
- Air temperature
- Air humidity
- Wind speed & gust
- Wind direction
- Light intensity
- Atmospheric pressure
- Precipitation
- Soil moisture (9 plots)
- Electro valve's status (opened/closed in 9 plots)

In order to develop the HYDRO 3 Pilot dashboard in Grafana, a choice was made to divide the aforementioned data in thirteen (13) distinctive categories:

- HYDRO 3 pilot (general information)
- Weather data
- 9 categories of Electro valves: 1 to 9
- Tank 1 and Tank 2 of HYDRO3

For the Grafana implementation, this means that the dashboard structure will contain thirteen (13) rows.

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Each of these rows contain panels – this is the name of the widgets Grafana uses to visualize data measurements or data sets.

Based on the available data, their type and the aforementioned categorization, the rows structured as follows:

- **Row 1: HYDRO3 Pilot**
  - Location (Worldmap panel)
  - HYDRO3 overview (Text panel)
- **Row 2: Weather data**
  - Temperature (Gauge panel)
  - Humidity (Gauge panel)
  - Wind speed (Gauge panel)
  - Wind gust (Gauge panel)
  - Temperature – Humidity (Graph panel)
  - Wind speed & wind gust (Graph panel)
- **Rows 3-11: Electrovalve 1 to Electrovalve 9**
  - Soil moisture (Gauge panel)
  - e-Valve status (Stat panel)
  - Moisture & e-Valve history (Graph panel)
- **Rows 12-13: HYDRO3 1^{st} & 2^{nd} tank**
  - pH (Gauge panel)
  - TDS (Gauge panel, only in the 2^{nd} tank)
  - Water level (Gauge panel)
  - Water temperature (Gauge panel)
  - pH history (Stat panel)
  - Water level & soil temperature (Stat panel)
- **Rows 14: HYDRO3 Performance indexes**
  - Water recovery efficiency
  - Rainwater harvesting performance
  - Practical irrigation efficiency
  - Oregano production water needs
  - Oil produced per Oregano mass
  - Irrigation energy efficiency
  - Lavender yield energy efficiency
  - Distillation energy efficiency

To summarize, the Grafana dashboard comprised of 14 rows containing 53 panels in total.

As inferred from the structure above, the unique types of panels that was used are five – the world map panel, the gauge panel, the stat panel, the graph panel, and the text panel

In the sections below, the creation of a panel from the five different panel categories will be explained, using the procedure explained in the previous chapter.

4.1. World map panel example (HYDRO3 location)

To receive the location data (latitude and longitude) from the GPS receiver of the nodes at the HYDRO3 Pilot site, a properly structured query was needed, having as input the node's IMEI which is the unique identifier used for each node.

The query is as follows:

```
SELECT
  lat,
  lng
FROM imei_coordinates
WHERE
  imei = " xxxxxxxxxxxxxxx"
```

After entering the query to the designated field, the visualization type panel (Worldmap panel) was set.

The panel was modified by using the options on the right side of the screen (Figure 4.1).

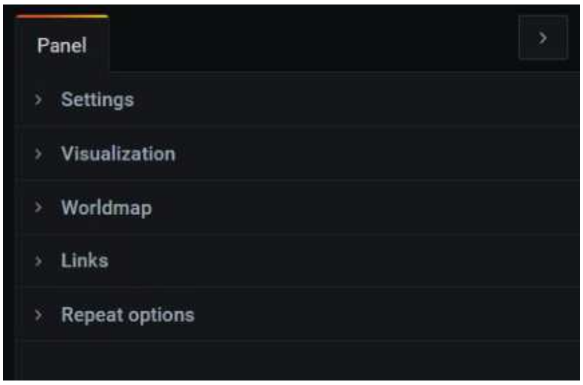

Figure 4.1 Options overview for the worldmap panel

By expanding "Settings", a title can be given to the panel (Figure 4.2).

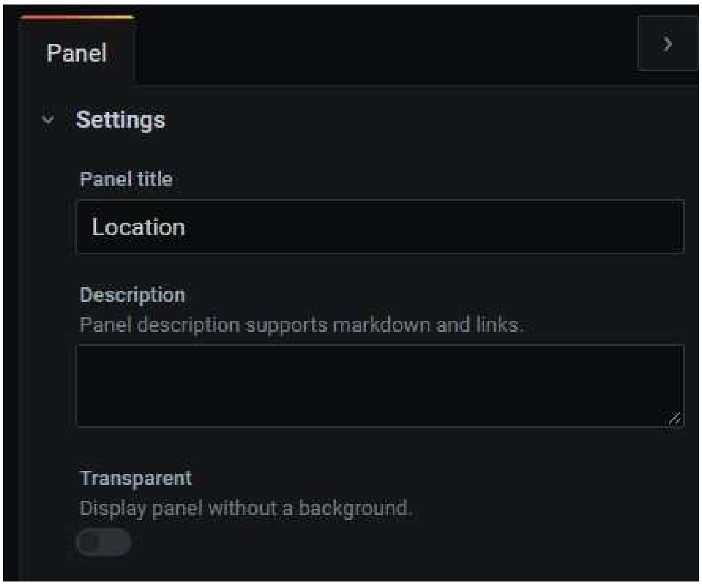

Figure 4.2 Settings for the worldmap panel

After giving title to the panel, the world map options was set, containing info such as the center of the map, the initial zoom, the maximum and minimum size of the circle, the location of the data, etc. (Figure 4.3).

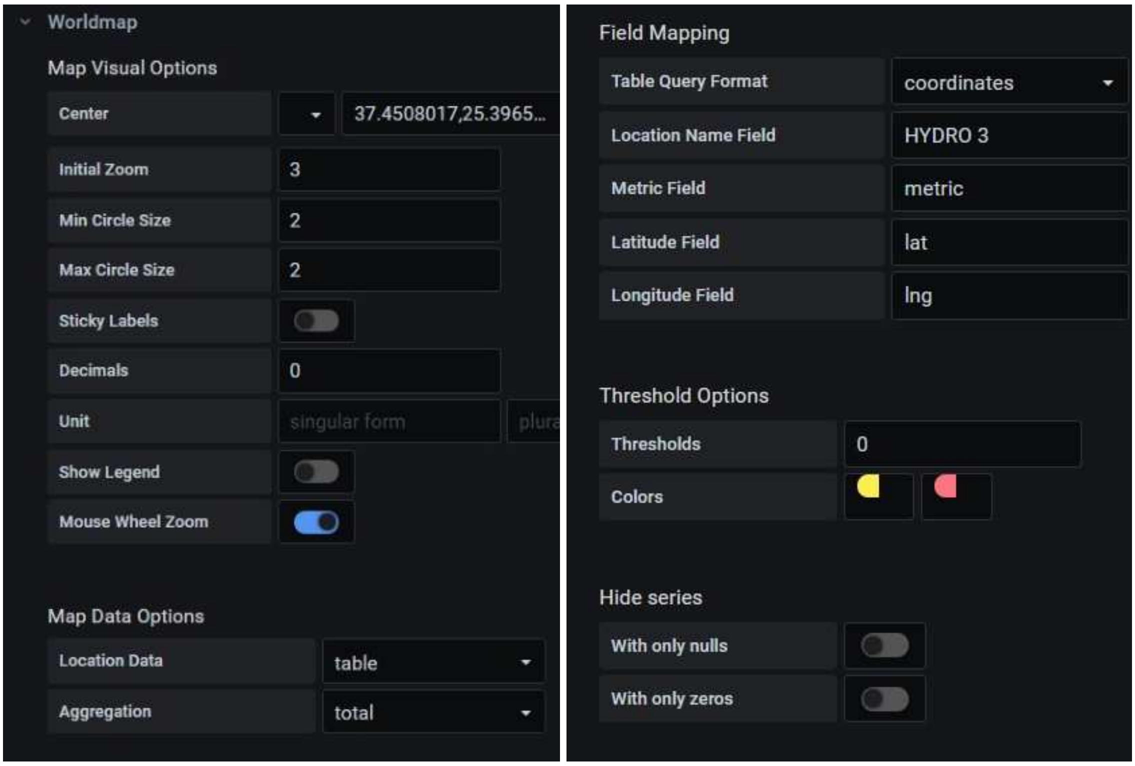

Figure 4.3 Additional world map options

The final form of the worldmap panel for HYDRO3 is presented in Figure 4.4.

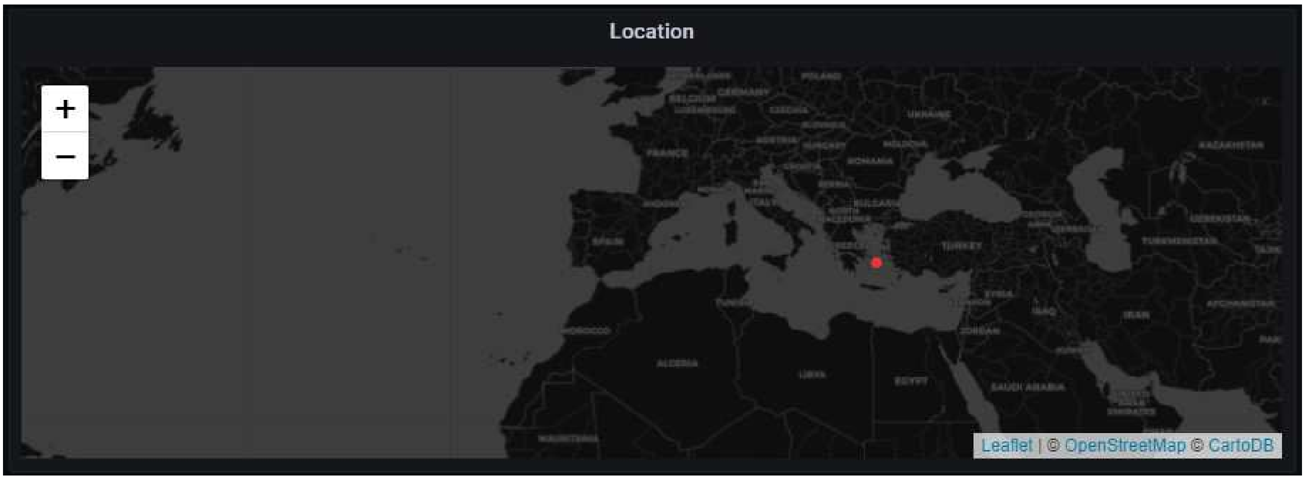

Figure 4.4 Final worldmap panel

4.2. Gauge panel example (Soil moisture)

In order to receive the soil moisture data from the soil moisture sensors at the HYDRO3 Pilot site, a properly structured query was needed, having as input the node's IMEI in which the sensors have been installed.

The query was as follows:

```
SELECT
  soil_moisture
FROM sensor_data
WHERE
```

```
  $__timeFilter(created_at)
  AND imei = " xxxxxxxxxxxxxxx"
ORDER BY created_at
```

After entering the query to the designated field, the visualization type panel (Gauge Panel) was set.

The panel was modified by using the options on the right side of the screen (Figure 4.5).

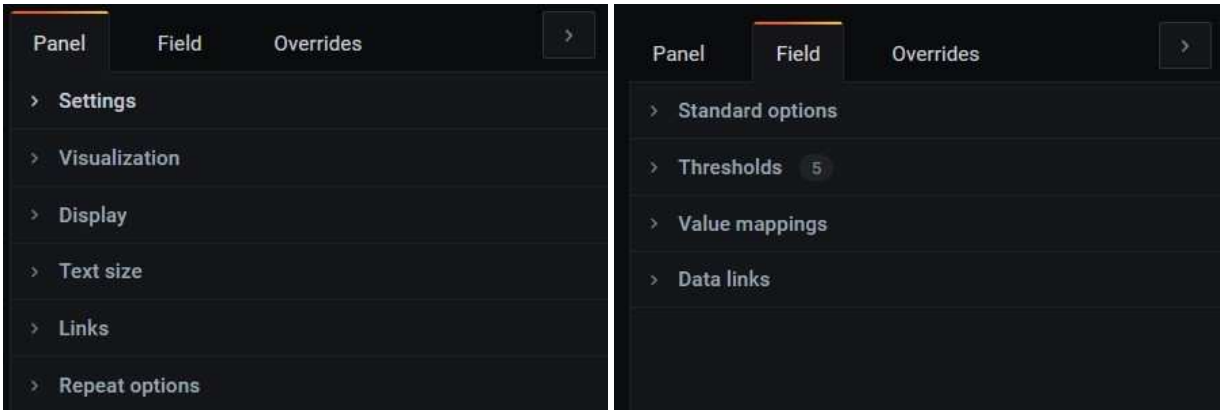

Figure 4.5 Options overview for the gauge panel

By expanding "Settings", a title was given to the panel (section 4.1).

After giving title to the panel, the gauge panel options for display were set (Figure 4.6). In the example of HYDRO3 Pilot dashboard, the options set to calculate the latest value (instead of showing the series of values), as well as showing the threshold markers.

