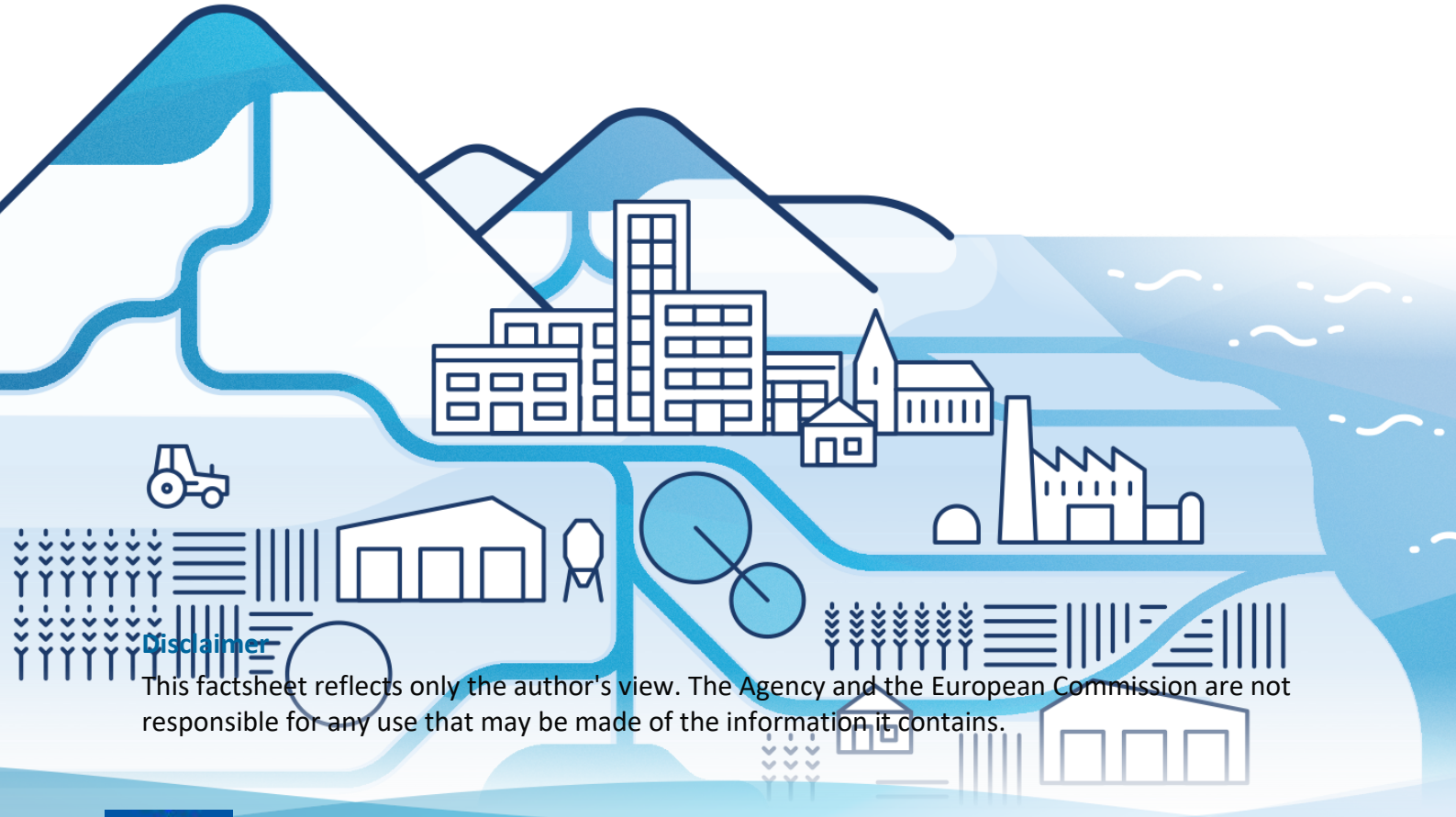
# Factsheet – Large scale Aquifer Storage & Recovery (ASR) Systems

