Deliverable 2.5

Replicability Study

Date: 31 August 2024

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▪ Living Labs ▪ Best practices ▪ Scale-up ▪ Replicability ▪ Recommendations

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Executive Summary

By 2030, the transition to a Water-Smart Society will be in full swing, driven by visionary front-running industries, cities and rural areas, taken the lead in laying out the migration paths towards the Water-Smart Society of the future. They will have implemented ambitious long-term investment and innovation programmes, as well as real-life Water Oriented Living Lab (WoLL) experimental areas. WoLLs will have created a European network of fertile and inclusive innovation ecosystems, where solution developers, researchers, forward-looking water users and water governing bodies will develop the leading solutions of the future. In Water Europe's vision[1] WoLLs will play an important role in driving the transition to the Water-Smart Society.

Water access and its related energy, environmental and economic costs are one of the greatest challenges for society today. According to the 2030 Water Resources Group of the World Bank global water demand by 2030 is expected to exceed sustainable water supply.

The WATER-MINING project aims to face this challenge and help ensure access to clean water and sanitation by developing innovative solutions for sustainable water management and by actively involving and engaging with stakeholders from across the water value chain, with a particular emphasis on the agricultural, urban and industrial sectors. Therefore, the creation of two WATER-MINING Living Labs offered an engaging environment around the different innovations demonstrated:

The Floating Farm[2] (FF) is a small-scale innovative circular farm located in the port of Rotterdam (the Netherlands), addressing animal welfare, sustainable food production, changing landscape conditions and wastewater management. The Floating Farm produces its required energy and products inside the city, and experiment with low-energy water desalination from the river Meuse, as well as urine-water purification to produce reusable water and recover nutrients to be used as fertilizer.

The Plataforma Solar de Almeria[3] (PSA) hosted by CIEMAT is located in southern Spain and has become a point of reference in the use of solar energy for desalination. PSA focuses on the use of solar thermal energy, both for concentrated solar power production and desalination, and as a WATER-MINING Living Lab it supports the engagement of stakeholders involved in the water-energy-food nexus.

This deliverable aims to report on the work carried out and results achieved in Work Package 2 " Co-creation through social engagement for societal embedding" and more specifically to the replicability of individual best practices developed by the two WATER-MINING Living Labs, FF and PSA. Therefore, this deliverable builds upon the evaluation reports of FF and PSA as presented in D2.4 - Evaluation report of two living labs[4], but it analyses the replicability of individual best practices developed by the Living Labs and not the replicability of the Living Lab in a whole.

The individual best practices could be diverse types of practices: an infrastructure (e.g. artificial sea, water purification installation), an equipment (e.g. dashboard for monitoring water pollution), a method (e.g. the way you run Communities of practice), a tool (e.g. a co-creation tool used to engage

[1] https://watereurope.eu/wp-content/uploads/2023/11/WE-Water-Vision-2023_online.pdf

[2] https://floatingfarm.nl/

[3] https://www.psa.es/es/index.php

[4] D2.4 – Evaluation report of two Living Labs. DOI: 10.5281/zenodo.13377928. https://zenodo.org/records/13377928

with citizens like) or a Living Lab service (e.g. testing and validation services, equipment and facility rental, co-creation services...)

A total of thirteen best practices were identified, Chapter 3 provides a detailed overview of the best practices shown here below:

- Purification and reuse of cow urine (infrastructure) (FF)
- Rainmaker (infrastructure) (FF)
- Integrated monitoring and processing (equipment) (FF)
- Test-bed for solar thermal applications (infrastructure) (PSA)
- Fully monitored multi-effect distillation plant (infrastructure) (PSA)
- Test-bed for membrane distillation at commercial scale (infrastructure) (PSA)
- Pilot plant for forward osmosis, reverse osmosis and nanfiltration (infrastructure) (PSA)
- Test bed for evaluate cooling systems for thermal desalination (infrastructure) (PSA)
- Pilot plant to test memberane distillation materials and applications (infrastructure) (PSA)
- Solar-powered zero-liquid discharge desalination system for greenhouse irrigation (infrastructure) (PSA)
- Engagement and participation of stakeholders (method) (PSA)
- Visitor centre as a tool for stakeholder engagement (tool) (PSA)
- Training activities (service) (PSA)

Following this, the individual best practices were presented to eleven external WoLLs from the European Network of Living Labs and Water Europe to assess their interest in the presented best practices and to identify barriers for replication from their perspective. More information about the assessment process can be found in Chapter 2.

The average interest rate for all presented individual best practices was 52,38% with a higher interest rate for Floating Farm (64%) than Plataforma Solar de Almeria (48,9%).

The most mentioned barriers for replicating the presented individual best practices were: non applicability of the presented solution, weather constraints, legal constraints, lack of physical space, lack of funding/capacity, lack of technical skills and the interoperability of data.

More details of the analysed results can be found in Chapter 4 of this deliverable.

Based on the analysis and the made suggestions to overcome the barriers for replication of the presented best practices of PSA and FF, guidelines for both were created to support the increase of possible replication of their individual best practices.

A total of 5 general guidelines (recommendations) to increase the possibility of replication of individual best practices were developed:

1. Development of comprehensive promotion materials
2. Identification of possible replication organizations
3. Participation in market-oriented events
4. Development of training modules
5. Offer of financial insights

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Acronyms

CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
COP	Community of Practice
ENoLL	European Network of Living Labs
FF	Floating Farm
GAIA	Industry Association of Applied Knowledge and Technologies
PSA	Plataforma Solar de Almeria
UAB	Universitat Autònoma de Barcelona
UFE	Utilizer Focused Evaluation
WoLL	Water-oriented Living Lab
WP	Work Package
T	Task
D	Deliverable
Q&A	Question & Answer
MOOC	Massive Open Online Courses

1 Introduction

Water access and its related energy, environmental and economic costs are one of the greatest challenges for society today.

According to the 2030 Water Resources Group of the World Bank[5] global water demand by 2030 is expected to exceed sustainable water supply.

The WATER-MINING project aims to face this challenge and help ensure access to clean water and sanitation by exploring alternative water sources and developing innovative solutions for sustainable water management, including tapping into urban and industrial wastewater and seawater desalination.

The WATER-MINING project aims to provide for real-world implementations of Water Framework Directive (and other water related legislation), as well as the Circular Economy and EU Green Deal packages by highlighting and validating innovative next generation water resource solutions at pre-commercial demonstration scale. These solutions combine WATER management services with the recovery of value-added renewable resources extracted/MINED from alternative water resources.

The project integrates selected innovative technologies that have reached proof of concept levels under previous EU projects. The value-added end-products (water, platform chemicals, energy, nutrients, minerals) are expected to provide regional resource supplies to fuel economic developments within a growing demand for resource security. Different layouts for urban wastewater treatment and seawater desalination are proposed, to demonstrate the wider practical potential to replicate the philosophy of approach in widening circles of water and resource management schemes. Innovative service-based business models (such as chemical leasing) are being introduced to stimulate progressive forms of collaboration between public and private actors and access to private investments, as well as policy measures to make the proposed water solutions relevant and accessible for rolling out commercial projects in the future. The goal is to enable costs for the recovery of the resources to become distributed across the whole value chain in a fair way, promoting business incentives for investments from both suppliers and end-users along the value chain. The demonstration case studies are to be first implemented in five EU countries (the Netherlands, Spain, Cyprus, Portugal, Italy) where prior successful technical and social steps have already been accomplished. The broader project consortium representation will be an enabler to transferring trans-disciplinary project knowledge to the partner countries while motivating and inspiring relevant innovations throughout Europe.

[5] https://2030wrg.org/

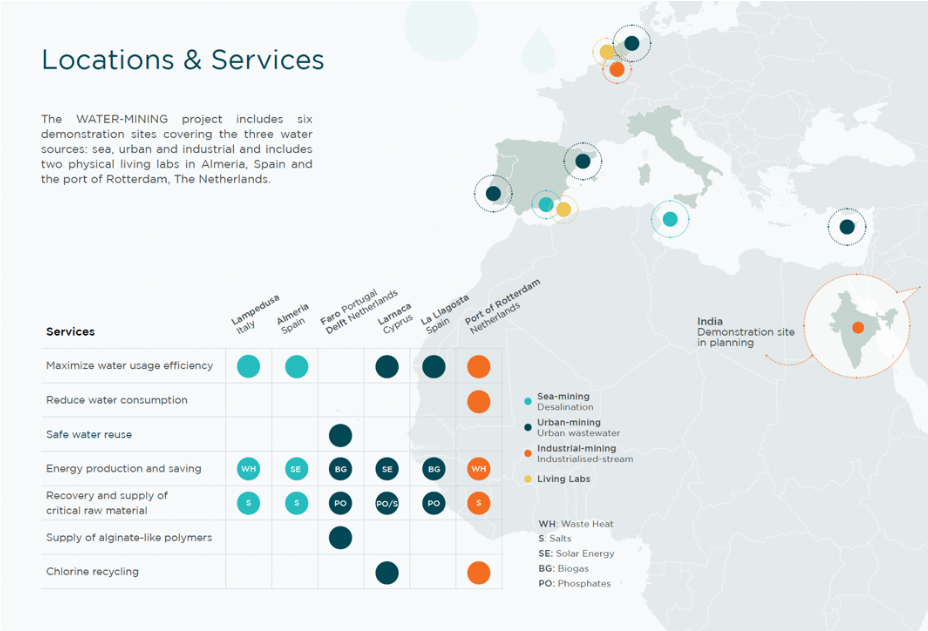


Figure 1. Overview WATER-MINING demonstration case studies and Living Labs

Within the WATER-MINING project two Living Labs are created: Plataforma Solar de Almeria (PSA) in Spain and Floating Farm (FF) in The Netherlands.

Figure 2. Logo Floating Farm

The Floating Farm is a small-scale innovative circular farm located in the port of Rotterdam, addressing animal welfare, sustainable food production, changing landscape conditions and wastewater management. The Floating Farm produces local food based on sustainable and circular principles, aiming for self-sufficiency in water and energy consumption.

The Floating Farm produces its required energy and products inside the city, and will experiment with low-energy water desalination from the river Meuse, as well as urine-water purification to produce reusable water and recover nutrients to be used as fertilizer. Floating Farm has a high public profile and attracts many citizens and local stakeholders to its activities, which engage in value exploration, behavioural reflection, and innovative solutions.

Figure 3. Logo Ciemat

The Plataforma Solar de Almeria (PSA) hosted by CIEMAT is located in southern Spain and has become a point of reference in the use of solar energy for desalination. PSA's infrastructure is contributing to the development of top-quality cutting-edge research, as well as the communication, exchange, and preservation of knowledge, technology transfer, and the promotion of innovation. In particular, PSA focuses on the use of solar thermal energy, both for concentrated solar power production and desalination, and as a WATER-MINING living lab it will support the engagement of stakeholders involved in the water-energy-food nexus through specific events and their regular programme of visits.

Within the WATER-MINING project, Work Package 2 (WP2) is focusing on the "Co-creation through social engagement for societal embedding", including Task 2.4 Living Labs in the Netherlands and Spain. In this task innovations of WATER-MINING were introduced and demonstrated and meetings with local stakeholders were organized within the context of the two Living Labs.

Since at the beginning of the WATER-MiNING Floating Farm and Plataforma Solar de Almeria were not yet Living Labs, this task included a mentoring and capacity building program to support both organization to become stable Living Labs. The Living Labs were mentored aligned to the high-quality standards as described by the European Network of Living Labs and the criteria for Water-oriented Living Labs as described by Water Europe.

In 2023, the maturity of Floating Farm and Plataforma Solar de Almeria as Living Labs was evaluated to assess the steps taken by them to become stable Living Labs.

This evaluation focused on six building blocks of a Living Lab: the strategy, the operations, the openness, the approach towards users & real-life environments, the values & impacts created and the stability & scale-up possibilities of the the Living Lab. Therefore it focused less on best practices developed by the two Living Labs. The results of this evaluation were presented in Deliverable D2.4 - Evaluation report of two Living Labs[6].

This public deliverable builds upon the results of the evaluation report of the Living Labs, focusing more on the best practices developed by the two Living Labs, assessing which barriers are in place to replicate them within other (Water-Oriented) Living Labs and identifying the interest from external (Water-Oriented) Living Labs concerning the developed best practices.

