ZERO BRINE

D6.2 Report on system tools for analysis, feedback and interface

October 2018

Deliverable 6.2	Report on systems tools for analysis, feedback and interface
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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

2 **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

ZERO BRINE

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ABBREVIATIONS

AC: Article Category

BOD: Biological Oxygen Demand

COD: Chemical Oxygen Demand

EWC: European Waste Catalogue

NACE: Nomenclature Statistique des Activités Économiques

OBP: Online Brine Platform

PC: Product Category

SAR: Sodium Absorption Ratio

SU: Sector of Use

TF: Technical Functions

TS: Total Solids

TSS: Total Suspended Solids

TVS: Total Volatile Solids

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1. Overview of the Project

The ZERO BRINE project aims to facilitate the implementation of the Circular Economy package and the SPIRE roadmap in various process industries by developing necessary concepts, technological solutions and business models to redesign the value and supply chains of minerals and water while dealing with present organic compounds in a way that allows their subsequent recovery.

These resources will be recovered from saline impaired effluents (brines) generated by the process industry while eliminating wastewater discharges and minimizing the environmental impacts of industrial operations through brines (ZERO BRINE). ZERO BRINE brings together and integrates several existing and innovative technologies to recover products of high quality and sufficient purity to represent good market value.

A large-scale demonstration plant will be tested in the Energy Port and Petrochemical cluster of Rotterdam Port by using the waste heat from one of the factories in the port. The quality of the recovered products will be aimed to meet local market specifications. Additionally, three large-scale pilot plants will be developed in other process industries in Poland, Spain, and Turkey, providing the potential for immediate replication and uptake of the project results after its successful completion.

2. Scope of the Deliverable

This deliverable includes the results from sub-task 6.1.2 entitled "Design and implementation of analysis, feedback and interface tools". The sub-task is led by NTUA. During ZERO BRINE project an active web service for promoting and practically implement Industrial Symbiosis (IS) will be developed. "IS is the process by which wastes or by - products of an industry or industrial process become the raw materials for another. Application of this concept allows materials to be used in a more sustainable way and contributes to the creation of a circular economy."[3] The work presented in this deliverable is concentrated on the implementation of analysis, feedback and interface tools to further support establishing and monitoring the process of symbiosis. Specifically in this deliverable is presented the system architecture, as well as the process of data collection from all the identified stakeholder categories, the matching process, the statistical and user feedback facility tool to measure the quality of the process. The provided information of this deliverable is part of the public data and can be accessed by all consortium partners of the ZERO BRINE project and the public interested in the results of the ZERO BRINE project.

[3] http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Industrial_Symbiosis.pdf

3. Platform and Portal Description

"In a circular economy, waste that can be recycled is injected back into the economy as secondary raw materials. These materials can be traded and shipped just like primary raw materials but, at present, they still account for only a small proportion of the materials used in the EU." [4] In this context, the **Online Brine Platform (OBP)** is an active web service which aims to promote the flow of secondary raw materials, by linking the Brine Owners with the Mineral/Water Users and the technology providers. The OBP will play a key role in replicating the paradigms generated in the framework of the ZERO BRINE project. The development of an Industrial Symbiosis platform for brine recovery will facilitate the application of a new, disruptive resource management concept of systemic eco-innovation proposed in ZERO BRINE project. In the OBP, the brine streams generated from process industries as well as the raw materials (minerals) and the water streams used by these industries can be mapped and possible interactions between the industries across the value chain can be identified.

The OBP will be linked with an Online Brine Portal. The key characteristics of both tools are described in the following sections.

3.1 Semantic Web Service Platform

The OBP will be applied for the case of the Netherlands. The service will receive and handle new entries letting users to register (by providing their address, industry name, contact information and industrial activity), search information and establish links with relevant stakeholders. Hence, a network of the interested stakeholders will be created. Users registered to the platform will be able to access information with respect to the available quantities and qualities of saline wastewater, recovered materials and resources needed by the end users as well as, to the location and proximity of the industrial sites. Thus, industries will be able to make informed decisions regarding the management of their own resources. Possible matches will be proposed to the registered users. The matching will be based on the required and available materials as well as on the available quantities, on the proximity and the on needed qualities.

A registered user will have the possibility to decide among one or more of the following roles:

- Brine Owners (Brine Producers and/or Brine Aggregators)
- Technology Providers
- Mineral/Water Users
- Waste Heat Provider

[4] http://ec.europa.eu/environment/green-growth/raw-materials/index_en.htm

The users will register their information according to their role (brine owners, technology providers, waste heat providers, mineral/water users). Finally, after registration of all the needed information, the user will be able to see the proposed matches with other industries (within the registered users).

The tool is designed in a user friendly and robust way. The outputs produced by the tool will be easily interpretable and clear and directly ready for the use by the brine owners and end users. The platform is designed in a way to be adaptable according to the needs of the users. For this reason the administrators of the platform will be able to monitor the whole process and propose changes in the current design. Additionally a user feedback facility will be integrated to the platform allowing registered users to give their opinion regarding their navigation to the platform and the portal.

3.2 Semantic Web Service Portal

The portal will offer access to relevant stakeholders on specific information in the domain of saline waste water management. The main concept is to present to the user a single web page that brings together content from various sources. Users will have the possibility to navigate through useful information such as:

- Brine streams generated by process industries (based on scientific and BREF documents)
- Industrial uses and properties of minerals (based on REACH regulation)
- ZERO BRINE technologies
- Successful ZERO BRINE case studies
- Symbiotic Brine Ontology
- View statistics regarding the information provided by the registered users.
- NACE, EWC, PC, TF, AC, SU, SBI codes explanation, etc.

Moreover, within the portal, users will have the possibility to communicate in a forum. A search engine will be integrated to the portal (and the platform). Browsing to the portal will be free but full access (to the platform and the portal) will remain limited unless for the registered users.

The portal will enable consultation and consensus building with the relevant stakeholders, facilitating the exchange of information and data produced by the project.

4. System Architecture and Components

The Online Brine Platform and portal system architecture consists of three main components, i.e. the client, the application services and the infrastructure services as shown in Figure 1. This figure is a technical diagram based on a number of assumptions following the SOA philosophy (Service Oriented Architecture). The software is a web based application running in the user's (client) web browser. The main application services use a number of infrastructure services provided by the various technologies that are used in the project, including semantic-enabled technologies (e.g. Virtuoso), RDBS (e.g. MySQL), Communication (e.g. Apache) etc.

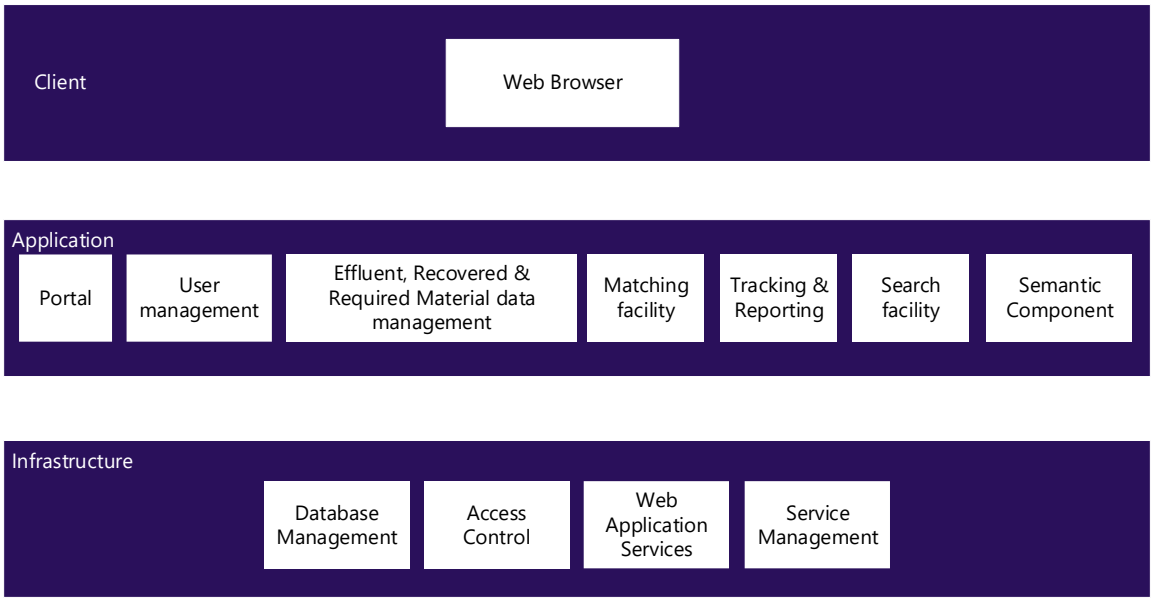

Figure 1: Architecture of Online Brine Platform

The current document focuses on the system tools for analysis, feedback and interface. More specifically it focuses on the data being input in the platform (user and resource management), the analytical, feedback and reporting tools of the platform and the user interface.

The main application components and services, as demonstrated in Figure 1 are:

1. Portal
2. User Management
3. Effluent, Recovered & Required Material Management
4. Matching Facility
5. Tracking & Reporting
6. Search Facility
7. Semantic Component.

