



**nextGen**

Circular Water Solutions

Stakeholder engagement  
in the circular water  
economy

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Singapore International  
Water Week  
19-04-2022

**KWR**



**MATERIALS**



**ENERGY**



**WATER**



The consortium has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 776541.

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# Demonstrating next generation circular water solutions

NextGen demonstrates:

- innovative technological, business and governance solutions for water in the CE
- in ten high-profile, local and regional demonstration cases across Europe
- and develops the necessary approaches, tools and partnerships, to transfer and upscale.

EU H2020 Nr.776541

2018-2022





# Closing water, energy & materials cycles



## Positive energy generators

Managing and recovering energy more efficiently to turn treatment plants into positive energy generators



## Optimise water resources

Advanced treatment technologies and nature-inspired storage to optimise water resources

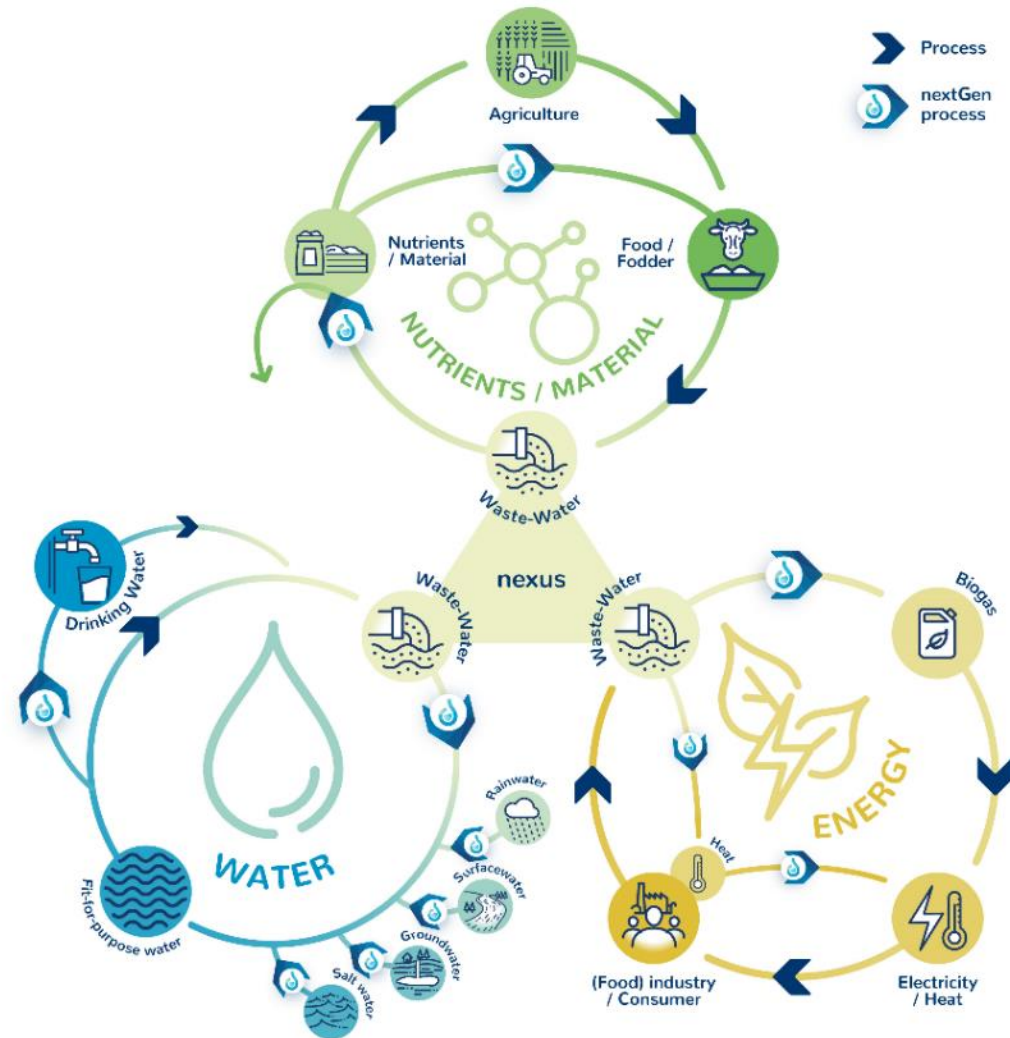


## Nutrient mining & reuse

Ground breaking nutrient mining and reuse that create new products from waste streams