The best practices could be diverse types of practices developed by the WATER-MINING Living Labs: an infrastructure (e.g. artificial sea, water purification installation), an equipment (e.g. dashboard for monitoring water pollution), a method (e.g. the way you run Communities of practice), a tool (e.g. a co-creation tool used to engage with citizens like) or a Living Lab service (e.g. testing and validation services, equipment and facility rental, co-creation services...)

[6] D2.4 – Evaluation report of two Living Labs. DOI: 10.5281/zenodo.13377928. https://zenodo.org/records/13377928

The work was led by ENoLL within Task 2.4 Living Labs in the Netherlands and Spain, and more specifically Subtask 2.4.4 Replicability study.

Chapter 2 presents detailed information about the process developed to assess the replicability of the individual best practices developed by the two WATER-MINING Living Labs, including the steps taken, the actors involved and the tools used.

Chapter 3 provides on overview of the thirteen individual best practices of Floating Farm (FF) and Plataforma Solar de Almeria (PSA).

Chapter 4 explains the collected feedback from external WoLLs and analyses the results.

Chapter 5 describes the created guidelines for the two WATER-MINING Living Labs to increase the replicability of their best practices.

Finally, Chapter 6, provides conclusions and describes the next steps which will be taken with the results of this replicability study.

2 The assessment process

The aim of the assessment process was to determine the replicability of identified best practices of the two WATER-MINING Living Labs. Next to this it classifies possible barriers for replication. Finally, it provides guidelines for the two WATER-MINING Living Labs to overcome these replication barriers.

The assessment process builds upon the results of the evaluation reports of the WATER-MINING Living Labs (D2.4), which was focusing on six building blocks of a Living Lab: the strategy, the operations, the openness, the approach towards users & real-life environments, the values & impacts created and the stability & scale-up possibilities of the the Living Lab. To do so, a harmonized assessment method[7]developed within the WATER-MINING project was used, mainly based on the standardized evaluation framework[8] developed by ENoLL.

While the former evaluation deliverable focussed on assessing the alignment of the two WATER-MINING Living Labs to this standardized evaluation framework, this deliverable is focusing more into depth on possible replication of individual best practices developed by the two Living Labs and not on the possible replication of the Living Labs in a whole with all their six building blocks. But, of course, the individual best practices are related to one of the buiding blocks of a Living Lab in a whole.

The individual best practices assessed could be diverse types of practices developed by the WATER-MINING Living Labs:

- **an infrastructure** (e.g. artificial sea, water purification installation...)
- **an equipment** (e.g. dashboard for monitoring water pollution...)
- **a method** (e.g. the way you run CoPs, the way you define the strategic roadmap...)
- **a tool** (e.g. a co-creation tool you used to engage with citizens like for instance the Farm Visits or the visitor center of PSA)
- **a Living Lab service** (e.g., testing and validation services, innovation network orchestration, Living Lab project planning and management, co-creation services, capacity building services, advisory services, market and sales support, infrastructure and data management services)

The assessment process consisted out of **four steps:**

1. Co-identification of individual best practices
2. Assessment of individual best practices by external Water-oriented Living Labs (WoLLS)
3. Analysis of results of the assessment
4. Co-creation of guidelines for the two WATER-MINING Living Labs

[7] Vervoort, K., Konstantinidis, E., Desole, M., Onur, O., Trousse, B., Woodcock, A., Garatea, J., Petsani, D., Ponomareva, A., Roset Pérez, B., gamboa, G., & Bamidis, P. (2024, juni 11). An harmonized assessment method and KPIs for evaluating Living Labs. https://doi.org/10.5281/zenodo.11581077

[8]https://www.researchgate.net/publication/371315414_Harmonizing_the_evaluation_of_living_labs_a_standardized_evaluation_framework

2.1 Co-identification of individual best practices

The first step within the assessment process was the co-identification of individual best practices for each of the two WATER-MINING Living Labs, PSA (Plataforma Solar de Almeria) and FF (Floating Farm).

Based on the evaluation reports and the recommendations provided by Living Lab experts from the ENoLL network (D2.4), in 2024, bilateral online discussions were organized between WP2 partners and the two WATER-MINING Living Labs to co-identify best practices within their Living Labs.

During these online discussions the goal of the Replicability Study was explained to the Living Labs and they were invited to identify within their operational teams possible best practices from their Living Labs. Next, they needed to describe each of the identified best practices in a couple of paragraphs and add some visual materials to support the descriptions.

Finally they needed to indicate for each of the identified best practices:

- *why could any other Living Lab benefit from this best practice?*
- *what would be needed to replicate this in another Living Lab?*

To organize these bilateral online sessions with the two WATER-MINING Living Labs, Microsoft Teams was used.

Microsoft Teams offers a comprehensive suite of functionalities for online meetings, making it a robust tool for both business and educational environments.

As a result of this co-identification exercise, FF identified three best practices to be assessed by external water-oriented living labs while PSA identified ten best practices. Chapter 3 provides a detailed description of each of the thirteen best practices

2.2 Assessment of individual best practices by external water-oriented Living Labs (WoLLs)

In order to assess the best practices provided by the two WATER-MINING Living Labs, external WoLLs from the ENoLL network and/or Water Europe members were invited via direct emails to provide their feedback.

In total, an invitation was sent to 18 WoLLs to participate in this assessment exercise. The invited water-oriented Living Labs are located in The Netherlands, Spain, Ireland, Andorra, Italy, Belgium, Sweden, Germany, Portugal, Norway, Slovenia, Turkey and Switzerland.

During the month of June 2024, 11 WoLLs provided their feedback anomynously via the feedback form.

Each of the invited external WoLL received a document with the descriptions of the best practices and a link to an online survey in Sogolytics to complete their feedback.

Sogolytics[9] is a software which allows users to access the surveys online, to collect data online in a user-friendly way, to visualize questions based on previous given answers and to interrupt the completion of a certain survey and restart the survey later via the 'Save and continue' function

[9] https://www.sogolytics.com

For each of the best practices three questions were answered by the external Living Labs:

1. Is this best practice interesting for your Living Lab?
2. What are the barriers for your Living Lab for implementing this best practice in your own Living Lab?
3. What is needed within your Living Lab to overcome these barriers

To safeguard the objectivity of the provided feedback, the feedback was collected in an anomynous way.Therefore, we can't report on the countries from the 11 Living Labs providing their feedback.

2.3 Analysis of results of the assessment

In this step we analysed the results of the collected feedback from the 11 WoLLs reviewing the best practices of the two WATER-MINING Living Labs.

First, we analysed the interest of the external WoLLs concerning the different best practice, presenting tables for Plataforma Solar de Almeria and Floating Farm, and summarizing the outcomes.

Following this, we dived deeper into the identified barriers for replication mentioned by the participating water-oriented Living Labs.

Finally, we analyzed the suggestions for overcoming these barriers. These suggestions came from the participating WoLLs on the one hand, and the two WATER-MINING Living Labs on the other hand.

2.4 Creation of guidelines for the two WATER-MINING Living Labs

The final step of the assessment process was the creation of general guidelines for the two WATER-MINING Living Labs to increase the chance of replication of their individual best practices.

The guidelines are meant to support the replication of individual best practices and not the Living Labs in a whole.

3 Overview of identified best practices

In this chapter, a total of **13 individual best practices** are presented: 3 best practices from Floating Farm and 10 best practices from Plataforma Solar de Almeria.

Floating Farm presented 3 best practices, 2 Living Lab infrastructures and 1 Living Lab equipment:

- Purification and reuse of cow urine (infrastructure)
- Rainmaker (infrastructure)
- Integrated monitoring and processing (equipment)

Plataforma Solar de Almeria presented 10 best practices, 7 Living Lab infrastructures, 1 Living Lab tool, 1 Living Lab method, and 1 Living Lab service:

- Test-bed for solar thermal applications (infrastructure)
- Fully monitored multi-effect distillation plant (infrastructure)
- Test-bed for membrane distillation at commercial scale (infrastructure)
- Pilot plant for forward osmosis, reverse osmosis and nanfiltration (infrastructure)
- Test bed for evaluate cooling systels for thermal desalination (infrastructure)
- Pilot plant to test memberane distillation materials and applications (infrastructure)
- Solar-powered zero-liquid discharge desalination system for greenhouse irrigation (infrastructure)
- Engagement and participation of stakeholders (method)
- Visitor centre as a tool for stakeholder engagement (tool)
- Training activities (service)

3.1 Floating Farm Best Practices

3.1.1 Purification and reuse of cow urine

Purpose

The purpose of this best practise presented is the transformation of slurry to hygienised dry manure and clean urine.

Process

On the stable floor, urine and manure (together forming slurry) are collected by the manure robot. Parts of the stable are also washed down, and water from the drinking troughs can fall onto the floor. All of this ends up in the manure separator. The wet fraction (liquid) is separated from the dry manure. The dry manure is deposited into a 1m3 container and can then be processed into pellets or composted. The wet fraction is stored in a container with a maximum capacity of 600 liters. It is emptied periodically by a pump installed in the wet fraction container. This pump is connected to a flexible 50mm pipe that leads to the urine treatment system.

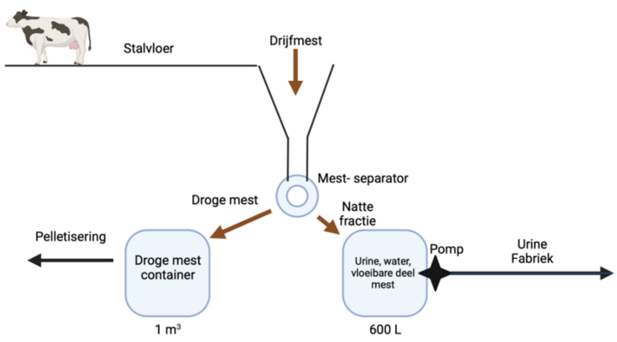


Figure 4. Process manure robot

Once the wet fraction has been pumped to the purification system from the farm, it is stored in the buffer intermediate bulk container (IBC). The capacity of this IBC is approximately 600 liters, but since a sewer connection is installed to accommodate excess wet fraction in case of overflow, the maximum capacity is about 500 liters.

A control valve (Kraan 1) is attached to the IBC itself, which is connected to a 50mm flexible pipe. Another control valve (Kraan 2) is integrated into this pipe. From this buffer IBC, the wet fraction can flow to the purification system. No pumps are required for this process; it operates entirely by gravity.

Figure 5. Intermediate bulk container (IBC)

In the purification system, the wet fraction enters through a 32mm transparent PVC pipe. Subsequently, lines 1 and 2 branch off from the pipe. There are two separate control valves per line, Kraan 3 for line 1 and Kraan 4 for line 2. This is necessary because the pressure in both systems may vary, requiring different regulation of the inflow. The wet fraction enters as influent at the bottom of IBC1 in the purification installation.

The purification installation consists of 2 identical lines, each with 4 IBCs. In IBC 1, bacteria are present that convert organic material into CO2 and H2O through aerobic combustion. Therefore, this IBC is equipped with an aeration system connected to a compressor. Due to the constant, gradual inflow of influent, the wet fraction flows over into IBC2. IBC2 is a settling IBC. Solid substances, including sludge, settle to the bottom here. IBC1 and 2 together form stage A. Subsequently, the wet fraction flows into IBC3. In this IBC, bacteria convert ammonium (NH4+) into nitrite (NO2-) under aerobic conditions, and then into nitrate (NO3-). This IBC also contains an aeration system to supply the bacteria with oxygen. The wet fraction then flows into IBC 4, where solid substances can settle as sludge. IBC3 and 4 together form stage B. In IBC 4, clean effluent flows into the sewer. Since we do not discharge into surface water, we do not need a permit from Rijkswaterstaat.