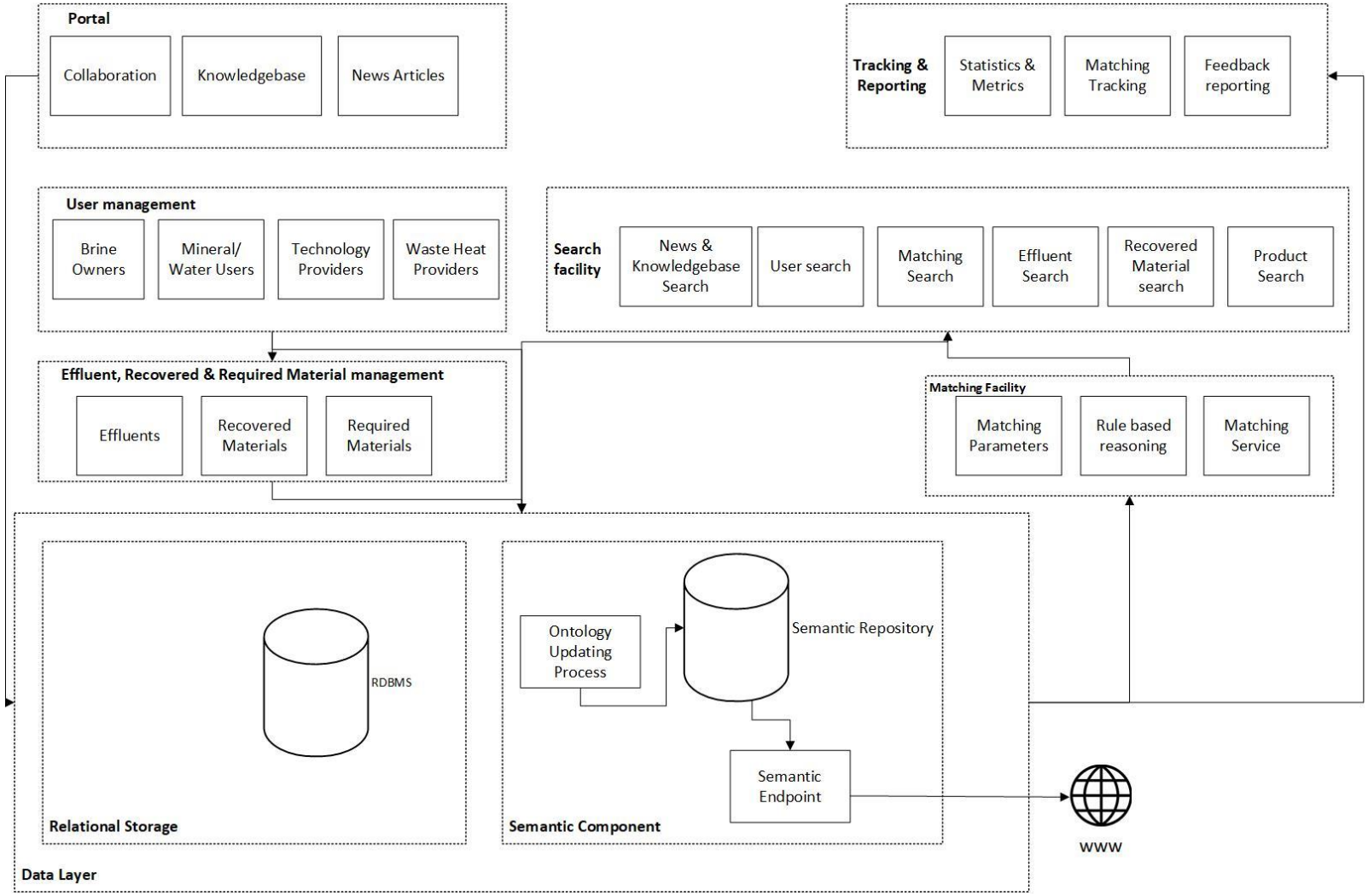

Figure 2: Functional Components of Online Brine Platform

Portal: The portal includes the knowledge base available to the OBP members and to the public as well as the new articles and collaboration tools (e.g. forum). It is built on PHP as back-end programming language and uses the relational storage (MySQL) to store all information.

User management: The User management component includes the users and their roles to the platform as well as the portal. The users of the system use the same credentials to login to either the portal or the platform and once they are logged in to one of them, they are automatically logged in in the other as well. User information is stored in the relational storage and some data that is needed for the matching procedure is also stored in the semantic repository.

Saline Effluent, Recovered & Required Material Management: The Effluent, Recovered & Required Material data management includes the data of “effluents”, “recovered materials” and “required materials” that each and every user may input in the platform according to their role. The interface for the data input of the platform is based on PHP and JavaScript and all data is stored in the relational storage. The data that is needed for the matching and the data that is available to the semantic web is also stored in the semantic repository.

Search Facility: The Search facility includes all search functionality available to the platform and the portal. There are different search utilities available to the users and the administrators of the system. In detail, there is the search function of the portal that allows users to search among the knowledge base and the news articles (based on PHP). In the platform, a search utility is built to navigate and filter more easily between data for Saline Effluents, Recovered and Required Materials, technology providers and users in general (based on PHP and JavaScript).

Matching Facility: The matching facility component includes the matching parameters, the rules upon the matching that takes place and the matching service that performs the actual matching. It is based on PHP and it runs each time an effluent, a recovered material or a required material is added to the system or is edited. The matching parameters are dynamic and they are stored in the relational storage.

Tracking & Reporting: The Tracking & Reporting component includes the tools available to track and monitor statistics, feedback and the matching process. These tools are based on PHP and SQL and JavaScript is used for the visualization of the data.

Semantic Component: The semantic component which is backed by the ontology described in “*Deliverable 6.1: Wastewater and solution provider knowledge models, correlations and interlinks*”, implements the semantic features of the platform and enables publishing a subset of the data to the semantic web via a Sparql endpoint.

Both the semantic component and the relational storage (MySQL), which is responsible for storage and retrieval of all data of the platform and the portal, are the two components that consist the data layer.

5. Platform Usage

5.1 User Management

Organization User Level

The users are able to do the following via the platform:

- **Register** their organization and fill in its contact details, activity description and representatives' details.
- **Define** their OBP role in the platform as a "Brine Owner", a "Mineral/water user" a "Technology Provider" and/or "Waste Heat Provider".
- **Input** further details, according to their role, about their: (i) activities, (ii) saline effluents, (iii) recovered materials, (iv) required materials (v) treatment technologies and/or (vi) waste heat characteristics.
- **Search** for "matched" results via the Level 1 and Level 2 Matching Process. (*see section 6.1.3*)
- **Access** information regarding the matching process results.
- **Communicate** with other users, respecting both sides' confidentiality terms.

A new user in order to be registered, has to complete a form that includes fields asking for contact details and additionally fields for password and username creation. After the user's registration, the user receives an email with the registration link, in order to confirm the registration process and the credentials in the OBP Platform. The user can select one or more of the roles as shown in the next figure (Figure 3) according to his role in the supply chain of saline wastewater and mineral/water use and recovery.

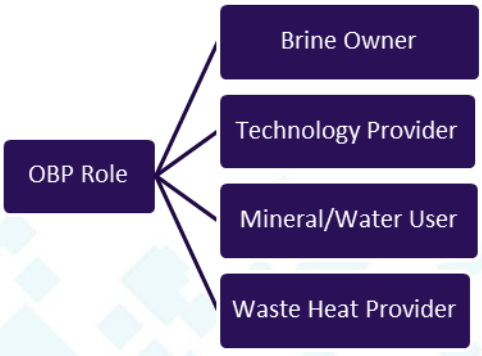

Figure 3: User Roles on the Online Brine Platform

Each role corresponds to a different profile which is edited by the user. According to the user's roles, different tabs and fields on the OBP screens are available to them. The process of profile editing consists of two ways of registering information in the tool:

1) The user fills in fields by selecting options from single and/or multiple dropdown lists and checkboxes.
2) The user inserts values in fields.

It has to be mentioned that the users have also the opportunity in some cases to add more than one option at the same time according to their needs.

Furthermore, there are some functionalities of the OBP that are visible to all users, and some features that are related to the use of the OBP by each and every user.

After signing in for the first time the Users are asked to select their *Role* to the platform. If the Users have completed the procedure they get navigated to the home screen (**Dashboard**, Figure 4) that includes the latest announcements and messages, some platform statistics and a map pinpointing the geographical locations of all the Registered Users of the Platform (only for the Users that have given their consent to be visible in the map). More specifically, the Dashboard is consisted of some statistical blocks summarizing the usage of the Platform, about the total number of Users, the total number of Saline Effluents, of Technology and Waste Heat Providers registered, of Recovered Materials that have been input in the Platform by the Brine Owners, of Required Materials asked by Mineral/Water Users and the total number of Matches that have been achieved during the Matching process (see Figure 4).

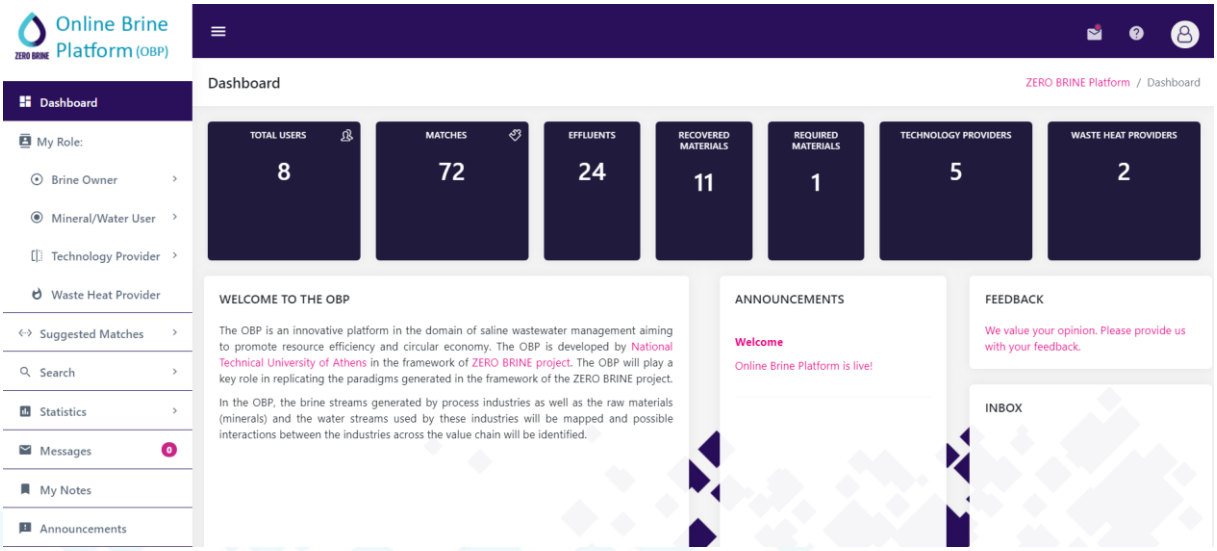

Figure 4: Example of the OBP Dashboard

Apart from the Dashboard screen, all Users can see the same interface regarding the tools and features of the OBP. On the left side of their screens, the main Menu can be found, indicating the respective Menu items;

- Dashboard (where a User can return to the home screen), OBP *Role* (where Users can revise and edit their role in the Platform),
- Brine Owner, Mineral/Water User, Technology Provide, Waste Heat Provider tabs and their sub-Menu items (where Users can provide information about their Saline Effluents and Recovered Materials, Required Materials, Technologies and Waste Heat characteristics according to their role as set in the OBP Role Menu Item),
- Suggested Matches (where a User can check if there are any achieved matches in Level 1 and Level 2, with other Users) (see section 6.1.3),
- Messages (where a User can check the Inbox and Sent messages),
- My Notes (where a User can reach Notes),
- Announcements (where a User can read recent and former Announcements) and finally,
- Two buttons leading to External Links; the OBP Portal and the ZERO BRINE Project Website.

Also there is a top Menu, on the right of the OBP Platform screens, with the envelop icon, leading to the Inbox Page, accompanied with a notification system and a User Icon, where a User can reach directly his Profile, his OBP Role and/or Log out. There is also a help icon where a User may read frequently asked questions (FAQ) and their answers and may contact the platform administrator if they need further assistance.

5.2 User Roles

5.2.1 Brine Owner

When Users select their OBP Role as Brine Owners, they have the opportunity to specialise more their activities as industries that produce saline wastewater, as aggregators of saline wastewater or both. This specialisation does not offer data input in the further matching processes, but is recorded for informative purposes only.

This OBP *Role* offers users two options to the Brine Owners that correspond to the two different stages of material recovery:

1) Saline wastewater addition (**Add Saline Effluent(s)**): Brine Owners register information of an untreated saline wastewater.

2) Recovered material addition (**Add Recovered Material(s)**): Brine Owners register information for the provided recovered materials and for the performed recovery process or for the bench scale experiments.

A User can select one of the options or both, as they are independent to each other. For both options, the series of appearance of the fields to be completed is formed in a way to prevent the user from forgetting filling in fields necessary for other fields' completion.

