ZERO BRINE

D6.5 Report on the application of the Online Brine Platform-case study: the Netherlands

February 2020

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Deliverable 6.5	Report on the Application of the Online Brine Platform – Case Study: Netherlands
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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

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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.

Minerals and water 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 6.2 entitled “Integration, validation and demonstration of the tools for the case of the Netherlands”. The sub-task is led by ISPT, with active partners (see GA Task 6.2)

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.

Section 3 presents the methodology followed, the results obtained and conclusions drawn for the main objective of Work Package 6.2: the demonstration and validation of the OBP for the case of the Netherlands.

In Section 4 information on the recording of the desalination plants for the case of the Netherlands is provided, including general information, the methodology followed and the results obtained including a list of 55 desalination plants (Table 4.3) organized (also) by manufacturer/supplier. It must be mentioned that the partner responsible (SEALEAU) for this part of the work, focused this research on the industrial end-users of the desalination plants, which is the scope of ZERO BRINE project, as described also within Task 6.2.

3. Application of the Online Brine Platform – Case Study: the Netherlands

3.1. Introduction and Objectives

According to the European Commission, in a circular economy, waste that can be recycled is injected back into the economy as secondary raw materials where they can be traded and shipped just like primary raw materials; however, at present, secondary raw materials account for only a small proportion of the materials used in the EU.[3] 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 brine owners with the mineral/water users and technology and waste heat 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 matches between the industries across the value chain can be identified.

The service will receive and handle new entries through user registration (providing their address, industry name, contact information and industrial activity), allow the searching of information and establishing of 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 depending on their role. 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.

In this task, the OBP was integrated, validated and demonstrated for the case of the Netherlands. Several tasks were carried out by ISPT for this application, as described in the following sub-sections.

3.2. Mapping the Industries

A primary step in the application of the OBP in the Netherlands was mapping the different industrial clusters of the Netherlands, namely Delfzijl, Emmen, Amsterdam, Chemelot, Zeeland and Rotterdam. A database was developed containing information on the companies in each cluster that are i) brine owners, ii) technology providers, iii) mineral/water users or, iv) waste heat providers. In addition to

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

their roles, individual companies in each cluster were categorized based on their locations, production types, and sectors. Types and quantities of salt in the brine effluents of brine owners were determined as well. Appendix A lists and describes the categories of the database in more detail.

Information about brine emissions was collected for all six clusters to map the industries as detailed a possible. The information was obtained from publicly available sources, including the Dutch Emission Register (source: http://www.emissieregistratie.nl). The results of the mapping process that are obtained from public sources are portrayed in Appendix B. In addition to publicly available data, information about real industrial brine was retrieved from previous ISPT projects. This information was used solely for the purpose of analyzing the relevance of industries for the OBP.

Table 1 outlines the sources, type, and size for the database developed by ISPT. As the database included an analysis of how relevant the industries are to the ZERO BRINE project and contact information, this database served as a primary basis for ISPT to contact relevant and potential users of the OBP.

Table 3.1: Brine producer database characteristics

Sources	Dutch Emission Register* + talks with companies + online
Type	quantitative & qualitative
Size	800 kt/year and 160 industries

*Source: http://www.emissieregistratie.nl

3.3. Contacting the Industries and Disseminating Information

The next task was to inform the industries of the OBP in the most efficient ways and stimulate their participation in it. ISPT carried out several actions for this. Firstly, ISPT contacted the industries directly using the contact list referred to in Section 3.2. All the contacts deemed relevant were contacted by means of phone calls and/or e-mails. The purpose of this was not only to inform the industries about the ZERO BRINE project and the OBP, but also to inform them about the workshops organized by ISPT for their respective industrial clusters and encourage them to register for those. In total, more than 150 potential users and stakeholders were contacted. In addition to initial contact methods, follow-up efforts were actively sought to stimulate increased participation.

Secondly, information about the ZERO BRINE project, the OBP, and matchmaking workshops was disseminated via various other channels including the official ZERO BRINE website, the ZERO BRINE newsletter and dedicated press releases sent to over 1400 industry stakeholders and media - and was also promoted on ZERO BRINE social media channels (by REVOLVE in WP10), the ISPT website, the ISPT newsletter, ISPT social media websites (e.g. LinkedIn), conference papers (e.g. IEEE) and magazines (e.g. Waterforum). For example, on 20 June 2019, ISPT published an article in Waterforum magazine to promote usage of the OBP and inform about the workshops, which was also picked up by Filtration+Separation and the Korean Water Journal. The OBP press release sent to ZERO BRINE media was picked up by Energy Post, Water Online, Climate control, Filtration + Separation, FuturEnviro, and

Envirotec (reaching over 95,000 people according to Meltwater monitoring metrics) and was also featured in ZERO BRINE partner network communications including social media accounts and mailings. A compilation of press coverage can be found here.

Thirdly, at the annual ISPT Conference, a special session was dedicated to the ZERO BRINE project and OBP. At the conference, ISPT presented an OBP poster and lead a game session, both designed with the support of REVOLVE. In addition, brine producers and potential users were asked to test the OBP on tablets and provide their feedback. The aim was to gather user feedback for further product development prior to the release, while at the same time promoting the ZERO BRINE project by visualizing (or disseminating) its preliminary results. To collect the feedback, an online closed-question questionnaire was prepared (see Appendix C) using a methodology that avoids biased user feedback. Results of the questionnaire and the feedback from users during interviews and discussions were collected and recorded (see Appendix D). Although the sample size was small (6), the questionnaire results provide a quantitative, reasonably objective validation of the OBP for the Dutch market.

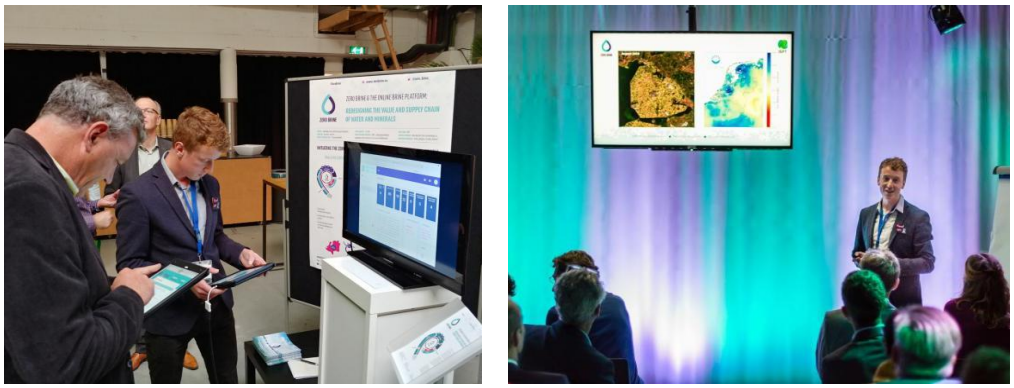


Figure 3.1. A prototype of the OBP and the Zero Brine project was presented and user feedback was collected at the annual ISPT day. The event attracted more than 200 attendees from process industries, academia, SMEs and policy makers.

3.4. Workshops to demonstrate the OBP

ISPT has organized 5 workshops in the five main industrial clusters of the Netherlands: Delfzijl/Emmen, Amsterdam, Chemelot, Zeeland and Rotterdam. The goal of the workshops is to bring brine producers and users of recovered materials in the Netherlands together and demonstrate the OBP. Secondly, the workshops aimed to disseminate project results and discuss water-related topics of interest to the process industry, including sustainable reuse of brine streams and fresh water availability. For each workshop, ISPT carried out the following activities:

- Gave presentations about the concepts and results of the ZERO BRINE project and the OBP, including demonstrations of the OBP showing how brines could be matched for the case of Rotterdam Rijnmond;
- At each workshop, industrial partners of ISPT gave relevant guest presentations. Evides Industriewater presented about the ZERO BRINE demonstration project in Rotterdam Rijnmond. WLN talked about brines and the environment and KWR gave guest presentations about brine recovery technologies;

- Carried out simulations of decision-making in water and brine re-use by means of a serious game with the ZERO BRINE theme, developed by ISPT;
- Led discussions about the challenges in the circular use of brines and matchmaking;
- Encouraged participants to register to the OBP.

Table 3.2: Details of the workshops organized by ISPT which in total attracted about 100 participants. The workshop in Amsterdam was organized as part of the Amsterdam International Water Week and had international outreach.

Location	Date
Terneuzen	2 July, 2019
Delfzijl	1 October, 2019
Brightlands	24 October, 2019
Rotterdam	29 October, 2019
Amsterdam	5 November, 2019

The serious game was developed by ISPT as means to promote the OBP, increase capacity building and raise awareness about industrial symbiosis. A serious game is a unique interactive approach to actively engage stakeholders, initiate matchmaking and promote collaboration between different actors. The game was played in the workshops. It allowed players to understand the different roles of each actor in the brine system and outline the necessity of trust, transparency and a sense of urgency to achieve collaboration. The game simulates the consequences of decisions that stakeholders can make in the complex reality of industrial (waste) water and brine power production. The participants fulfilled different roles, such as brine producer, technology provider and mineral trader or regulator. In this way, participants were given the opportunity to invest or not in technology for water reuse. They were also able to trade salts and talk with governments that set new rules to curb water consumption or grant subsidies to stimulate the development of new technology.

Figure 3.2. ISPT orchestrated the "ZERO BRINE Serious Game" during the workshops. The game simulates the consequences of decisions that stakeholders can make in the complex reality of industrial (waste) water and brine stream production.

3.5. Outcomes

As a result of the workshops and other communication means, several points of feedback were acquired from industry stakeholders about the concept of the OBP. Overall, the OBP was validated as

a useful tool for brine producers, mineral/water brine users, technology providers and waste heat providers. The stakeholders were positive and interested in it. Most found the concept of the OBP to be clear and useful and were positive about collaborating and exchanging information with others. However, several additional points for improvement were provided:

1) Within regional clusters in the Netherlands, brine producers and users often already know each other. Regional development organizations also facilitate interactions. Because of these aspects, the added value from an online matchmaking platform in contrast to brine producers and users contacting each other directly is limited on the regional scale. The OBP is therefore considered to be more valuable for connecting brine producers and users from different regional clusters. For those cases, concentrating minerals from brines to reduce transported volumes is deemed particularly interesting.

2) Potential users are hesitant to put sensitive information about their organizations online. They state competition concerns as main reason and data privacy concerns as second reason (reflected also in the questionnaire results in Appendix D). With respect to the privacy concerns, it was made clear to potential users that the OBP follows strict privacy regulations.

3) A possible cause is also the lack of examples with a positive business case. Thirdly, a possible barrier is the time spent on gathering all the necessary information to completely register their brine characteristics. The outcome of the pilot projects and Work Package 8 of ZERO BRINE may contribute to positive examples of brine reuse in practice.

4) The algorithm of the OBP leads to simplified matches. The tolerance for matches might be strict. Creative solutions incorporating expert intelligence could enable more matches to be generated. Experts could see, for instance, that a brine producer and user that appear to be incompatible can actually be made compatible by addition of a component like Ca or Mg.

5) The facilitation of matches between water (not brine) users and wastewater providers to stimulate reuse of water is perceived as very interesting. Participants suggested to market the OBP for this as much as for brine matching.

6) Brine re-use is not yet stimulated enough by governmental bodies. Participants emphasized that the government has an important role in facilitating brine re-use.

7) Uncertainty about whether the OBP will be continued after the ZERO BRINE project ends. In response, NTUA confirmed the OBP will be maintained after the ZERO BRINE project ends, which was communicated by ISPT in news article published by Waterforum.

3.6. Conclusions

In this task, the OBP was demonstrated and validated for the case of the Netherlands.

The brine producers and users in the different industrial clusters of the Netherlands, namely Delfzijl, Emmen, Amsterdam, Chemelot, Zeeland and Rotterdam, were mapped. More than 150 potential users and stakeholders were contacted, based on the recorded brine producers and users, to promote participation to the OBP and demonstration workshops.

Information about the ZERO BRINE project, the OBP, and matchmaking workshops was disseminated via various other channels and events. A questionnaire survey was conducted to collect feedback for validation of the feasibility of the OBP for the case of the Netherlands. A serious game was developed as means to promote the OBP, increase capacity building and raise awareness about brine stream production, reuse and industrial symbiosis.

Workshops were organized in the five main industrial clusters of the Netherlands. The aims of the workshops were to demonstrate the OBP to the brine producers and users of recovered materials in the Netherlands, to collect feedback for validation of the feasibility of the OBP for the case of the Netherlands, to disseminate ZERO BRINE project results and to discuss brine and water-related topics of interest to the process industry.

Overall, many brine producers and users recognized the proposed benefits of the OBP. The face-to-face interactions at the workshops were particularly effective for creating awareness of the topic and of the perspectives of other organizations, creating visibility, attracting enthusiasm, building trust and provoking thinking about brine re-use. However, participants had reservations about registering. At the time of writing, there are 68 registrations on the OBP but no matches yet. A complete registration of all the brine producers and users in the Netherlands on the OBP appears to be not yet possible as a part of the potential users are reluctant to register to the platform, even despite the best efforts of ISPT to encourage it and provide assistance during their registration process. It is proposed that the registration process should continue further with more registrations and more characterized brines in order for the OBP to function as intended.