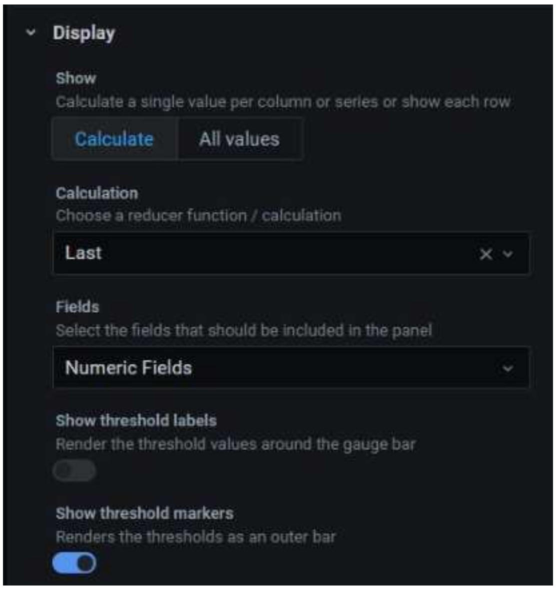

Figure 4.6 Additional gauge panel options for display

In the standard options menu, the units for the panel were set to Percent (0-100), having a minimum and maximum value of 0 and 100 respectively, with 1 decimal. The panel's color scheme was defined from the threshold's menu, where colors for four different thresholds have been set (at 5%, 10%, 20% and 25%), as well as the color of the base-zero value (Figure 4.7).

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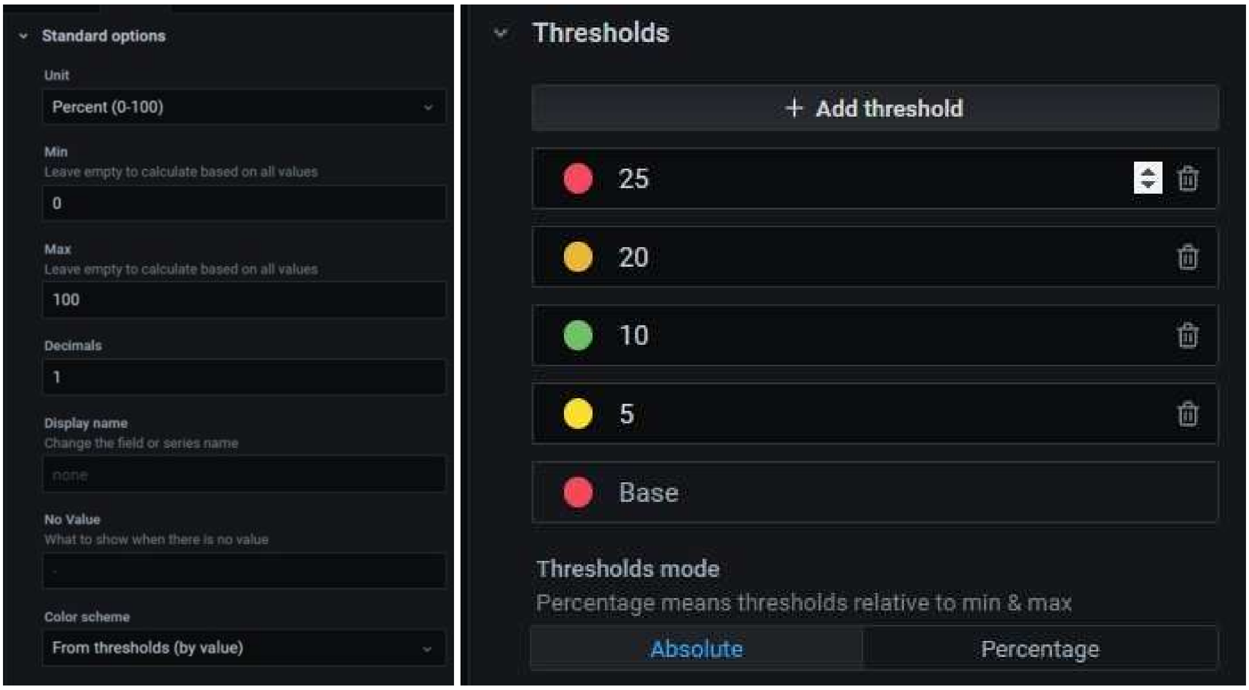

Figure 4.7 Additional gauge panel options

The final form of the gauge panel for soil moisture is presented in Figure 4.8.

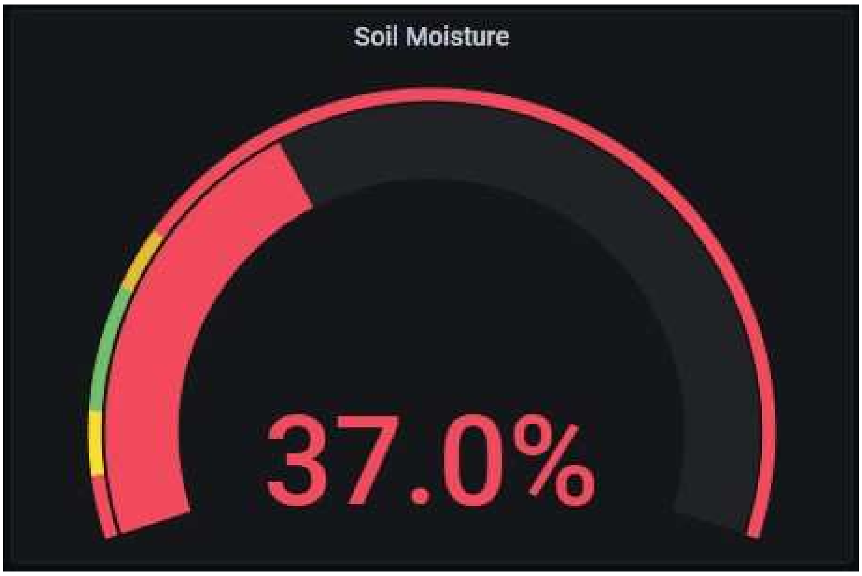

Figure 4.8 Final gauge panel

4.3. Graph panel example (Wind)

In order to receive the wind data (wind speed and wind gust) from the weather station at the HYDRO3 Pilot site, a properly structured query was needed, having as input the node's IMEI, in which the weather station has installed.

The query was as follows:

```
SELECT
  timestamp AS "time",
  wind_speed,
```

```
  gust_speed
FROM sensor_data
WHERE
  $__unixEpochFilter(timestamp) AND
  imei = " xxxxxxxxxxxxxxx"
ORDER BY timestamp
```

After entering the query to the designated field, the visualization type panel (Graph Panel) was set.

The panel was modified by using the options on the right side of the screen (Figure 4.9).

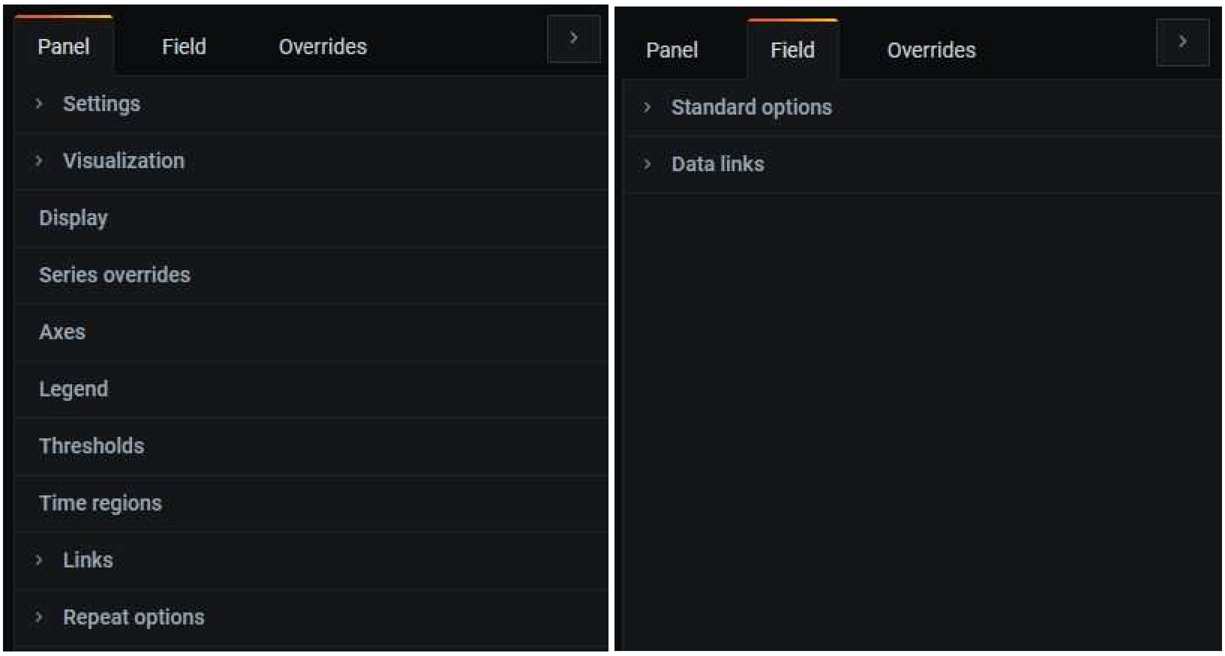

Figure 4.9 Options overview for the graph panel

By expanding “Settings”, a title was given to the panel (section 4.1). After giving title to the panel, the graph panel options for display, axes and legend were set (Figure 4.10), as apart from the graph itself, the minimum, maximum, average and current values for both wind gust and wind speed should appear at the graph. Moreover, the units in axis Y were set to meters/second (m/s), while axis X shows time (in 24h format).

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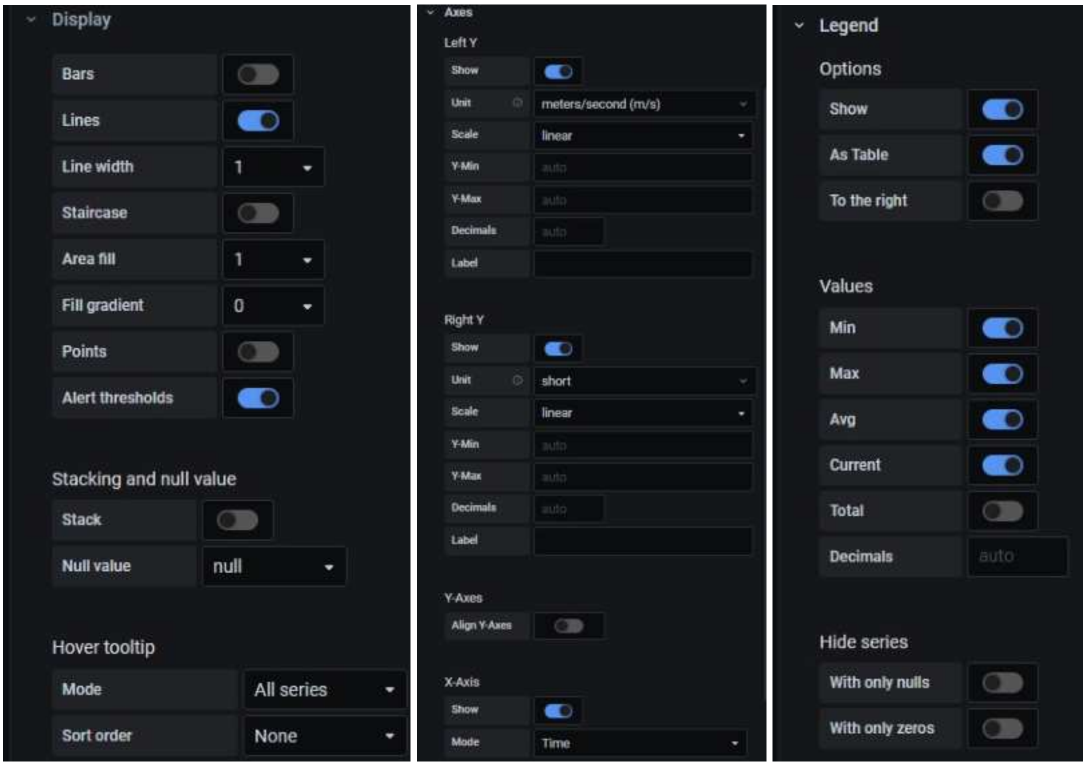

Figure 4.10 Additional graph options for display, axes and legend

Additionally, the units for the minimum, maximum, average and current values for both wind gust and wind speed were set at the standard options of field section (Figure 4.11) as meters/second (m/s).

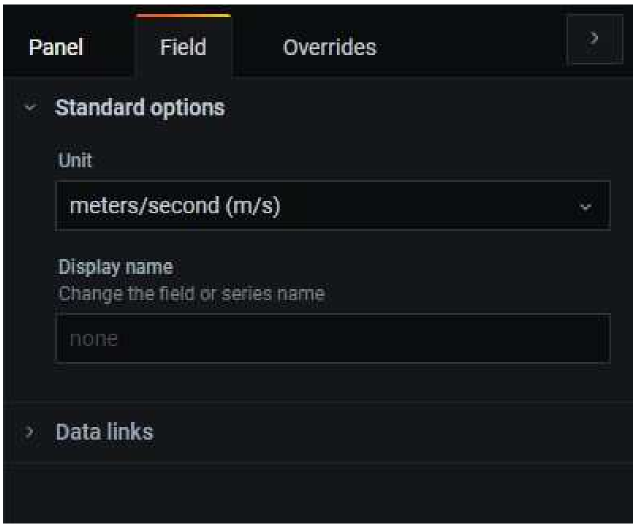

Figure 4.11 Additional graph options field

The final form of the graph panel for wind is presented in Figure 4.12.