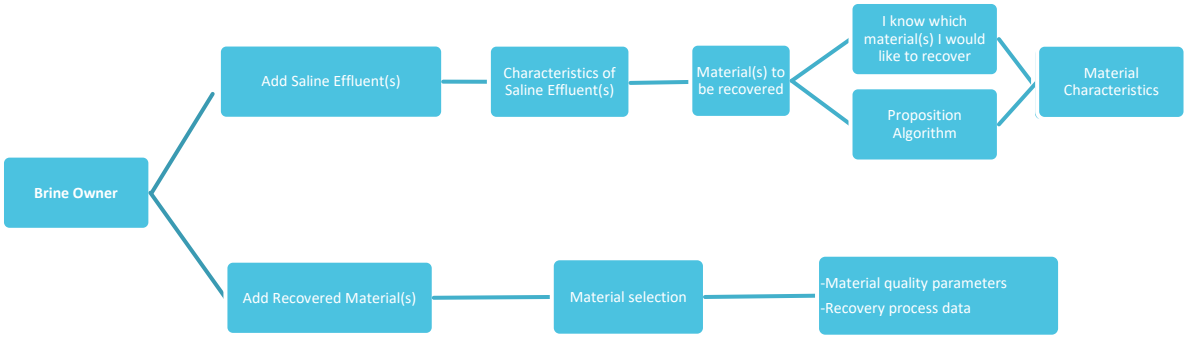

Figure 5: Steps of fields completion for the OBP User Role: Brine Owner

5.2.1.1 Saline Effluent Data Fields

In the first option (**Add Saline Effluent(s)**), Brine Owners Users can add their Effluent(s) and the characteristics of each effluent by registering the respective information in the "Add Saline Effluent(s)" sub-Menu item. The process consists of three major steps; the "Characteristics of Saline Effluent(s)", the "Material(s) to be recovered" and the "Material Characteristics" (see Figure 5).

Step 1 - "Characteristics of Saline Effluent": Brine Owners can add as many Saline Effluents as they want, by filling the respective fields. The Saline Effluent fields are: (i) the identifier field (where the User uses an identifier to recognize each effluent), (ii) the effluent flow per day (m^3/day), (iii) the flow per month ($m^3/month$), (iv) the TDS value (g/l), the presence or not of (v) COD and (vi) BOD, (vii) the NACE classification code (selection from NACE as added in the user profile) and European Waste Catalogue (EWC) codes. For every new Saline Effluent stream, the Brine Owner can add a new effluent ("Add Saline Effluent" button) (see Figure 6).

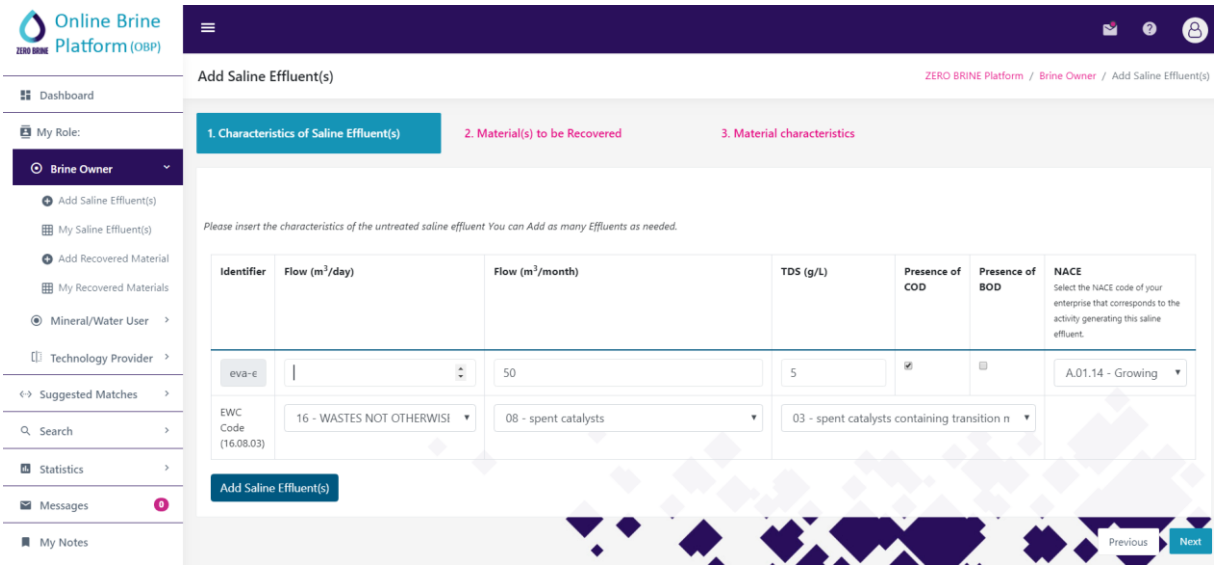

Figure 6: Example of fields completion in the step "Characteristics of Saline Effluent(s)

Step 2 - "Material(s) to be recovered", the Brine Owner can:

a) select which material(s) can be recovered from the Saline Effluent, if they are known in advance, and/or ,

b) ask the OBP to propose which mineral(s) could be recovered from the saline effluent.

In the first option (a - known materials to be recovered), the Brine Owner selects the materials from a dropdown list (see Figure 7).

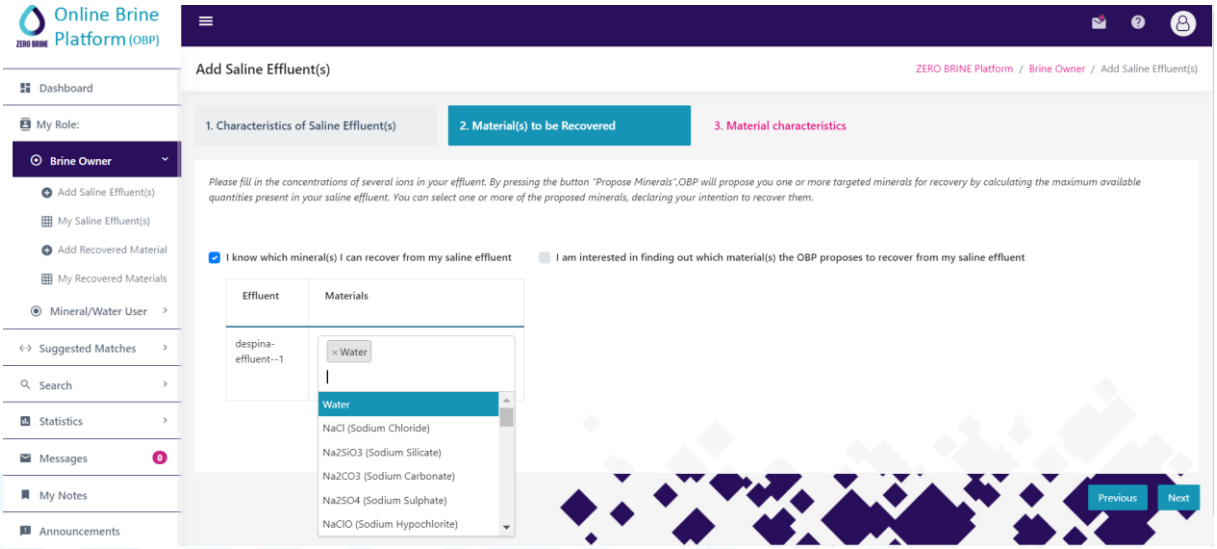

Figure 7: Example of fields' completion in the step "Material(s) to be Recovered" (option a)

In the second option (b - minerals proposed), the Brine Owner asks from the OBP to propose the possible materials to be recovered, according to the OBP proposal algorithm. In order to let the algorithm take place, the Brine Owner has to input the concentration of different ions in the effluent. The algorithm uses these values and calculates the maximum available concentration and quantity of targeted materials that can be recovered from the effluent, using also the effluent flow as input in the first step. Then the Brine Owner can select which of the suggested, by the algorithm, materials wants to be recovered and can proceed to the third step (see Figure 8).

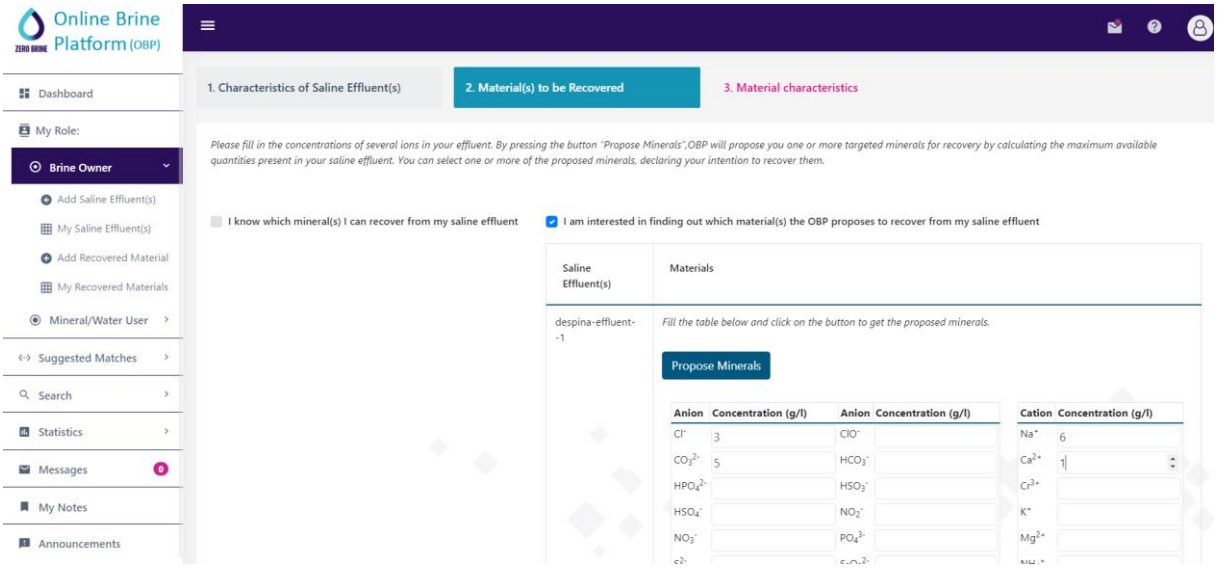

Figure 8: Example of fields' completion in the step "Material(s) to be Recovered" (option b)

Step 3 - "Material Characteristics": if the Brine Owner has selected in the second step "materials to be recovered" from the Saline Effluent (option a), can fill in the Concentration (*g/l*) of this material in the specific effluent. The Effluent Flow per month will be retrieved as inserted by the user in the "step 1". However, the User has the possibility to change this value if desired. By pressing the Finish button, the process "Add Saline Effluent" is finished and saved in the Platform (see Figure 9).