AUTHORS: J. Frijns, M. Paalman, A. Serra

DATE: 01/03/2021

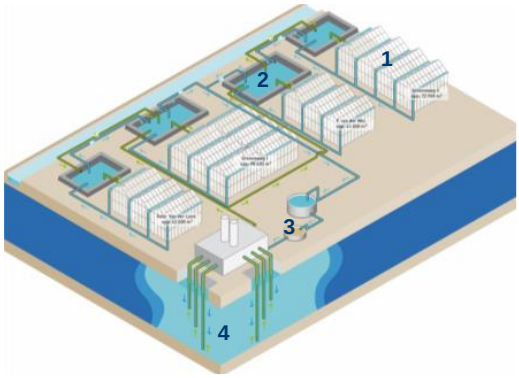
VERSION: v7





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°776541.

# Large scale Aquifer Storage & Recovery (ASR) Systems




**Unique selling points:**

- ✓ High storage of rainwater: approximately 95% of rain fallen on roofs can be harvested.
- ✓ High recovery of the previously stored groundwater (≥ 30%) with desired quality to be reused (for example, to irrigate greenhouses). The lowest recovery percentage is obtained for the brackish groundwater environments, whereas the highest recovery percentage is achieved for the fresh groundwater environments.

## Description of the technology

**Large scale Aquifer Storage & Recovery (ASR) systems** are human-made or human-enhanced natural systems that harvest (*e.g.* from roof) and collect (*e.g.* in basins) rainwater to later inject it to the aquifers aiming to replenish them, to store freshwater in aquifers and reuse it for beneficial purpose (*e.g.* agriculture irrigation). These systems aim to avoid aquifer salinization as well as to improve the quantity of available water used for different applications (irrigation, drinking water, etc.). They are linked to ecosystem restoration projects. Moreover, they are cost-effective systems because of optimal use of the natural conditions (Zuurbier, 2016; Dillon, 2006).

In the NextGen project, by the **ASR systems**, the rainwater (winter) is collected from the roofs (area about 2500 ha) and partly stored in aboveground basins (average 800 $m^3$/ha/year), whereas the rest of rainwater collected (7700 $m^3$/ha/year) is temporarily stored in an aquifer (depth approximately of -20m to -40 m below surface) so it can be recovered in summer period to be reused (as irrigation water, for example). Moreover, the infiltration of freshwater limits also further salinization of the aquifer.

The capacity of the system in the NextGen project corresponds to an average of 8500 $m^3$/ha/year of water stored; and an average of 5000 $m^3$/ha/year of water recovered and reused (= sum of rainwater collection tank (basin) + ASR).

The simplified diagram of the process is schematized in Figure 1.

**Error! No s'ha trobat l'origen de la referència.** shows some images of the ASR systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°776541.

## Flow scheme of the ASR technology

The scheme of the ASR system used in the NextGen project is shown in the following figures.

