Building Energy Management Application

User Manual

February 2018

European Commission
Horizon 2020
European Union funding
for Research & Innovation

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1. Introduction

The Building Energy Management Application provides a variety of functions such as real-time monitoring of energy consumption of your building, the diagrammatic illustration of this, automatic and manual entry of sensor and meters placed in the building and more. An important advantage of the platform is the ability to track energy usage from any mobile device such as smartphones and tablets, provided that there is internet connection. There are five different user roles, presented in Table 1. Furthermore, GAIA has developed a mobile Participatory Sensing Application for manual uploading of measurements.

In the following sections, the features offered by the applications and how to use them are presented in detail.

Table 1 Application User Roles

Role	Access	
Administrator	Full rights for all schools in GAIA	*Group A*
Global Manager	Rights to insert all building details as well as energy and other sensor readings; rights to view all analytics and tag anomalies; receives alerts and notifications; participatory sensing; creation of virtual sensors for multiple schools	
Local Manager	Rights to insert all building details as well as energy and other sensor readings; rights to view all analytics and tag anomalies; receives alerts and notifications; participatory sensing; creation of virtual sensors	
Teacher	View of all analytics; participatory sensing; creation of virtual sensors	*Group B*
Student	View of all analytics; participatory sensing	

2. Desktop Application

2.1 Login and User Registration

In order to log in the online energy management application, the user types http://bms.gaia-project.eu on their browser, add their username and password and clicks “Login”, Figure 1.

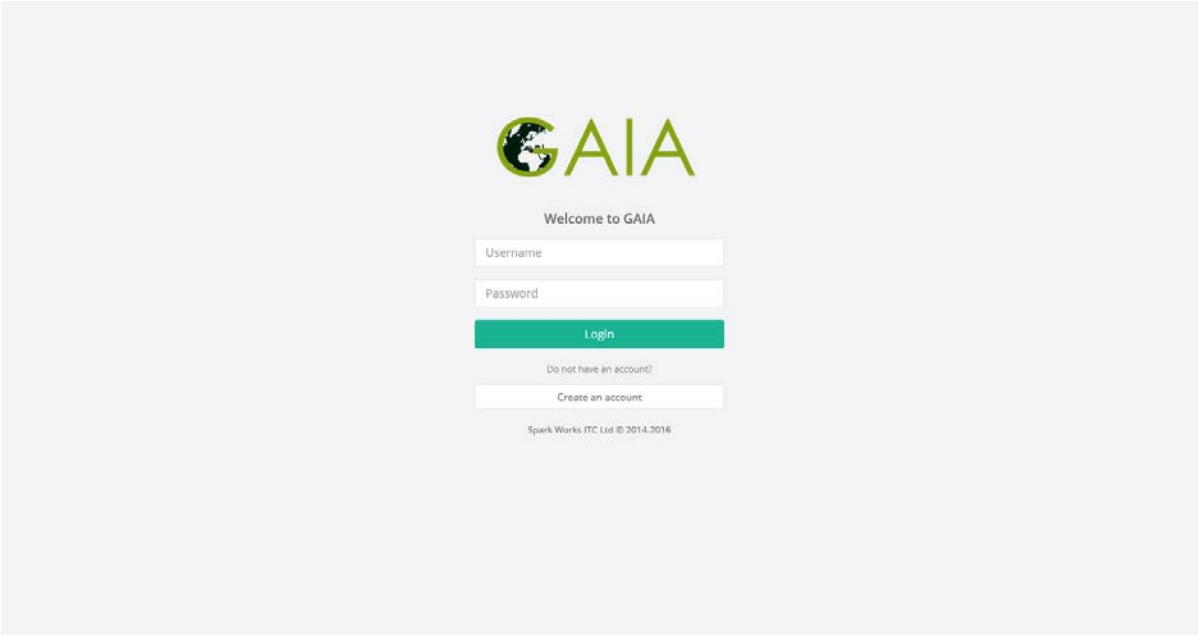

Figure 1 Login

If they are a new user who wishes to create an account they click “Register”. This leads the user to the page depicted in Figure 2.

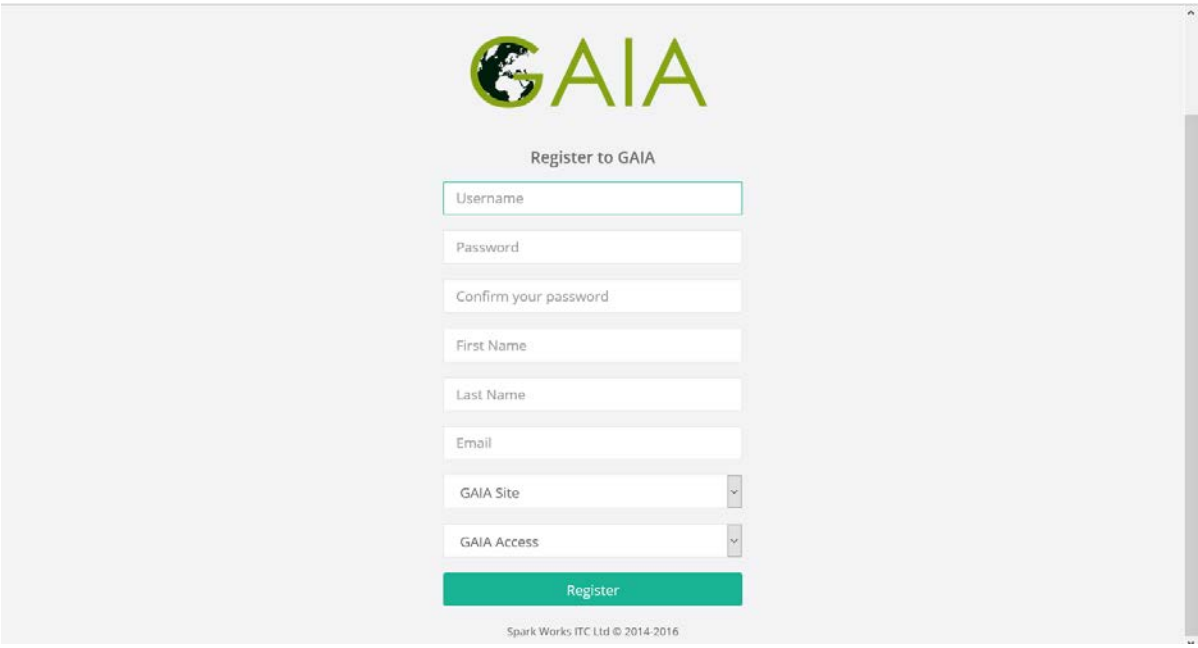

Figure 2 User registration page

This page contains a registration form that must be filled with necessary personal information for identification and security purposes. The school the user is interested in as well as the role they will be assuming in their interaction with it (manager, teacher, student etc.) needs to be added here as

well. After properly filling their information the user clicks on “Register” button located at the bottom of the page. To ensure proper functionality and avoid malicious users trying to access the system, all new registrations are not processed instantly, but need to be approved by another member of the GAIA community in the selected school. Therefore **upon completing the previous step, the users are kindly requested to contact the authorized personnel of their school to receive the approval of their account**.

A new account can also be created by accepting an invitation from a higher level user as described in section 2.3 User Profile Account Dashboard.

2.2 Dashboard

As soon as they are successfully logged in, they land on the application Dashboard, Figure 3. From this page the user is able to access all buildings registered in their account.

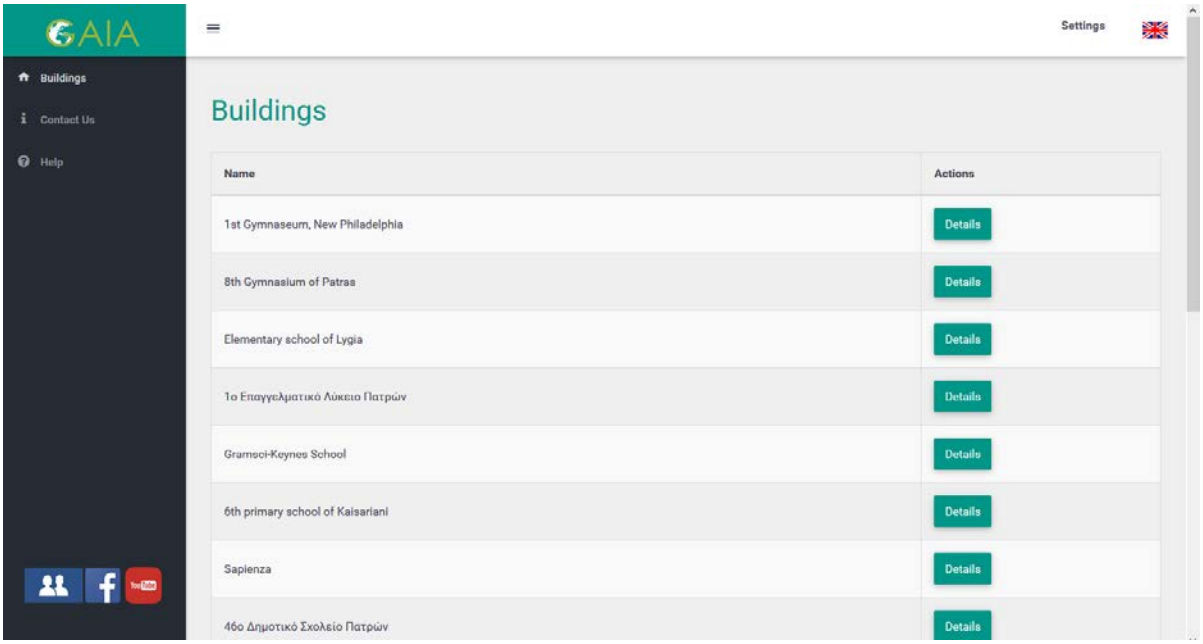

Figure 3 Main Dashboard

The ☰ button in the upper left corner expands or hides the application main menu which appears on the left part of the screen.

The button ℹ “Contact Us” directs the user to a page where they can see the means by which the can contact GAIA, Figure 4, as well as the links for this User Manual and the application video tutorials.

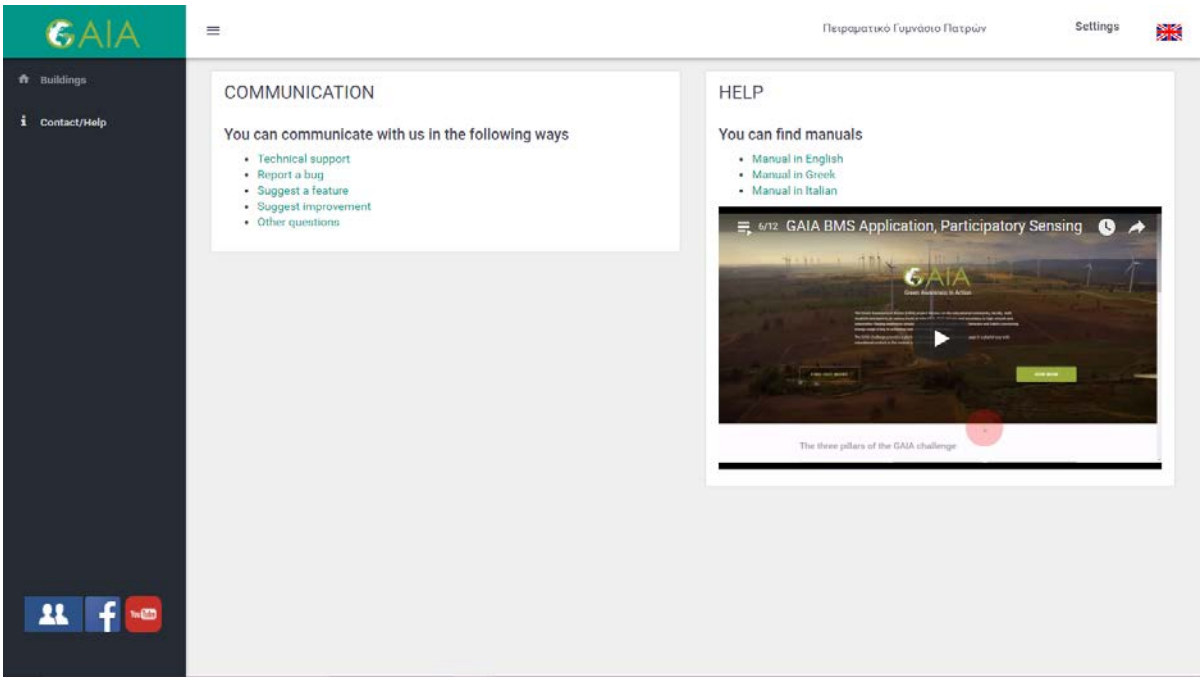

Figure 4 Contact GAIA

The  button allows the user to return to the dashboard from any other point in the application.

Through the  buttons on the left bottom of the screen, the users are invited to socialize in GAIA's Facebook Page and Group.

In the upper right corner they can change the application language. From the "Settings" icon they can log out from the application by clicking "Log out" or go to their user profile by clicking "My profile".

2.3 User Profile

Upon clicking "My profile" the user lands on a part of the application dedicated to their account, Figure 5. They have access to the following account features:

- My Profile
- Dashboard
- Users

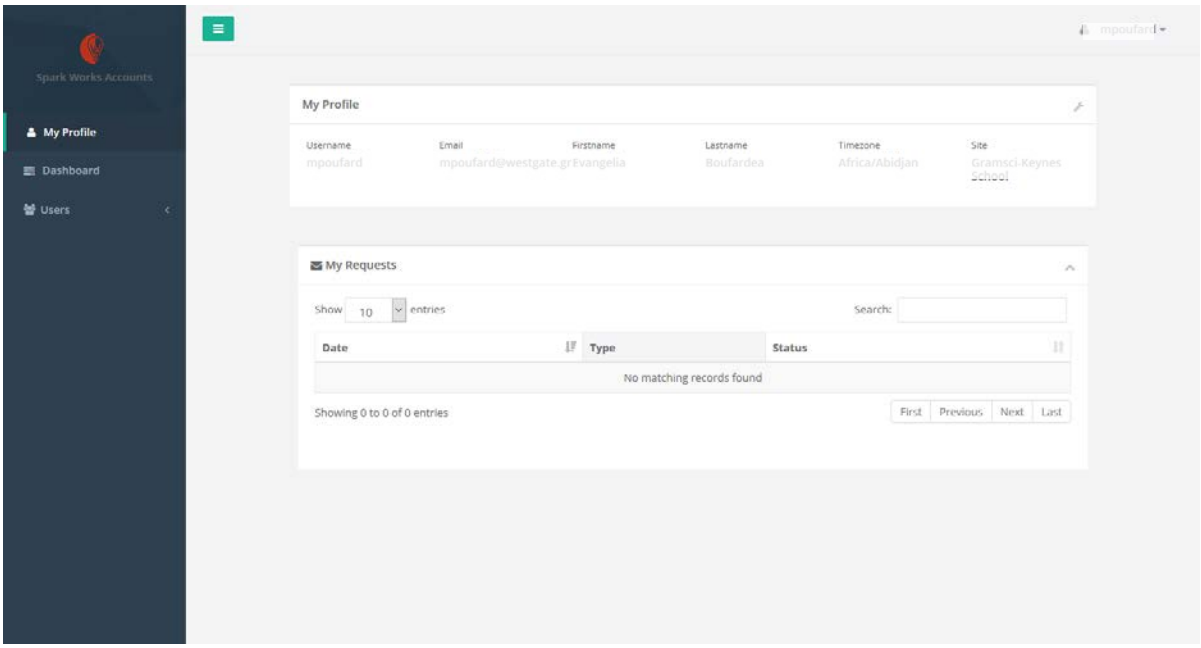

Figure 5 Account landing page

My Profile main page

The landing page is called “My Profile” and contains all basic user information (i.e. username, email, first and last name), as well as the user’s school.

The user is able to perform changes in their account by clicking the wrench icon , located in the top right corner of the top white frame, Figure 6.