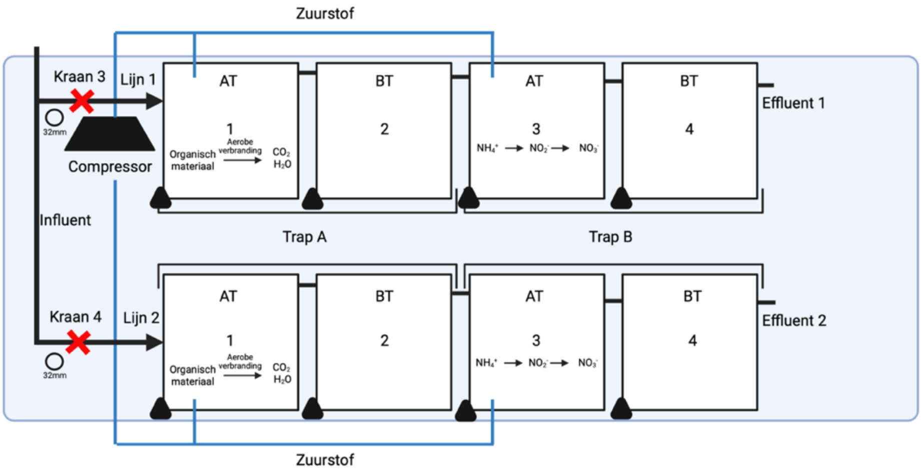


Figure 6. Purification installation

Flow Rate

To minimize variation in the conditions within the purification IBCs, it is essential that the inflow of new influent occurs as gradually as possible. We do not want sudden large inflows followed by periods of no inflow, as this can cause significant fluctuations in the conditions within the purification IBCs, potentially leading to shock for the bacteria in IBC 1 and 3, impairing their ability to carry out biological breakdown effectively.

To achieve a constant flow while still processing all the produced wet fraction, a flow meter is required at the farm. This allows us to determine the exact production of wet fraction and adjust the inflow of effluent accordingly. Additionally, flow meters are needed after the control valves in the urine purification system. This enables us to measure the inflow to the purification IBCs and create a feedback system where the wet fraction production and inflow into the purification system are synchronized. Optionally, flow meters can be placed at the clean effluent outlet. This allows us to compare the inflow and outflow to calculate the loss/production of sludge.

pH Measurement

pH monitoring is essential in aerobic bacteria IBCs. pH greatly influences biological processes and the biological activity of bacteria. A pH between 6.5 and 8.5 is desired for both nitrifying and organic material decomposing bacteria.

pH meters are required in IBC 1 and 3 of both lines to monitor these parameters and make adjustments if necessary.

Nitrogen

The wet fraction contains a high concentration of dissolved ammonium (NH4+). This is a waste product produced by cows, stored in urine, and is toxic to humans, animals, and plants in high concentrations. The nitrifying bacteria in IBC 3 (B stage) convert this ammonium into nitrite (NO2-) and then into nitrate (NO3-).

It is therefore essential to measure the concentrations of these substances. Systems for measuring these concentrations could be well integrated into IBC 2 and 4. This allows the exact determination of the effect of nitrifying bacteria on the concentrations of these substances. This way, it can be determined whether the effluent meets the standards for discharge into surface water.

Phosphate

Similar to nitrogen, an excess of phosphate in surface and groundwater can cause problems, and the concentration of phosphate that can be discharged is regulated. Phosphate is not removed from the wet fraction in the current purification system. However, it is important to measure the concentration of this substance in the effluent to determine its quality.

Phosphate can be removed from the wet fraction using phosphate-accumulating organisms (PAOs). However, in the current installation, we cannot utilize these organisms because the proper conditions cannot be created.

Temperature

Temperature greatly influences the biological activity of bacteria. In the purification system, it is desirable for the water temperature to be above 20°C. In winter, the temperature was found to be around 12/13 degrees. A system must be devised to raise this temperature, allowing more contaminants to be removed from the wet fraction.

Oxygen

Oxygen is an essential component of aerobic combustion of organic material and for the conversion of ammonium to nitrite and nitrate. Therefore, IBC 1 and 3 are equipped with oxygen supply through a compressor. To ensure the right conditions for bacterial growth, measuring the oxygen content in IBC 1 and 3 is important.

3.1.2 Rainmaker

Rainmaker is a nice example of harbour water purification, using heat/energy from a solar boiler and the urine from the cows of Floating Farm

Rainmaker makes water the natural way, using state of the art technology to follow the natural water cycle using an innovative distillation technology.

When comparing desalination technologies, thermal methods are less sensitive than their membrane counterparts. Rainmaker leverages this strength to generate water that is a factor of 100 better than compared to RO's dissolved solids performances.

A waste-water stream (from the harbour) is routed to an innovative evaporator that induces efficient phase change and minimises scaling. External energy input to the process is lowered by upgrading and reusing heat from the vapor so generated.

The entire system is modular and engineered for long duties with easy maintenance measures. Since the system is built as a containerised solution, the product is suitable for mobile use-cases and remote deployment.

Figure 7. Rainmaker installation

One containered unit can produce up to 30.00 litres of water (WHO drinking water quality standards).

Rainmaker units use (waste) heat to recycle wastewater. This approach empowers companies/organizations to diminish their water footprint without adding extra energy to the system.

Figure 8. Rainmaker process

3.1.3 Integrated monitoring and processing

Montreal Solutions B.V.[10], a Rotterdam based company, is specialised in monitoring and processing all sorts of data. With the aim to maximise circularity and sustainability goals, it fits perfectly with Floating Farm's circularity philosophy. Together, the Floating Farm and Montreal Solutions work to map, measure, visualise and connect all the processes from the Farm.

Starting with a weather station, it helped to understand the workings of the wind turbine, which in his turn gave data on power generation. Together with the output from the solar panels, which is also measured, it gives insight in the power consumption of the Farm.

From there on we expanded on processes and how to measure them. The greenhouse gasses produced by the cows, ammonia and CO2 gives the opportunity to measure effects on the surrounding and the limitation of pollution.

The milk production of the cow, one of the central processes of the Farm is measured, with detailed sensoring on the percentages of protein and fat within the milk. This also gives input for the most important thing, the well being of the animals. By keeping a close watch on indicators as this, we can focus on this and steer where needed.

We can also combine the milk production data with a newer system that keeps track of the types of food that the cows get fed every day. Since part of the food is "waste" from other companies in the area, this can vary. This combination can give very useful information about the productiveness of certain food types.

[10] https://montrealsolutions.eu/

The fecal matter of the animals gets collected and turned into other products. The wet part can't easily be used for other things, so this is getting filtered/cleaned and dumped into the sewage system. This process requires a lot of supervision which is made easy by our measuring devices.

And in the end all the goods produced and used by the Floating Farm also need to be transported. The electric vehicles that are used by the Farm are also tracked by a few of our GPS's.

With more measuring points in the way, for example the number of people visiting the farm, the water usage of the farm, indicators for the vertical farming, the Floating Farm and Montreal Solutions keep a close watch on the processes of the Farm and its effect on it's environment. It will give us the opportunity to fine tune and optimise, so we can reach a truly circular process.

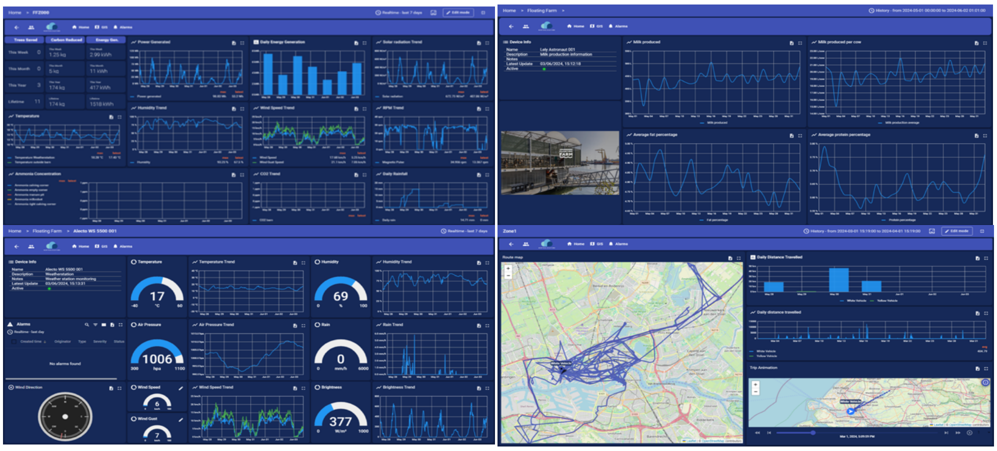


Figure 9. Screenshots integrated monitoring and processing

3.2 Plataforma Solar de Almeria best practices

3.2.1 Engagement and participation of stakeholders

Active stakeholder engagement can be achieved with a thorough selection of key stakeholders and refinement by choosing the most active ones during several activities, a continous monitoring of the stakeholders composition in the context of the Quadruple Helix as well as self-evaluation by the group.

Thanks to the previous creation of a Community of Practice in the environment of the Water Mining Project, deep thought was already given to the composition of a group of stakeholders that covered all areas of the Quadruple Helix. When it was necessary to form the group of stakeholders for this Living Lab, we reviewed the representativeness of each of the sectors that make up the Quadruple Helix and strengthened it by requesting the involvement of some stakeholders in a sector which seemed to us to be a little weaker in representation. Furthermore, we continuously monitor the representativeness of our Community by asking members if they miss any significant actors. Thanks to these procedures we usually engage in our Living Lab a long list of very active stakeholders that includes citizens, water users, technology developers and suppliers on agricultural, solar and water sector (desalination), agriculture producers, exporters and consultants, desalination promoters and operators, researchers on water, energy and agriculture, and government agencies at local and regional level dealing with water and energy. The stakeholders contribute very effectively to the Living Lab co-creation activities with their different points of view and appreciations coming from each social focus.

Our community of stakeholders can be shared with other Living Lab that have similar or close objectives in the water-energy-food nexus.

(a) Stakeholder attending the CoP meeting, 21th February 2023.

(b) One of the co-creation groups during the CoP meeting, 21st September 2021.

(c) Stakeholder attending the CoP meeting, 23rd February 2022

Figure 10. Screenshots Community of Practice meetings

3.2.2 Visitor centre as a tool for stakeholder engagement

Plataforma Solar de Almería has a visitor service center (CAV) where every year thousands of visitors with very diverse profiles and different educational levels, both national and foreign, are received. Since the inauguration of the 'Sustainable Desalination' Living Lab in November 2022 and until March 2024, we have received a total of 5,859 visitors at the CAV, distributed as follows:

- Primary students (Spain): 1,583 students
- Secondary students :
  - Spain: 2,876 students
  - Foreign: 320 students
- University Students:
  - Spain: 265 students
  - Foreign: 139 students
- Businesspersons and general tourism:
  - Spain: 465 visitors
  - Foreign: 211 visitors

During the visit, the entire Solar Platform is shown, and the projects underway in each of the research units, electricity production with solar thermal energy, materials testing, solar water treatments and, of course, sustainable desalination, are explained.

In order to serve each of the visitors and ensure that visits to the research center are in accordance with each of them, the contents have been adapted based on the visitors, so that the experience is understood, fun and enjoyable for everyone. Furthermore, in the case of primary and secondary school students, teaching material has been prepared with which students explore each of the research fields developed at the Almeria Solar Platform.

Thanks to all this direct interaction with a large part of society, feedback from the Living Lab is continously received. Furthermore, links have been established that in numerous cases have led to the participation of some of the visitors who turned out to be involved with the issue of water, either at a business level or at the level of research and who have finally turned out to be members of our community of Living Lab stakeholders.

The activities of the Visitor Centre can be extended to cover topics of interest to other Living Labs with similar or close objectives in the water-energy-food nexus.

Figure 11. Visitor center PSA

3.2.3 Test-bed for solar thermal applications

The existing infrastructures of the Living Lab are part of Plataforma Solar de Almería, which is recognized by the European Commission as a Large Research Facility. It is also accredited by the Spanish Government in the map of the so-called Unique Scientific and Technical Infrastructure (ICTS). These are exceptional facilities that develop cutting-edge and top-quality research, and acting as centres for transmitting, exchanging and preserving knowledge, transferring technology and promoting innovation.

Amongst this infrastructure, the Living Lab has a test-bed for solar thermal applications, consisting on a solar field of large aperture static solar collectors coupled to flat mirrors tracking the Sun in order to enhance the effective collection surface without increasing land occupation. The solar field is connected to a heat storage of 40 m^3 based on liquid water. The purpose of this facility, which is fully automated and monitored, is to assess the behaviour of the solar field with the tracking mirrors and the heat storage, and its coupling with thermal energy systems at 60-90 °C temperature levels, such as thermal desalination and brine concentration systems.

