EMB3Rs
Heat and Cold matching platform

EMB3Rs Unified Modelling Platform

Final demonstrator

EMB3Rs D3.7

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26TH OCTOBER 2022

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Technical References

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
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1. Introduction

The EMB3Rs Unified Modelling Platform is a tool to assist on modelling the recovery of industrial excess heat and cold and its reuse to meet final energy demand within and beyond the boundaries of industrial sites. The tool consists on several simulation modules, a knowledge base where all data is stored and a core functionalities module where all interaction between user, knowledge base and analysis modules is handled.

EMB3Rs fully replaces the current, mostly manual, analysis process, typically hired to external entities (consultants) with specific expertise in the different analysis dimensions. It was conceived to be user-friendly and intuitive in such a way that even non expert users are able to find possible scenarios to recover industrial excess heat and cold.

This document describes the operation of the platform, from the user account creation, infrastructure creation, configuring a simulation, how the different modules are involved and the output reports to the user. Some of this information is closely related to the deliverables describing the platform, such as D3.1-D3.6.

This document starts with an EMB3Rs overview, then presents the platform and its basic features; it proceeds with a brief description frontend and how users shall interact with the platform; the following sections describe how a simulation will be configured and run by a user and how will the results be presented in the reports; the last section presents an overview of the backoffice where administrators of the instance may configure the inner functionalities of the platform.

1.1. Purpose and Scope

This Document describes the EMB3Rs Platform and how to use it, and refers to the System and User Manual. It starts with introductory sections for a typical final user, such as account creation, interaction with the map, adding infrastructures to the platform, configuring a simulation, an overview of the simulation reports and an introduction to the challenges participation.

The second part covers the administration features and is mainly aimed to the platform administrations. It covers the installation and deployment of and EMB3Rs instance and the details of the backoffice, such as the user and roles management, template definitions and simulation and challenges definitions.

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2. EMB3Rs Overview

The EMB3Rs project aims to promote the valorisation and utilization of excess thermal energy by developing an analysis tool - the EMB3Rs Platform - to simulate alternative paths towards recovering, transferring, transporting and potentially selling the energy to different compatible final users including: within a given industrial plant, other industries (intra-sectorial) and other sectors (inter-sectorial) – i.e. buildings and agriculture. The platform encompasses several complementary and stand-alone analysis modules that can be invoked and run in different sequences to help users to maximize the benefits of recovering and using excess heat/cold, improve the environmental impacts of local energy systems and increase the efficiency of energy use in industry, amongst other goals. The users will be able to access their own dedicated area within the platform to add sources, sinks and links, and to run, store and share simulations and results.
The EMB3Rs platform is composed of five functional components – i.e. modules:

1. **Core Functionalities module (CF)**
2. **GIS module**
3. **Techno-economic module (TEO)**
4. **Market module (MM)**
5. **Business models module (BM)**

Users of the EMB3Rs platform will be able to estimate available excess thermal energy and map sinks, sources and links (GIS) through customized user interfaces and industrial thermal process optimization models (via the Core Functionalities Module and Process submodule) and link excess HC supply and demand nodes within least cost HC distribution routes (GIS module). An optimization module based on the OSeMOSYS model will explore alternative technological scenarios for excess heat recovery, distribution and matching with compatible demand by estimating the cost-benefit of the different scenarios (Techno-economic Optimization Module).The users of the platform will also be able to estimate the benefits of selling the excess HC in centralized and decentralized market structures - pool and two-way P2P networks - via the Market Module. Finally, the platform will allow users to explore different business models considering financial, policy and regulatory constraints (including social and environmental) within the value-chain of a heat use scenario (Business Module). These different analysis modules will be supported by a data processing/simulation manager system and have access to a common repository of data on default parameters, costs, technologies, information shared between modules, regulations and previous module runs, among other data (Knowledge Base).
A brief description of the functionalities of the platform, interfaces with users, the analysis modules and the inputs and outputs can be found in this document, as well as the specific deliverables for each module (D3.3 to D3.6).

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3. EMB3Rs Platform System Manual

The module dynamic system, developed for the Emb3rs project, has been designed in accordance with microservice architecture.
In the beginning of the project, the communication layer of the project were totally focused on the redis framework, then based on the needs that were appearing regarding the customization of how the simulations are done, work with the data and giving the user the choice to customize the mapping, flow and presentation of the data, the communication system went away from redis interface (still being available in the system) and was implemented a gRPC based microservice communication system.

3.1. Redis Communication

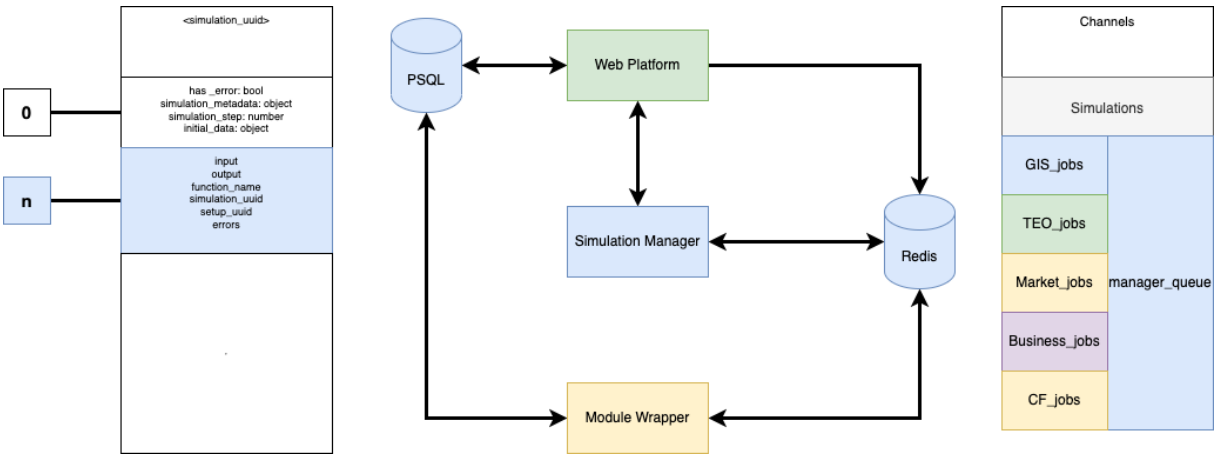

Figure 1 - Redis Communication

Everytime the platform wants to start a simulation, a publish to the channel simulations happens and the module Simulation Manager takes care of processing the simulation metadata to organize all the steps of the simulation and into which module's channels to publish (call) to process that simulation step.
All this happens in an asynchronous way, so that the scalability and responsiveness of the simulation would be ideal. From the platform, a Module developer can register a new module to be available in the Simulation System, by giving all the details that are required for the module to work.
The naming convenctions applied in the system, usually follows a rule, by telling that every channel ending with "_jobs" is where they tell to the manager that they've finished their task.

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Therefore the list of available Module Channels:

- CF Module (cf_jobs)
- GIS Module (gis_jobs)
- TEO Module (teo_jobs)
- Market Module (market_jobs)
- Business Module (business_jobs)

3.2. Simulation Flow

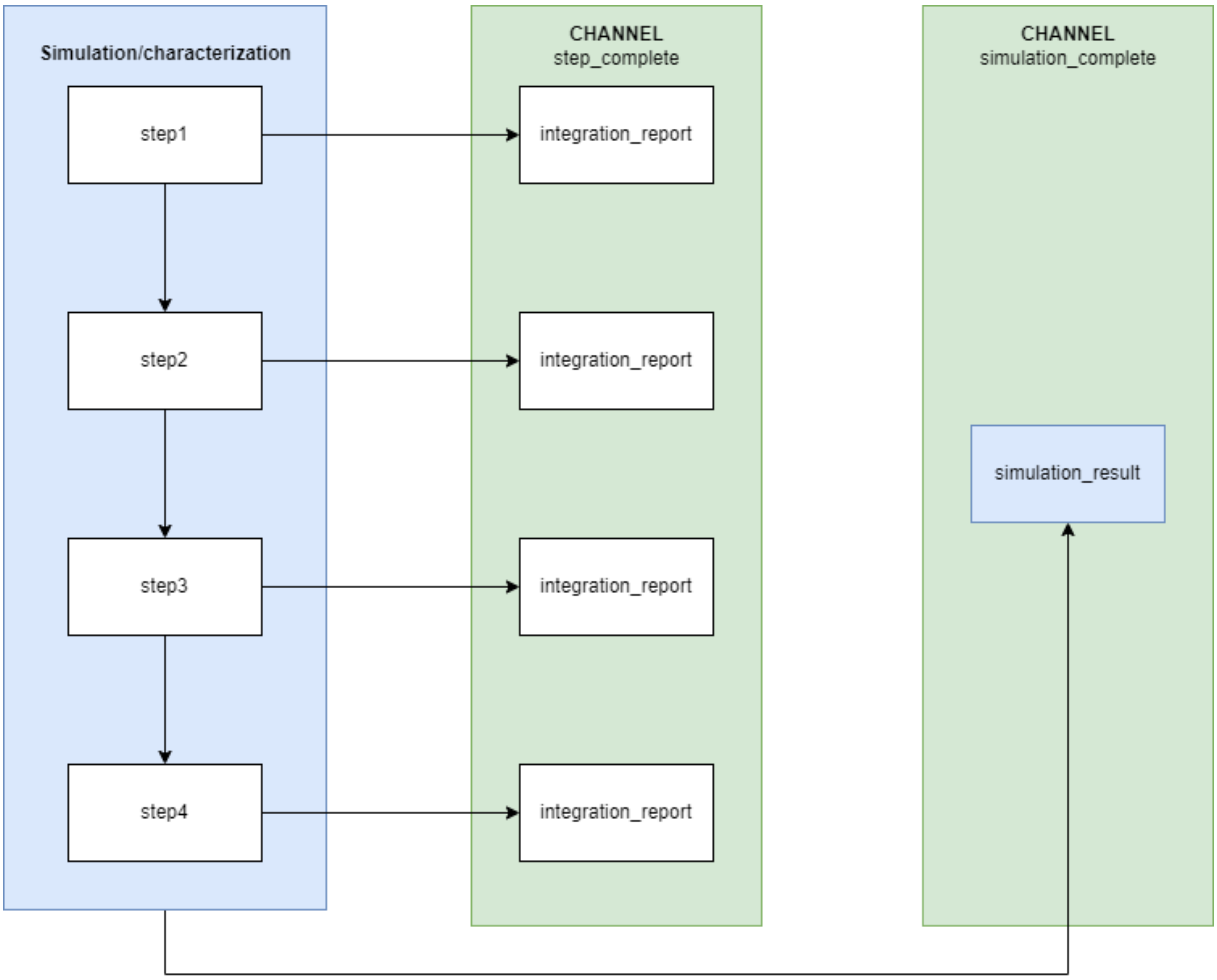

Figure 2 - Simulation Flow

Everytime a simulation is running, there is a report sent to the platform about every step that was completed, so that the user knows what is happening in the simulation process, finishing with a Simulation Result Report.
Module Wrapper (integration flow)
Below is explained in a diagram, the flow of the communication that happens between the Module, Redis and Postgres, everytime a module is “triggered”

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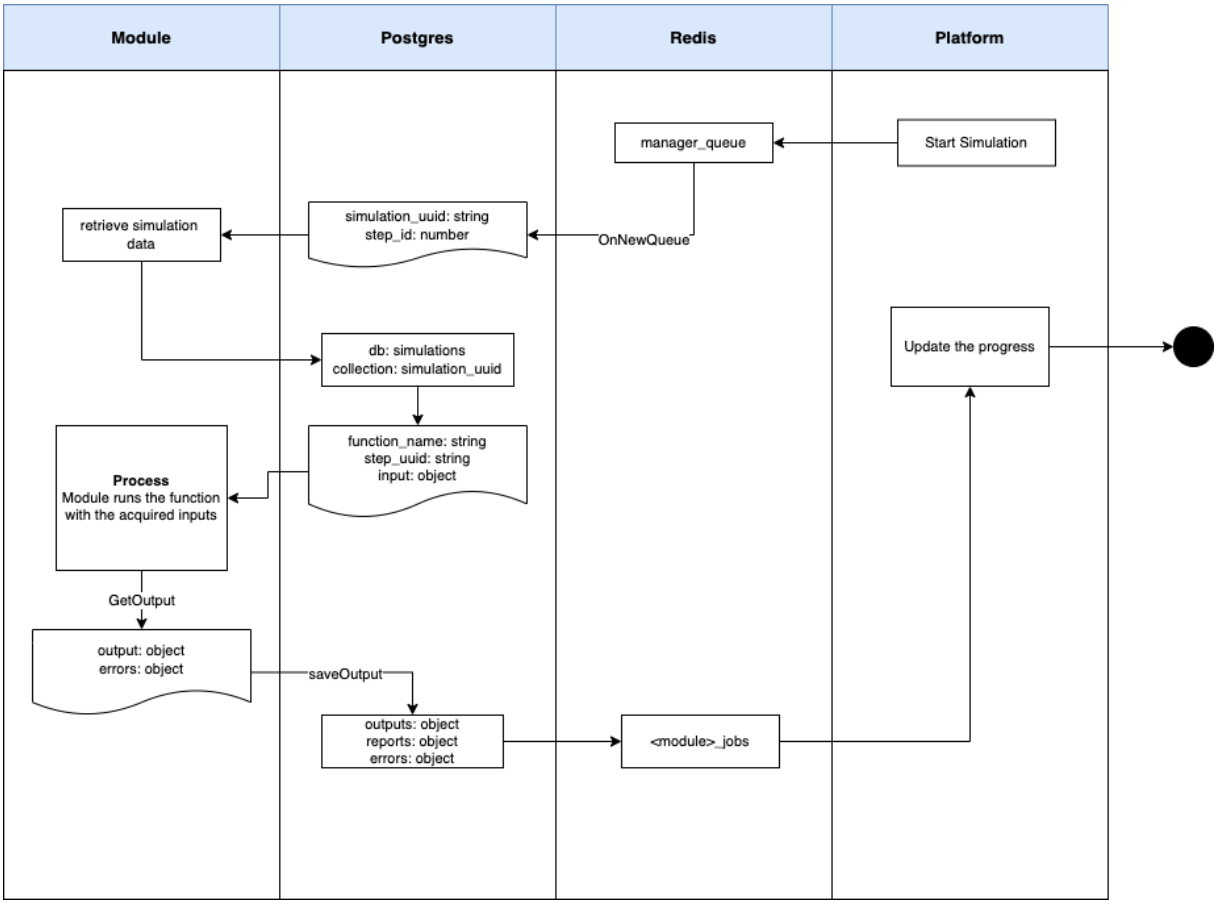

Figure 3 - gRPC Communication

3.3. Websockets for realtime updates

To show the platform events in realtime on the frontend such, notifications, simulations results that are continuously being sent bu the backend server and the simulations modules, the platform uses a protocol called websockets to listen and track all the events that are sent for the users private channel and translatend into a frontend event like a notifications.

Every time that the users logs in the platform subscribe the user into a private channel and from this moment the users frontend will track all the events transmited into the private Channel.

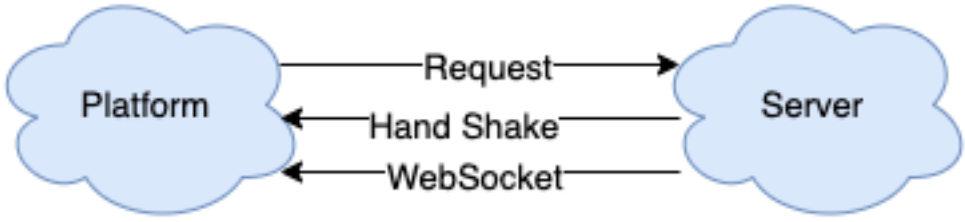

Figure 4 – Websockets protocol

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3.4. Microservices inter-process communication

A microservices-based software system requires applications to talk to each other using an inter-process communication mechanism. Microservices can communicate with each other as

- Synchronous communication (request-reply): In this pattern, a service calls an API exposed by another service and waits for the response. The API must have well-defined semantics and versioning.
- Asynchronous communication: In this pattern, a service sends a message, without waiting for a response from another service. And, one or more services can process the message.

A most common way of implementing a request-reply style of communication is by using RESTful services, typically implemented as JSON payload over HTTP. However, RESTful services can be quite bulky, inefficient, and limiting for lots of use cases. The bulkiness of RESTful services is because of the fact that most implementation relies on JSON, a text-based encoding format. The JSON format uses lots of space compared to the binary format.

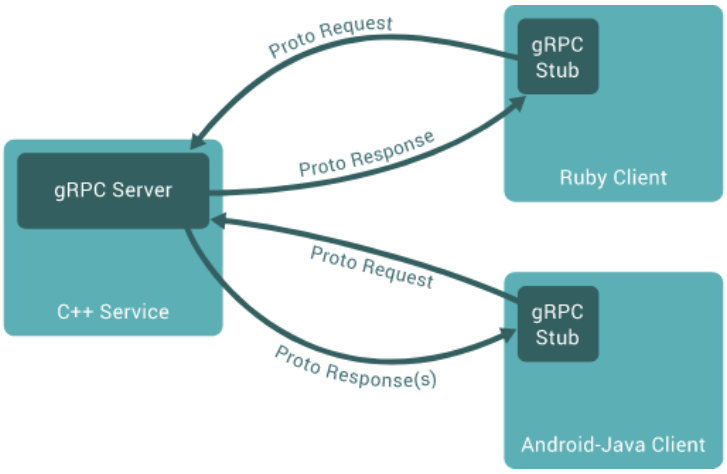

Figure 5 - Flow of a simulation

In the gRPC Simulation System, a user can call directly every module, so the user decides the flow of the simulation.

Module gRPC Wrapper

In the public repository Emb3rs-Project/ms-grpc: Module System gRPC definitions and generation (github.com), resides the proto definitions and the generated code for the gRPC implementation for every module that has been made available in the Simulation System so far.

The only implementation of the gRPC wrapper for the modules, is the serialization and deserialization of the Messages between the Clients and the Modules.