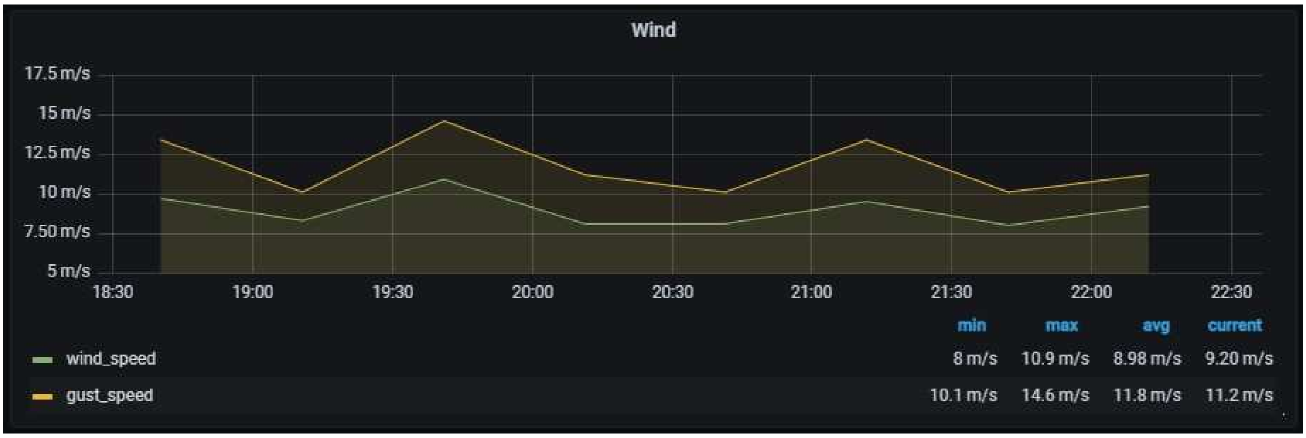

Figure 4.12 Final graph panel

4.4. Stat panel example (Atmospheric pressure)

To receive the pressure data from the weather station at the HYDRO3 Pilot site, a properly structured query was needed, having as input the node's IMEI, in which the weather station has installed.

The query was as follows:

```
SELECT
  pressure
FROM sensor_data
WHERE
  $__timeFilter(created_at)
  AND imei = " xxxxxxxxxxxxxxx"
ORDER BY created_at
```

After entering the query to the designated field, the visualization type panel needs were set.

The panel then was modified by using the options on the right side of the screen (Figure 4.13).

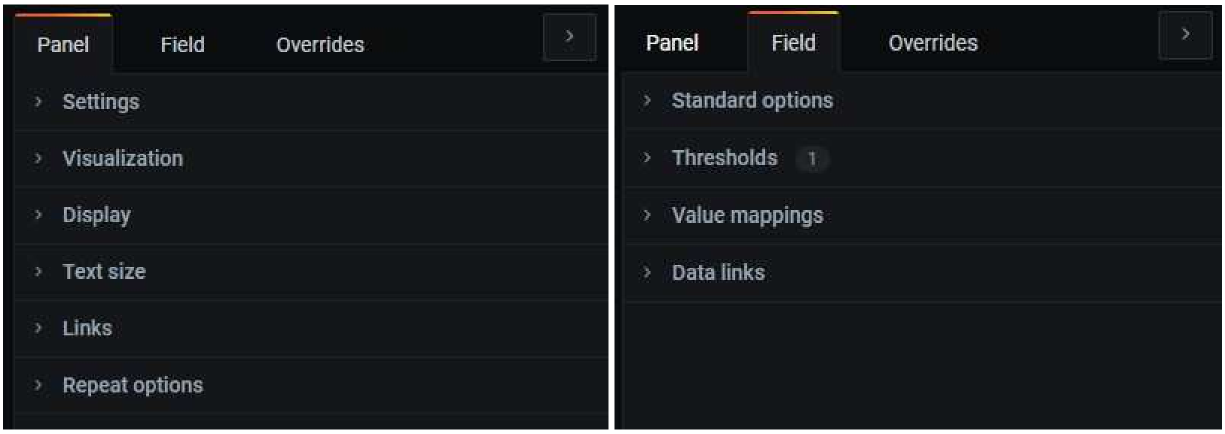

Figure 4.13 Options overview for the stat panel

By expanding "Settings", a title was given to the panel. After giving title to the panel, the stat panel options for display and standard options were set (Figure 4.14). In the example of HYDRO3 Pilot dashboard, the options set was to calculate the latest value (instead of showing the series of values), setting the displayed color and setting the unit to Hectopascals.

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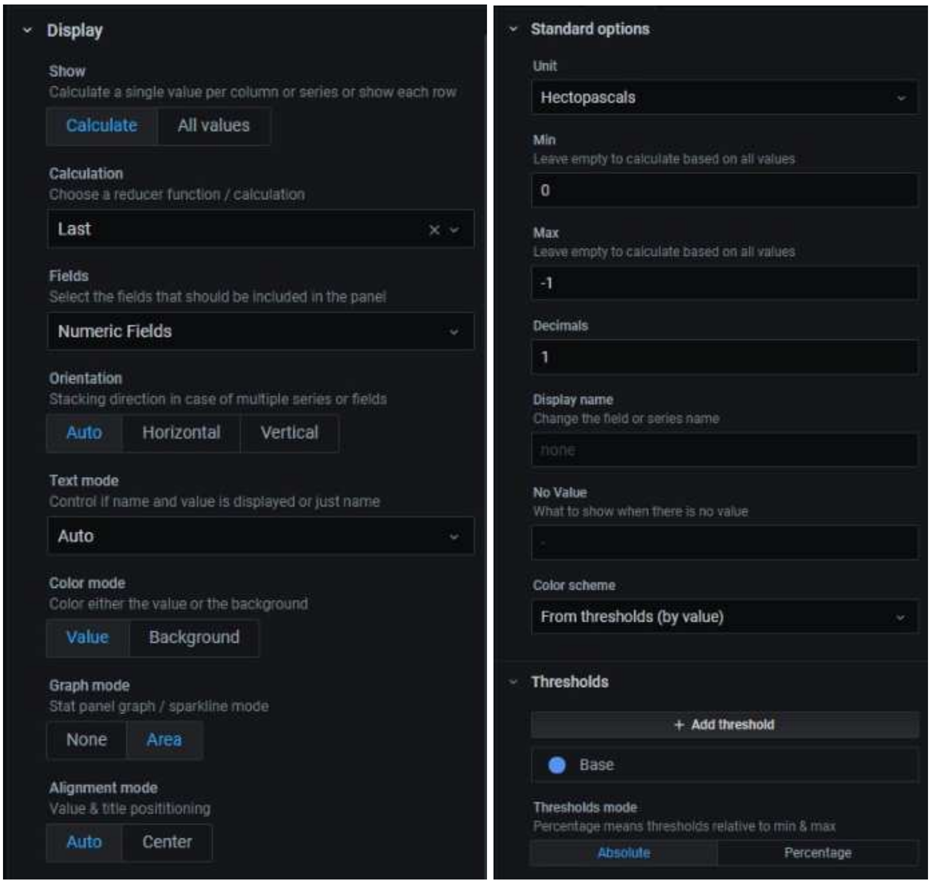

Figure 4.14 Additional stat panel options

The final form of the stat panel for pressure is presented in Figure 4.15.

Figure 4.15 Final stat panel

4.5. Text panel example (HYDRO3 overview)

In order to show a figure with the pilot site overview, a text panel is being used and instead of an HTML formatted text, a figure that is already uploaded on a website is used and with appropriate HTML code (image source and styling) is inserted in the content of the text panel (see Figure 4.16).

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The code is as follows:

```
<img src="https://www.agenso.gr/wp-content/uploads/2023/03/hydro3cr.png"
style="height: 100%; width: auto; object-fit: contain; display: block;
margin: auto;">
```

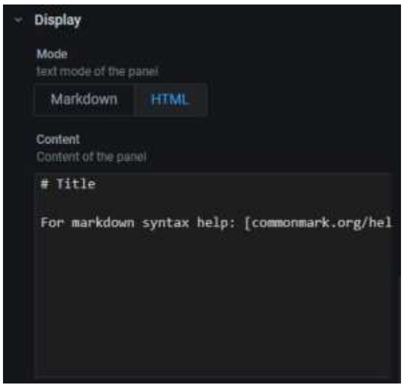

Figure 4.16 Display properties in the text panel

4.6. Customizing the Dashboard

For each panel, users can change their size or placement, so that the final layout suits their needs. Figure 4.17 presents an example of changing the size and placement of the two panels in the soil moisture row. The changing of placement can be done by clicking on the panel and dragging it around to the desired space, whereas the panel’s size can be changed by dragging the arrow of the panel’s lower right corner to the desired size (Figure 4.18).

Figure 4.17 Changing size and placement of panels

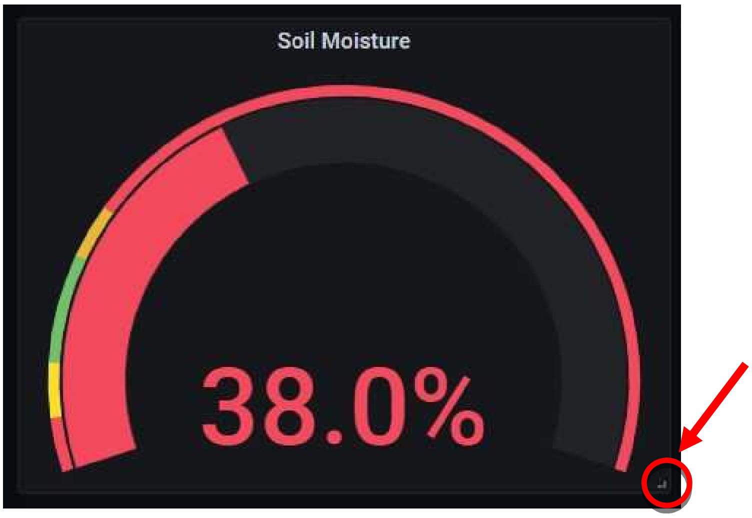

Figure 4.18 Arrow for changing the panel's size

At the top right corner of the dashboard, the user can select the time range (Figure 4.19) in which the data of the sensors will be projected at the graph panels of the selected dashboard.

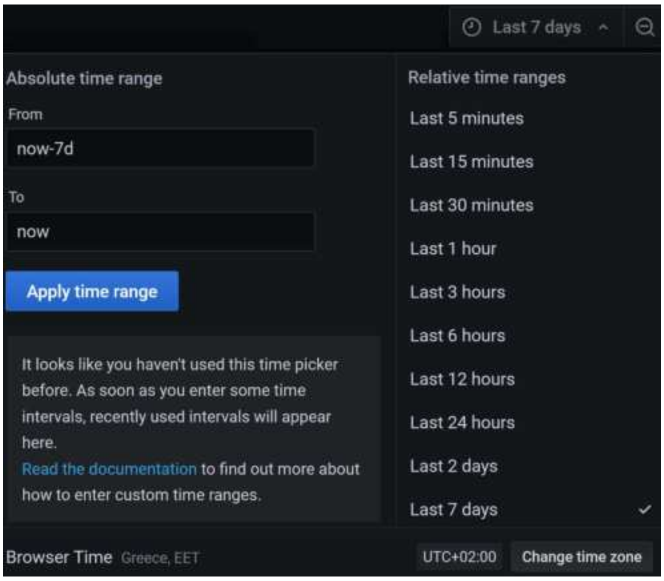

Figure 4.19 Selection of the time range of the dashboard charts

In addition, the user can view and export the data projected at the panels in CSV format (Figure 4.20) by clicking at the panel title menu and then by selecting the option "Inspect".

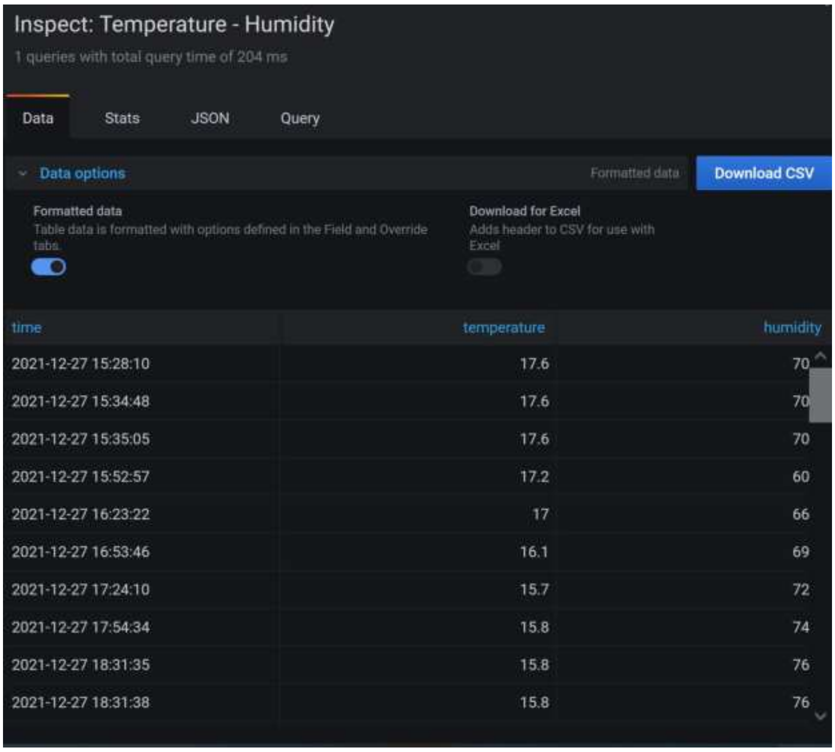

Figure 4.20 Data export

Finally, the user can add custom alerts by creating alerts at any dashboard graph panel (Figure 4.21). An example is given at Figure 4.22 where an alert was created for soil moisture value under 10%.

