ZERO BRINE

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

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Final

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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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Executive summary

The Online Brine Platform (OBP) is an active web service to promote and practically implement Industrial Symbiosis, enabling communication between stakeholders throughout the supply chains of brines, industrial water and salts. The aim of the report is to present the results based on the demonstration of the OBP at five workshops, one for each Dutch industrial cluster: Zeeland, Delfzijl, Chemelot, Rotterdam and Amsterdam, in order to increase capacity building and disseminate the project results. In addition, registration of the brine effluent producers, as well as salt end-markets for the case of the Netherlands and the current status of the Dutch desalination market is presented. Brine producers and end-users recognized the benefits of the OBP. The face-to-face interaction and the use of the serious game at the workshops were particularly effective to create awareness concerning the topic and perspectives of other organizations, creating visibility, attracting enthusiasm, building trust and provoking thinking about brine re-use. On the other hand, participants had reservations about registering. In total eleven Dutch chemical sectors were identified to be potential end-markets of products recovered by the project. Furthermore, it was found that very few online desalination plants are suitable for brine recovery, among them the horticulture sector was found to have significant potential.

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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 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 Task 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 fraction of the materials used in the EU (European Commission, 2020). 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 searching information and establish links with relevant stakeholders. Hence, a network of 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, the location and proximity of the industrial sites. Thus, industries will be able to make informed decisions regarding the management of their resources. Possible matches will be proposed to the registered users depending on their role. Matching will be based on the required and available materials as well as on the available quantities, on the proximity and 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. An Excel Database was developed containing information on the companies in each cluster that are i) brine producers, ii) technology providers for brine treatment, or iii) mineral/water end-users. In addition to their roles, individual companies in each cluster were categorized based on their locations, production types, and sectors. Types and quantities of brine effluents of brine owners and minerals consumed by end users were determined. Appendix A lists and describes the categories of the Excel Database in more detail.

Information about brine emissions was collected for all six clusters to map the industries as detailed as 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 consists of information obtained from public sources, anonymized information about real industrial brine retrieved from previous ISPT projects and anonymized information about minerals end-users are portrayed in Appendix B, Appendix C and Appendix D. This information was used for the purpose of analyzing the relevance of industries for the OBP.

Table 3.1 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

Minerals end users

Among the different minerals investigated by ZERO BRINE project, salt is produced and consumed in largest quantities. We can generally classify the products of salt manufacturing industry into three sodium-based salt classes, one calcium based class and one magnesium based salt class: industrial vacuum salt, specialties salt, off-spec salt, calcium-based salt and magnesium-based salt, respectively. Table 3.2 shows typical examples of each product class. The greatest single use for salt is as feedstock for the production of chemicals (Westphal et al., 2010). The chemical industry is the largest consumer employing approximately 68% of the total production worldwide as shown in Figure 3.1 (Wikipedia, 2020) and 80% of the total production in the Netherlands (Scherpbier, 2018). Salt has several direct uses but it is mainly used to produce soda ash, caustic soda and chlorine products. These products have a vast range of industries where they are consumed. Figure 3.2 illustrates the various direct and indirect industrial uses of salt and Table 3.3 presents major minerals end users and the purpose of their application.

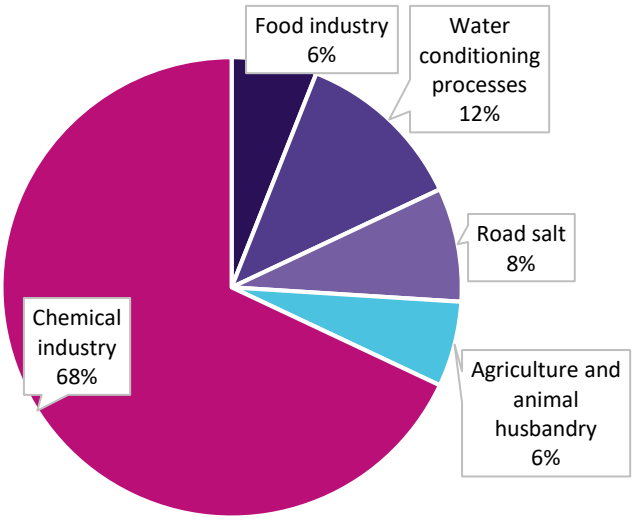

Figure 3-1. Salt direct consumption worldwide

Table 3-2. Salt product classes and typical examples (Source: Brinkmann et al., 2014; Scherpbier, 2018)

Salt classes	Product example	Dutch market value [€/ton]
Industrial vacuum salt	Water softener, textile dye, electrolysis salt	57
Specialties salt	Table salt, pharma salt, feed salt	60
Off-spec salt	De-icing salt, road salt, dishwasher salt	46
Calcium-based salt	Calcium chloride	150
Magnesium-based salt	Magnesium chloride, magnesium oxide, magnesium hydroxide	150

Table 3-3. Mineral end users and the purpose of its application (Source: Unknown, 2020a, 2020b, 2020c)

End user	Application	Type of mineral
Chlor-alkali industry	Brine generation, electrolysis	NaCl [1], Na_2SO_4 [2], $NaNO_3$ [2]
Plastic industry	In various stages of production and to functionalize the polymers	$Mg(OH)_2$ [3]
Water treatment industry	In recharge of water softening units	NaCl [4]
Petrochemical industry	In well drilling muds and biogas plants to remove hydrogen sulfide	NaCl [5] (with or without additives)
Textile industry	To fix and standardize the batches of dye	NaCl [11], Na_2SO_4 [6]
Rubber industry	As nitrosating agents in vulcanization process	Nitrite salts [7]
Glass and ceramic industry	As glazing and coloring agents and to control the material properties of glass and ceramics	NaCl, KO_2 [8]
Agriculture and animal husbandry	Used to ensure feeding of livestock with high-quality nutrients, minerals, etc.	NaCl [4], $NaHCO_3$ [10]
Food industry	As flavor enhancer, preservative, color developer, texture-control agent and binder	NaCl [4], $NaNO_2$ [4], $NaHCO_3$ [10]
State-owned organizations	As de-icing agent or brine ingredient in road surfaces, chemical reagents in WWTPs	NaCl [4], $Mg(OH)_2$ [9], $MgCl_2$ [9]
Pharmaceutical industry	To prepare of saline solutions and produce capsules	Mix of NaCl, KCl and Trisodium citrate, $NaHCO_3$ [10]
General public	Flavor enhancer	NaCl [4]

Sources: [1] (Garcia-Herrero et al., 2018), [2] (Zhao et al., 2019), [3] (Seeger et al., 2011), [4] (Westphal et al., 2010), [5] (Morton Salt, n.d.), [6] (Mandal, n.d.), [7] (Beliczky and Fajen, 2011), [8] (Kogel et al., 2006), [9] (Mulder et al., 2017), [10] (Thieme, 2000), [11] (Talukder et al., 2017)

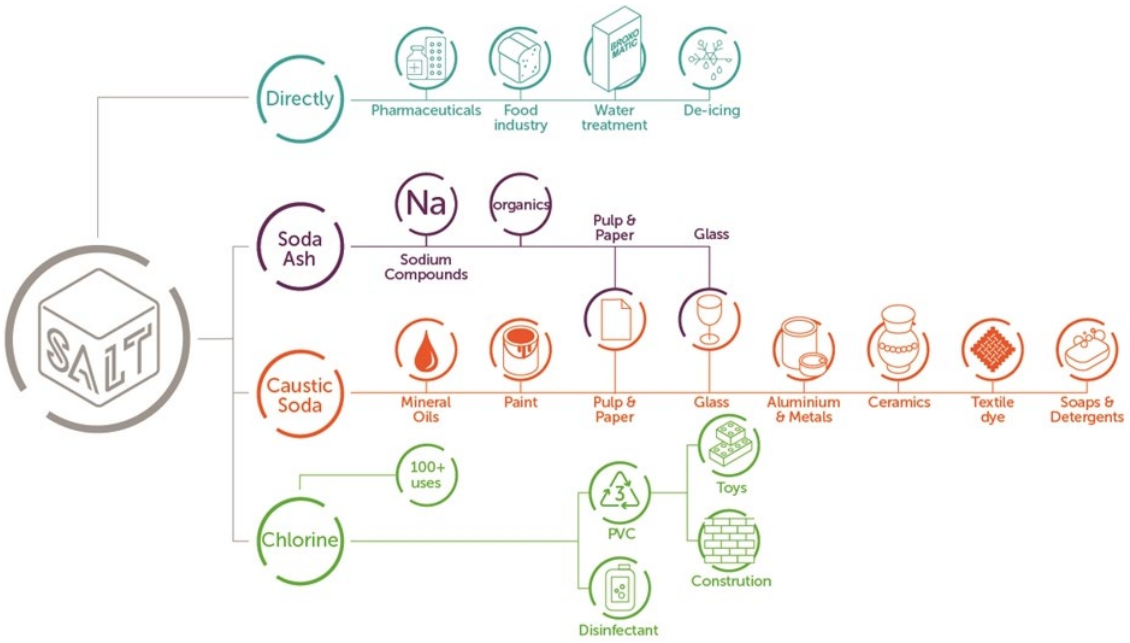

Figure 3-2. Direct and indirect use of salt adopted from Nouryon (Source: Nouryon, n.d.)

Brine end users

A special product which is generated from salt is brine. Brine is a solution which mainly consists of salt. Brine is considered as wastewater in industrial processes and it is either treated to recover materials or disposed. If brine would be sold from the producer to another corporation, it would result in higher logistic costs than buying salt and generating brine on site. As a result, the latter is preferred and brine is generated based on end user needs. Brine is used in the food industry and chlor-alkali industry. However, recently brine started to be preferred over road salt due to its de-icing benefits (Eurosalt, n.d.):

- brine speeds up the road-ice melting process,
- brine is not blown away, in comparison to road salt and
- brine is less slippery than road salt.

International mineral standards

On one hand minerals end users may process the purchased minerals, for instance generate brine or dilute it to achieve a specific lower purity depending on end use. On the other hand, international mineral standards exist, especially for NaCl that will be used in food production or by the public. Table 3.4 provides an overview of such international standards.

Table 3-4. International standards for salt use

Type of mineral	Purpose of standard	Jurisdiction
NaCl, $CaCl_2$	Food Grade Salt	Codex Alimentarius Commission (FAO)
	Use by food industry	Food and Nutrition Board, Academy of Sciences
NaCl, $CaCl_2$	De-icing	American Association of State Highway Transportation Officials
NaCl	Pharmaceutical use	European Directorate for the Quality of Medicines and HealthCare
NaCl	Regeneration of ion exchangers	European Committee for Standardization
$CaSO_4$	Gypsum products	European Committee for Standardization

Dutch minerals end markets

Salt produced globally varies in purity from 90% NaCl for rock salt to even 99.99% for vacuum salt. The Dutch annual salt production amounts several million tons of rock salt and approx. a quarter of a million ton of magnesium salt. Rock salt in the Netherlands is produced via solution mining. Solution mining refers to the production of salt by pumping water into subterranean salt deposits, dissolving the salts and pumping the brine to the surface for drying and further use. The salt produced is mainly used for human and animal food, and for the chemical industry ("Global Salt Industry," 2018). Table 3.5 presents minerals quality standards and quantities employed by identified end markets in the Netherlands. Many more potential end users were contacted but several industries (such as textiles and leather) have moved their production facilities to countries with lower labor cost or changed their business-as-usual operation resulting in no ZERO BRINE-related minerals use, such as the paper and pulp industry focuses on recycling instead of processing virgin paper.

Table 3-5. Typical characteristics of Zero Brine minerals used by Dutch industry

Sector	Type of mineral	Quality (% db)	Quantity (ktons/year)
Chemicals production	NaCl	99.5-99.9	667.5
Water treatment	NaCl	99.8	5.56
	$MgCl_2$	32	2,407
Textiles production	NaCl	99.7	22.2
	Na_2CO_3	99	0.001
Mineral production	$MgCl_2$	76.9	Not known
Road salt production	NaCl	99	507
Paper and pulp	NaCl	99-99.96	20
	Na_2CO_3	94	40
Thermoplastic production	NaCl	99.8	0.002
Agriculture	$CaCl_2$	78	Not known
	Na_2CO_3	99.5	Not known
Pharmaceutical	$CaCl_2$	93	Not known
	NaCl	>99	Not known
	$(NH_4)_2SO_4$	>99	Not known
	$Mg(OH)_2$	>95	Not known
Food industry	NaCl	97	Not known
	$(NH_4)_2SO_4$	>99	Not known
Cosmetics	$Mg(OH)_2$	>95	Not known

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 directly 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 (Figure 3.3), 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 E) 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 F). Although the sample size was small (6), the questionnaire results provide a quantitative, reasonably objective validation of the OBP for the Dutch market.