# Towards a nexus CE







# #8. Athens

## Greece



### Circular solutions for

Water



Materials

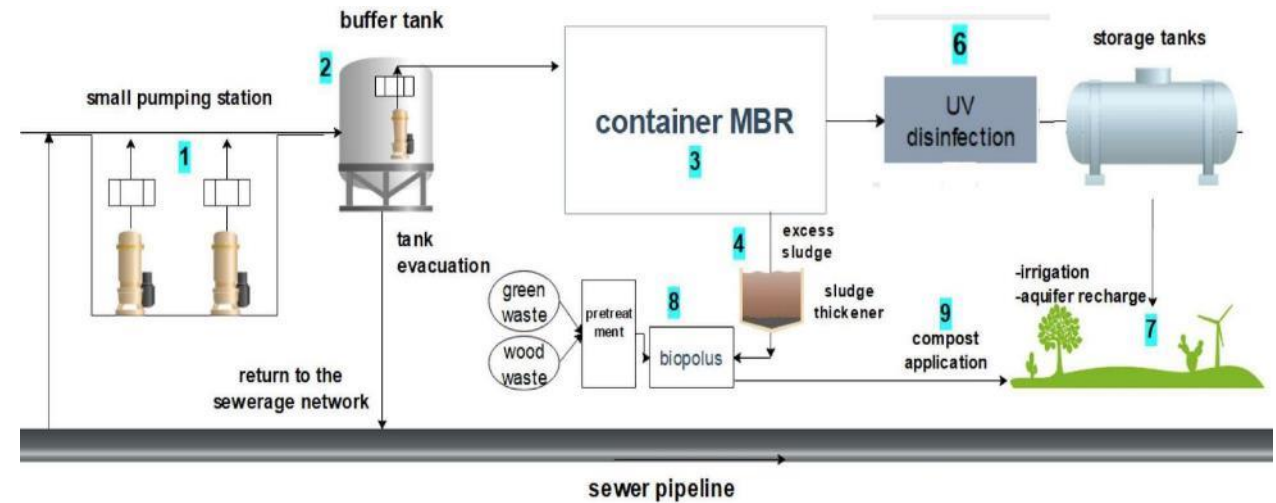


Energy



## Sewer mining at urban tree nursery

- Modular unit for wastewater treatment with Membrane Bioreactor (MBR) and disinfection
- Wastewater reuse at the point of demand for urban irrigation
- Composting with nutrient and energy recovery



Partners:



National Technical University of Athens

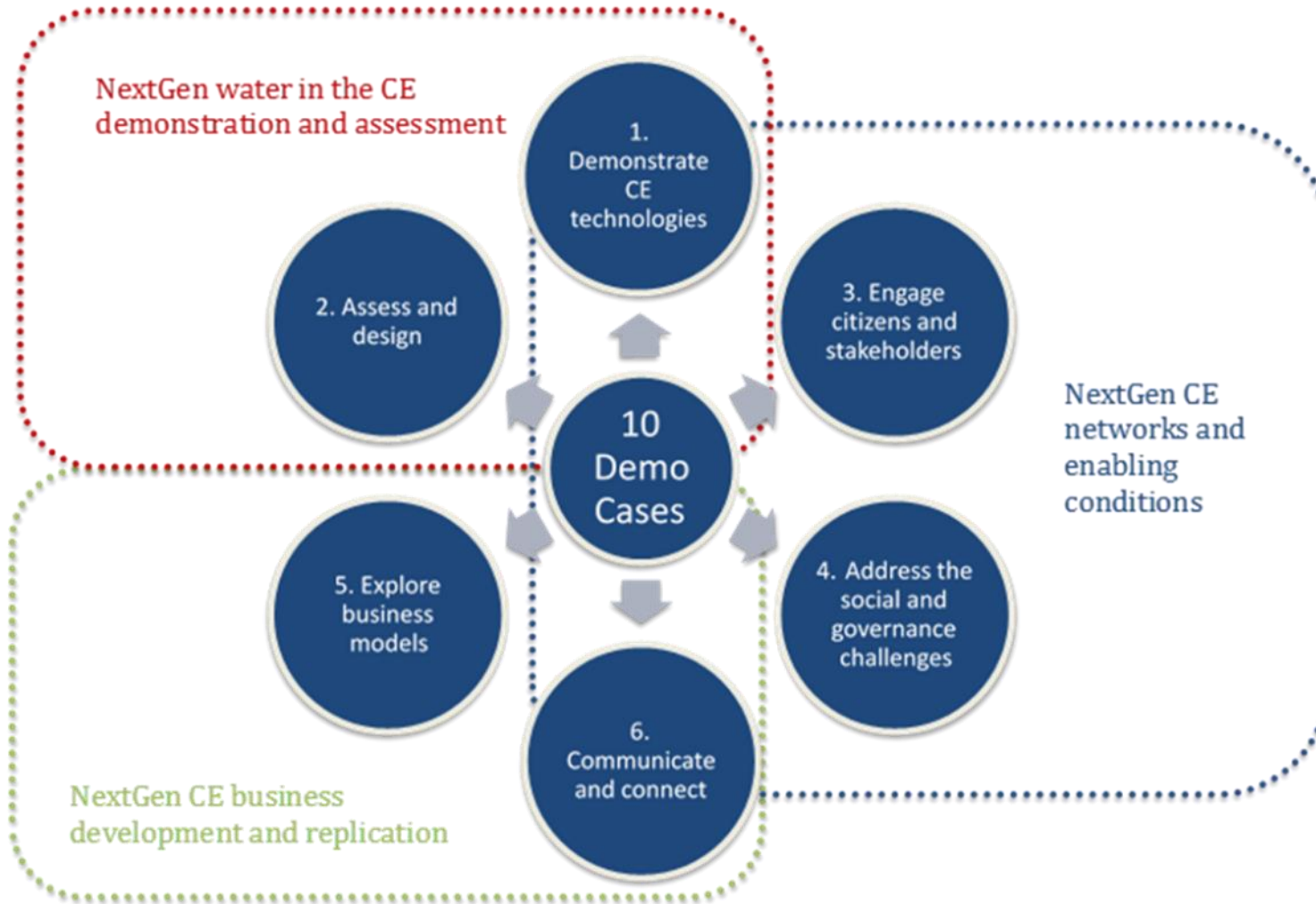


BIOPOLUS  
The Living Technology Alliance



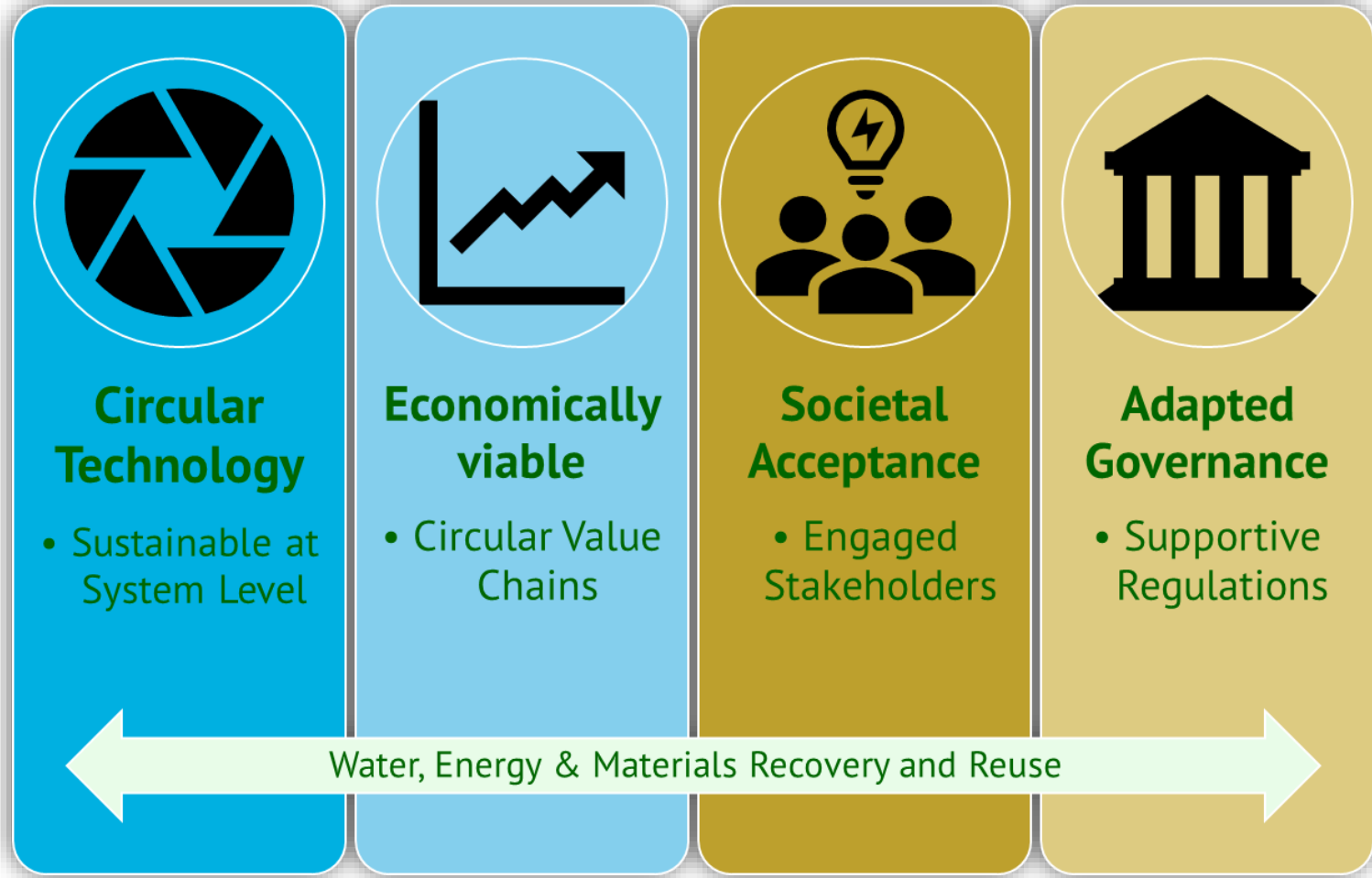


# Integrated approach





# Circular water economy requirements





# Engagement of stakeholders and citizens

Re-designing the water system requires active involvement and engagement and strong levels of collaboration of stakeholders from the whole water value chain