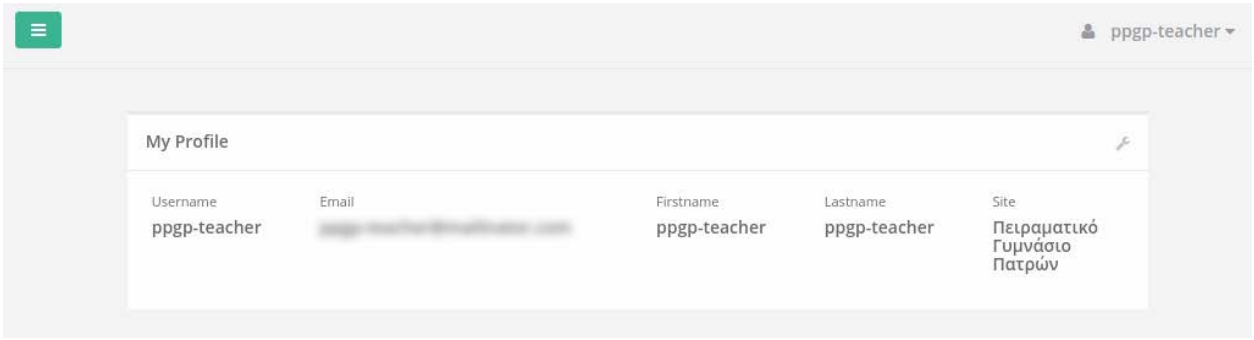

Figure 6 Account main details

Common changes may include new permission requests or basic account information updates. To submit a permission request the user simply clicks the wrench icon and selects the most suitable option from the pop-up dialog that appears, Figure 7.

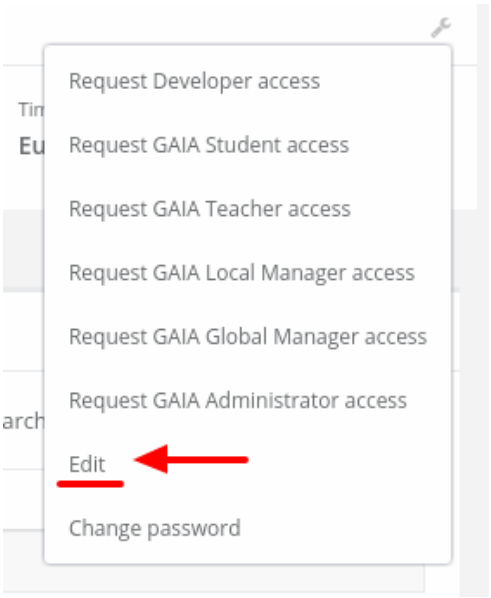

Figure 7 Edit account drop down menu

The wrench icon also allows for changing the account details through the "Edit" option. This activates a secondary form, Figure 8, from which account information can be altered. After conducting all necessary changes, the user clicks "Update" or "Cancel" to discard the changes.

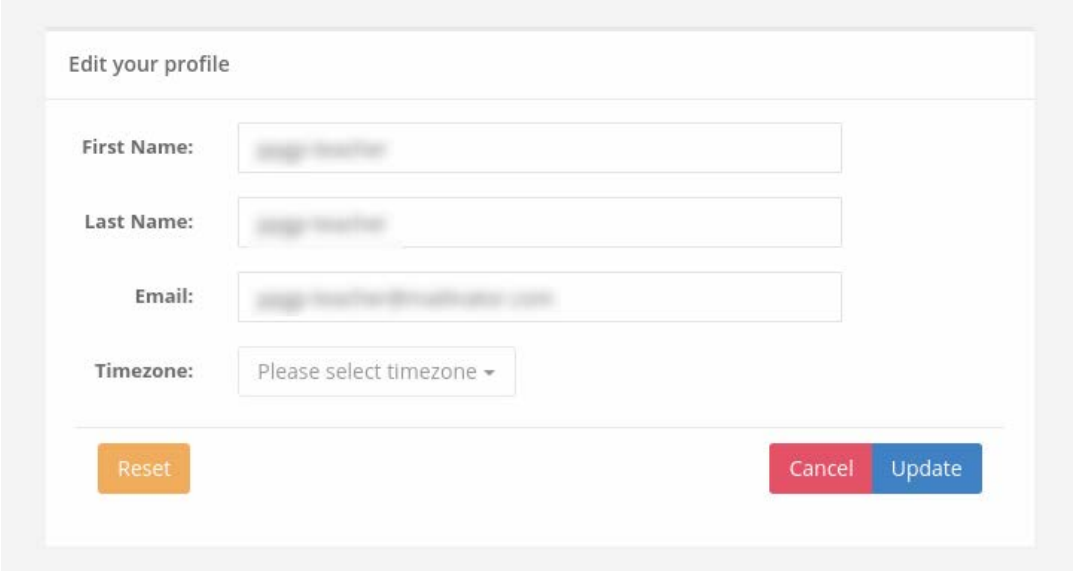

Figure 8 Edit profile page

Similarly, the user can update the account password by selecting the appropriate option from the pop-up dialog appearing upon clicking the wrench icon. This triggers the "Change Password" pop-up dialog, Figure 9. For changing the account password, type the new password in the first box, re-type it for confirmation purposes to the second box and click "Update". Changes can be discarded by clicking "Cancel".

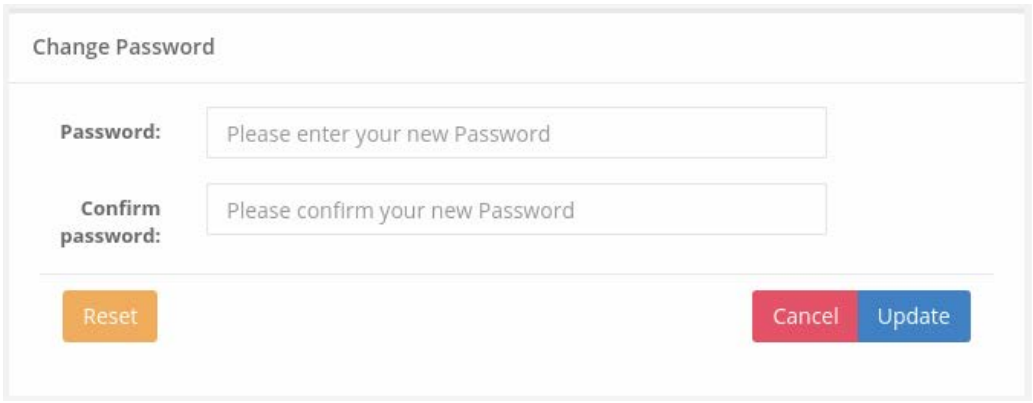

Figure 9 Change password page

The second part of the "My Profile" page includes a panel, Figure 10, with all the account's history, such as extended permissions or account upgrade requests received by the system. Each request is listed together with a unique timestamp indicating the date and time in which the action was initiated by the account owner. The panel also contains the status of each request in a dedicated column.

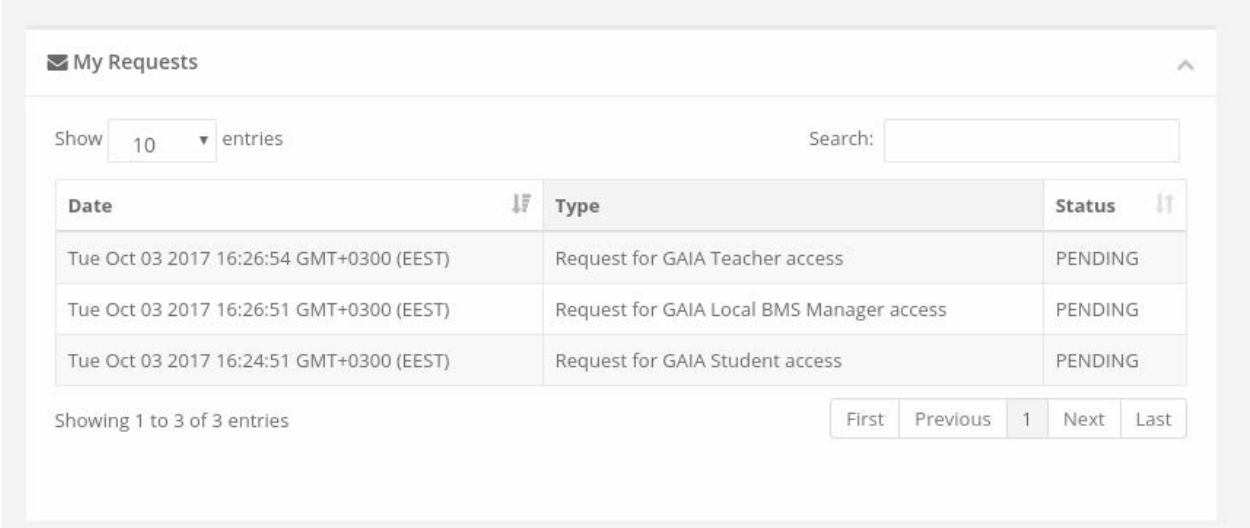

Figure 10 Account history panel

Account Dashboard

Group A users have access to the Dashboard page of their profile. The Dashboard contains all the information and functionality about inviting new users and managing the access requests. This page contains three basic panels:

Invite a User: Allows the user to invite others by email, selecting their role and the site they should be assigned to, Figure 11. In this case an email is sent to the address of the invited user, whence they may add their information and set a username and password to access the application.

In this way, a school manager may invite the teachers they wish to take part in the project and the teachers may in turn invite the students they want to interact with the application.

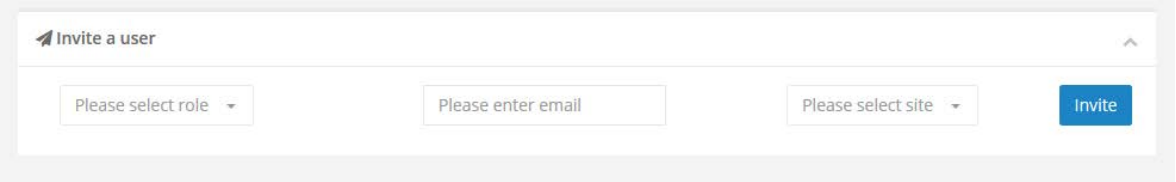

Figure 11 Invite a user panel

My Assigned Requests: Shows all the access requests that are assigned to the user. In the last column the user can approve or decline a request, Figure 12.

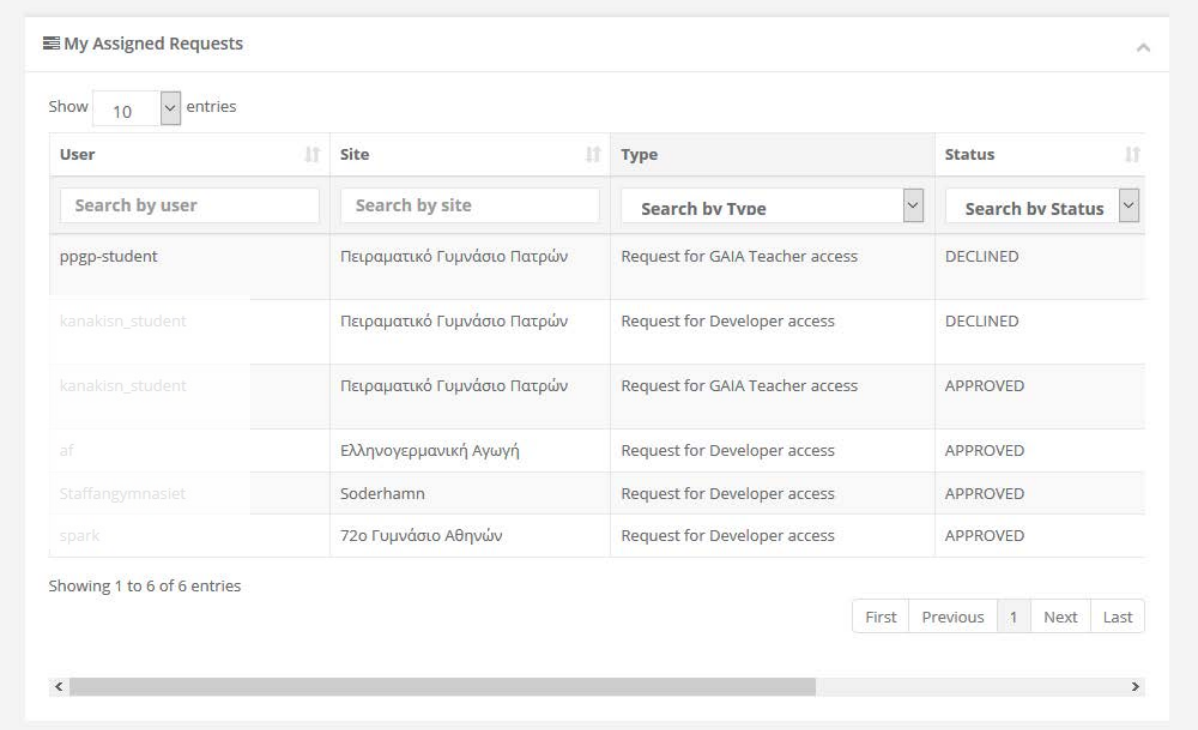

Figure 12 My Assigned Requests panel

My Invitations: Shows all the invitations a user has sent with their information and status (*Completed*, *Pending*, *Expired*, etc), Figure 13.

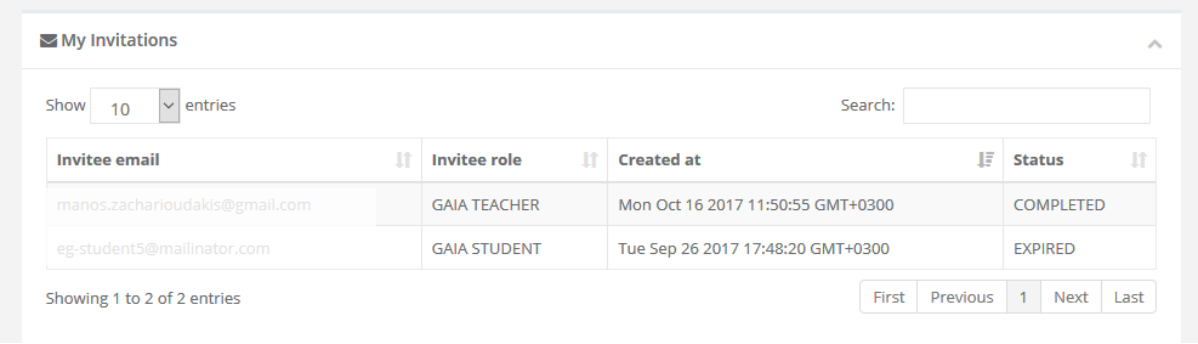

Figure 13 My Invitations panel

Users

The third option “Users” on the Profile main menu is also available for ***Group A*** users only and takes the user to a page that lists all the users who have access to all the schools the user is managing, Figure 14.