Figure 12. Test-bed for solar thermal applications at the sustainable Desalination Living Lab

The infrastructure, as part of an ICTS, is open to competitive access and can be offered in that access program as a service.

This facility provides unique possibilities of evaluating solar thermal technologies, models and algorithms for solar thermal energy use and optimization, benefitting from the exceptional opportunities offered by Plataforma Solar de Almería in terms of climate and expert personnel for support and operation.

3.2.4 Fully monitored multi-effect distillation plant

The Living Lab has a multi-effect distillation test facility, consisting on a 14-effect multi-effect distillation plant with thermal consumption of 190 kWth and nominal distillate production of 3 m^3/h. The plant is fully automated and monitored and has the possibility of using nanofiltration as a pre-treatment. It is connected to an artificial sea consisting of real seawater containers with a total volume of 300 m^3, as well as a solar thermal field to supply the required hot water as a heating source. The plant can also be coupled to a double effect absorption heat pump that raises the enthalpy of the low-pressure saturated steam generated in the last effect of the MED to that the first effect, improving the thermal performance by recovering the lateng heat of condensation. The heat requirement of the heat pump is saturated steam at 180°C (10 bar abs), that can be generated with a boiler or with a field of small solar parabolic concentrators also available at the facility.

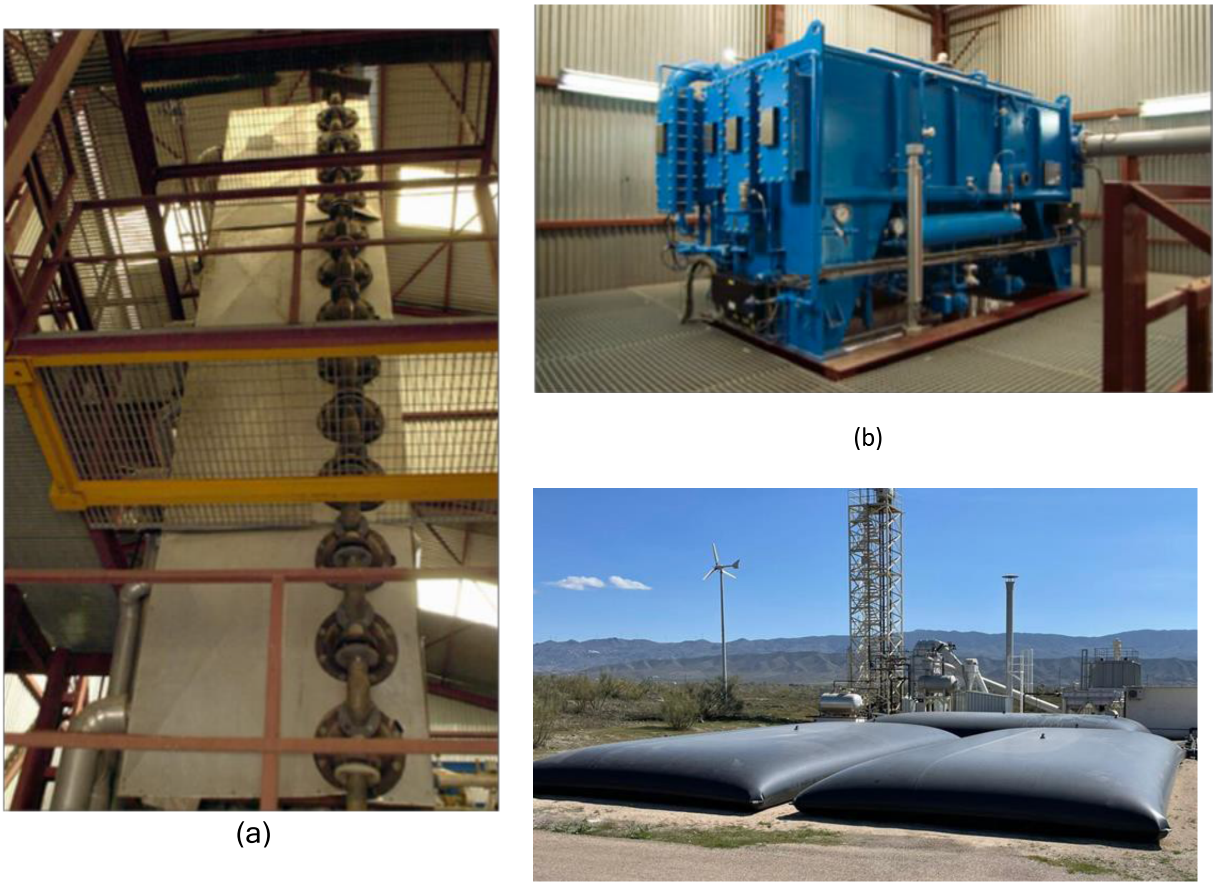


Figure 13. Multi-effect distillation plant (a); double-effect absorption heat pump (b); and artificial sea (c)

The infrastructure, as part of an ICTS, is open to competitive access and can be offered in that access program as a service.

This plant is unique, it is the most efficient solar-powered multi-effect distillation plant existing at its scale, and it offers possibilities of evaluating models and applications of the technology at industrial scale for desalination and brine concentration, as well as evaluating design improvements such as the use of different materials as evaporators.

3.2.5 Test-bed for membrane distillation at commercial scale

The Living Lab has a membrane distillation test-bed with commercial pilots of all available technologies. It can be supplied with hot water coming from two different solar thermal collectors fields with maximum thermal power of 7 kWth and 14 kWth respectively, at temperatures up to about 90°C. The facility is fully monitored, automated and connected to an artificial sea consisting of real seawater containers with a total volume of 300 m^3, and it has a separate water circuit that can be used for cooling.

This installation can be used to evaluate commercial membrane distillation modules coupled with solar thermal energy, and it has a wide range of different commercial and pre-commercial units from different commercial manufacturers for reference and benchmarking.

(a)

(b)

Figure 14. Internal (a) and external (b) views of the test-bed for membrane distillation at commercial scale

3.2.6 Pilot plant for forward osmosis, reverse osmosis and nanofiltration

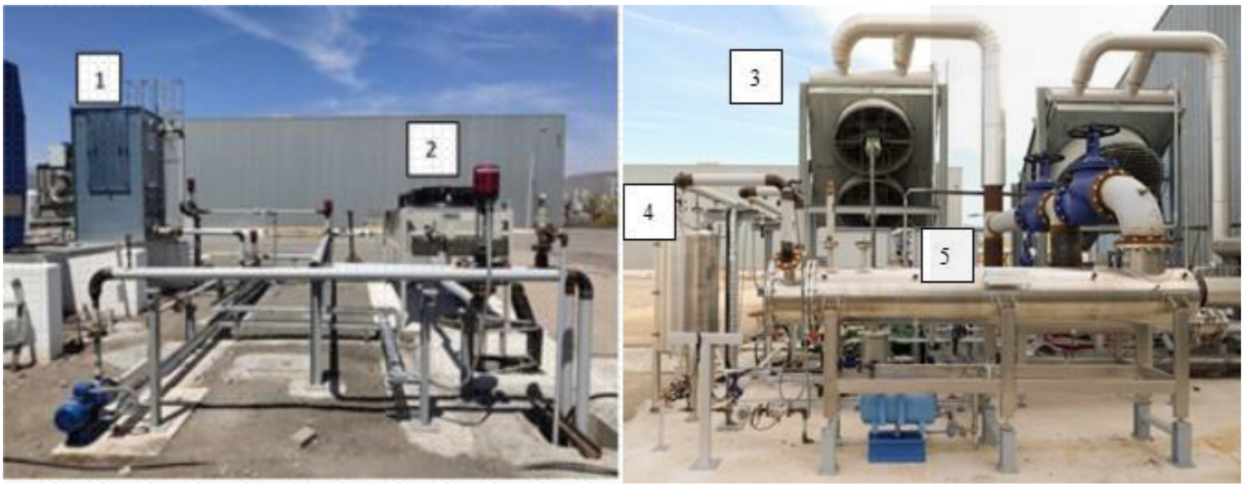
The Living Lab has a pilot plant for studying Forward Osmosis (FO), Reverse Osmosis (RO) and Nanofiltration (NF), individually or combined. The FO unit uses 12 hollow fibre modules (Aquaporin HFF02) 0.2 mm long with 2.3 m^2 total membrane area each one, operating in counter-current flow, inside-out, laid out in a flexible rack that allows combining them in series or parallel configuration. The nominal flow rate is 3.6 m^3/h. The RO/NF unit has one 8” and two 4” pressure vessels that can be connected in series or parallel, each of which able to host four membranes. The nominal flow rate is 3 m^3/h and the pumping system can work at different pressures up to a maximum of 80 bar (RO) or 16 bar (NF). The facility is coupled to a batch microfiltration unit with 3 m^3/h nominal flow rate that can be used as pre-treatment, as well as to an artificial sea consisting of real seawater containers with a total volume of 300 m^3.

Figure 15. Pilot plant for FO, RO and NF

The installation is completely monitored with pressure sensors, conductivity and flowmeters, and it is designed in a flexible way regarding the interconnection of the units so that FO can be used as a pre-treatment for RO, or NF can be used in combination with FO, and even the FO can be used in PRO mode using the pumping system of the RO unit. Different feed waters can be used in all cases.

3.2.7 Test bed to evaluate cooling systems for thermal desalination

The Living Lab has a test bed to evaluate innovative cooling systems for Concentrated Solar Power and thermal desalination plants. The innovative cooling system is a combined cooling system composed of a wet cooling tower and a dry cooling tower (Air Cooled Heat Exchanger), each with 200 kWth power. In the exchange circuit, an 80 kWth steam generator powered by solar thermal energy produces saturated steam (in the range of 120-300 kg/h) at different temperatures (42-60°C), which is then condensed in the surface condenser while releasing the condensation heat to the cooling water that is heated. The condensate from the surface condenser is reused in the as feed water to the steam generator when needed. In order to compare with conventional air-cooled condenser, the steam generator can supply either to the surface condenser connected to the hybrid cooler or to the Air-Cooled Condenser (335 kWth).



(a) (b)

Figure 16. Hybrid-cooling test-bed: (a) cooling circuit with wet cooling tower (1) and air-cooled heat exchanger (2). (b) exchange circuit with air-cooled condenser (3), condensate tank (4) and surface condenser (5).

The hydraulic circuit of the test bench has been designed to enable the testing of the wet and dry cooling separately and the series and parallel configurations. The testing facility can also compare this kind of combined cooling system with conventional ones composed by a wet cooling tower and an air-cooled condenser.

3.2.8 Pilot plant to test membrane distillation materials and applications

The Living Lab has a pilot MD unit for testing membrane distillation applications in different configurations, with the following unique features essential for representative and scalable results: (i) a plate and frame module with effective membrane surface area 220 mm x 150 mm which is sufficient for flow distribution and regime being applicable to full-scale MD technology ; (ii) a smaller plate and frame module with effective membrane surface area 100 mm x 60 mm for testing materials and solutions ; (iii) adjustable MD channel configuration to all channel variants (PGMD, AGMD, DCMD, VAGMD) ; (iv) controllable driving force temperature difference with high precision (0.5 °C) and fully automated control system with a large range of possible parameter settings.

Figure 17. Pilot plant to test membrane distillation materials and applications

The facility is a high precision laboratory grade research equipment designed for testing fundamental and feasibility test trials on membrane distillation, including different membranes and feed solutions, with results that can be scalable to commercial scale modules.

3.2.9 Solar-powered zero-liquid discharge desalination system for greenhouse irrigation

As part of the research infrastructures of the Living Lab, CIESOL contributes with a unique facility for studying solar desalination for greenhouse irrigation with brine concentration for valorization. It consists of a photovoltaic energy powered reverse osmosis (RO) pilot plant with 500 l/h capacity for seawater desalination and a solar thermal energy powered membrane distillation (MD) pilot plant with 250 l/h capacity for concentrating the RO brine. The facility is directly connected to the sea hrough a beach well and to a 1900 m^2 experimental greenhouse with advanced climate control and fertigation system that uses the water produced.