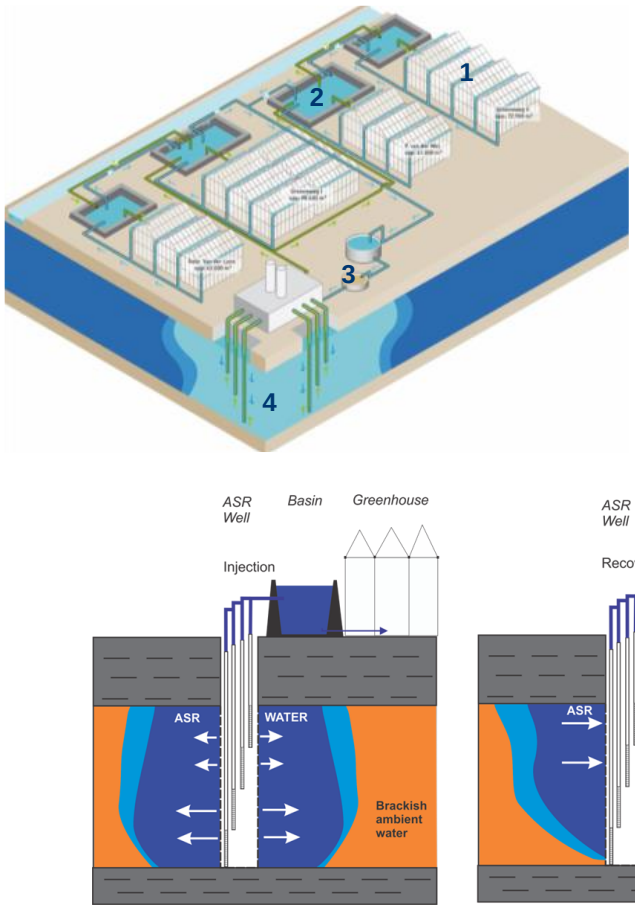



**Figure 1.** Scheme of the ASR system used in the NextGen project.

## Pictures of the technology

**Figure 2.** ASR system at Prominent in the Westland area. The aboveground water basins in combination with the ASR unit.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°776541.

## Synergetic effects and motivation for the implementation of the technology

✓ **Reduction of the aquifer salinization and ecosystem restoration**

The **ASR systems** allow to replenish the aquifers with rainwater), which presents a low electrical conductivity. The storage of the rainwater in the aquifer avoids/minimizes the saline water intrusion into freshwater aquifers and control land subsidence thus contribute to the ecosystem restoration.

✓ **Reduction of the drinking water consumption**

By the proposed scheme, the recovery of the stored groundwater in summer period is an effective alternative to desalinate brackish water for the irrigation. The water recovered can be later used for several applications. This contributes to decrease the drinking water consumption from the direct exploitation of the aquifers.

## Requirements of the technology and operating conditions

The following table summarize the requirements of the **ASR system** for an optimal performance.

**Table 1.** Required specifications for the ARS system.

| Parameter | Units | Min | Max | Reference |
|---|---|---|---|---|
| **Sodium concentration of harvested water** | mg/L | **0** | **15** | Zuurbier, 2016 |
| **Pressure** | bar | **0.3** | **1** | Zuurbier, 2016 |
| **Above ground temporarily storage capacity** | $m^3$/ha | **500** | **5000** | |

## Key performance indicators

**Table 2.** KPIs for the ARS system.

| Parameter | Units | Min | Max | Reference |
|---|---|---|---|---|
| **Percentage of water stored** | % | **95** | **> 95** | NextGen, D1.2 |
| **Percentage of water recovered** | % | **30** | **> 95** | NextGen, D1.2 (In Westland, a recovery of 30% is achieved for the brackish groundwater environment, whereas the recovery can increase to >90% for the fresh groundwater environment. |

## Links to related topics and similar reference projects

| ASR system | Reference |
|---|---|
| NextGen | **Case study "Westland" (NextGen)** |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°776541.

## References

Zuurbier K. (2016). Increasing freshwater recovery upon aquifer storage. Thesis TU Delft. ISBN 978-90-74741-00-02. http://www.subsol.org/uploads/deliverables/LR-Thesis_KoenZuurbier.pdf

Dillon, P.; Pavelic, P.; Toze, S.; Rinck-Pfeiffer, S.; Martin, R.; Knapton, A.; Pidsley, D. (2006). Role of aquifer storage in water reuse. *Desalination, 188*(1-3), 123-134. https://doi.org/10.1016/j.desal.2005.04.109

## Outlook

**Case study specific information will be provided, when the results of the other work packages are available:**

- Lessons learned from the case study
- Outcome of the assessments
- Legal and regulatory information concerning the whole value chain concerning the technology
- Business opportunities

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°776541.