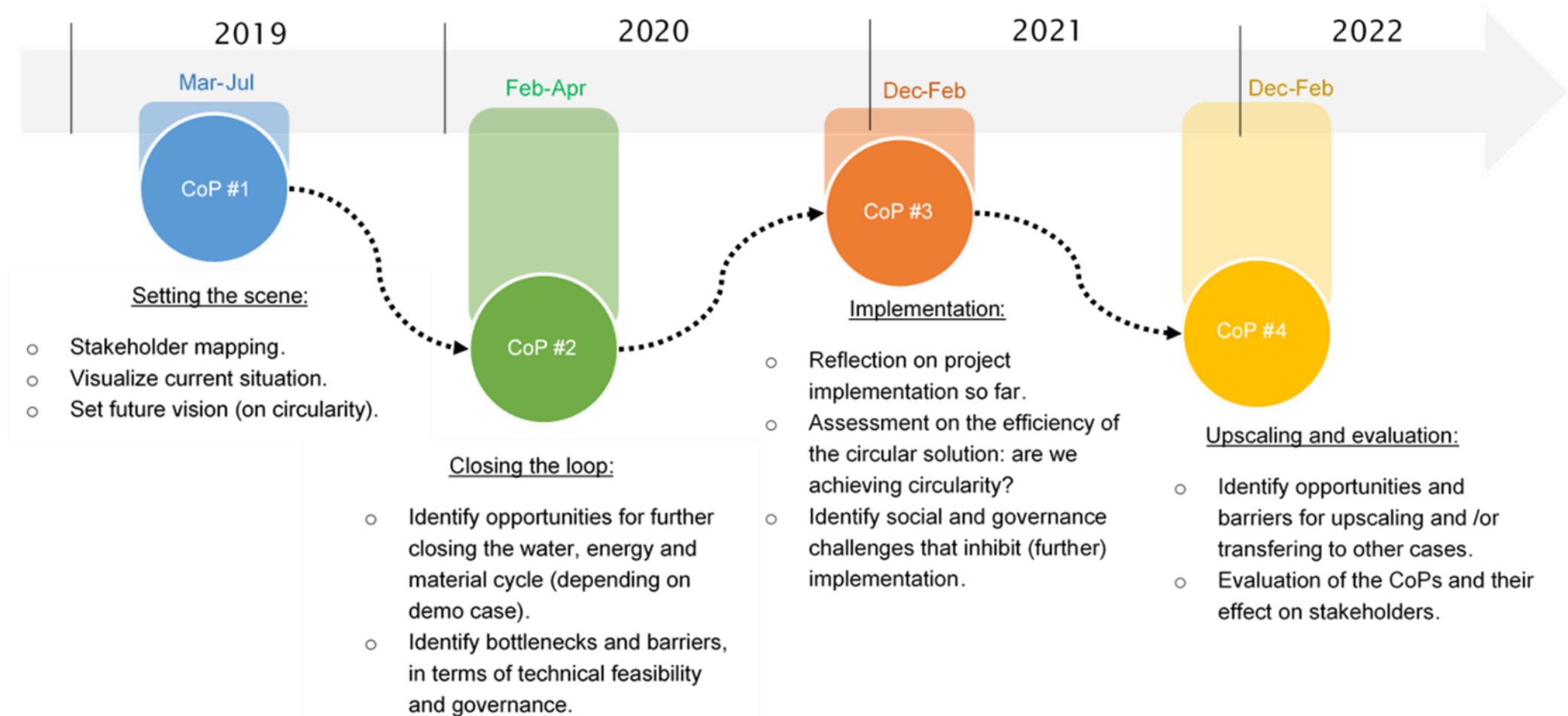


- Create and synchronise **Community of Practices** to promote a *multi-stakeholder* approach to discuss CE water technologies in its institutional context
- Engage *end-users and citizens* in experiencing and visualising CE water technologies by demonstrating **public outreach, Augmented Reality and Serious Games** activities





# NextGen CoP Roadmap

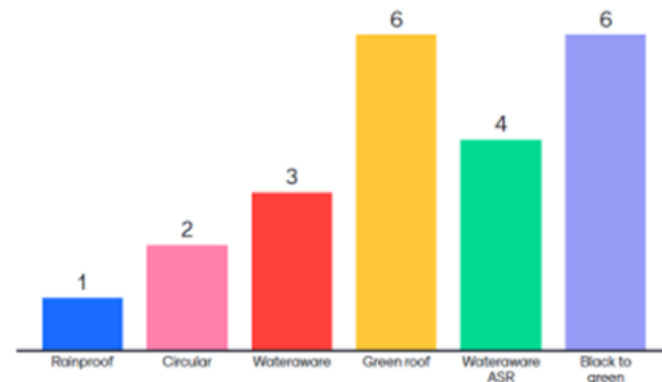




# CoP engagement on technology scenarios

## Scenario preferences

- Technical feasibility and sustainability
- CE interactions: energy, agriculture, industry, urban sector



**Rainproof**  
25% of hh's have RWH  
GHs rely on RW basins

A

**Circular**  
25% of hh's have circular system (RWH/GWR)  
GHs rely on RW basins

B

**Water-aware**  
25% of hh's have circular system (RWH/GWR)  
25% of hh's have water-saving devices  
GHs rely on RW basins

C

**Green roof**  
25% of hh's have RWH  
50% of public impervious spaces have green roofs  
GHs rely on RW basins

D

**Water-aware ASR**  
25% of hh's have circular system (RWH/GWR)  
25% of hh's have water-saving devices  
10% of GHs have ASR

E

**Black to green**  
25% of hh's have circular system (RWH/GWR)  
5% of water treated from WWTPs returned to GHs

F





# CoP social and governance challenges

## Policy survey:

- Helpful and hindering regulations, e.g. end-of-waste status

## Public acceptance survey:

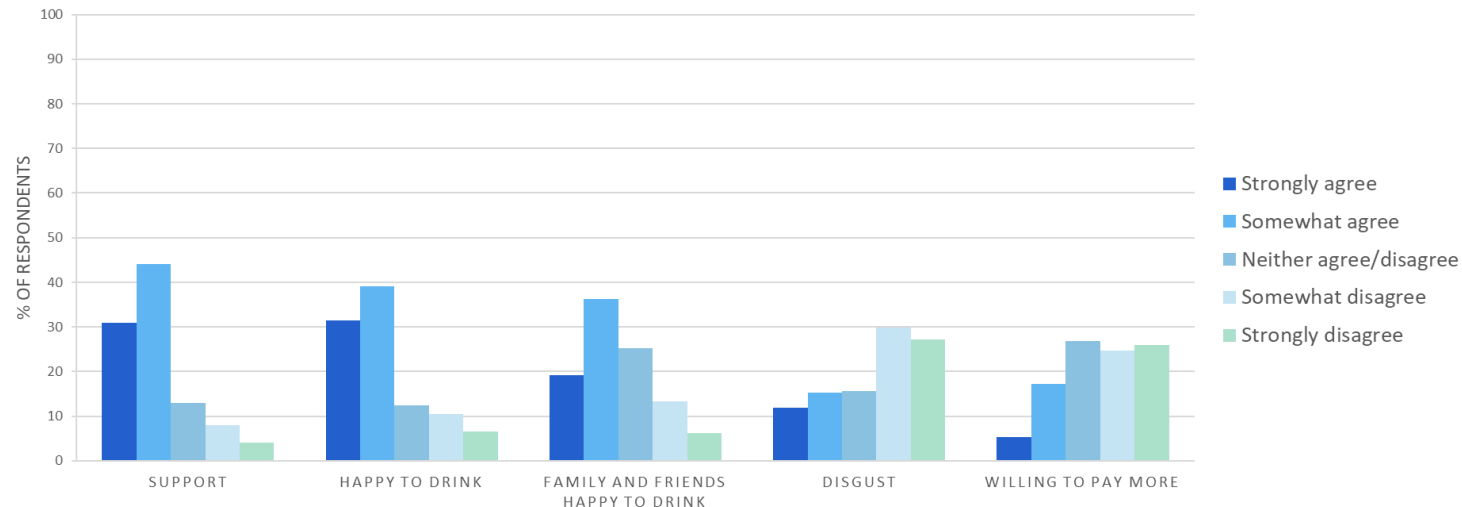
- Proportion of respondents who supported or strongly supported the use of recycled water for drinking: 67-75%