4. Recording of desalination plants

4.1 Introduction

For the successful implementation of the Online Brine Platform (OBP), it is essential to map all the brine streams generated by the process industries along with the raw materials and water streams utilized by these industries. During the previous sections, ISPT presented the mapping of the process industries that produce brines and use salts in their processes.

In this section, SEALEAU will present an extended recording of all the desalination plants operating in the Netherlands. The aim of this deliverable is to get an overview of the industrial desalination market in the Netherlands and to contact the industrial end-users of the desalination plants so that these plants also to be included in the OBP. During the recording process, many insights were revealed for the desalination market in the Netherlands and contact information was retrieved (where available) for the suppliers and customers of the desalination plants.

4.2 Methodology

The research methodology of this work is based on the two following steps:

The first step involves the extraction of useful information about the desalination plants installed in the Netherlands, using the following market report: Desalination Markets 2016 published by Global Water Intelligence. Using this database we identified 88 desalination plants that have been installed in the Netherlands since 1951. The database reports data until 2016. The total volume of brine generated by these plants is 207,186 m^3 per day.

Each desalination plant has been categorized according to its operational status into the following four (4) categories:

1. Online
2. Presumed online
3. Presumed offline
4. Under construction

The number of plants in the Netherlands by category is presented in the figure below:

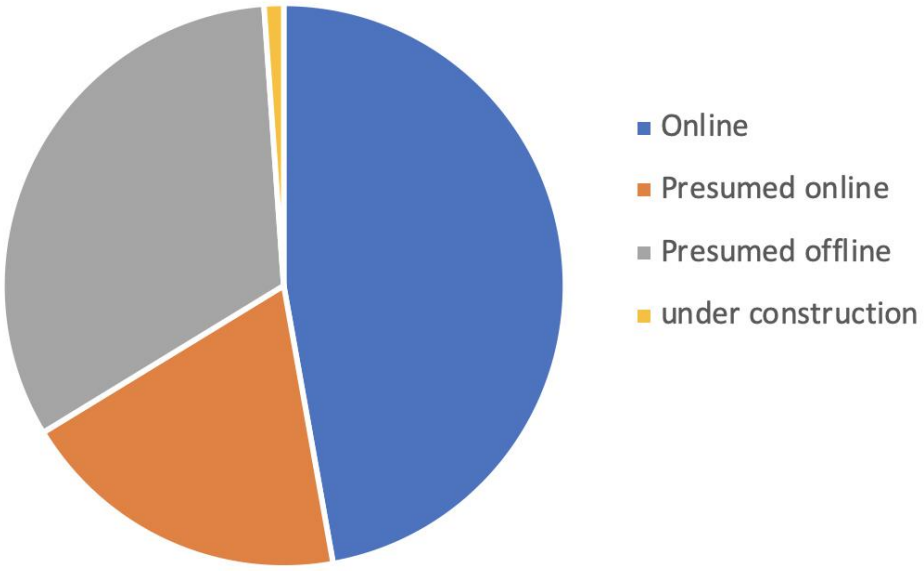


Figure 4.1. Breakdown of installed desalination plants in the Netherlands by operational status (1951 – 2016) (Source: GWI, 2016).

As illustrated in the figure above, out of the 88 plants registered in the Netherlands, 58 are either online, (presumed) online or under construction.

The second step involves the establishment of communication with each of these 58 desalination end-users. Within the database, the following relevant information was also registered: (a) project name; (b) plant supplier; and (c) the customer. The customer was mentioned only for 25 out of the list of 58 desalination plants.

In order to double-check the validity of the data reported in the market report, SEALEAU prepared a list of the desalination plants by supplier (Table 4.1) and got in contact with the plant suppliers, making a phone survey, as well as physical meetings.

Table 4.1: List with the number of desalination plants in the Netherlands by manufacturer & operational status

No	Manufacturer / Plant supplier	Total	Not presumed offline	Presumed offline
1	Hubert Stavoren B.V. (DP1 – DP12)	12	1	11
2	Pentair Water Treatment (UF) (DP13 – DP21)	9	9	0
3	STORK (DP22 – DP30)	9	9	0
4	Veolia (DP31 – DP38)	8	6	2
5	GLV (DP39 – DP45)	7	1	6
6	Gauff Ingenieure (DP46- DP51)	6	6	0
7	Logisticon Water Treatment (DP52 – DP56)	5	5	0
8	Amfitec (DP57 – DP60)	4	3	1

No	Manufacturer / Plant supplier	Total	Not presumed offline	Presumed offline
9	GENERAL ELECTRIC GROUP (GE) (DP61 – DP64)	4	4	0
10	Aiton GB (DP65 – DP67)	3	0	3
11	Amiantit Group (DP68 – DP69)	2	0	2
12	Mitsui Babcock (DP70 – DP71)	2	2	0
13	Salt Separation Services (DP72 – DP73)	2	2	0
14	Wafilin, NL (DP74 – DP75)	2	0	2
15	Alco Energy Rotterdam (DP76)	1	1	0
16	Altus capital Partners (DP77)	1	1	0
17	Atlantis Water Desalination System (DP78)	1	1	0
18	Demitec (Hatenboer-Water) (DP79)	1	1	0
19	Envirogenics (DP80)	1	0	1
20	Evoqua Water Technologies, LLC (DP81)	1	0	1
21	Grupo SETA, S.L. (DP82)	1	1	0
22	Hatenboer-Water bv (DP83)	1	1	0
23	IDE Technologies Ltd. (DP84)	1	1	0
24	Mitsubishi (DP85)	1	1	0
25	Promac BV (DP86)	1	0	1
26	VA Tech Wabag Ltd. (DP87)	1	1	0
27	Witteveen NL (DP88)	1	1	0

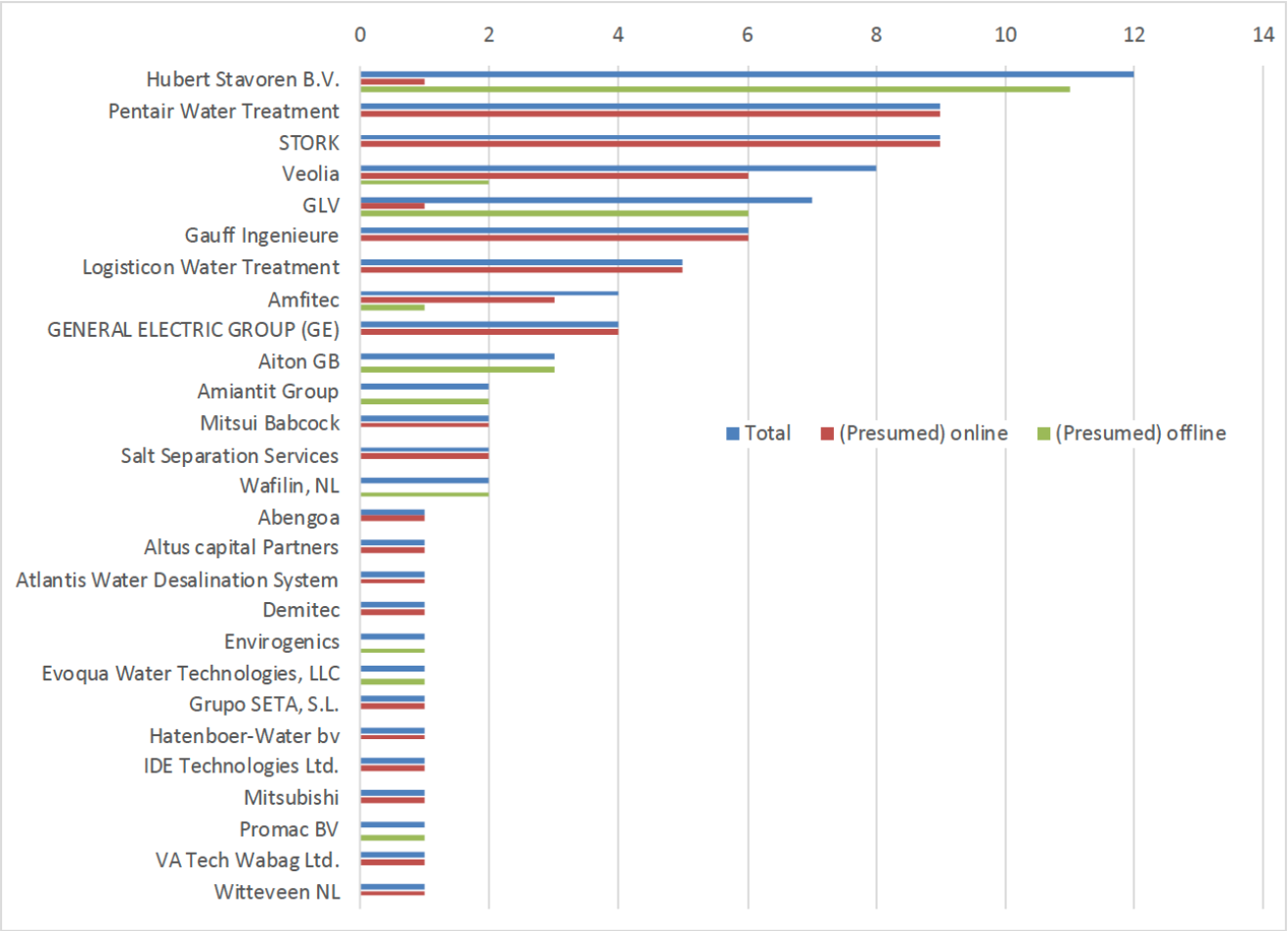


Figure 4.1: Number of desalination plants in the Netherlands by manufacturer and operational status

Afterwards, a list with the desalination plants was made for each of the above-mentioned manufacturers and physical meetings (where possible) were made to cross-check the data with them. These tables are presented in Section 4.3.

This phase of the recording process revealed many insights for the validity of the data as well as provided new insights for the desalination market in the Netherlands. Most importantly, from the first contacts with the suppliers, we got the feedback that in the Netherlands, apart from the desalination plants installed in the industries, a large number of plants (in the order of 1,500 plants) is installed in the horticulture sector, with a typical capacity of 100-200 m3/day per plant. These new insights are mentioned in Section 4.3. This phase resulted in establishing (regular) communication with the manufacturers. The final step of the recording phase included extensive web-based research, where efforts were made to retrieve as much information as possible for the online desalination plants suitable for brine recovery.

4.3 Results & Discussion

In this section, we present the first results from the recording process for the case study of the Netherlands regarding the installed desalination plants. Useful information about the desalination plants installed in the Netherland was extracted from the Global Water Intelligence report (GWI, 2016). The share of the applied technologies , raw water's type and user category in the abovementioned desalination plants are depicted in Figures 4.3, 4.4 and 4.5 respectively.