Public Repository Structure (for More Information)

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ModuleSystem/ (All the Redis Based Core Services/Modules):

- ms-manager
- ms-reporter
- ms-wrapper
- ms-core
- ms-mapper-service
- ms-network

Platform (Front End application)

- web

Module/ (Wrapped Modules)

- m-core-functionalities
- m-gis
- m-market
- m-business
- m-teo

Prototypes/ (Pre-Wrapped Modules)

- p-core-functionalities
- p-gis
- p-market
- p-business
- p-teo

gRPC Core Modules

- m-grpc-client (gRPC client Repo)
- ms-grpc (gRPC protos and Generated Code)

gRPC Wrapped Modules

- m-grpc-core-functionalities
- m-grpc-gis
- m-grpc-market
- m-grpc-business
- m-grpc-teo

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4. EMB3Rs Platform User Manual

4.1. Part 1 - Basic Functionalities

This manual describes the basic functionalities for a typical EMB3Rs user.

EMB3Rs project website is accessible via the URL:

https://www.emb3rs.eu/

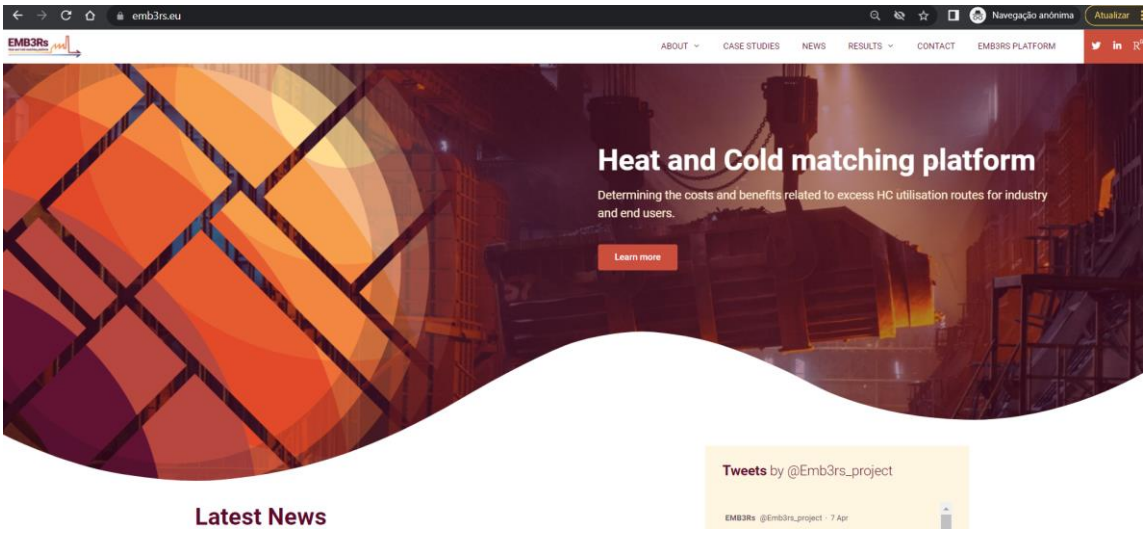

Figure 4 - EMB3Rs project website

4.1.1. Account

4.1.1.1. User Account

On the EMB3Rs website top menu there is a link to the EMB3Rs platform, that leads to the login page.

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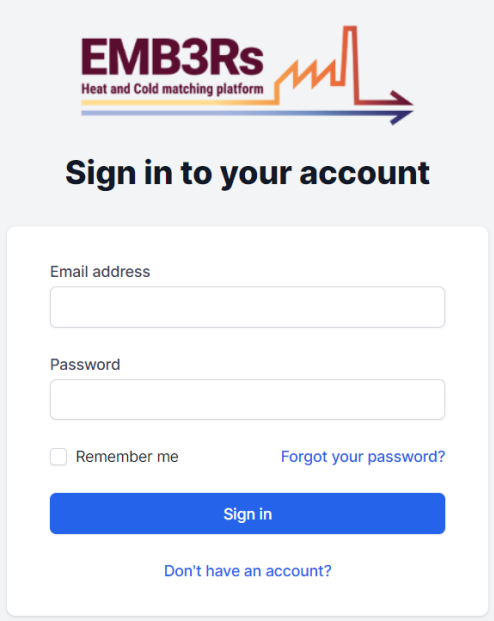

Figure 5 - Login screen

To use an instance of EMB3Rs platform one must start by creating an user account. The account creation form is accessible through the link “Don’t have an account”:

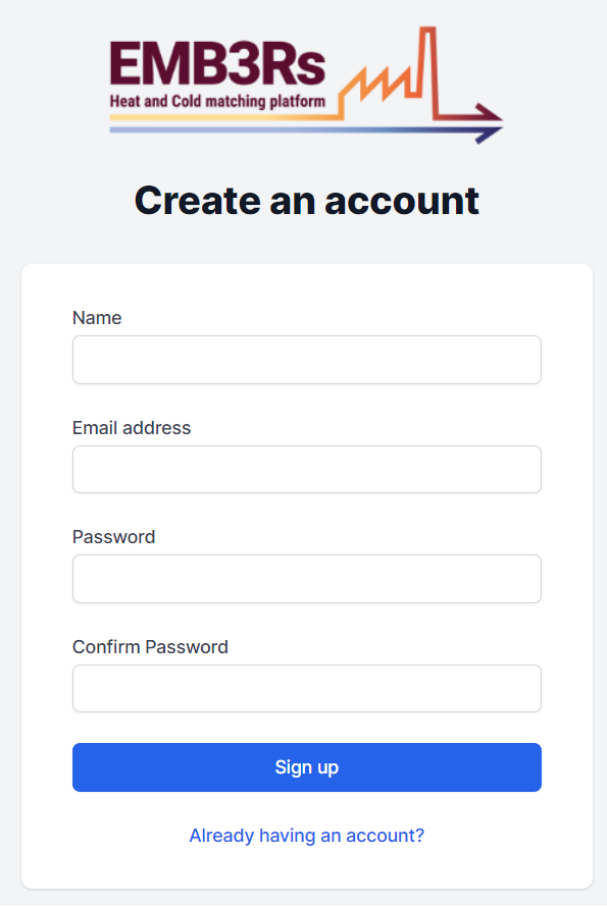

Figure 6 - Create account

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After creating the account the user is immediately led to the platform dashboard:

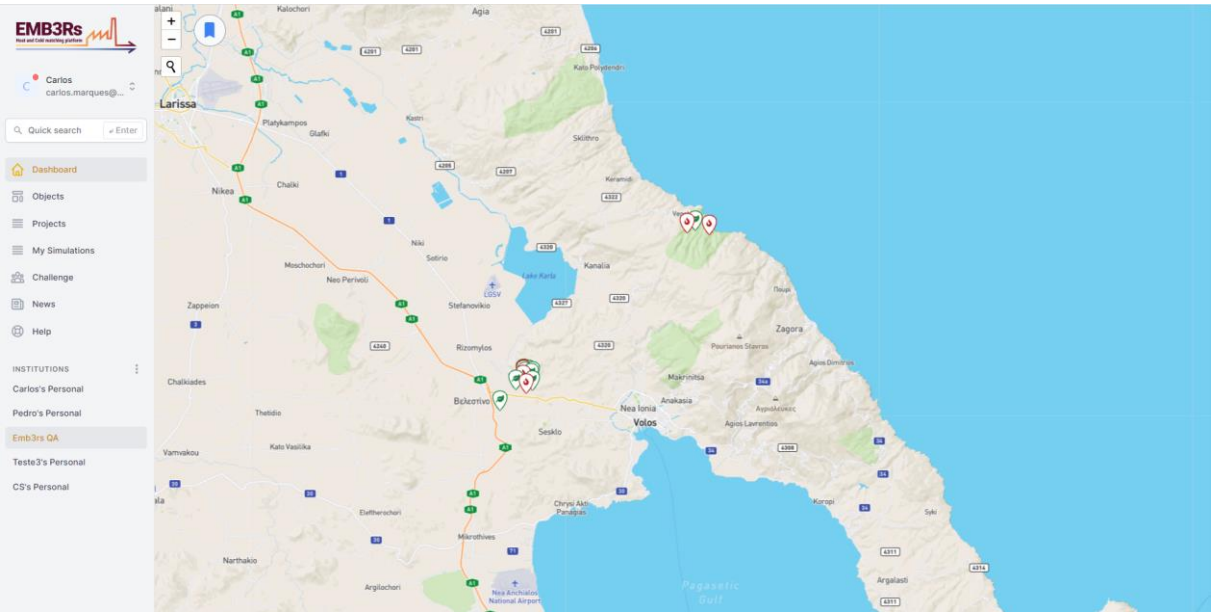

Figure 7 - Dashboard

4.1.1.1.1. Account Details

The account menu is accessible right below the EMB3Rs logo, by clicking on the username. From this menu the user may access the profile details, notification definitionsand logout from the current session on the platform.

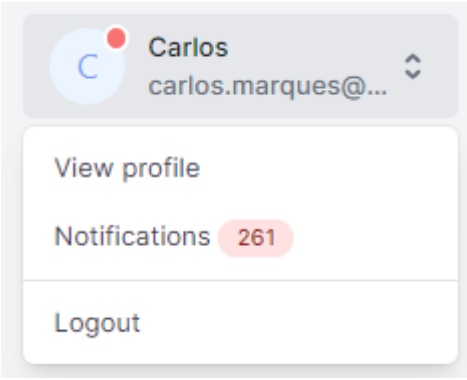

Figure 8 - Account menu

The profile details page allows the user to see and edit the account information, such as the Name and Email, to update the password for the account, enable/disable the two factor authentication, logout from other unfinished sessions, and delete the account.

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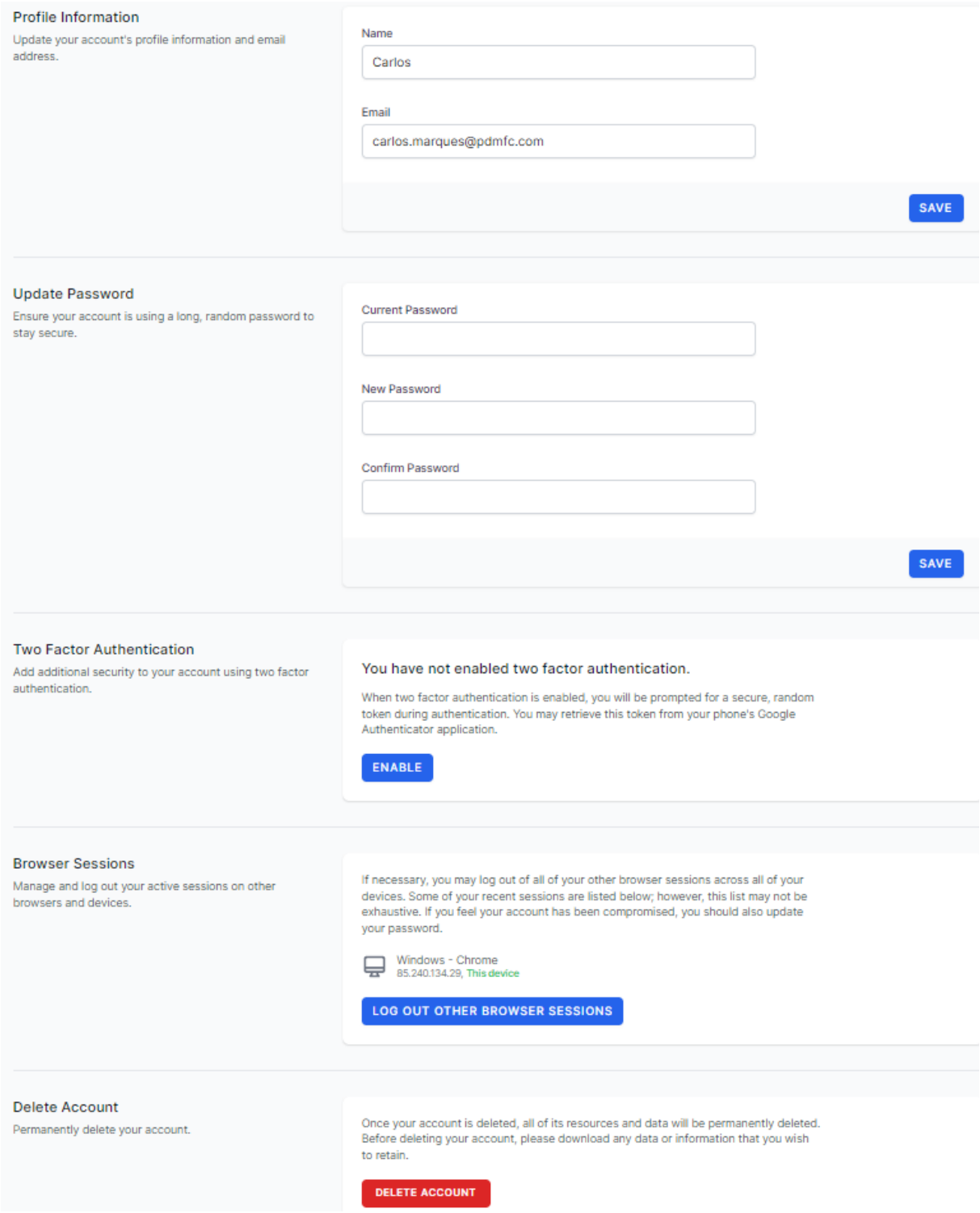

Figure 9 - Account Profile Details

4.1.1.1.2. Notifications

When the user receives any notification in his account a new notification badge appears (a red circle):

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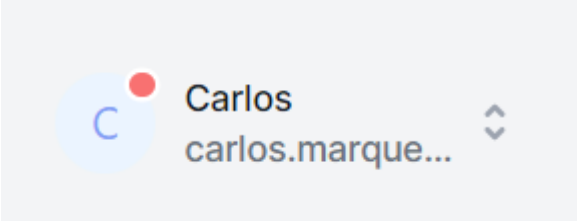

Figure 10 - New notification badge

By clicking on the username, the menu shows the number of new notifications and gives access to the notification page.

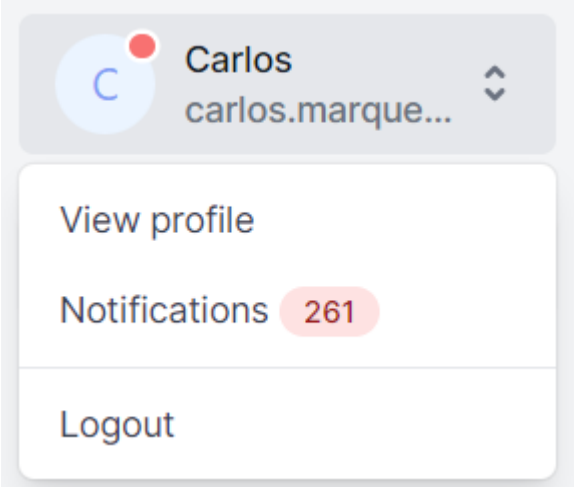

Figure 11 – Notifications

The notifications page shows a page with 2 lists of notifications: New and Read.

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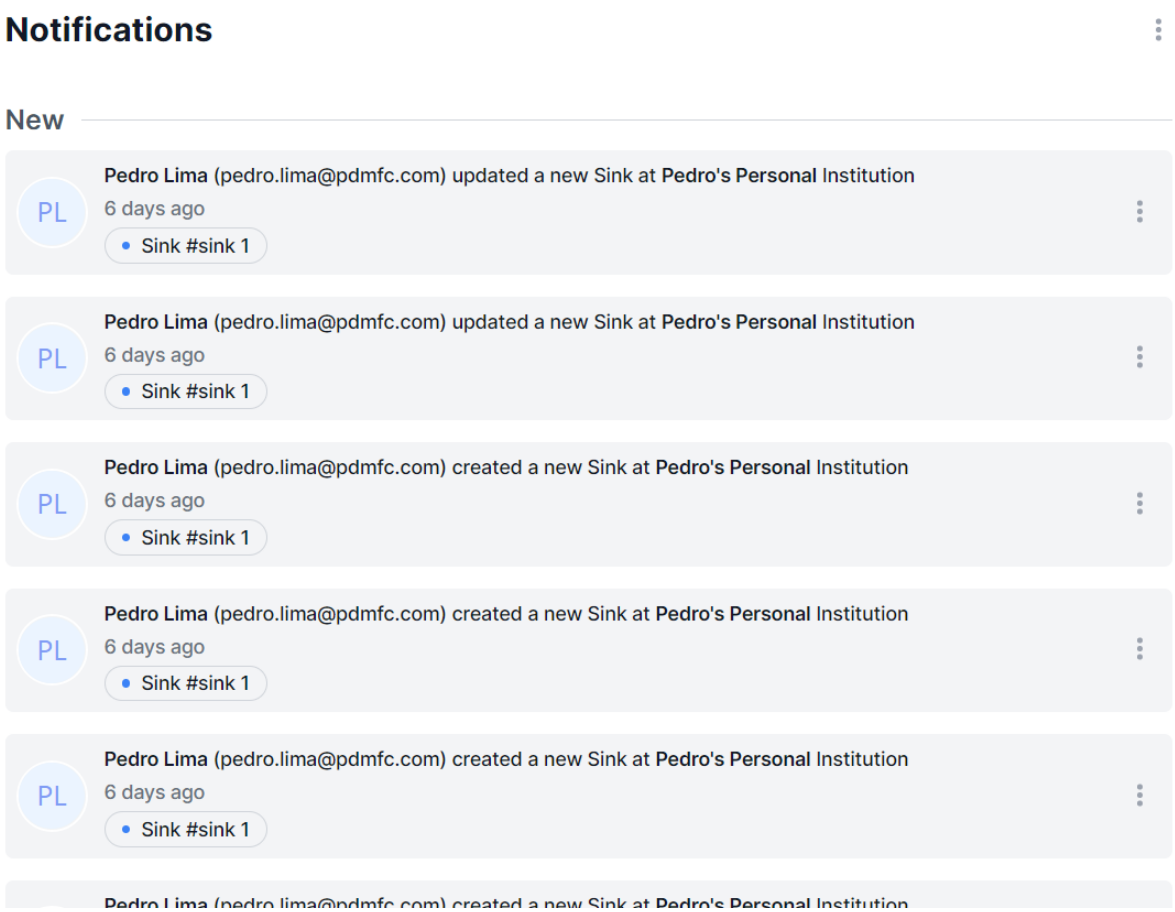

Figure 12 – New Notification list

Notifications will keep on the New list until the user marks them as read, through the menu entry, either one by one on the notification entry or all at once via the Notifications context menu.