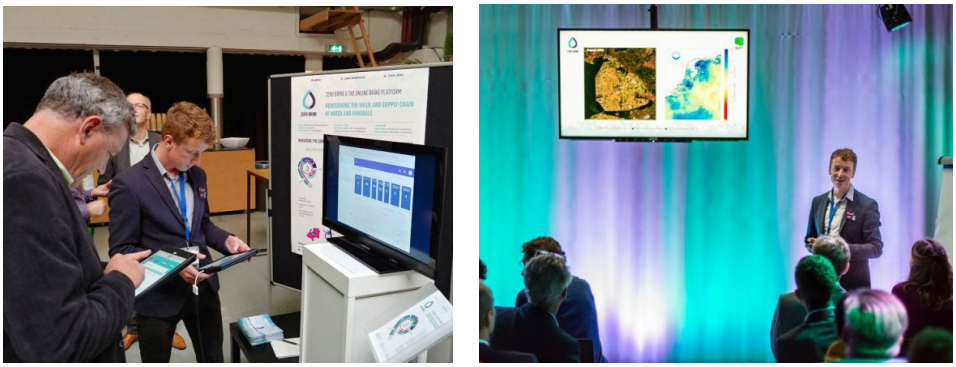

Figure 3-3. A prototype of the OBP and the Zero Brine project was presented and user feedback was collected at the annual ISPT Conference. The event attracted more than 200 attendees from process industries, academia, SMEs and policy makers.

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 3-6. 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
Zeeland	2 July, 2019
Delfzijl	1 October, 2019
Chemelot	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 3-4. 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. Several additional remarks and 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) It was very important for potential OBP users to ensure privacy and data protection, in order to prevent privacy and competition issues. It was clarified that OBP follows strict privacy rules and gives the potential to the users to be registered without revealing their identity.

3) A possible barrier is the time spent on gathering all the necessary information to completely register their brine characteristics. However, companies which need to request for environmental permits to dispose their brine, must already know this information. This means that employees with the right position in an organization can gather needed information for the OBP quickly.

4) 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.

5) Brine recovery and brine re-use, irrespective of intermediate processing, is not yet stimulated enough by Dutch governmental bodies. Participants emphasized that the Dutch government has an important role in facilitating brine recovery and brine re-use.

6) In the question to whether the OBP will be continued after the ZERO BRINE project ends, NTUA confirmed that 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 minerals end-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 directly contacted, based on the recorded brine producers and end-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 to validate 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 with the process industry. As a result, an Industrial Symbiosis forum was created because participants (representing various types of Dutch organizations) understood when playing the serious game the different stakeholder roles and actions needed to achieve industrial symbiosis and the importance of collective benefits due to industrial symbiosis.

Overall, many brine producers and end-users recognized the proposed benefits of the OBP. The face-to-face interactions at the workshops were particularly effective to create awareness concerning the topic and perspectives of other organizations, creating visibility, attracting enthusiasm, building trust and provoking thinking about brine re-use. However, participants had reservations about registering. It is proposed that the registration process should continue further with more registrations and more characterized brines and mineral end-users 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:

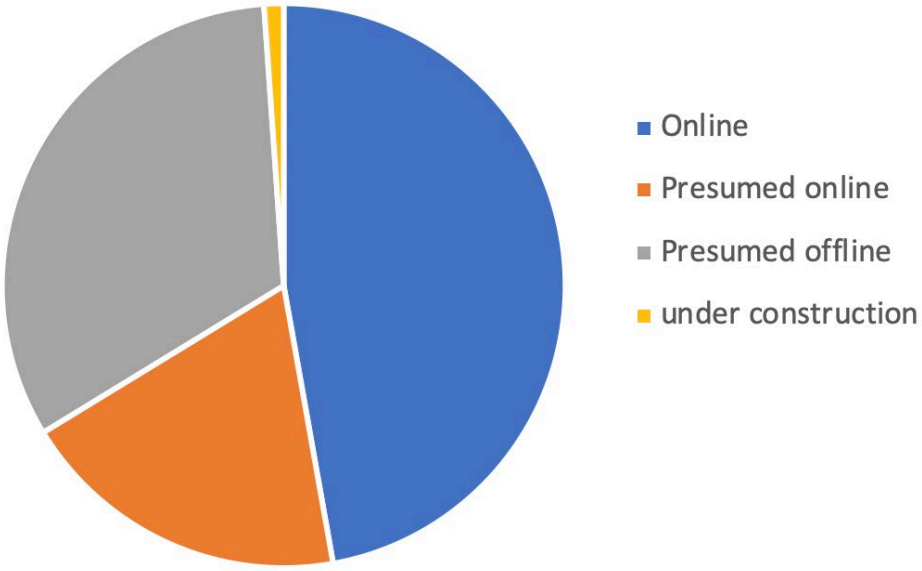

Figure 4-1. Breakdown of installed desalination plants in the Netherlands by operational status (1951 – 2016) (Source: GWI, 2016).

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

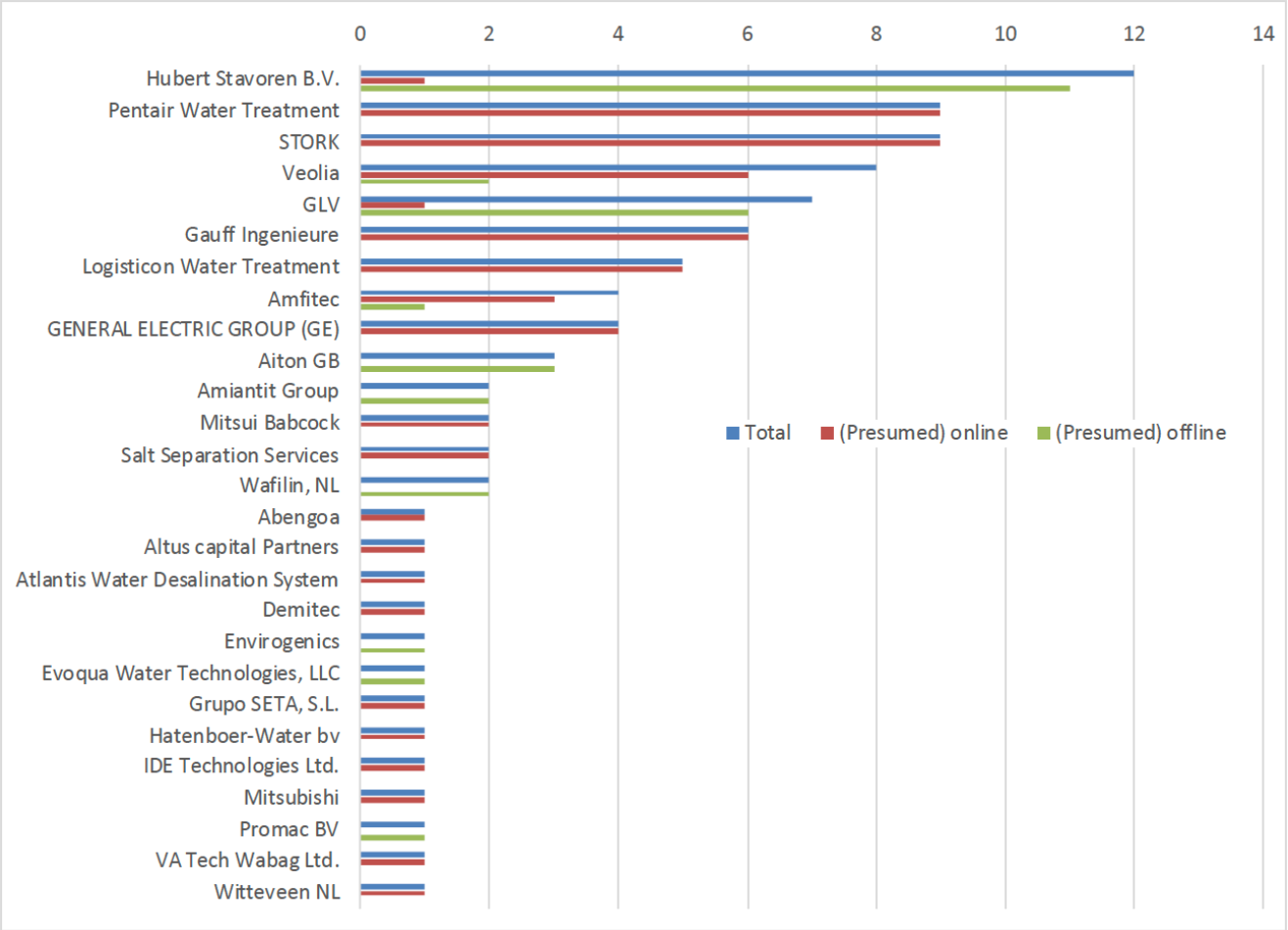

Figure 4-2. Number of desalination plants in the Netherlands by manufacturer and operational status

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.

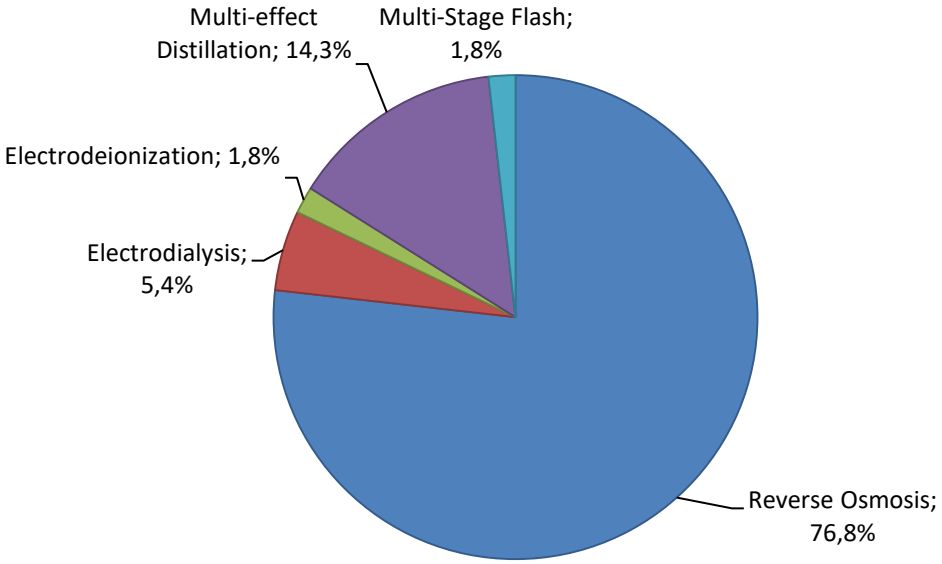

Figure 4-3. Breakdown of applied technologies for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