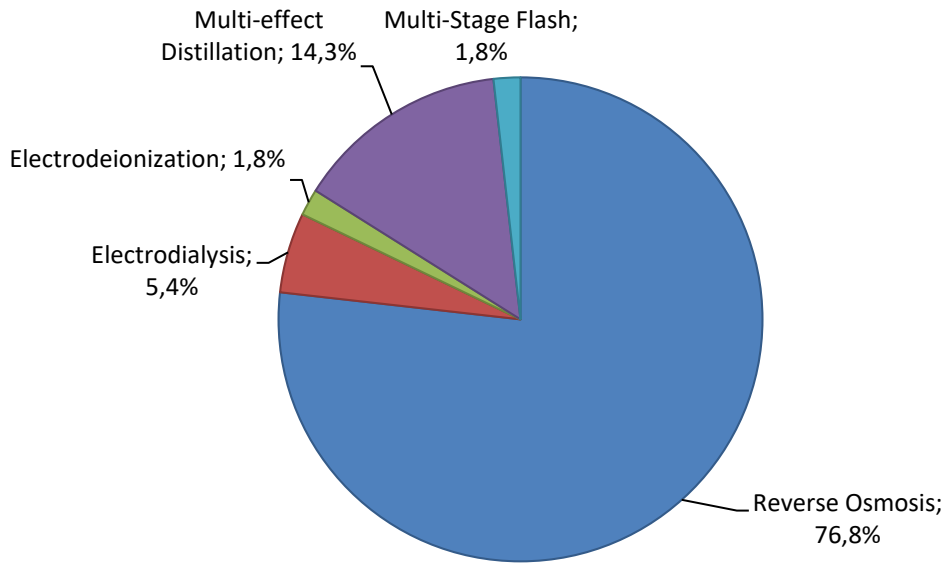


Figure 4.2: Breakdown of applied technologies for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

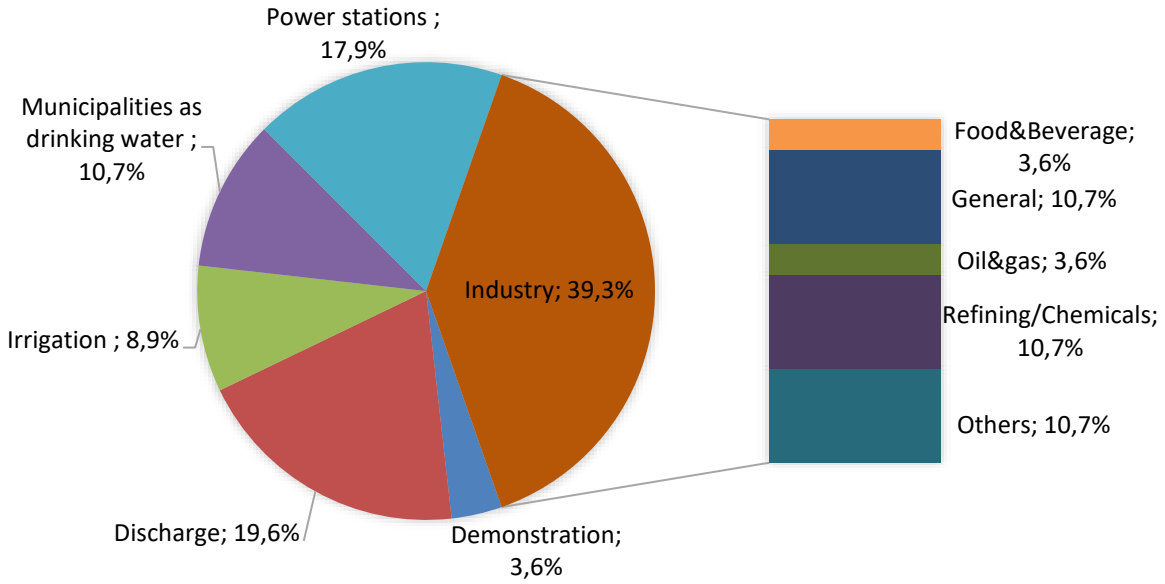


Figure 3.4: Breakdown of raw water's type for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

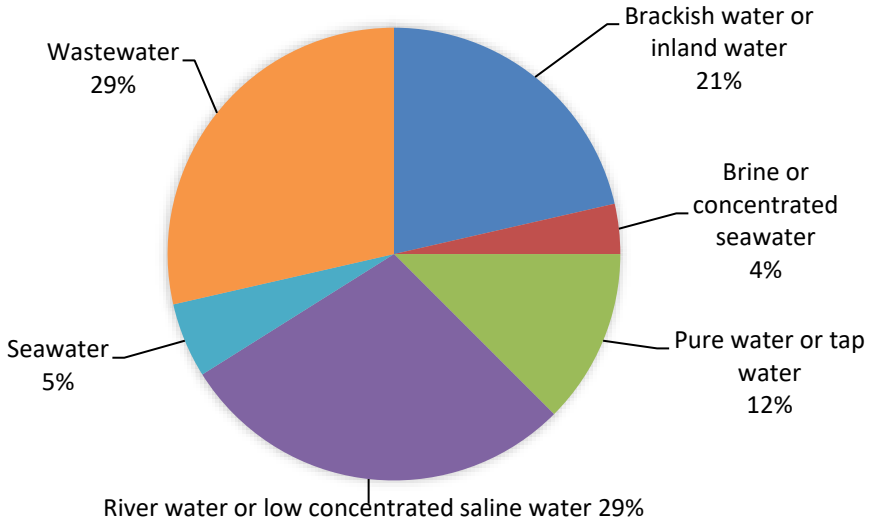


Figure 4.4: Breakdown of user's category for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

After getting in contact with the suppliers of the desalination plants, the data provided by the Global Water Intelligence market report (GWI, 2016) were cross-checked to portray the current operational condition of the plants. In the Appendix E, the details of all the 88 desalination plants by manufacturer are presented separately.

4.3.1.1 Overview of industrial desalination plants in the Netherlands

After analyzing all the data gathered from the suppliers of the desalination plants (Table 4.1) was revised and the results are presented in Table 4.2 along with the contact details of each supplier.

Table 4.2: Revised list with the number of desalination plants in the Netherlands by manufacturer, operational status & contact person

No	Manufacturer / Plant supplier	Contact Person	Total	Online	Offline
1	Hubert Stavoren B.V. (DP1 – DP12)	Piet Demmer	12	0	12
2	Pentair Water Treatment (UF) (DP13 – DP21)	Karel Bruins Slot	9	9	0
3	STORK (DP22 – DP30)	Jascha Zwaving,	9	9	0
4	Veolia (DP31 – DP38)	Dennis Korthout	8	6	2
5	GLV (DP39 – DP45)	Jorg Korver	7	1	6
6	Gauff Ingenieure (DP46- DP51)	No contact person yet	6	6	0

7	Logisticon Water Treatment (DP52 – DP56)	Pieter van Staveren	5	5	0
8	Amfitec (DP57 – DP60)	No contact person yet	4	3	1
9	GENERAL ELECTRIC GROUP (GE) (DP61 – DP64)	Onno Workum	4	4	0
10	Aiton GB (DP65 – DP67)	No contact person yet	3	0	3
11	Amiantit Group (DP68 – DP69)	No contact person yet	2	0	2
12	Mitsui Babcock (DP70 – DP71)	Leeyeol Ryu	2	2	0
13	Salt Separation Services (DP72 – DP73)	Daniel W Shackleton	2	2	0
14	Wafilin, NL (DP74 – DP75)	Henk Schonewille	2	0	2
15	Alco Energy Rotterdam (DP76)	No contact person yet	1	1	0
16	Altus capital Partners (DP77)	No contact person yet	1	1	0
17	Atlantis Water Desalination System (DP78)	No contact person yet	1	1	0
18	Demitec (Hatenboer-Water) (DP79)	Carel W. Aeijelts Averink	1	1	0
19	Envirogenics (DP80)	No contact person yet	1	0	1
20	Evoqua Water Technologies, LLC (DP81)	No contact person yet	1	0	1
21	Grupo SETA, S.L. (DP82)	No contact person yet	1	1	0
22	Hatenboer-Water (DP83)	Carel W. Aeijelts Averink	1	1	0
23	IDE Technologies Ltd. (DP84)	Boris Liberman	1	0	1
24	Mitsubishi (DP85)	Pieter van Staveren	1	1	0
25	Promac (DP86)	No contact person yet	1	0	1
26	VA Tech Wabag Ltd. (DP87)	Dr. Florian Hell,	1	0	1
27	Witteveen NL (DP88)	Arjen van Nieuwenhuijzen	1	1	0

It was found that 55 out of the 88 registered industrial desalination plants are online, since after contacting the suppliers it was discovered that some of the registered online desalination plants have been out of order.

Following, a complete list with all the 55 online desalination plants is presented in Table 4.3 with the following relevant information (a) plant supplier; (b) project name; (c) customer; (d) user category; (e) raw water type; and (f) technology applied.

Table 4.3: List of 55 online desalination plants by plant supplier, project name, customer, user category, raw water type and technology applied

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
Pentair Water Treatment (UF)	DP13	Evides	Evides Industriewater	Industry	Seawater	RO
	DP14	Veendam	World Bank Group	Industry	Brackish water or inland water	RO
	DP15	Lieshout	Bavaria Brewery	Industry	Brackish water or inland water	RO
	DP16	Veendam	World Bank Group	Industry	Brackish water or inland water	RO
	DP17	Sas van Gent	-	Power stations	Wastewater	RO
	DP18	Wijster	Essent	Industry	Wastewater	RO
	DP19	Sas van Gent	-	Power stations	Wastewater	RO
	DP20	Oosterbierum	-	Power stations	Wastewater	RO
	DP21	Vaassen	-	Discharge	Wastewater	RO
STORK	DP22	Ter Apelkanaal	-	Industry	Wastewater	MED
	DP23	Oostermoer	-	Discharge	Wastewater	MED
	DP24	Foxhol	-	Discharge	Wastewater	MED
	DP25	Gasselte	-	Industry	Wastewater	MED
	DP26	Wijster	-	Discharge	Wastewater	RO
	DP27	Nijmegen	-	Discharge	Wastewater	MED
	DP28	Helmond		Discharge	Wastewater	MED
	DP29	Wieringen		Discharge	Wastewater	RO
	DP30	Haps		Discharge	Wastewater	RO
Veolia	DP31	Rotterdam	Bechtel ENKA	Power stations	Brackish water or inland water	RO
	DP32	Rotterdam	AVR	Industry	Pure water or tap water	RO
	DP33	Rotterdam	Avr- Euro Sport	Industry	Brackish water or inland water	RO

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
	DP34	Amsterdam	Akzo Nobel	Industry	River water or low concentrated saline water	RO
	DP37	Dordrecht	WBE	Industry	Brackish water or inland water	RO
	DP38	Amsterdam	Akzo Nobel	Industry	River water or low concentrated saline water	RO
GLV	DP41	Sloe Power Station		Industry	River water or low concentrated saline water	RO
Gauff Ingenieure	DP46	Netherlands		Power stations	River water or low concentrated saline water	RO
	DP47	Netherlands		Industry	River water or low concentrated saline water	RO
	DP48	Netherlands		Municipalities as drinking water	River water or low concentrated saline water	RO
	DP49	Netherlands		Power stations	River water or low concentrated saline water	RO
	DP50	Netherlands		Irrigation	Brackish water or inland water	RO
	DP51	Netherlands		Irrigation	Brackish water or inland water	RO
Logisticon Water Treatment	DP52	MRO	Evides Industriewater	Industry	Pure water or tap water	RO
	DP53	Mobile RO plants	Evides Industriewater	Industry	Pure water or tap water	RO
	DP54	Oosterhof Holman	Gietwater Berlikum	Industry	Pure water or tap water	RO
	DP55	ZS Lekkerkerk	Dutch Drinking Water Authority	Demonstration	Brackish water or inland water	RO
	DP56	Gouda		Industry	Wastewater	RO
Amfitec	DP57	Greenhouses		Irrigation	River water or low concentrated saline water	RO

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
	DP58	Greenhouses		Irrigation	River water or low concentrated saline water	RO
	DP59	Greenhouses		Irrigation	River water or low concentrated saline water	RO
GENERAL ELECTRIC GROUP (GE)	DP61	Netherlands		Power stations	Pure water or tap water	RO
	DP62	Netherlands		Municipalities as drinking water	Brackish water or inland water	ED
	DP63	Terneuzen		Industry	River water or low concentrated saline water	RO
	DP64	Amsterdam		Demonstration	River water or low concentrated saline water	ED
Mitsui Babcock	DP70	Moerdijk	EPZ	Power stations	River water or low concentrated saline water	ED
	DP71	Geleen	Edea	Power stations	River water or low concentrated saline water	RO
Salt Separation Services	DP72	Total A15 Offshore Oil Platform	Total E&P Netherland	Municipalities as drinking	Seawater	RO
	DP73	Windfarm	Hollandia	Municipalities as drinking water	Seawater	RO
Alco Energy Rotterdam	DP76	Bioethanol Plant	Abengoa Bioenergy	Industry	River water or low concentrated saline water	RO
Altus capital Partners	DP77	Netherlands		Industry	Brine or concentrated seawater	MED
Atlantis Water Desalination System	DP78	Netherlands	Vam	Discharge	Wastewater	MSF
Demitec (Hatenboer-Water)	DP79	Amsterdam	Artis Zoo	Industry	Brackish water or inland water	RO

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
Grupo SETA, S.L.	DP82	OI BW 2000		Industry	Brackish water or inland water	RO
Hatenboer-Water	DP83	Rotterdam	Evides Industriewater	Municipalities as drinking water	Pure water or tap water	RO
Mitsubishi	DP85	Nuon Magnum	North Water	Power stations	Pure water or tap water	EDI
Witteveen NL	DP88	Heemskerk	PWN	Municipalities as drinking water	River water or low concentrated saline water	RO

In Figure 4.5 the location of the above listed desalination plants is presented where it is available.

Figure 4.5: Location of online desalination plants suitable for brine recovery in the Netherlands (Source: own production /SEALEAU)

4.4 Conclusions of recording of desalination plants

In this section, we have recorded the installed desalination plants in the Netherlands from 1951 to 2016. To do so, we used a market report by Global Water Intelligence regarding desalination markets. Based on this report, out of the 88 plants registered in the Netherlands, 58 are either online, (presumed) online or under construction. However, to double-check the validity of these data, the suppliers of the desalination plants were contacted. It was found that the online desalination plants comprise the **55 out of the 88 registered plants**. This can be explained by the fact that the report has registered the plants till 2016 and information for the following years is not included.