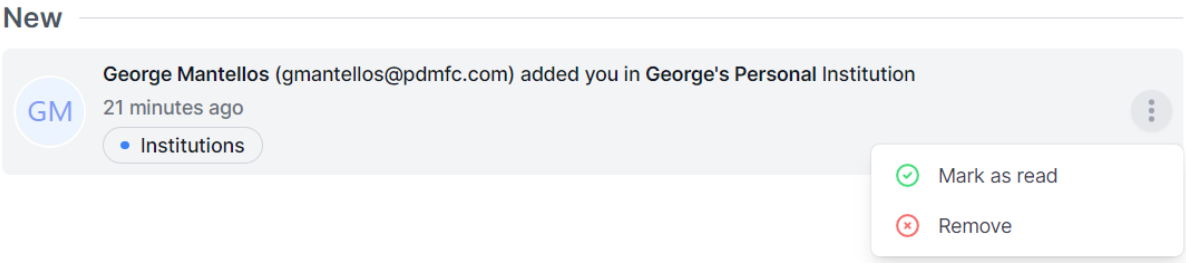

Figure 13 - New notification context menu

Once the user has marked some notification as read, the Read list section appears and shows the old notifications. If there are no other new notifications on the New list, a message will show in that section informing that there are no new notifications.

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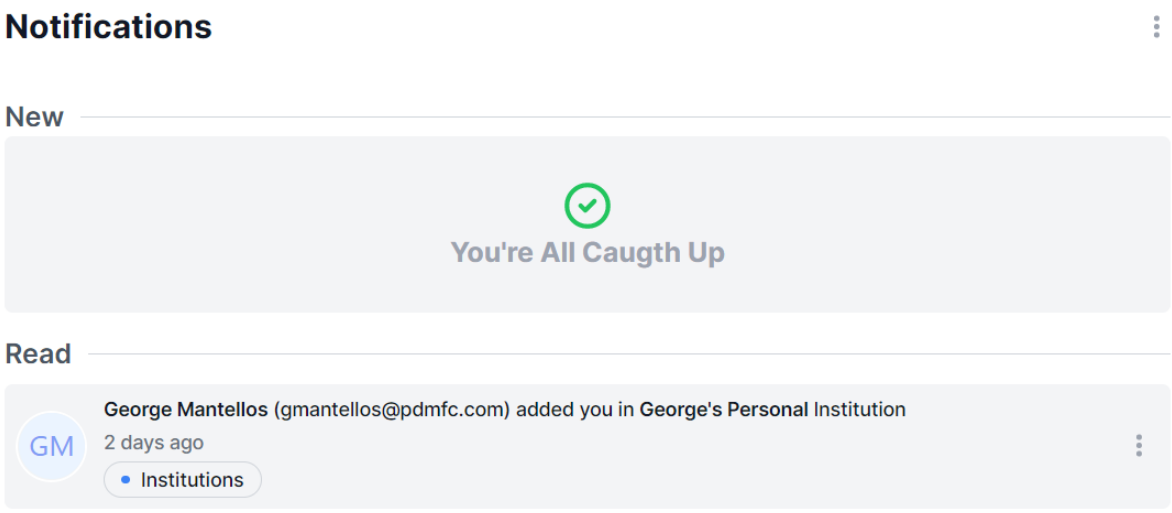

Figure 14 - New and Read Notifications

4.1.1.2. Institutions

Below the main menu area, there is a section with the user institutions.

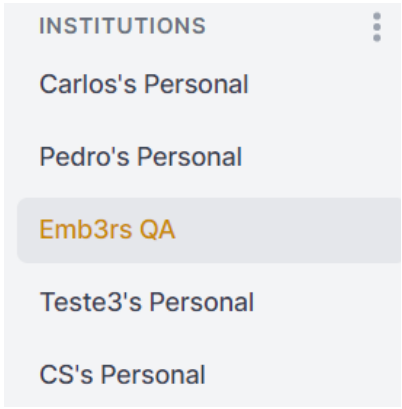

Figure 15 - User Institution List

When a user registers an account, an Institution is also created as his personal institution. An Institution allows users to share assets among colleagues associated with the institution. The user may create other institutions, edit its details, add or remove users and manage their roles or delete the institution.

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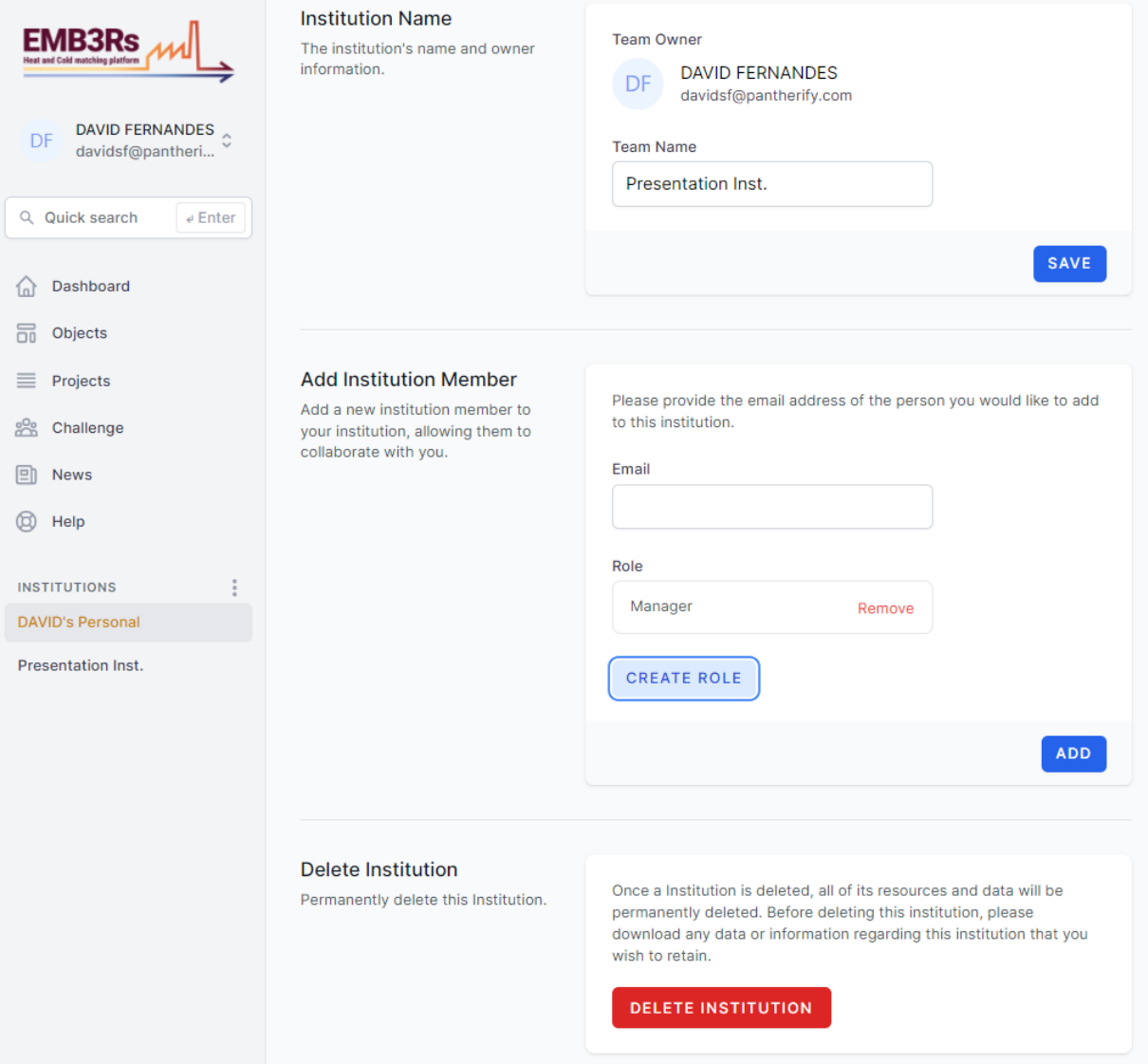

Figure 16 - Institution Details Page

When adding a member to an institution a role must be assigned. Roles may be created to assign to the users, and with custom permissions, by object type (Sources, Sinks, Simulations…).

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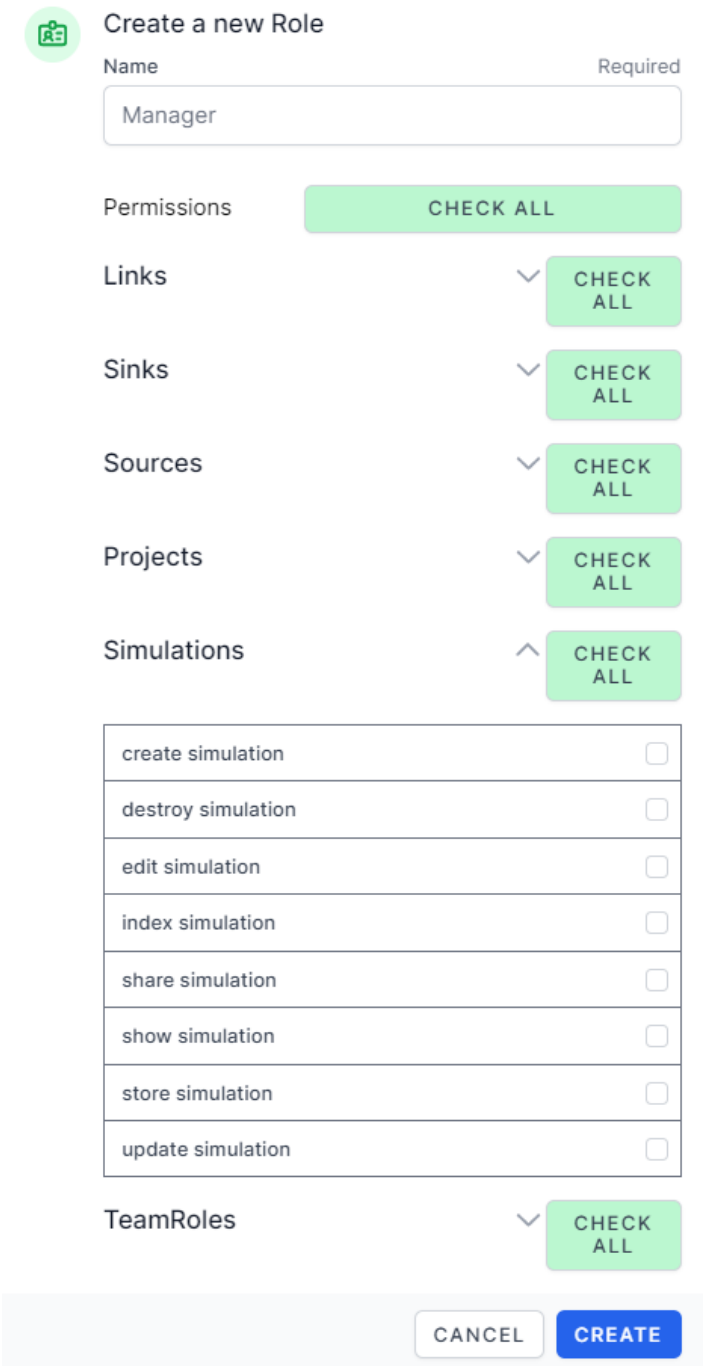

Figure 17 - Create Institution Role Form

While on a session the user is always in the context of an institution (by default his personal institution) and the objects, areas, menus, etc that he can see and access depend on the profile permissions associated to the role he has on that institution.

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4.1.2. Dashboard

The Dashboard is the first main menu entry, and the default view when a user logs into the platform. It shows a map centered in the user default location, and the sources, sinks and links in the platform database, to which the current institution has access. existing in the visible part of the map.

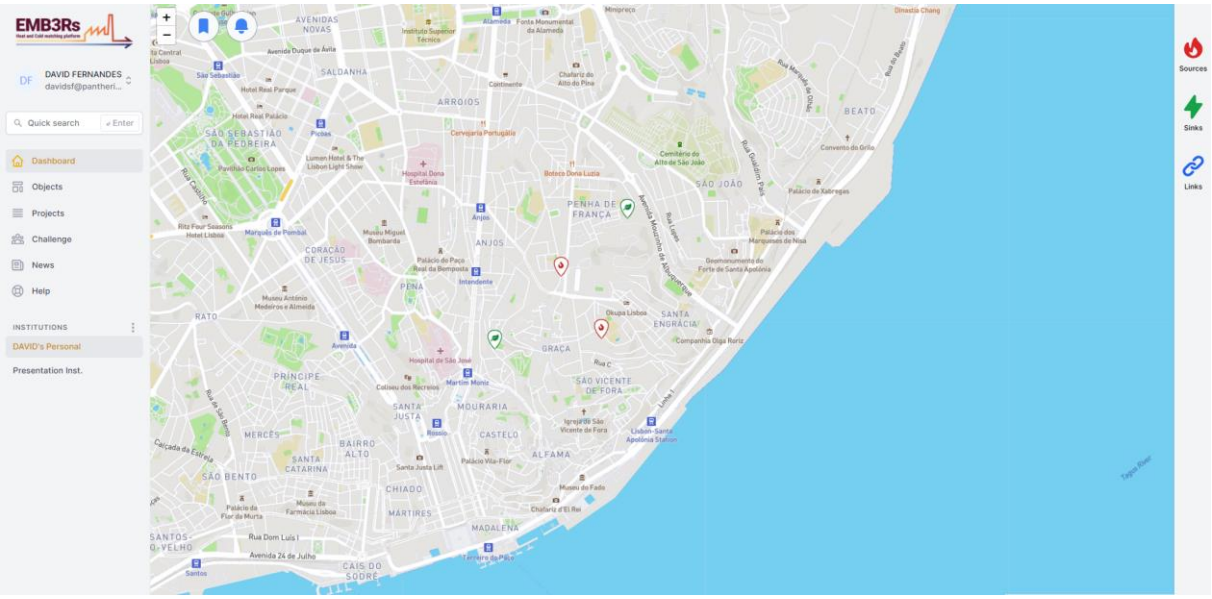

Figure 18 - Dashboard example with some infrastructures

4.1.3. Objects

The basic objects within EMB3Rs are Sources, Sinks and Links. Sources are infrastructures that generate thermal energy, Sinks the ones which consume the energy produced by Sources and Links are the connections between them allowing for the heat to flow.

The menu entry Objects, shows a view similar to the Dashboard with two main differences.

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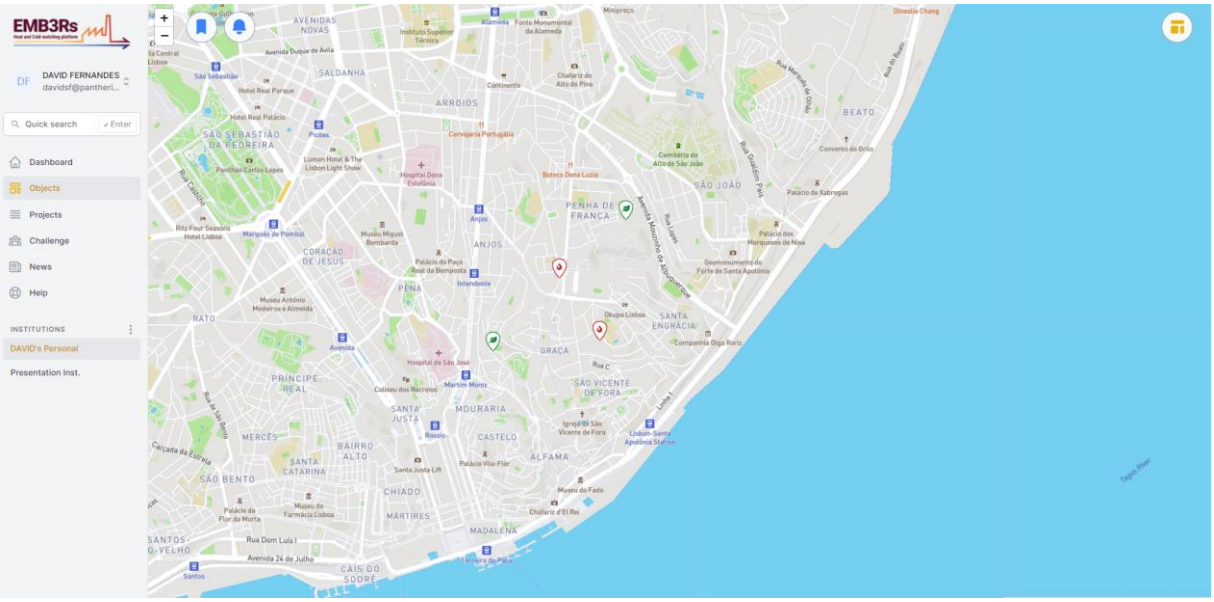

Figure 19 - Objects view example

The first one is the context menu allowing several actions to be executed directly on the map.