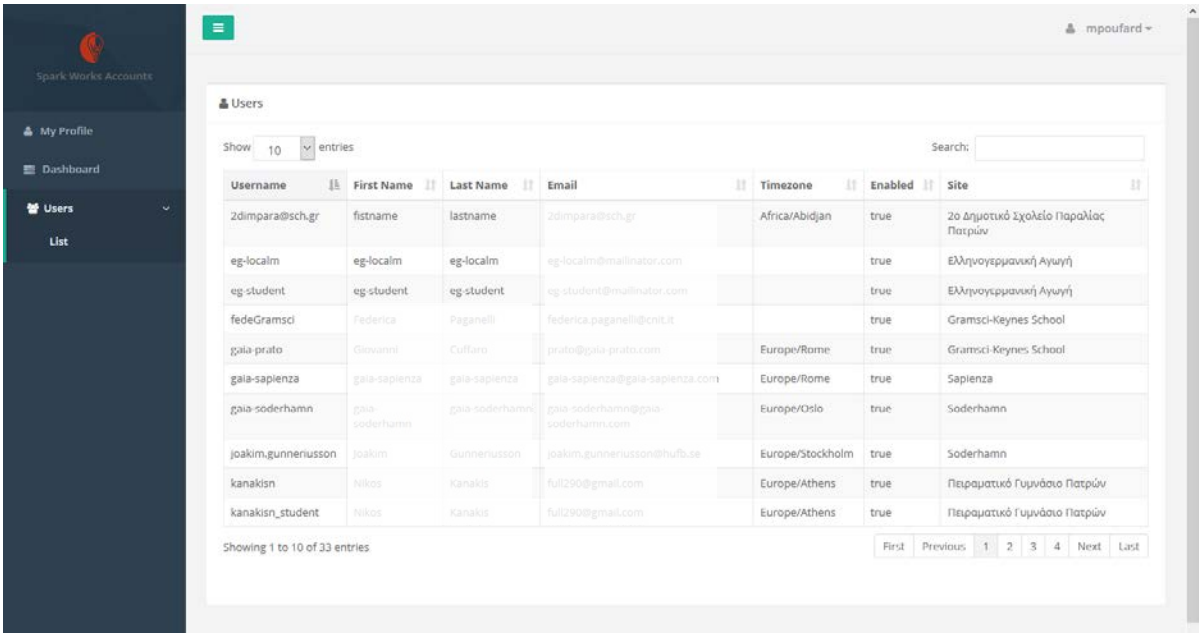

Figure 14 User list

2.3.1 View Building

Back on the application main dashboard, clicking the “Details” button which appears next to a building, the user is transferred to the main page of the corresponding building, Figure 15.

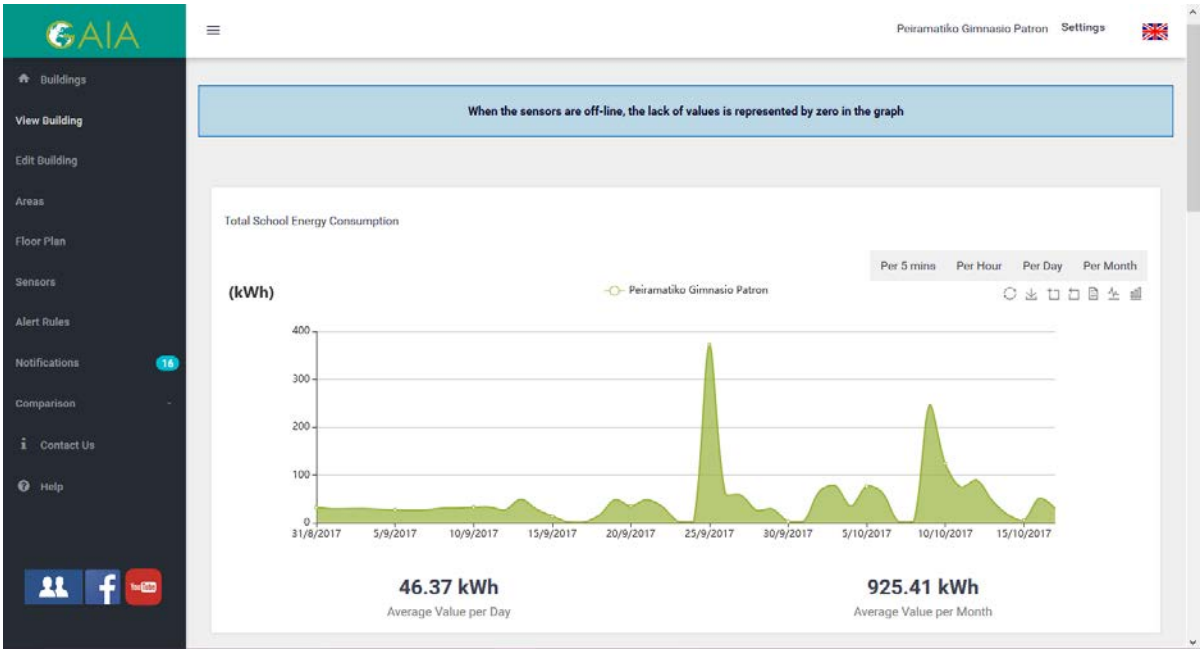

Figure 15 Building Management Page

In this page the user can view in detail all the recorded data of the particular building in the form of charts, where the x axis represents time and y axis the chosen measurement. In any chart, the application allows to alter the granularity through the buttons “Per 5 minutes”, “Per Hour”, “Per Day”,

"Per Month". The user may save the illustration locally on their computer in the form of an image through the button, to zoom in a chart area and return it to its original form through the buttons, to see the recorded data , to turn the chart in bar form through and return it to linear form through . The button restores the chart to its initial state. The charts offer the last 48 recorded values of the chosen metric under the pitch the user has selected. Placing the mouse on the chart, the user can view the exact value for a specific time. The system also presents the daily and monthly average value.

The user may return in this initial page of the building through the View Building button in the Building mini menu at the main applicationmenu.

2.4 Edit Building (Group A users)

The "Edit Building" page, accessed from the corresponding button in the main menu, in the Building mini menu, allows the user to view and alter the building's characteristics.

In the *General Characteristics* tab, Figure 16, the manager may declare general school building data such as the name of the school, country and size in cubic and square meters. They may also choose the available energy sources and declare their annual cost. The name of the person chosen for monitoring the energy consumption can also be added in this tab. Clicking on the "Save" button, all the data is updated in the system.

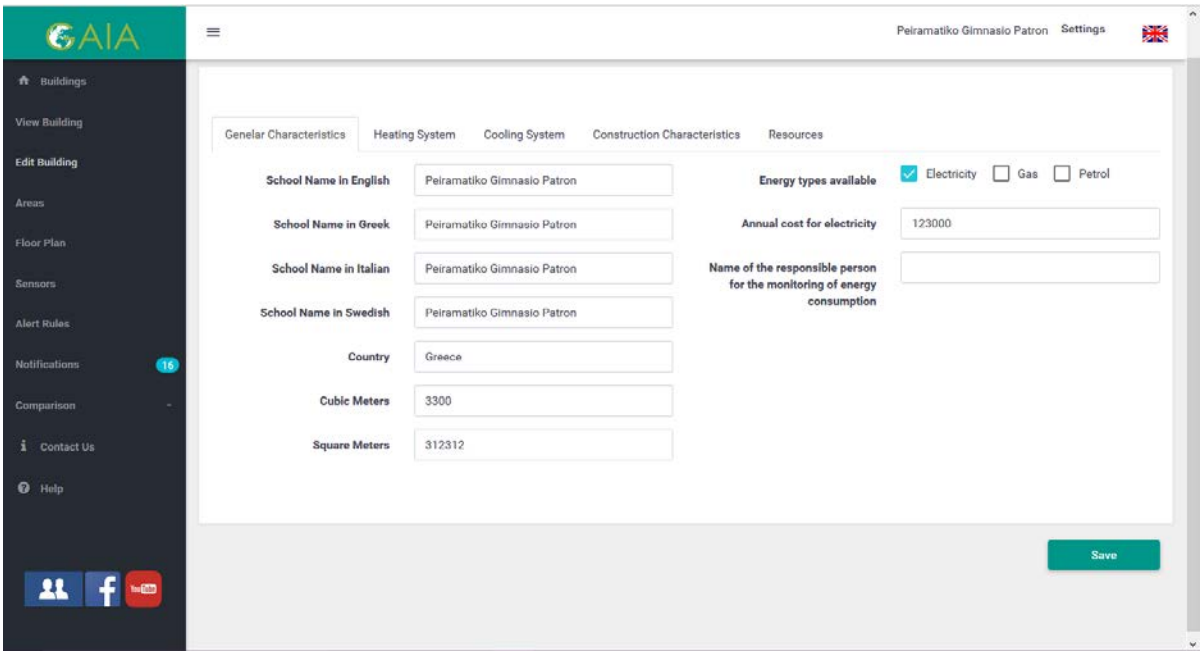

Figure 16 Edit Building, General Characteristics tab

In the *Heating System* tab, Figure 17, the manager selects if there is an automated thermostat installed and declare its threshold value. They may add the date of the system's installation and choose if it is regularly maintained or not. They can also input the consumption meter's serial number, as well as the energy source for the system.

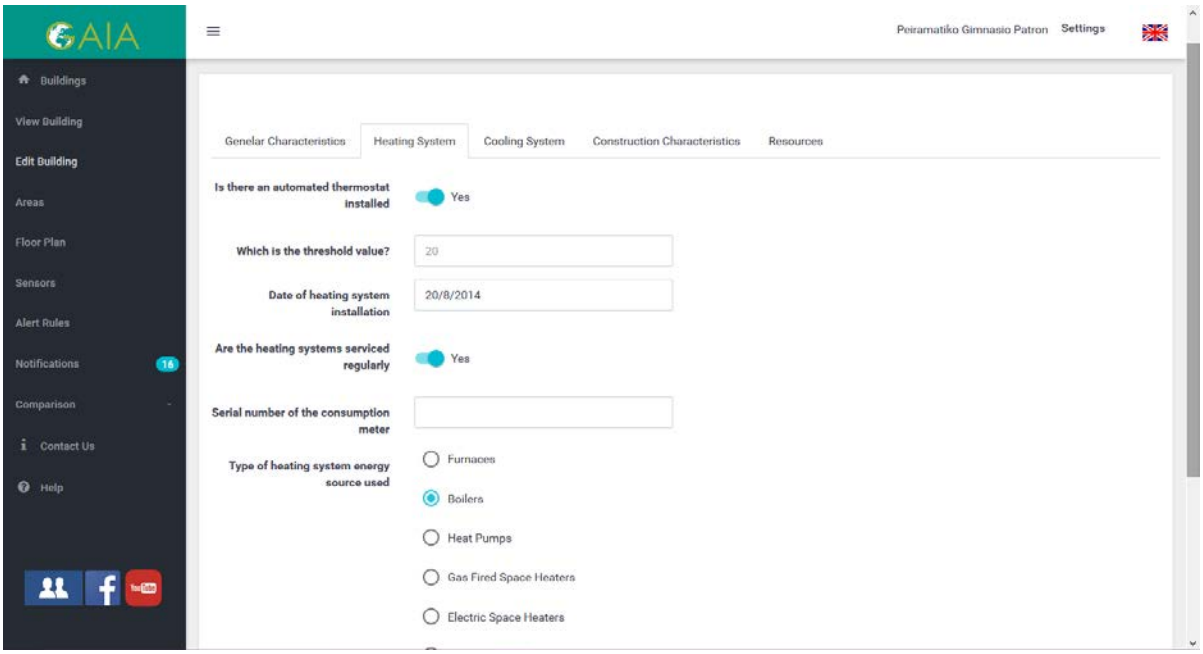

Figure 17 Edit Building, Heating System tab

Similarly, in the *Cooling System* tab, Figure 18, the manager selects if there is an automated thermostat installed, its threshold value, the date of the system's installation and choose if it is regularly maintained or not. They can also select the energy source for the system and declare if there are fans installed or not in the building.

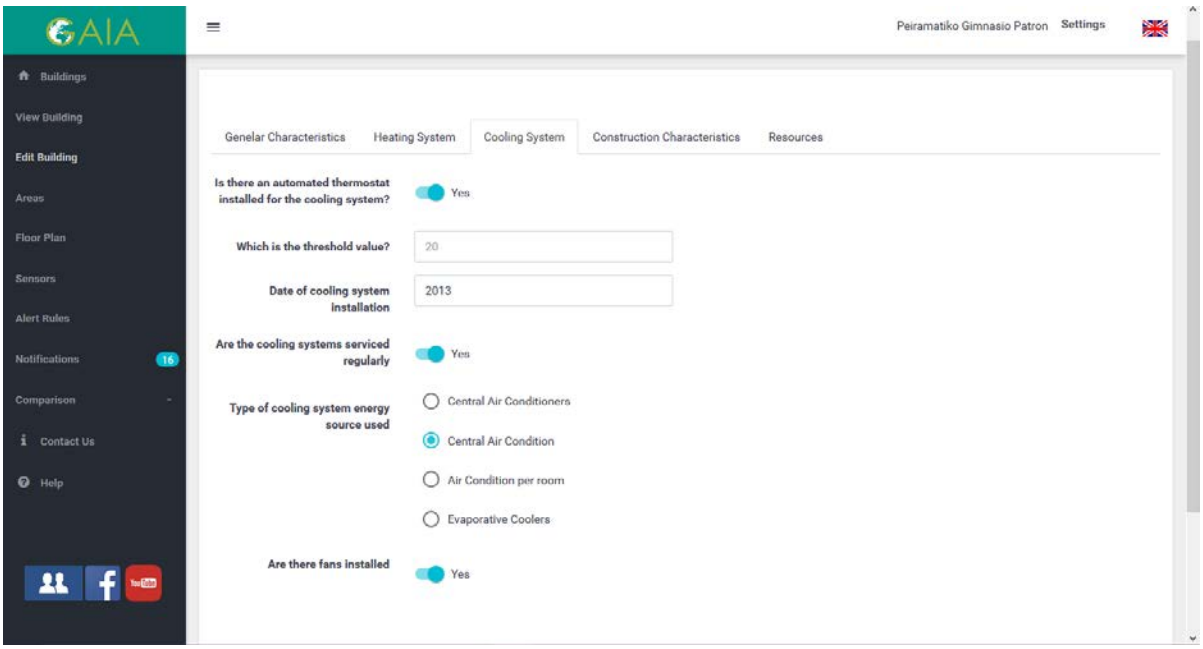

Figure 18 Edit Building, Cooling System tab

In the *Construction Characteristics* tab, Figure 19, the manager inputs the year the building was built, the annual energy cost, its average user number and its orientation. The manager may also declare the kind of bulbs used for indoor and outdoor lighting and if they are cleaned regularly, the number of operating devices, if natural light is adequately exploited as well as if there are timers installed for the lighting systems.

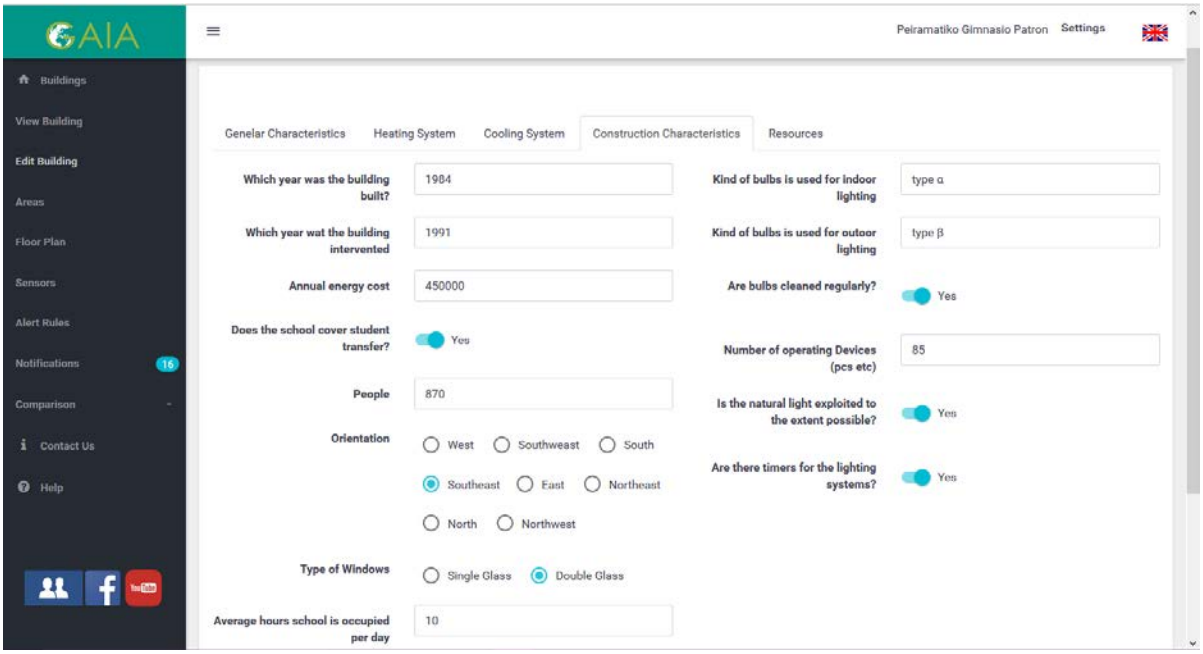

Figure 19 Edit Building, Construction Characteristics tab

In the *Resources* tab the manager may match measurements, such as energy consumption or temperature to the available for the building sensors, Figure 20. The basic measurements of Energy Consumption, Temperature, Relative Humidity and Luminosity are pre-installed.