Following, the communication with the manufacturers was also very beneficial to identify the desalination plants suitable for brine recovery. It was discovered that the plants that may be suitable for brine recovery are **42 out of 56 online** desalination plants located in the Netherlands. Finally, by combining the information provided by the suppliers of the desalination plants and performing extensive web-based research, information for the customers (end –users) of the plants was retrieved. These data were limited due to the fact that manufacturers were reluctant to give information about the customers.

By recording and analyzing the information gathered from the report and communicating with the above-mentioned manufacturers, it was found that very few online desalination plants are suitable for brine recovery. Furthermore, some registered manufacturers are not providing desalination plants, but only pre-treatment technologies. More specifically, regarding the suppliers registered in the Global Water Intelligence report, Pentair Water Treatment (UF) is not providing desalination plants, but only pre-treatment technology and Amfitec's plants concern only greenhouses.

In addition, the type of the raw water used in the desalination plants is critical for brine recovery. Generally, seawater and brine or concentrated seawater are indicated for the recovery of brine and valuable materials. Three (3) desalination plants were identified to use seawater or brine. These are presented in Table 4.4, with the following information: (a) plant supplier; (b) project name; (c) customer; (d) user category; (e) raw water type; and (f) technology applied.

For future research, the horticulture sector was found to have significant potential of ~1,500 small-scale desalination plants.

Table 4.4. List of 3 desalination plants that use seawater and brine

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
Salt Separation Services	DP72	Total A15 Offshore Oil Platform	Total E&P Netherland	Municipalities as drinking	Seawater	RO
	DP73	Windfarm	Hollandia	Municipalities as drinking water	Seawater	RO
Altus capital Partners	DP77	Netherlands	-	Industry	Brine or concentrated seawater	MED

Appendices

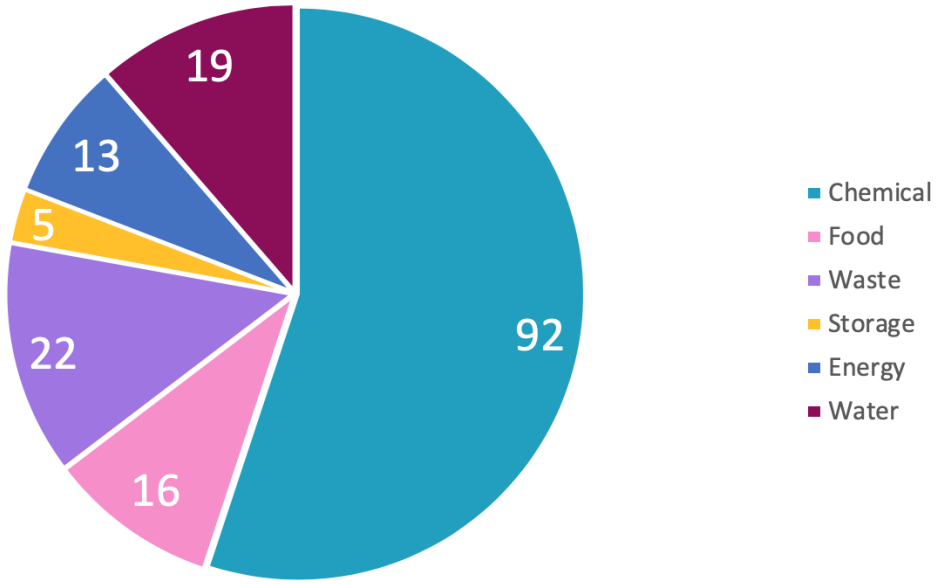
Appendix A. Industry Mapping Categories and Explanations

''Company name''	Name of the company being analyzed
''Type'' (Producer/Treater/Re-user)	**Producer** - discharges (produces) brine. **Re-user** – re-uses some material or water already. **Treater** - Processes (treats) water. Can be both wastewater treatment as well as purification (e.g. demi water).
''Location/Cluster''	In each case a company was assigned to a specific cluster plus its exact location/city was mentioned.
''Production/Sector''	Each company was assigned a specific production and more general sector in which it operates.
''Contact person/E-mail/Website''	For each company a search was made for a possible contact within the ISPT database. Each time a reference to a website was made also.
''Status/Date Last Status''	Whenever a contact with some organization was made, it was noted together with the date.
''Comments''	Gives additional information for a specific information. This can either be more explanation of the production process or some comment with respect to the relevance to the ZERO BRINE.
'Amount of Chloride, Sulphate, Total Organic Carbon, Total Nitrogen'' & ''Emitted to''	Gives quantitative information on the indicators (Total Chloride, Total Sulphate, Total Nitrogen, Total Organic Carbon) as retrieved from the Emissieregistratie. When no data on the indicator was found it was assigned ''not available''. Total Chloride and Total Sulphate are mentioned in 'kton/year' whereas Total nitrogen and TOC in 'kg/year'. ''Emitted to'' - can either be to ''Surface Waters'' or to ''Sewers''.
''Comments'	Gives additional information mainly with respect to the discharge.
''Relevance''	Assesses an organization based on its relevance to ZERO BRINE. Four categories of relevance are used: ''Highly Relevant'', ''Relevant'', ''Less Relevant'', ''Not Relevant''. This qualitative assessment was made based on the quantitative discharges as well as on additional information (e.g: type of process, content of organics).

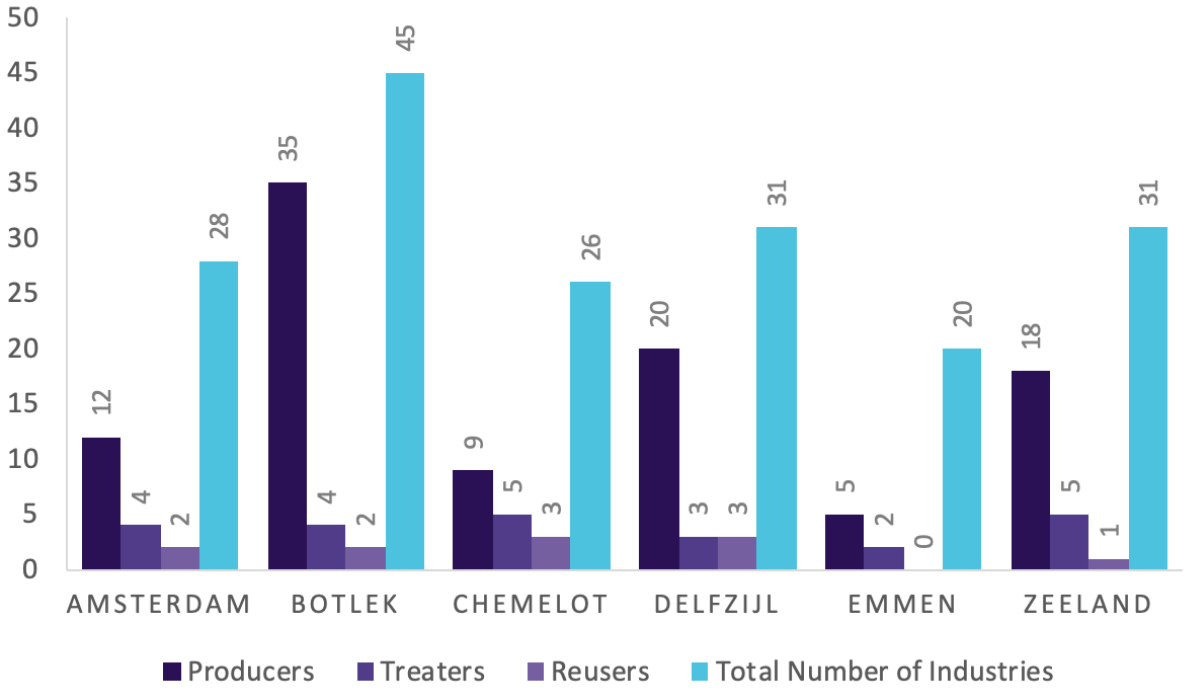
Appendix B. Industry Mapping Results

Results portrayed in Appendix B are obtained from publicly available information sources including the Dutch Emission Register (source: http://www.emissieregistratie.nl).

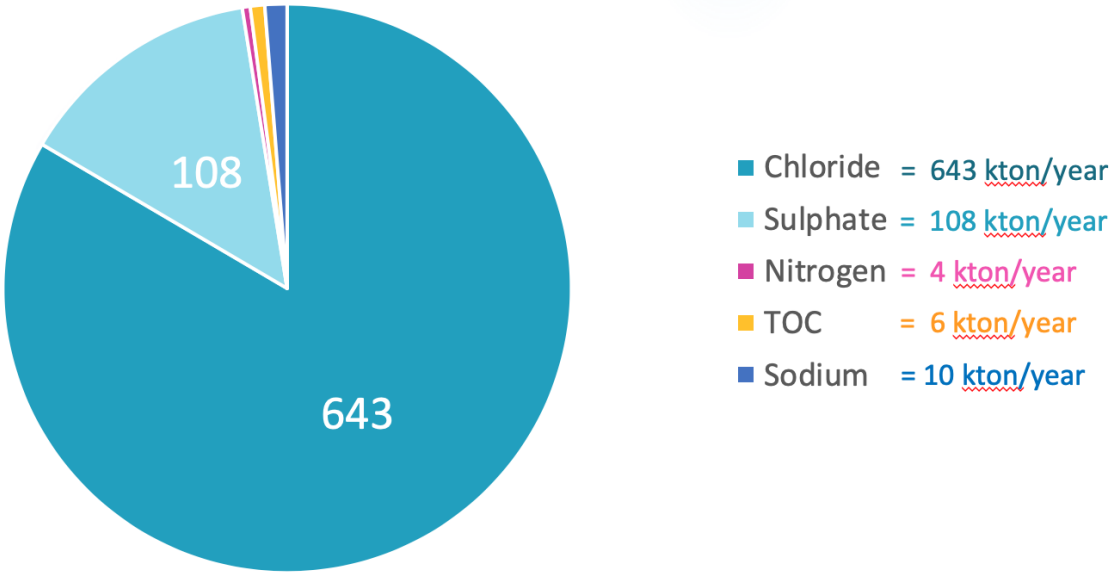
Types of Industries



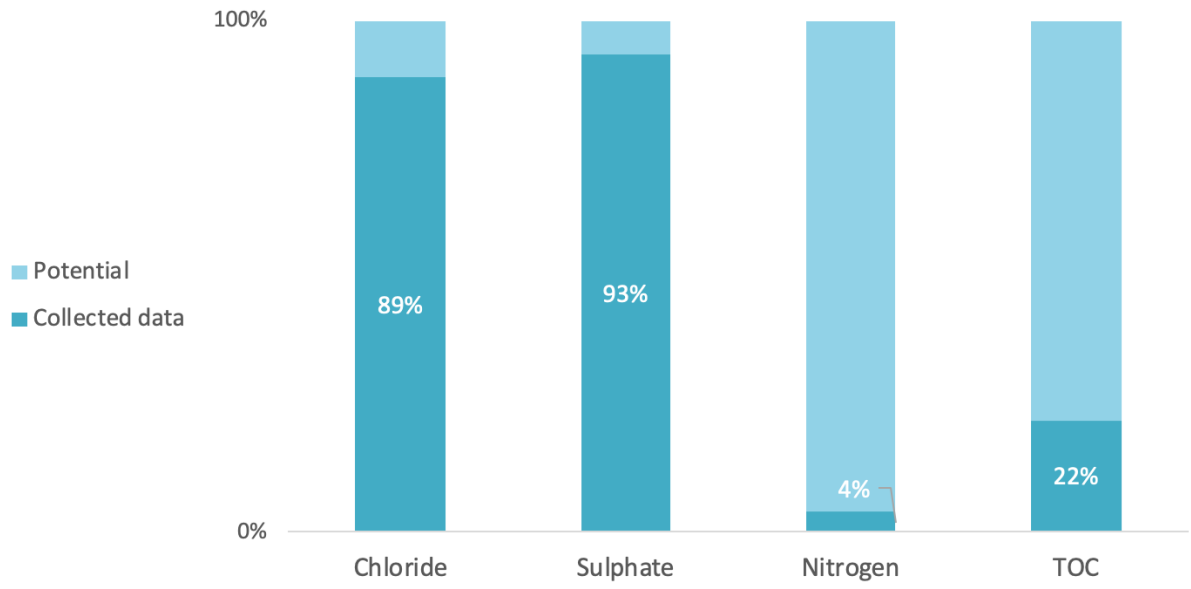
Number and Types of Industries Identified Per Cluster