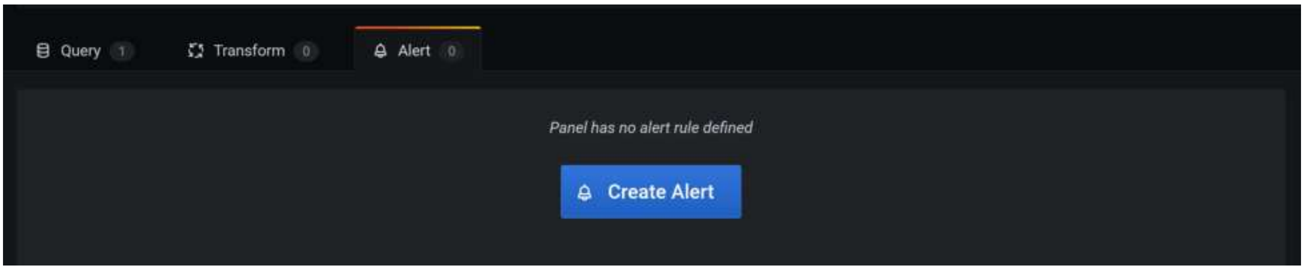

Figure 4.21 Create alert.

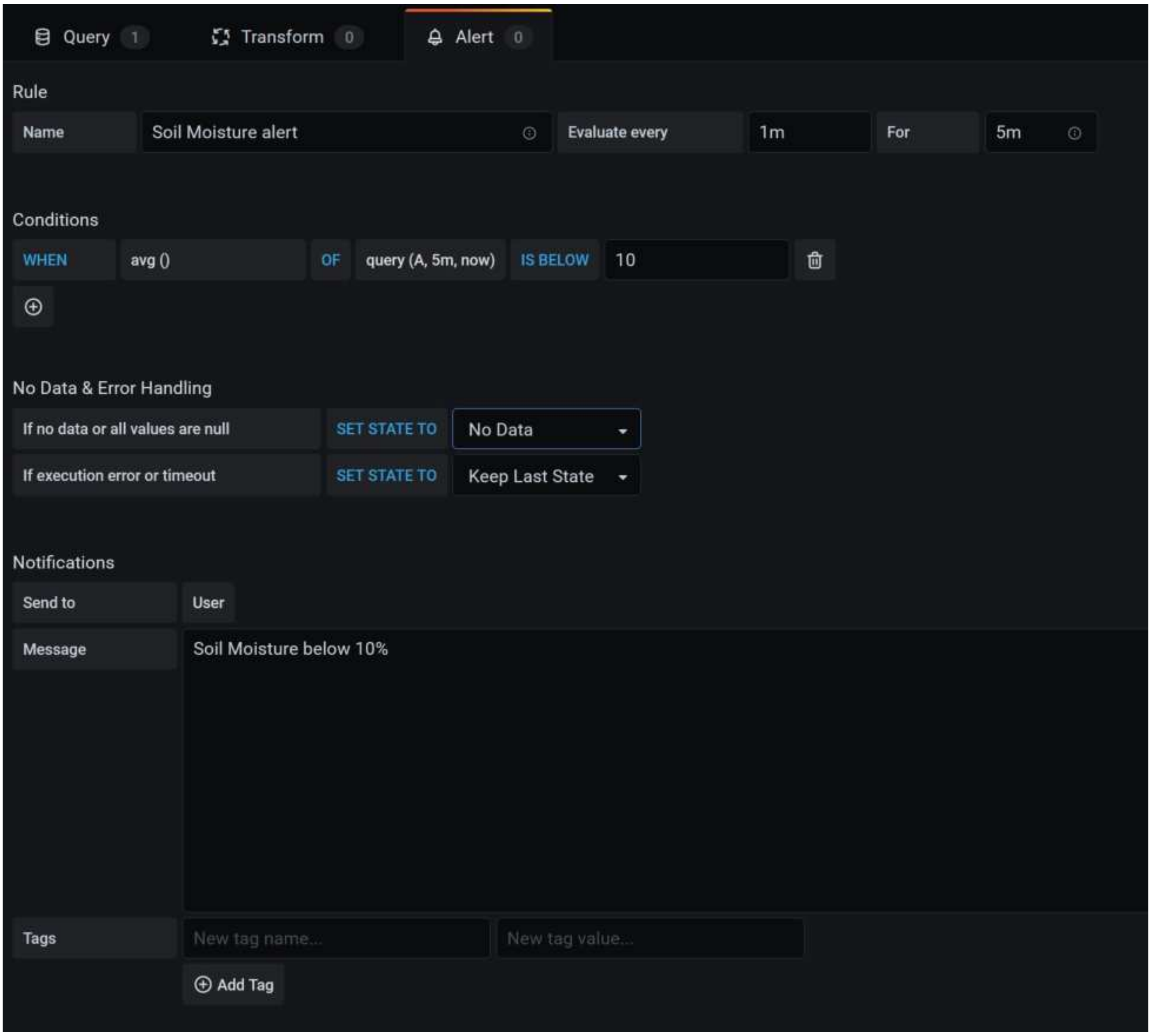

Figure 4.22 Alert rules

4.7. Extending Grafana capabilities by creating plugins

As Grafana is a platform that has been originally developed for visualization of data, it's not directly supporting the controlling of any type of device. For making the system capable to control the ICT systems developed for the needs of HYDROUSA project, a plugin that called "Button Panel" was used. This plugin facilitates the integration of Grafana with various HTTP/REST APIs and a middleware was developed using the PHP language for making it compatible with the HYDROUSA data repository (see deliverable D5.6 "Data Repository"). As a result, users can control through Grafana platform the relays and electro valves installed at HYDROUSA pilot site (Figure 4.23).

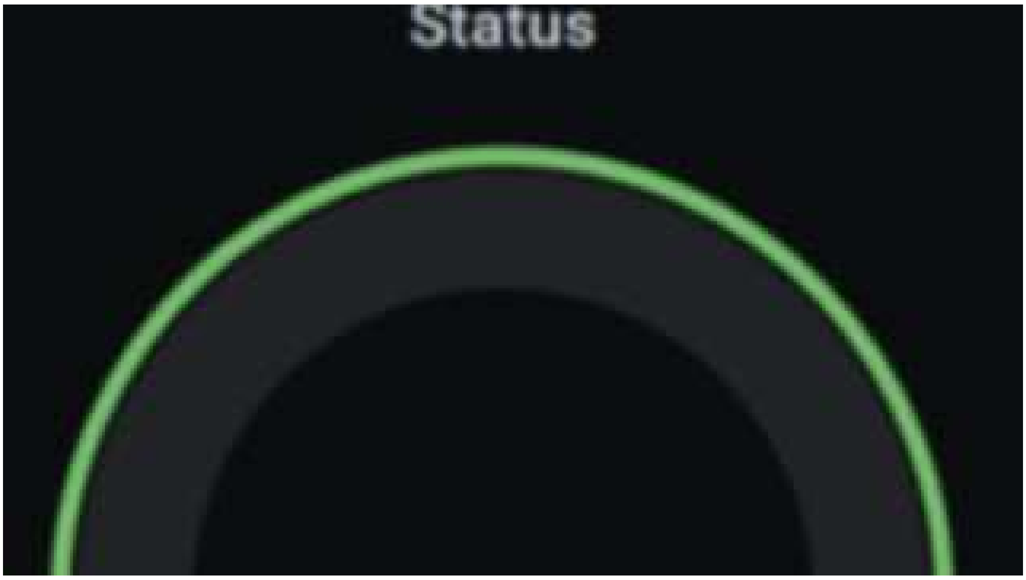

Figure 4.23 Plug in for controlling through Grafana platform the relays and electro valves

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5. SYSTEM UPGRADE FOR IMPORTING OFFLINE DATA: THE CASE OF HYDRO1 PILOT SYSTEM

To provide the opportunity for entering offline data the system has been upgraded. For this purpose, database forms have been created where the user is able to insert the parameters which are saved in the database. These data can be accessed and viewed then from Grafana platform. Indicatively Figure 5.1 presents the input form for HYDRO1 and Figure 5.2 the accessing of data through the Grafana dashboard.

This upgrade of the system was important because the offline and online stored data are being combined by utilizing database functions to estimate important quantities related to the environmental and financial performance of the systems. These calculated results are also accessible from the Grafana platform.

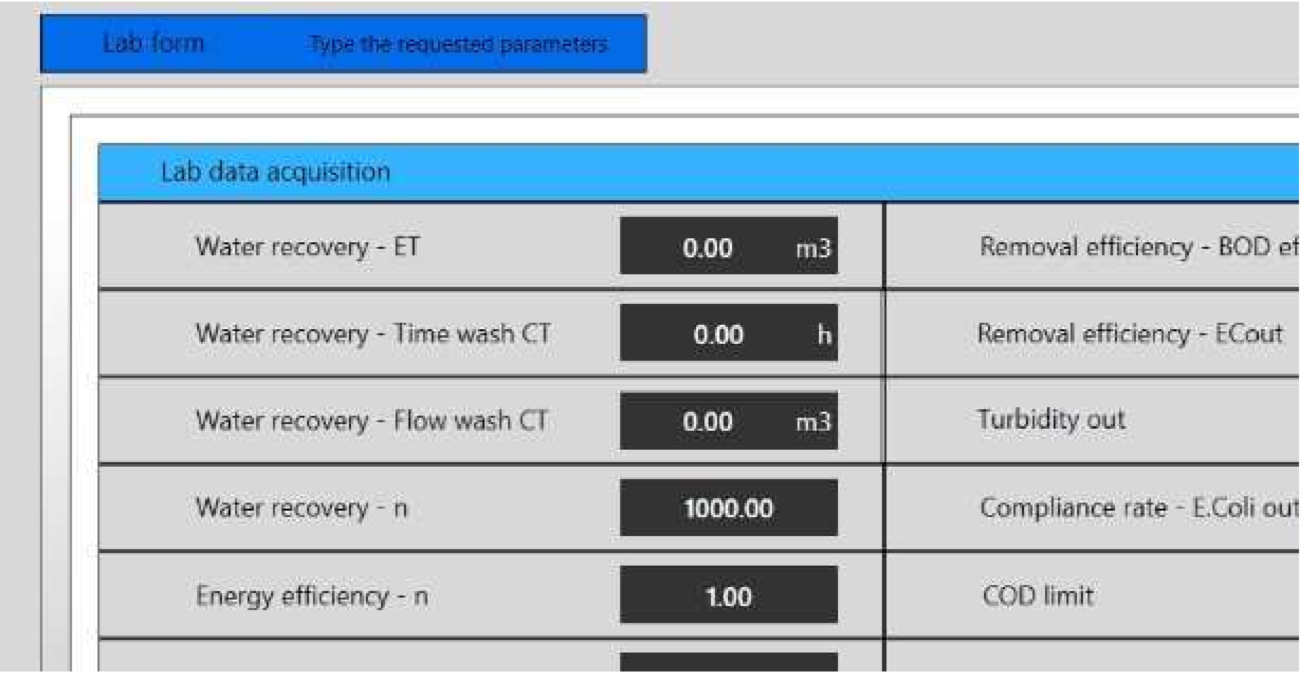

Figure 5.1 Input form for offline results

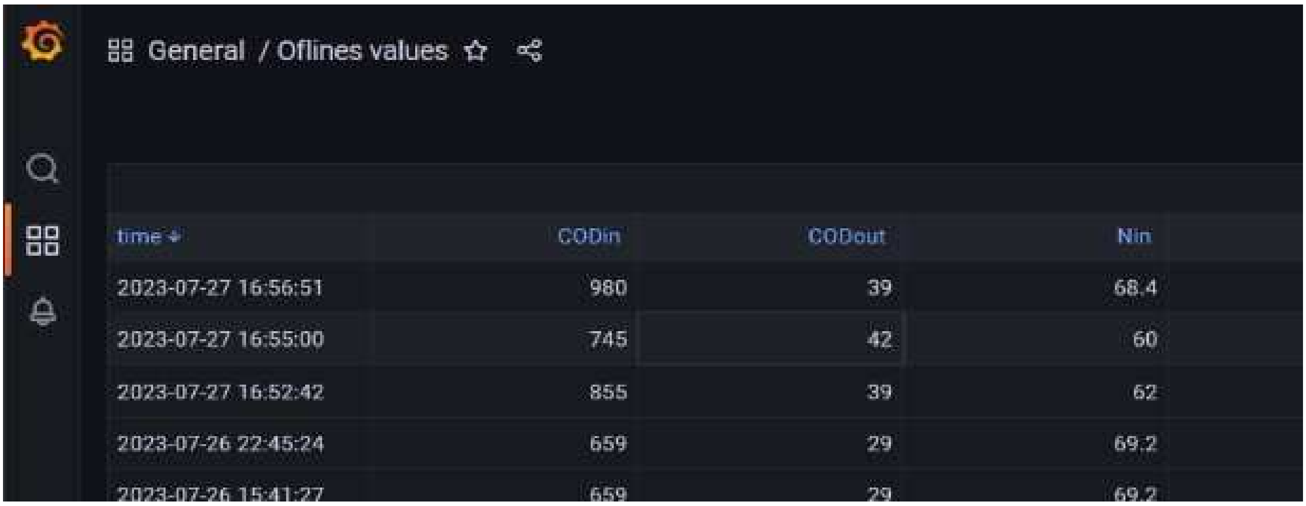

Figure 5.2 Offline results access via Grafana platform

6. PRESENTATION OF HYDRO 1&2 PILOT SYSTEM DASHBOARDS

Figure 10.1 - Figure 10.9 illustrate the final dashboards created for the HYDRO 1 & 2 pilots.