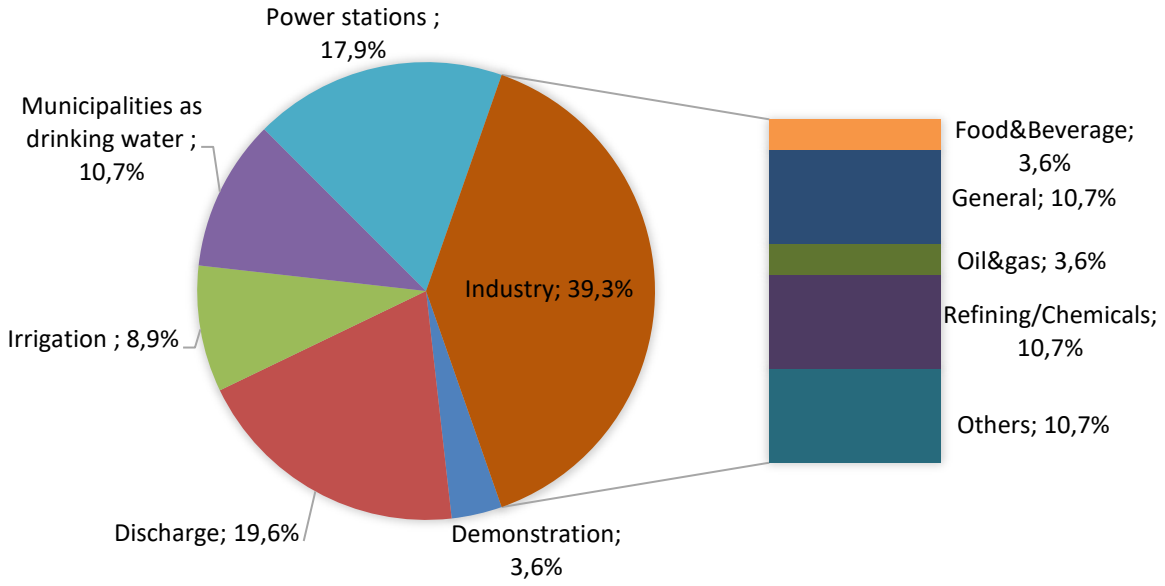

Figure 4-4. Breakdown of raw water's type for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

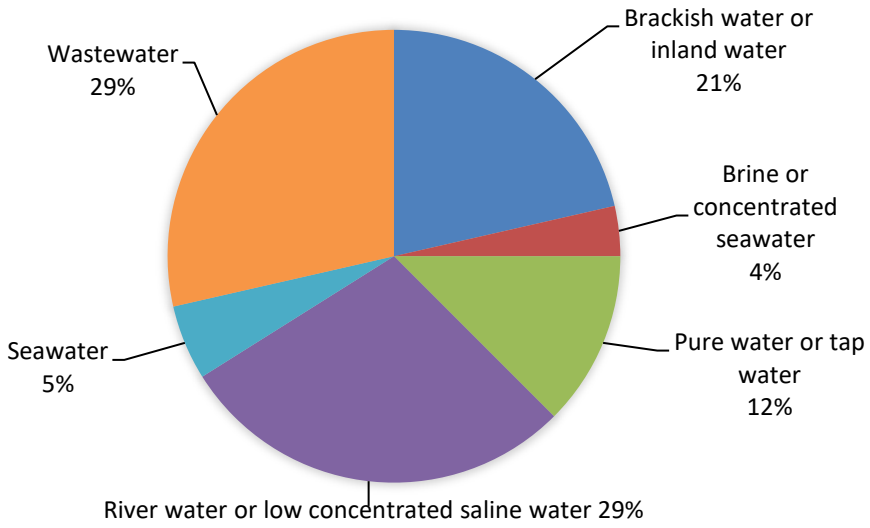

Figure 4-5. Breakdown of user's category for the online desalination plants in the Netherlands (1951 – 2016) (Source: GWI, 2016)

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 G, 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

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
	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
	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

Manufacturer / Plant supplier	No	Project Name	Customer	User Category	Raw water type	Technology
	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
	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

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
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
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 4.6 the location of the above listed desalination plants is presented where it is available.

Figure 4-6. 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

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Appendices

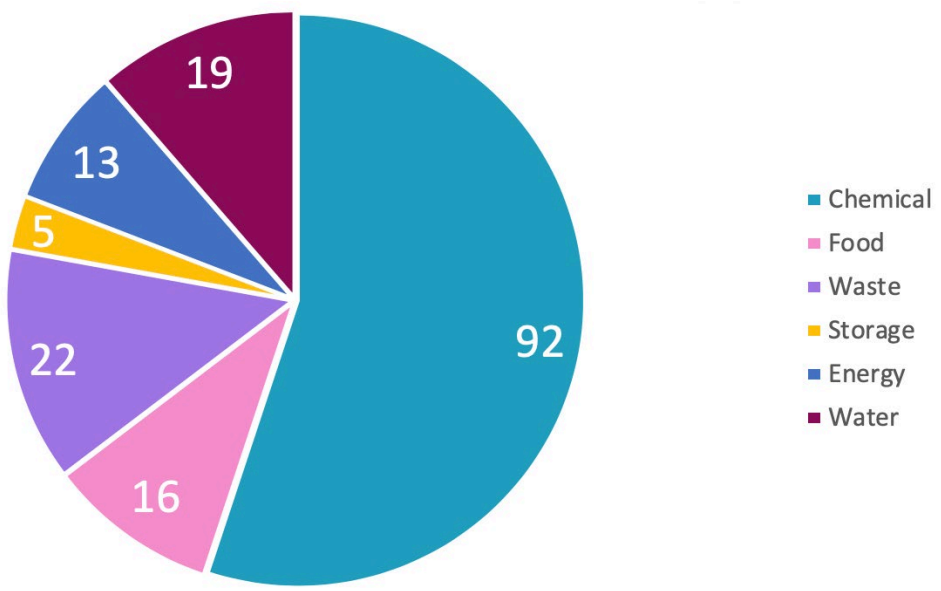
Appendix A. Industry Mapping Categories and Explanations

''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).
	End-user - consumes the same type of salt and minerals which are recovered by ZERO BRINE pilots
“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.
“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''.
“Quality/Quantity of sodium chloride, calcium chloride, ammonium sulphate, magnesium chloride, magnesium hydroxide and sodium carbonate”	Gives quantitative information on purity of employed minerals in percentage and consumed quantities on annual basis in 'kton/year'.
''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).

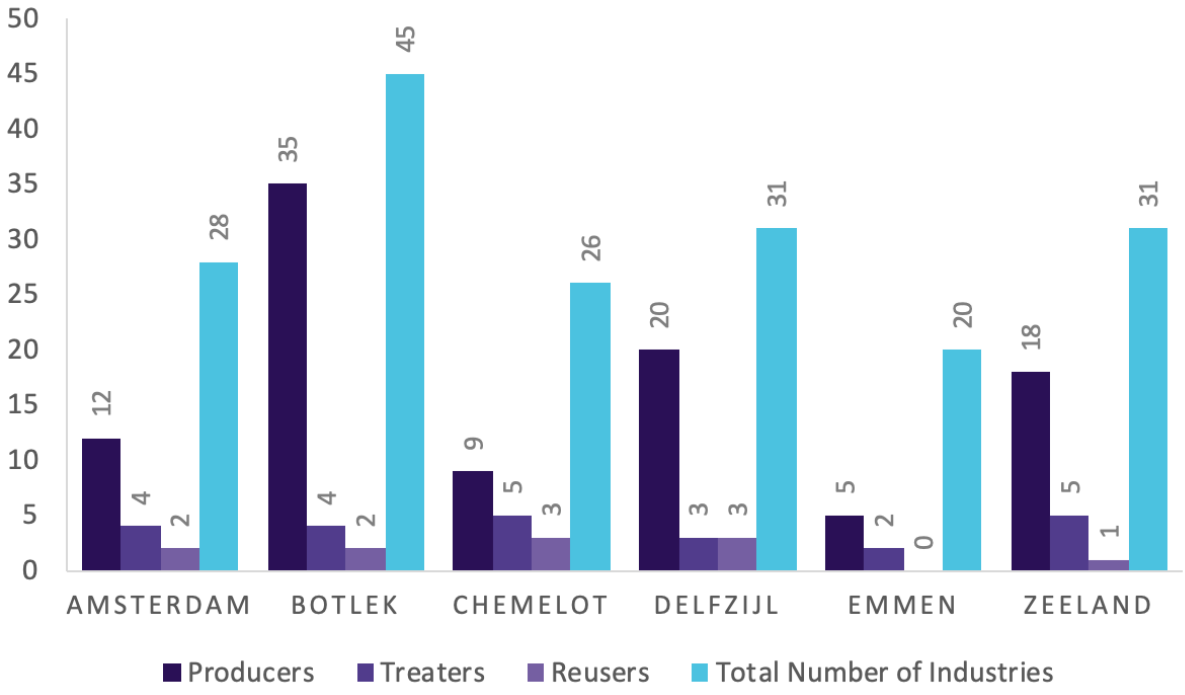
Appendix B. Industry Mapping Results

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

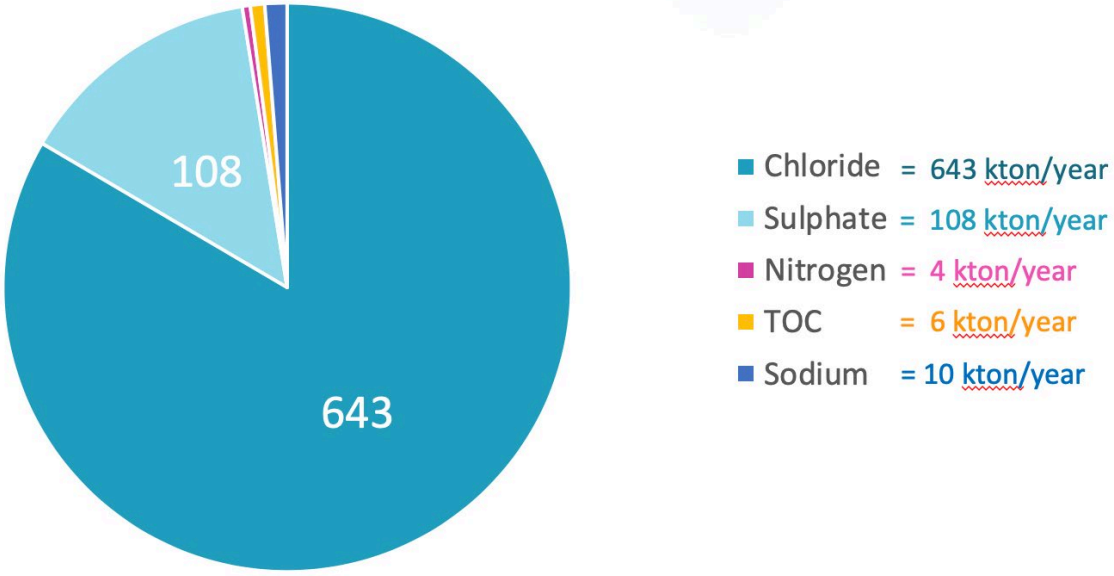
Types of Industries



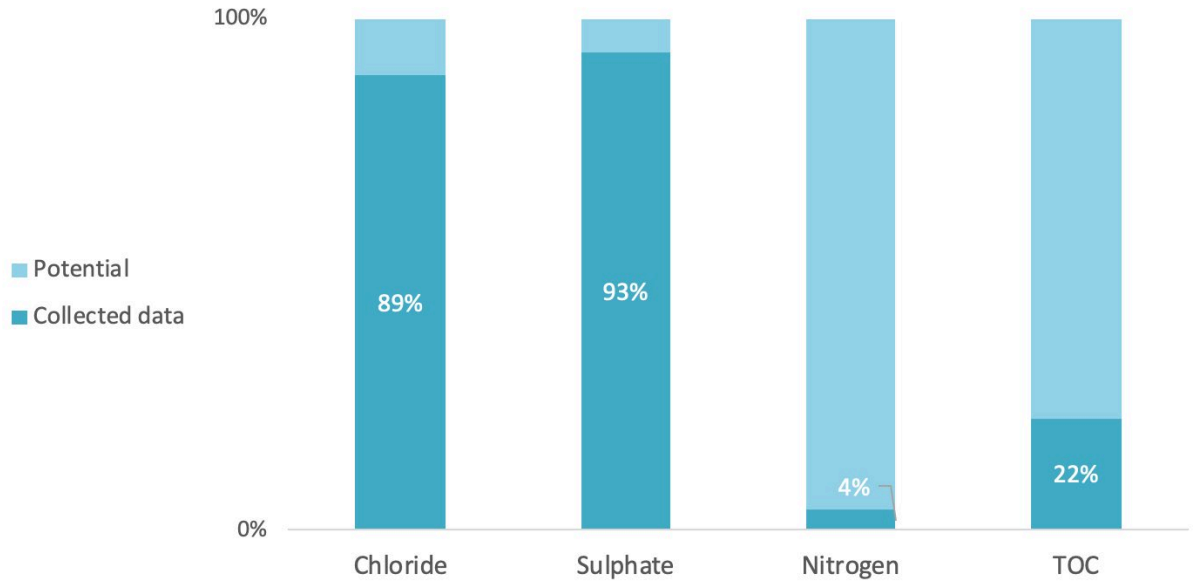
Number and Types of Industries Identified Per Cluster