	Helpful	Neutral (i.e. no effect)	Hindering	Not applicable	Don't know
Discharge to / pollution of the water environment	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Abstraction of water	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of water for drinking purposes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

	Helpful	Neutral (i.e. no effect)	Hindering	Not applicable
Waste handling (incl. transport and disposal)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
'End of waste' status	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sludge management	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

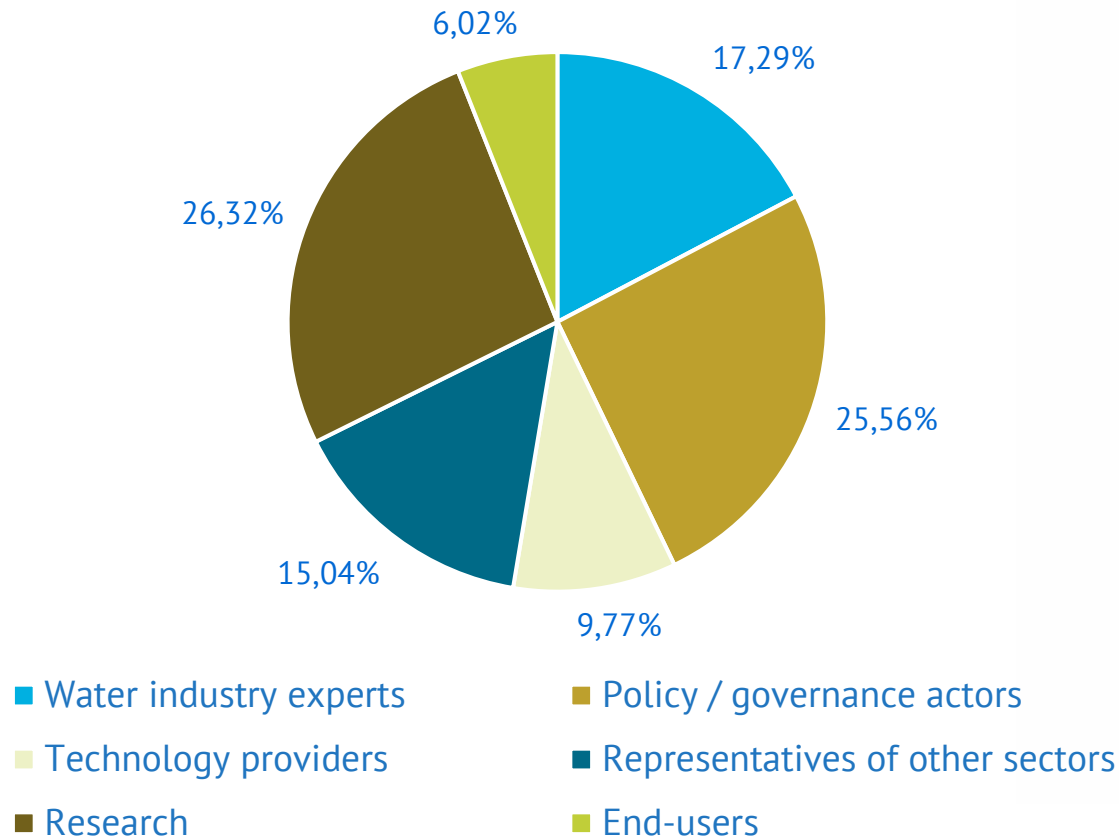
NETHERLANDS ACCEPTANCE (N=752)