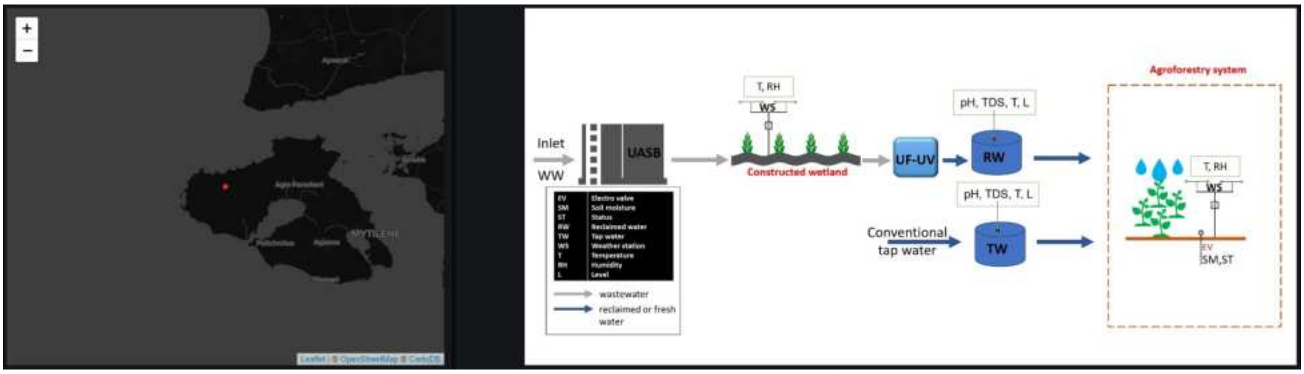

Figure 6.1 General information about the pilot site

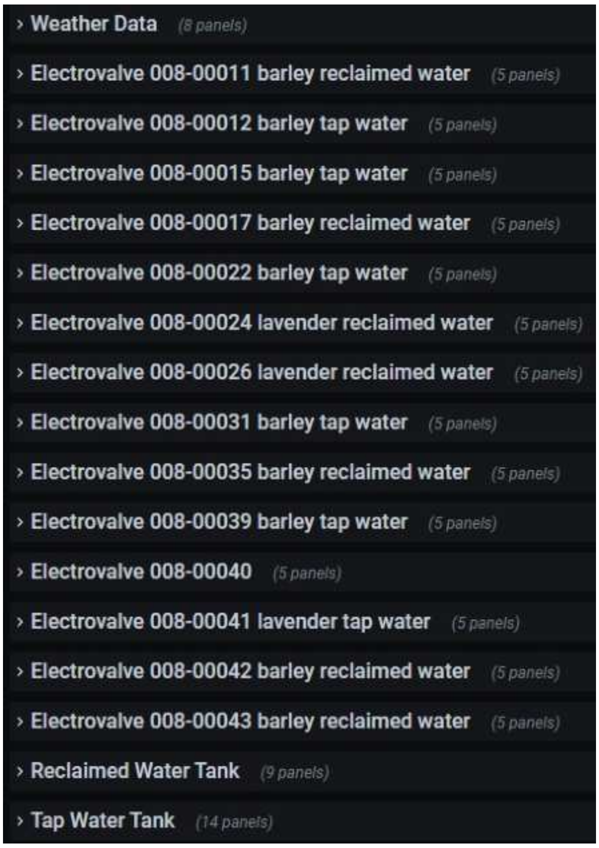

Figure 6.2 The rows of the HYDRO 1 & 2 pilot dashboard

Figure 6.3 Weather data for HYDRO 1 & 2

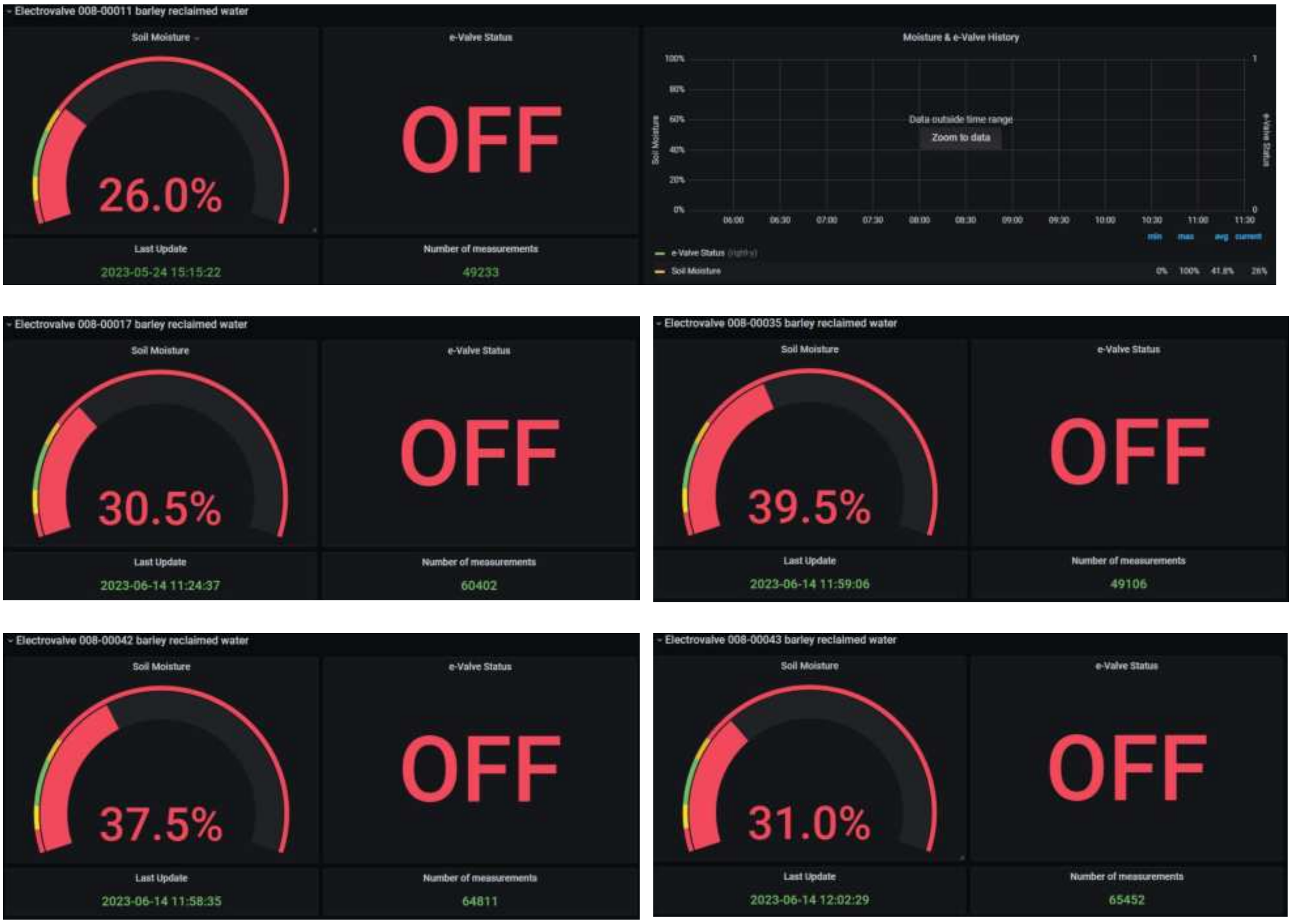

Figure 6.4 Electrovalves 008-00011, 008-00017, 008-00035, 008-00042, 008-00043 barley reclaimed water data

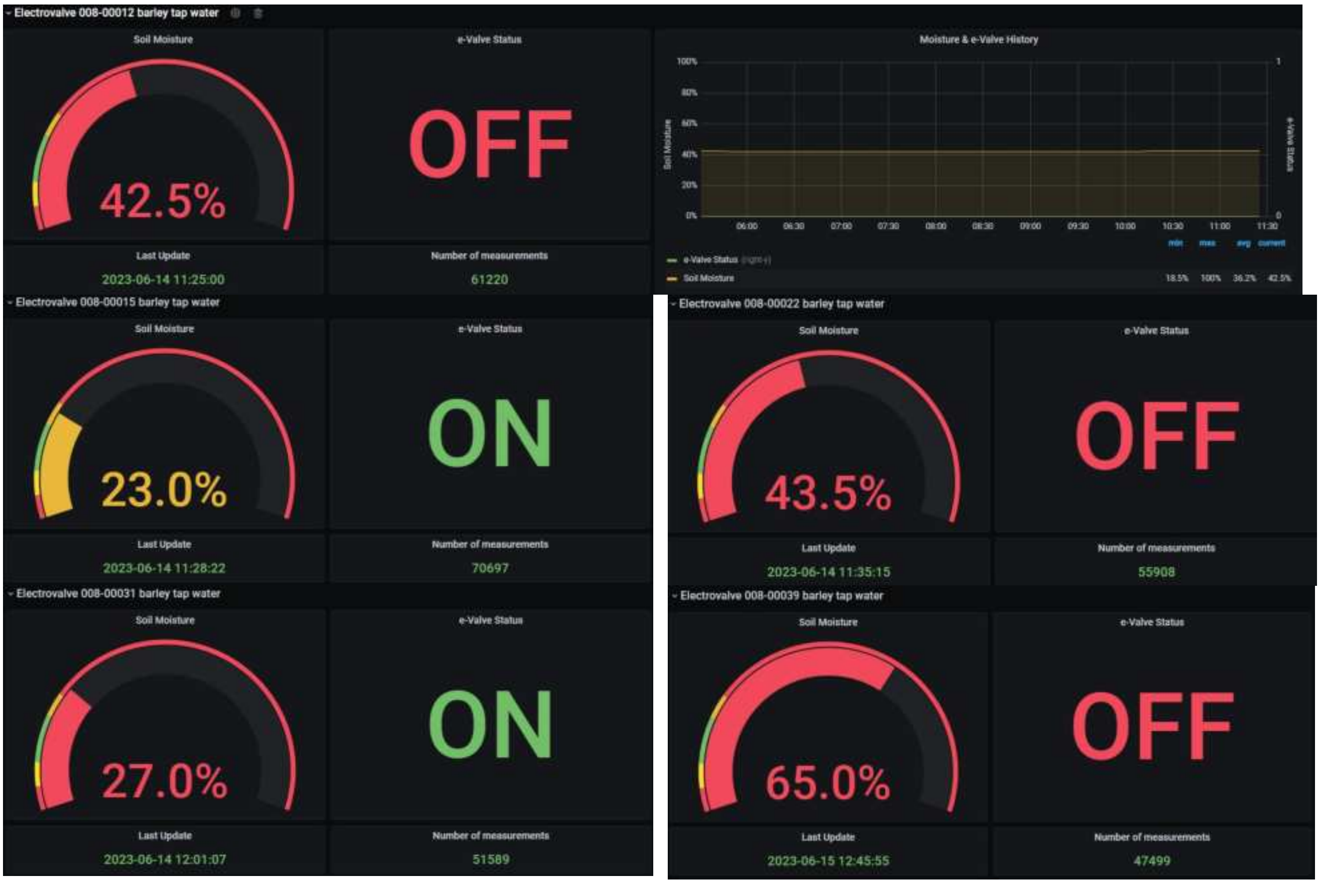

Figure 6.5 Electrovalves 008-00012, 008-00015, 008-00022, 008-00031, 008-00039 barley tap water data