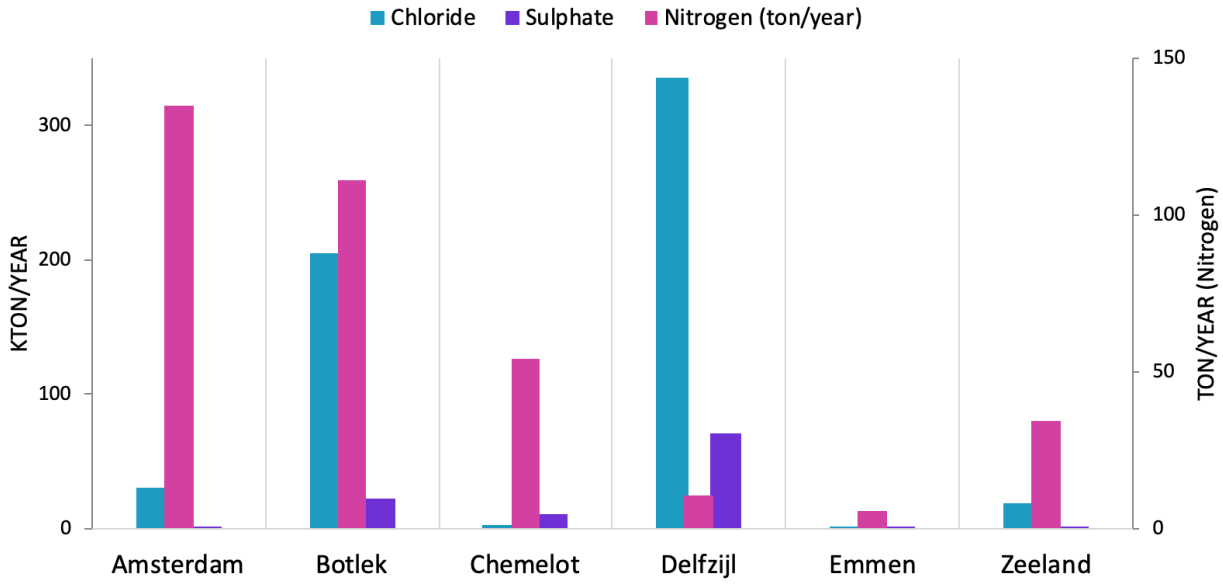
Total Discharge (kton/year)



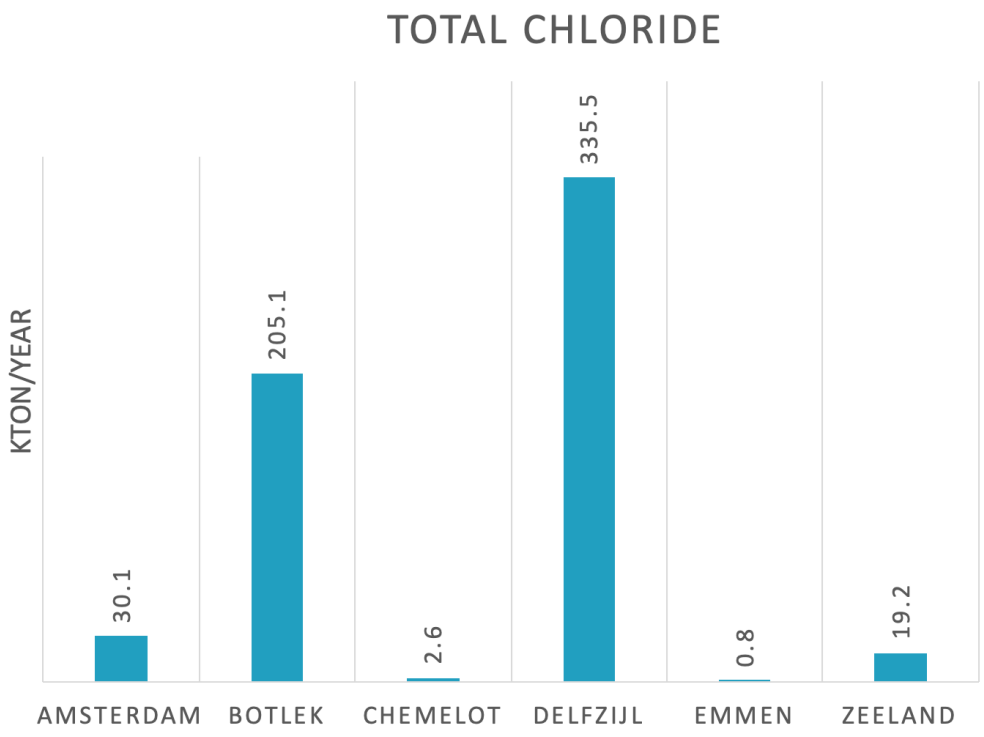
Collected Data vs Potential



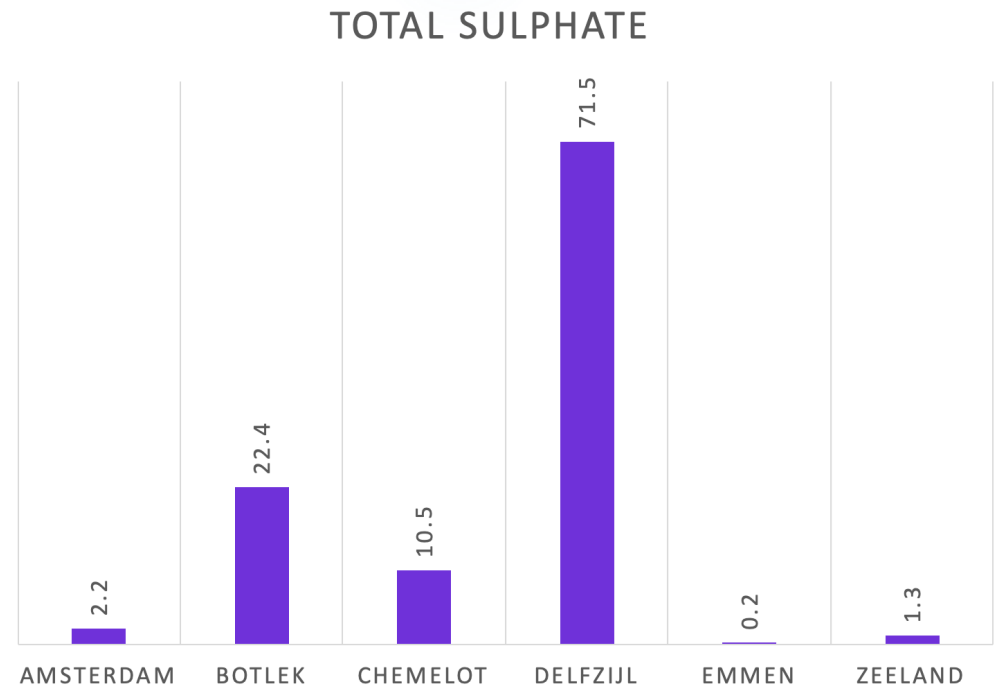
Cluster Results: Overview Discharge Per Cluster



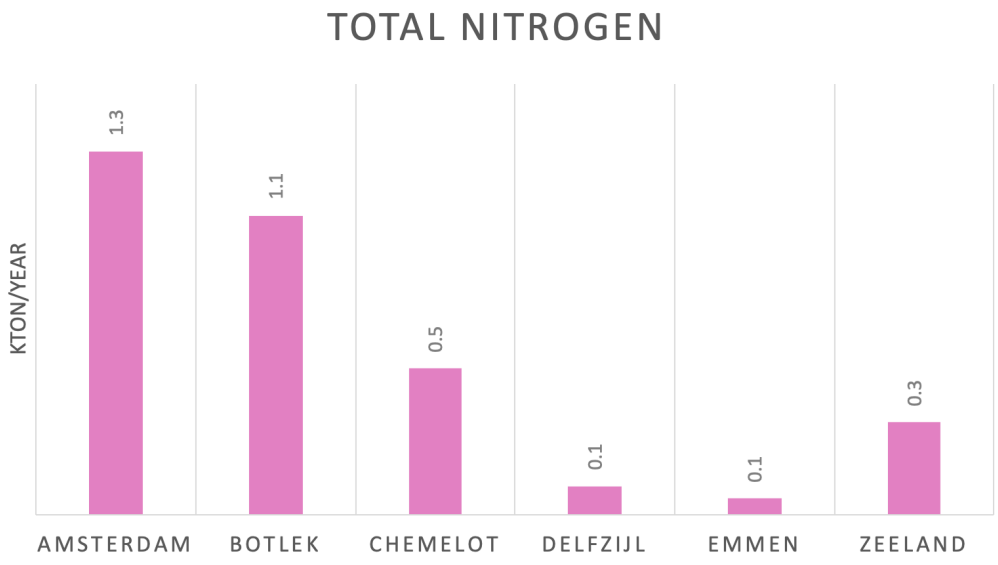
Cluster Results: Total Chloride Discharge Per Cluster



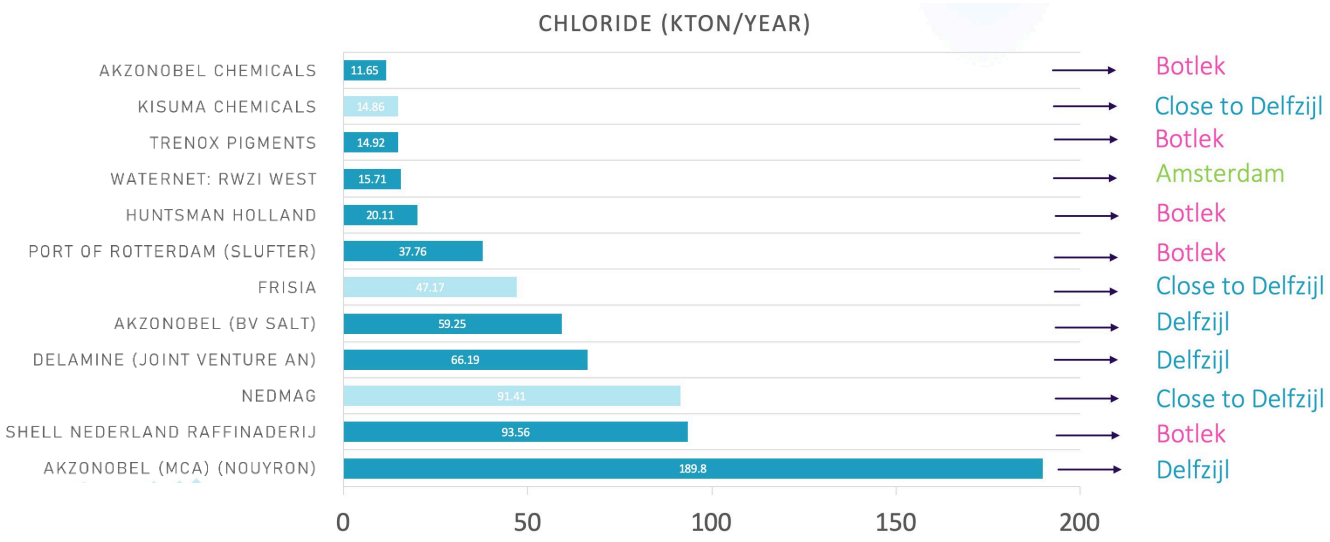
Cluster Results: Total Sulphate Discharge Per Cluster