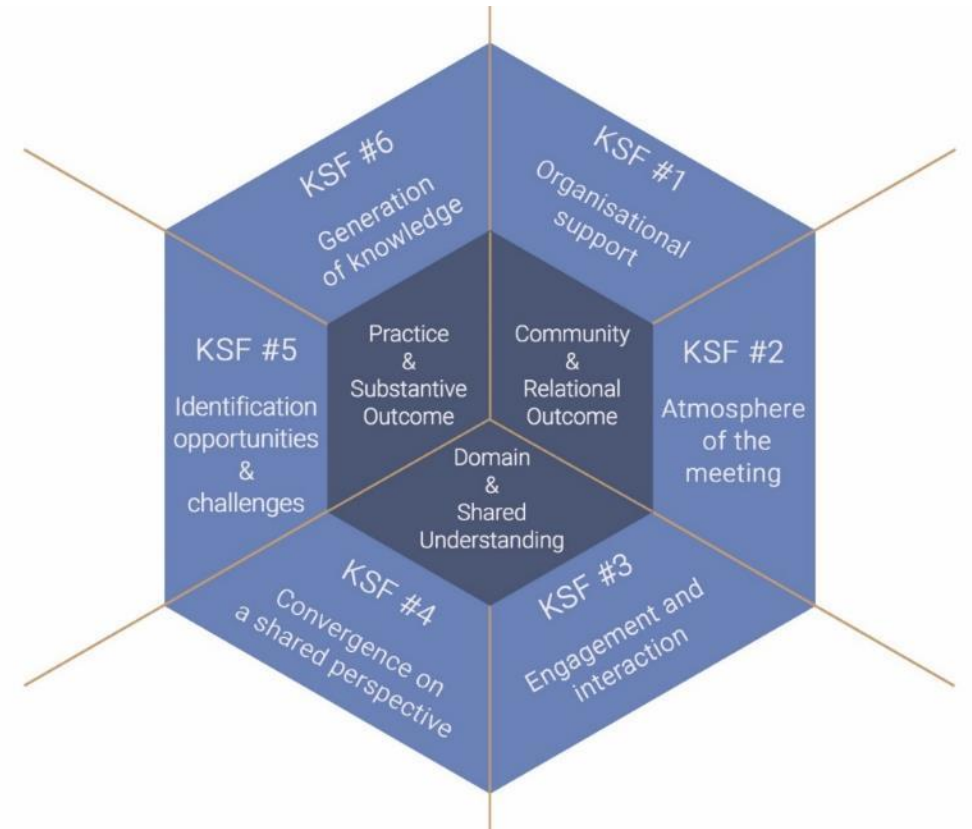


# CoP key success factors

## Broad stakeholder representation



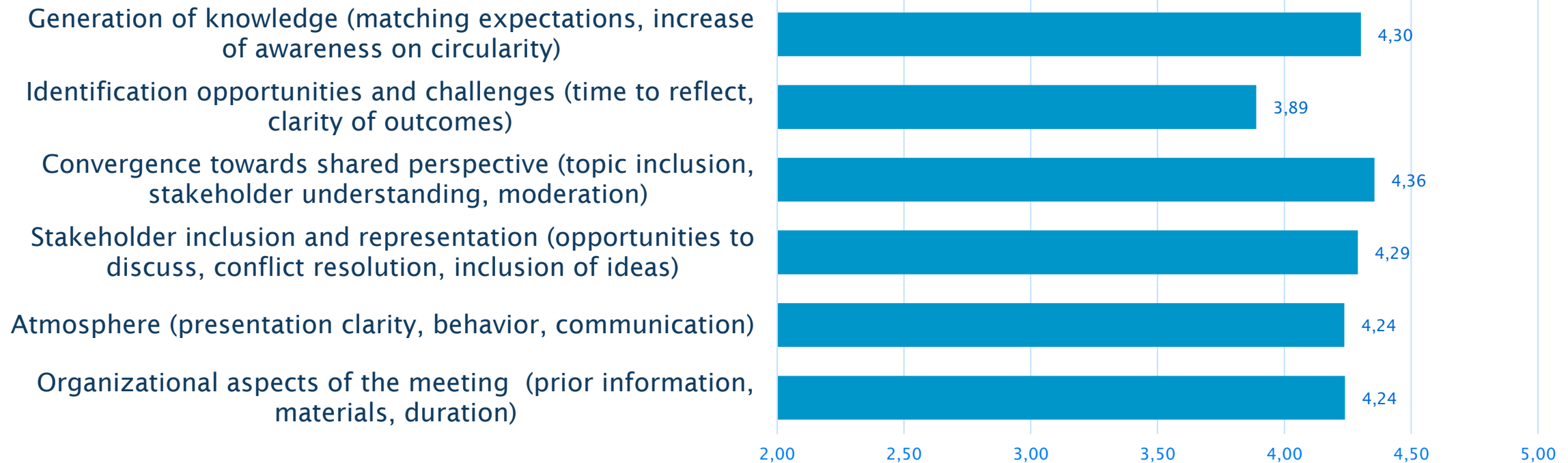
## Scope for dialogue (social learning)