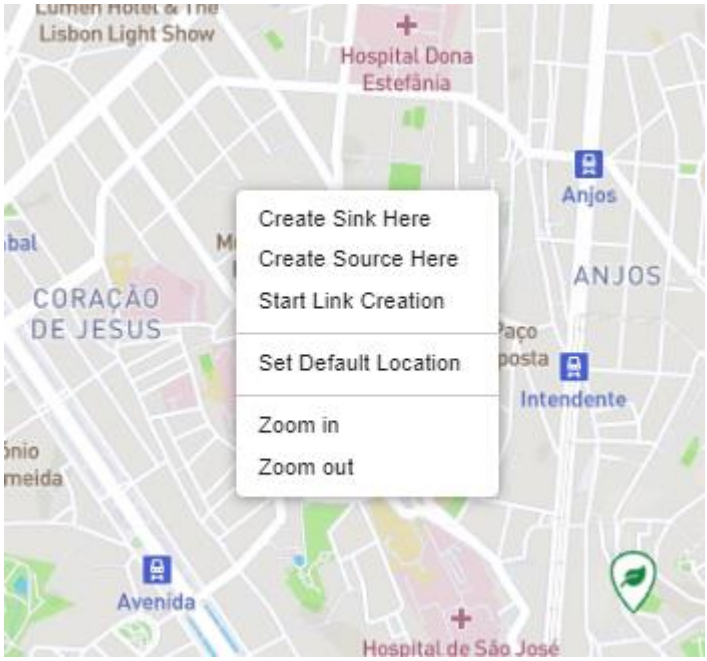

Figure 20 - Objects context menu

The other difference is an icon on the top right corner of the map which opens a slide showing a list of the objects on the visible part of the map.

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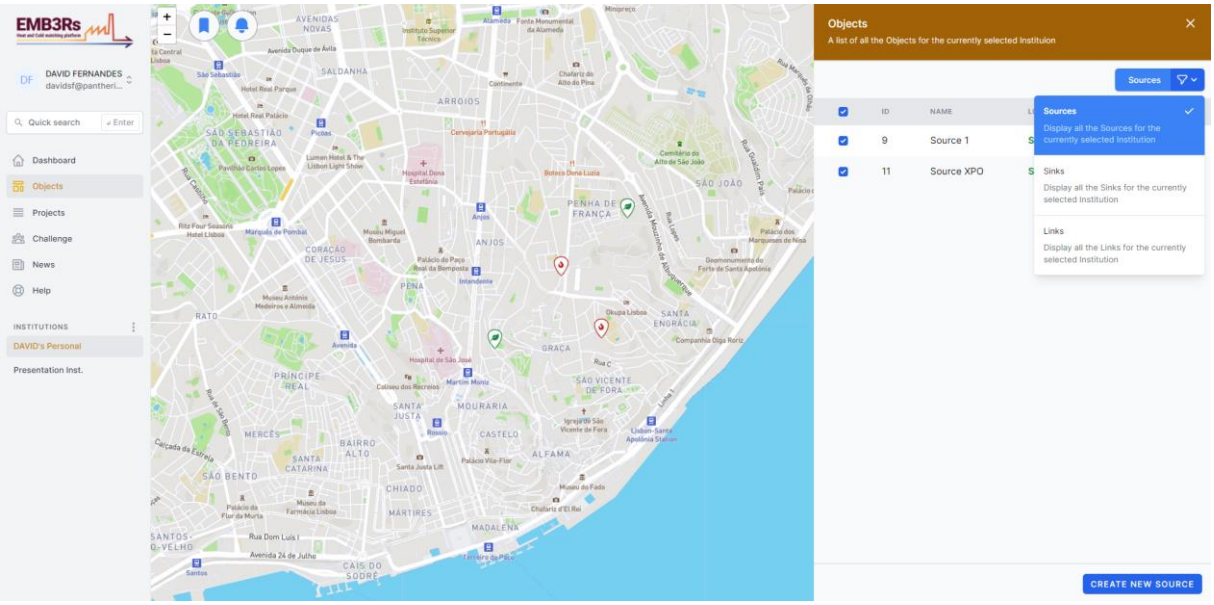

Figure 21 - Object view example with Sources slider

In this view the user can see the list of objects, filtered by object type. The list also allows to turn on and off the display of each individual object on the map, view or edit the object details or delete the object.

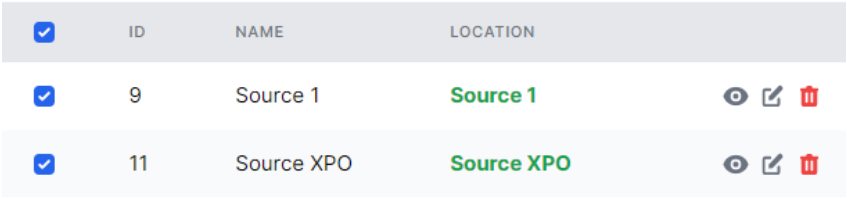

Figure 22 - Detail of the Sources list

Either by clicking on an object on the map or on the details icon on the list, the user will have access to the detailed information of the object.

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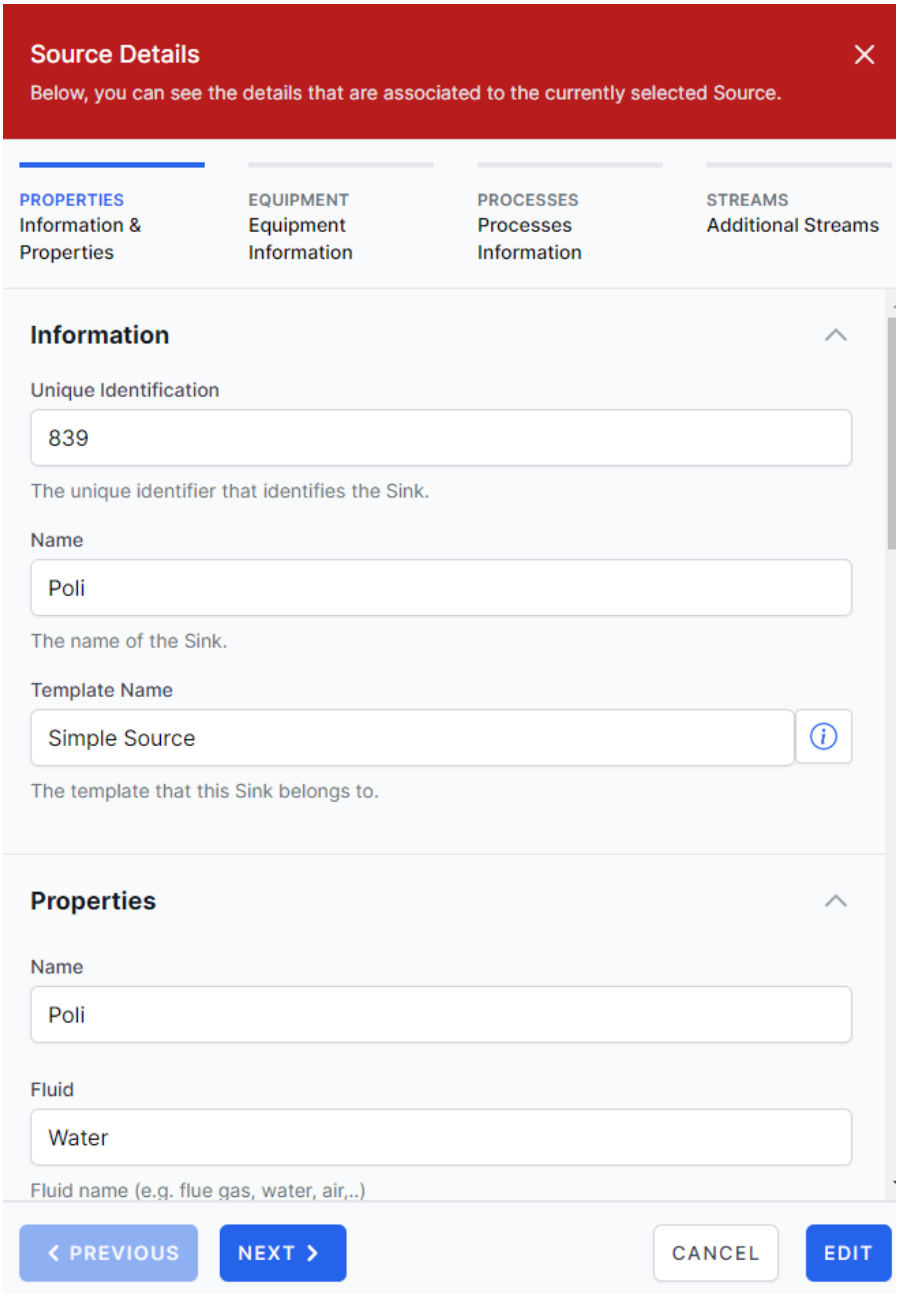

Figure 23 - Source detail view

In the detailed view, the user can see the properties of the object, and, in the case of Sources, any equipment and/or processes associated to the source and the object template used to create the instance of the object.

To edit the object properties, the user may either click on the edit button on the detail view or the edit icon on the objects list.

To create a new object, the user may use the context map or the button on object list. For instance, to create a new Sink, the “Create new Sink” button on the Sink list or “Create Sink Here” by right clicking on the map on the spot one wants to create a new Sink.

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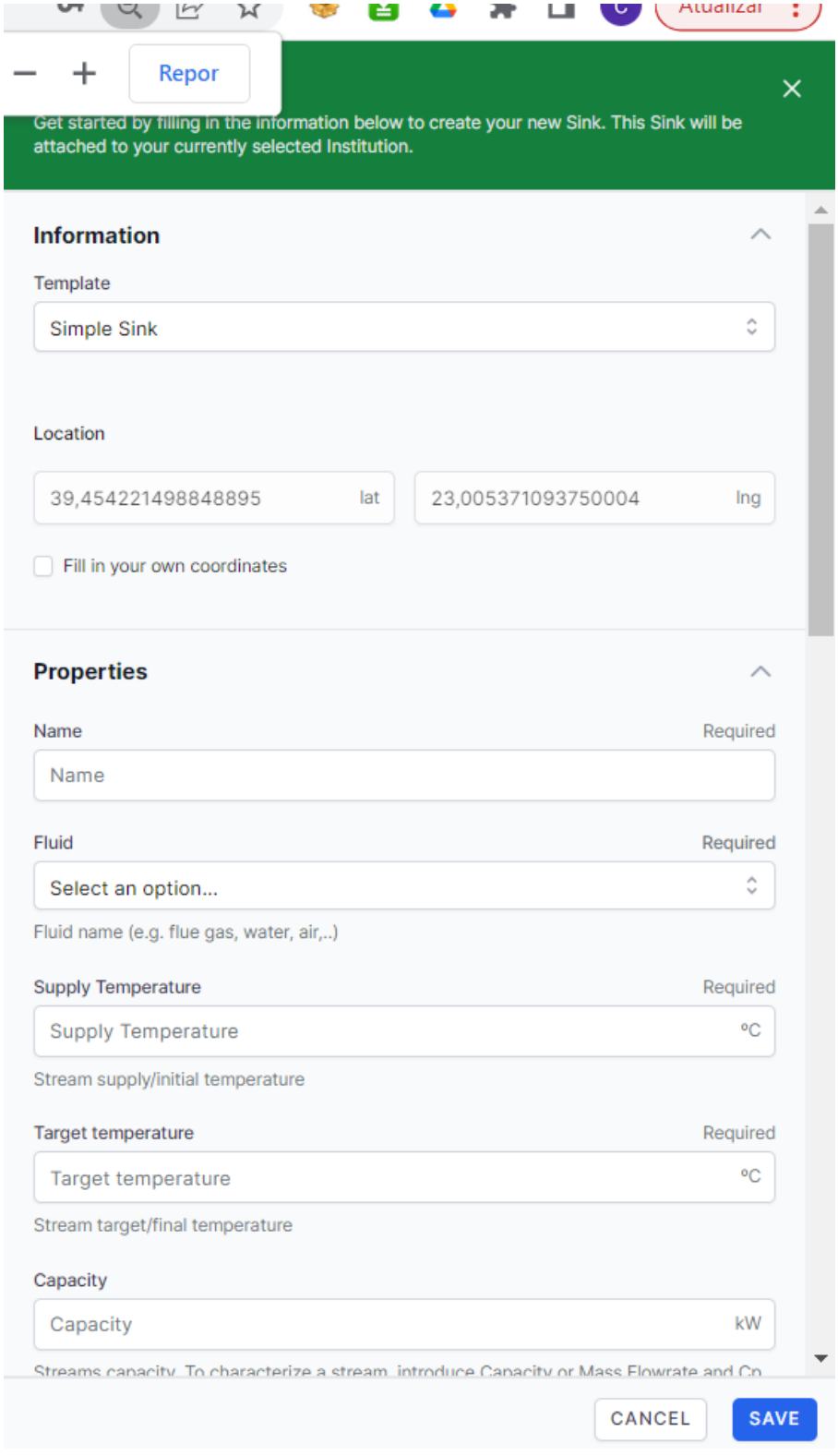

Figure 24 - Create new Sink view

Links may be created by the user on the map, by selecting “Start Link Creation” on the context menu and then setting waypoints by selecting “Next Point Here” on the context menu and finishing the link creation by selecting “Stop Link Creation” on the context menu after the last waypoint.

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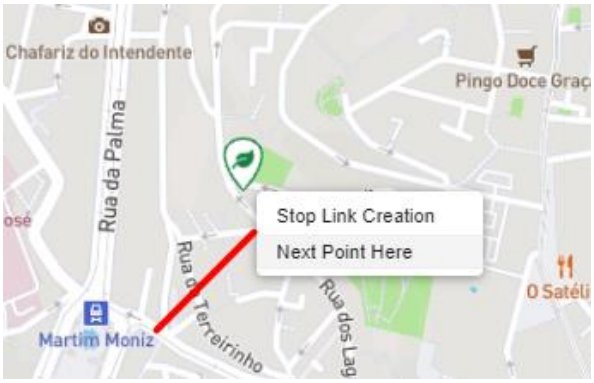

Figure 25 - Example of Link Creation

The platform will then ask for the properties related to the Link and the User can Save the Link just created.

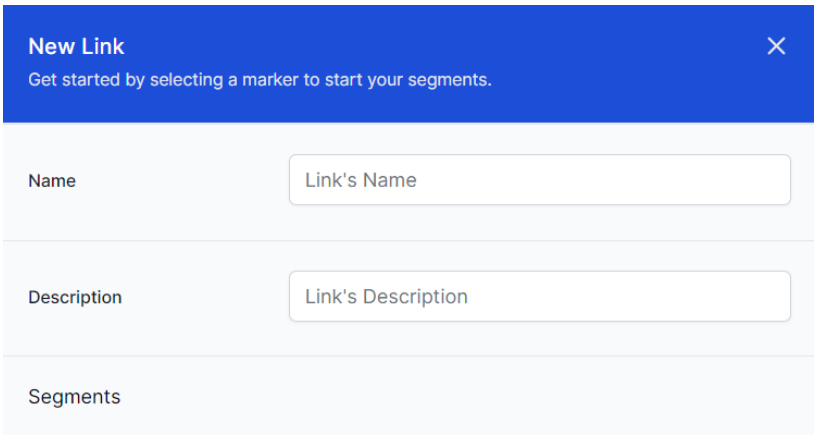

Figure 26 - Link properties example view

4.1.4. Projects

The Simulations within EMB3Rs are organized in projects. In the Projects Area the User will have access to a list with all his projects where the details of each project can be viewed, edited or the user may delete an existing project.

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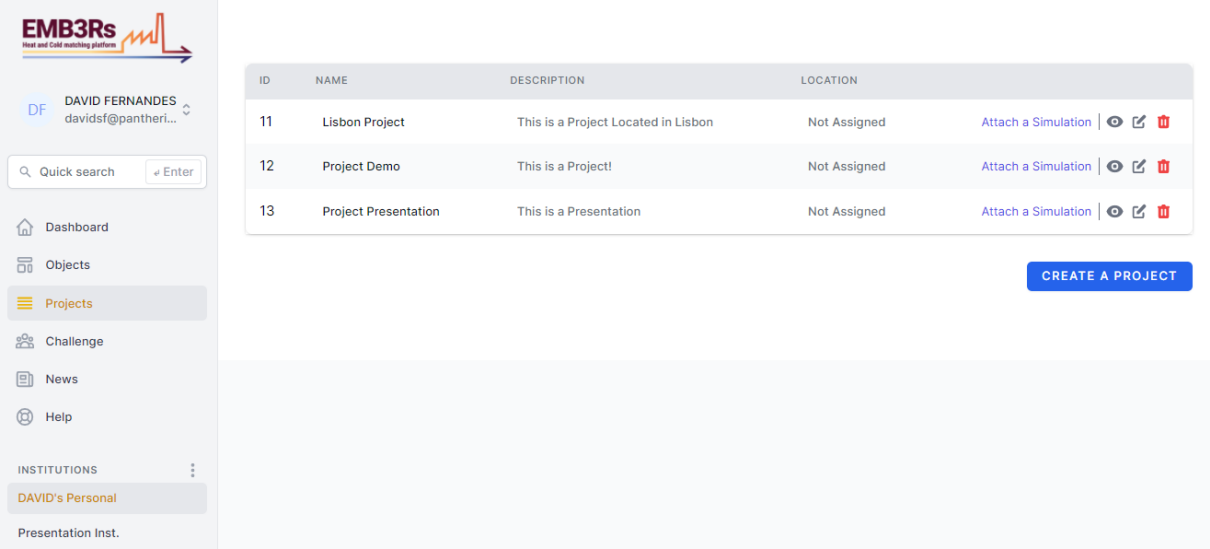

Figure 27 - Projects List view example

By clicking on the “Create A Project” button, the user may create a new project, set a name and description and define the project area.