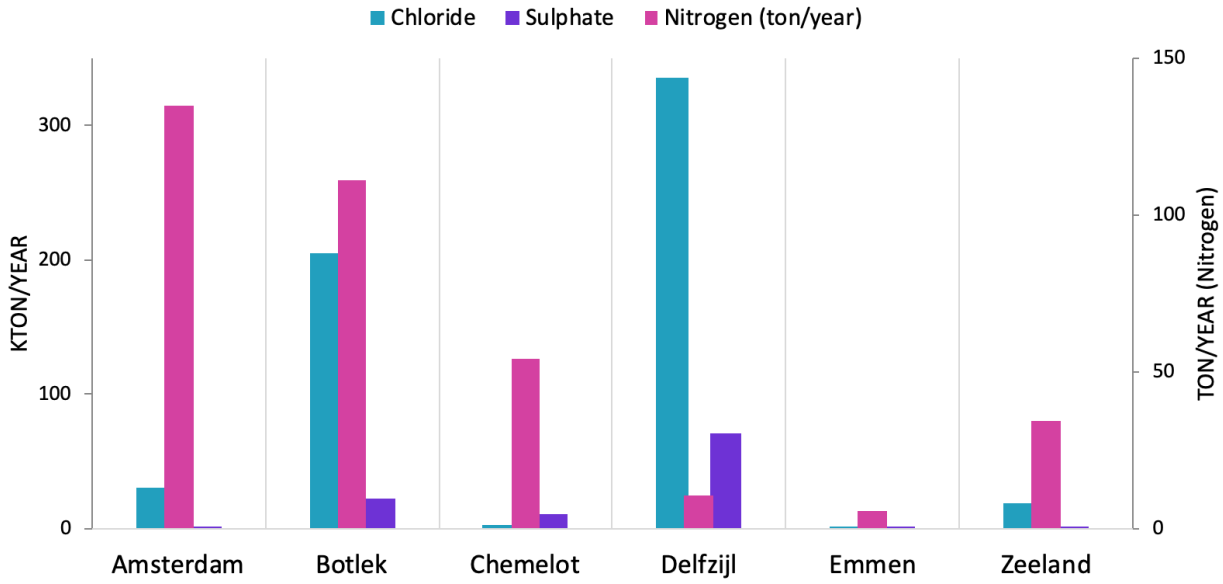
Total Discharge (kton/year)



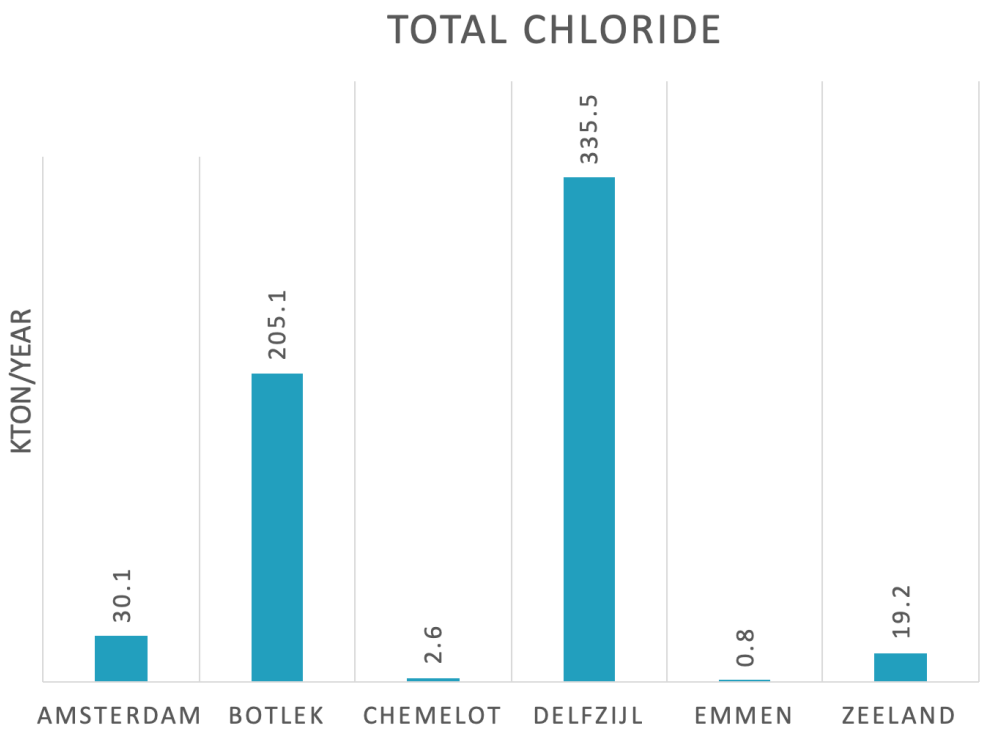
Collected Data vs Potential



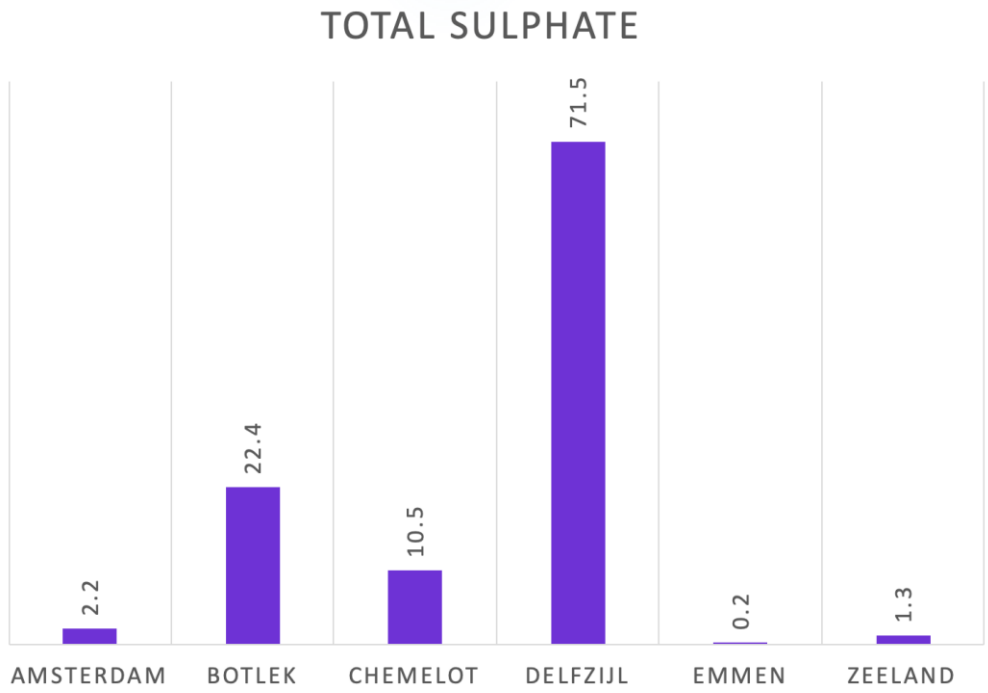
Cluster Results: Overview Discharge Per Cluster



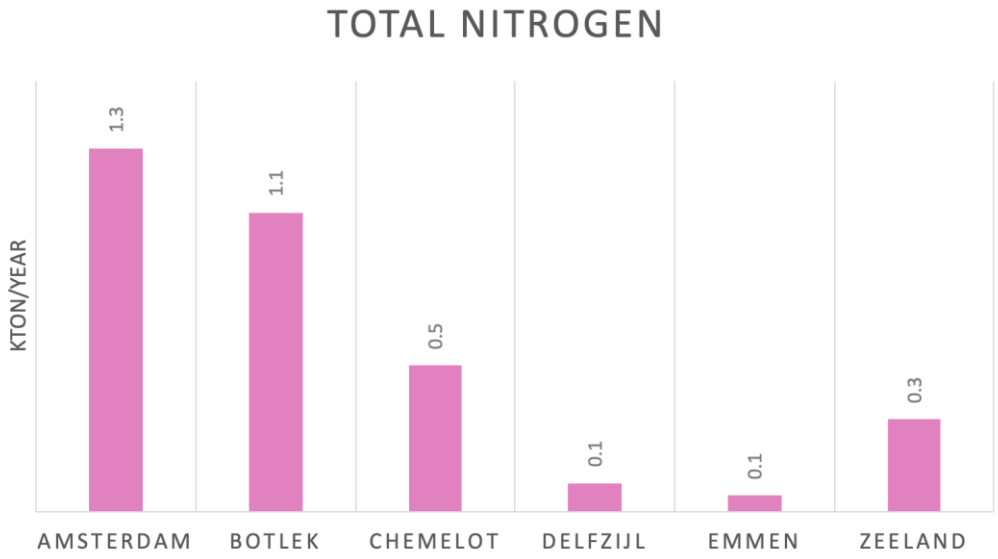
Cluster Results: Total Chloride Discharge Per Cluster



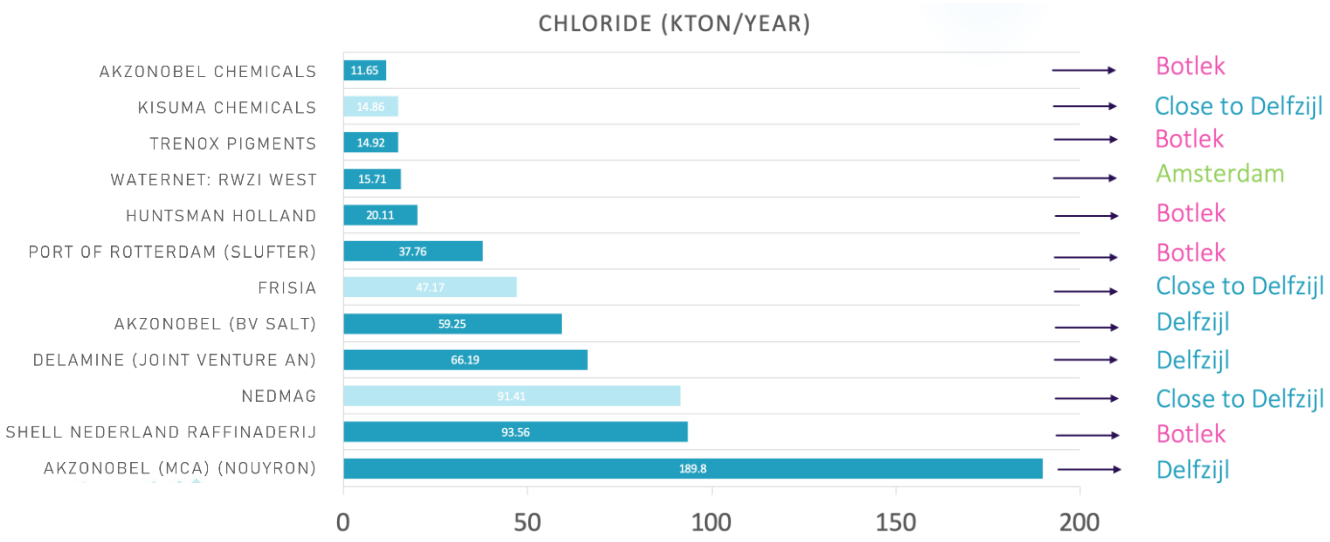
Cluster Results: Total Sulphate Discharge Per Cluster



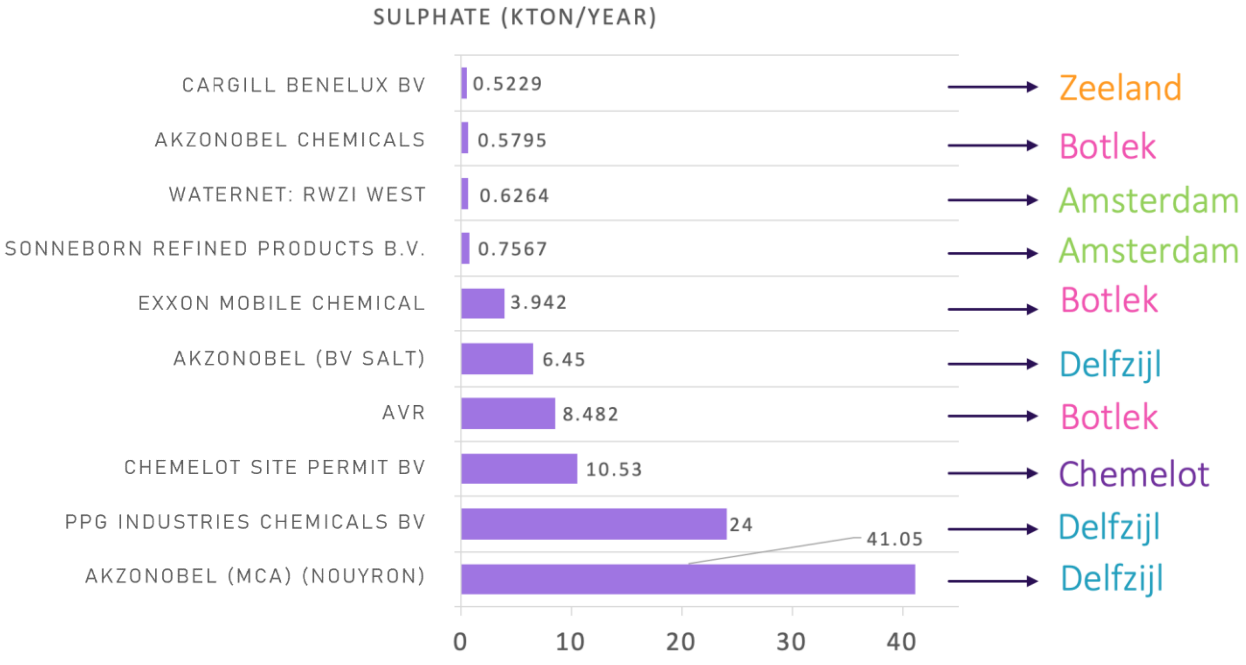
Cluster Results: Total Nitrogen Discharge Per Cluster