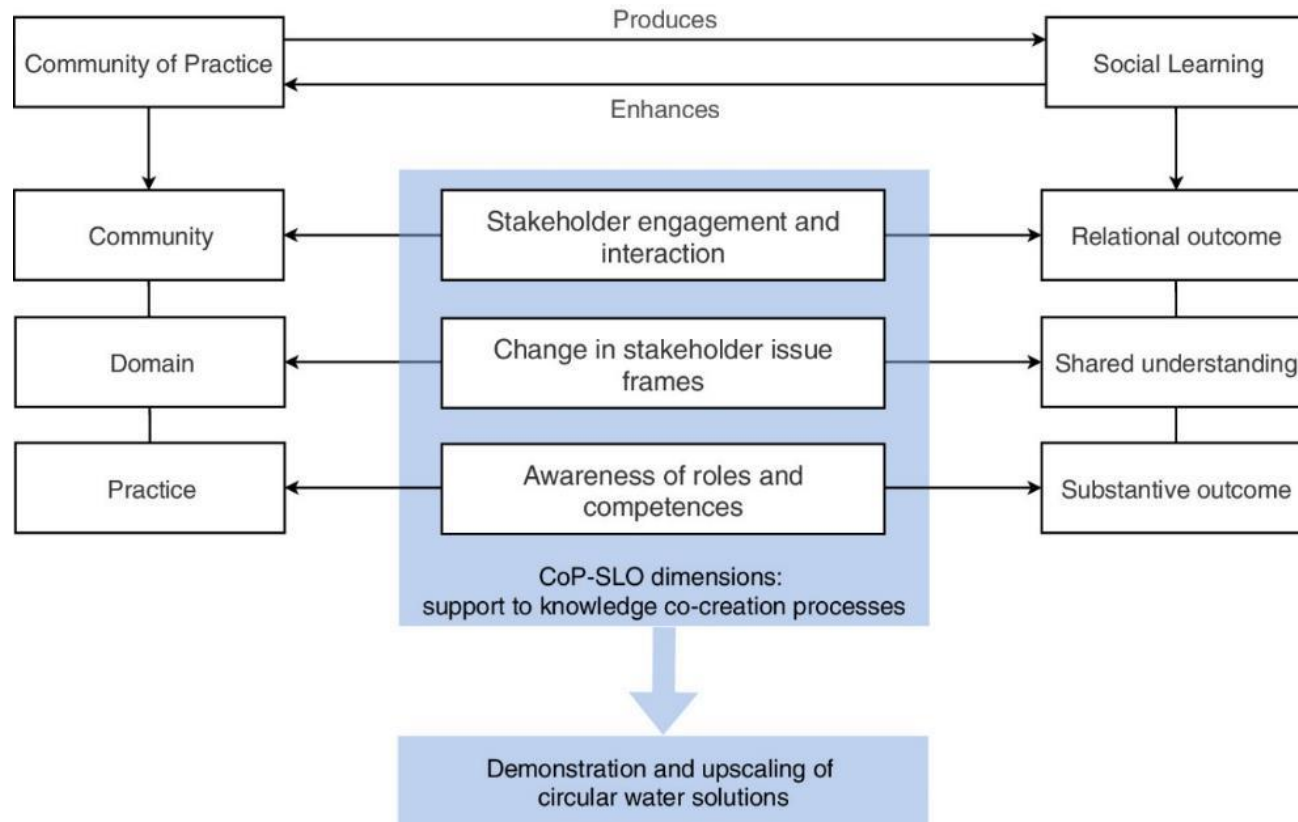
# CoP social learning





# CoPs stakeholder engagement conclusions

Properly organised CoP's that facilitate social learning are a good way to actively involve stakeholders and interact on the circular water solutions





# Public Outreach

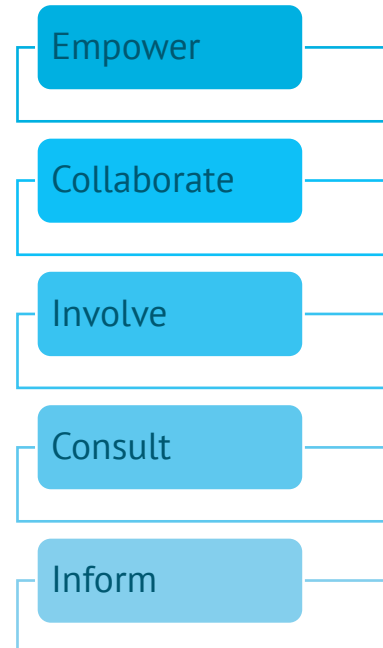
## Physical engagement activities

- Visitors centres, open days, technology festivals, tasting events

## Public outreach inspiration guide

Learnings from frontrunner cases paired with general best practices

- e.g. provide public information from the start
- e.g. be clear about the level of public participation foreseen.





# NextGen Serious Game

Serious Game objective: interactive visualization, role playing, decision support system, learning sandbox

- Insight into options for circular water solutions and motivations of stakeholders
- Participants: general public, policy makers, water – energy - environment specialists

Aim of the NextGen serious game is to maximise the benefits of Circular Economy in a water system.

- The players can change settings in the game to observe the interactions between different components in the urban water cycle and their effects on water availability, energy use, material recovery, environmental health, and costs.



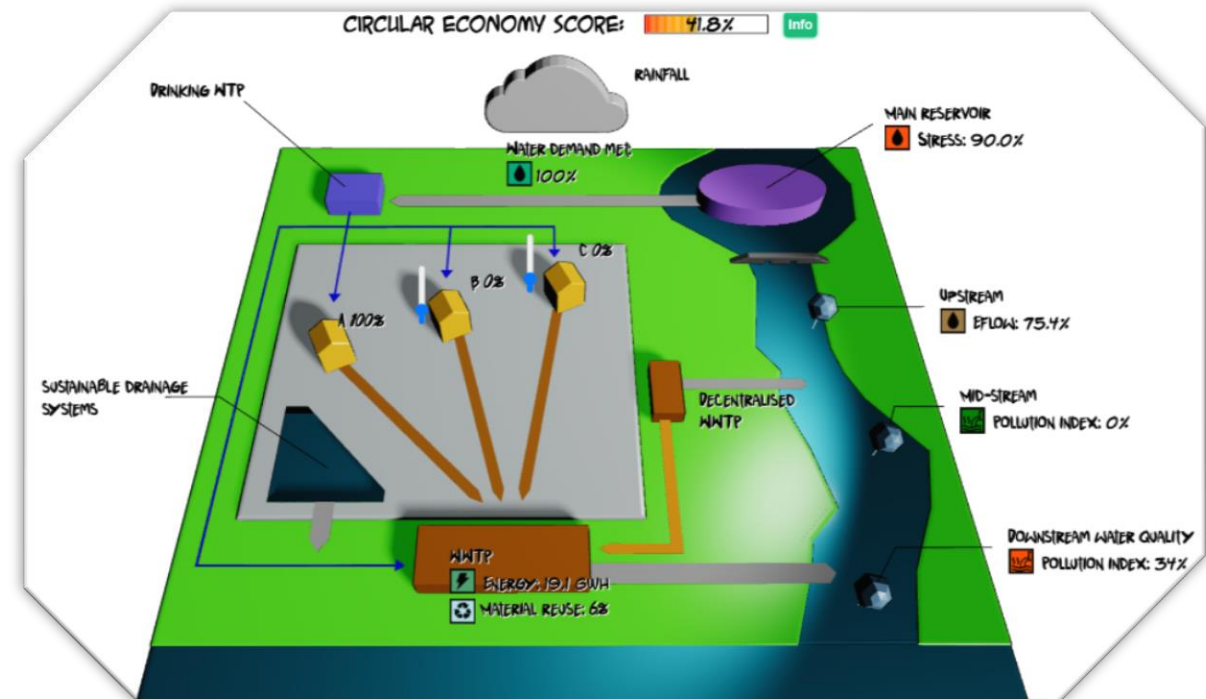


# Toytown Serious Game

Toy town: generic virtual catchment

- 300,000 inhabitants
- with water saving devices in households, sustainable drainage systems, decentralized WWTP, water reuse, recovery of energy and nutrients, etc.