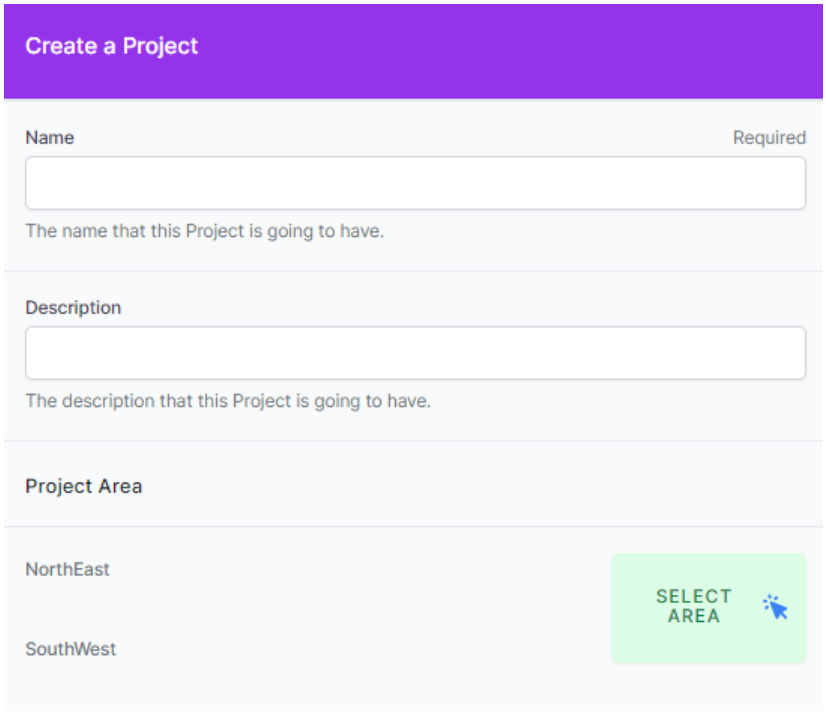

Figure 28 - Create New Project view

In the project details view the user can check the details of the project, the project area and a list of the simulations associated to the project.

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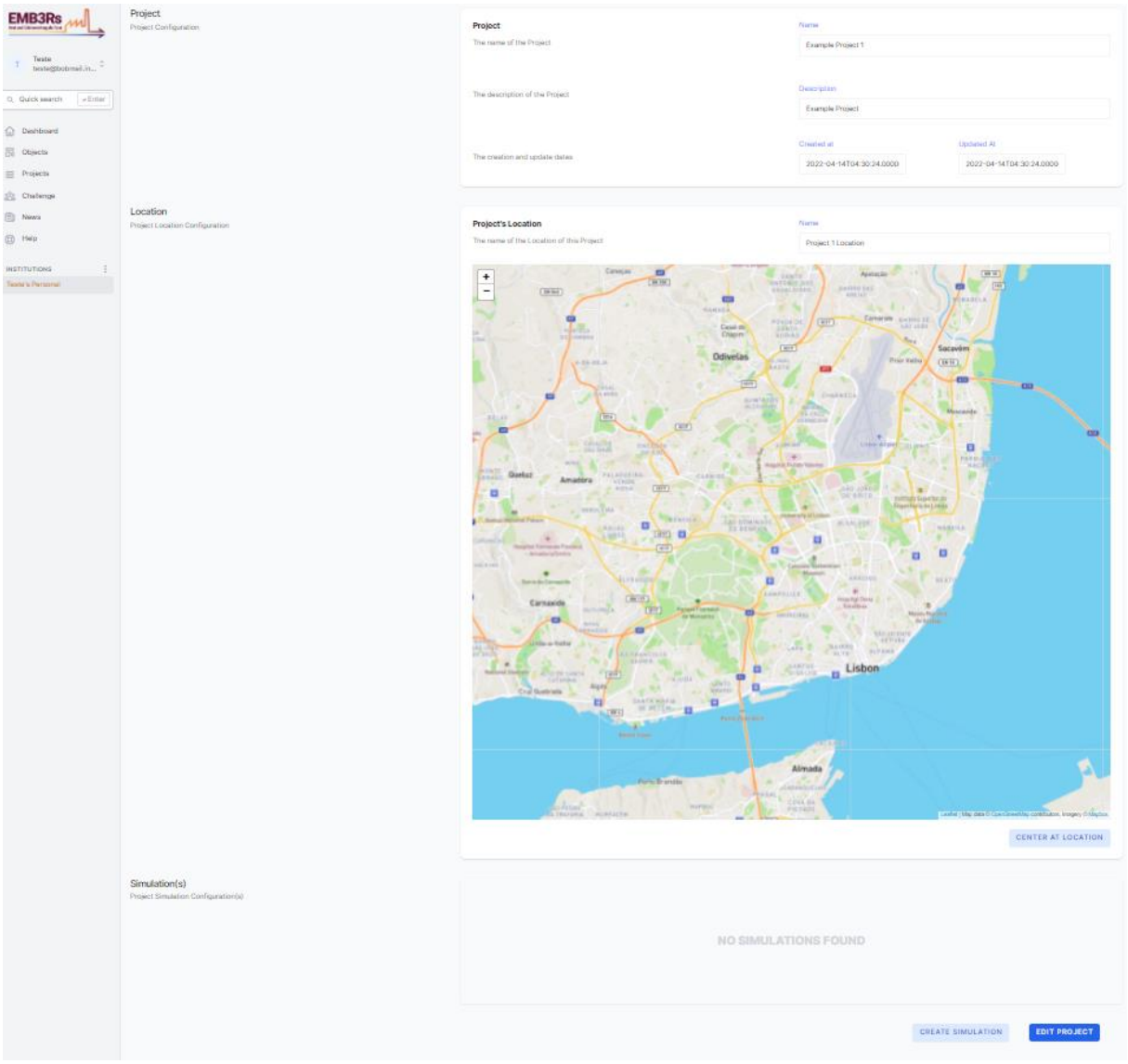

Figure 29 - Project Details view

4.1.4.1. My Simulations

Simulation is the core functionality of the EMB3Rs platform. The platform will allow the user to run a comprehensive range of simulation types in an user-friendly way so users can get initial results with relatively reduced effort. The simulations can be later refined by adding additional and/or more accurate data, so that the simulated scenario can be as close as possible to the real one.

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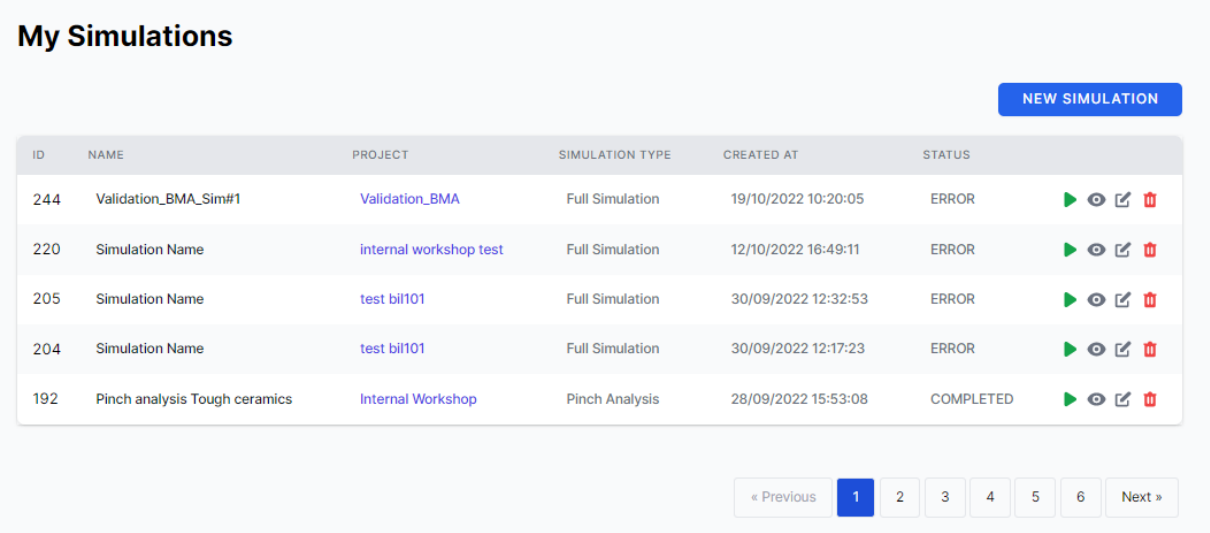

Figure 30 - My Simulations List

4.1.4.1.1. Simulation Wizard

An EMB3Rs simulation starts when the user clicks the “Create Simulation” button on the project details page. A step by step wizard is shown to guide the user through the simulation configuration process.

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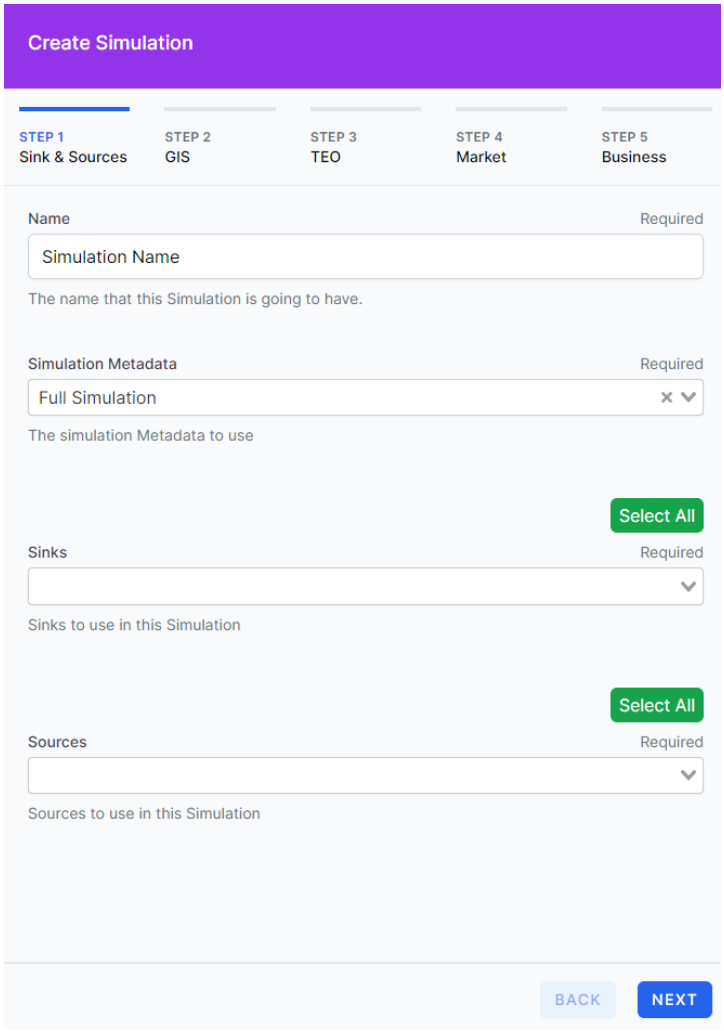

Figure 31 - Create Simulation Wizard Configurations

The wizard will start by asking the user to choose the simulation Name, type and the list of Sources and Sinks to be included.

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Figure 32 - Create Simulation Wizard Constraints

Through the next steps the user shall define the configurations required by each of the modules that take part in the simulation.

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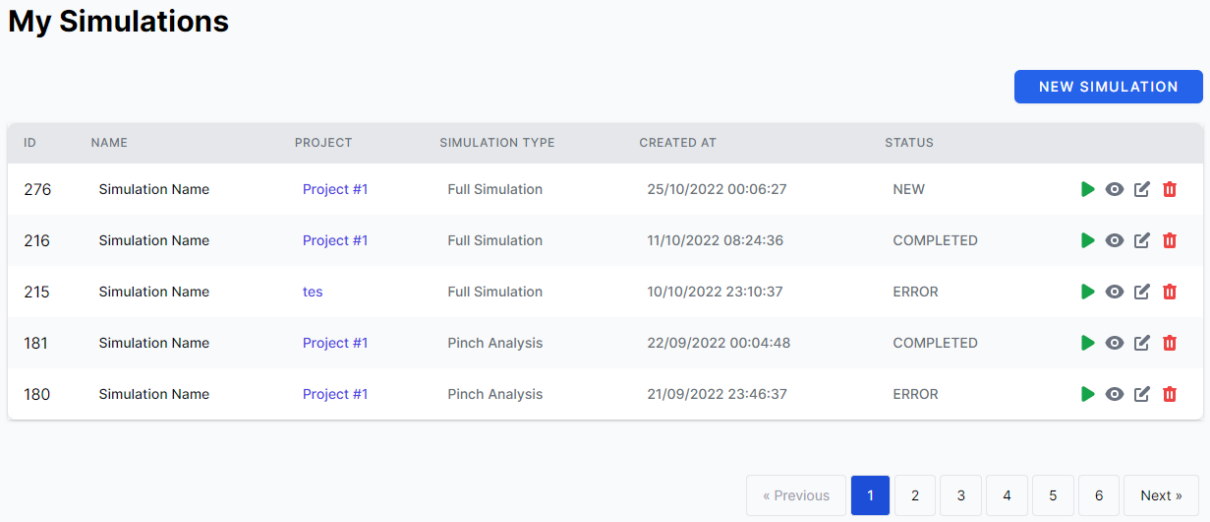

Figure 33 - List of existing Simulations

After creating a Simulation it will appear on the project details page, and in My Simulations. The simulation is the status NEW, so not yet Running. To start the execution, the User must access its details and click on “Run Simulation”.

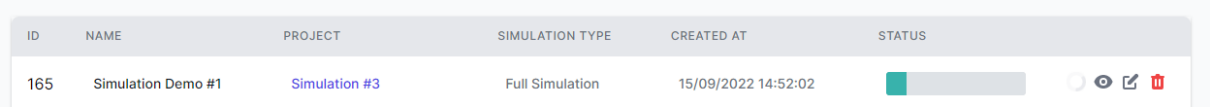

Figure 34 - Simulation progress

The Status will change to a progress bar, that will show the simulation progress as it goes through the modules.

If the simulation requires any additional input from the user it will change to WAITING FOR USER and send a notification to the User. Otherwise, it will eventually change to COMPLETED, unless something unexpected happens in which case it may change to ERROR.

By default, all the simulations are saved when the user finishes the configuration and initiates the simulation. The user can also save simulations while configuring them in each of the wizard steps by clicking on the save button. After the simulation finishes the saved record is updated (a link is added) associating the saved configuration to the output reports.

In the “Simulation” menu, the user has a submenu which leads to the Saved Simulation List. The list presents all the saved simulations with the basic info (Label, creation date, run date, status, etc.) and after the simulation is finished a link to the output is created and shown. The user can filter and/or sort the list. The simulation details are available by clicking on the Label, which will open the simulation wizard in the appropriate step.

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If the simulation was already finished, clicking on Run again will clone the previous simulation.

4.1.4.1.2. Simulation Types

The Simulation type will define what objects the user wants to connect. For instance, the user may have a Source and may want to find nearby Sinks and optimize a configuration which maximizes the integration of the available excess HC. Alternatively, the user may already have a Source and a Sink and just wants to find the best connection and evaluate the possible Business Models for that configuration. The simulation type will define what the user wants to connect in the Simulation. Only one Simulation Type may be selected for a Simulation. The next subsections present a few examples of simple Simulation Types.

4.1.4.1.2.1. Link a Source to a Sink

This is the simplest simulation type. The user selects a Source and a Sink (and optionally a Link) and the simulation will connect them through a link (if not provided) and run the simulation to present the results of the simulation modules to his scenario.

4.1.4.1.2.2. Link a Source to multiple Sinks

This Simulation Type is a variation of the previous one. The user selects a Source and a set of Sinks (and optionally Links) and the simulation will connect them through links (if not provided) and perform simulation to present the results of the simulation modules to his scenario.

4.1.4.1.2.3. Link multiple sources to multiple Sinks

This Simulation Type is a variation of the previous one. The user selects a set of Sources and a set of Sinks (and optionally Links) and the simulation will connect them through links (if not provided) and perform simulation to present the results of the simulation modules to his scenario.

4.1.4.1.2.4. Find and Link for Sinks to my Source

In this case, the user only selects a Source and the simulation will try to find and link existing Sinks within the Location (with maximum distance to Source or defined by the

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user). The simulation will run the modules to present the results of all suitable Sinks to the users Source.

4.1.4.1.2.5. Find and Link for Sources to my Sink

This is the opposite case of the previous one, the user only selects a Sink and the simulation will try to find and link existing Sources within the Location (with maximum distance to Sink or defined by the user). The simulation will run the modules to present the results of all suitable Sources to the users Sink.

4.1.4.1.2.6. Find the best Location to my Source

In this Simulation Type, the user has a Source configured, but it's not associated to a single Location. Instead the user will choose several possible Locations for the Source and the simulating modules will try to find the best of these locations where the excess thermal energy from the Source is most profitably used by nearby Sinks.

4.1.4.1.2.7. Find the best Location to my Sink

This is exactly the opposite as the previous one, the user as a Sink configured, but it's not associated to a single Location. The user must select several possible Locations, so the simulating modules can try to find the best, where the excess thermal energy from nearby Sources is most profitably used by the users Sink.

4.1.4.1.3. Simulation Targets

Similarly, to the process described for the Simulation Type, the user may define a target for the Optimization. For instance, to minimize the initial investment, maximize the long term return or even to find the configuration which allows the maximum reduction of GHG emissions. Only one Simulation Target may be selected at each time for a Simulation. The Simulation Target will be used by the Simulation Manager to be used as the value to be optimized.

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4.1.4.1.3.1. Minimize Initial Investment

Simulations with this type of target will aim to find the configuration for the selected type, which minimizes the initial investment. This analysis will look for the connections defined by the simulation type and select the configuration with the lowest initial investment.

4.1.4.1.3.2. Minimize payback time

Simulations with this type of target will aim to find the configuration for the selected type, which minimizes the payback time. This analysis will look for the connections defined by the simulation type and select the configuration in for which the return will surpass the initial investment within a smaller period of time.

4.1.4.1.3.3. Maximize long term return

Simulations with this type of target will ask the user for a period expressed in years for the Simulation and try to find the configuration for the selected type, which maximizes the absolute return after that period.

4.1.4.1.3.4. Minimize GHG emissions

Simulations with this type of target will aim to find the configuration for the selected type which has the highest reduction in GHG emissions. This analysis will look for the connections defined by the simulation type and select the configuration with the highest value for the Greenhouse Gases emissions reduction.

4.1.4.1.4. Simulation Constraints

The user may wish to apply constraints to the simulation. For instance, a limited budget or a maximum payback time. The platform will run the simulation for the inserted configuration, type and target and exclude all the results which do not comply with the restriction before presenting the results to the user. Contrary to the Simulation Type and Target, the user may add as many Restrictions for a Simulation as needed. The Simulation Manager will use the information from these Restrictions to make sure that all the Simulations are within these requirements, discarding the results that are not complying with them.