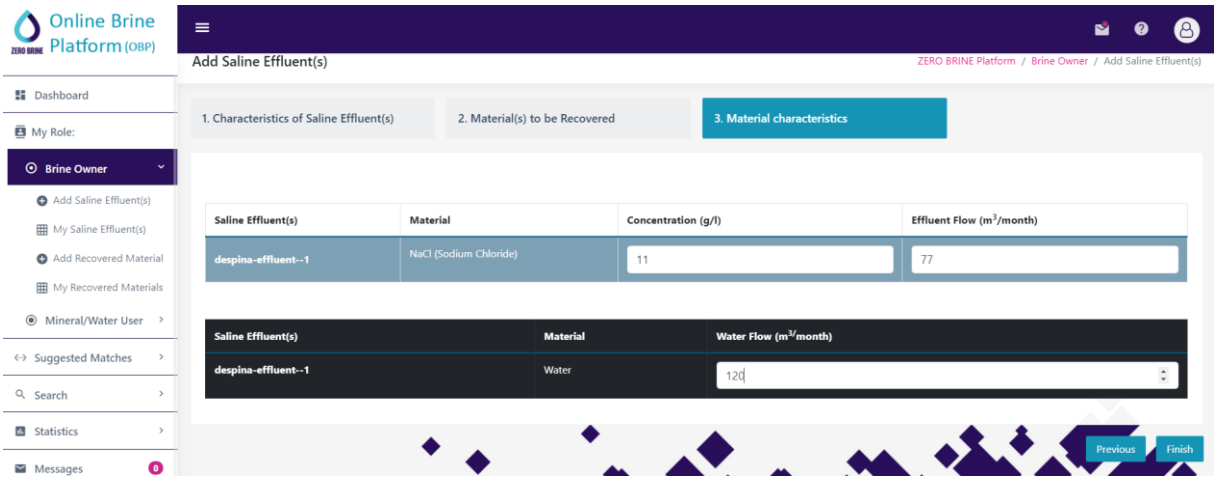

Figure 9: Example of fields' completion in the step "Material Characteristics".

For future use, a Brine Owner can View and/or Edit the registered data of Saline Effluents (see Figure 10).

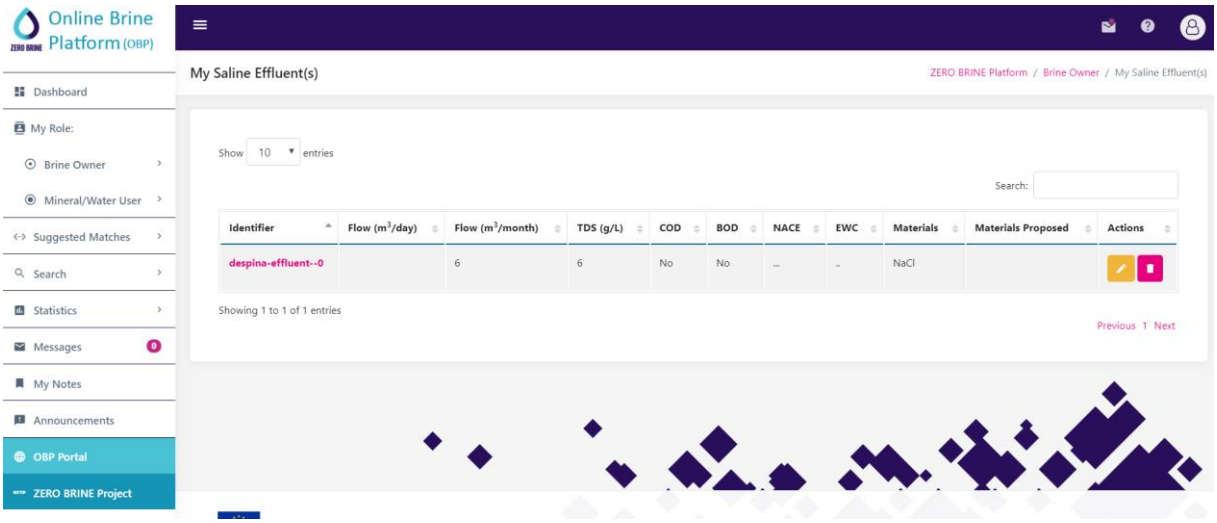

Figure 10: Example of the item "My Saline Effluent(s)"

5.2.1.2 Recovered Material Data Fields

In the second option (**Add Recovered Material(s)**), the Brine Owners that have performed a recovery process can add the materials recovered from their wastewater stream(s). This process consists of three steps; the "Select Materials", the "Quality Parameters" and the "Recovery Process" (see Figure 5).

Step 1 - "Select Materials" the Brine Owner selects the recovered materials from a dropdown list. (see Figure 11)

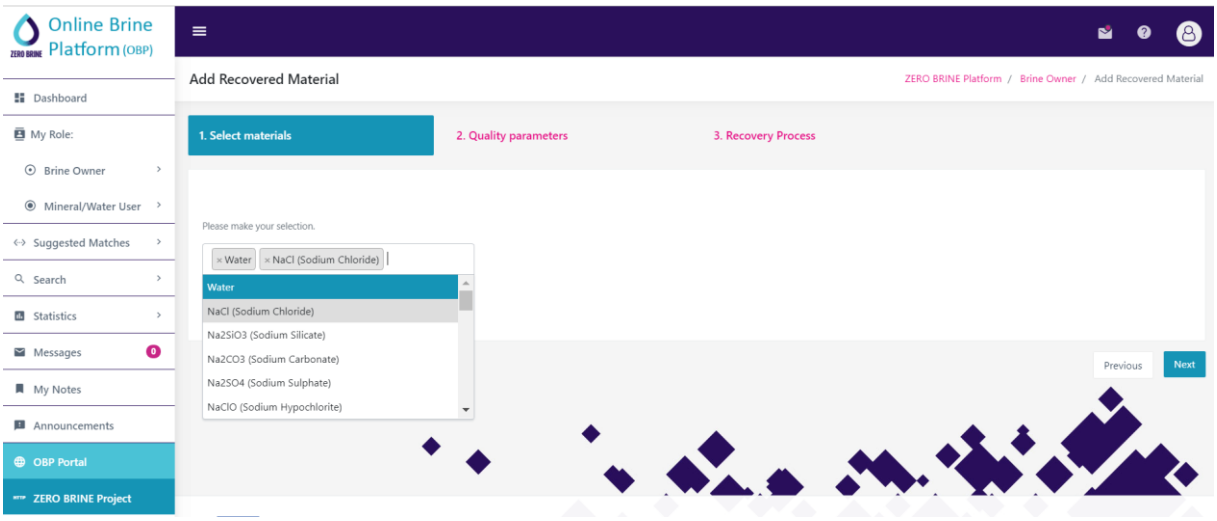

Figure 11: Example of selection in the step "Select material(s)

Step 2 - "Quality Parameters": Brine Owners have to insert quality parameters values for each material declared as recovered in the first step. Brine Owners can (i) use an identifier name per each material, (ii) input the recovered quantity per month (*kg/month*) and fill the values for quality parameters: (iii) Purity (%), (iv) Moisture (%), (v) TOC (%) and (vi) maximum acceptable values of Heavy Metals (lead (Pb), Arsenic (As), Cadmium (Cd), Chromium (Cr) and Mercury (Hg)) concentration (*ppm*) (see Figure 12).

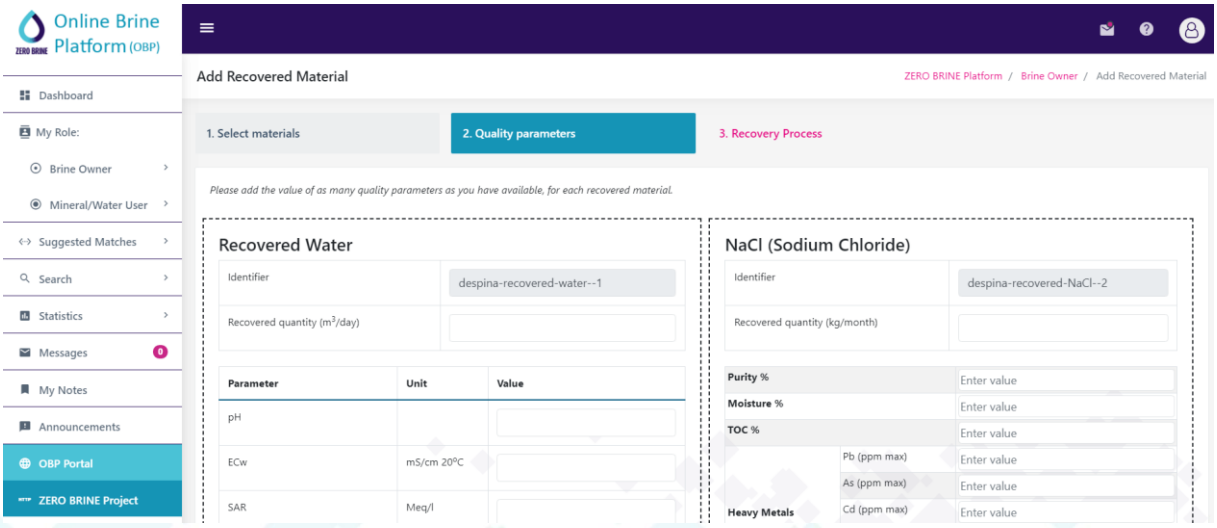

Figure 12: Example of fields' completion in the step "Quality parameters".

Step 3 - "Recovery Process" the user can input (i) information about the technology/ies used to recover materials, (ii) economic indexes and (iii) environmental data. For the Technology information, the listed technologies are grouped into Organics Removal, Brine Purification/Ion Separation, Brine Concentration and Brine Crystallization. For the Economic data, the Brine Owner can fill in the CAPEX (in Euro, €) and the OPEX (in Euro/year) indexes. For the Environmental data, the Brine Owner can fill in the LCA indicators per name, their Units and their Values (see Figure 13).

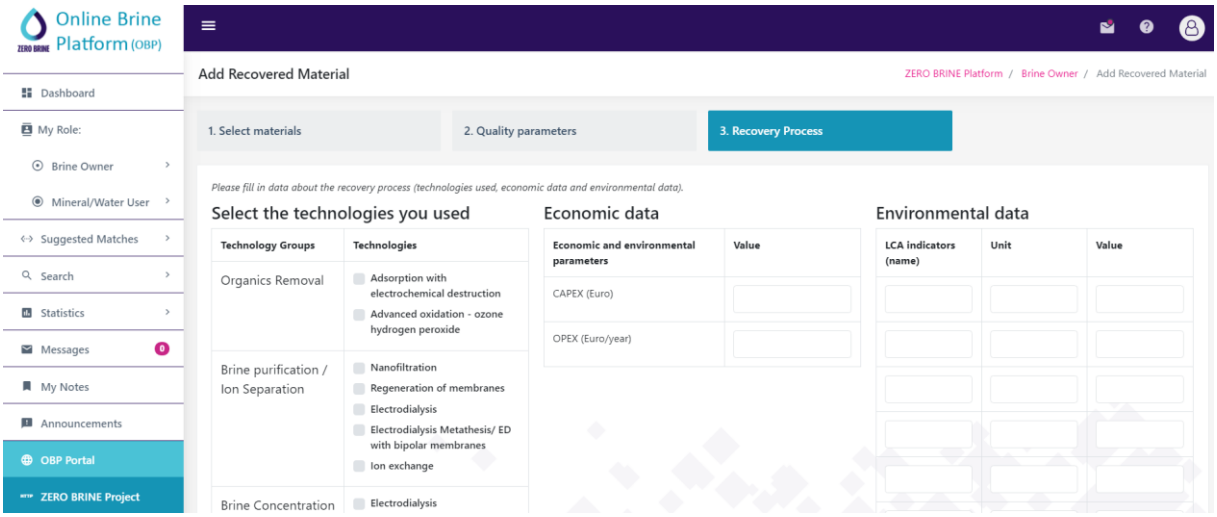

Figure 13: Example of fields' completion in the step "Recovery Process"

5.2.2 Technology Provider

5.2.2.1 Technology Management Data Fields

When Users set their OBP *Role* as Technology Provider, they can select the technologies they provide for the treatment of a Saline Effluent (from the technology toolbox of ZERO BRINE project).