Figure 18. Desalination plants, sola energy fields and experimental greenhouse at CIESOL

This infrastructure allows studying the water-energy-food nexus at its core, analysing the use of renewable energies for sustainable desalination applied to intensive agriculture. It is designed to generate scientific data and that can be shared with other parties through collaboration agreements and knowledge that can be transfered through other collaboration arrangements.

3.2.10Training activities

The training activities for students developed under the Sustainable Desalination Living Lab aim to develop playful scenarios, hands-on projects and resources for water-energy education. Our purpose is to offer a sutainiblity education attractive and valuable that encourages scientific vocations and strengthens society's environmental awareness. During our training activities students of different ages (from kindergarten to high-school) learn, in a fun way, about climate change, solar energy, water scarcity, desalination and brine recovery.

(a) Five-years kids learning about membrane desalination technologies

(b) Gymkana activiy about sustainable desalination

(c) AR tool related to sustainable desalination

Figure 19. Some examples of training activities

These activities can be used or easily adapted to other Living Lab that have similar or close objectives, such as renewable energies, circular economy, desalination, or focused on some of the great societal challenges (sustainable agriculture, clean and efficient energy, climate action or environment).

We can collaborate with other Living Labs in developing an specific training activity, we can also conduct these experiences or share our didactive guides developed.

4 Analysis of results

A total of **13 individual best practices** were shown to the external WoLLs: 3 best practices from Floating Farm and 10 best practices from Plataforma Solar de Almeria.

For each of the best practices three questions were answered by the external Living Labs:

1. Is this best practice interesting for your Living Lab?
2. What are the barriers for your Living Lab for implementing this best practice in your own Living Lab?
3. What is needed within your Living Lab to overcome these barriers

This chapter provides an overview of the analysis of the feedback concerning this 3 questions asked.

4.1 Interest in Best Practices.

The **average interest rate for all presented best practices** is 52,38% with a higher interest rate for Floating Farm (64%) than Plataforma Solar de Almeria (48,9%).

Based on the feedback of the **best practices of Floating Farm (FF)** all 3 best practices were perceived as interesting by the external water-oriented Living Labs as shown in Table 1 here below. Furthermore, the Living Lab equipment (73%) presented seem to be more interesting as the infrastructures (64% and 55%).

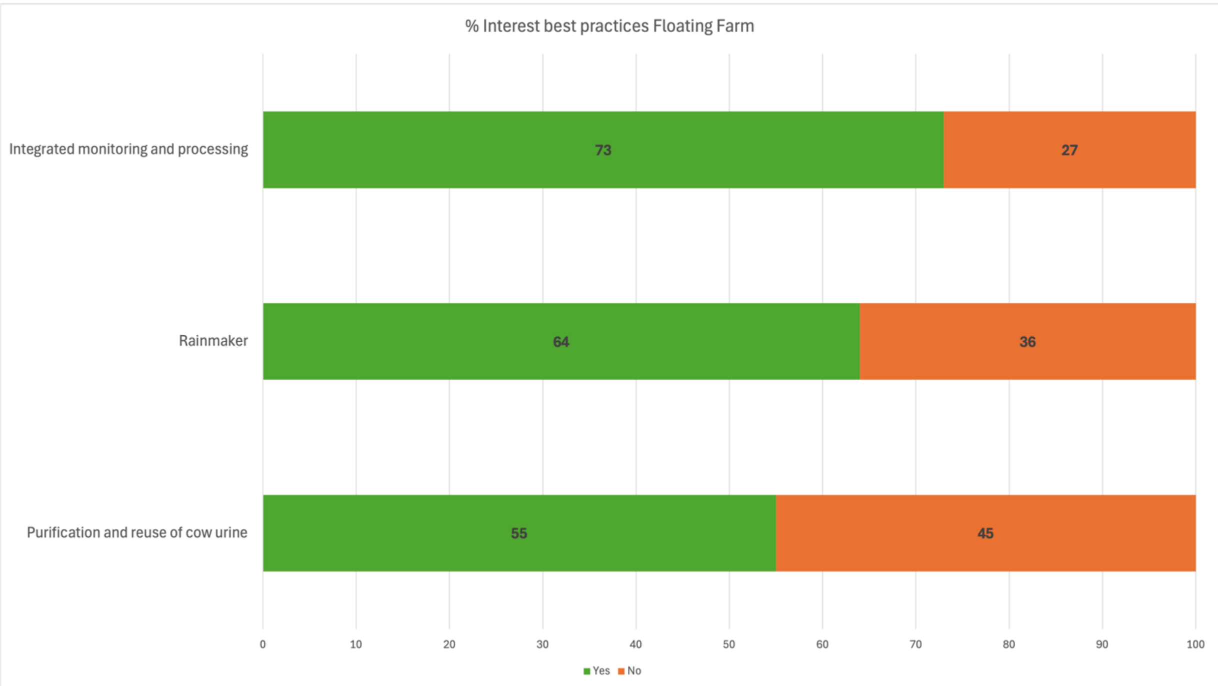


Table 1 Interest in best practices Floating Farm

Looking at the feedback of the **best practices of Plataforma Solar de Almeria (PSA),** the best practices presented weren't all perceived as to be interesting by the external water-oriented Living Labs as shown in Table 2 here below.

Analyzing the interests further shows that there is a higher interest in the presented Living Lab method (82%) and Living Lab service (91%) than the presented infrastructures and Living Lab tool.

This can be explained considering that PSA mainly focuses on the use of solar thermal energy, both for concentrated solar power production and desalination. Therefore, the infrastructures presented by PSA are less interesting for water-oriented Living Labs since not all these water-oriented Living labs are also working with solar energy solutions.

Next to this, the collected feedback on the Visitor centre as a Living Lab tool shows that the main reason for the lower interest is linked to the impossibility within the external water-oriented Living Labs to create such a visitor centre in their premises.

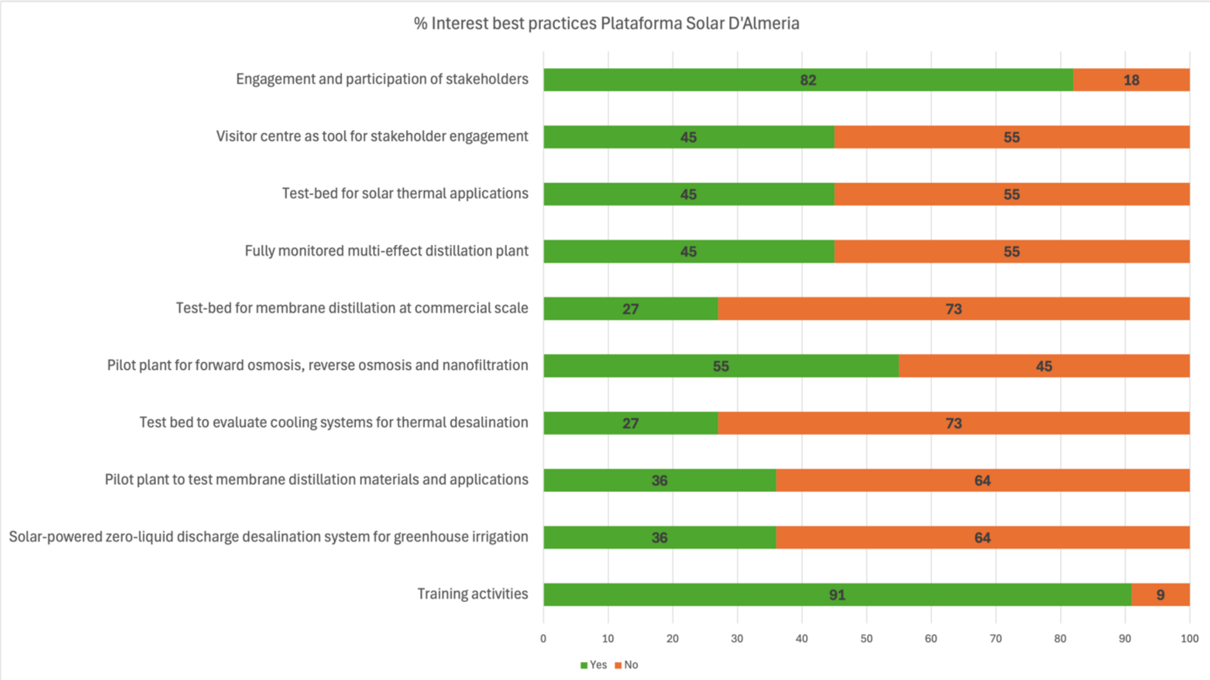


Table 2 Interest in best practices Plataforma Solar de Almeria

Nevertheless, over all the feedback on the presented best practices indicates that there are certainly possibilities for the two WATER-MINING Living Labs to replicate solutions offered by their Living Labs.

As presented in the conclusions already two out of eleven external water-oriented Living Labs indicated the wish to be connected with the WATER-MINING Living Labs to further explore replication of presented best practices within their own Living Lab ecosystems.

4.2 Identified barriers for replication

First, it's important to highlight that due to the fact that the presented best practices are different in origin, the feedback on each of them is different as well. However, we can divide the provided feedback into general categories as shown here below.

In general, the most mentioned barriers for replicating the presented best practices within the external water-oriented Living Labs assessing the best practices are related to:

- **Non-applicability of the presented solution**: Not all presented best practices are fitting in the strategies and/or contexts of the external water-oriented Living Labs. For example, not all Living Labs providing feedback are focusing on agriculture. Therefore, the solutions presented related to cows are not applicable to their Living Labs
- **Weather constraints**: This barrier relates mainly to the best practices related to solar power. Not all Living Labs providing feedback are located in a country where they can take advantage of the sunny conditions, but instead are facing a lot of rain and even snow.
- **Legal constraints**: Sometimes national governments are prohibiting certain solutions. For example, big desalination plants are not allowed in Slovenia. Also, in some countries the authorities are having a non-progressive approach towards these types of innovative best practices.
- **Lack of physical space**: Concerning the bigger size of certain presented best practices (e.g., Fully monitored multi-effect distillation plant), multiple external water-oriented Living Labs indicated they currently don't have the physical area to implement the best practice and its infrastructures.
- **Lack of funding/capacity**: The most mentioned barrier is the lack of funding for investing in the presented best practices and covering the costs related to them.
- **Lack of technical skills**: Before implementing a presented best practice, for most of them technical training of personnel would be crucial and necessary.
- **Interoperability of data**: A barrier could be the system adaptability for other types of services (e.g. not only for agricultural processes, but also for urban processes). Next to this, the integration of different monitoring systems is also mentioned as a barrier.

Annex 1 is showing all the provided feedback around the identified barriers for each of the presented best practices from Floating Farm and Plataforma Solar de Almeria.

4.3 Overcoming barriers for replication

Again, since the best practices are focusing on different perspectives of a Living Lab (e.g. LL infrastructures versus LL method and/or tool), also the suggestions made for overcoming identified barriers are different. Nevertheless, we can also divide the provided feedback into general categories.

To overcome the barriers for replication, the suggestions made the most frequent are related to:

- **Financing model**: One of the most mentioned actions for overcoming the barriers, together with funding, is more insights in the financing model of the presented best practices to understand the costs for setting up the solution, but also the costs related to the maintenance of the solution once installed.
- **Funding**: Finding money via new or existing projects/initiatives for investing in the best practices is the most mentioned action to replicate them. For example, one of the participating Living Labs refers to the need to work in projects related to major coastal zone hazards like, floods, wildfires, contamination, soil and water management.
- **Capacity building**: related to the barrier of technical skills, multiple external water-oriented Living Labs indicate that capacity building in the form of trainings and or knowledge exchange would be benificiary to replicate the presented best practices.

- **Interaction with the WATER-MINING Living Labs:** To fully understand the usefulness of the presented best practices, mulitple external Living Labs stipulate they want to interact with the two WATER-MINING Living Labs.
- **Presence and engagement of local stakeholders**: In multiple cases, currently the needed local stakeholders (e.g., farmers) are not present in the ecosystems of the external water-oriented Living Labs. Therefore, connections with these local stakeholders need to be created and explored to identify if best practices could be relevant for these local stakeholders.