Figure 6.6 Electrovalves 008-00024 and 008-00026 lavender reclaimed water data

Figure 6.7 Electrovalve 008-00041 lavender tap water data

Figure 6.8 Reclaimed Water Tank data

Figure 6.9 Tap Water Tank data

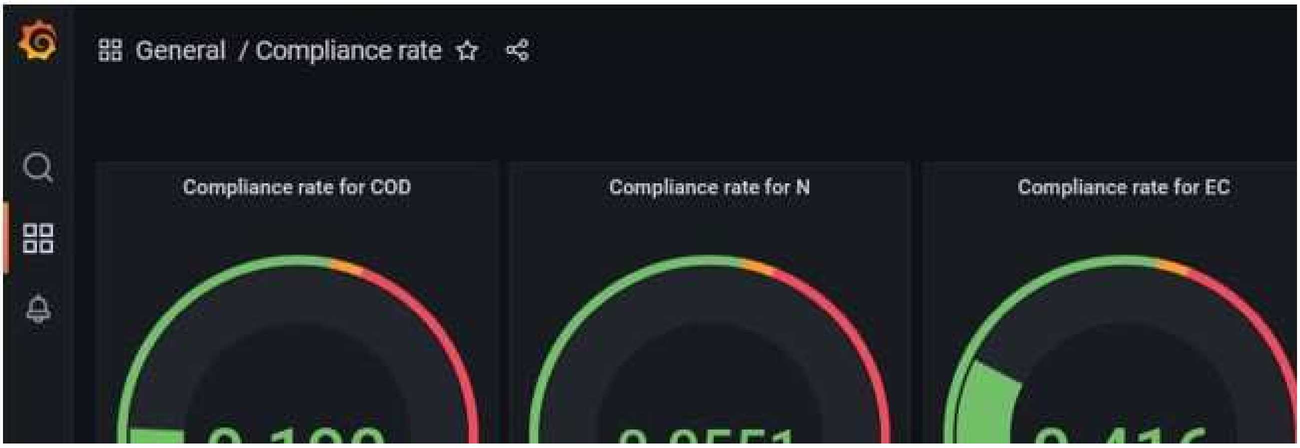

Figure 6.10 Visualization of performance indexes regarding the compliance rate

Figure 6.11 Visualization of performance indexes regarding water recovery

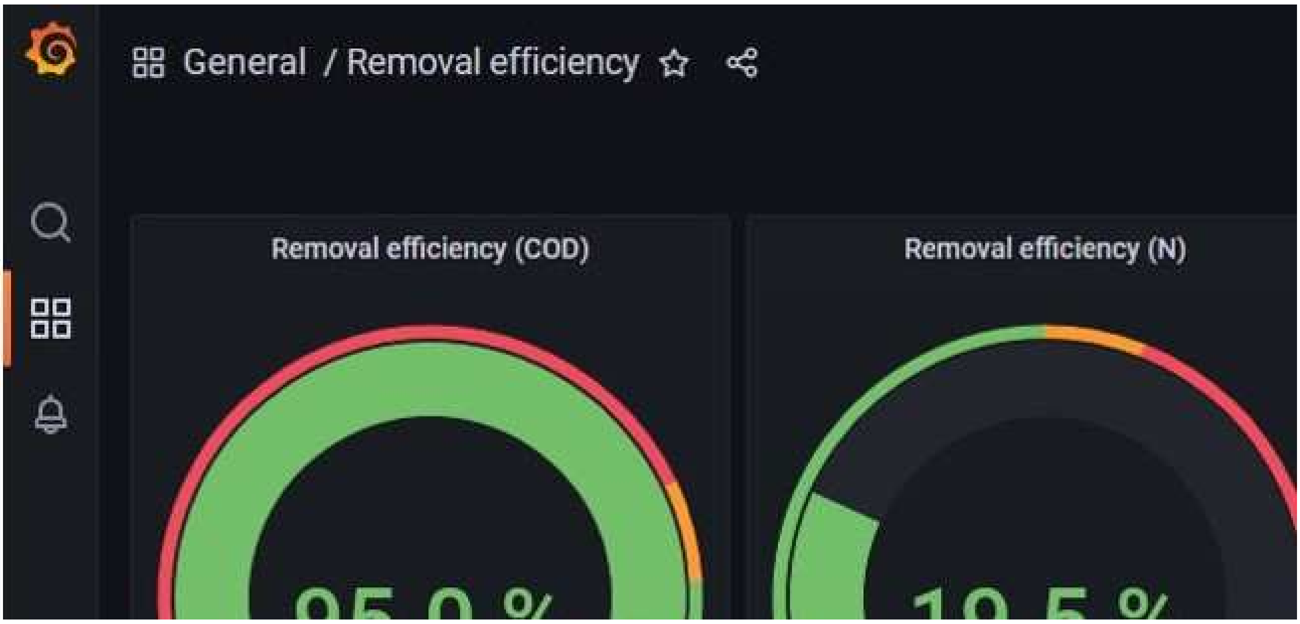

Figure 6.12 Visualization of performance indexes regarding the removal efficiency

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7. PRESENTATION OF HYDRO3 PILOT SYSTEM DASHBOARD

Figure 7.1-Figure 7.10 present the final dashboard created for the HYDRO3 pilot.

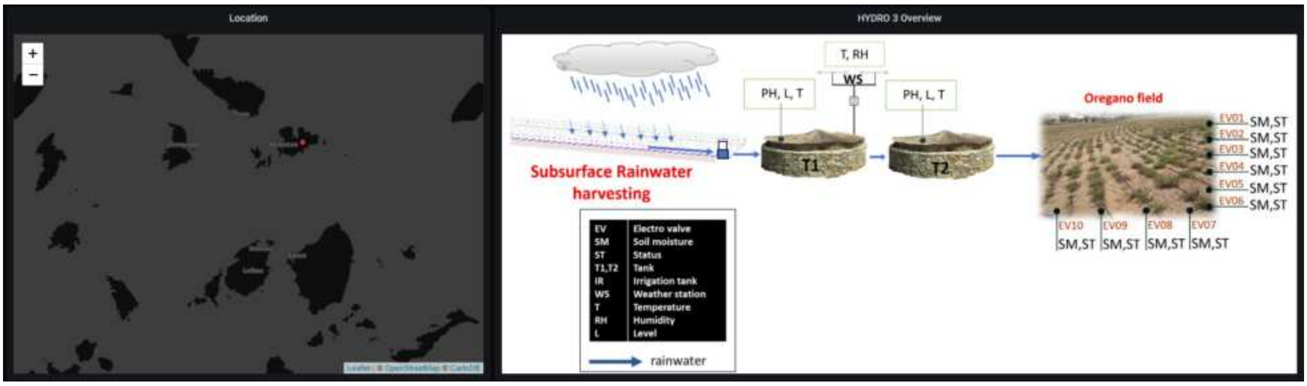

Figure 7.1 General information about the HYDRO3 pilot site

Figure 7.2 The rows of the HYDRO3 pilot dashboard

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Figure 7.3 Weather data for HYDRO3

Figure 7.4 Electrovalve 1 to 4 data

Figure 7.5 Electrovalve 5 to 9 data

Figure 7.6 HYDRO3 1st tank data

Figure 7.7 HYDRO3 2nd tank data

Figure 7.8 Visualization of performance indexes for HYDRO3

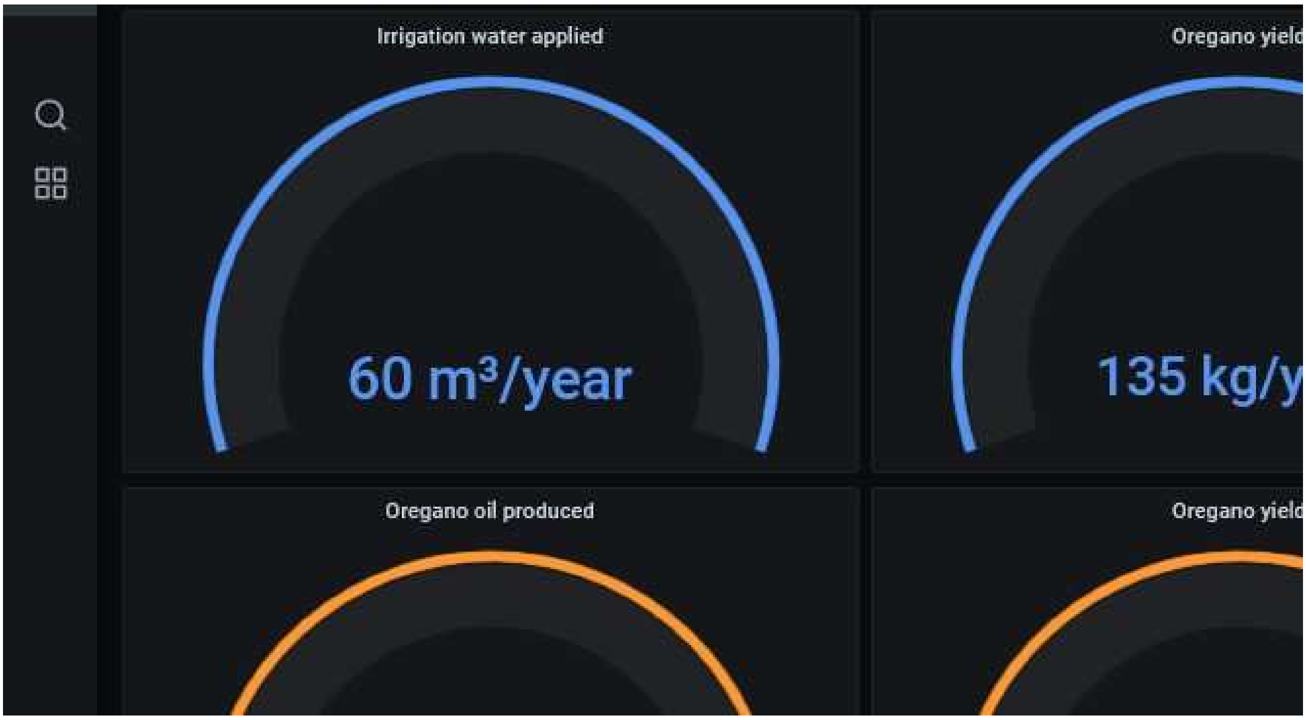

Figure 7.9 Visualization of performance indexes for HYDRO3

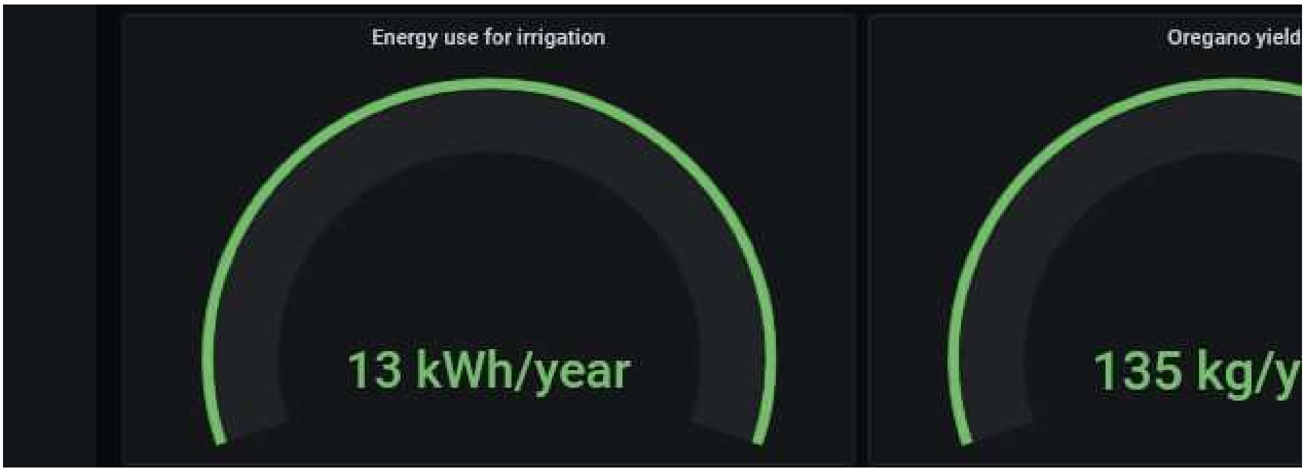

Figure 7.10 Visualization of performance indexes for HYDRO3

8. PRESENTATION OF HYDRO4 PILOT SYSTEM DASHBOARD

Figure 8.1 - Figure 8.8, present the final dashboard created for the HYDRO4 pilot.

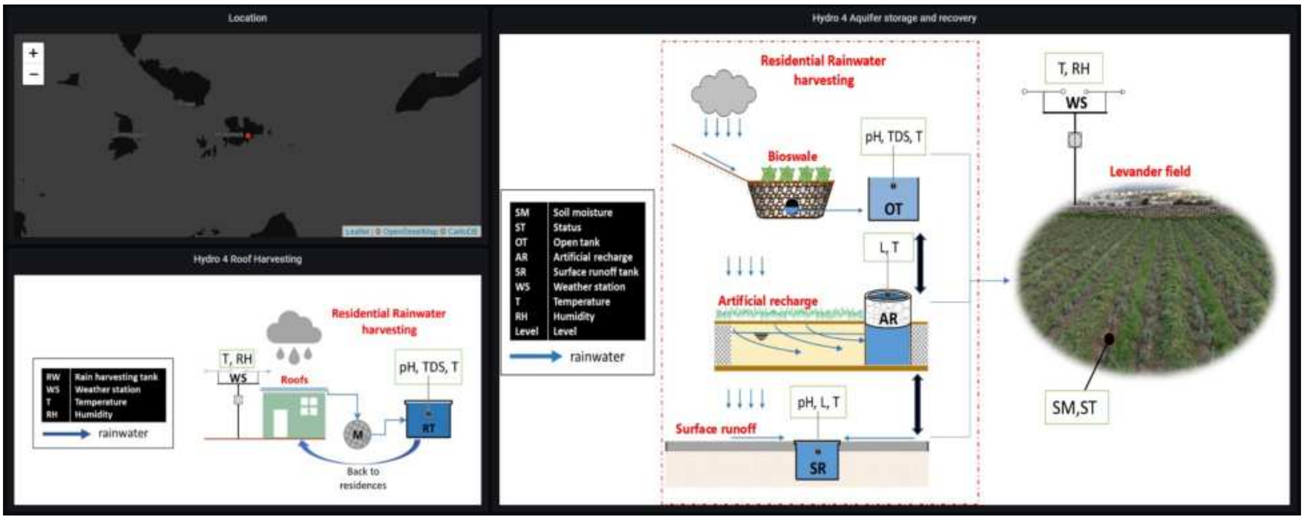

Figure 8.1 General information about the HYDRO4 pilot site

Figure 8.2 The rows of the HYDRO4 pilot dashboard

Figure 8.3 Weather data for HYDRO4

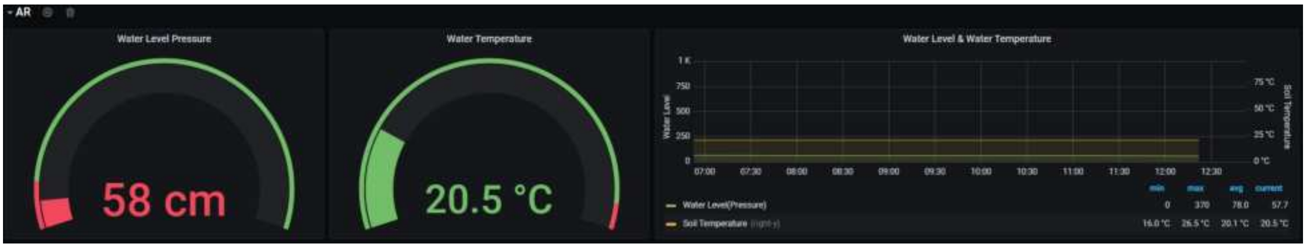

Figure 8.4 AR data

Figure 8.5 Well 1 data

Figure 8.6 Roof Harvesting Tank data

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Figure 8.7 Surface Runoff Tank data