Figure 14: Field completion for the OBP User Role: Technology Provider

Technology Providers can add, edit and delete their technologies in the "My Technologies" sub-Menu item. They can add as many technologies as they want and other users will be able to search for them, by technology type (see Figure 14 and Figure 15).

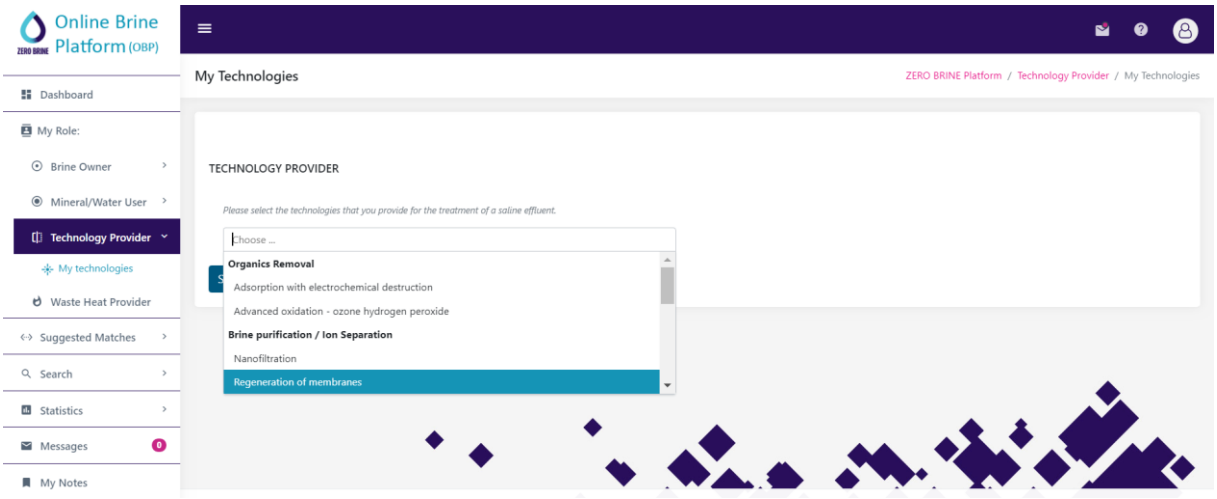

Figure 15: Example of technology selection of a Technology Provider

5.2.3 Waste Heat Provider

5.2.3.1 Waste Heat Management Data Fields

When Users set their OBP Role as Waste Heat Provider, they can add the characteristics of the provided waste heat (such as: form of waste heat, temperature, amount, load rate variation).

Waste Heat Provider — Add Waste Heat Characteristics

Figure 16: Field completion for the OBP User Role: Waste Heat Provider

Waste Heat Providers can add, edit and delete their waste heat characteristics in the “My Waste Heat” sub-Menu item. They can add as many waste heat flows as they want and other users will be able to search for them.

5.2.4 Mineral/Water User

5.2.4.1 Required Material Data Fields

The last and fourth type of *Role* that a User can select in the OBP is the one of a Mineral/Water User. This type of User is registering in the platform information for materials that requires in processes and looks for recovered quantities of them, under certain quality parameters, from the Brine Owners.

A Mineral/Water User can add a Required Mineral/Water within three steps; "Select Required Material(s)", "Quality of the Required Material(s)" and "Extra parameters for the Selected Minerals(s)", in the sub-menu item "Add Required Material(s)" (see Figure 17).

Figure 17: Steps of fields completion for the OBP Role Mineral/Water User

Step 1 - "Select Required Material(s)": the Mineral/Water Users can select from a dropdown list the Required Material(s) (mineral or water). (see Figure 18).

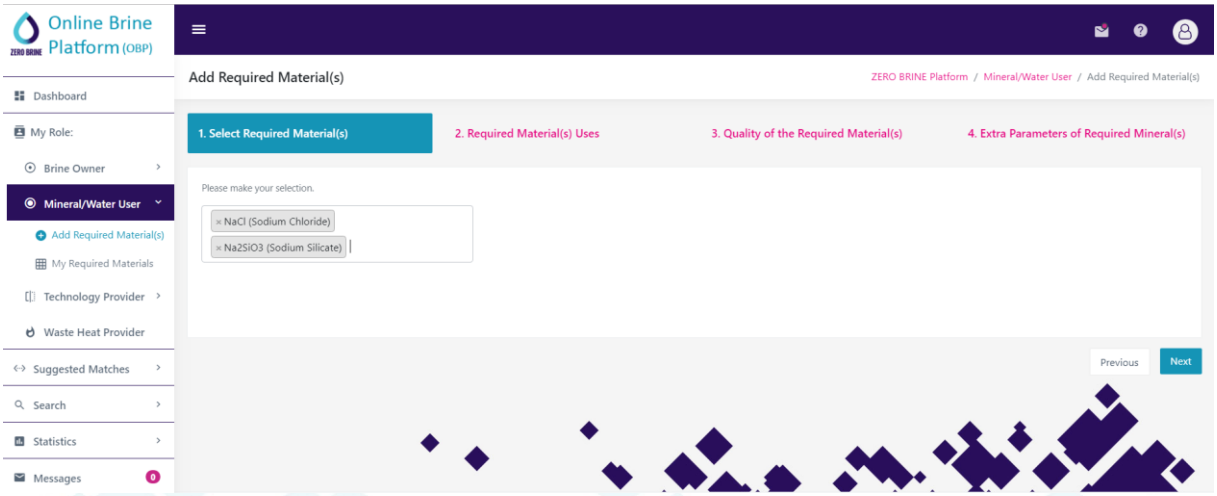

Figure 18: Example of Materials selection in the step "Select Required Material(s)".

Step 2 – Required Material(s) Uses, the Mineral/Water user can indicate the use of each resource in the processes. If the User chooses the Water Use, can (i) use an identifier, and (ii) input the required flow per day (m^3/day). If the User chooses one or more minerals, can (i) use an identifier name, (ii) input the required quantity per month (kg/month), (iii) indicate the SU, PC, AC and TF indexes. All these apply per selected Required Material. If the User wants to use one of the selected material in more than one process with different quality parameters can add another series of Material fields. (see Figure 19)

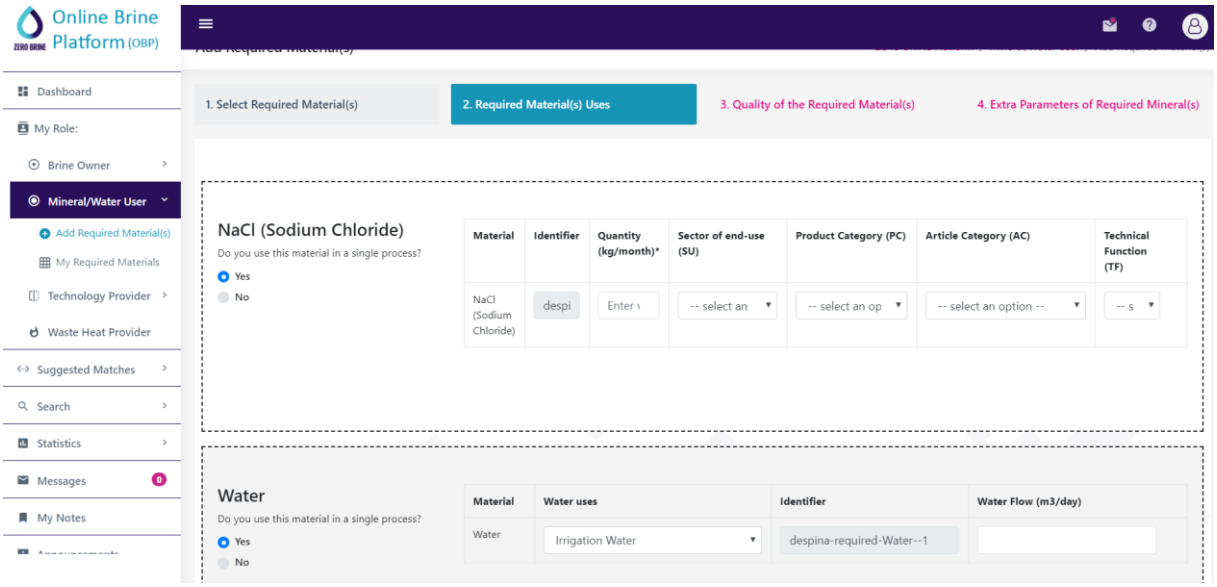

Figure 19: Example of uses indication in the step "Required Material(s) Uses".

Step 3 – Quality of the Required Material(s), the Mineral/Water User can add the required quality parameters per selected Material. If the selected material is Water, then the User can add the Maximum and Minimum limit values the material can have in pH and Turbidity values, concentrations of specific ions, metals, COD, BOD, TDS, TSS and bacteria. If among the selected materials are minerals, then the User can fill in the required values of (i) Purity (%), (ii) Moisture (%), (iii) TOC (%) and (iv) maximum acceptable values of Heavy Metals (lead (Pb), Arsenic (As), Cadmium (Cd), Chromium (Cr) and Mercury (Hg)) concentration (*ppm*) per mineral (see Figure 20).