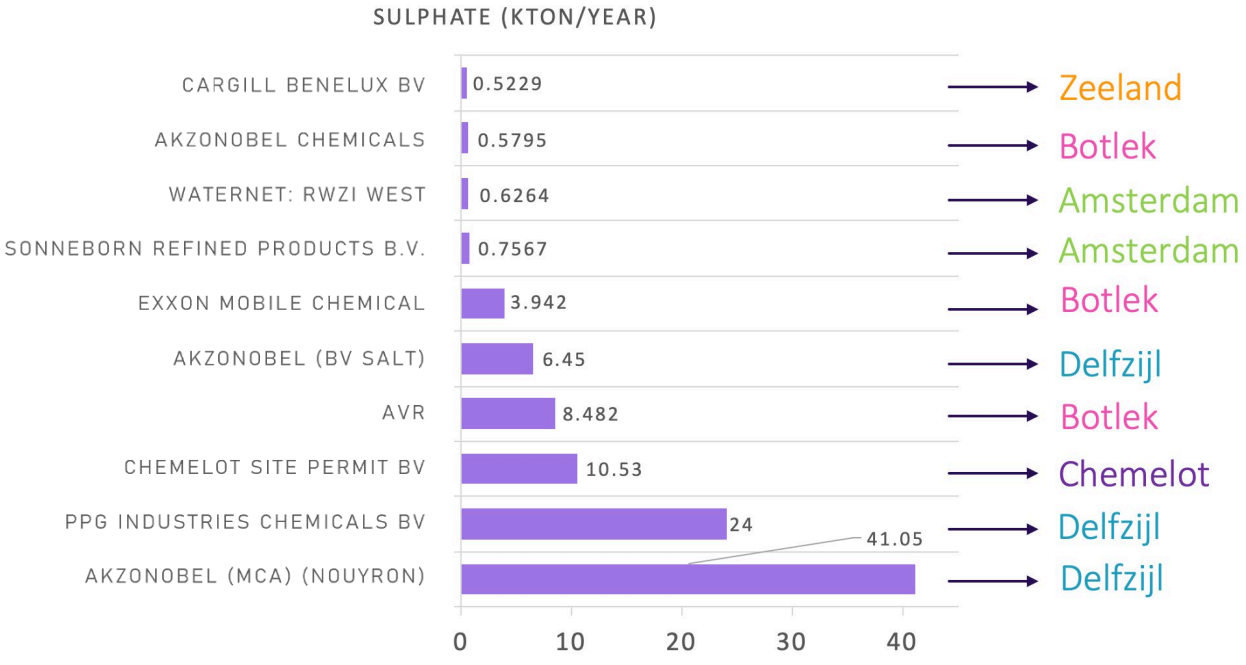
Cluster Results: Total Nitrogen Discharge Per Cluster



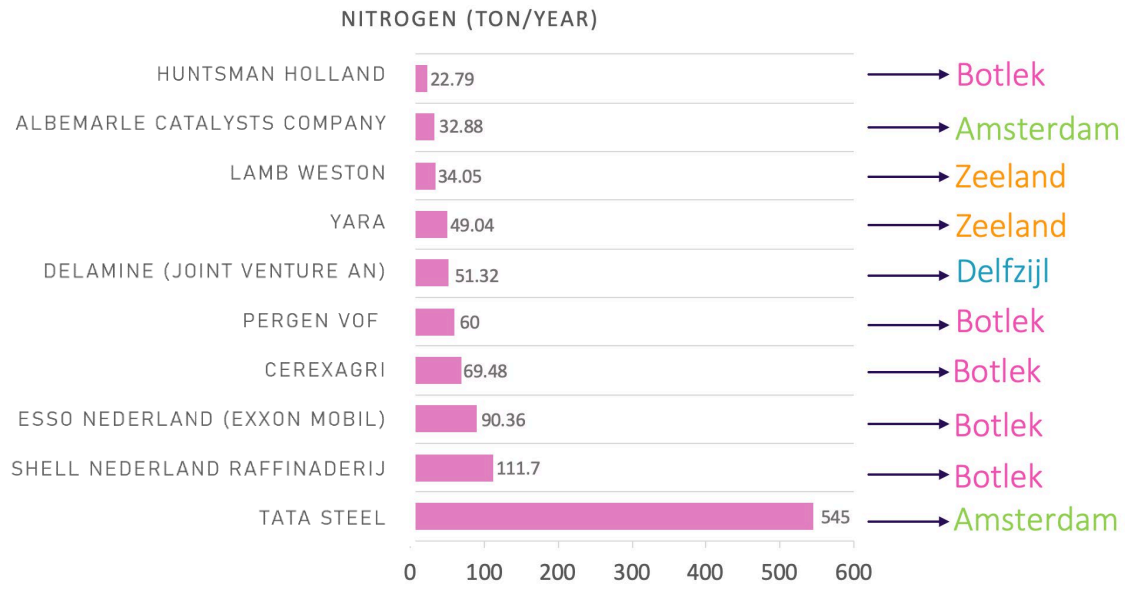
Cluster Results: Top Chloride Producers



Cluster Results: Top Sulphate Producers



Cluster Results: Top Nitrogen Producers



Appendix C. Industry Mapping Database: Brine producers

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
Waternet: RWZI West	Amsterdam	Wastewater treatment plant	Water treatment	15.71	0.6264	817300	565000	Surface waters	Relevant	Emissieregistratie 2016
Waternet: RWZI Westpoort	Amsterdam	Wastewater treatment plant	Water treatment	10.21	0.2486	394600	183300	Surface waters	Relevant	Emissieregistratie 2016
A1	Amsterdam	The cluster operator	-	-	-	-	-	-	Relevant	
A2	Amsterdam	Online platform	-	-	-	-	-	-	Highly relevant	
Companies										
Afval Energie Bedrijf (AEB Amsterdam)	Amsterdam	Separation/Incineration of waste	Waste Processing	3.414	-	4227	1782	Surface waters	Highly relevant	Emissieregistratie 2016
Albemarle Catalysts Company	Amsterdam	Production of lithium, bromine, refining catalysts (for petrochemical)	Chemical	negligible	negligible	negligible	32880	Sewers	Highly relevant	Emissieregistratie 2016
A3	Amsterdam	Road construction products	Construction	na	na	na	na	na	Less relevant	
A4	Amsterdam	Bio-based chemicals + Catalysts	Chemical/R&D	na	na	na	na	na	Not relevant	
A5	Amsterdam	Soy products, emulsifiers and other foodstuff	Food	na	na	na	na	na	Relevant	
A6	Amsterdam	Production of biodiesel from waste fats and oils	Chemical	na	na	na	na	na	Relevant	
Sonneborn Refined Products B.V.	Amsterdam	Specialty hydrocarbons from base and petroleum oils	Chemical	0.03489	0.7567	10100	negligible	Surface waters	Highly relevant	Emissieregistratie 2016
Cargill (Multiseed)	Amsterdam	Oilseed crushing facility	Food	0.07201	negligible	28970	1754	Load to sewers	Relevant	Emissieregistratie 2016
Cargill (Soja)	Amsterdam	Soya processing	Food	0.02978	0.5105	na	7349	Load to sewers	Relevant	Emissieregistratie 2016

Chemtura Netherlands BV (now Lanxess)	Amsterdam	Flame retardant and lubricant additives	-	0.09058	negligible	negligible	negligible	Load to sewers	Not relevant	Emissieregistratie 2016
ICL Fertilizers	Amsterdam	Fertilizer production	Chemical	0.02575	na	na	na	Load to sewers	Relevant	Emissieregistratie 2016
A7	Amsterdam	Converting org. waste into biofuels	Waste Processing	na	na	na	na	na	Less relevant	
MAIN BV	Amsterdam	Waste Collection	Waste Processing	0.5578	0.04004	na	4839	Load to sewers	Less relevant	Emissieregistratie 2016
A8	Amsterdam	Coal and gas fired power plants	Energy utility	na	na	na	na	na	Relevant	
Oxea	Amsterdam	Production of oxo products	Chemical	negligible	negligible	negligible	negligible	negligible	Relevant	Emissieregistratie 2016
A9	Amsterdam	Organig waste stream processing	Chemical	na	na	na	na	na	Highly relevant	
A10	Amsterdam	Paints manufacturing	Chemical	na	na	na	na	na	Relevant	
A11	Amsterdam	Production of pellets from waste	Waste Processing	na	na	na	na	na	Less relevant	
A12	Amsterdam	Processing of used cooking oil	Waste Processing	na	na	na	na	na	Relevant	
Simadan Group	Amsterdam	Processing and upgrading of organic waste streams	Waste Processing	na	na	895,6	5995	Load to sewers	Relevant	Emissieregistratie 2016
Tata Steel	Amsterdam	Steel production	Steel production	na	na	206100	545000	Surface waters	Highly relevant	Emissieregistratie 2016
A13	Amsterdam	Biomass Power Plant	Energy utility	na	na	na	na	na	Relevant	
A14	Amsterdam	Calcite pellets reuse	Water treatment	na	na	na	na	na	Highly relevant	
A15	Amsterdam	Water processing	Water treatment	na	na	na	na	na	Relevant	

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
B1	Botlek	Cluster operator	-	-	-	-	-	-	-	-
B2	Botlek	Production of demiwater	Water treatment	na	na	na	na	na	Highly relevant	
AVR	Botlek	Energy provider/Water treater	Waste treatment/Energy utility	5.801	8.482	8745	2441	Surface Waters	Highly relevant	Emissieregistratie 2016
RWZI Rotterdam-Dokhaven	Borlek	Wastewater treatment plant	Water treatment	7.921	0.2763	1302000	620000	Surface Waters	Less relevant	Emissieregistratie 2016
RWZI Rotterdam-Hoogvliet	Botlek	Wastewater treatment plant	Water treatment	0.4294	0.04821	245600	43920	Surface Waters	Less relevant	Emissieregistratie 2016
Companies										
Air Products	Botlek	Production of industrial gasses	Chemical	na	na	2174	289	Surface Waters	Less relevant	Emissieregistratie 2016
AkzoNobel Chemicals	Botlek	Chlorine and other chemicals	Chemical	11.65	0.5795	3833	9031	Surface Waters	Highly relevant	Emissieregistratie 2016
Almatis BV	Botlek	Alumina production	Chemical	na	na	na	na	na	Less relevant	
Aluchemie	Botlek	Production of anoeds	Chemical	na	na	1857	782,1	Surface Waters	Less relevant	Emissieregistratie 2016
B3	Botlek	Sulfur products	Chemical	na	na	na	na	Surface Waters	Relevant	
AVR	Botlek	Energy production	Waste processing/Energy utility	5.801	8.482	8745	2441	Surface Waters	Highly relevant	Emissieregistratie 2016
Biopetrol Rotterdam BV	Botlek	Biodiesel production	Chemical	na	na	5550	1159	Phosphorus 1138 kg/year	Less relevant	Emissieregistratie 2016
B4	Botlek	PVC production	Chemical	na	na	na	na	na	Highly relevant	

BP Rotterdam Refinery	Botlek	Oil refinery	Chemical	na	na	45040	10850	Fluorine and inorganic compounds 22890 kg/year. Discharge to surface waters	Less relevant	Emissieregistratie 2016
Caldic BV	Botlek	Formaldehyde derivatives	Chemical	na	na	1122	negligible	Surface Waters	Less relevant	Emissieregistratie 2016
Cargill Refined Oils BV	Botlek	Refined oils	Chemical/Food	na	na	66420	17270	surface waters	Less relevant	Emissieregistratie 2016
Cerexagri	Botlek	Crop protectino products	Chemical	na	na	39470	69480	surface waters	Relevant	Emissieregistratie 2016
Climax Molybdenum	Botlek	Molybden products	Chemical	na	na	1876	842,1	surface waters	Relevant	Emissieregistratie 2016
Ducor Petrochemicals	Botlek	Polymer production	Chemical	na	na	6960	833	surface waters	Relevant	Emissieregistratie 2016
Emerald Kalama Chemicals	Botlek	Benzoic acid production	Chemical	negligible	0.06842	23880	3250	surface waters	Relevant	Emissieregistratie 2016
Enecogen	Botlek	Gas energy production	Energy utility	0.07618	na	na	369	surface waters	Relevant	Emissieregistratie 2016
B5	Botlek	Electricity, heat	Energy utility	na	na	na	na	na	Relevant	
Esso Nederland (Exxon Mobil)	Botlek	Refinery	Chemical	3.436	na	56480	90360	surface waters	Highly relevant	Emissieregistratie 2016
Euroliquids	Botlek	Fertilzier/Adblue	Chemical	negligible	negligible	negligible	negligible	surface waters	Relevant	Emissieregistratie 2016
Exxon Mobile Chemical	Botlek	Refinery	Chemical	negligible	3.942	2516	5215	surface waters	Highly relevant	Emissieregistratie 2016
Friesland Campina	Botlek		Food	0.04393	0.2167	66000	7670	Load to sewers	Relevant	Emissieregistratie 2016
B6	Botlek	Coal power plant	Energy utility	na	na	na	na	na	Less relevant	
Port of Rotterdam	Botlek	Cluster/Port operator	Cluster/Port operator	37.76	negligible	negligible	negligible	surface waters	Highly relevant	Emissieregistratie 2016