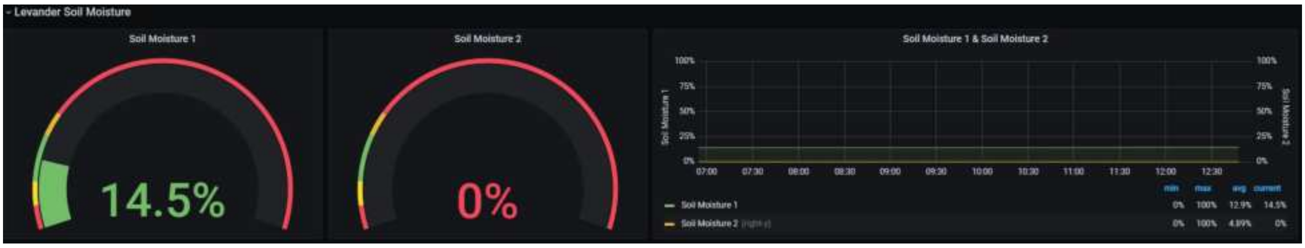

Figure 8.8 Levander Soil Moisture data

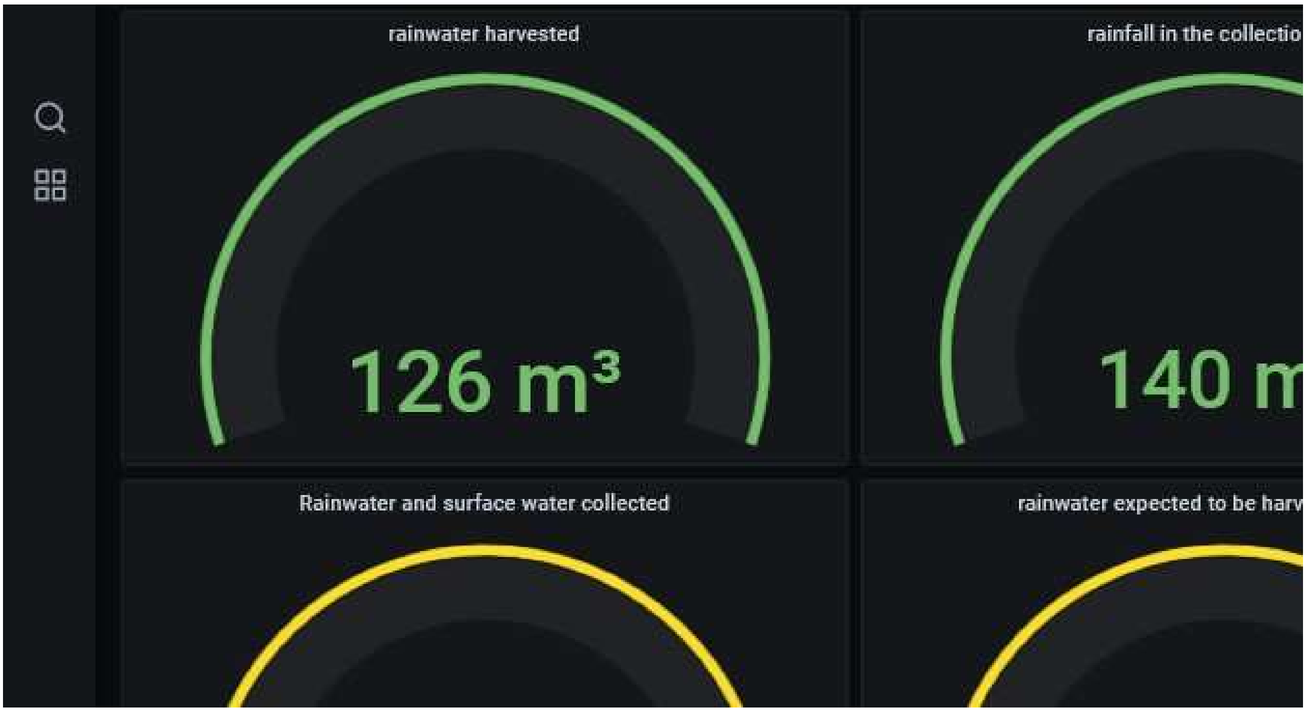

Figure 8.9 Visualization of performance indexes for HYDRO4

Figure 8.10 Visualization of performance indexes for HYDRO4

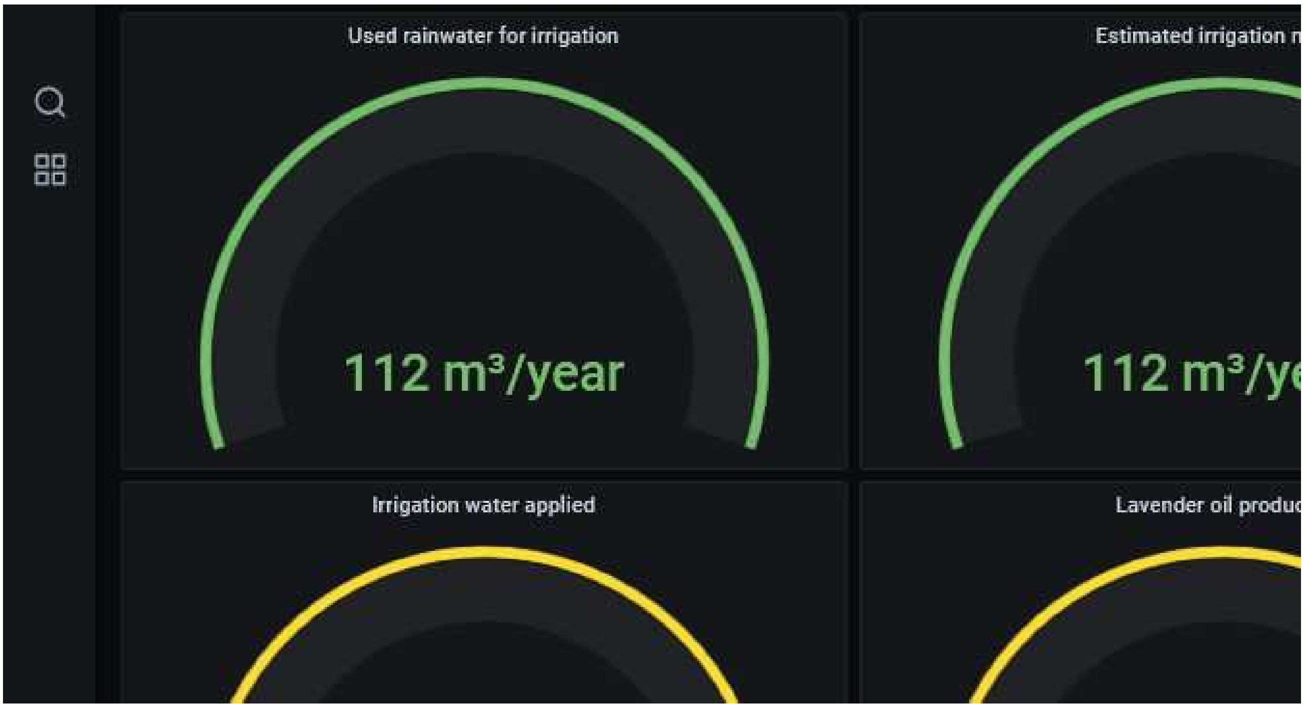

Figure 8.11: Visualization of performance indexes for HYDRO4

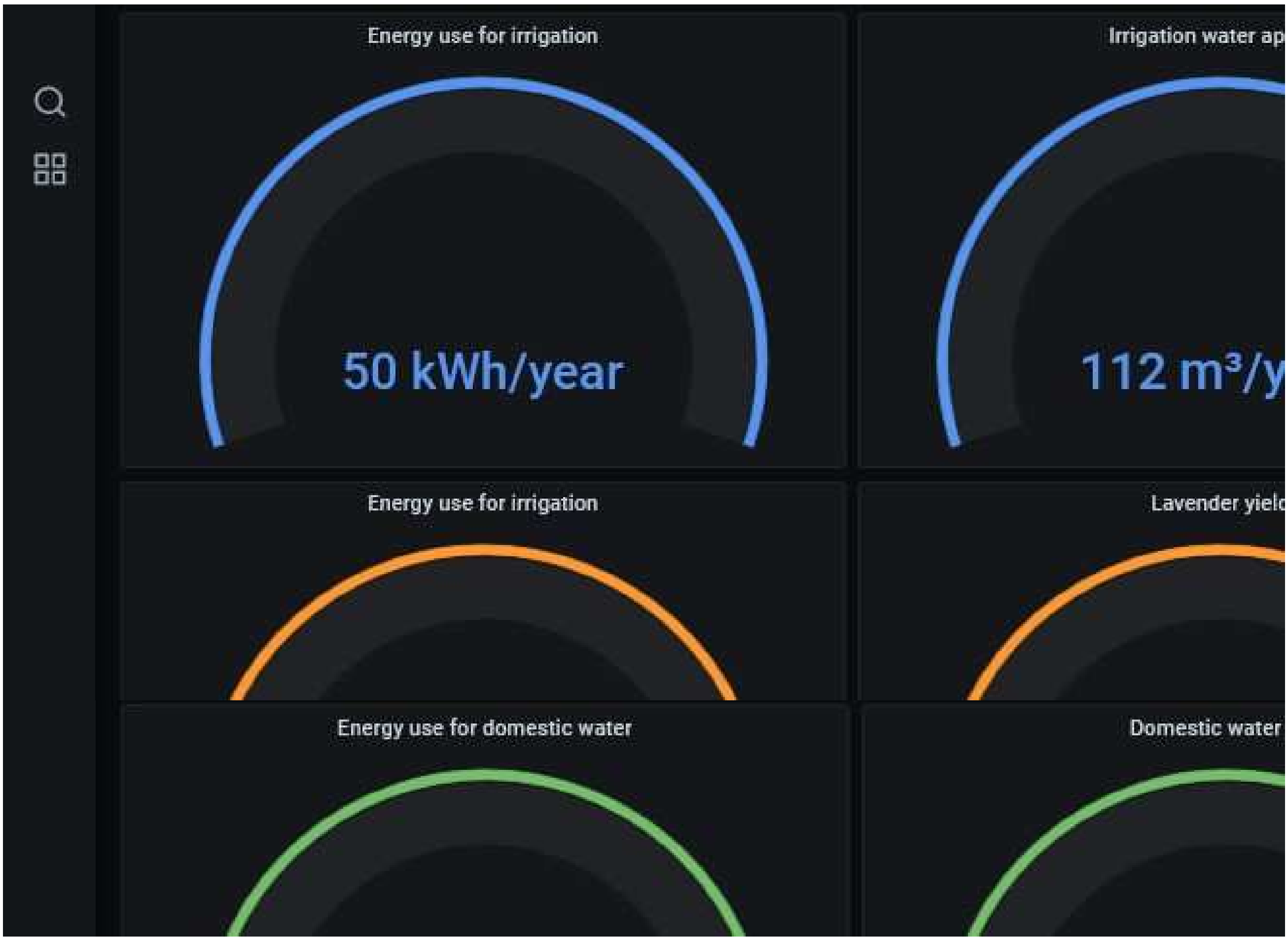

Figure 8.12 Visualization of performance indexes for HYDRO4

9. PRESENTATION OF HYDRO5 PILOT SYSTEM DASHBOARD

Figure 9.1 - Figure 9.7, illustrate the final dashboard created for the HYDRO5 pilot.

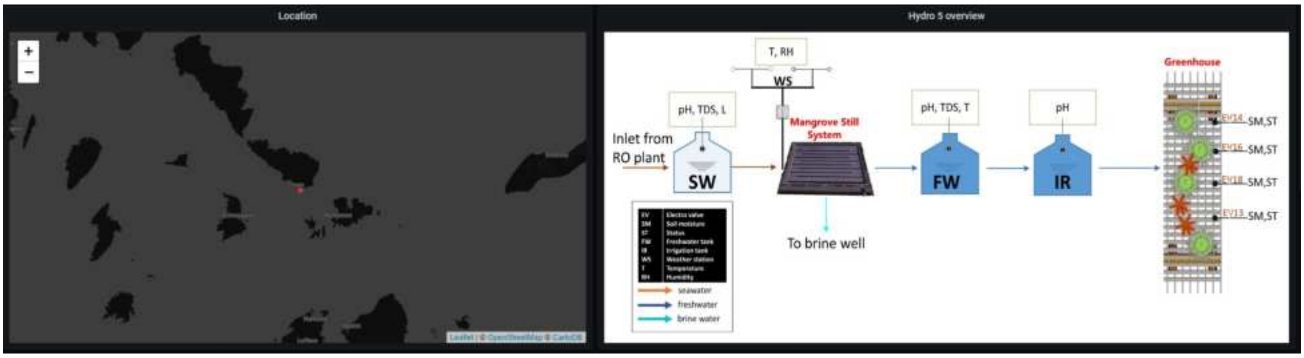

Figure 9.1 General information about the HYDRO5 pilot site

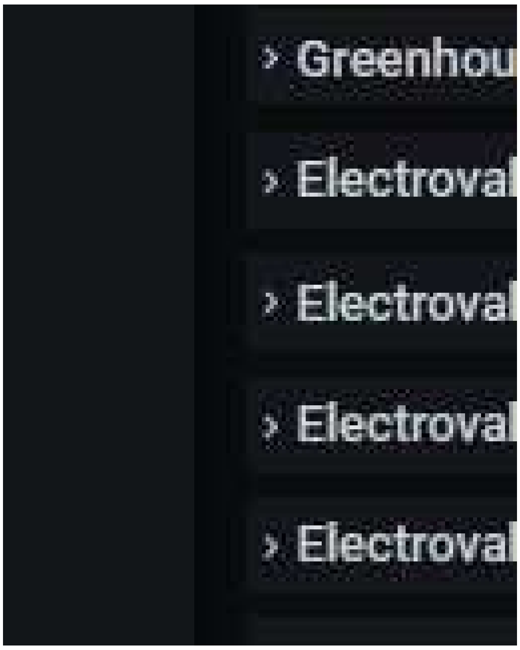

Figure 9.2 The rows of the HYDRO5 pilot dashboard

Figure 9.3 Greenhouse data

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Figure 9.4 Electrovalve 13, 14, 16, 18 data

Figure 9.5 Fresh Water Tank data

Figure 9.6 Irrigation Tank data

Figure 9.7 Sea Water Tank data

Figure 9.8 Visualization of performance indexes for HYDRO5

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10. PRESENTATION OF HYDRO6 PILOT SYSTEM DASHBOARD

Figure 10.1 - Figure 10.9, presents the final dashboard created for the HYDRO6 pilot.