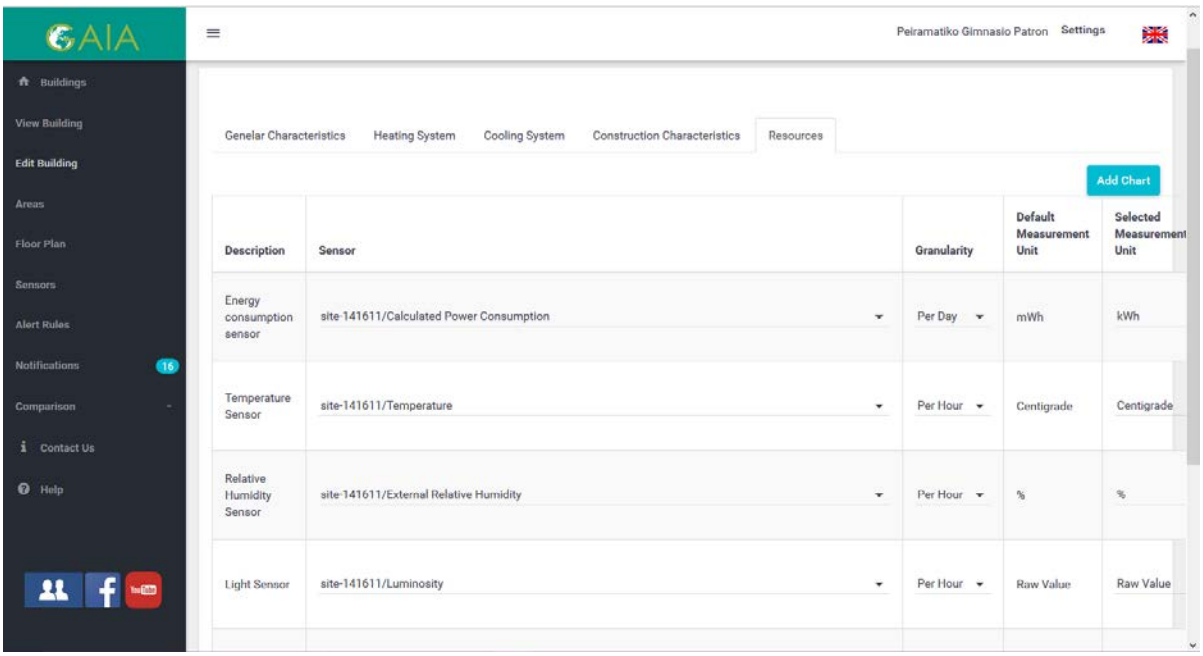

Figure 20 Edit Building, Resources tab

When the user clicks on the “Add Chart” button the window of creating a matching of a sensor to its measurement pops up, Figure 21. The user gives the name of the chart and clicks the “Save” button causing the new item to appear in the tab.

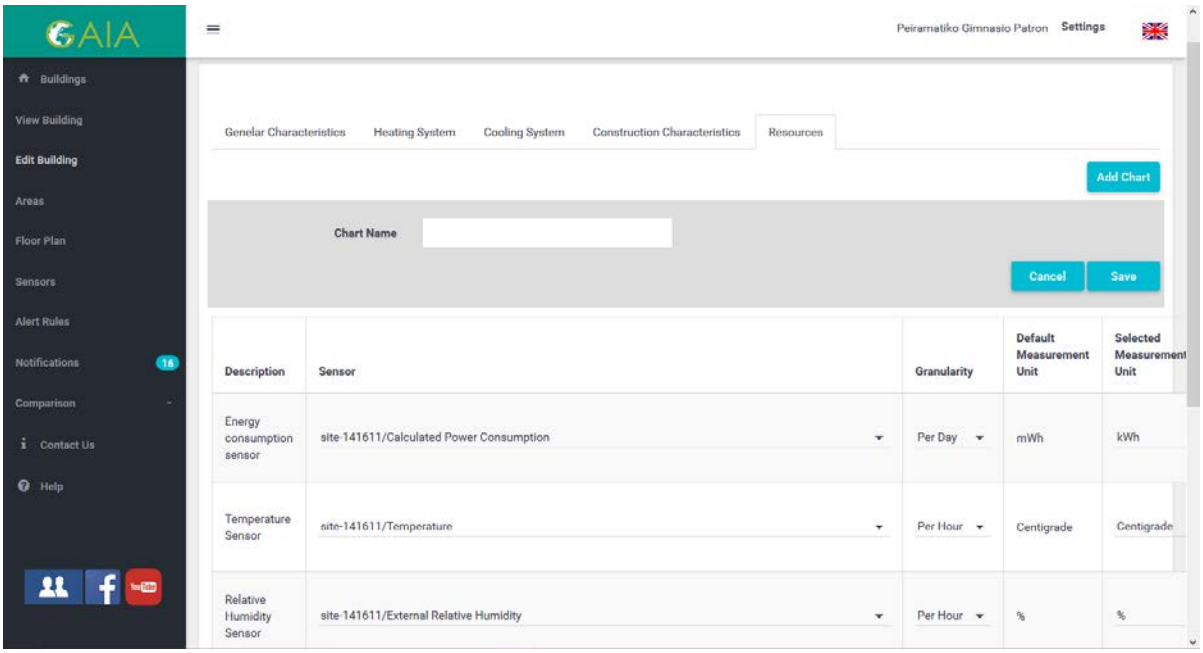

Figure 21 Creating a chart

The user then chooses the corresponding sensor, the regularity for the chart and the measurement unit from the drop down menus on the right of the chart name, Figure 22.

In Table 2 the measurement units the application uses for GAIA are presented.

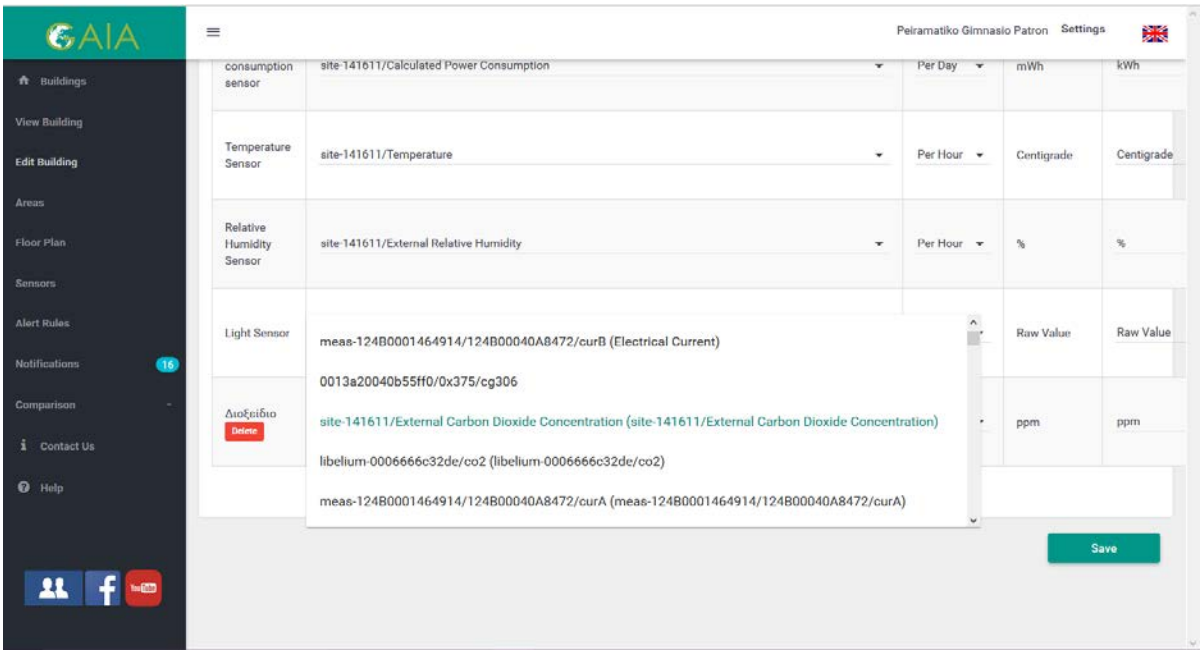

Figure 22 Matching measurements to their sensors

The “Delete” button below the chart name allows the user to delete the matching at any given time.

Upon clicking the “Save” button the new charts will appear under their new settings in the building’s main page.

Table 2 Measurement Units

Measurement Unit	Metric
mWh	Default measurement unit for energy consumption
KWh	Measurement unit for energy consumption (set by the user)
%	Humidity percentage
Centigrade	Measurement unit for temperature
mA	Measurement unit for electrical current
Raw Value	Measurement unit for values that are not expressed by usual measurement units but rather are relative values received by the sensors. It is also used to express metrics uploaded by the users in the virtual sensors, such as Comfort Level.

2.5 Areas (Group A users and Teachers)

In the Areas page the user accesses the information of the separate areas within the building. The user clicks the "Details" button on the right of the name of an area of interest and in the window that appears all the information is at hand, Figure 23.

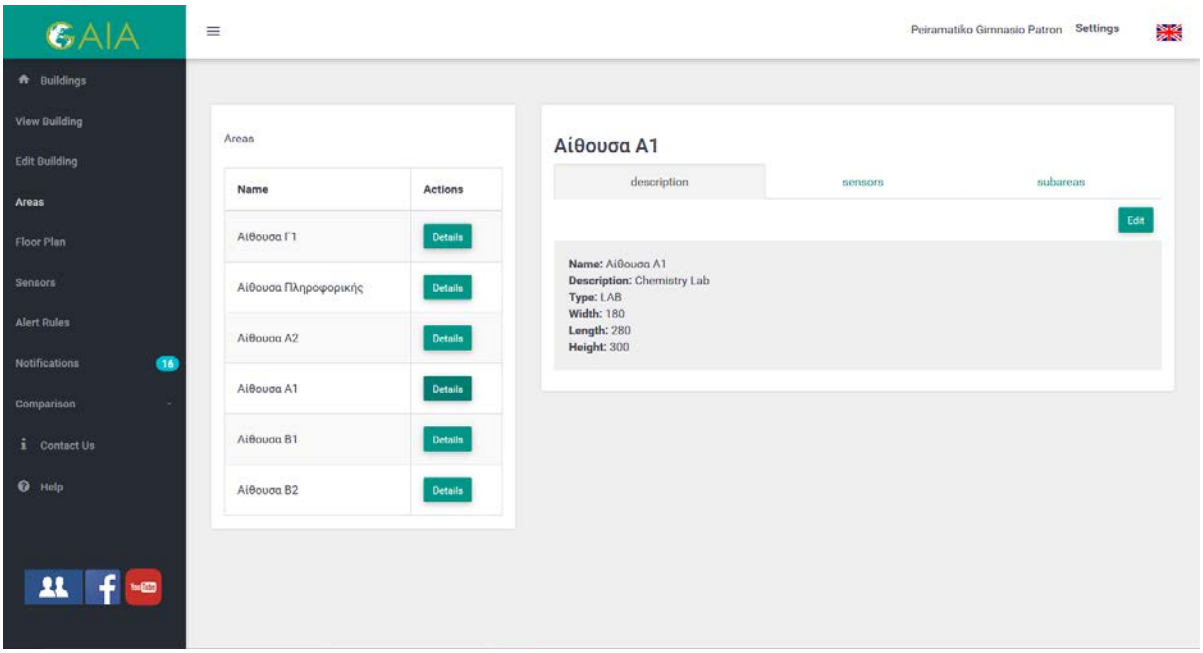

Figure 23 Area Details

Group A users are able to edit the details of an area, Figure 24, altering its name, description, type and size by clicking on the "Edit" button.

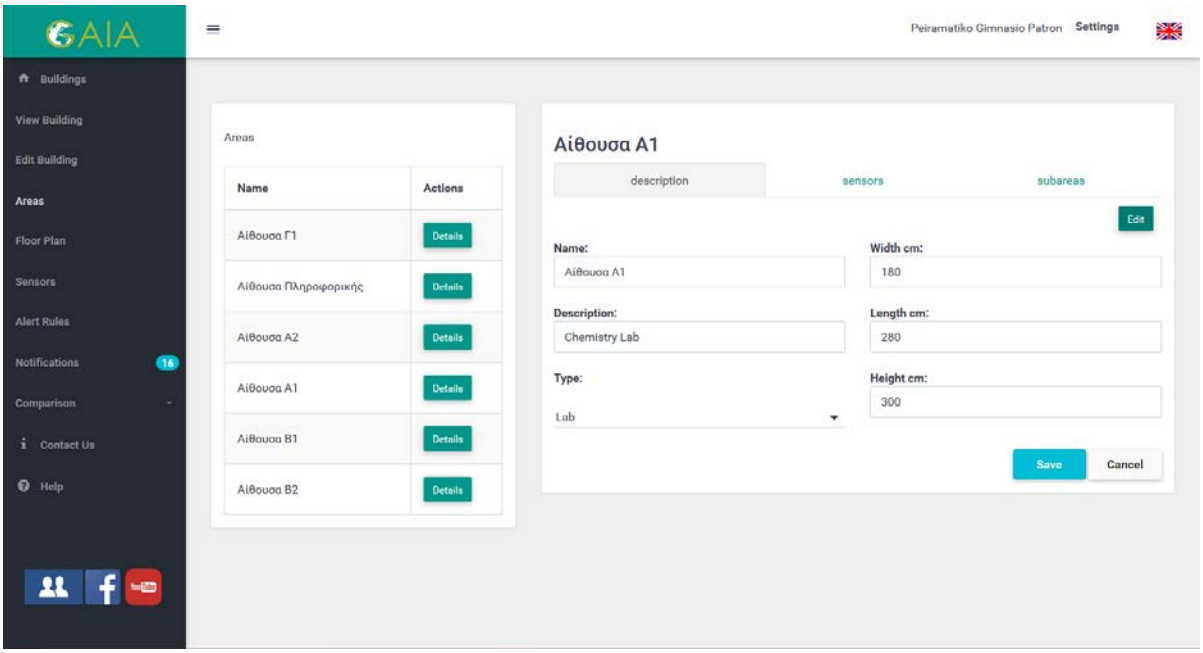

Figure 24 Edit area details

In the Sensors tab, all sensors installed in the specific area appear, Figure 25.