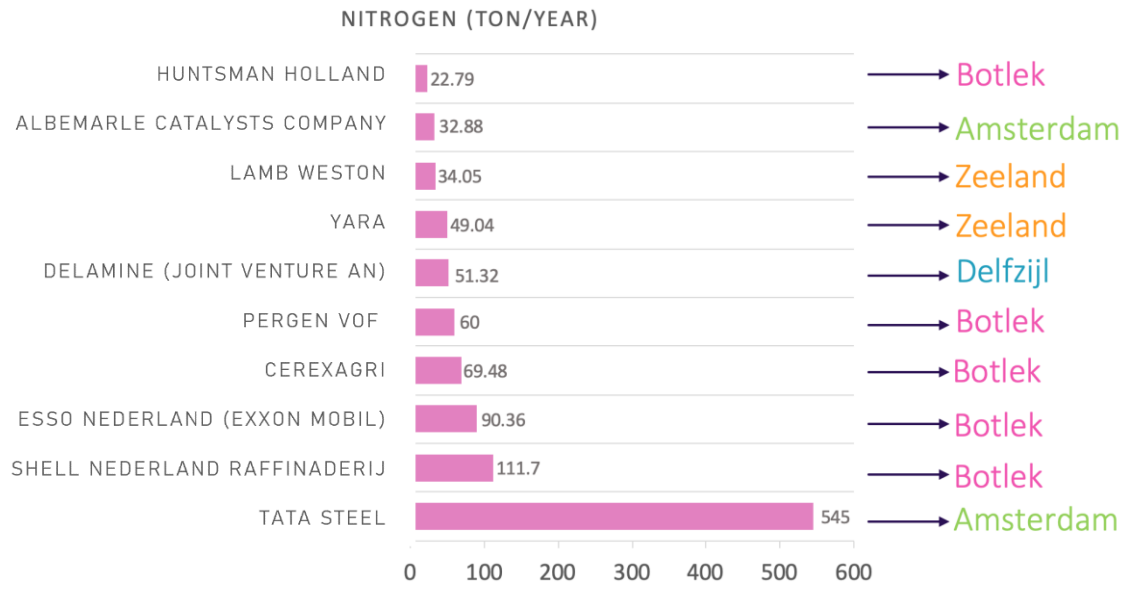
Cluster Results: Top Chloride Producers



Cluster Results: Top Sulphate Producers



Cluster Results: Top Nitrogen Producers



Appendix C. Questionnaire ISPT Conference on 19.11.2018

ZERO BRINE

The ZERO BRINE project focuses on recovery of minerals and water from brines. This will be facilitated via the Online Brine Platform where producers of brines and potential reusers can match. The platform is currently in a Demo version and we would appreciate any input you could provide us. We would be very grateful, if you could fill in this questionnaire to help us improve the platform. It won't take more than 5 minutes!

Brine Recovery

1. **What priority would you give to ensuring stable water supply for your company?**
   Many companies anticipate water shortages in the future and the impact it could have on their business. Do you share similar views?
   Mark only one oval.

	1	2	3	4	5	
No priority	◯	◯	◯	◯	◯	Highest priority

2. **Have you encountered any problems with treatment of brines in the past?**
   For example discharge costs or discharge permits
   Mark only one oval.

   ◯ Yes
   ◯ No

3. **If Yes, could you be more specific? (optional)**

4. **Do you currently recover any materials (salts or water) from brines?**
   Mark only one oval.

   ◯ No, I do not *Skip to question 5.*
   ◯ Yes, I recover Water *Skip to question 6.*
   ◯ Yes, I recover Salts *Skip to question 6.*
   ◯ Yes, I recover both *Skip to question 6.*

Skip to question 5.

Brine Recovery

5. **Are you investigating any possibilites to recover water or minerals from brines?**
   Mark only one oval.

   ◯ Yes
   ◯ No

Matchmaking - Online Brine Platform

6. **How important is finding new business partners for you?**
Mark only one oval.

	1	2	3	4	5	
Not at all important	◯	◯	◯	◯	◯	Very important

7. **Would you be willing to matchmake with other partners on the Online Brine Platform?**
Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Absolutely

8. **Do you find the concept of the Online Brine Platform useful?**
Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Absolutely

9. **Would you be willing to upload information regarding your brine streams on this platform?**
Mark only one oval.

- ◯ Yes
- ◯ No

10. **Would you be willing to upload company information on this platform?**
For example: Industry Name, Adress or NIC
Mark only one oval.

- ◯ Yes
- ◯ No

11. **What could discourage you from using the platform?**

Tick off the box which could discourage you
Check all that apply.

Privacy issues ☐
I do not want to share information with competitors ☐
Layout/Design of the platform is unappealing ☐
It is too time consuming ☐
It is too complicated ☐
Too much information is required from me ☐
Other ☐
Nothing ☐

12. **After seing the platform for few minutes, do you find it understandable and clear?**

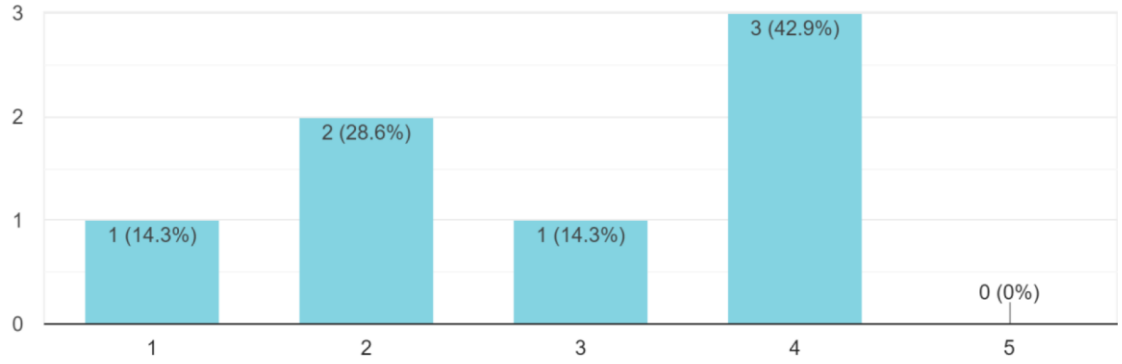
Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Absolutely

Appendix D. Questionnaire Results

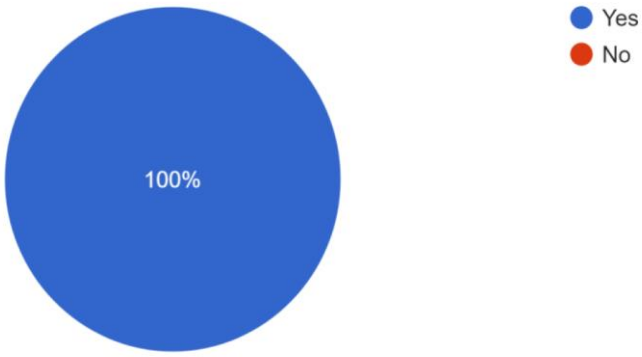
What priority would you give to ensuring stable water supply for your company?

7 responses



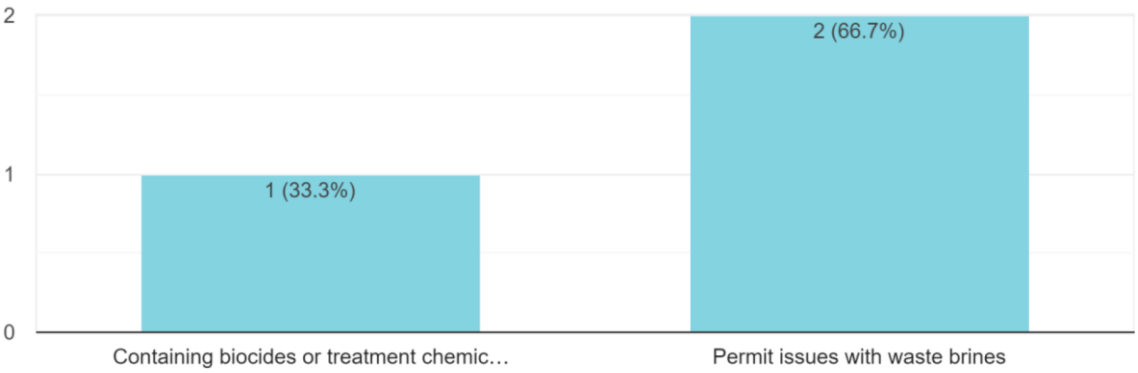
Have you encountered any problems with treatment of brines in the past?

7 responses



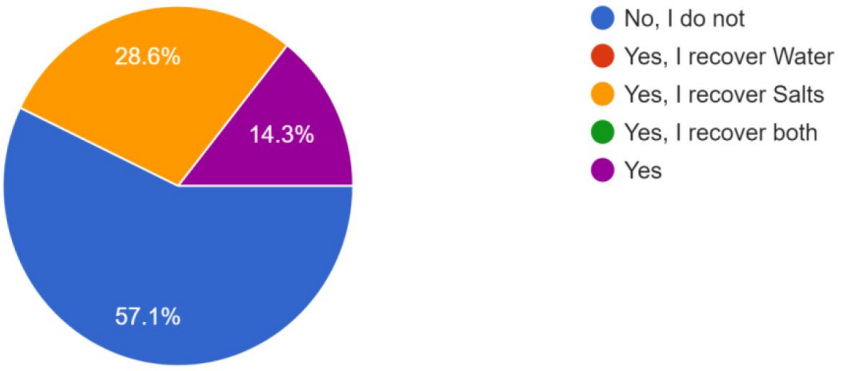
If Yes, could you be more specific? (optional)

3 responses



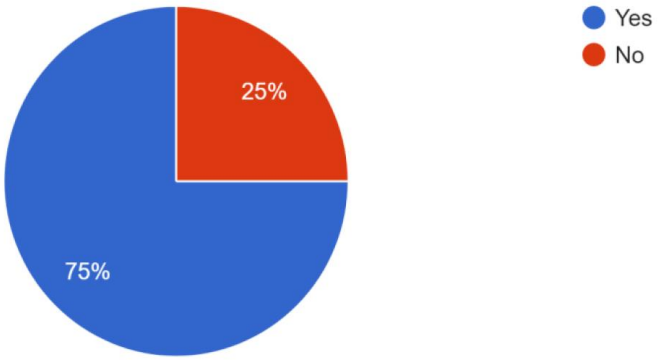
Do you currently recover any materials (salts or water) from brines?

7 responses



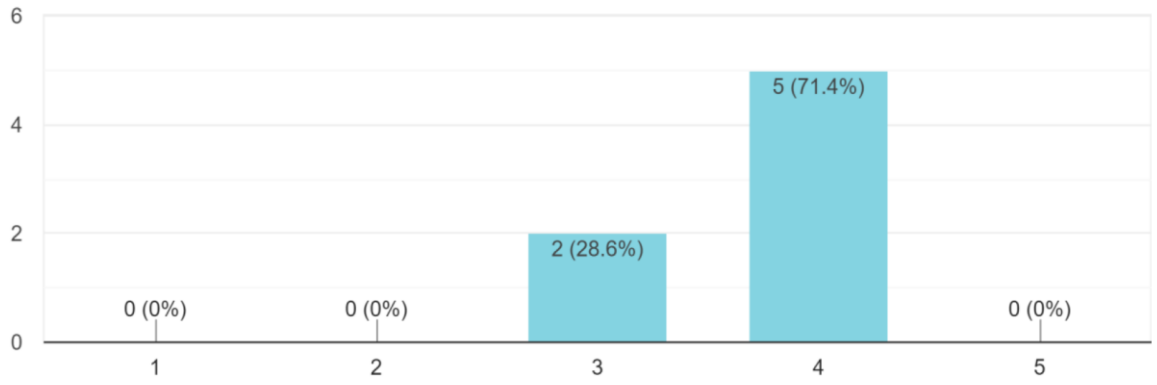
Are you investigating any possibilites to recover water or minerals from brines?