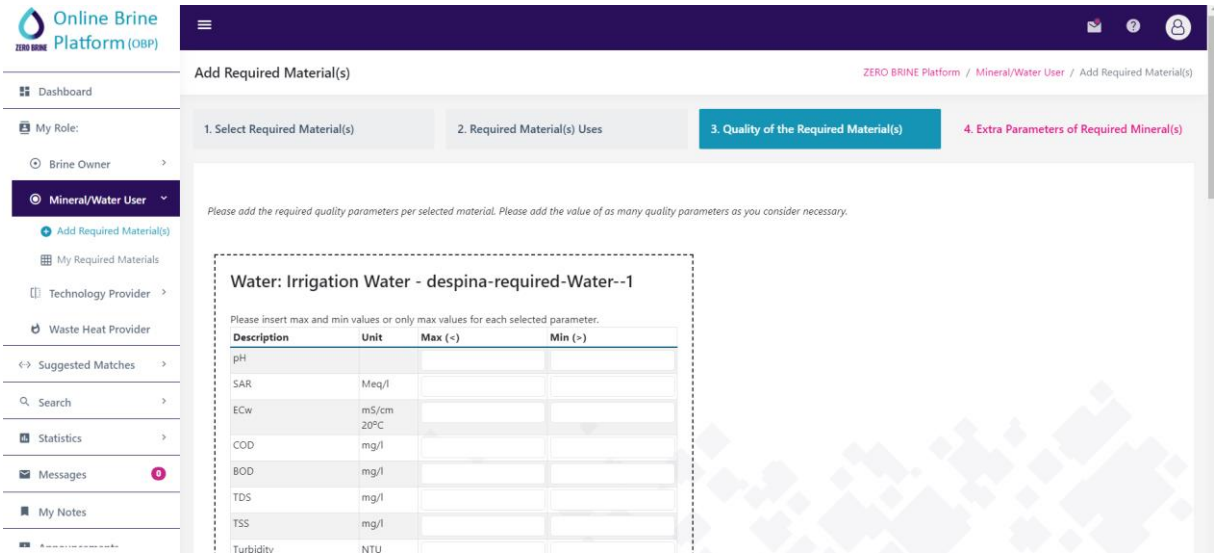

Figure 20: Example of fields' completion in the step "Quality of the Required Material(s)"

Step 4 - Extra Quality Parameters: If among the selected materials are minerals, the Mineral/Water Users can add extra parameters for them, related to their tolerable maximum concentration (*ppm*) of metals, metallic and allogeneic ions, nitrogen ions, volatile and non-volatile matter (see ANNEX, Table 6).

Finally, after adding the Required Materials, the Mineral/Water User can revise the inputs in the "My Required Material(s)" sub-Menu item.

5.3 Data Collection

The infrastructure for data collection consists of the data input screens of the platform available to all users. As described above it includes the following pages:

- Registration/Profile page
- “Add Saline Effluent”
- “Add Recovered Material”
- “Add Required Material”
- “My Technologies”
- “My Waste Heat”
- Feedback pages

In the context of protecting the confidentiality and security of industry data, the Users will be able to register to the platform by providing a “username” instead of industry name. This way it is assured that there will be no straight connection between the industry data and the industry name if not desired. The information registered by the users will be open to the other users registered to the platform but with no reference to the industry name. In this way, it is facilitated the matching process. Once a user is matched with another user or desires to communicate with him/her (by using the search engine), both could be able to send a message to each other and then if they are both willing, they will provide more information (e.g. industry name) to each other. Regarding the provision of geographical data, the user will have the possibility to register his address but this address will remain hidden to other users in order to prevent the identification of the industry name with the address unless the user gives consent. However, the driving distance between registered users will be calculated and taken into account in the matching process by sorting the matched users in order of distance. In the case that a user is not willing to provide the address to the OBP, he could continue the data registration but when matched with other users, the geographical distance will not be taken into account (see section 6).

6. Matching Process

6.1 Analysis

The collected data from all the Users will be stored in the data layer. From that information, a dataset will be used for the matchmaking process. Another dataset of information will be collected from the users and will include the additional parameters that the Users will register to the OBP and not contribute to the matching process. All these additional parameters, which not contribute to the matching process, will facilitate the generation of potential synergies. Synergies between the matched users could be created in a collaborative approach between the matched users. Then these case studies could be examined and analyzed in technical and regulatory terms to further investigate the possible synergies.

The "matching results" will be the expected output of the platform for the Brine Owners and the Mineral/Water Users.

6.1.1 The Role of Matching in the OBP

In the context of Industrial Symbiosis and Circular Economy, the matching algorithm of the OBP aims to address the significant issue of creating networks between different actors across various supply chain stages of saline wastewater management. The management of wastewater flows coming from different sectors requires consistent data collection for the estimation of composition, patterns of supply, quantity and quality in order to achieve reliable linkage between users of relevant raw materials and water. Moreover, the results of the OBP matching process will contribute to the targeted access to raw materials and water.

Via OBP, different users will have the possibility to approach each other in two ways, as described below.

1) The users will be able to **search** and access open information of other registered users according to their interests. This way, all the registered users will have the possibility to browse to the profiles and relevant open data of other users.

2) The users will be able to contact each other once their effluents/recovered materials/required materials are **matched** automatically by the platform. The matching process will take into consideration information in relation with: (i) the kind of materials, (ii) the quality of the materials, (iii) the quantity set by users and (iv) the driving distance. In the matching process only the Brine Owners and the Mineral/Water Users participate.

6.1.2 Matching Parameters Selection

Prior to the selection of the matching parameters an extensive research (as described in *Deliverable 6.1*) was performed in order to define the composition of the brine streams generated by process industries and the needs as set by the end-users of minerals and water. Moreover, it was taken into account the "user friendly" character of the OBP by preventing the user from hesitating to fill in fields.

Subsequently, the matching process has a four-pillar structure as described below:

1st pillar: Kind of the Material

Users will be matched according to the kind of the material offered by the Brine Owners and requested by the Mineral/Water Users.

2nd pillar: Quantity parameters

The available quantity of a raw material is an important parameter for the Mineral/Water User. Consequently, the matching process will take into account the quantity of the material as filled in by the Brine Owners and the Mineral/Water Users.

3rd pillar: Quality parameters

As mentioned above, the stakeholders that can be matched via OBP are **Brine Owners** and **Mineral/Water Users**. It is assumed that a Brine Owner desires to eliminate his/her wastewater discharge, minimizing the environmental impact of the process and to recover marketable resources (Mineral and/or Water) from the saline impaired effluent/s. In parallel, a Mineral/Water User is interested for appropriate raw materials intended to be used in various processes.

According the new Waste Framework Directive (2008/98/EC)[5], it is necessary that "the recovered material fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products"[6]. Additionally, the technical characteristics (for specific uses) in the material recovery process are of high importance. A recovered substance must be "useful" in the market and consequently this implies that it must have specific technical characteristics, as desired by the industries according to their needs and to the legal framework.

The technical requirements for a substance may vary significantly from industry to industry even in the case that the industries belong to the same sector.

The technical specifications as set by the Mineral/Water Users may be extensive, however in order to facilitate the Users and the matching process, a research was performed in order to find out the most common and important quality parameters for the use of minerals by the Mineral/Water Users. These parameters are presented in the table below (Table 1).

[5] Waste Framework Directive (DIRECTIVE 2008/98/EC)
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

[6] European Chemicals Agency
https://echa.europa.eu/documents/10162/23036412/waste_recovered_en.pdf/657a2803-710c-472b-8922-f5c94642f836

Table 1: Quality parameters selection for the matching process

Quality Parameter		Unit
Purity		%
Moisture		%
TOC		%
Heavy Metals	Arsenic (As)	ppm
	Lead (Pb)	
	Cadmium (Cd)	
	Chromium (Cr)	
	Mercury (Hg)	

For these parameters, as described in Section 5.2.4, Mineral/Water User will input values (numbers) in order to define the acceptable limits for the minerals.

The use of water is also taken into account in the OBP as a material to be recovered from Saline Effluents and reused in different processes. Specifically, the use of water for irrigation and for industrial purposes was investigated. The parameters taken into account for both cases are presented in the ANNEX (see Table 4 and Table 5).

4th pillar: Geographic Location of Users

The distance between the Users is considered as an important matching parameter. For this reason, the matched Users will be sorted in distance order.

6.1.3 Matching Levels

As described in the section 5.2.1 the OBP role of Brine Owner offers users two options that correspond to the two different stages of material recovery: (i) to add the characteristics of an untreated saline effluent and (ii) to add information of the recovered material and of the performed recovery process. The OBP matching process aims to match both options with the Required Materials of Mineral/Water Users. However, the parameters taken into account in the two matching processes differ. Hereinafter, these two ways of matching will be called “Levels”. The matching levels are divided in two categories: (i) Level 1 and (ii) Level 2.

In **Level 1** the Brine Owners that have an untreated saline effluent will be matched with Mineral/Water Users.

In **Level 2** the Brine Owners that have a performed a recovery process will be matched with Mineral/Water Users.

6.1.4 Level 1

As mentioned before, in "Level 1" matching, Brine Owners that have an untreated saline wastewater are matched with Mineral/Water Users.

The matching parameters for "Level 1" are:

- The kind of material
- The quantity of the material
- The geographic location of users

For this reason, Brine Owners fill in the fields concerning the following when register their profile.

- **Kind** of material they are possibly able to recover (e.g. NaCl, $CaCl_2$, water)
- Present **quantity** ($g_{mineral}$ /$l_{effluent}$) of the mineral in the effluent they desire to treat and/or the maximum water flow (m^3/day) that is possible to be recovered in the case of water.

It must be mentioned that in this stage, Brine Owners have not yet data neither for the recovery process they are going to perform nor for the materials that it is feasible to recover and their expected quantity and quality.

Respectively, the Mineral/Water Users fill in the fields concerning the following.

- **Kind** of required materials (e.g. NaCl and water)
- Required **quantity** of the mineral (*kg/month*) and/or of water (m^3/day).

Mineral/Water Users can provide information for the desired quality parameters, but this data won't be used for matching Level 1, but only for matching Level 2. The image that follows presents an example of a matching result in "Level 1":

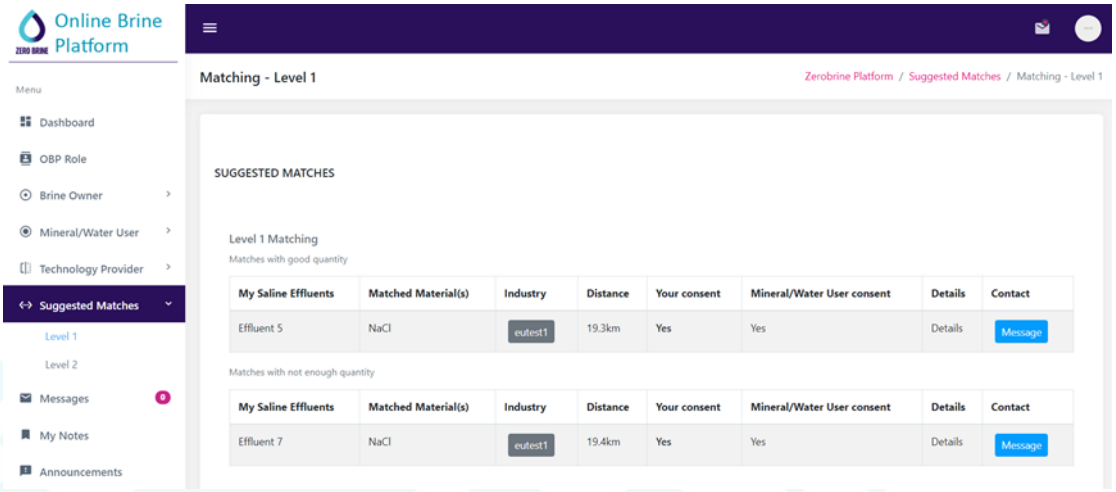

Figure 21: Example of "Level 1" Matching Results

By this way, the Brine Owners and Mineral/Water Users have a first screening about the potential collaborations. Taking for granted that the quantity requirements are fulfilled, the matches between Brine Owners and Mineral/Water Users are shown in distance order.

As a result of the matching process, the Brine Owners would have the possibility to contact the matched Mineral/Water Users of the materials presented in their wastewater, and direct the recovery process towards the Mineral/Water Users' requirements being able to take into consideration the quality parameters set by the matched Mineral/Water Users.