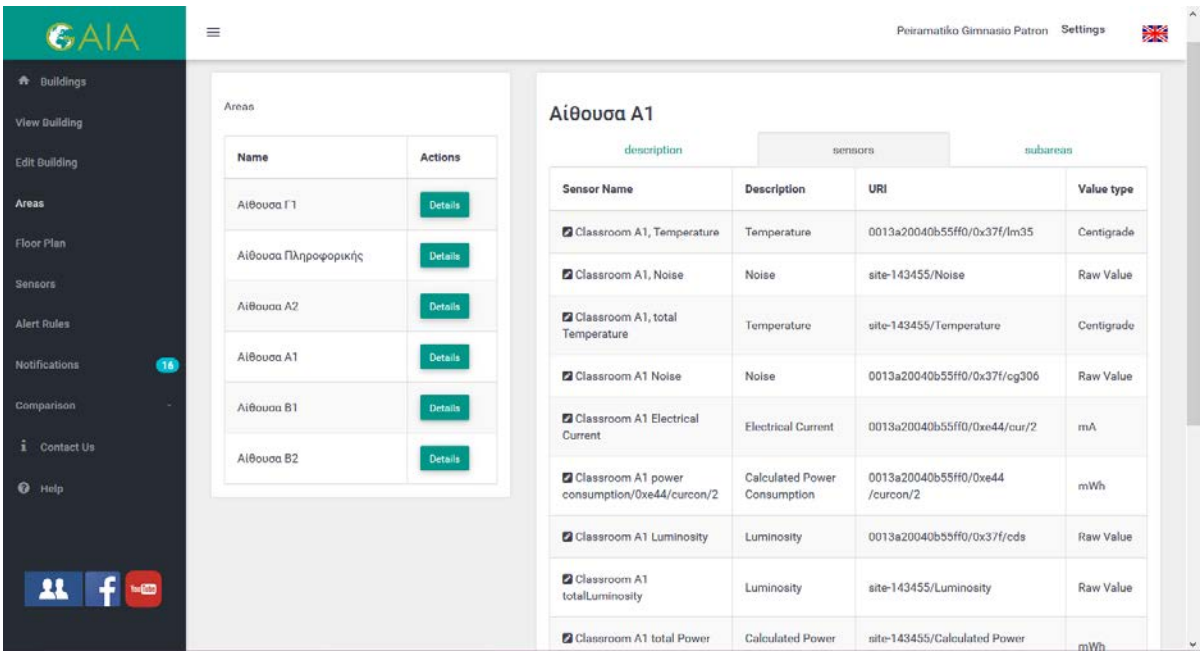

Figure 25 Area details, sensors tab

The ✎ button allows a ***Group A*** user to give the respective sensor an appropriate name. If the user has not defined a name for the sensor in its place the sensor URI will appear when needed throughout the application. In the description column the use for each sensor is visible. The commonly used descriptions are:

- Temperature, for temperature readings
- Luminosity, for light readings
- Power Consumption, for energy consumption readings
- Relative humidity, for relative humidity readings
- Motion, for room user mobility readings

- Noise, for room user noise level readings
- Electrical current, for electrical current readings

In the Sub-areas tab, all possible smaller areas which have been assigned to an area appear.

2.6 Floor Plan

In the Floor Plan page, the user has access to a depiction of the top view of all the Areas of the building. The depiction of each area is in the form of a parallelogram which dimensions correspond to their actual dimensions as they have been defined by the manager in the Areas page. The user is able by holding the left mouse button to drag each room depiction and leave it in its correct place in the building scheme; then they click "Save"[1], Figure 26.

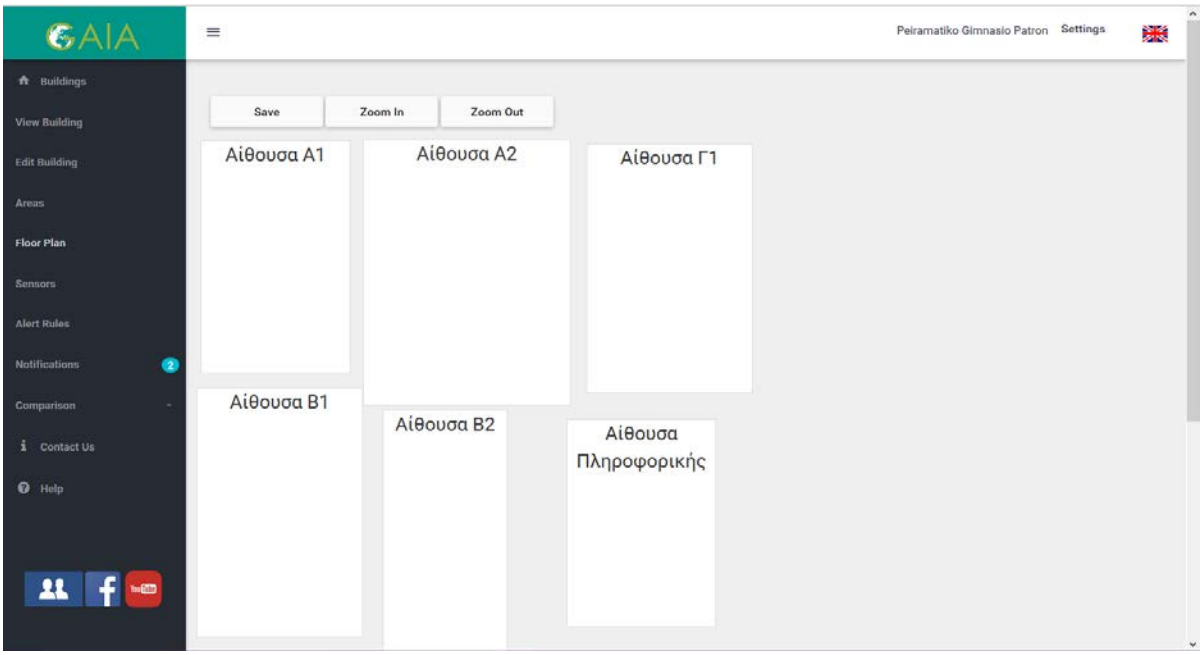

Figure 26 Floor Plan page

Each box carries the possible alerts derived by the rules that may have been set by the manager for its corresponding area (see Alert Rules section). Clicking on a box the sensors placed in the chosen area and their measurements appear, Figure 27. In this way the user may, at any given time, have a summarised view of the building's status, on a realistic depiction.

[1] The "Save" function saves the view locally; each separate computer may have different depictions of the building plan.

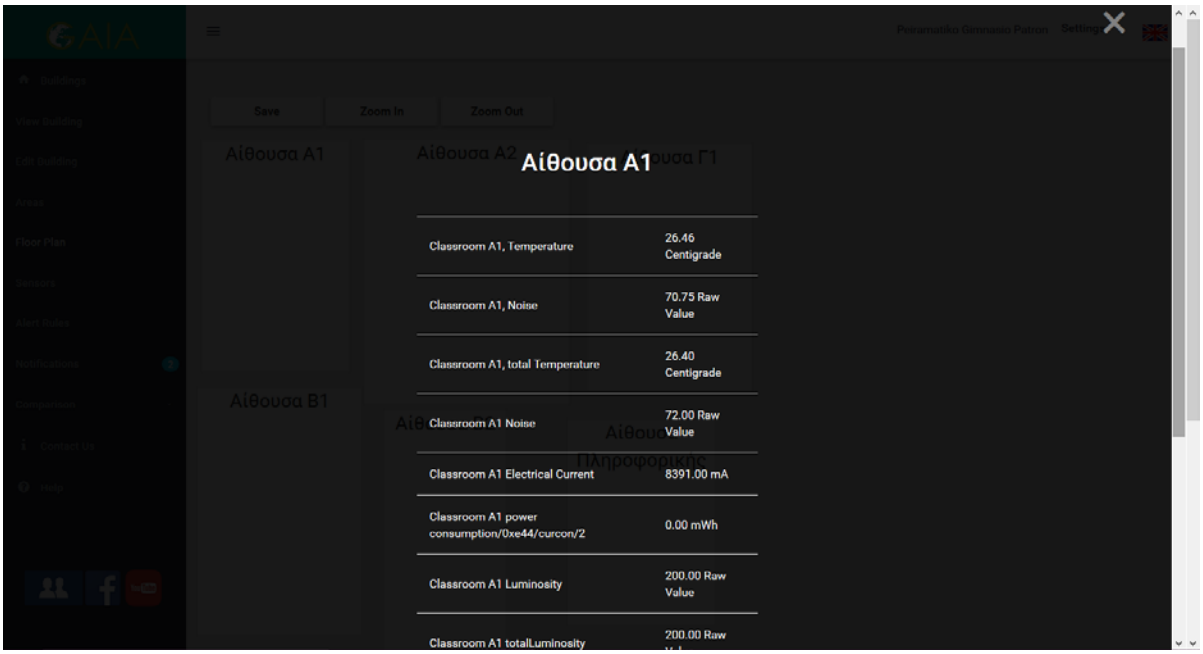

Figure 27 Floor Plan, Area summary

2.7 Structure

In the Structure page the user may view the recorded by the application data analytics. Values on average daily and monthly energy consumption are presented as well as the energy consumption for the current day and month. There is also a chart of the energy consumption per weekday, Figure 28. The values apply for the area the user has selected and are calculated on the measurements of the last 12 months.

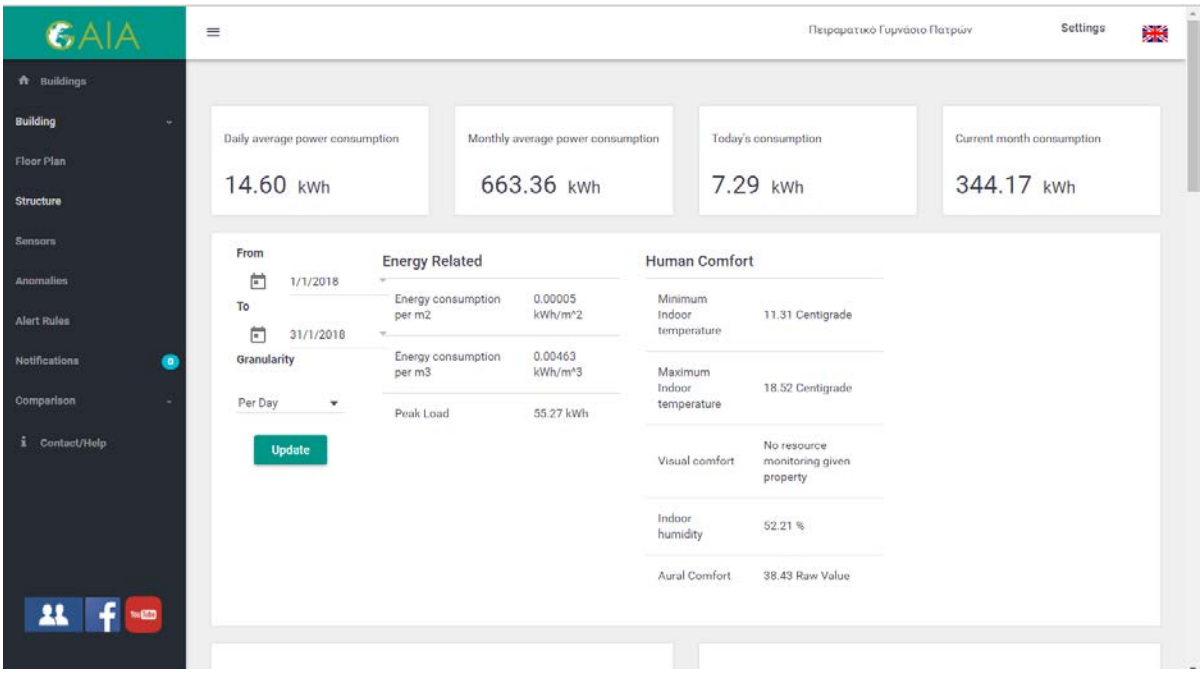

Figure 28 Structure page, Energy Data Analytics

Underneath these values, there is a dedicated area where the user may select a specific time frame for which they can receive interesting values such as average consumption per square or cubic meter, energy consumption peak value, minimum or maximum recorded indoor temperature among others.

Energy reading are also presented in the form of diagrams for the past 12 months, while a very interesting diagram is the one that shows Carbon Dioxide emissions per square meter based on energy consumption.

Scrolling down, on the left of the page a list with the building's areas appears, whence the user may select the area for which they wish to see analytics. On the right, a list of the selected areas sensors appear, Figure 29. Clicking on a sensor, the user may view their history.

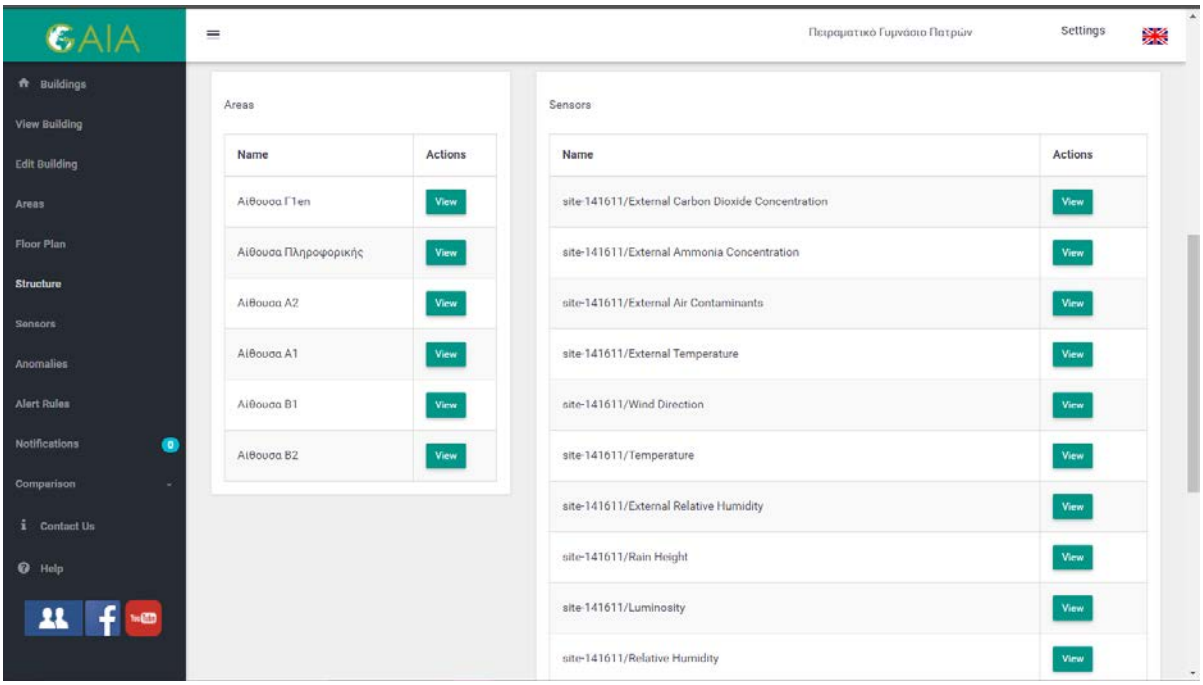

Figure 29 Areas and Sensors in the Structure page

2.8 Sensors

In the Sensors page the user may view the current values of all the real and virtual sensors placed in a building, Figure 30. In the page the sensors placed in the separate areas of the building appear. Clicking on the "View General Resources" button in the top right corner, the sensors for measurements concerning the building as a whole appear.

The values which appear are the last recorded values by the sensors. The optimal values (based on literature) for the metrics that have been chosen in the project for teaching in a classroom are presented in Table 3.

Table 3 Optimal metric values in classrooms

Metric	Optimal Value	
	Minimum	*Maximum*
Temperature	18 °C	24 °C
Humidity	30 %	60 %
Luminosity	200 Lux	500 Lux (Computer Room)
Noise	30 dB	80 dB

Furthermore, the user may add virtual sensors for any area they wish. Any type of measurement which can be uploaded manually in the system falls under the category of a virtual sensor. These can be metrics of Energy and Temperature not uploaded automatically by a sensor, User Comfort Level, any other measurement they wish to keep track of and metrics uploaded from the Participatory Sensing Application.