Huntsman Holland	Botlek	MDI Production	Chemical	20.11	na	102300	22790	surface waters	Highly relevant	Emissieregistratie 2016
Indorama Holdings Rotterdam	Botlek	PTA and PET production	Chemical	na	na	5689	1349	surface waters	Relevant	Emissieregistratie 2016
Kemira Rotterdam	Botlek	Polyacrilamides	Chemical	na	na	5700	na	surface waters	Less relevant	Emissieregistratie 2016
Koch HC Partnership (VITOL)	Botlek	Refienry	Chemical	0.04951	na	1231	144,9	surface waters	Less relevant	Emissieregistratie 2016
Gunvoer Petroleum Rotterdam	Botlek	Refinery	Chemical	na	negligible	10800	10070	surface waters	Less relevant	Emissieregistratie 2016
Lyondel Chemical	Botlek	Petrochemical	Chemical	na	na	1287	335	surface waters	Relevant	Emissieregistratie 2016
Shell Nederland Raffinaderij	Botlek	Refinery/petrochemical	Chemical	93.56	na	421100	111700	Surface Water	Highly relevant	Emissieregistratie 2016
B7	Borlek	Petrochemical	Chemical	na	na	na	na	na	Highly relevant	
Neste oil Netherlands	Botlek	Biofuel	Chemical	na	na	2355	18840	Surface Water	Highly relevant	Emissieregistratie 2016
OCI Nitrogen	Botlek	Fertilizer	Chemical	na	na	na	negligible	Surface Water	Highly relevant	Emissieregistratie 2016
Organik Kimya	Botlek	Acryloc polyer	Chemical	0.05066	na	5513	544		Relevant	Emissieregistratie 2016
Pergen VOF	Botlek	Heat and power (gas PP)	Energy utility	1.006	0.275	na	60000	Surface Water	Relevant	Emissieregistratie 2016
RDM	Botlek	R&D	Innovation hub	0.01066	na	na	na	Load to sewers	Less relevant	Emissieregistratie 2016
Trenox pigments	Botlek	TiO2 production	Chemical	14.92	na	na	na	Surface Water	Highly relevant	Emissieregistratie 2016
B8	Botlek	Municipal waste processing	Waste processing	na	na	na	na	na	Relevant	
Vopak	Botlek	Tank storage	Tank storage	2.505	na	40040	1430	Surface Water	Relevant	Emissieregistratie 2016
B9	Botlek	Vegetable oil processing	Food	na	na	na	na	Surface Water	Not relevant	

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
C1	Chemelot	Industrial Utility / Provision of services	Service provider	na	na	na	na	na	Highly relevant	
C2	Chemelot	Industrial Utility	Service provider	na	na	na	na	na	Highly relevant	
C3	Chemelot	Water board	-	na	na	na	na	na	Less relevant	
C4	Chemelot	Industrial Utility	Service provider	na	na	na	na	na	Highly relevant	
C5	Chemelot	Knowledge institute	Innovation Knowledge institute	na	na	na	na	na	Relevant	
C6	Chemelot	The cluster operator	-	na	na	na	na	na	Relevant	
Companies										
Chemelot site permit bv	Chemelot	Probably a utility of Sitech or USG	?	2.598	10.53	275100	542000	surface water	Highly relevant	Emissieregistratie 2016
C7	Chemelot	Producer of fertilizers	Chemical	na	na	na	na	na	Highly relevant	
C8	Chemelot	Production of raw materials for petrochemical purposes	Chemical	na	na	na	na	na	Highly relevant	
C9	Chemelot	Producer of basic chemicals	Chemical	na	na	na	na	na	Highly relevant	
C10	Chemelot	Elastomers producer	Chemical	na	na	na	na	na	Less relevant	
C11	Chemelot	Plastomers production	Chemical	na	na	na	na	na	Relevant	
C12	Chemelot	Production of refractory concrete	Chemical	na	na	na	na	na	Less relevant	
C13	Chemelot	Surface treatment/protection	Chemical	na	na	na	na	na	Less relevant	

C14	Chemelot	Research center	Chemical/knowledge institute	na	na	na	na	na	Relevant	
C15	Chemelot	Technical service provider	-	na	na	na	na	na	Less relevant	
C16	Chemelot	Caprolactam production	Chemical	na	na	na	na	na	Relevant	
C17	Chemelot	Development and production of styrene maleic anhydride	Chemical	na	na	na	na	na	Less relevant	
C18	Chemelot	Waster recycling/processing	Waste processing	na	na	na	na	na	Relevant	
C19	Chemelot	Cleaning of industrial sites + waste management	Waste processing	na	na	na	na	na	Less relevant	
C20	Chemelot	Engineering and management consultancy	-	na	na	na	na	na	Relevant	
C21	Chemelot	CHP	Energy utility	na	na	na	na	na	Highly relevant	
C22	Chemelot	Production of the PVB film	Chemical	na	na	na	na	na	Relevant	
C23	Chemelot	Concrete constructions	Construction for industrial projects	na	na	na	na	na	Less relevant	
C24	Chemelot	Civil engineering	Civil engineering	na	na	na	na	na	Less relevant	
C25	Chemelot	Production of PVC powder	Chemical	na	na	na	na	na	Highly relevant	

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
RWZI Delfzijl	Delfzijl	(Municipal) Water treatment	Water treatment	0.20	0.02	179100	25240	Surface Water	Less relevant	https://www.watersector.nl/rwzi/164/rwzi
North Water	Delfzijl	(Industrial) Water treatment	Water treatment	na	na	na	na	Surface Water	Highly relevant	https://www.chemportdelfzijl.eu/water/; www.northwater.nl/en/projects/swwtp/
D1	Delfzijl	Cluster Operator	-						Relevant	
D2	Delfzijl	Industrial Water Treatment	Water treatment						Highly relevant	
Companies										
BioMCN	Delfzijl	Biofuels	Chemical	0.001301	na	na	na	Surface Water	Less relevant	Emissieregistratie 2015
Delamine (Joint venture AN)	Delfzijl	Ethylene amine production (Dichlorethane + ammonia reaction)	Chemical	66.19	na	27950	51320	Surface Water	Highly relevant	Emissieregistratie 2016
AkzoNobel (MCA) (Nouyron)	Delfzijl	Monochloroacetic production (liquid and dry) (Chlorination of acetic acid)	Chemical	189.8	41.05	134200	17790	Surface Water	Highly relevant	Emissieregistratie 2016
Teijin	Delfzijl	Aramid production	Chemical	6.477	na	na	na	Surface Water	Highly Relevant	Emissieregistratie 2016
Zeolyst CV	Delfzijl	Production of Zeolite powder (adsorbents or catalysts)	Chemical	4.3	na	na	2483	Surface Water	Highly relevant	Emissieregistratie 2016
ESD-SIC BV	Delfzijl	Production of anorganic base chemicals (sillicum carbide production SiC)	Chemical	0.02121	na	na	na	Surface Water	Relevant	Emissieregistratie 2016
PPG Industries Chemicals BV	Delfzijl	Production of anorganic base chemicals - sillica production for tire production	Chemical	na	24	4162	949	Surface Water	Highly relevant	Emissieregistratie 2016

Rohm and Haas BV	Delfzijl	Production of anorganic base chemicals	Chemical	negligible	negligible	na	na	na	Not relevant	Emissieregistratie 2016
D3	Delfzijl	Production on Plaster	Chemical	na	na	na	na	na	Not relevant	
D4	Delfzijl	Production of Methyleen Difenyl di-Isocyanaat (MDI) - basis for polyurethane	Chemical	na	na	na	na	na	Relevant	
D5	Delfzijl	Tank Storage	Oil and Gas	na	na	na	na	na	Not relevant	
D6	Delfzijl	Ceramic products for construction sector	Construction	na	na	na	na	na	Not relevant	
AkzoNobel (BV Salt)	Delfzijl	Extraction of Salt	Mining	59.25	6.45	12680	1328	Surface Water	Highly relevant	Emissieregistratie 2016
Lubrizol	Delfzijl	Production of Chlorinated PVC (use of Cl2 + PVC powder)	Chemical	4.117	na	na	na	Surface Water	Relevant	Emissieregistratie 2016
AkzoNobel Delesto BV	Delfzijl	Production of electricity	Oil and Gas (Energy utility)	0.08642	na	na	1384	Surface Water	Relevant	Emissieregistratie 2016
D7	Delfzijl	Refinery	Oil and Gas (Energy utility)	na	na	na	na	na	Not relevant	
D8	Delfzijl	Distribution of Pharmaceuticals/Intermediary	Chemical	na	na	na	na	na	Not relevant	
Noveon Holland BV	Delfzijl	Trade intermediation in fuels, ores, metals, chemicals	Oil and Gas, Metals, Steel and Iron	4.986	na	7880	19	Surface Water	Relevant	Emissieregistratie 2005
D9	Delfzijl	Thermal Waste recycle plant	Energy utility (Provision of heat/electricity)	na	na	na	na	na	Relevant	
D10	Delfzijl	Production of electricity from biomas (woodchips from waste wood)	Energy Utility (Provision of heat/electricity)	na	na	na	na	na	Relevant	
D11	Delfzijl	Aluminum	Aluminium Production	na	na	na	na	na	Less relevant	

FMC Chemicals Netherlands BV	Delfzijl	Production of anorganic base chemicals	Chemical	0.04537	na	36680	na	Sewer	Less relevant	Emissieregistratie 2010
Dynea BV/Chemcom industries	Delfzijl	Plastics	Chemical	na	na	3386	2976	na	Less relevant	Emissieregistratie 2016
D12	Delfzijl	Master alloys production	Chemical	na	na	na	na	na	Less relevant	
Koninklijke Nedalco BV (Farmsum)	Delfzijl	Production of alcohol for Industry or Distillery (consumer alcohol)	Food and Drinks/Industry	0.0643	na	102000	1295	Surface Water	Relevant	Emissieregistratie 2016
D13	Delfzijl	Gas powered power plant	Energy utility (Provision of heat/electricity)	na	na	na	na	Surface Water	Relevant	
D14	Delfzijl	Glycerine production	Chemical	na	na	na	na	na	Relevant	

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
E1	Emmen	The cluster operator	-	-	-	-	-	-	Relevant	
E2	Emmen	Network plaftorm for SMEs	-	-	-	-	-	-	Highly relevant	
E3	Emmen	The cluster operator	-	-	-	-	-	-	Highly relevant	
Emmtec Services	Emmen	Service provider (heat, power, water)	Industrial wastewater	na	na	19130	11960	Surface waters	Highly relevant	Emissieregistratie 2016
E4	Emmen	Bioplastics	-	-	-	-	-	-	Relevant	
RWZI Emmen	Emmen	WWTP		0.835	0.09114	216700	46360	Surface waters	Less relevant	Emissieregistratie 2016