6.1.5 Level 2

In "Level 2" matching, Brine Owners that have performed a recovery process from a saline wastewater are matched with Mineral/Water Users.

The parameters that are taken into consideration in this Level of matching are:

- The kind of the material
- The quantity of the material
- The quality of the material
- The geographic location of users

For this reason, Brine Owners and Mineral/Water Users fill in the relevant fields of parameters as shown in the table below (Table 2).

Table 2: Selected Quality parameters for the OBP matching process

	Brine Owner (recovered material)	**Mineral/Water User**
Kind of material	kind of available materials they recovered (e.g. NaCl, $CaCl_2$ and water)	kind of required materials (e.g. NaCl and water)
Quality parameters	Minerals - purity (%) - moisture (%) - TOC (%) - heavy metals As, Pb, Cd, Cr, Hg (ppm)	Water See Table 3,*Table* 4 and *Table* 5 of the ANNEX
Quantity (kg/month for minerals) or (m^3/month for water)	Quantity that can be recovered	Required quantity
Geographic location		

The fields that concern the quality, the quantity and the geographic location of the user are not obligatory neither for Brine Owners nor for the Mineral/Water Users. However, as more of these fields are filled in by the user, higher quality in the matching result is assured .

The role of “Level 2” matching is to rate possible matches between the recovered materials produced by Brine Owners and the required materials by Mineral/Water Users. Matching results are shown in order of these rates. Matched users are informed if the demanded quantity by the Mineral/Water User is fulfilled by the Brine Owner or not. Additionally for each matched material, the Brine Owner is also informed for the use of this material by the Mineral/Water User. Finally, the driving distance between a matched Brine Owner and a Mineral/Water User is also shown. (Figure 22).

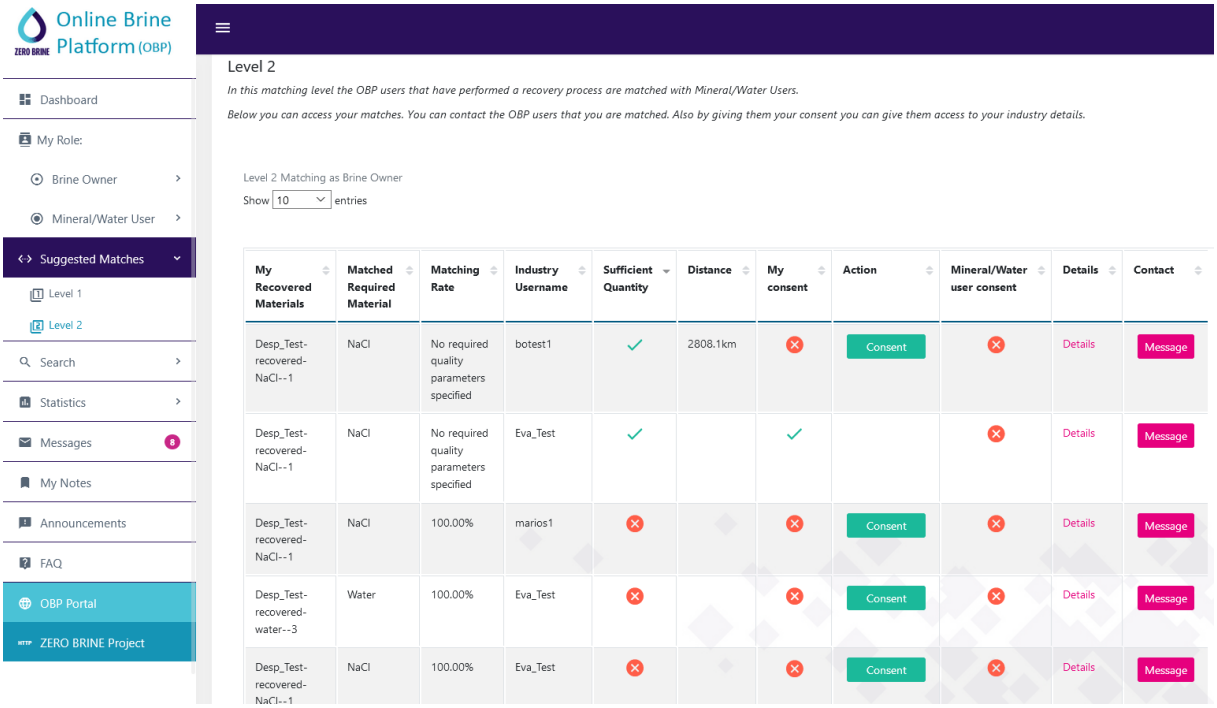

Figure 22: Examples of “Level 2” Matching Results

6.2 Matching Monitoring

The matching process will be evaluated and measured by the administrator of the platform through graphical and statistical tools. The administrator will have access to all the matched elements and may verify and monitor the process as Saline Effluents, Recovered and Required Materials are inserted by the users in the platform.

6.2.1 Level 1 Matching Monitoring

The administrator may view all possible matches and be notified of any new matches via a system message. The administrator may also view the number of users whose effluents and required materials are matched in this level.

6.2.2 Level 2 Matching Monitoring

Level 2 matching takes into consideration quality parameters such as the purity, moisture, TOC and heavy metals concentration. This can be quantified and represented with a matching rate valued from 0% to 100%. The administrator may monitor all possible matches and get a graphical presentation of the number of cases and the matching rate between the Recovered and Required materials. The number of users whose Recovered and Required Materials are matched is also shown in this level (Figure 23).

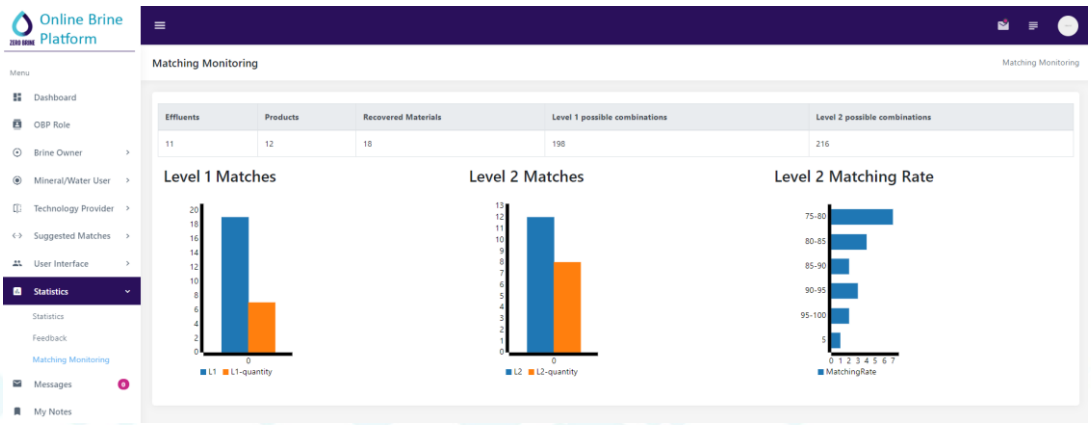

Figure 23: Example of Matching Monitoring by the OBP administrator

7. Graphical Presentation of Metrics and Parameters

A registered user to the OBP can view metrics obtained from the information that all the registered users have filled in. The statistics could be in relation with:

- the geographic location (users per cluster)
- the created matches (matching rate)
- the registered effluents by the brine owners (per EWC code)
- the registered users (per NACE code)

The statistics will be presented in graphs (pies and bars) and will always be up to date as they will get calculated on the fly. Figure 24 shows some indicative examples of the graphical presentation of OBP metrics.

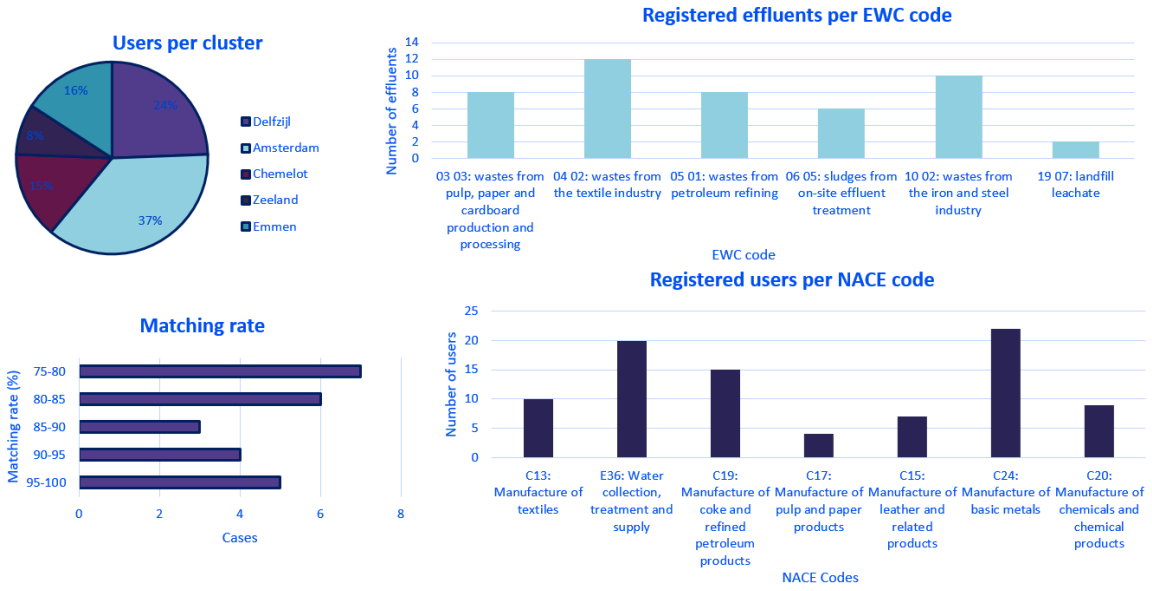

Figure 24: Example of the graphical presentation of OBP metrics

8. User Feedback Facility

A user feedback facility is integrated to the OBP in order to obtain feedback from the registered users. The administrator of the OBP will evaluate this feedback and if it is necessary he/she will make the proper adjustments to the tool according to the answers of the users. Thereby, it will be ensured that the quality requirements of the users will be met.

The feedback facility tool is designed in a "user friendly" way. It will be simple, short and comprehensive to allow the users to fill it easily and provide the required information. It consists of a list of questions and it will be appeared after the completion of each role of the platform as well as after the suggestion of possible matches to the users, as follows:

- One questionnaire after the completion of the "Brine Owner-Add Saline Effluent(s)" profile (see section 5.2.1.1 and 5.2.1).
- One questionnaire after the completion of the "Brine Owner-Recovered Material(s)" profile (see section 5.2.1.2).
- One questionnaire after the completion of the "Mineral/Water User" profile (see section 5.2.4)
- One general questionnaire in the Dashboard.

The user will select the desired answer in "ticking box" form or he could write a short answer if needed.

Below are presented some examples of the questions that will be part of the user feedback facility tool.