4 responses



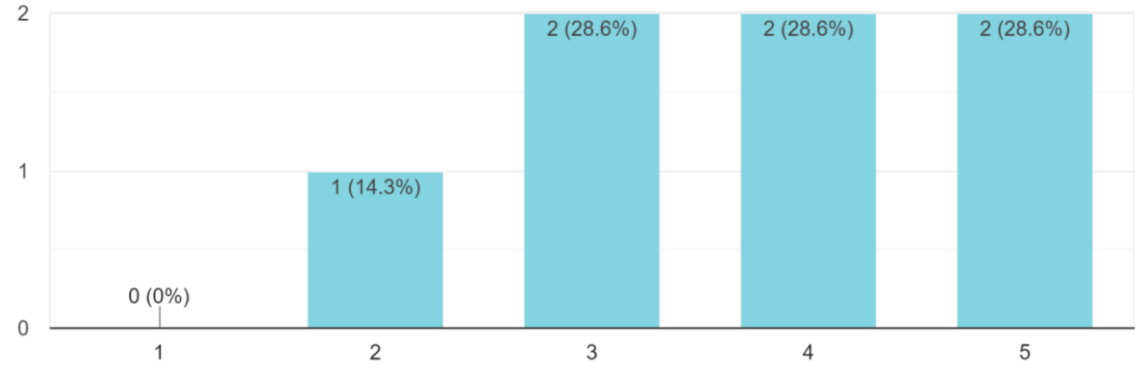
How important is finding new business partners for you?

7 responses



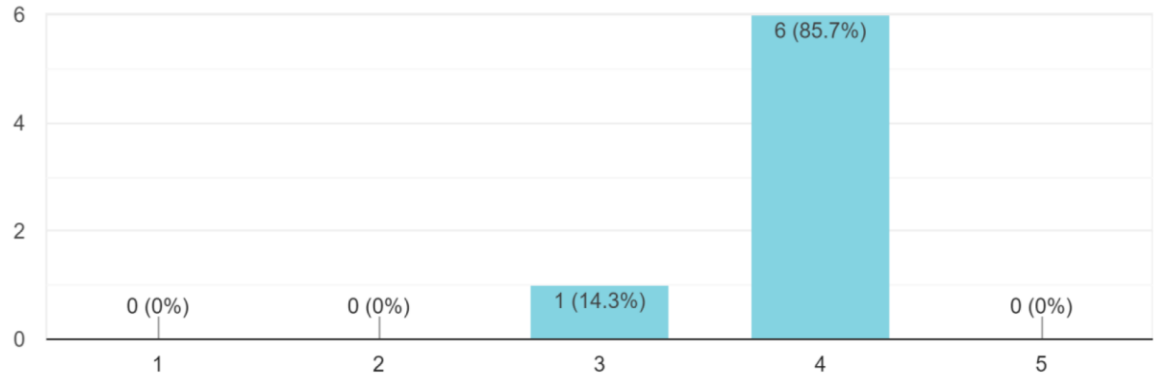
Would you be willing to matchmake with other partners on the Online Brine Platform?

7 responses



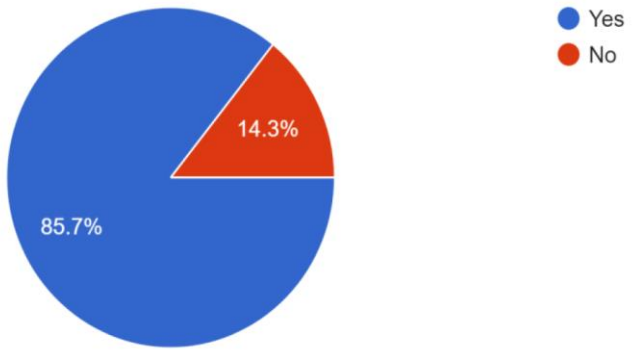
Do you find the concept of the Online Brine Platform useful?

7 responses



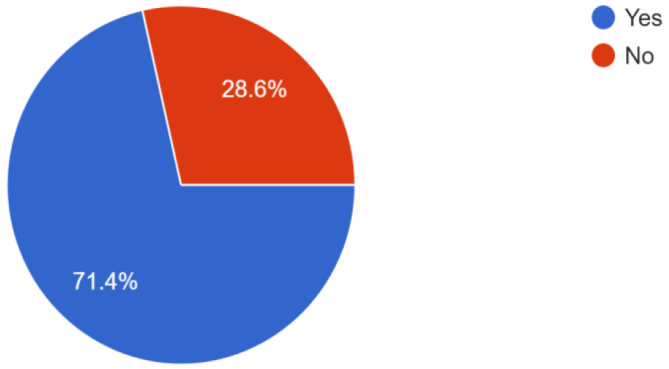
Would you be willing to upload information regarding your brine streams on this platform?

7 responses



Would you be willing to upload company information on this platform?

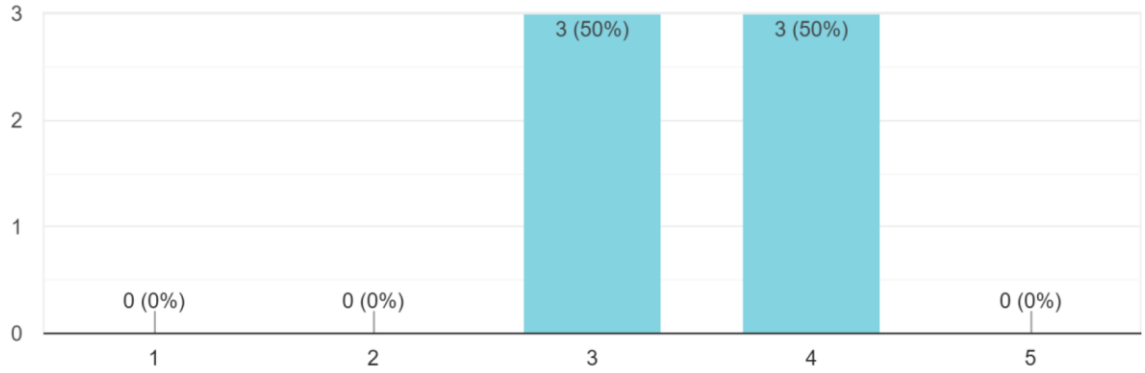
7 responses



What could discourage you from using the platform?

After seing the platform for few minutes, do you find it understandable and clear?

6 responses



Appendix E. List of desalination plants

Aiton GB

Number of desalination plants in the Netherlands
3 in total, all offline

Main technology applied
Multi-effect Distillation (MED)

Table E.1: List offline desalination plants supplied by Aiton GB in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP65	Rotterdam	4276	$10,710,000	Industry (TDS <10ppm)	Gulf Oil	MED	Seawater (TDS 20000ppm - 50000ppm)	1968	1970	Offline
DP66	Netherlands	223	$190,000	Industry (TDS <10ppm)	Owens-Illinois	MED	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1951	1952	Offline
DP67	Flushing	174	$470,000	Industry (TDS <10ppm)	-	MED	Seawater (TDS 20000ppm - 50000ppm)	1953	1954	Offline

Alco Energy Rotterdam (former Abengoa Bioenergy)[4]

Number of desalination plants in the Netherlands
1 in total, online

Main technology applied
Reverse Osmosis (RO)

Comments: Not a desalination supplier, rather an end-user

Table E.2: List of online desalination plant owned by Alco Energy Rotterdam in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP76	Bioethanol Plant	2,880	-	Industry (TDS <10ppm)	Abengoa Bioenergy	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	2007	2008	Online

[4] In 2016, Alcogroup with its partners Groep Vanden Avenne Commodities and Vandema signed an agreement to purchase Abengoa Rotterdam Plant assets, in the frame of the Bankruptcy procedure of Abengoa Bioenergy Nederland. The Rotterdam plant is one of the largest European Biorefinery with an annual production capacity of 480 million litres ethanol for fuel use, 360,000 Mt of DDGS (Dried Distilled Grain with Solubles, high protein feed products), 48 MW of electricity and 300,000 MT of CO_2 for greenhouses.

Altus Capital Partners

Number of desalination plants in the Netherlands
1 in total, online

Main technology applied
Multi-effect Distillation (MED)

Table E.3: List of online desalination plant supplied by Altus Capital Partners in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP77	Netherlands	230	$750,000	Industry (TDS <10ppm)	-	RO	Brine or concentrated seawater (TDS >50000ppm)	1991	1993	Online

Amfitec

Number of desalination plants in the Netherlands
4 in total, 3 online

Main technology applied
Reverse Osmosis (RO)

Comments: It concerns only greenhouses.

Table E.4: List of offline and online desalination plants for greenhouses supplied by Amfitec in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP57	Greenhouses	1000	$840,000	Irrigation (TDS <1000ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1986	1986	Online
DP58	Greenhouses	1000	$840,000	Irrigation (TDS <1000ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1987	1987	Online
DP59	Greenhouses	500	$420,000	Irrigation (TDS <1000ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1988	1988	Online
DP60	Greenhouses	500	-	Irrigation (TDS <1000ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1988	1988	Offline

Amiantit Group

Number of desalination plants in the Netherlands
2 in total, all offline

Main technology applied
Electrodialysis (ED)

Table E.5: List offline desalination plants supplied by Amiantit Group in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP68	Rotterdam	5900	$6,070,000	Industry (TDS <10ppm)	-	ED	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1969	1970	Offline
DP69	Rotterdam	680	$700,000	Industry (TDS <10ppm)	-	ED	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1965	1966	Offline

Atlantis Water Desalination System

Number of desalination plants in the Netherlands
1 in total, online

Main technology applied
Multi-Stage Flash (MSF)

Table E.6: List of online desalination plant supplied by Atlantis Water Desalination System in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP78	Netherlands	240	$360,000	Industry (TDS <10ppm)	VAM	MSF	Wastewater	1994	1996	Online

Demitec

Number of desalination plants in the Netherlands
1 in total, online

Contact Person: Carel W. Aeijelts Averink, Director Operations

Main technology applied
Reverse Osmosis (RO)

Table E.6: List of online desalination plant supplied by Demitec in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP79	Amsterdam	240	-	Industry (TDS <10ppm)	Artis Zoo	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1999	2000	Online

Doosan Babcock (former Mitsui Badcock)[5]

Number of desalination plants in the Netherlands
2 in total, all online

Contact Person: Leeyeol Ryu, Representative, Frankfurt Office

Main technology applied
Electrodialysis (ED)
Reverse Osmosis (RO)

Table E.7: List of online desalination plants supplied by Doosan Badcock in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP70	Moerdijk	720	$600,000	Power stations (TDS <10ppm)	EPZ	ED	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1993	1995	Online
DP71	Geleen	-	-	Power stations (TDS <10ppm)	Edea	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1996	1998	Online

[5] In January 2007, Mitsui Babcock parent company Mitsui Engineering & Shipbuilding sold its UK energy business to Doosan Heavy Industries (UK) Limited. Doosan Heavy Industries is a subsidiary of Doosan Heavy Industries & Construction, the South Korea-based engineering and Construction Company.

Envirogenics

Number of desalination plants in the Netherlands
1 in total, offline

Main technology applied
Reverse Osmosis (RO)

Table E.8: List of offline desalination plant supplied by Envirogenics in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP80	Hensbroek	121	$130,000	Industry (TDS <10ppm)	-	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1977	1978	Offline

Evoqua Water Technologies, LLC

Number of desalination plants in the Netherlands
1 in total, offline

Main technology applied
Reverse Osmosis (RO)

Table E.9: List of offline desalination plant supplied by Evoqua Water Technologies in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP81	Dortrecht	1037	$1,530,000	Industry (TDS <10ppm)	DuPont	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1971	1972	Offline

Gauff Ingenieure/ SETEC Engineering

Number of desalination plants in the Netherlands
6 in total, all online

Main technology applied
Reverse Osmosis (RO)

Table E.10: List of online desalination plants supplied by SETEC Engineering in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP46	Netherlands	2065	$1,610,000	Power stations (TDS <10ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1996	1996	Online
DP47	Netherlands	1730	$1,370,000	Industry (TDS <10ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1999	1999	Online
DP48	Netherlands	1440	$1,150,000	Municipalities as drinking water (TDS 10ppm - <1000ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1999	1999	Online
DP49	Netherlands	1020	$830,000	Power stations (TDS <10ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1999	1999	Online
DP50	Netherlands	150	$160,000	Irrigation (TDS <1000ppm)	-	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1998	1998	Online
DP51	Netherlands	150	$160,000	Irrigation (TDS <1000ppm)	-	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1998	1998	Online

GLV/OVIVO[6]

Number of desalination plants in the Netherlands
7 in total, 1 online

Contact Person: Jorg Korver, Process Engineer

Main technology applied
Reverse Osmosis (RO)

Table E.11: List of offline and online desalination plants supplied by Ovivo in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP39	Nijmegen	1,051	$1,300,000	Industry (TDS <10ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1985	1986	Offline
DP40	Eindhoven	480	$1,000,000		-	RO		1984	1985	Offline
DP41	Sloe power station	326			-	RO		2007	2008	Online
DP42	Eindhoven	240	$800,000		-	RO		1983	1984	Offline
DP43	Eindhoven	240	$800,000		-	RO		1986	1986	Offline
DP44	Groningen	150	$1,000,000		-	RO		1985	1986	Offline
DP45	Eindhoven	120	$400,000		-	RO		1986	1986	Offline

[6] All plants were supplied by Christ Water Technology group. **GLV acquired the Christ Water Technology Group in 2009**. GLV changed their name to OVIVO Inc. as approved by its shareholders on November 14, 2014. The name was effective starting on December 18, 2014.