The contraints in the pipeline to be implemented are:

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- **Maximum storage capacity;**
- **Minimum share of excess heat**
- **Maximum Budget for the project**
- **Maximum emission limit**
- **Carbon tax**

These are explained in more detail in D3.4. - The EMB3RS Techno-Economic Optimization Module.

4.1.5. Simulation Manager

The EMB3Rs platform simulation capabilities allow the user to optimize the excess available HC among a set of facilities, involving producers and consumers of HC (Sources/Sinks). The user configures the desired objects, select the modules to include in the simulation, and the platform will find:

1 – A network connecting the facilities

2 – A technological and economic implementation plan

3 – A market and business plan analysis

The outputs will be optimized to fit different goals according to the type of simulation, including minimization of costs and emissions, maximizing the profitability of the reuse of excess thermal energy, maximizing use of local sources for DH networks, etc. The user may improve the results by fine tuning the object definitions or changing some configurations and rerunning the simulation. These outputs will undoubtfully be tailored to the needs of the user and in most real-life scenarios will offer a potential pathway and technical solutions to recover and distribute excess HC, potentially maximizing the economic returns, improving environmental impacts or reducing energy costs.

The platform will also allow users with other purposes, objectives and/or that have some constraints which are not consistent with an economic optimization to tailor the simulations to their needs. For instance, a company may be interested in finding the best location for a new factory by searching an area where the heat demand is high, or a municipality may have a budget to reduce GHG emissions, and wants to use the platform to find a configuration that maximizes this goal within a given budget. In these examples the user may try several configurations and compare the outputs of the simulations. However, this process would be very time consuming and not practical. For these reasons (and others as we'll see later in this document), a Simulation Manager will be included in the EMB3Rs platform, within the CF module, to manage simulations. This will allow the user to configure the purpose of the simulation, the simulation objectives and the constraints. Based on those user defined options, the Simulation Manager will create and manage the needed simulations.

The Simulation Manager will also be able to solve some problems (as described below) that may arise within a simple simulation, avoiding returning an imprecise result to the user, or no result at all.

The capabilities that the Simulation Manager could have are multiple, and here we'll present a few, explaining a possible scenario where the capability could be useful and how it would operate. In the following subsections, these capabilities will be presented according to the expected complexity of its implementation:

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Problem 1: There is not enough excess HC form the Sources to meet all the demand from the set of selected Sinks

Solution: Split the simulation into several smaller simulations, created by taking out one of the Sinks to explore what is the best configuration. Each result is then shown independently, sorted by the simulation objective best results.

Problem 2: The temperature drop is too high between a Source and a Sink for the Sink temperature needs

Solution: Ask the GIS module for a new network comprising two different sections: one where the Source is connected directly to this Sink and another with the remaining objects (without this Sink). Send both results to the TE Module.

Problem 3: The user wishes to find the best location for a Source (or Sink) within a region.

Solution: The Simulation Manager will generate different simulations within the designated area near the Sinks (Sources) available and able to consume(produce) the heat from(to) the facility to be installed. The outputs are shown to the user independently, sorted by the simulation objective.

Problem 4: The user wishes to make a sensitivity analysis for different business models. The user selects the parameters to be scanned by the modules (for instance the heat selling price) and the range of the scan (for instance from 50% to 150%)

Solution: The Simulation Manager will create several simulations, one for each value of the parameter to be scanned, selecting the appropriate module(s) to be run more than one accordingly. The results are aggregated and only one report is shown with the value range for the variables which changed in the different simulations.

Problem 5: A Municipality has a budget intended for intervention that lead to decrease GHG emissions and wishes to find the configuration which maximizes the emissions reduction within the budget.

Solution: This is a more complex problem as additional settings are needed to use the modules for these types of compounded optimizations. The Simulation Manager will have some intelligence to avoid a brute force method which would be too resource and time consuming. A possible approach would be the selection of all the objects within the municipality area and create a simulation. The platform could then run the modules to analyse the GHG reductions associated with each connection, remove any negative contributions to the emissions and rerun the simulation. Once the reruns are ready, the costs for each branch of the network would be known and an estimation of which objects had the best performance/cost ratios would be possible. With this information the Simulator Manager could again create a set of simulations within the budget to test the results of a few additional configurations. This may require several iterations. In the end it would present the top performant configurations sorted by the objective.

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Problem 6: A company wishes to sell excess HC with the goal of minimizing the payback period.

Solution: This solution is similar to the previous one as the Simulation Manager would need to explore a wide array of configurations to meet the user goals. It could start by linking the source to all the suitable sinks and perform an analysis of the results to find the combination of objects which rank lower in the payback period. The remaining process would be very similar to the one described above.

4.1.6. Reports

As the simulation modules finish their processing reports for each individual module are generated and made available for the user throught the Simulation Session details page:

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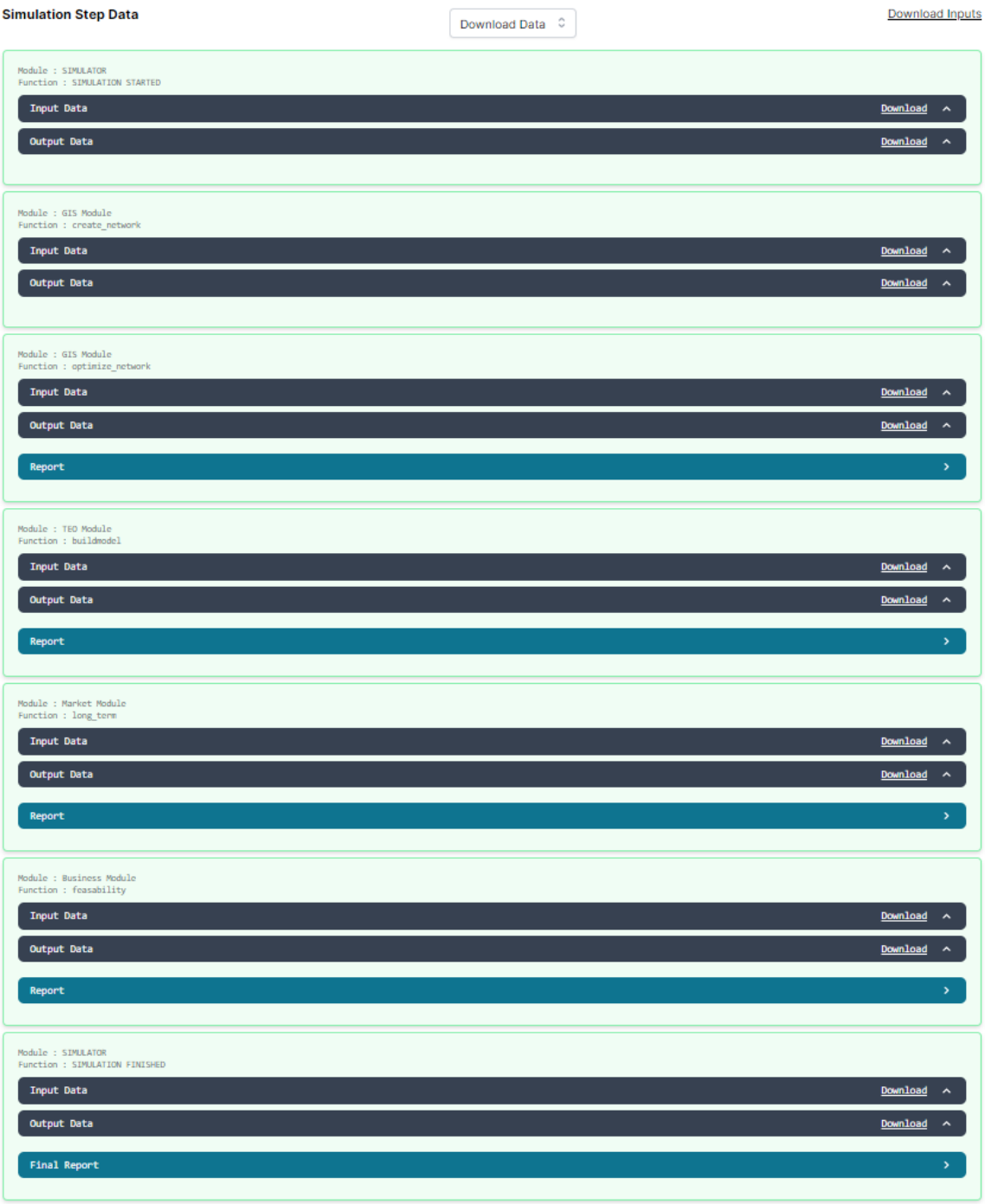

Figure 35 - Simulation Outputs and Reports

4.1.6.1. Final Report

When the simulation is finished a Final Report and detailed reports for each module are produced. If notifications by email are activated, the Final Report may be sent by email as soon as the simulation finishes. This Report will have the Simulation Metadata and the most important Data from each of the modules that have been run, and it will

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also be available through an icon in the Saved Simulations List where it can be converted to pdf format, downloaded and shared with other users and institutions.

Figure 36 - Final report cover page

4.1.6.2. Show Detailed Simulation Reports

The individual module Reports, as well ans the inputs used for the processing and the Outputs produced by each module are available to the user as soon as the from links within it. Each Module Report can be converted to pdf format, downloaded and shared with other users and institutions.

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EMB3Rs
Heat and Cold matching platform

Techno-economic optimization : Report

Welcome to the module simulation report of the Techno-economic optimization (TEO) module in the EMB3RS platform. The TEO module determines the cost optimal matching of sinks and the sources. The optimal capacity of the technologies and storages, and their optimal operation is determined while considering several constraints. The techno-economic optimization of your case has been succesfully completed. The results of the analysis are presented in this report. The report contains several sections. Each of them will present tables, plots and some text describing the main results of your case. For a detailed analysis of the results, you can download the results of the TEO module from the platform.

1. Capacity of Sources and Sinks

The installed capacity of technologies all the sources and sinks for the final year in the analysis period is shown in the table below. The installed capacity can be used to analyse which technologies are chosen by the TEO for each sink and source.

Final Source and Sink Capacities in kW

District Heating Network	Grid Specific Biomass Boiler	Sink592 Stream1Heat Pump	Sink593 Stream1Heat Pump	Sink594 Stream1Heat Pump	Sink595 Stream1Heat Pump	Sink596 Stream1Heat Pump	Sink597 Stream1Heat Pump	Sink598 Stream1Single Heat Exchanger	Sink599 Stream1Heat Pump	Sink600 Stream1He Pump
8018.52	3024.15	273.09	11.12	280.17	11.54	121.52	4.95	116.8	680.73	73.91

The installed capacity of technologies for all sources and sinks

The installed capacity of technologies for all sources and sinks are visualized in the graph below.

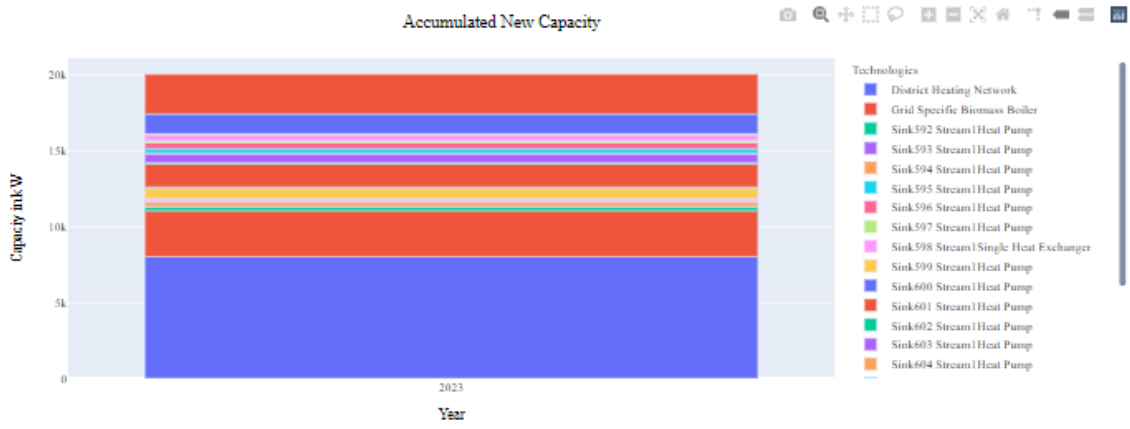

Figure 37 - Individual module Report Example

4.1.7. Challenges

The EMB3RS platform is being gamified to promote its usage, create awareness and drive engagement. The game proposed relies on the creation of some challenges which aim at finding configurations with the EMB3RS capabilities that might be implemented.

The goals of the game are environmentally oriented and vary according to the specific targets set for each challenge. Some of the goals can be to minimize greenhouse gases, reduce CO_2 emissions or either increase revenues. The challenges are initiated by special users such as governments, energy agencies, European agencies, city mayors (municipalities), university professors and companies who create challenges

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for their institutions accordingly. The challenges can be public, which means that they will be available to everyone who wants to play the game or private, which will be available to specific users defined by the challenge promoter who can set filters. For instance, if a challenge is initiated by a specific municipality, only residents of this municipality can participate. However, there can be many challenges running at the same time which either are available to all users or not. There will be one open continuous challenge available to all users that will ask them to start optimizing their city by identifying sources and sinks of energy.

For the users to start playing, they need to be logged in with a registered an account. There will be a section with a description and specific goals for each challenge. Participants will be able to pick the challenge they want to take part in based on the criteria defined by the challenge promoter. They will be using the real platform and they will be able to create simulations that will be submitted to the challenge(s) they participate. The challenge promoter will be able to define the goals of the simulation (e.g. GHG emission reduction, ROI). Thus, each challenge will have some constraints set by the challenge promoter, hence, participants will be sorted according to the constraints/ goals. Simulations that do not comply with those constraints will be removed. The potential winner of the challenge will be checked to verify that the data they provided are correct and reliable. The results of the public challenges can be published on the website.

With the aim of not only advertising the platform, but also gaining more data regarding energy sources, crowd sourcing will be the mechanism to receive more data and characterize sources and sinks as well as calculate the energy usage. The above described process can be validated by curators who will transform data from people into reliable information. Furthermore, professionals working in agencies as well as citizens with engineer background and/or environmentally oriented can participate in the validation process. As, a consequence, mapping energy links will be expedited.

4.1.8. News

News related to the EMB3Rs platform will be available in this area. This may comprise any new developments, or functionalities added to the application, relevant results made public, security updates and other important announcements related to the platform.

4.1.9. Help and FAQ

The Help menu entry will allow the user to look for information on the platform, namely this manual, which will be continuously updated with information on how to use and take the most out of the platform.
The FAQ section shows answers to frequent questions about the platform, solutions to common problems users face with its usage. The FAQ is organized by topics, similar to the structure of the manual and is searchable by keywords allowing for a quick reply to any sort of difficulty or doubt a user may encounter.

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4.2. Part 2 - Backoffice

Administrators of EMB3Rs platform instances will have access to the backoffice of the application where most of the configuration of the platform is available to expert users. In this section we describe the main structure and functionalities of the backoffice.

Figure 38 - Detail of the Backoffice menu

4.2.1. Categories

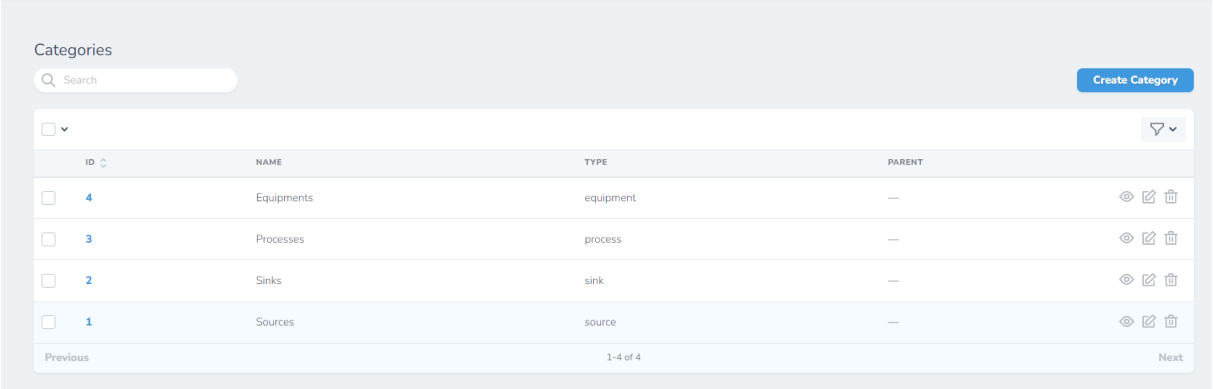

Figure 39 - Categories List

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Categories are the main objects in EMB3Rs. This comprises Sources, Sinks, Equipment and Processes. These work as aggregators for the Templates (see below). In this area the administrator may check the existing categories, view and edit the details or delete a category.