Figure 10.1 Location of the HYDRO6 pilot site

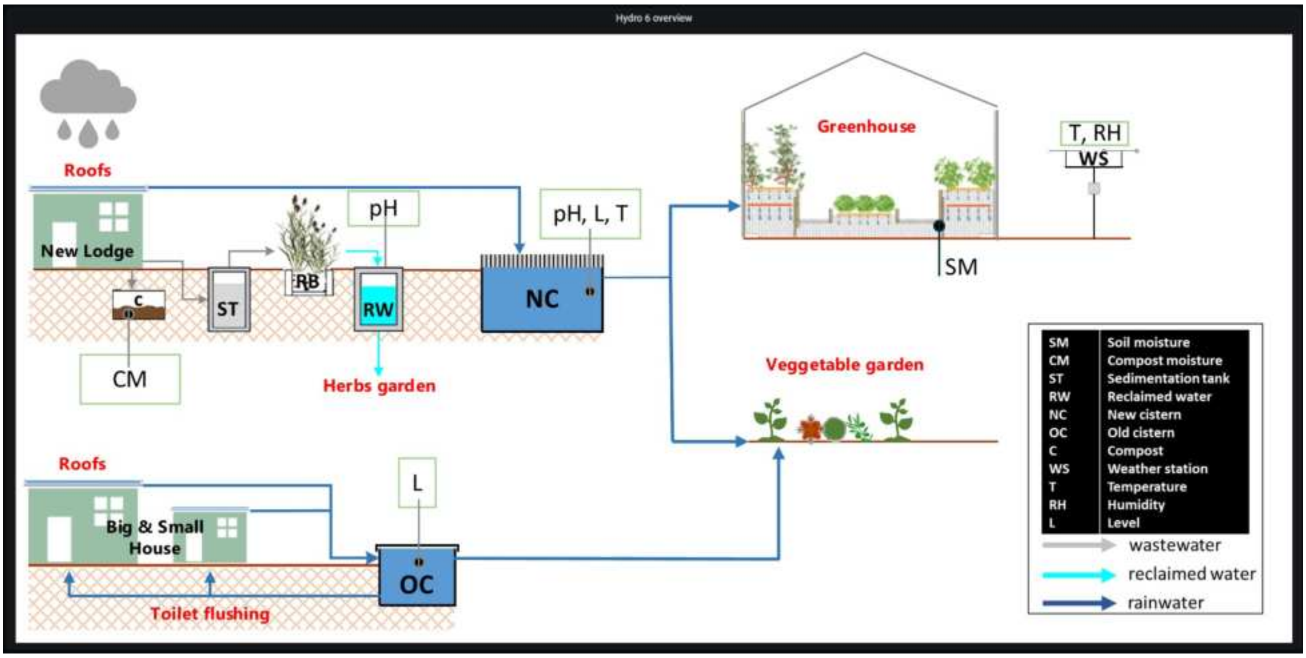

Figure 10.2 HYDRO6 overview

Figure 10.3 The rows of the HYDRO6 pilot dashboard

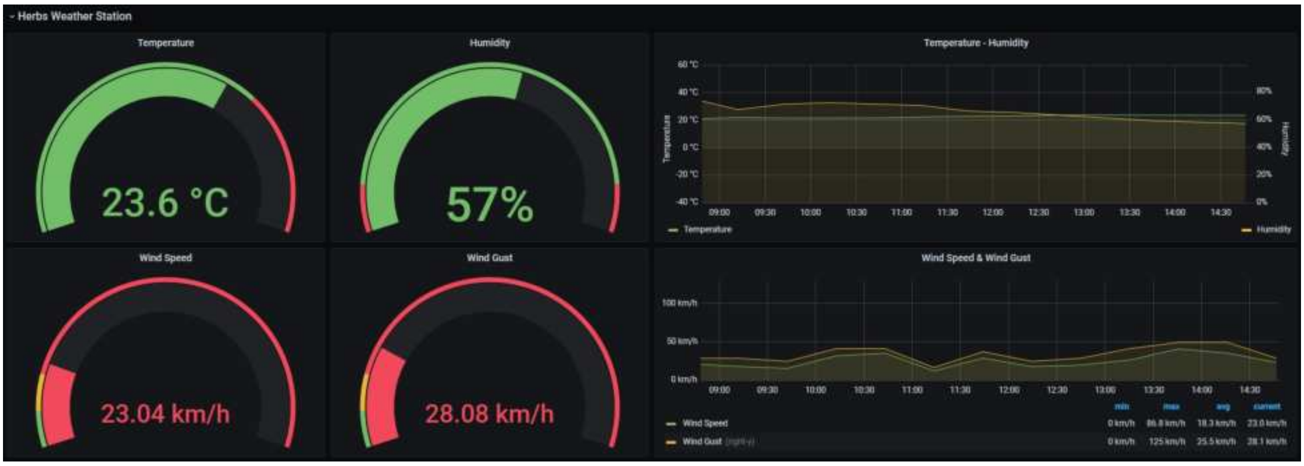

Figure 10.4 Herbs Weather Station data

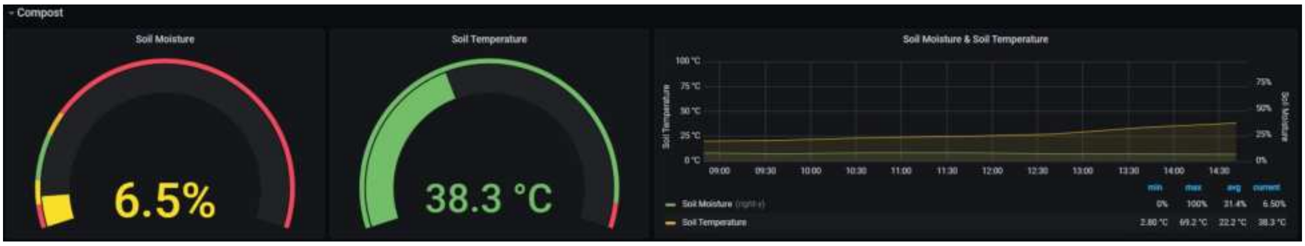

Figure 10.5 Compost data

Figure 10.6 Reclaimed Water data

Figure 10.7 New Cistern data

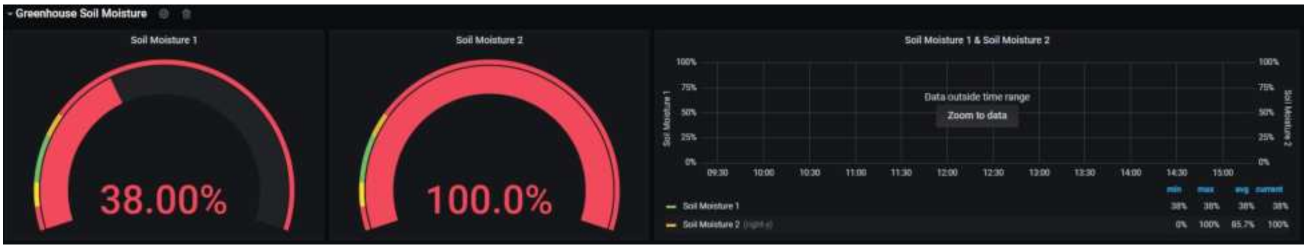

Figure 10.8 Greenhouse Soil Moisture data

Figure 10.9 SM-GH-Mobile data

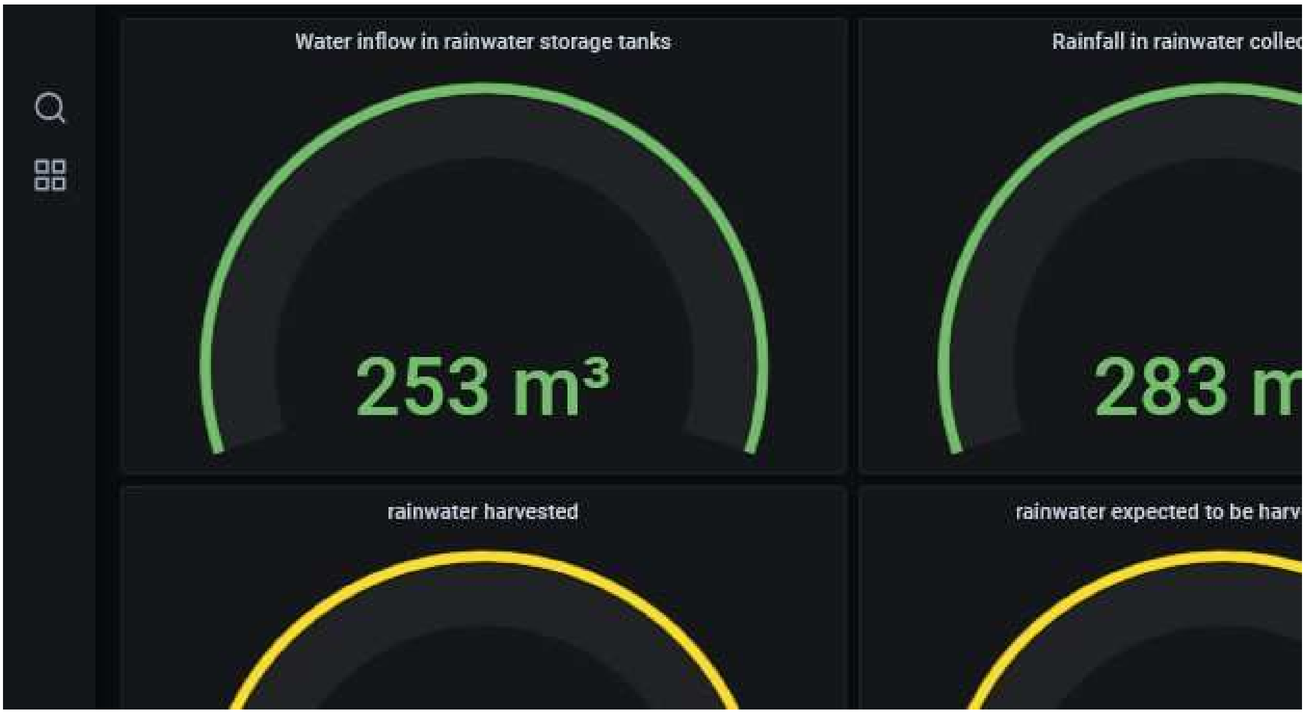

Figure 10.10 Visualization of performance indexes for HYDRO6

Figure 10.11 Visualization of performance indexes for HYDRO6

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11. CONCLUSIONS

An overview of the Grafana platform is presented, along with a detailed, step-by-step process of how to create a dashboard. A dashboard was created for each of the HYDRO sites, totaling six dashboards, where users can access valuable information about the overall system operation and performance.

Specifically, the Grafana platform visualizes all process schemes in a user-friendly environment. Users have access to real-time sensor readings stored automatically in the database, as well as offline data (laboratory measurements) through a platform upgrade that has been successfully implemented. Additionally, computations are made between offline and online stored data utilizing database functions to estimate important quantities related to the environmental and financial performance of the systems. The Grafana platform also makes these results available in a visually appealing format.

It's worth noting that in the previous version of this deliverable, an attempt to enable control through Grafana was described. However, this solution was ultimately abandoned due to results that did not meet the project's standards. Instead, more dedicated tools were developed for this purpose. For the control of the irrigation systems in all HYDROs the ardeusi.gr tool was developed by Agenso, while for the control of the operation of the most sophisticated and complicated HYDROs 1,4 and 5 specific control tools, including PLCs and SCADA were implemented (see deliverable D5.5, "Design and Implementation of ICT Infrastructure for Data Gathering and Control"). Consequently, the online platform that has been created offers a comprehensive overview of all process loops and system performance, with additional indicators calculated within the platform.

The created dashboards have been customized based on operators' feedback and HYDROUSA project requirements. However, they can be easily adapted to meet the specific needs of different end-users, enhancing the platform's post-project utility and reusability beyond the HYDROUSA project.