- *"Did you find in the dropdown list the minerals that you would like to recover?"*
- *"Where you able to provide all the information you were asked for, in the step "characteristics of the saline effluent"?"*
- *"Did you find any other difficulty during editing your profile as "Brine Owner"?"*
- *"Do you think that the parameters that you were asked to fill in are sufficient for the characterization of your recovered water?"*
- *"Do you consider that the parameters asked for the technical specification of minerals are sufficient to define the characteristics of the mineral you use?"*
- *"Do you think that the links created by the OBP will be useful for you?"*
- *"Do you think that the speed and response time of the platform was satisfactory?"*
- *"Was it easy for you to navigate through the platform?"*

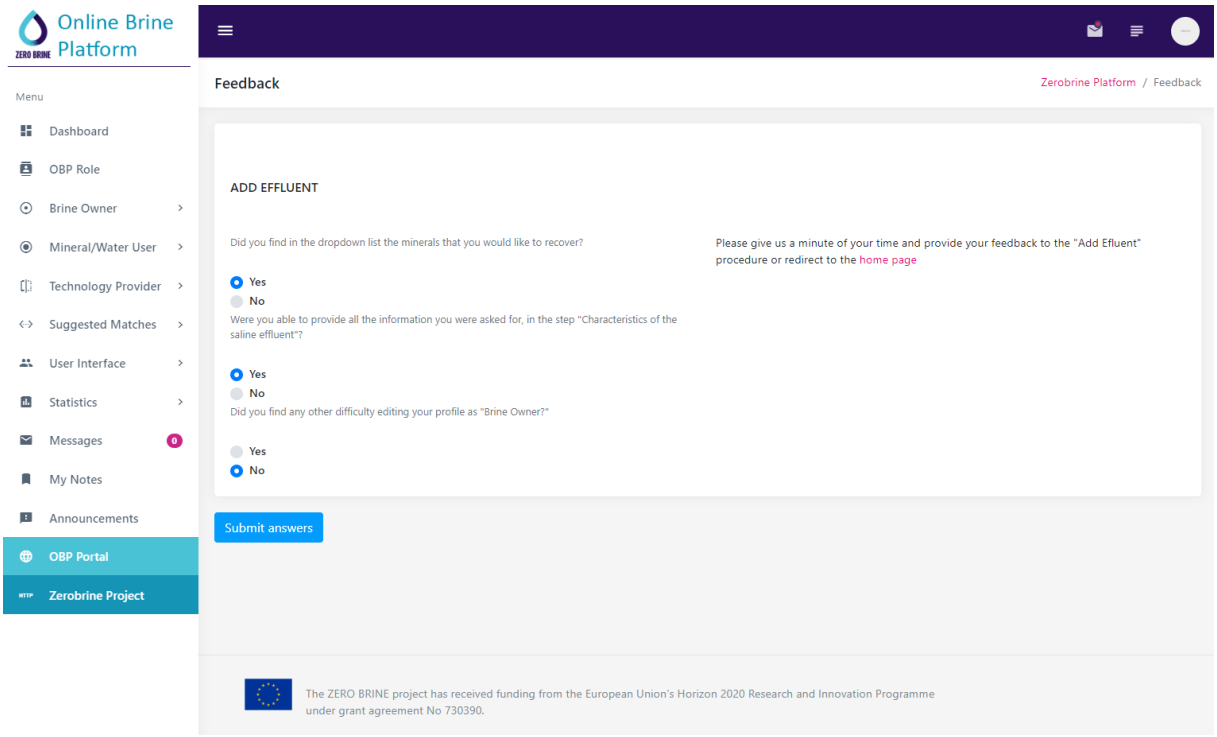

Figure 25: Example of OBP Questionnaires

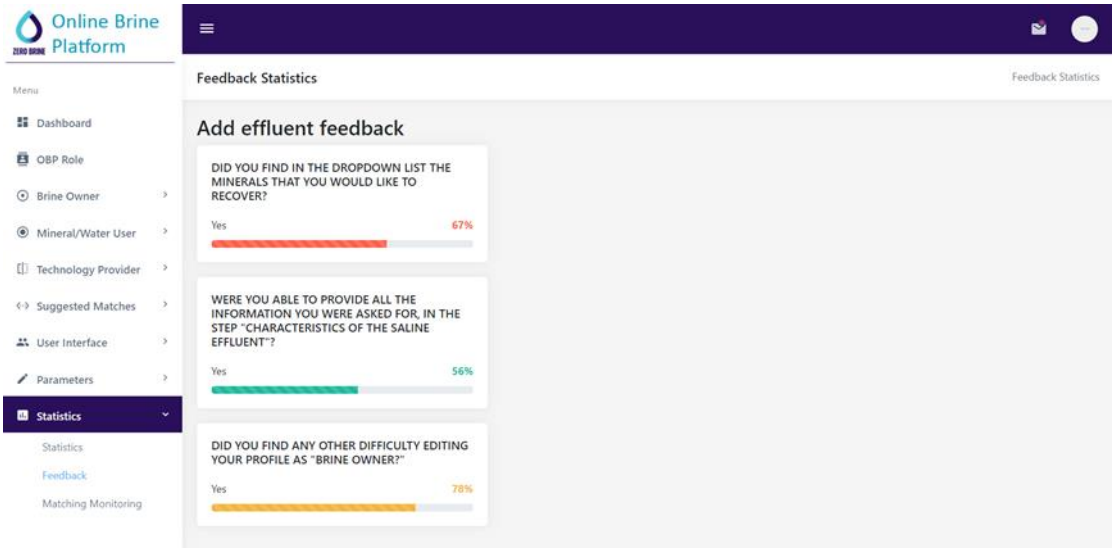

Figure 26: Example of OBP User Feedback Statistics

9. ANNEX

Table 3: Recovered Water Quality parameters.

Parameter	**Unit**
pH	
ECw	mS/cm in 20°C
SAR	me/l
COD	mg/l
BOD	mg/l
TSS	mg/l
SS	mg/l
TDS	mg/l
Turbidity	NTU
Total hardness as $CaCO_3$	mg/l
Alkalinity as $CaCO_3$	mg/l
SiO_2 (silicon dioxide)	mg/l
CO_3^{2-} (carbonate)	mg/l
HCO_3^- (bicarbonate)	mg/l
$N\text{-}NH_4^+$ (ammonia nitrogen)	mg/l
$N\text{-}NO_3^-$ (nitrate nitrogen)	mg/l
$P\text{-}PO_4^{3-}$ (phosphates)	mg/l
Cl^- (chlorides)	mg/l
SO_4^{2-} (orthosilicate)	mg/l
S^{2-} (sulfide)	mg/l
B (boron)	mg/l
Fe (iron)	mg/l
Ca^{2+} (calcium)	mg/l
Pb (lead)	mg/l

As (arsenic)	mg/l
Cd (cadmium)	mg/l
Cr (chromium)	mg/l
Mn (manganese)	mg/l
Ni (nickel)	mg/l
Cu (copper)	mg/l
Al (aluminium)	mg/l
Zn (zinc)	mg/l
Na^+ (sodium)	mg/l
Mg^{2+} (magnesium)	mg/l
K (potassium)	mg/l
I^- (iodide)	mg/l
F^- (fluoride)	mg/l
Ecoli	cfu/100ml
Legionella	cfu/100ml

Table 4: Quality parameters for Required Irrigation Water.

Parameter	**Unit**
pH	
SAR	Meq/l
ECw	mS/cm 20°C
COD	mg/l
BOD	mg/l
TDS	mg/l
TSS	mg/l
Turbidity	NTU
CO_3^{2-} (carbonate)	mg/l
HCO_3^- (bicarbonate)	mg/l

$N\text{-}NH_4^+$ (ammonia nitrogen)	mg/l
$N\text{-}NO_3^-$ (nitrate nitrogen)	mg/l
$P\text{-}PO_4^{3-}$ (phosphates)	mg/l
Cl^- (chloride)	mg/l
SO_4^{2-} (sulfate)	mg/l
B (boron)	mg/l
Fe (iron)	mg/l
Ca^{2+} (calcium)	mg/l
Pb (lead)	mg/l
As (arsenic)	mg/l
Cd (cadmium)	mg/l
Cr (chromium)	mg/l
Mn (manganese)	mg/l
Ni (nickel)	mg/l
Cu (copper)	mg/l
Al (aluminium)	mg/l
Zn (zinc)	mg/l
Na^+ (sodium)	mg/l
Mg^{2+} (magnesium)	mg/l
K (potassium)	mg/l
e-Coli	cfu/100ml
Legionelle	cfu/100ml

Table 5: Quality parameters for Required I industry water.

Parameter	**Unit**
pH	
ECw	mS/cm in 20°C
COD	mg/l

BOD	mg/l
SS	mg/l
TDS	mg/l
Turbidity	NTU
Total hardness as $CaCO_3$	mg/l
Alkalinity as $CaCO_3$	mg/l
SiO_2 (silicon dioxide)	mg/l
CO_3^{2-} (carbonate)	mg/l
HCO_3^- (bicarbonate)	mg/l
$N\text{-}NH_4^+$ (ammonia nitrogen)	mg/l
$N\text{-}NO_3^-$ (nitrate nitrogen)	mg/l
$P\text{-}PO_4^{3-}$ (phosphates)	mg/l
Cl^- (chlorides)	mg/l
SO_4^{2-} (orthosilicate)	mg/l
B (boron)	mg/l
Fe (iron)	mg/l
Ca^{2+} (calcium)	mg/l
Pb (lead)	mg/l
As (arsenic)	mg/l
Cd (cadmium)	mg/l
Cr (chromium)	mg/l
Mn (manganese)	mg/l
Ni (nickel)	mg/l
Cu (copper)	mg/l
Al (aluminium)	mg/l
Zn (zinc)	mg/l
Na^+ (sodium)	mg/l
Mg^{2+} (magnesium)	mg/l

K (potassium)	mg/l
Ecoli	cfu/100ml
Legionella	cfu/100ml

Table 6: Extra quality parameters for minerals (set by end user)

Parameter	**ppm max**
volatile matter	
non volatile matter	
CN^- (cyanide)	
CO_3^{2-} (carbonate)	
TN (total nitrogen)	
NH_4^+ (ammonium)	
NO_3^- (nitrate)	
NO_2^- (nitrogen dioxide)	
NH_3 (ammonia)	
TP (total phosphorus)	
PO_4^{3-} (phosphate)	
P_2O_5 (phosphorus pentoxide)	
Cl^- (chloride)	
Fe (iron)	
Ca (calcium)	
Pb (lead)	
As (arsenic)	
Hg (mercury)	
Cd (cadmium)	
Cr (chromium)	
Mn (manganese)	
Ni (nickel)	
Cu (copper)	
Al (aluminium)	
Zn (zinc)	

Se (sellenium)	
Br (bromide)	
Sr (strontium)	
Zr (zirconium)	
Mo (molybdenum)	
Sn (tin)	
Sb (antimony)	
Be (beryllium)	
V (vanadium)	
Ti (titanium)	
Ba (barium)	
Si (silicon)	
S (sulphur)	
SO_4^{2-} (sulphates)	
S^{2-} (sulphides)	
Na^{+} (sodium)	
Mg^{2+} (magnesium)	
K (potassium)	
F^{-} (fluoride)	
I^{-} (iodide)	