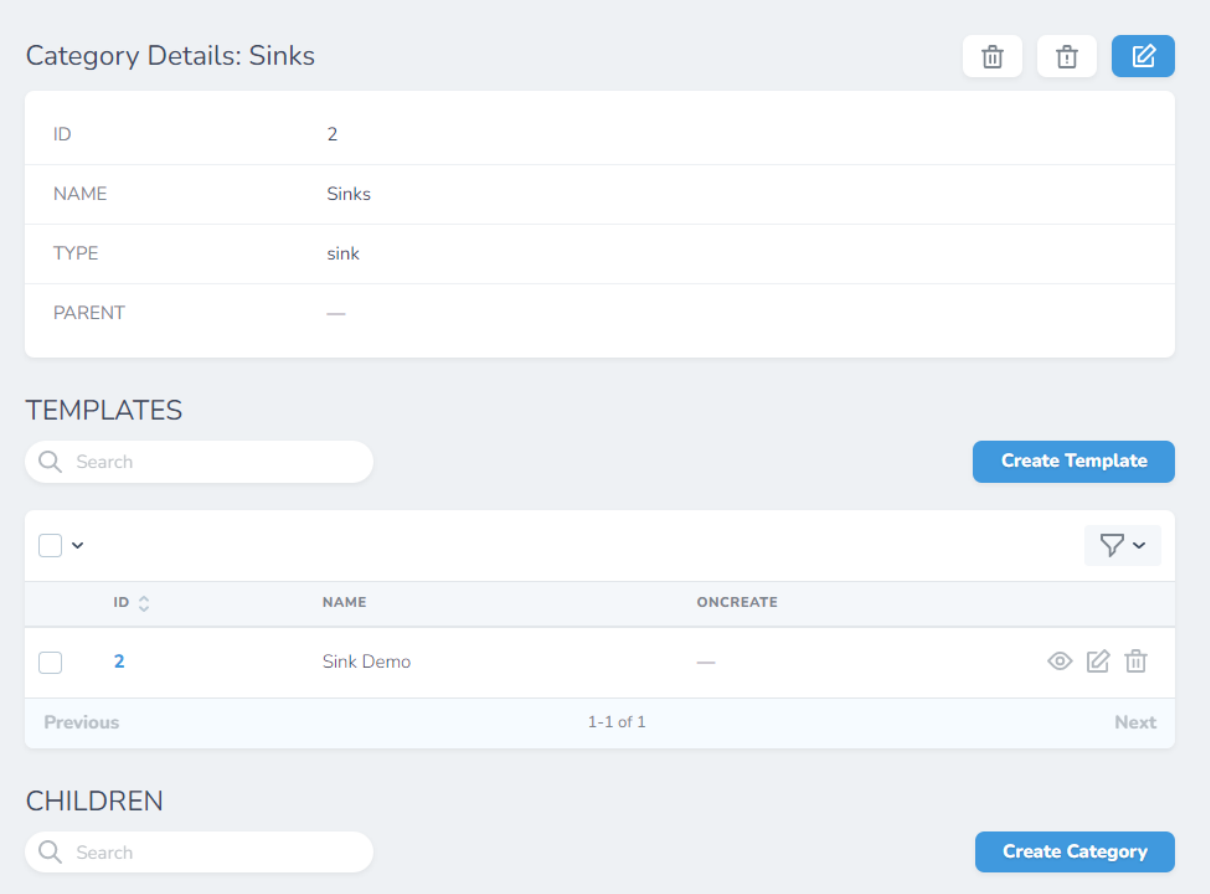

Figure 40 - Category detail example (Sinks)

In the detail view of a category the user may see the details for the category, and also the existing Templates associated with the category.

4.2.2. Templates

Each object category must have some templates for that category for the user to implement instances created from the template.

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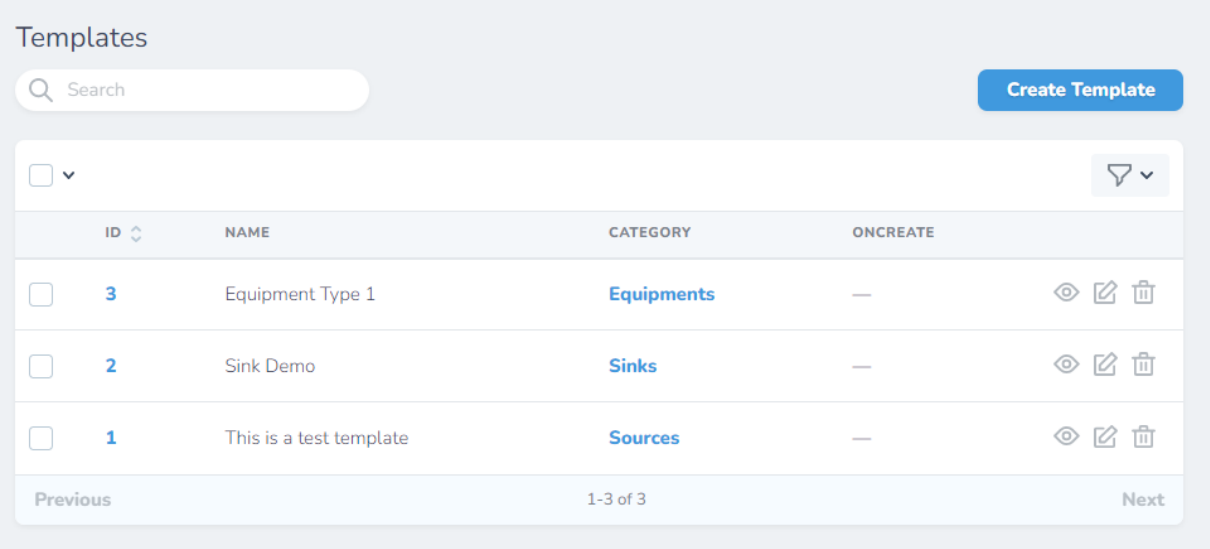

Figure 41 - Template List

The detailed view of a Template, along with the Template configuration itself, shows a list of the object instances created rom that template and the properties associated with the Template.

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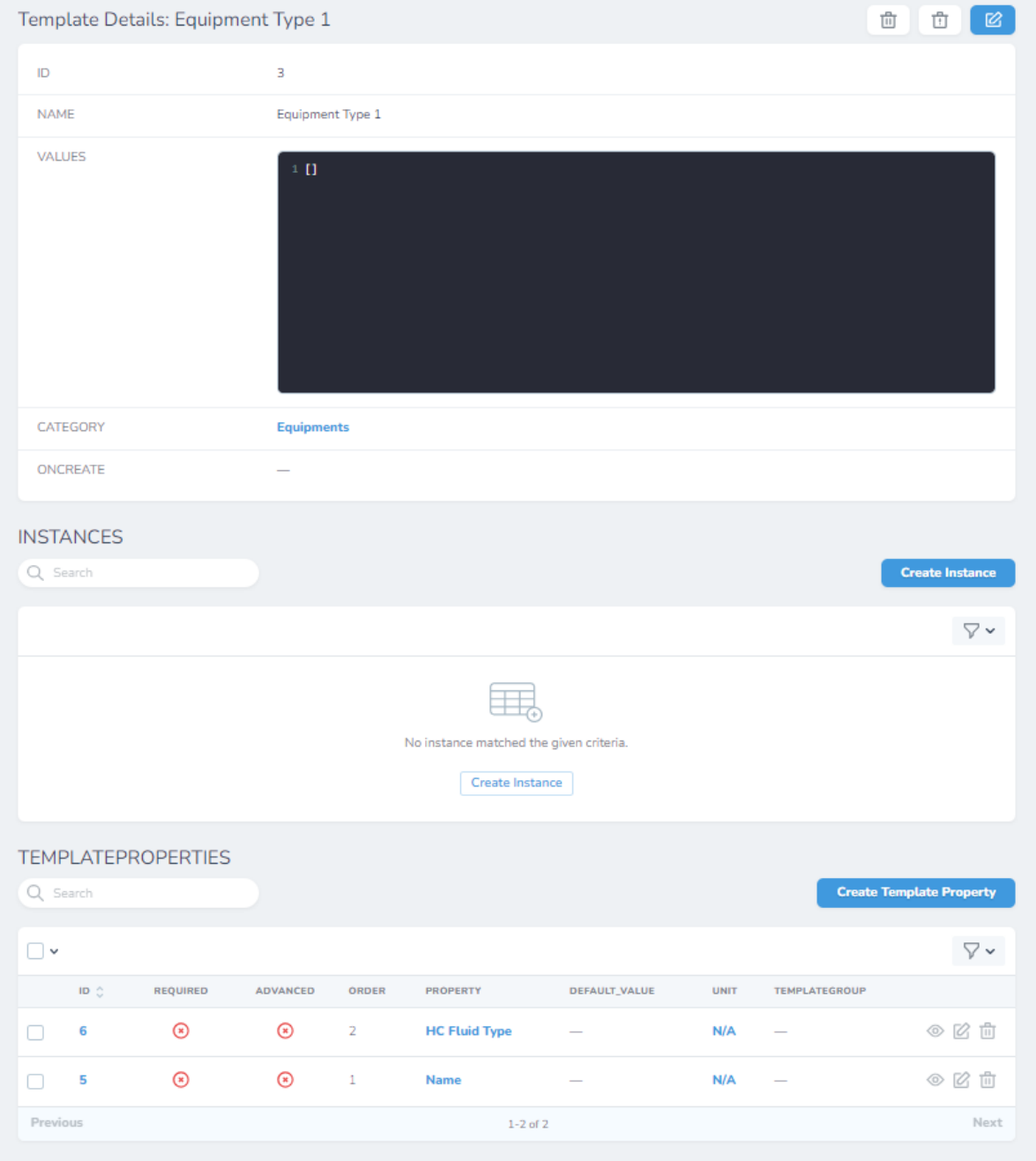

Figure 42 - Template detail

4.2.3. Units List

EMB3Rs supports a wide variety of Units, from physical quantities (Length, Energy, Time, Temperature) to currencies and costs. The administrators may create new units and even setup conversions between units of the same type (See Unit Conversion below).

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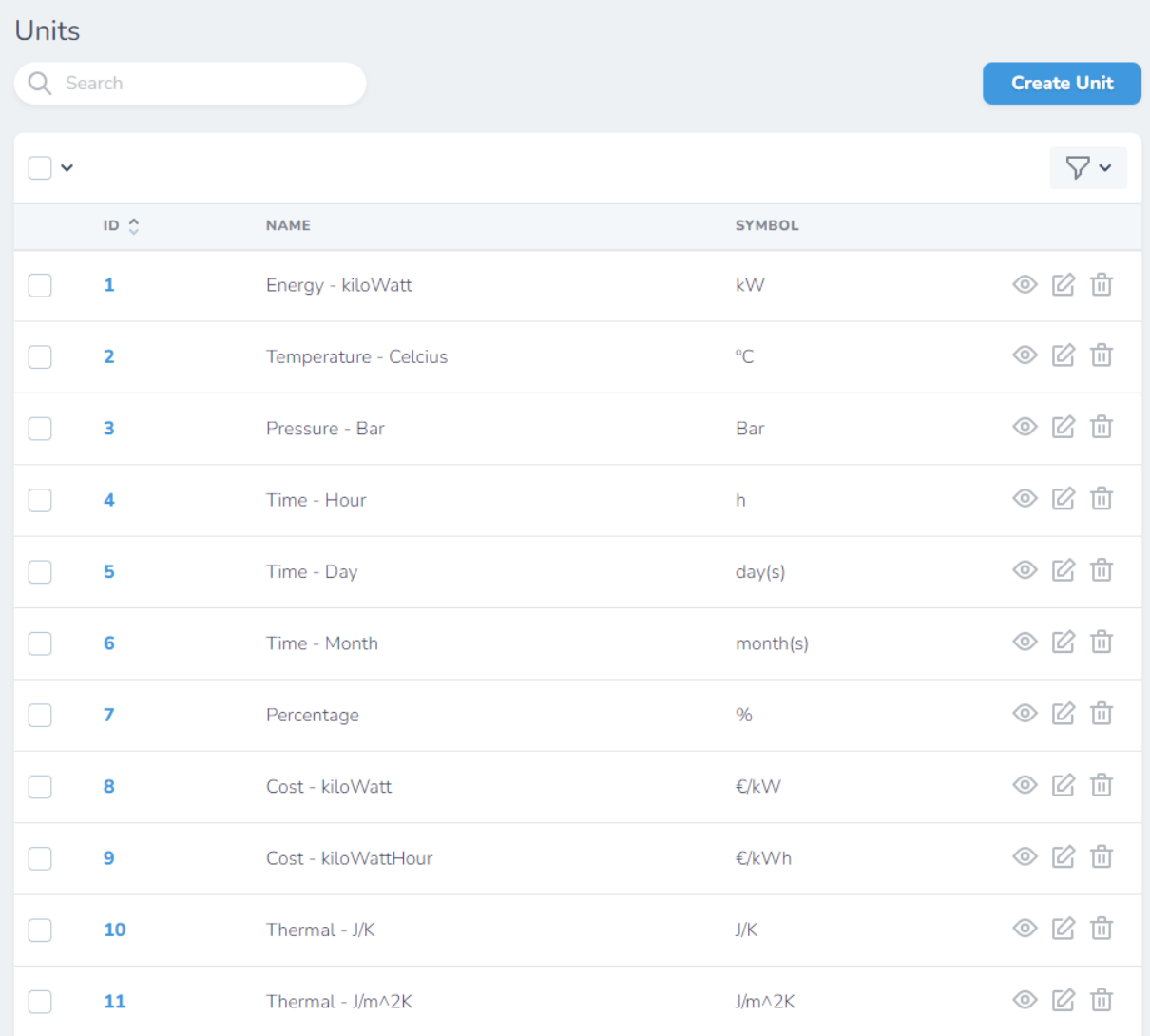

Figure 43 - Unit List example

4.2.4. Properties List

As described above, the Templates will need to have some properties defined. In this area the available properties for the templates are shown and the administrator may edit them or create additional properties.

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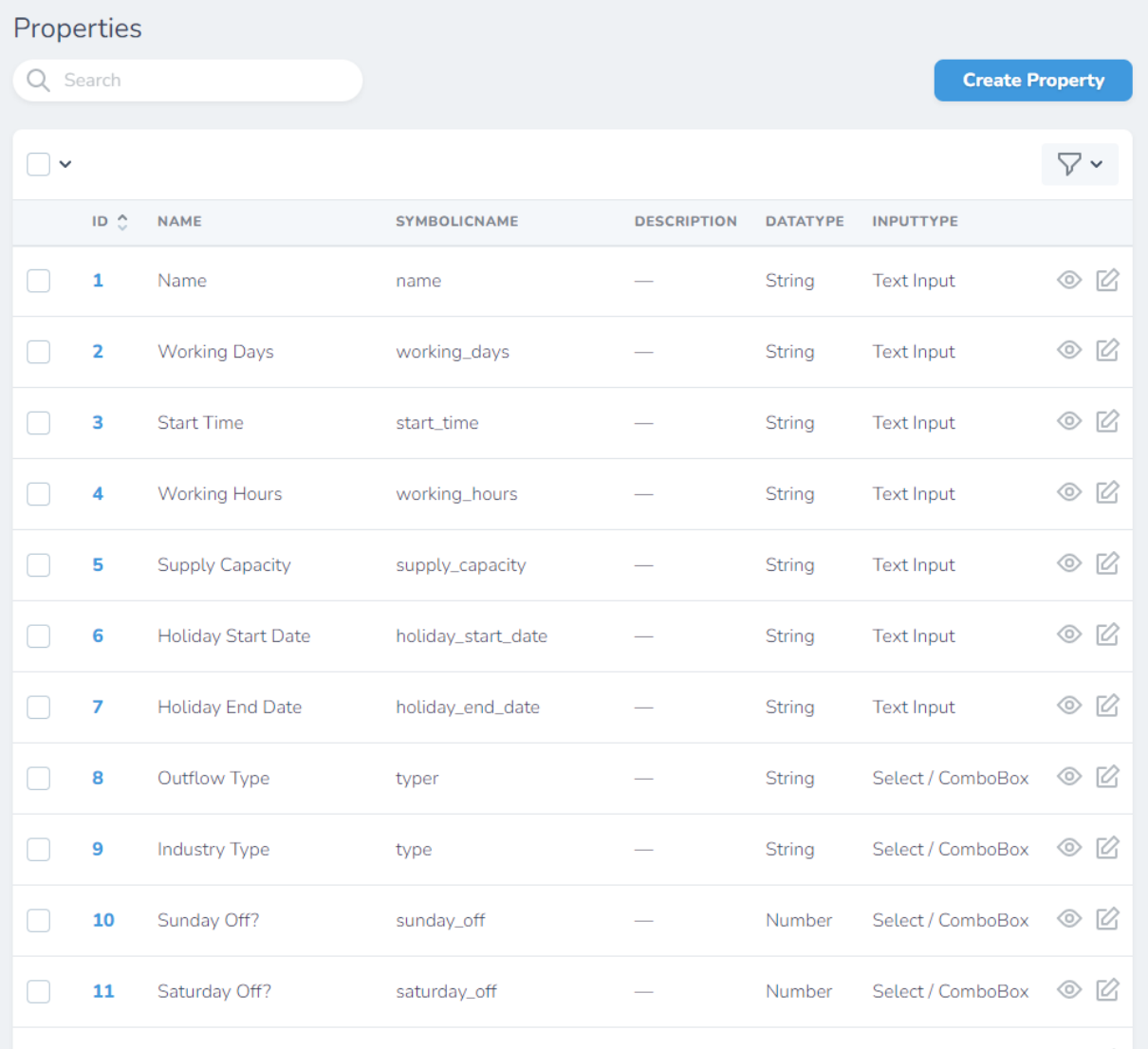

ID	NAME	SYMBOLICNAME	DESCRIPTION	DATATYPE	INPUTTYPE
1	Name	name	—	String	Text Input
2	Working Days	working_days	—	String	Text Input
3	Start Time	start_time	—	String	Text Input
4	Working Hours	working_hours	—	String	Text Input
5	Supply Capacity	supply_capacity	—	String	Text Input
6	Holiday Start Date	holiday_start_date	—	String	Text Input
7	Holiday End Date	holiday_end_date	—	String	Text Input
8	Outflow Type	typer	—	String	Select / ComboBox
9	Industry Type	type	—	String	Select / ComboBox
10	Sunday Off?	sunday_off	—	Number	Select / ComboBox
11	Saturday Off?	saturday_off	—	Number	Select / ComboBox

Figure 44 - Properties List example

The definition of the property includes setting the data type for that property (String, Integer, Float, Datetime), the type of input the user will see (Text, datetime selector, combobox, Schedule), and a json field so any default values, restrictions or validations may be set)