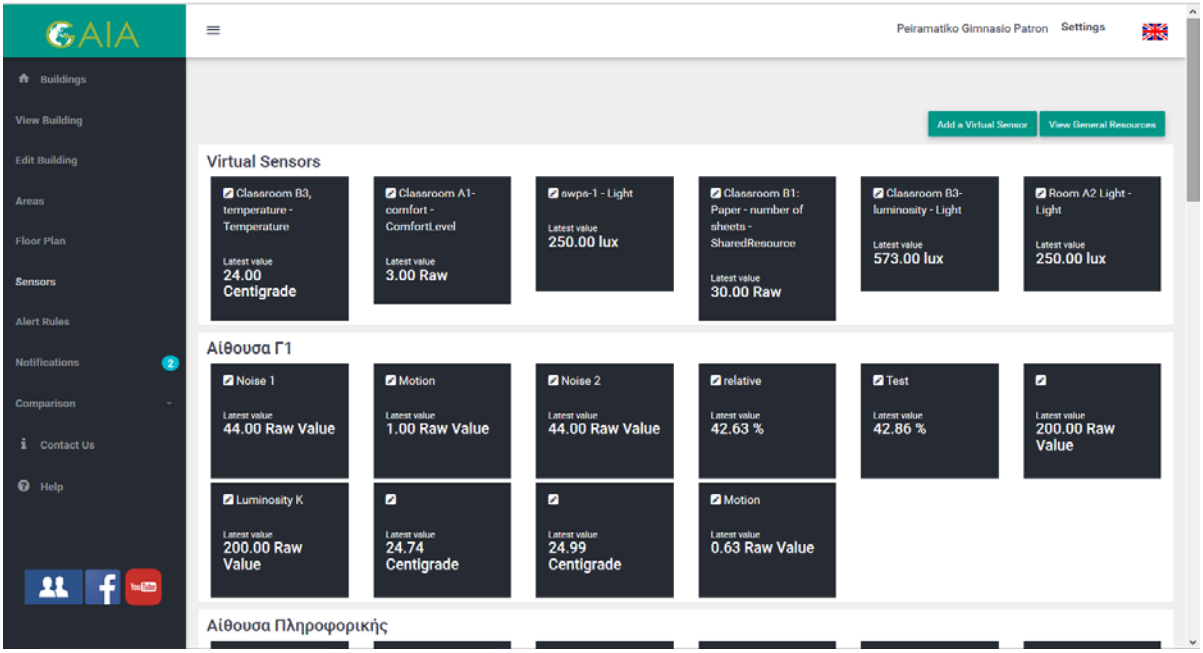

Figure 30 Sensors main page

The ✎ button appearing at the top of each sensor panel allows a ***Group A*** user to give or change the sensor's name. The user, in this page as well, by clicking on a sensor of interest may view its history, Figure 31. The chart which appears presents the last recorded values.

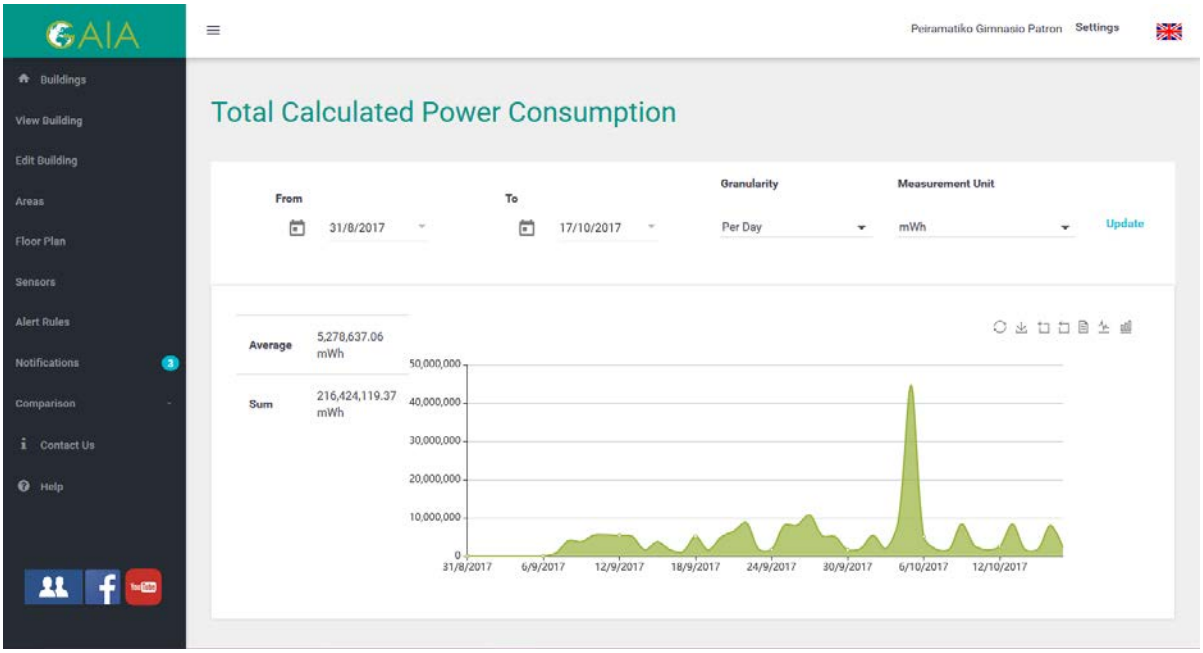

Figure 31 Sensor History

Furthermore the user is able to declare the specific time frame for which they would like to view the sensor's values as well as the chart pitch, from the corresponding fields, "From", "To" and "Granularity". As soon as they have decided on the new settings they click "Update".

From the Sensor's main page, the "Add a Virtual Sensor" button allows a ***Group A*** user and a ***Teacher*** to create a virtual sensor, Figure 32. The user gives the name of the sensor, chooses its observation category from the drop down menu and clicks "Save".

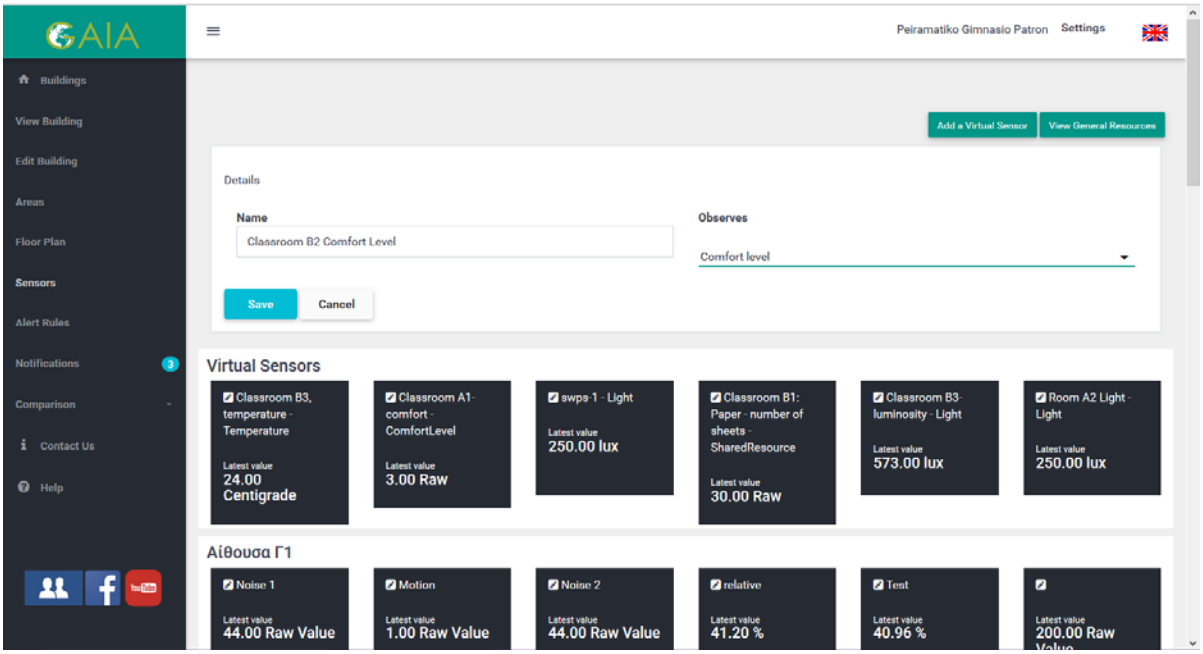

Figure 32 Adding a Virtual Sensor

Clicking on a virtual sensor the user may upload values to the system from the "Add Measurements"[2] button, Figure 33. The user can also input values at a specific date and time from the calendar on the left. If no time is chosen the system will use the current one.

[2] For data harmonisation, concerning the **Comfort Level** measurement, users are advised to choose an integer value from the **scale 1-5**.

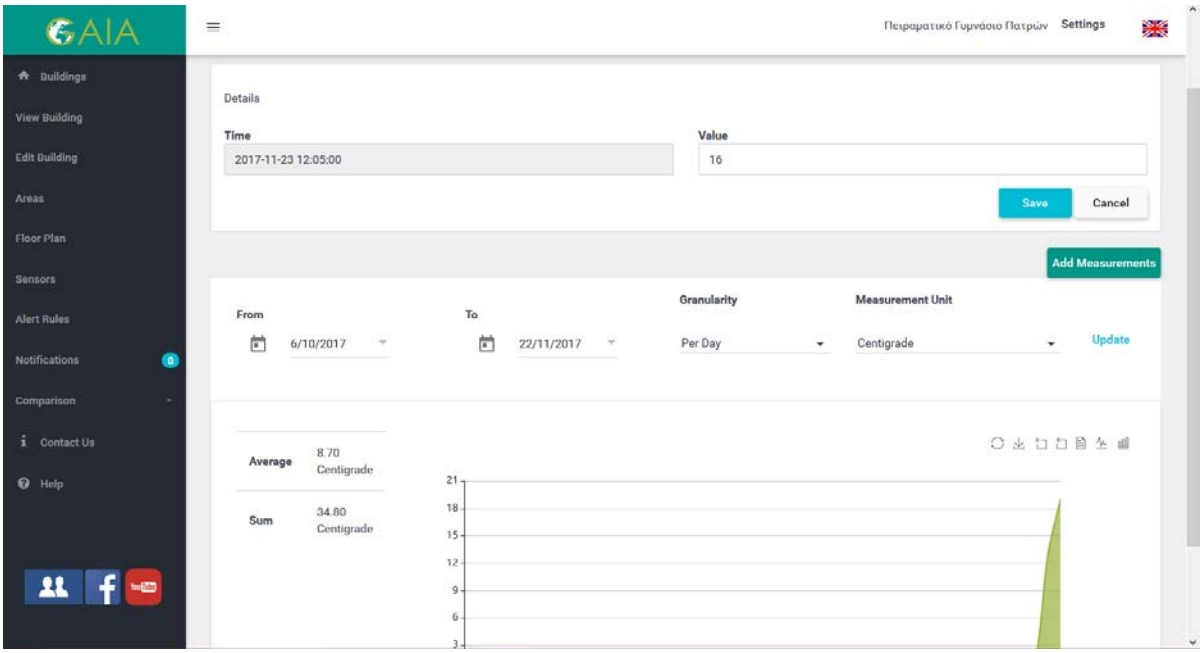

Figure 33 Adding Measurements

2.9 Anomalies

In the Anomalies page a list with all the recorded anomalies in energy consumption appears, Figure 34. As an anomaly we define any unusual value in the consumption, either very high or very low.

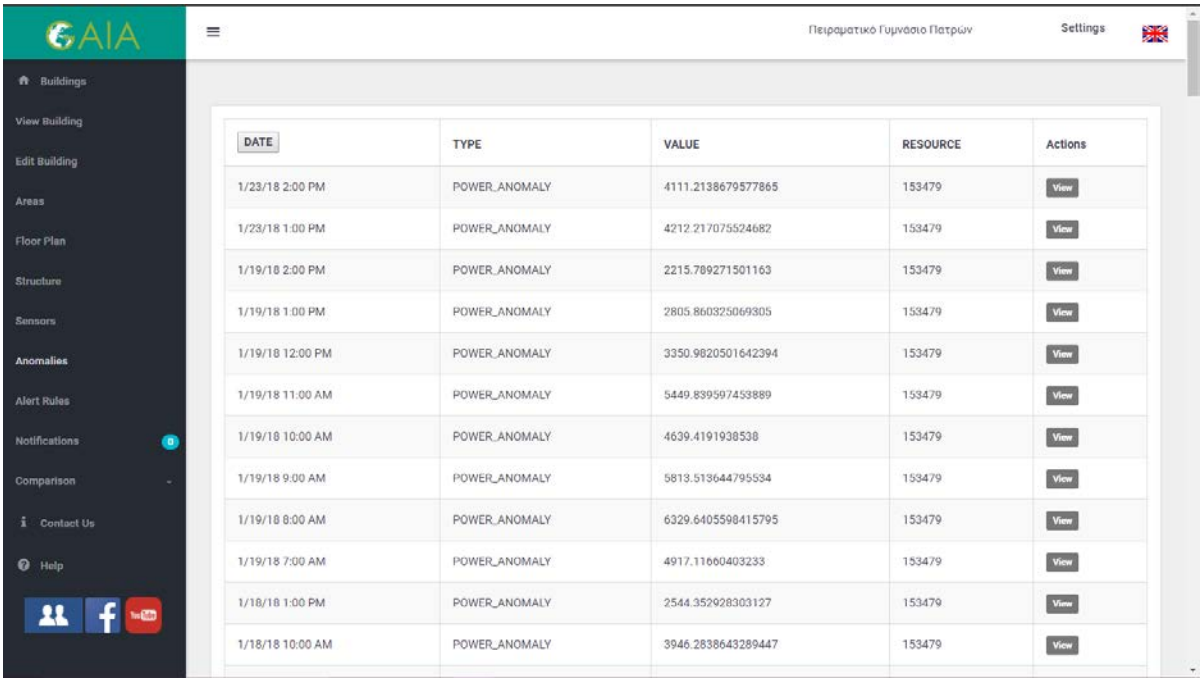

Figure 34 Anomalies page

Clicking on the “View” button in the Actions column, the user may view the details of the specific event.

2.10 Alert Rules (Group A users)

In the Alert Rules page, Figure 35, a user with managerial rights can define rules on the measurements of the sensors. As soon as these rules are activated they create notifications in the corresponding application page (see next section).

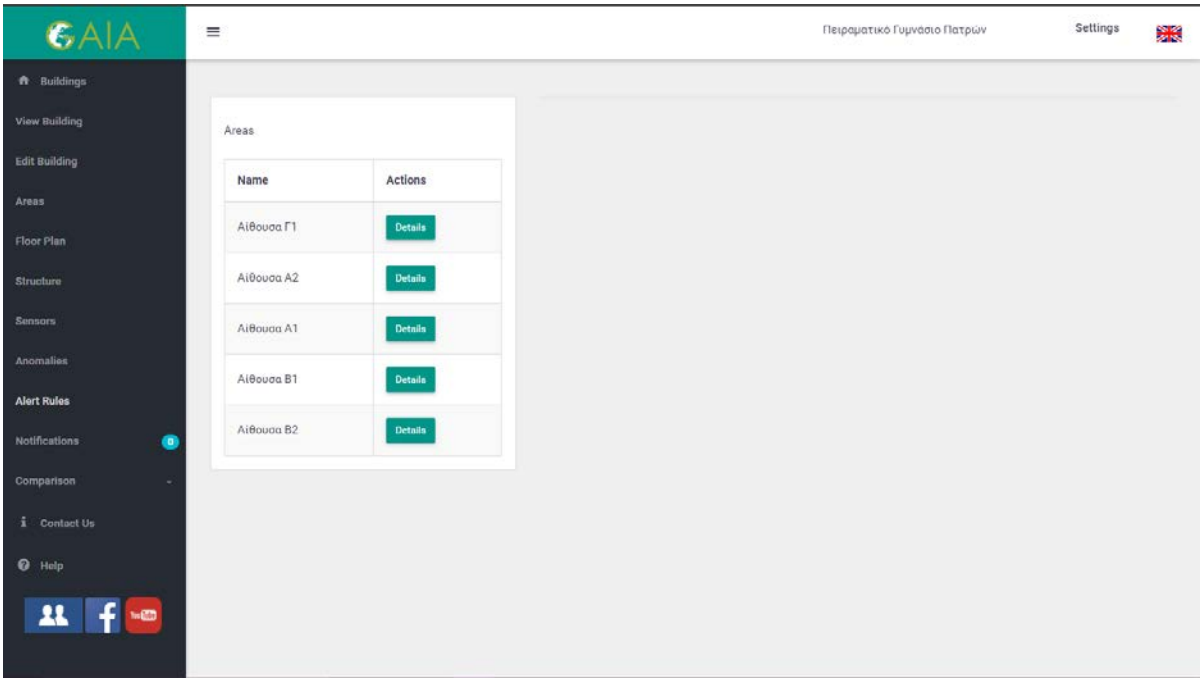

Figure 35 Alert Rules page

The user clicks on the "Details" button next to the Area for which they wish to create a rule. All the possible preexisting rules of the area appear along with the "New Rule" button, Figure 36.