Companies										
E5	Emmen	Nylon production	Chemical (Polymer Industry)	na	na	na	na	na	Highly relevant	
E6	Emmen	Polyester production	Chemical (Polymer Industry)	na	na	na	na	na	Highly relevant	
Teijin Aramid	Emmen	Aramid production	Chemical	na	0.121	na	na	Surface waters	Highly relevant	Emissieregistratie 2016
E7	Emmen	Polyester uprgrading	Chemical (Polymer Industry)	na	na	na	na	na	Relevant	
E8	Emmen	Plastic producer/recycler	Chemical (Polymer Industry)	na	na	na	na	na	Relevant	
E9	Emmen	Fabrics/technical textile production	Textile	na	na	na	na	na	Relevant	
E10	Emmen	Producer of recycled plastics	Chemical (Polymer Industry)	na	na	na	na	na	Relevant	
E11	Emmen	Waste recycling	Waste processing	na	na	na	na	na	Not relevant	
E12	Emmen	Plastic producer	Chemical (Polymer Industry)	na	na	na	na	na	Relevant	
E13	Emmen	Gelatin and collagen production	Chemical/Meat process	na	na	na	na	na	Relevant	
E14	Emmen	Biodiesel production	Chemical	na	na	na	na	na	Less relevant	
E15	Emmen	Applied polymer research	Chemical (Polymer Industry)	na	na	na	na	na	Not relevant	
E16	Emmen	Producer of 3D filaments	Chemical (Polymer Industry)	na	na	na	na	na	Less relevant	
E17	Emmen	Fertilizer producer		na	na	na	na	na	Relevant	

Company name	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Emitted to	Relevance for ZB	Source of information
Utilities & Other stakeholders important for the Cluster										
Z1	Zeeland	Cluster operator	-	-	-	-	-	-	Relevant	
RWZI Berkel	Zeeland	WWTP	WWTP	0.1636	0.01608	50740	10580	Surface Waters	Less relevant	Emissieregistratie 2016
RWZI Nieuwe Waterweg	Zeeland	WWTP	WWTP	0.5645	0.06161	344000	74060	Surface Waters	Less relevant	Emissieregistratie 2016
RWZI Zwaanshoek	Zeeland	WWTP	WWTP	0.5322	0.05976	192500	36810	Surface Waters	Less relevant	Emissieregistratie 2016
RWZI Terneuzen	Zeeland	WWTP	WWTP	1.794	0.04502	274400	57200	Surface Waters	Relevant	Emissieregistratie 2016
Z2	Zeeland	Industry water treatment (AWZI)	Industry water treatment (AWZI)	na	na	na	na	na	Highly relevant	
Companies										
Cargill Benelux BV	Zeeland	Manufacture of starches	Food	2.012	0.5229	65930	13540	Surface Waters	Relevant	Emissieregistratie 2016
Z3	Zeeland	Transportation/storage	Transportation/storage	na	na	na	na	na	Not relevant	
Z4	Zeeland	Palm oil products	Food	na		na	na	na	Relevant	
Z5	Zeeland	Styrene polymers	Chemical	na	na	na	na	na	Relevant	
Z6	Zeeland	Plastic production	Chemical	na	na	na	na	na	Less relevant	
Z7	Zeeland	Oil storage	Storage	na	na	na	na	na	Less relevant	
Dow Chemical	Zeeland	Petrochemical	Chemical	na	na	157200	na	Surface Waters	Highly relevant	Emissieregistratie 2016
ICL-IP Terneuzen	Zeeland	Products based on Bromine	Chemical	0.174	0.0701	4738	1474	Surface Waters	Highly relevant	Emissieregistratie 2016

Z8	Zeeland	Wind and Nuclear energy	Energy utility	na	na	na	na	na	Less relevant	
Zeeland Refinery (JV of Total and Lukoil)	Zeeland	Petrochemical (Refinery)	Chemical	na	na	10400	2502	Surface Waters	Less relevant	Emissieregistratie 2016
Arkema Vlissingen	Zeeland	Chemical	Chemical	na	na	201	na	Surface Waters	Relevant	Emissieregistratie 2016
Z9	Zeeland	Aluminium production	Chemical	na	na	na	negligible	Surface Waters	Not relevant	
Z10	Zeeland	Storage of oil products	Storage	na	na	na	na	na	Less relevant	
Z11	Zeeland	Polyols manufacturing	Chemical	na	na	na	na	na	Relevant	
Z12	Zeeland		Chemical	na	na	na	na	na	Less relevant	
Coroos	Zeeland	Preservation of Food	Food	8.858	na	na	7703	na	Highly relevant	Emissieregistratie 2016
Lamb Weston	Zeeland	Processinga and preserving of potatoes	Food	1.326	na	104000	34050	Surface Waters	Relevant	Emissieregistratie 2016
Suiker Unie (Cosun)	Zeeland	Manufacture of sugar	Food	0.1927	na	39050	20970	Surface Waters	Highly relevant	Emissieregistratie 2016
Yara	Zeeland	Fertilizer and nitrogen compounds	Chemical	na	0.04711	4618	49040	Surface Waters	Highly relevant	Emissieregistratie 2016
Z13	Zeeland	Metal processing	Metal processing	na	na	na	na	na	Less relevant	
Heros Sluiskil	Zeeland	Secondary materials reuse	Waste Processing	1.86	0.173	16350	3617	Load to sewers	Highly relevant	Emissieregistratie 2016
Rosier Nederland	Zeeland	Fertilizer compounds	Chemical	na	0.09607	na	14160	Surface Waters	Highly relevant	Emissieregistratie 2016
Cargil BV	Zeeland	Manufacture of starches	Food	1.725	0.1648	75780	12280	Load to sewers	Relevant	Emissieregistratie 2016
Sabic Innovative Plastics	Zeeland	Polycarbonate and resin production	Chemical	na	na	12290	5411	Surface Waters	Relevant	Emissieregistratie 2016
Lamb Weston	Zeeland	Potato processing	Food	na	na	na	14420 + (32760 of P)	Load to sewers	Highly relevant	Emissieregistratie 2016

Company name	Type	Location	Cluster	Production	Sector	Amount of chloride (kta/year)	Amount of Sulphates (kta/year)	Total Organic Carbon (kg/year)	Total Nitrogen (kg/year)	Sodium & Compounds (kg/year)	Emitted to	Relevance for ZB	Source of information
Frisia	Producer	Harlingen	Close to Delfzijl	Salt Production	Mining/Chemical	47.17	na	na	na	na	Surface Water	Highly Relevant	Emissieregistratie 2018
Nedmag	Producer	Veendam	Close to Delfzijl	Magnesium salt production	Mining/Chemical	88.85	0.5597	na	na	na	Surface Water	Highly Relevant	Emissieregistratie 2018
Kisuma Chemicals	Producer	Veendam	Close to Delfzijl	Magnesium compounds	Chemical	14.86	negligible	3097	1235	9659000	na	Highly Relevant	Emissieregistratie 2018
Friesland Campina Bedum	Producer	Bedum	Close to Delfzijl	Dairy products	Food	7.56	na	46370	18100	na	Surface Water	Highly Relevant	Emissieregistratie 2018
Avebe	Producer	Foxhol	Close to Delfzijl	Food products (potato base)	Food	5.335	0.1157	na	15620	na	Surface Water	Highly Relevant	Emissieregistratie 2018
Koch HC partnership	Producer	Europoort Rotterdam	Botlek	Refining	Chemical	0.04951	negligible	1231	negligible	32190	Surface Water	Relevant	Emissieregistratie 2018
ESD-SIC BV	Producer	Farmsum	Delfzijl	Silicumcarbide	Chemical	0.02121	na	na	na	13790	Surface Water	Relevant	Emissieregistratie 2018

Appendix D. Industry Mapping Database: Minerals end users

Company name	Cluster	Production	Sector	Quality of NaCl (%)	Quality of $CaCl_2$ (%)	Quality of $(NH_4)_2SO_4$ (%)	Quality of $MgCl_2$ (%)	Quality of $Mg(OH)_2$ (%)	Quality of Na_2CO_3 (%)	Quantity (kt/year)
M1	Delfzijl	Chlorine and other chemicals	Chemical	99.5						93
M2	Botlek	Chlorine and other chemicals	Chemical	99.5						499
M3	Botlek	Demiwater	Water treatment	99.8						4.5
M4	Amsterdam	Water	Water treatment				32			2407
M5	Chemelot	Chlorine and other chemicals	Chemical	99.9						70-80
M6	Outside Clusters	Textile	Textile	99.7						22
M7	Outside Clusters	Minerals	Chemical				76.9	98.5		
Dutch municipalities	Outside Clusters	- (Road salt)*	Public	99						507
Flevoland communities	Outside Clusters	-	Public	93						
Pharma	Outside Clusters	Medicine	Pharmaceutical	>99	93	>99		>95		
M8	Outside Clusters	Thermoplastic products	Manufacturing	99.8						0.002
M9	Outside Clusters	Process water	Water treatment	99.8						0.06
M10	Outside Clusters	Paper	Paper and pulp	99.96						Low quantity
M11	Amsterdam	Fertilizer	Agriculture		78				99.5	
M12	Outside Clusters	Paper	Paper and pulp	99						20
M12	Outside Clusters	Paper	Paper and pulp						95	40
M13	Delfzijl	Chemicals	Chemicals	99.5						0.498
M14	Outside Clusters	Textile	Textiles	99.7						0.175
M14	Outside Clusters	Textile	Textiles						99	0.0013
M15	Outside Clusters	Fertilizer	Agriculture		As pure as possible					0.05-0.1
M15	Outside Clusters	Fertilizer	Agriculture				As pure as possible			0.1-0.2

* consumption of road salt to ensure safety in highways

Appendix E. 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?**

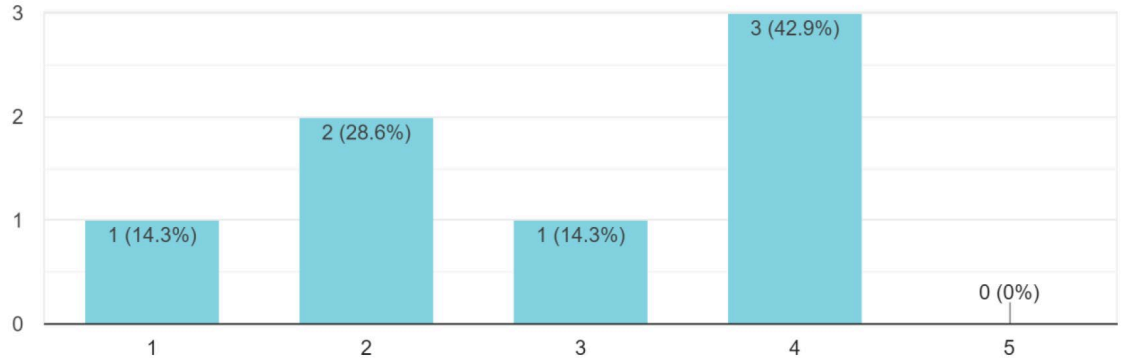
Mark only one oval.

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

Appendix F. Questionnaire Results

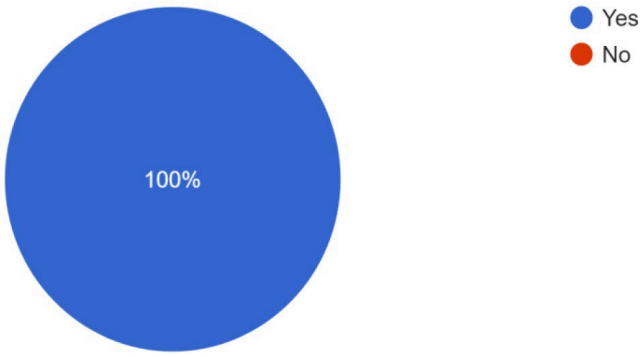
What priority would you give to ensuring stable water supply for your company?

7 responses



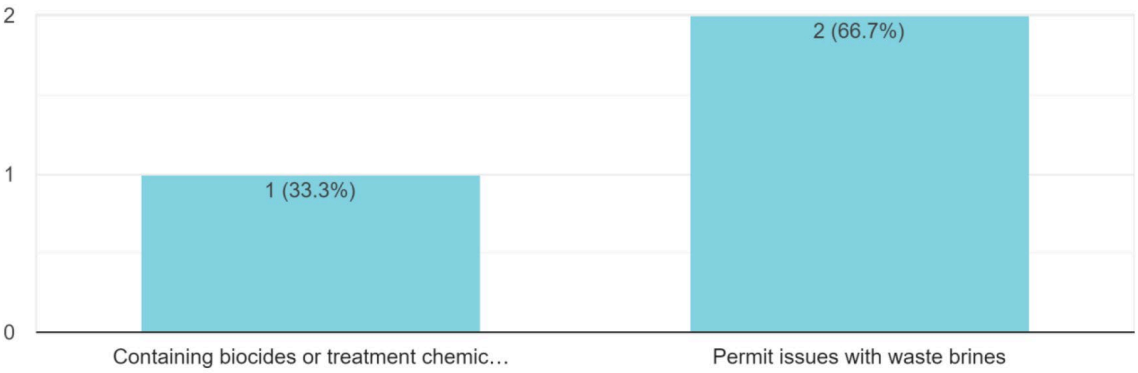
Have you encountered any problems with treatment of brines in the past?