Annex 1 is showing all the provided feedback around overcoming the identified barriers for each of the presented best practices from Floating Farm and Plataforma Solar de Almeria.

5 Guidelines for the two WATER-MINING Living Labs

A total of 5 general guidelines (recommendations) to increase the possibility of replication were developed:

- Development of comprehensive promotion materials
- Identification of possible replication organizations
- Participation in market-oriented events
- Development of training modules
- Offer of financial insights

To create these general guidelines, first, the original input about replication made by the two WATER-MINING Living Labs was considered.

Plataforma Solar de Almeria mentioned following items to pay attention to in relation to their best pratices

- **Engagement and participation of stakeholders**: Active stakeholder engagement can be achieved with a thorough selection of key stakeholders and refinement by choosing the most active ones during several activities, a continous monitoring of the stakeholders composition in the context of the Quadruple Helix as well as self-evaluation by the group.
- **Visitor centre as a tool for stakeholder engagement**: The services of a Visitor Centre require personnel with communication skills and a close collaboration with the scientific and technical team to share relevant information and continuous updates on the research and innovation activities performed.
- **Test-bed for solar thermal applications**: Adequate solar conditions, 2200 m^2 of land without shades and advanced solar thermal collectors with flat plate mirrors, as well as a control and monitoring system including solar tracking for the mirrors. Expert operators are also required.
- **Fully monitored multi-effect distillation plant**: The space required is abut 50 m^2 for the MED plant (although XX height are needed) and 500 m^2 for the artificial sea, which also requires access to filteres seawater to fill it. Expert operators are also required.
- **Test-bed for membrane distillation at commercial scale**: The facility is not complicated in terms of design and operation, but requires a lot of land (about 1000 m^2, with additional 500 m^2 for the artificial sea) and, especially, connections with the membrane distillation market to secure a series of commercial modules.
- **Pilot plant for forward osmosis, reverse osmosis and nanofiltration**: The pilot plant is unique, but can be replicated with our technical and design support, as well as the membrane supplies, from Aquaporin for the FO, Hydranautics for the NF, and Dupont for the RO.
- **Test-bed to evaluate cooling systems for thermal desalination**: The plant is unique, but a similar one can be built with our technical and design support, land occupation is about 300 m^2 of open space.
- **Pilot plant to test membrane distillation materials and applications**: The plant is unique, but a similar one can be built with our technical and design support, including training on operation.

- **Solar-powered zero-liquid discharge desalination system for greenhouse irrigation**: Replication is very complicated, since it requires not only the desalination technologies, that can be purchased from suppliers (Elemental Water Makers in the case of the RO and Aquastill in the case of the MD), but also a fully equipped 1900 m^2 greenhouse close to the sea, a beach well to extract sea water, a solar photovoltaic and a solar thermal field (500 m^2 of total land occupation). Expert operators in several fields (desalination, solar energy, agriculture) are also required, as well as field workers that can carry out the agricultural growth needed in the greenhouse.
- **Training activities**: We can collaborate with other Living Labs in developing a specific training activity, we can also conduct these experiences or share our didactive guides developed.

Floating Farm indicated the following in relation to their best practices:

- **Purification and reuse of the cow urine**: Subsidy will be needed to scale up and make investments
- **Rainmaker:** The advantage of the units is that they are modular and scalable and can be optimized to for the necessary volume, quality, and price. Which makes it possible to tailor the water production to your needs. Subsidy will be needed to scale up and make investments
- **Integrated monitoring and processing**: Contextualization will be needed since it's difficult to design a good system that is well coordinated to supprt all the needs of the local Living Lab

Next, the feedback and the made suggestions to overcome the barriers as mentioned by the 11 external WoLLs (Chapter 4) were considered too.

This approach led to the creation of 5 general guidelines to increase the possibilities of replication of individual best practices.

5.1 Development of comprehensive promotion materials

The first and most crucial step to be taken by the two WATER-MINING Living Labs in order to increase the chances of replication of their best practices by other organizations, companies and/or Living Labs is the development of comprehensive promotion materials for each of their best practices.

The promotion material of the best practice they want to promote should not only include a clear description of the solution, including visuals to support the description, but should also clearly explain:

- the benefits of implementing the solution
- the technical requirements to implement the solution, including proper dimensions
- the cost structures for the solution, not only explaining what it costs to implement the solution, but also indicating the maintenance costs

Next to this, using the general branding of the Living Lab will support the recognazibility of the Living Lab and using the promotion material for a specific best practice as possible katalysator for other organizations, companies and Living Labs to discover the Living Lab in a whole.

Therefore, it's strongly recommended to centralize the promotion materials on the website of the WATER-MINING Living Lab to expand cross-fertilization based on organizations, companies and Living Labs looking for different individual best practices.

5.2 Identification of possible replication organizations

The second step for the WATER-MINING Living Labs is to identify organizations, companies and/or Living Labs who might be interested in replicating solutions developed.

Concerning the identification of possible Living Labs, we recommend the WATER-MINING Living Labs to interact with Living Lab networks like ENoLL (European Network of Living Labs) and the WoLL-network of Water Europe.

Following this, they can actively interact with other Living Labs from the sister projects of WATER-MINING: Rewaise[11], B-Water Smart[12], Wider Uptake[13] and Ultimate[14]. This can be done within the context of the CIRSEAU[15] cluster or directly with individual Living Labs.

Collaborating with other Living Labs and exchanging knowledge will help Floating Farm and Plataforma Solar de Almeria to increase their sustainability by increasing the chance of replication of their individual best practices by other Living Labs.

Next to this, the WATER-MINING Living Labs could constantly scan their ecosystems to identify possible companies which might be interested in scaling-up solutions developed by the Living Labs. We recommend the Living Labs to keep on overview of companies in order to track interest at a commercial scale.

5.3 Participation in market-oriented events

Once the promotion materials are developed the WATER-MINING Living Labs cab participate in market-oriented events where industry & companies come together to discover new innovative solutions for their organizations.

Of course, they need to decide to which degree replication of individual best practices is part of their strategic roadmap. Next to this, it's up to the WATER-MINING Living Labs to decide wether they want to promote multiple best practices or focus on one specific best practice.

5.4 Development of training modules

To guarantee a succesful implementation of the best practice solid and comprehensive training materials should be developed to support organizations, companies and/or Living Labs replicating solutions.

Depending on the solution the Living Lab should choose the best training formats.

Some possible formats could be:

- Instruction videos
- Manuals

[11] https://rewaise.eu/living-labs/

[12] https://b-watersmart.eu/living-labs/

[13] https://wider-uptake.eu/

[14] https://ultimatewater.eu/stakeholder-engagement/living-labs/

[15] https://watermining.eu/news/water-mining-joins-the-cirseau-cluster-advancing-the-circular-water-economy/

- Podcasts
- Q & A
- MOOCs
- Mentoring
- On-site training
- ...

5.5 Offer of financial insights

The WATER-MINING Living Labs should provide clear insights in the cost structures of their best practices. What does it cost to implement their solutions, but also what maintenance costs are linked to the best practice?

Providing this information to interested organizations, companies and/or Living Labs will increase the chances of replication.

Finally, we recommend the WATER-MINING Living Labs to also deliver insights to interested parties about how they managed to finance the solution.

6 Conclusions & Next steps

This deliverable analysed the possibility to replicate individual best practices developed by the two WATER-MINING Living Labs, Floating Farm (FF) and Plataforma Solar de Almeria (PSA). Therefore, it doesn't focus on the replication of the Living Labs in a whole.

An individual best practices could be a Living Lab infrastructure (e.g. test-bed for membrane distillation), but also Living Lab equipment (e.g. monitoring tools), Living Lab methods (e.g. community of practice) or Living Lab services (e.g. capacity building, network orchestration).

Looking at the results of the feedback from external WoLLs the most interesting individual best practices of both WATER-MINING Living Labs are the presented Living Lab equipment (i.e. integrated monitoring and processing), the Living Lab method (i.e. engagement and participation of stakeholders) and the Living Lab service (i.e. training activities). The presented Living Lab infrastructures seem to be less interesting for the external WoLLs.

The indicated barriers explain these results since Living Lab infrastructures are more complicated to be replicated, require more technical skills and take more investments to replicate than Living Lab equipment, methods or services.

Moreover, not all infrastructures are applicable for other WoLLs due to different contexts of the WoLLs (e.g. not focusing on solar power). Next to this, legal constraints and different weather circumstances in the regions of the external WoLLs and a lack of space are hindering the implementation of presented individual best practices.

However, the results also show that there is a possibility for all presented individual best practices to be replicated by external Living Lab ecosystems if the two WATER-MINING Living Labs provide:

- more details about the financing model (set-up and maintenance) of the individual best practices,
- training (technical skills) and knowledge exchange about the individual best practices
- insights in the local stakeholders involved with the individual best practices.

The guidelines developed within this deliverable will support FF and PSA to decrease possible barriers and increase the promotion and common understanding about their individual best practices. Interaction with possible replicators is crucial next to the development of the necessary promotion materials, training modules and financial insights.

Currently, already two out of eleven external water-oriented Living Labs indicated the wish to be connected with the WATER-MINING Living Labs to further explore replication of presented best practices within their own Living Lab ecosystems: Ozeans Living Lab (Spain) and Living Lab Koper (Slovenia).

In August 2024 we created direct connections between the Living Lab leaders of Floating Farm and Plataforma Solar de Almeria and the leaders of these two external WoLLs and discussions between them are ongoing.

Furthermore, both WATER-MINING Living Labs will be supported via bilateral mentoring sessions which are organized within the context of WP2 to support the development of promotion materials, training modules and financial insights concerning the individual best practices within their own Living Lab contexts.

Next to this, this deliverable will be shared with the project coordinators from the other projects of the CIRSEAU cluster, being Rewaise, B-Water Smart, Wider Uptake and Ultimate to promote the individual best practices to other relevant water-oriented organizations, companies and Living Labs.

Finally, both WATER-MINING Living Labs, Plataforma Solar de Almeria and Floating Farm will have the possibility to present their individual best practices to relevant stakeholders during a third roll-out event , focusing on Industrial Mining within the context of the closing conference of the WATER-MINING project in Rotterdam on September 30 to October 2. This will support them to increase acceptance by relevant organizations and companies and to collect feedback on exploitation relevant perspectives.

7 References

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Annex 1 - Overview of collected feedback (Sogolytics)

European Network of Living Labs

Water Mining Best Practices evaluation

June - 2024

05-Jun-2024 - 23-Jun-2033

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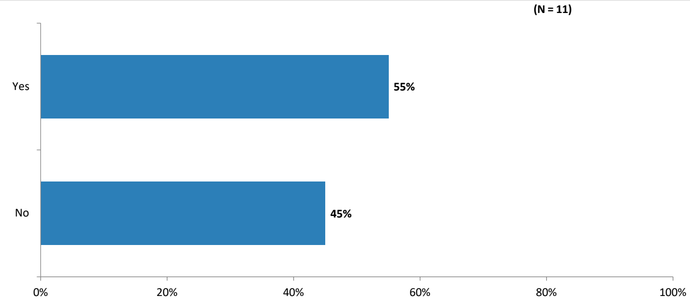
Purification and reuse of cow urine

Is this best practice interesting for your Living Lab?

(N = 11)



2

sogolytics

Purification and reuse of cow urine

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
1	At Inagro we don't have cow stables, so co-creating at farms is required, which is perfect, but here the question is, who makes the investment, what is the incentive (certified ammoniareduction?)
2	No barriers, we are already doing this.
3	Agriculture is not readily available in its vicinity
4	we are not focusing on agricultural processes
5	Not relevant, no livestock in the neighbourhood
6	We do not have capacity to take on new projects at present but this is interesting to us with respect to the development of biomethane from cattle slurry. It would be challenging to transport slurry to a centralised plant but the separation of wet/dry materials could help to address this.
7	There is no evidence that there is a problem in Andorra related with the management of cow urine and manure. We are not currently working with livestock farmers.
8	The sensors are very interesting for us for the measurement of the soil in our case. Since we are working in soil related projects. The context is different. We are working in biodiversity soils so we may need to adapt it to our needs.
9	There is not a large amount of cows in the region.
10	Our LL is not suited for this kind of process
11	Technical barriers - We don't have specific technical skills in our Living Lab to develop or use this kind of solution. However, it could be useful in our teaching practice as an example of an innovative solution for environmental engineers.