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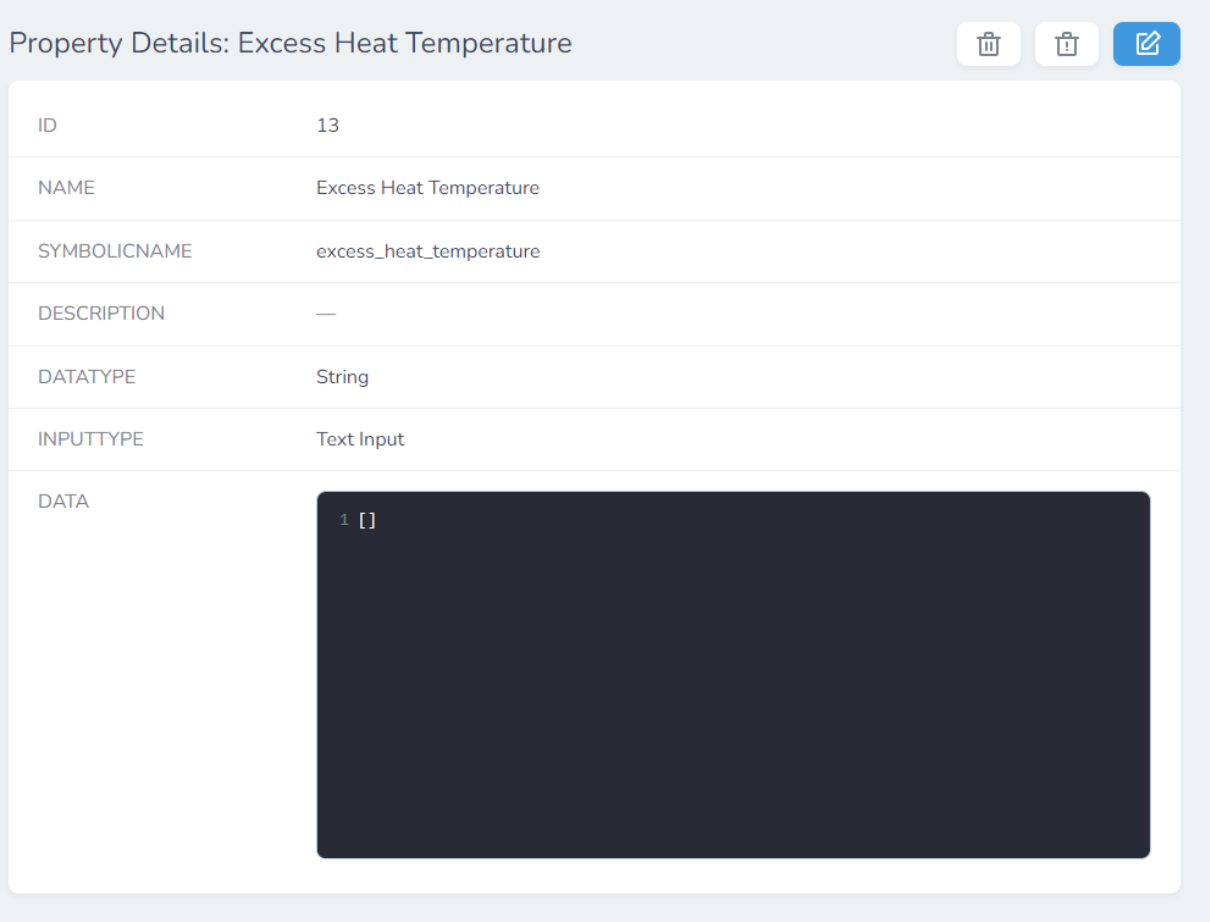

Figure 45 - Edit Property view

4.2.5. Template_Properties

The Relation between the Templates and Properties are stored in the Template_properties area of the backoffice. The list shows information like if the property is required for that template, if it is a basic or advanced property, default values and units.

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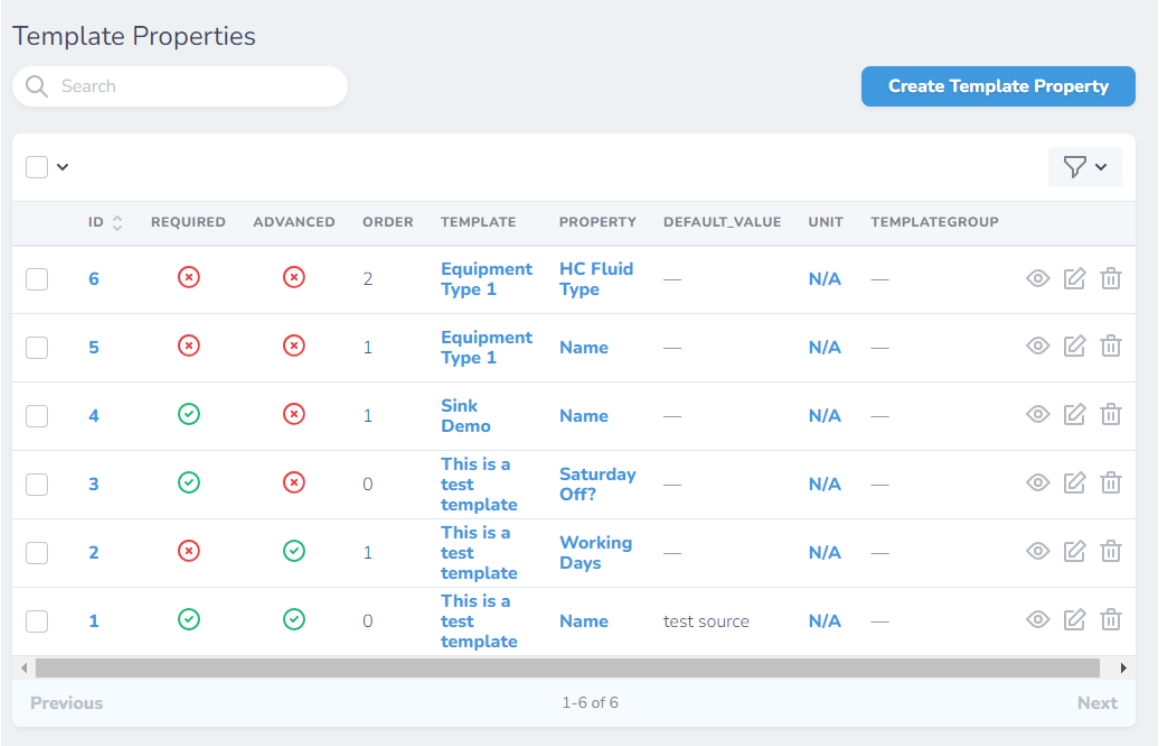

Figure 46 - Template_property list example

In the detailed view screen for the template_property the user may also set the order for the property to be shown to the user when configuring an instance of that Template, and set a default value for the property.

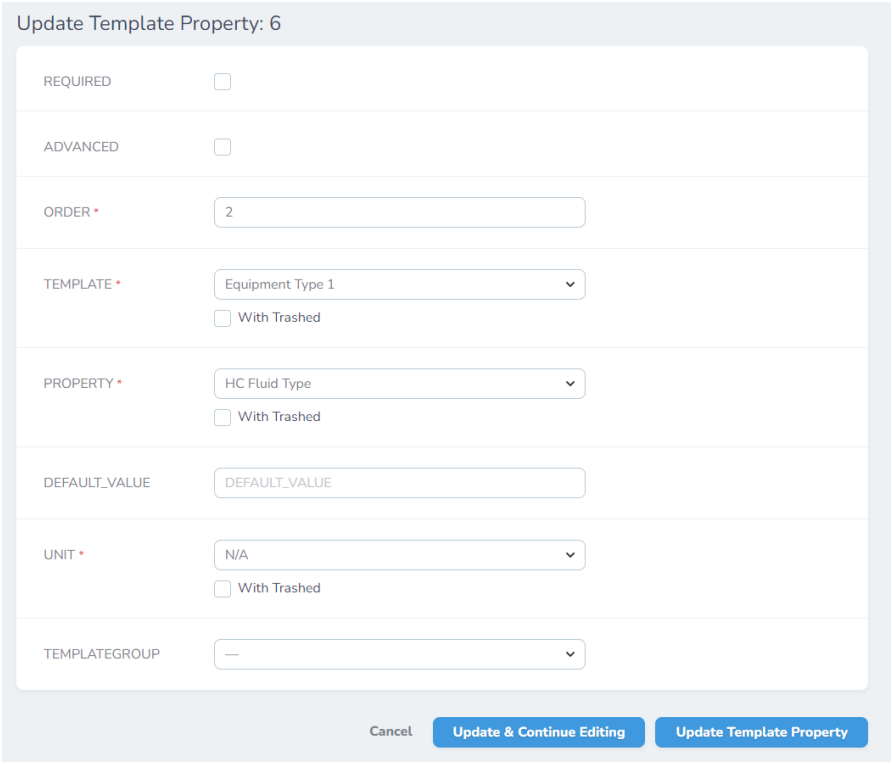

Figure 47 - Template_property edit view

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4.2.6. Unit Conversion

Units may have relations with other units, and these relations, either fixed (like Celsius to Fahrenheit degrees) or dynamic (like the exchange rate between 2 currencies).

These conversions may be set in this area allowing the user to set the inputs or see the outputs in different units.

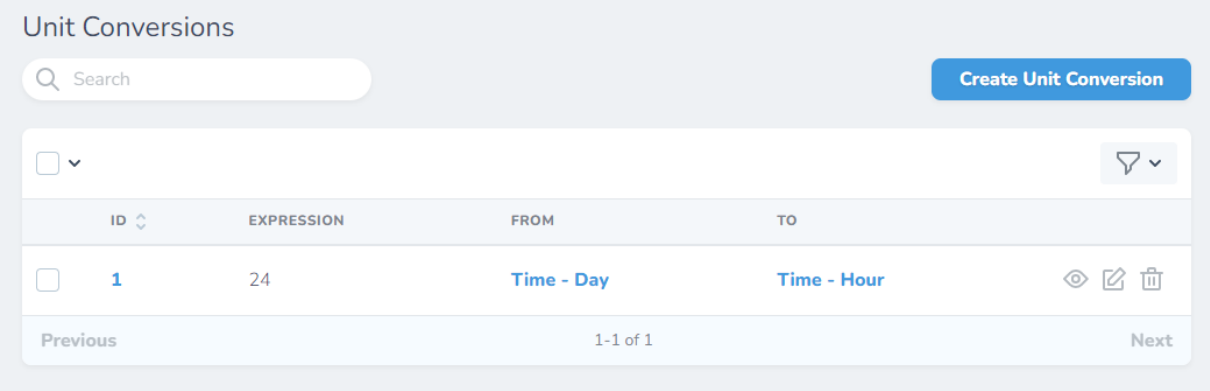

Figure 48 - Unit conversion example

4.2.7. FAQ

The administrators may see, edit and add or remove new entries to the FAQ in this section, simply by inserting a question and an answer.

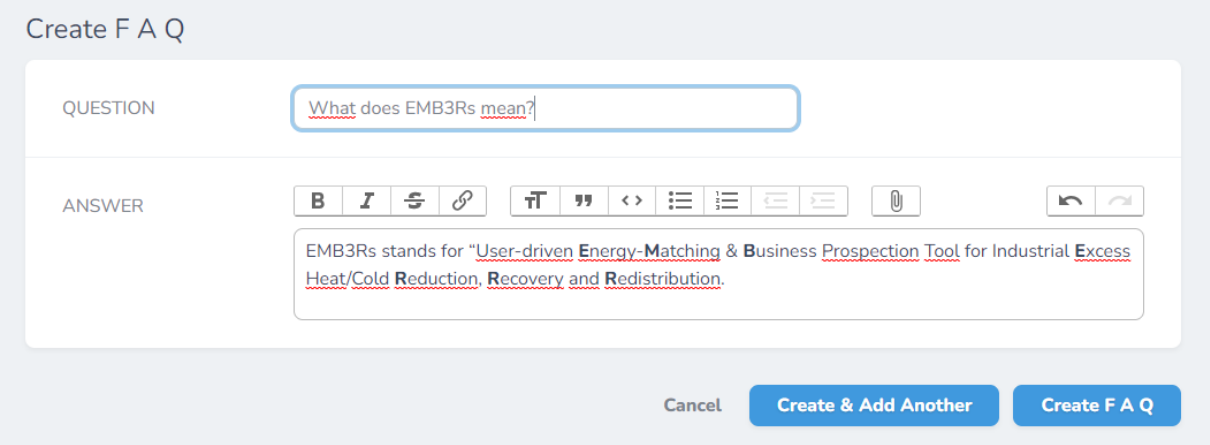

Figure 49 - Creating a new FAQ entry

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4.2.8. News

Similarly to the FAQ, the administrator may add new entries to the News, and even specify an Institution (Team) so that this particular entry is only seen by the users within that institution.

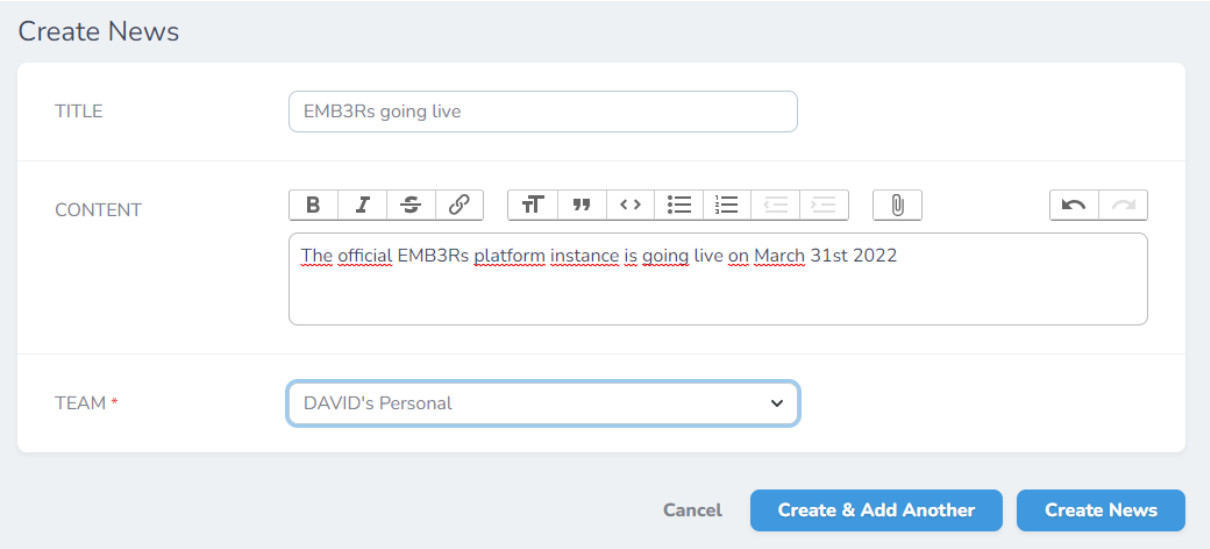

Figure 50 - News addview example

4.2.9. Other backoffice menu entries

Although there are other entries in the backoffice menu (such as the ones related to simulations or reports), these are not meant for configuration but mainly to store and present information that is shown to the user. For instance the Simulations entry shows all the simulations, the related project and the current status of the simulation. In case something goes wrong (like if a very long simulation was erroneously started the administrator may check the details and cancel its execution.

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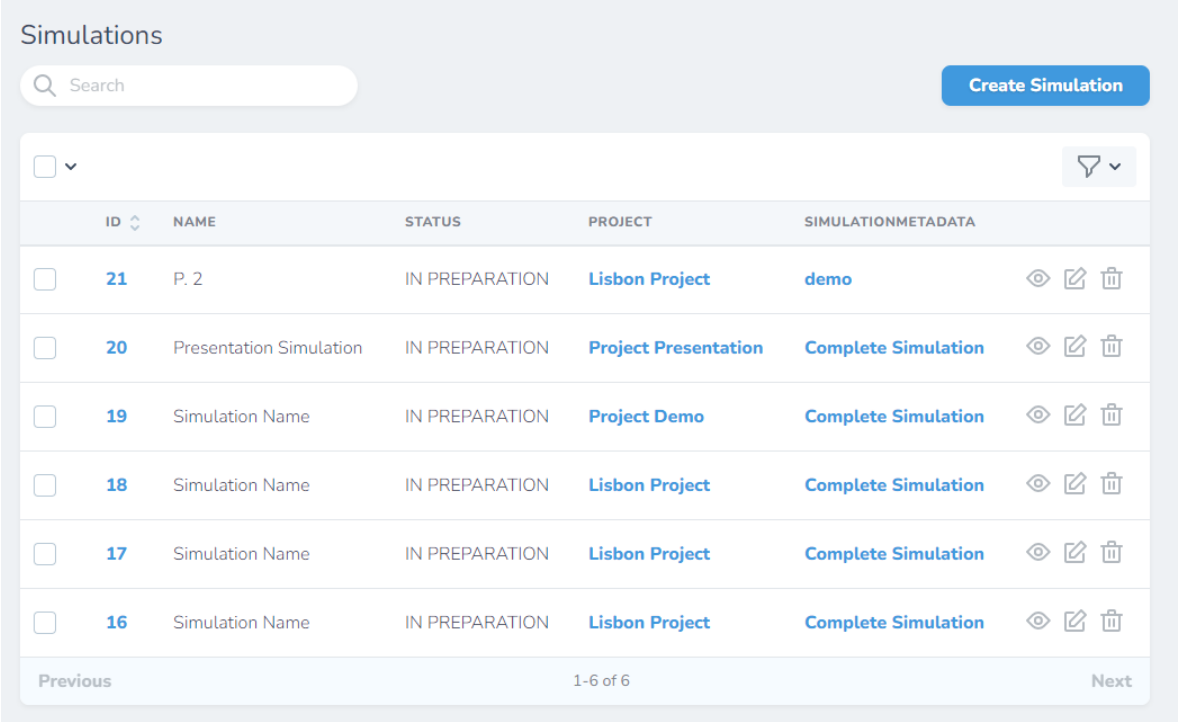

Figure 51 - Simulation List example

4.3. Module Description

This manual describes the frontend and backoffice of the EMB3Rs platform. However the platform consists on much more than these, and the core of the simulation are the simulation modules. These are presented with detail in the user and system manuals of each individual module, and these documents should be part of the technical manual of the platform.

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