7 responses



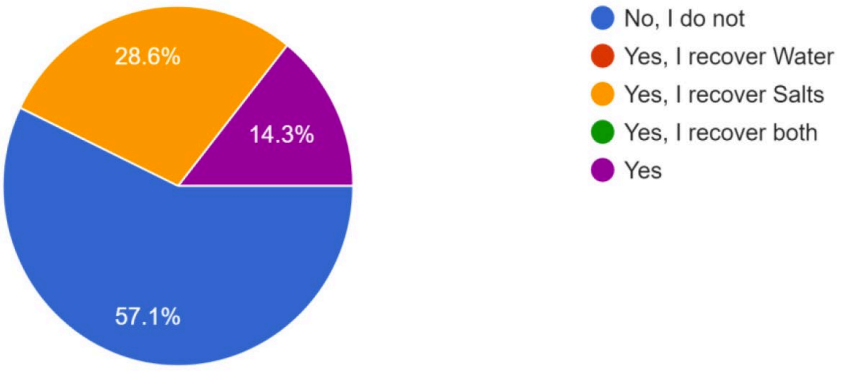
If Yes, could you be more specific? (optional)

3 responses



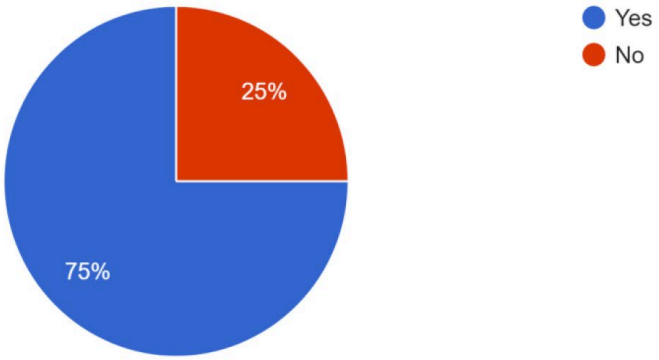
Do you currently recover any materials (salts or water) from brines?

7 responses



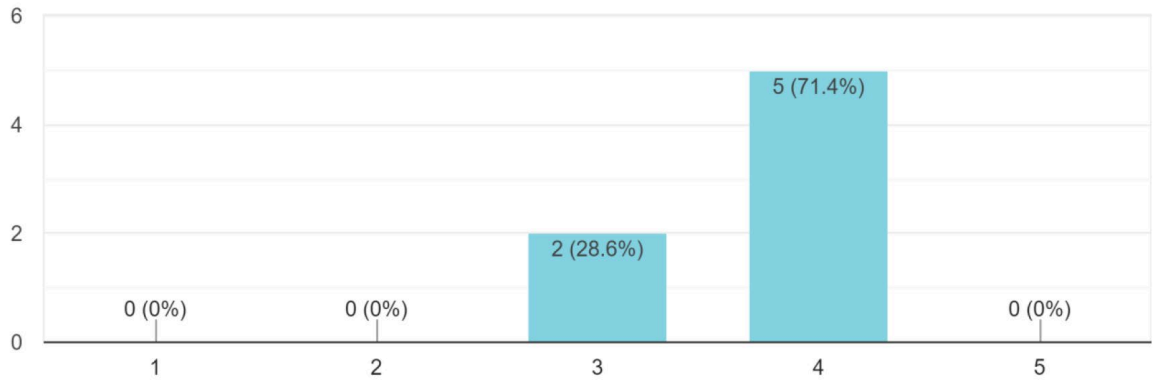
Are you investigating any possibilites to recover water or minerals from brines?

4 responses



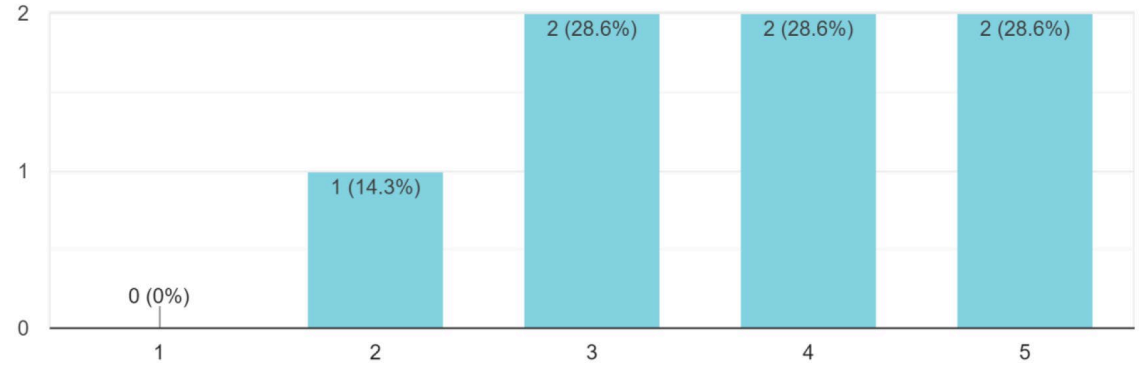
How important is finding new business partners for you?

7 responses



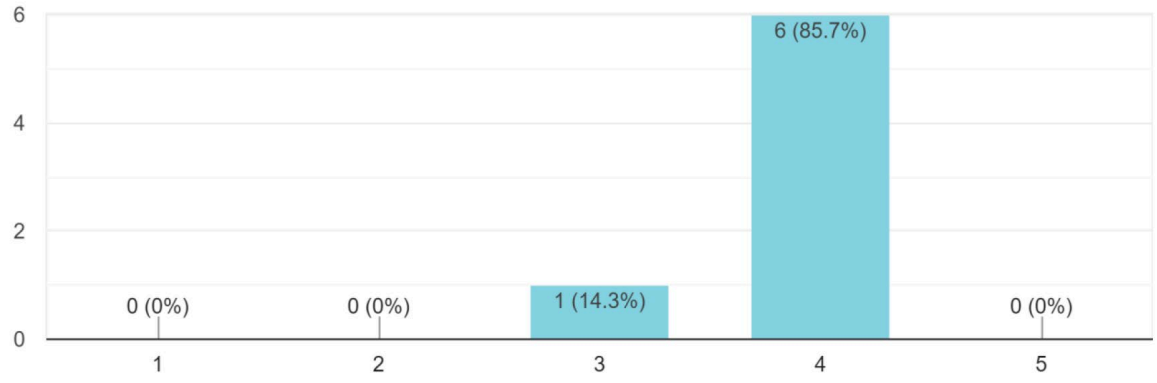
Would you be willing to matchmake with other partners on the Online Brine Platform?

7 responses



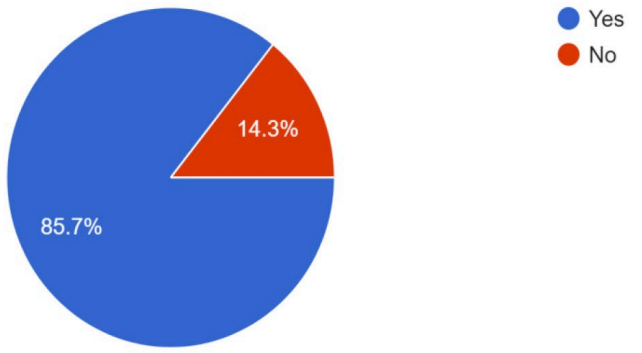
Do you find the concept of the Online Brine Platform useful?

7 responses



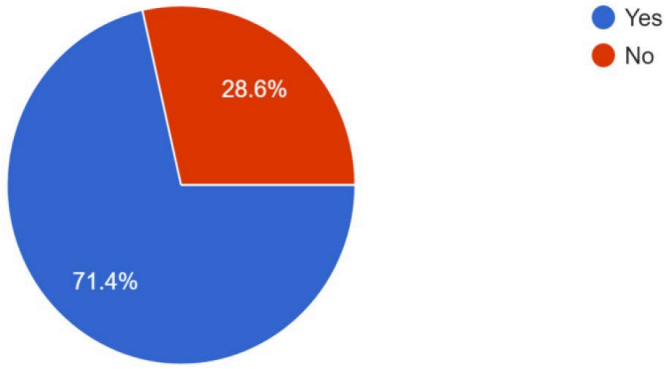
Would you be willing to upload information regarding your brine streams on this platform?

7 responses

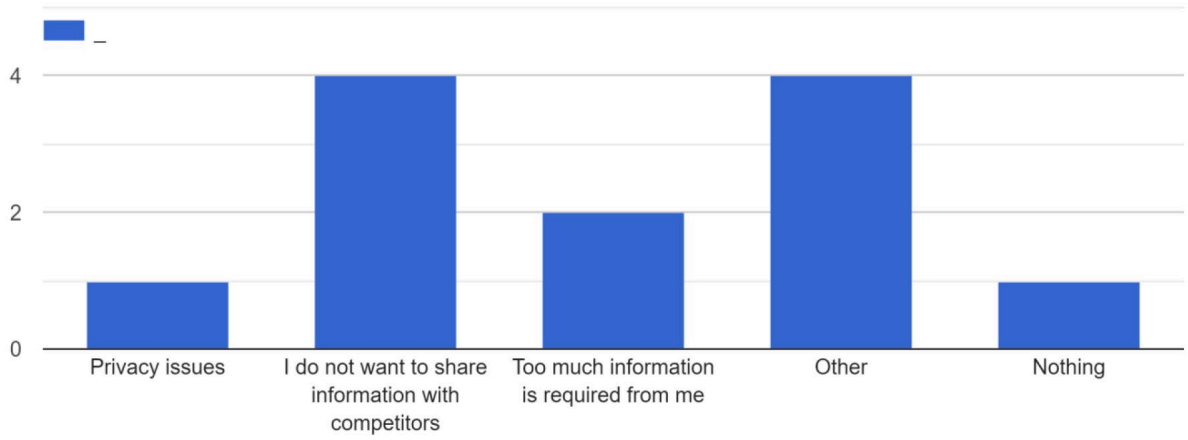


Would you be willing to upload company information on this platform?

7 responses

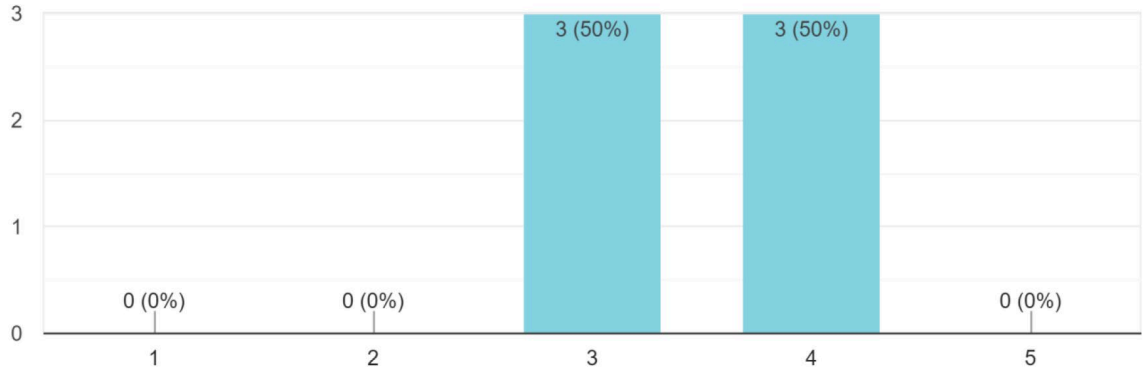


What could discourage you from using the platform?



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

6 responses



Appendix G. 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)[3]

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

[3] 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)[4]

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

[4] 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[5]

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

[5] 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)[6]

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

[6] 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