3

sogolytics

Purification and reuse of cow urine

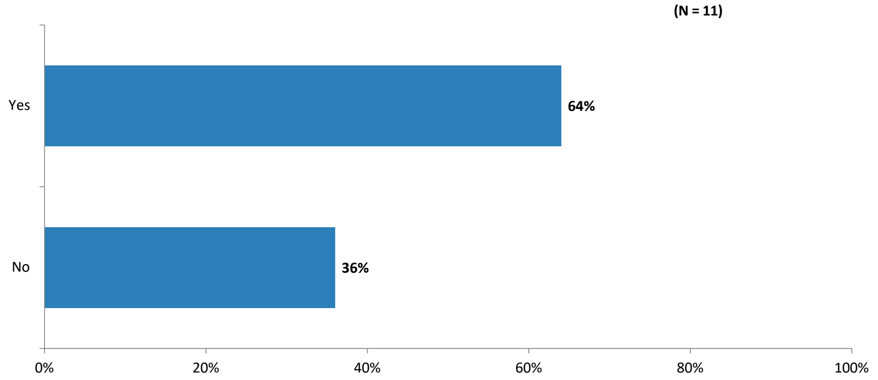
What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
1	A project where investments are made, emissions are measured, certification can be provided
2	n.a.
5	/
6	Progression on Anaerobic Digestion development and related capacity build for this project
7	We need the engagement and participation of farmers in the Living Lab to analyse and understand if there is a need of purification and reuse of cow urine.
8	To have a talk to the owners and check if this is useful for us. If it is ok we can start working in order to scale up to our living lab space to be tested.
9	A dairy farm would need to be in the region.
10	We need to partner with an animal farm
11	To reorient our strategy towards technical installations, which is not our primary objective today.

4 sogolytics

Rainmaker

Is this best practice interesting for your Living Lab?



5 sogolytics

Rainmaker

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
1	Information and trust of in the technology.
2	The water treatment option are numerous, we make use of other systems
3	costs, unfamiliar, non-progressive authorities
4	knowing more about the costs related to implementation
6	We do not have capacity to take on new projects at present but this is interesting to us with respect to the development of biomethane from cattle slurry. It would be challenging to transport slurry to a centralised plant but the separation of wet/dry materials could help to address this.
8	we need to check the cost of producing such a container. The context is different.
9	Not enough cows
10	Access to harbour water
11	Quite the same as the previous example: our Living Lab currently don't have the specific technical skills necessary to develop or operate advanced technical systems like Rainmaker. However, we are based at the Engineering school and it's a good example for our teaching practice (multiple courses on Innovations, Experimentation and the Living Lab approach).

6 sogolytics

Rainmaker

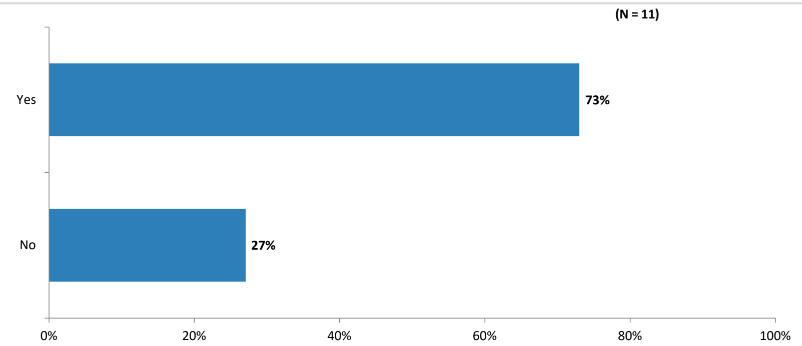
What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
1	we have in the network farmers with cows, and the port of Antwerp/Sea Bruges, if we can inform them about the opportunities, and convince them to investigate the potential to invest, it might be a solution
2	n.a.
3	Funding, training
6	Progression on Anaerobic Digestion development and related capacity build for this project
8	To have a talk to the owners and understand better the product first. Secondly to find a partner or a company interested in partnering and/or buying the technology.
9	A larger amount of cows
10	Have a treatment facility near the harbor
11	Develop the capacity within our own team or (most probably) to address to our existing partners network.

7 sogolytics

Integrated monitoring and processing

Is this best practice interesting for your Living Lab?



8 sogolytics

Integrated monitoring and processing

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
1	Again, we don't have a lighthouse stable, but we could contact and test this with collaborating with farmers.
2	We use other tools to map and visualise data
3	Perhaps not of interest directly to the CCLL, but as a research organisation having more knowledge would certainly include it as a proposal option for our LL.
5	This is implemented in the living lab
6	We are working with a range of technology providers to deliver similar solutions for farms on the peninsula. The challenge is the integration of the different monitoring systems.
7	Our Living Lab is the whole country (Andorra) so the main barrier to implement this practice is the absence of an identified process to map, measure and visualise. Anyway, the proposed monitoring and processing by the floating farm could be an inspiration to build a similar dashboard monitoring main processes of our Living Lab.
8	The data monitoring can be of interest if aligned with the data taken from the sensors. We are working in biodiversity soils so we may need to adapt it to our needs.
10	none
11	It's interesting in terms of using monitoring online systems in our current projects (e.g. smart urban mobility, monitoring for the buildings renovation). The barriers could be system adaptability for other types of services (e.g., not only for a Floating Farm, but also for urban processes); financial investment & organisational barriers - it should be related to some project for us to be able to use such solutions.

9 sogolytics

Integrated monitoring and processing

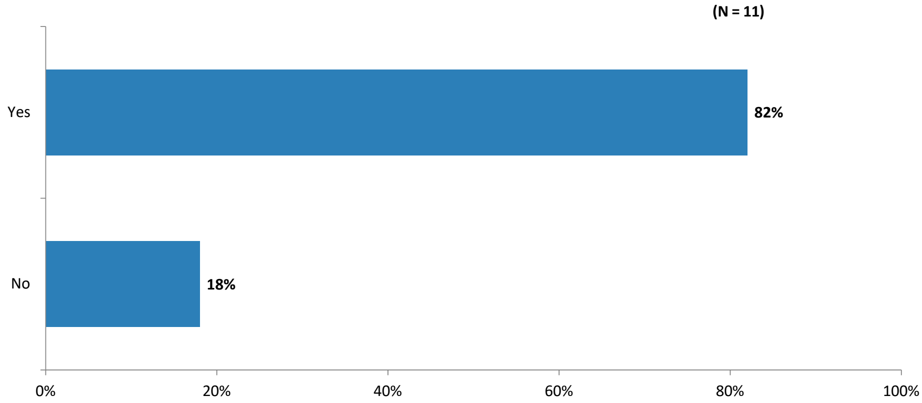
What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
1	A project where the farmers are subsidised to test the technology
2	n.a.
3	training, knowledge retrieval
6	Further understanding of the full suite of processes to be monitored and analysed and a single technology provider to provide all in one package.
7	We need to think about the processes of our Living Lab and identify the most relevant to monitor.
8	To have a talk to the owners and check if this is useful for us. If we can use it from data taken from the sensors. If it is ok we can start working in order to scale up to our living lab space to be tested.
10	none
11	To find new or join existing initiatives / projects we could contribute to related to such solutions.

Engagement and anticipation of stakeholders

Is this best practice interesting for your Living Lab?

(N = 11)



Engagement and anticipation of stakeholders

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
2	Our practices to engagement stakeholders are different, but work very well for us nevertheless
3	always happy to learn about identical stakeholder searches
4	none
6	We strongly agree with this best practice and it is central to our living lab. We build resources into each project for this work.
8	none
9	Financing and resources
11	There are no particular barriers for our Living Lab here, we are quite aligned with the approach illustrated by this best practice. To keep stakeholders engaged beyond the project/initiative is quite challenging though. In this regard, sharing the stakeholder community seems a good idea.

Engagement and anticipation of stakeholders

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
1	We have some kind of self-assessment and refined co-creation groups
2	n.a.
4	we are already using CoPS
6	Sometimes project budgets are constrained and we don't get sufficient resources - we have found it is better not to proceed with these projects and to focus on the ones that provide sufficient budgets.
9	Financing and resources
11	Developing/using a simple intuitive and not very time consuming system of exchange between stakeholder communities around similar challenges/topics.

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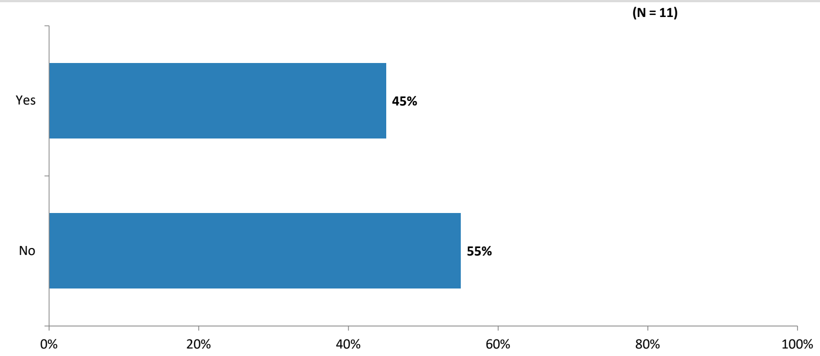
Visitor centre as tool for stakeholder engagement

Is this best practice interesting for your Living Lab?



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Visitor centre as tool for stakeholder engagement

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
2	No barriers, our main building already acts as visiting centre for stakeholders
4	currently, we don't have a space at our facilities to host such centre :(
6	We like to use the full Peninsula to showcase the many different initiatives underway. That way, we are not in one central location but dispersed with different communities hosting different showcase events.
8	none. The context is different.
9	Long term financing, long term tools and technologies the municipality is invested in
11	Accessibility to data obtained: A major barrier with such centers is that the data (feedback) received is not shared with other organizations in an anonymised form.

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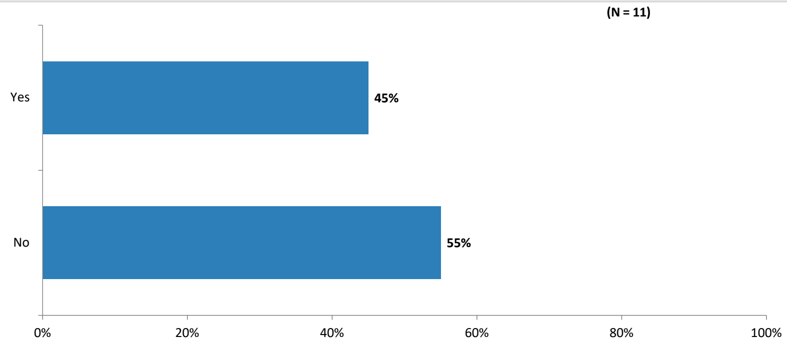
Visitor centre as tool for stakeholder engagement

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
2	n.a.
6	na
9	Long term financing, Long term detailed planning
11	It'd be interesting to think of the data exchange system or opportunity to receive summarised feedback from different specific stakeholder groups.

Test-bed for solar thermal applications

Is this best practice interesting for your Living Lab?



Test-bed for solar thermal applications

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
1	It would be interesting to know the specific novelty of these algorythms and how this can help farmers
3	Big desalination plants are not allowed in Slovenia, so we would want to learn about smaller units, downscaled.
4	investments from our host institution
6	Beyond our scope to evaluate technologies of this type
8	Test bed models is very interesting for us since we are working in Energy communities living labs and trying to develop lighthouses as test beds. The context is different. And we are working in Energy communities. So we may need to adapt it to our needs.
9	high amounts of snow and rain in the region, general weather constraints
10	Space

Test-bed for solar thermal applications

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
3	funding, research, tech, knowledge
6	na
8	To have a talk to the owners and check if this is useful for us. If it is ok we can start working in order to scale up to our living lab space to test and adapt the model.
9	Cannot change climate related barriers
10	Finding the land

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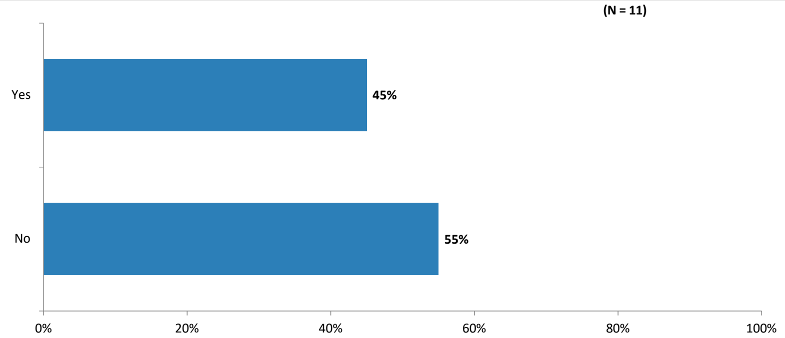
Fully monitored multi-effect distillation plant

Is this best practice interesting for your Living Lab?