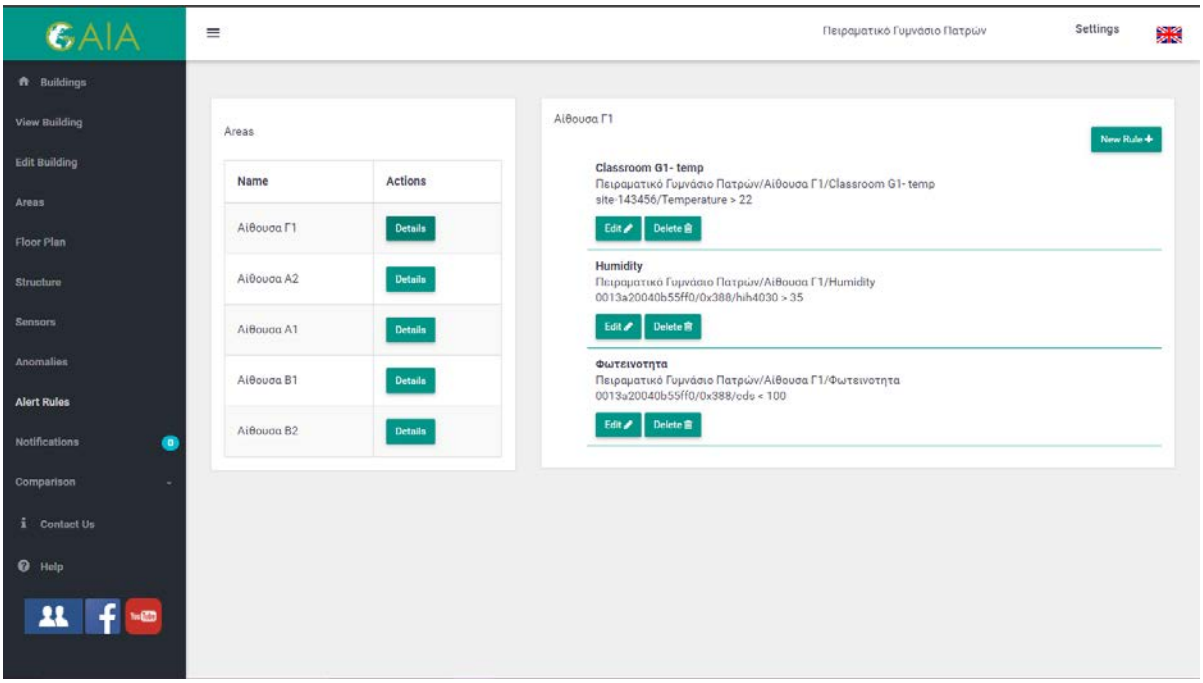

Figure 36 Area details for Rule creation

As soon as the user clicks on this button, they are able to set a new rule for this area. They add the name and a description for the rule, as well as the message they wish to appear at its activation. From

the drop down menu they choose their preferred sensor, they pick an operator <,> or == and the preferred threshold value. For example, when the luminosity in the room is less than 100, the message “Please turn on the lights” will appear, Figure 37.

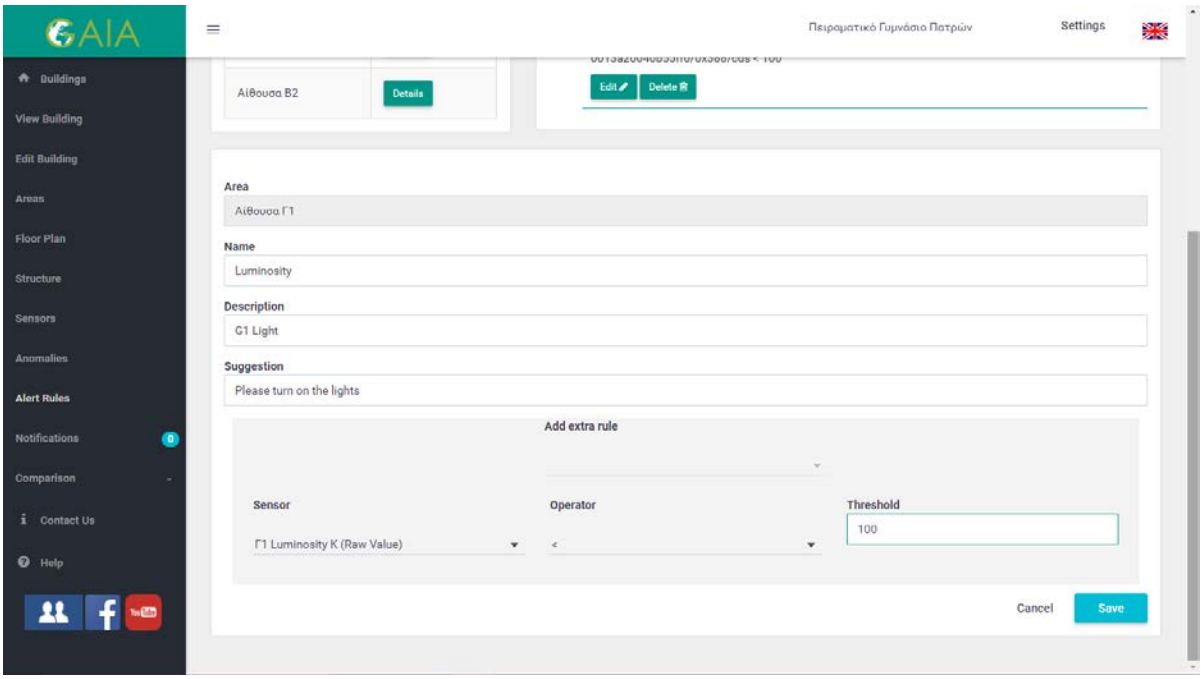

Figure 37 Setting a Simple Alert Rule

The user may set more than one parameters for their rule if they wish, form the drop down menu “Add extra rule”. Choosing AND they may set an extra condition that needs to be realized at the same time as the first for the rule to be activated, while OR will activate the rule when either of the conditions apply, Figure 38. For example if at the previous rule the user adds the condition Motion>0.5, the rule will be activated only when there are low luminosity levels at high motion levels.

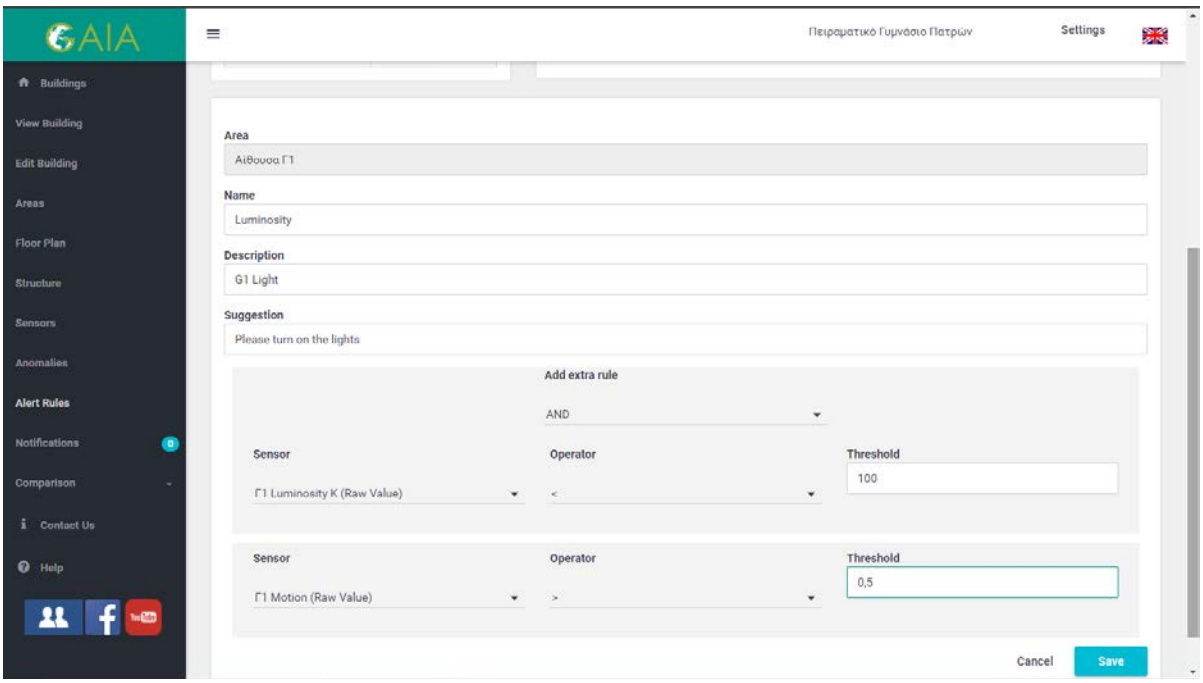

Figure 38 Setting a Composite Alert Rule

The “Edit” and “Delete” buttons allow the user to respectively edit or delete an existing rule.

2.11 Notifications

In the Notifications page a list with all the recorded notifications – based on rules created by a **Group A** user in the Alert Rules page – for the specific building appear, Figure 39. The timestamp of the activation, the name of the rule, the threshold value, the current value and the message towards the users appear.

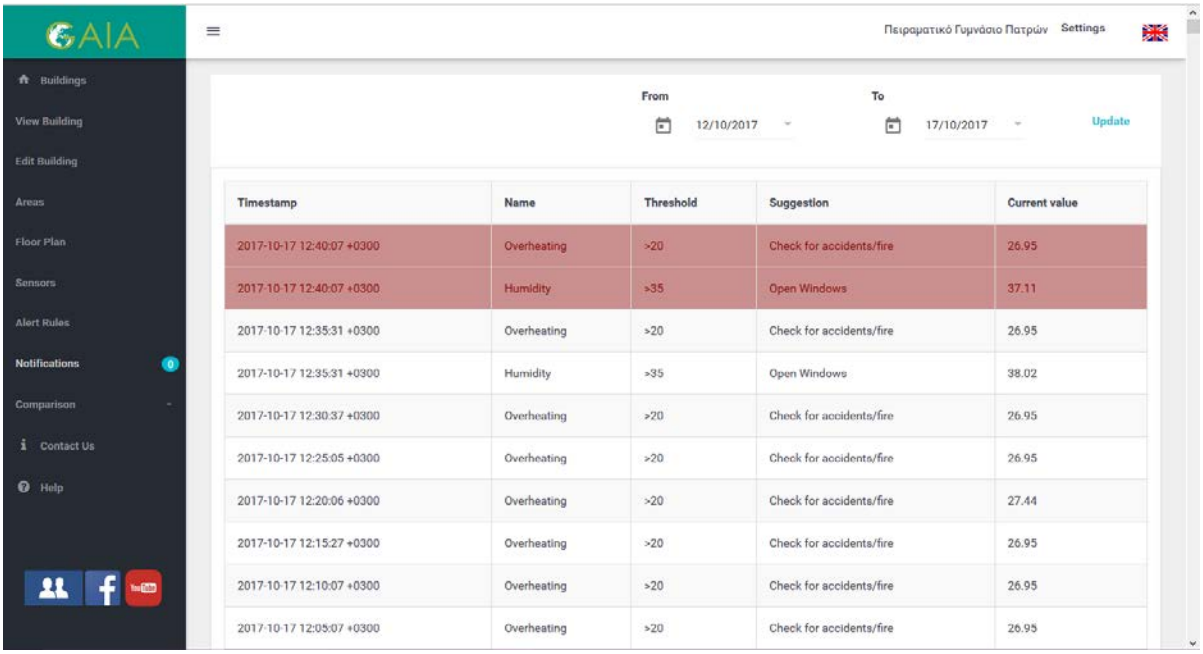

Figure 39 Notifications

The notifications, meaning rules, which have been activated since the user's last login to the application (running session) appear on the top of the list marked with red. The numerical icon next to the "Notifications" button in the main menu shows the same number of these. Furthermore the user is able to view the notifications for a specific time range set for the "From" and "To" fields on the top of the page.

2.12 Comparison

The Comparison feature allows the user to compare values of total building measurements of Energy, Relative Humidity, Temperature and Luminosity in different time frames in their own building or with another similar building, as well as measurements between sensors of different measurements in a single time frame.

In the "Your School" page, the user chooses 2 time frames, the measurement and the granularity and receives a combinational chart of the building's chosen measurement for these time frames, Figure 40. Two different charts appear in their usual form, as well as the total and average values for each period on the top of the screen.

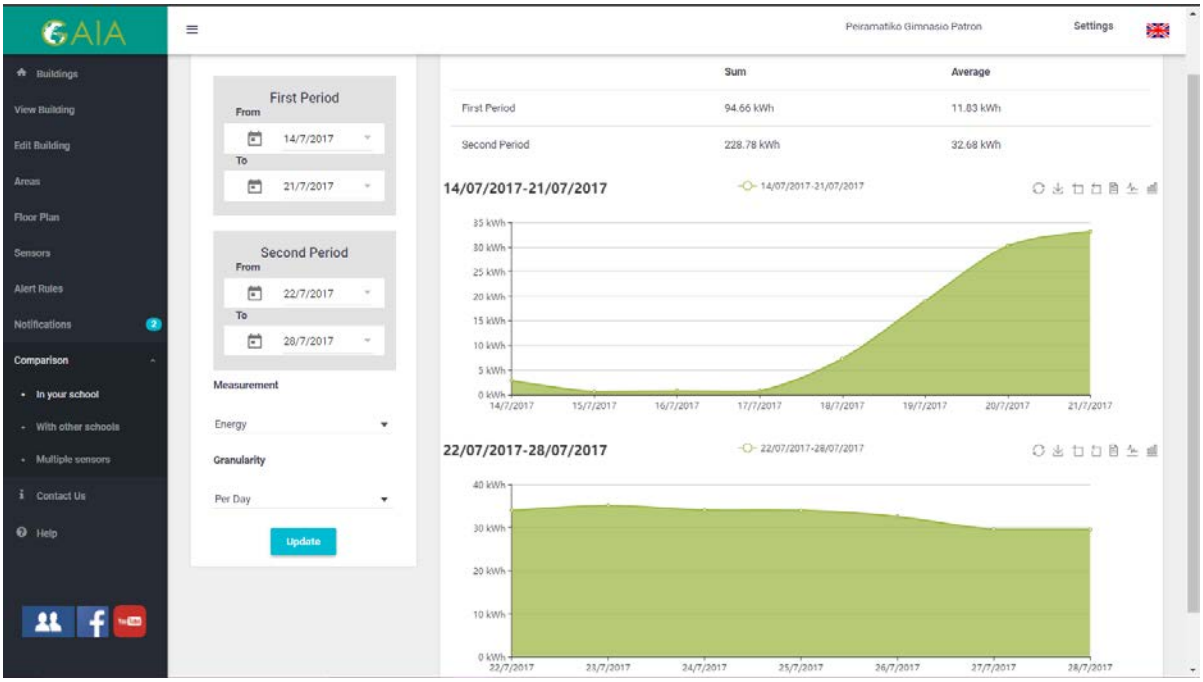

Figure 40 Two different time frames energy consumption comparison

From the "Compare with other schools" page they may choose the school, time frames and measurements they would like to receive charts of in a similar fashion, Figure 41. The legends on the top of the chart reveal which colour represents which school and act as buttons through which the schools may be hidden from the chart or revealed back.