Grupo SETA, S.L.

Number of desalination plants in the Netherlands
1 in total, online

Main technology applied
Reverse Osmosis (RO)

Table E.12: List of online desalination plant supplied by Grupo SETA in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP82	OI BW 2000	2000	-	Industry (TDS <10ppm)	-	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	2008	2008	Online

Hatenboer-Water

Number of desalination plants in the Netherlands
1 in total, online

Contact Person: Carel W. Aeijelts Averink, Director Operations

Main technology applied
Reverse Osmosis (RO)

Table E.13: List of online desalination plant supplied by Hatenboer - Water in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP83	Rotterdam	7200	-	Municipalities as drinking water (TDS 10ppm - <1000ppm)	Evides Industriewater	RO	Pure water or tap water (TDS <500ppm)	2007	2007	Online

Hubert Stavoren B.V.

Number of desalination plants in the Netherlands
12 in total, all offline

Contact Person: Piet Demmers, Sales Manager

Main technology applied
Multi-Stage Flash Distillation (MSF),
Reverse Osmosis(RO)

Table E.14: List of offline desalination plants supplied by Hubert Stavoren in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP1	Rotterdam	32,400	$15,000,000	Industry (TDS <10ppm)		MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1971	1973	Offline
DP2	Terneuzen	29,000	$15,000,000	Power stations (TDS <10ppm)	Zeeland Electric	MSF	Seawater (TDS 20000ppm - 50000ppm)	1967	1969	Offline
DP3	Zoeterwoude	10,400	$9,970,000	Industry (TDS <10ppm)	Heineken	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1978	1979	Offline
DP4	Texel Island	3,000	$7,300,000	Municipalities as drinking water (TDS 10ppm - <1000ppm)		MSF	Seawater (TDS 20000ppm - 50000ppm)	1970	1973	Offline
DP5	Rozenburg	1,200	$1,210,000	Industry (TDS <10ppm)	Esso	MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1969	1970	Offline
DP6	Geertruide	750	$2,000,000	Power stations (TDS <10ppm)	Electricity	MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1974	1976	Offline

No	Project name	Output water (m3/d)	EPC price	User category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP7	Texel Island	500	$1,330,000	Demonstration	Estel	MSF	Seawater (TDS 20000ppm - 50000ppm)	1978	1979	Offline
DP8	Ijmuiden	250	$670,000	Industry (TDS <10ppm)	Steel Works	MSF	Seawater (TDS 20000ppm - 50000ppm)	1964	1965	Offline
DP9	Rotterdam	250	$260,000	Industry (TDS <10ppm)	Afvalverwerker	MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1968	1969	Offline
DP10	Amsterdam	200	$210,000	Power stations (TDS <10ppm)	AVI-Noord	MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1988	1989	Offline
DP11	Naaldwijk	100	$100,000	Irrigation (TDS <1000ppm)	Government of The Netherlands	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1973	1974	Offline
DP12	Overschie	100	$100,000	Industry (TDS <10ppm)	Commercial Metals Company	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1979	1980	Offline

IDE Technologies Ltd

Number of desalination plants in the Netherlands
1 in total, offline

Contact Person: Boris Liberman, CTO, Vice President

Main technology applied
Multi-effect Distillation (MED)

Table E.15: List of offline desalination plant supplied by IDE Technologies Ltd in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP84	Schoonebeek	1200	3,790,000	Industry (TDS <10ppm)	NAM	MED	Brine or concentrated seawater (TDS >50000ppm)	1991	1993	Offline

Logisticon Water Treatment

Number of desalination plants in the Netherlands
5 in total, all online

Contact Person: Pieter van Staveren, Business Developer

Main technology applied
Reverse Osmosis (RO)

Table E.16: List of online desalination plants supplied by Logisticon Water Treatment in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP52	MRO	4,800	-	Industry (TDS <10ppm)	Evides Industriewater	RO	Pure water or tap water (TDS <500ppm)	2010	2010	Online
DP53	Mobile RO plants	4,800	-	Industry (TDS <10ppm)	Evides Industriewater	RO	Pure water or tap water (TDS <500ppm)	2011	2011	Online
DP54	Oosterhof Holman	1,500	-	Industry (TDS <10ppm)	Gietwater Berlikum	RO	Pure water or tap water (TDS <500ppm)	2011	2011	Online
DP55	ZS Lekkerkerk	1,440	-	Demonstration	Dutch Drinking Water Authority	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	2011	2011	Online
DP56	Gouda	1,240	-	Industry (TDS <10ppm)		RO	Wastewater	2013	2014	Online

Mitsubishi Heavy Industries / Logisticon Water Treatment (Consortium)

Number of desalination plants in the Netherlands
1 in total, online

Contact Person: Peter Van Staveren, Business Developer

Main technology applied
Electrodeionization (EDI)

Table E.17: List of online desalination plant supplied by Mitsubishi Heavy Industries in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP85	Nuon Magnum	1200	-	Power stations (TDS <10ppm)	North Water	EDI	Pure water or tap water (TDS <500ppm)	2010	2011	Online

Pentair Water Treatment

Number of desalination plants in the Netherlands
9 in total, all online

Contact Person: Karel Bruins Slot, Area Sales Manager

Main technology applied
Ultrafiltration, Micro-filtration and recently nanofiltration

Comments: Pentair is not providing desalination plants, but only pre-treatment technologies

Table E.18: List of online desalination plants supplied by Pentair Water Treatment in the Netherlands

No	Project name	User category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP13	Evides	Industry (TDS <10ppm)	Evides Industriewater	RO	Seawater (TDS 20000ppm - 50000ppm)	2007	2008	Online
DP14	Veendam	Industry (TDS <10ppm)	World Bank Group	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	2002	2003	Online
DP15	Lieshout	Industry (TDS <10ppm)	Bavaria Brewery	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1999	2000	Online
DP16	Veendam	Industry (TDS <10ppm)	World Bank Group	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1998	1999	Online
DP17	Sas van Gent	Power stations (TDS <10ppm)	-	RO	Wastewater	1998	1999	Online
DP18	Wijster	Industry (TDS <10ppm)	Essent	RO	Wastewater	1998	1999	Online
DP19	Sas van Gent	Power stations (TDS <10ppm)	-	RO	Wastewater	2000	2002	Online
DP20	Oosterbierum	Power stations (TDS <10ppm)	-	RO	Wastewater	2002	2003	Online
DP21	Vaassen	Discharge	-	RO	Wastewater	2003	2004	Online

Promac

Number of desalination plants in the Netherlands
1 in total, offline

Contact Person: No contact person

Main technology applied
Reverse Osmosis (RO)

Table E.19: List of offline desalination plant supplied by Promac in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP86	Schiphol	120	130,000	Industry (TDS <10ppm)	-	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1981	1982	Offline

Salt Separation Services

Number of desalination plants in the Netherlands
2 in total, all online

Contact Person: Daniel W Shackleton BSc, Director

Main technology applied
Reverse Osmosis (RO)

Table E.20: List of online desalination plants supplied by Salt Separation Services in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP72	Total A15 Offshore Oil Platform	15	-	Process water for well injection	Total E&P Netherland	RO	Seawater (TDS 20000ppm - 50000ppm)	2013	2014	Online
DP73	Windfarm	1	-	Fresh water (for showers/fresh water services)	Hollandia	RO	Seawater (TDS 20000ppm - 50000ppm)	2011	2012	Online

STORK

Number of desalination plants in the Netherlands
9 in total, all online

Contact Person: Jascha Zwaving, Global Business Development Coordinator

Main technology applied
Multi-effect Distillation (MED)
Reverse Osmosis (RO)

Table E.21: List of online desalination plants supplied by Stork in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP22	Ter Apelkanaal	5,100	$ 6,440,000	Industry (TDS<10ppm)	-	MED	Wastewater	1989	1991	Online
DP23	Oostermoer	5,000	$ 6,870,000	Discharge	-	MED	Wastewater	1982	1984	Online
DP24	Foxhol	2,680	$ 3,660,000	Discharge	-	MED	Wastewater	1984	1986	Online
DP25	Gasselte	2,680	$ 3,660,000	Industry (TDS<10ppm)	-	MED	Wastewater	1979	1981	Online
DP26	Wijster	700	$ 1,020,000	Discharge	-	RO	Wastewater	1986	1987	Online
DP27	Nijmegen	420	$ 620,000	Discharge	-	MED	Wastewater	1985	1987	Online
DP28	Helmond	260	$ 390,000	Discharge	-	MED	Wastewater	1987	1989	Online
DP29	Wieringen	190	$ 280,000	Discharge	-	RO	Wastewater	1987	1988	Online
DP30	Haps	140	$ 210,000	Discharge	-	RO	Wastewater	1992	1993	Online

SUEZ (former GE WATER)[7]

Number of desalination plants in the Netherlands
4 in total, all online

Contact Person: Onno WORKUM, Sales Director NL

Main technology applied
Electrodialysis (ED)
Reverse Osmosis (RO)

Table E.22: List online desalination plants supplied by SUEZ in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP61	Netherlands	2,616	$1,900,000	Power stations (TDS <10ppm)	-	RO	Pure water or tap water (TDS <500ppm)	1997	1997	Online
DP62	Netherlands	818	$830,000	Municipalities as drinking water (TDS 10ppm - <1000ppm)	-	ED	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1999	2000	Online
DP63	Terneuzen	545		Industry (TDS <10ppm)	-	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	2013	2014	Online
DP64	Amsterdam	340	$280,000	Demonstration	-	ED	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1996	1996	Online

[7] SUEZ together with Caisse de depot et placemenent du Quebec (CDPQ), acquired the former GE Water & Process Technologies (GE Water), effective as of September 30th, 2017.

VA Tech Wabag Ltd.

Number of desalination plants in the Netherlands
1 in total, offline

Contact Person: Florian Hell, Process Engineer

Main technology applied
Multi-effect Distillation (MED)

Table E.23: List of offline desalination plant supplied by VA Tech Wabag in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP87	Rotterdam	24,000	$17,440,000	Industry (TDS <10ppm)	AVR	MED	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1997	1999	Offline

Veolia

Number of desalination plants in the Netherlands
8 in total, 6 online

Contact Person: Dennis Korthout, Commercial Director

Main technology applied
Multi-Stage Flash Distillation (MSF)
Reverse Osmosis (RO)

Table E.24: List of offline and online desalination plants supplied by VEOLIA in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP31	Rotterdam	22,30	$ 18,360,000	Power stations (TDS <10ppm)	Bechtel ENKA	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	2002	2002	Online
DP32	Rotterdam	10,800	$ 7,160,000	Industry (TDS <10ppm)	AVR	RO	Pure water or tap water (TDS <500ppm)	1997	1998	Online
DP33	Rotterdam	5,200	-	Industry (TDS <10ppm)	AVR	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1997	1998	Online
DP34	Amsterdam	3,700	$ 2,670,000	Industry (TDS <10ppm)	Akzo Nobel	RO	River water or low concentrated saline water (TDS 500ppm-<3000ppm)	2000	2000	Online
DP35	Pernis	2,884	$ 2,740,000	Industry (TDS <10ppm)	Bataafse Petroleum Maatschappij (Shell Pernis)	MSF	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1961	1963	Offline
DP36	Netherlands	609	-	Municipalities as drinking water (TDS 10ppm - <1000ppm)		MSF	Seawater (TDS 20000ppm - 50000ppm)	1963	1963	Offline
DP37	Dordrecht	-	-	Industry (TDS <10ppm)	WBE	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1998	1999	Online

DP38	Amsterdam	-	-	Industry (TDS <10ppm)	Akzo Nobel	RO	River water or low concentrated saline water (TDS 500ppm-<3000ppm)	2000	2001	Online

Wafilin Engineering

Number of desalination plants in the Netherlands
2 in total, all offline

Contact Person: Henk Schonewille, CEO

Main technology applied
Reverse Osmosis (RO)

Table E.25: List of offline desalination plants supplied by Wafilin Engineering in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP74	Andijk	121	$130,000	Municipalities as drinking water (TDS 10ppm - <1000ppm)	PWN	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1979	1980	Offline
DP75	Netherlands	121	$130,000	Industry (TDS <10ppm)	Zwethlanden	RO	Brackish water or inland water (TDS 3000ppm - <20000ppm)	1976	1977	Offline

Witteveen NL

Number of desalination plants in the Netherlands
1 in total, online

Contact Person: Arjen van Nieuwenhuijzen, CTO

Main technology applied
Reverse Osmosis (RO)

Table E.26: List of online desalination plant supplied by Witteveen in the Netherlands

No	Project name	Output water (m3/d)	EPC price	User Category	Customer	Technology	Raw water type	Award date	Online date	Plant status
DP88	Heemskerk	48000	33,010,000	Municipalities as drinking water (TDS 10ppm - <1000ppm)	PWN	RO	River water or low concentrated saline water (TDS 500ppm - <3000ppm)	1999	2000	Online