(N = 11)



20 sogolytics

Fully monitored multi-effect distillation plant

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
2	Our focus is on RO en ED systems
3	lack of tech and operational knowledge
6	Beyond our scope to evaluate technologies of this type
8	The cost and the use of it need to be analysed.
9	Investment, winter cliamte, large amounts of rain and cloudy weather,
10	Space
11	Technical, financial, infrastructural barriers.

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Fully monitored multi-effect distillation plant

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
3	training
6	na
10	Creating space
11	To ensure that the solution is aligned with the current activities of our organisation.

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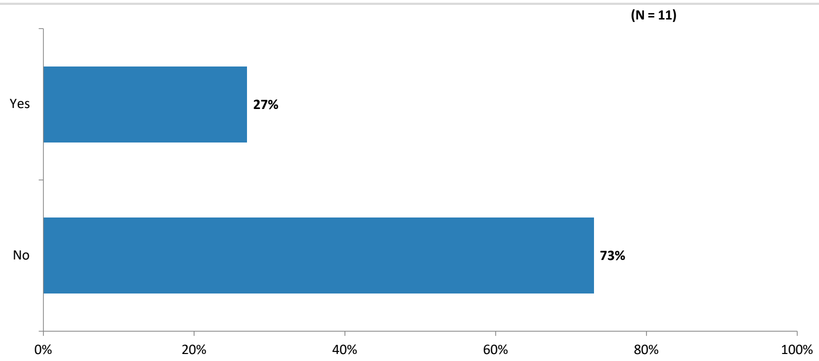
Test-bed for membrane distillation at commercial scale

Is this best practice interesting for your Living Lab?



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Test-bed for membrane distillation at commercial scale

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
6	Beyond our scope to evaluate technologies of this type
8	The context is different. So we may need to adapt it to our needs.
9	challenges with solar in winter and rainy climate

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Test-bed for membrane distillation at commercial scale

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
6	na
8	To have a talk to the owners and check if this is useful for us. If it is ok we can start working in order to scale up to our living lab space to test and adapt the model.

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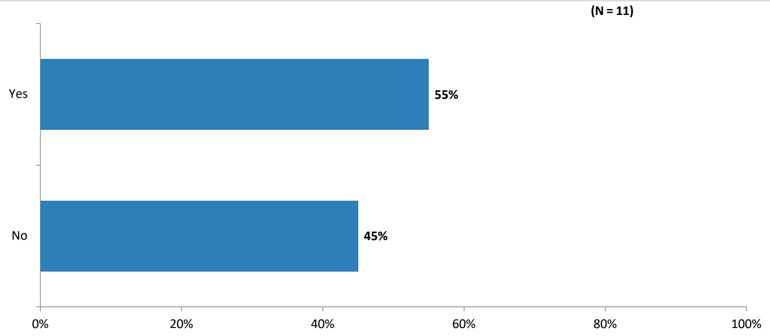
Pilot plant for forward osmosis, reverse osmosis and nanofiltration

Is this best practice interesting for your Living Lab?



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Pilot plant for forward osmosis, reverse osmosis and nanofiltration

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
1	We already work with a technology provider that can perform reverse osmosis on manure
2	In our LL we already have access to this technology at different scales, incl. full scale.
3	lack of tech and operational knowledge
4	more technical details to know how to install it
6	Beyond our scope to evaluate technologies of this type
8	This can be of interest to the researchers part of our living lab.
9	Costs

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Pilot plant for forward osmosis, reverse osmosis and nanofiltration

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
2	n.a.
3	training
6	na
9	Financing

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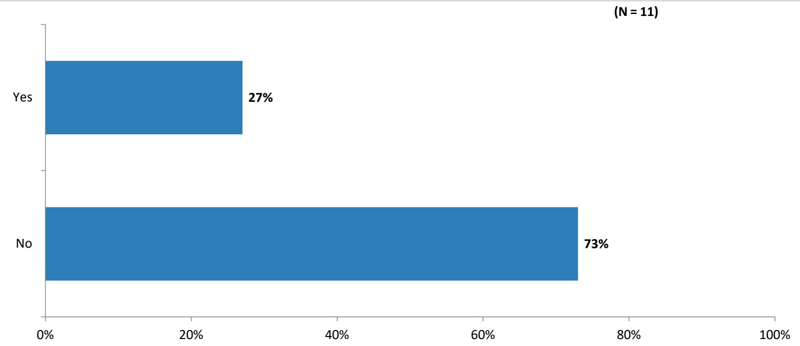
Test bed to evaluate cooling systems for thermal desalination

Is this best practice interesting for your Living Lab?



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Test bed to evaluate cooling systems for thermal desalination

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
4	investments again from our host institution
6	Beyond our scope to evaluate technologies of this type
8	This can be of interest to the researchers part of our living lab.
9	Challenges with solar in northern, winter climates
10	Space and Technological know how
11	Technical, financial, infrastructural barriers, co-creation potential.

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Test bed to evaluate cooling systems for thermal desalination

What is needed within your Living Lab to overcome these barriers?

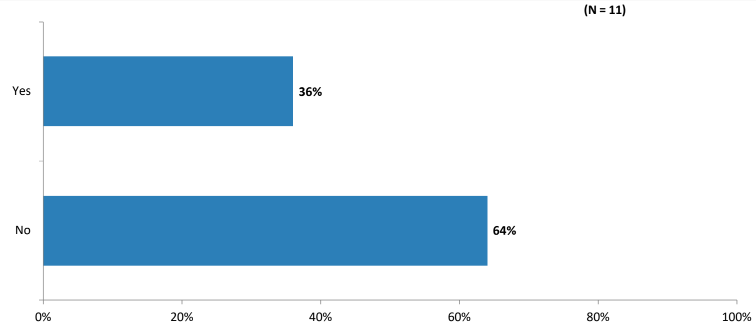
Response No.	Answer text
6	na
8	I must know the interest from the researcher or academia.
10	To find the space and experts
11	To ensure that the solution is aligned with the current activities of our organisation. The goal of our Living Lab activities is to co-design solutions with the users. It's interesting to have testing solutions for evaluation of cooling systems, however, I'm not sure there is a potential for co-design in this case.

31 sogolytics

Pilot plant to test membrane distillation materials and applications

Is this best practice interesting for your Living Lab?

(N = 11)



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Pilot plant to test membrane distillation materials and applications

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
6	Beyond our scope to evaluate technologies of this type
8	This can be of interest to the researchers part of our living lab.
9	Cost, operation and maintenance

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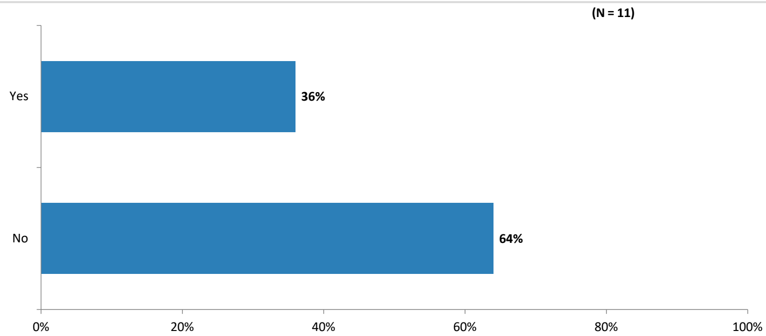
Pilot plant to test membrane distillation materials and applications

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
6	na
8	I must know the interest from the researcher or academia.
9	Financing model

Solar-powered zero-liquid discharge desalination system for greenhouse irigation

Is this best practice interesting for your Living Lab?



Solar-powered zero-liquid discharge desalination system for greenhouse irigation

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
2	We have developed selective technology that only takes out the Na+ so that the "useful" K+ can be returned to the greenhouse
3	lack of tech and operational knowledge
6	Beyond our scope to evaluate technologies of this type
8	This can be of interest to the researchers in our LL
9	Challenges with solar in snowy, rain climate
10	Find the land

Solar-powered zero-liquid discharge desalination system for greenhouse irigation

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
2	n.a.
3	training
6	na
8	I must know the interest from the researcher or academia.
10	Partner with a farm owner

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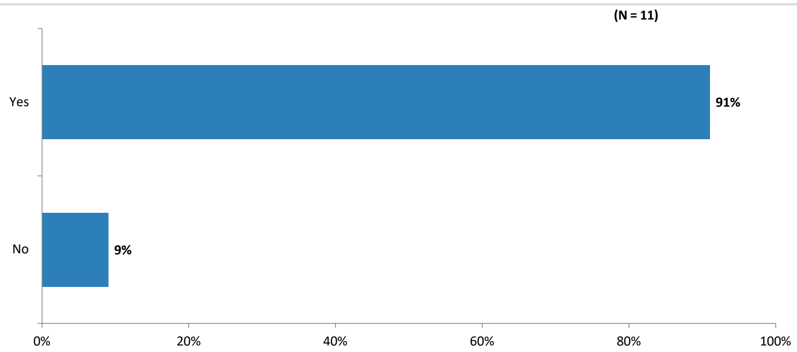
Training activities

Is this best practice interesting for your Living Lab?



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Training activities

What are the barriers for your Living Lab for implementing this best practice in your own Living Lab

Response No.	Answer text
2	We are doing this by creating education tool kits, e..g. for science projects at schools
3	funding for exchange, not familiar yet with local stakeholders attitudes towards this technology
4	none
6	Once capacity is in place, we are always looking for best practice tools and resources
7	In general we have a good environment to implement this best practice in our Living Lab. In fact, we have been working in the last years in activities with similar purposes. The main barrier of our living lab is that we have no people exclusively dedicated to this type of activities.
8	It depend on the training content and if this can be of interest for the potential stakeholders.
11	Understanding of these educational activities and lack of knowledge in specific topics.

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Training activities

What is needed within your Living Lab to overcome these barriers?

Response No.	Answer text
2	n.a.
3	funding, exchange
4	we are doing training but we can definitely learn from others like this best practice
6	Alignment of materials with the objectives of one of our projects
7	Dedicate more budget to have people exlusively dedicated to this type of activities.
8	It depend on the training content and if this can be of interest for the potential stakeholders.
11	Capacity building, guidance to be able to use these activities in our own Living Lab.

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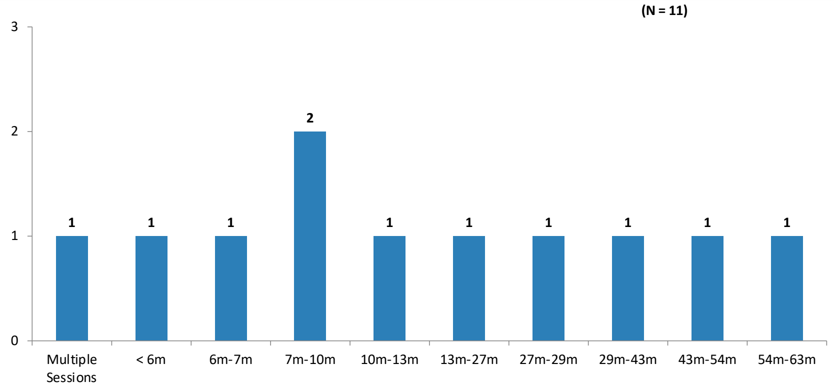
Time to complete the survey



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Time to complete the survey (Continued)

Field	Min	Max	Mean	Standard Deviation	Responses	Sum
Duration (in seconds)	311.00	4121.00	1774.09	1347.26	11	19515.00

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