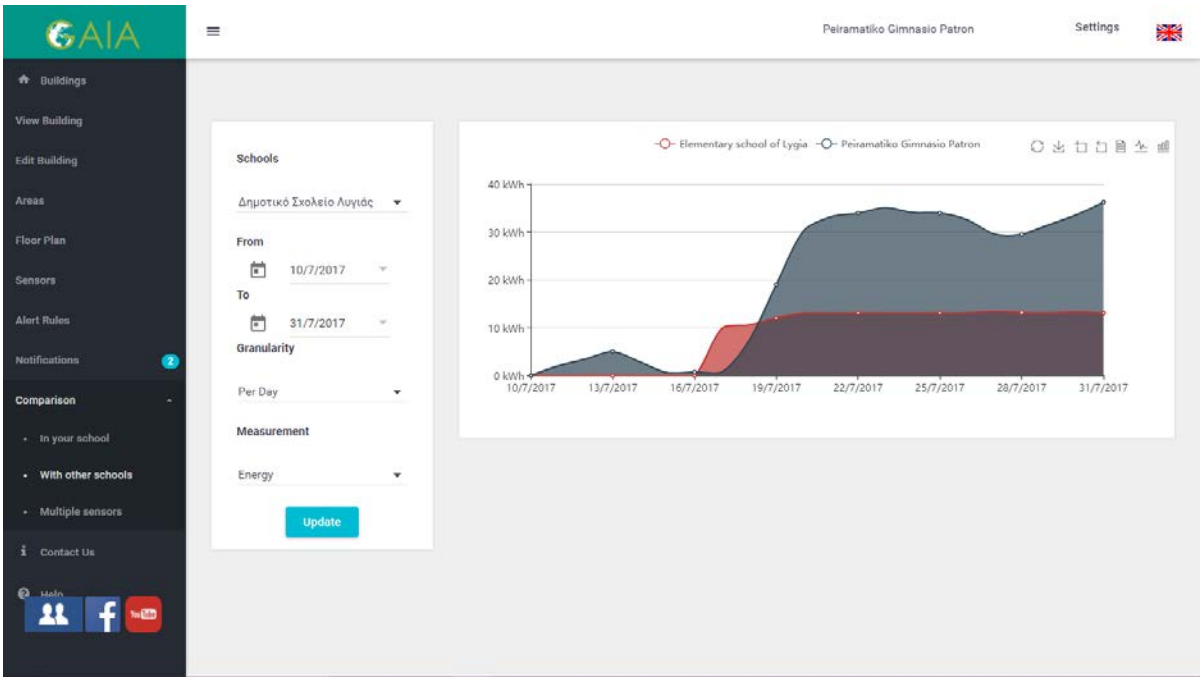

Figure 41 Two different buildings measurement comparison in a single time frame

In the "Multiple Sensors" page, they may receive comparison charts between different sensors placed in their school, Figure 42. This applies for the basic measurements as they have been defined in the *Resources* tab of the Edit Building page. Again, the legends double as buttons for hiding their respective measurement from the chart. In any such action the y axis of the chart shifts to better accommodate the depicted values.

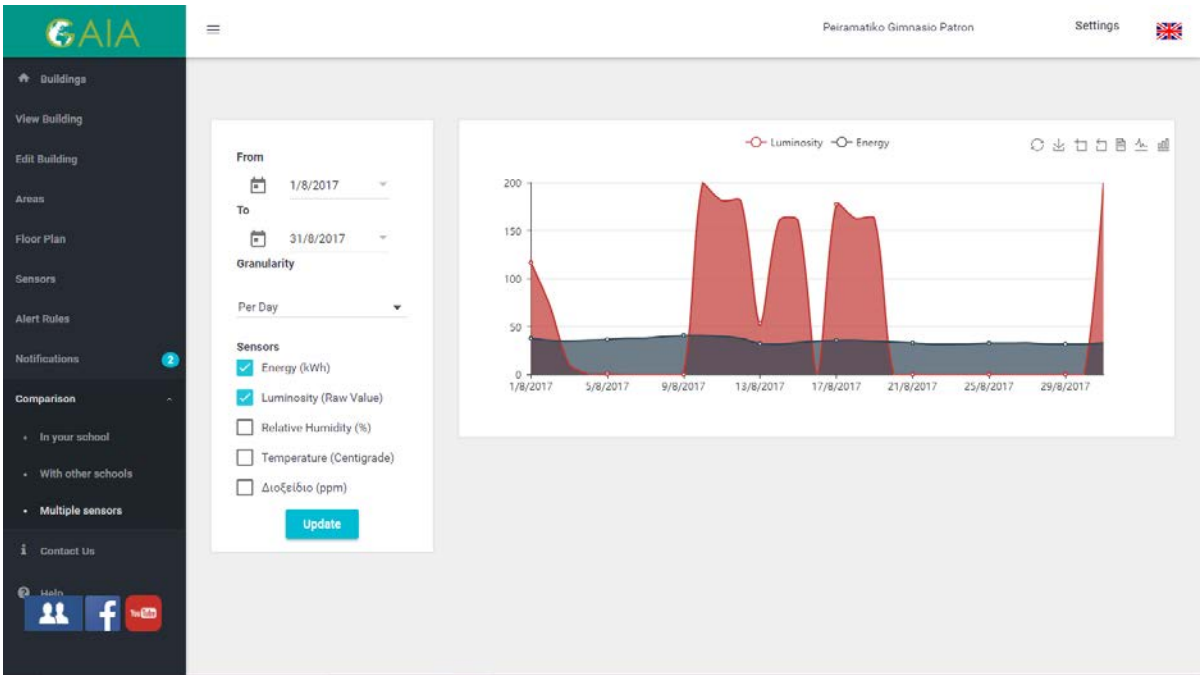

Figure 42 Two different sensor values comparison in a single time frame, a

In the Choose Resources page the user, as in the "Multiple Sensors" page, may receive comparison charts between different sensors placed in all areas of their school, Figure 43.

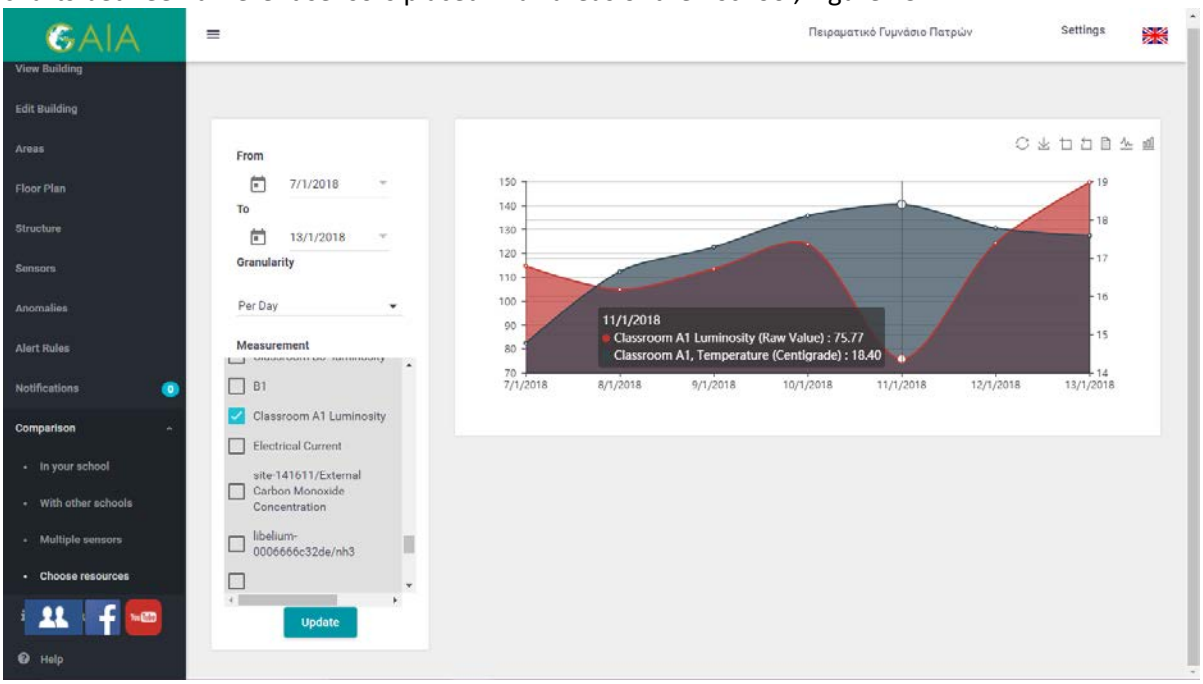

Figure 43 Two different sensor values comparison in a single time frame, b

3. Mobile Applications

3.1 Building Management Application

The Building Management application can also be accessed through a mobile device. At the log in page the user enters their credentials and are directed to their dashboard, Figure 44.

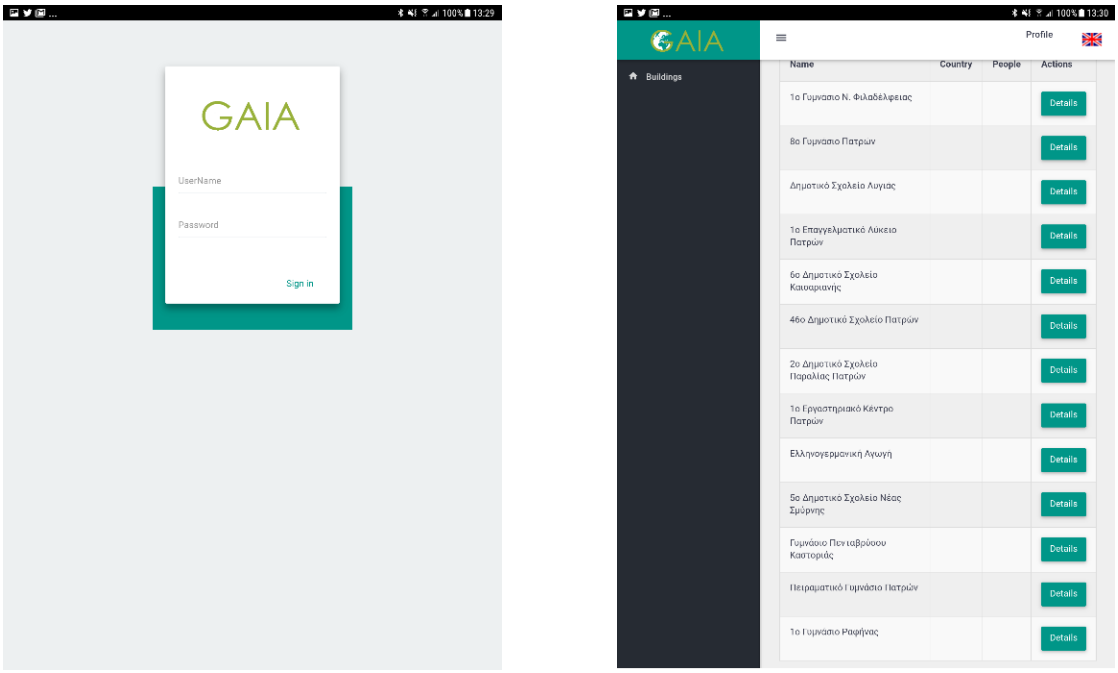

Figure 44 Login and Dashboard, Mobile Application View

Clicking on the "Details" button they are taken to the corresponding building's page, Figure 45.

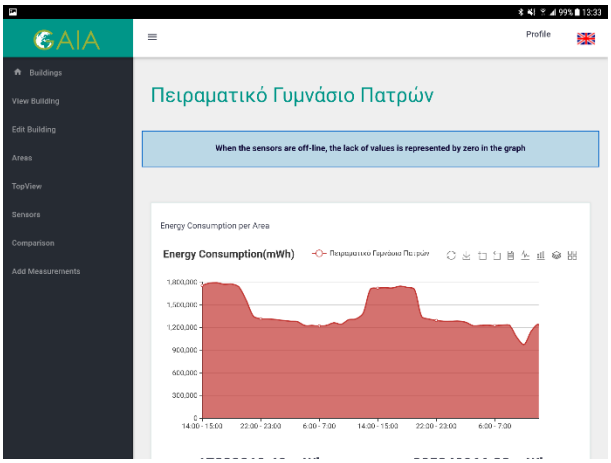

Figure 45 Mobile Application View, Building main page

3.2 Participatory Sensing Application

Through the Participatory Sensing Application the user is able to manually upload measurements in the system, under the Virtual Sensors as they have already been defined by the teachers. Upon login the user is presented with the buildings to which they have access, Figure 46.

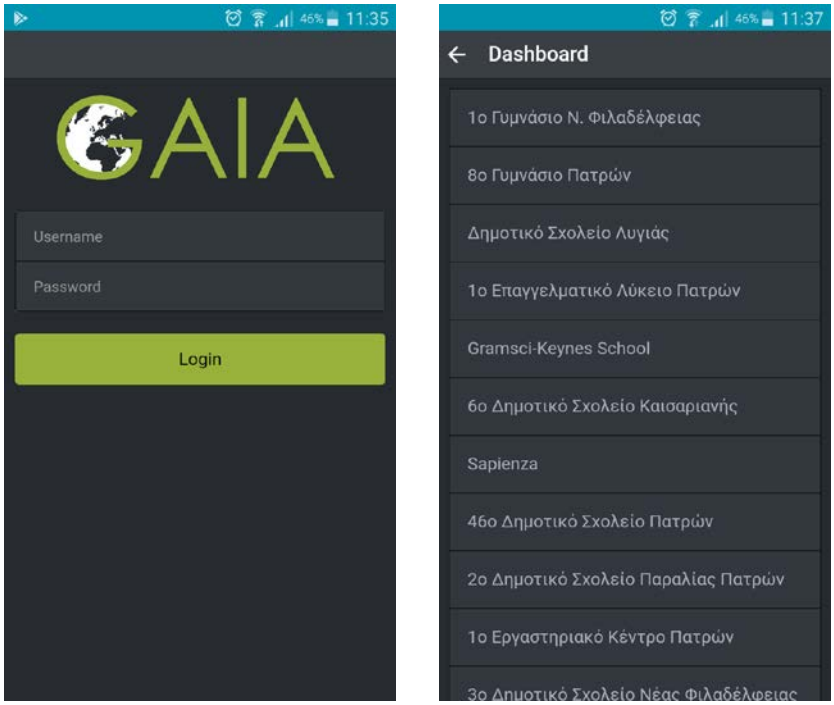

Figure 46 Participatory Sensing Application login and landing page

Upon selecting a school they are presented with all the pre-installed (through the building management application) virtual sensors. Selecting one they are able to associate the measurement they desire by typing in the field provided and clicking “Save”. If they prefer their device’s sensor to provide values automatically, e.g. for light measurements, they may turn Auto Gathering on by clicking on the button at the bottom right corner of their screen, Figure 47.

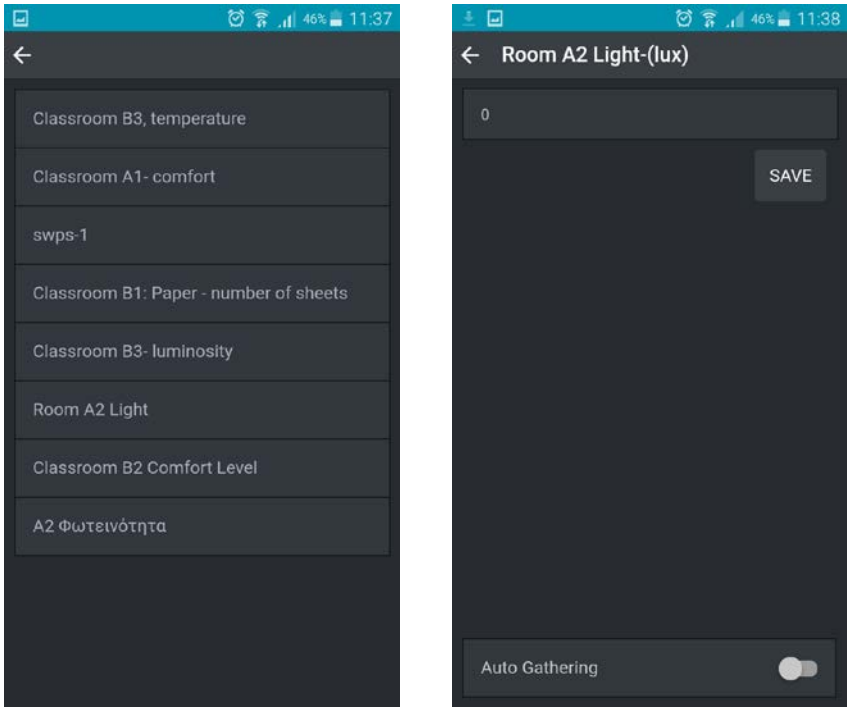

Figure 47 Virtual Sensor List and Adding Measurements

The Participatory Sensing Application is available at the Google Play Store under GAIA – Participatory Sensing, goo.gl/LFj2S4.