SG Model: System Dynamic Model (SDM) engine, Julia programming language, online browser-based single player SG, data modelling





# Serious Game results

Result:

- Circular Economy Score (weighted average)
- Explanatory “stories”

Initial engagement lessons learned:

- Playing the game induces a statistically significant change in the participants understanding of some technical aspects of circular economy for water.
- *e.g. using greywater reuse in households leads to a better water quality in the river downstream than using rainwater harvesting*





# NextGen Augmented Reality

AR objective: making demonstrated solutions visible to visitors

- Engaging end-users and citizens in experiencing and visualising CE water technologies
- Participants: general public, students, young people (schoolchildren), tourists, researchers

Aim of the NextGen CircularAR app is to

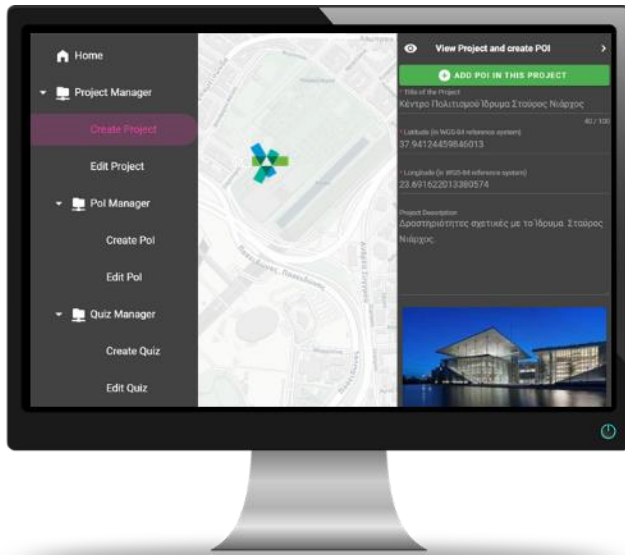
- Explain the need to shift to a more circular approach for water management
- Visualise the main principles of CE in the water cycle
- Show context on how much water can be reused, reduced, etc.
- Provide fun and interesting facts to engage citizens, and practices to adopt a circular water use





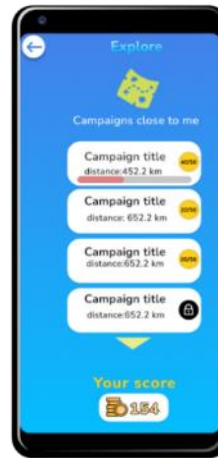
# Mobile AR & Content Management Service

Through the AR Content Management System the users:



- Create campaigns/projects to consolidate information
- Add relevant text content
- Select on the map locations of interest
- Add digital media

Select a campaign to augment relevant content (eg. about events, sites)



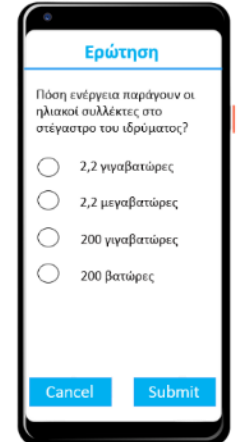
Watch videos or see images embedded to the physical surroundings



Manipulate 3D and 2D objects

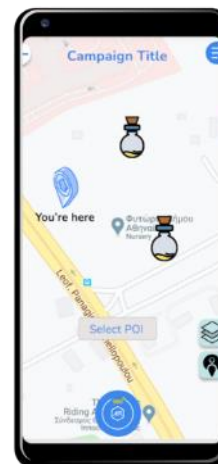


Learn and test their understanding through quizzes

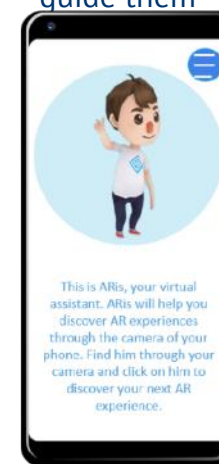


Through the mobile AR app the users:

Visit/navigate towards a Point of Interest on map



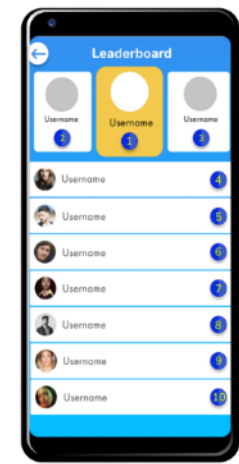
Have a tutorial, hints and a virtual assistant to guide them



Scan QR codes and see AR content



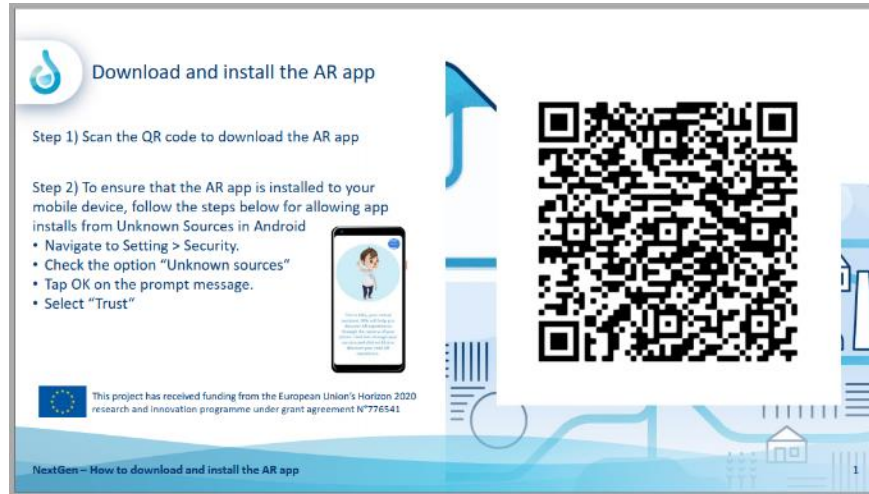
Create a profile, earn badges and improve their score







# CircuAR for Gotland and Athens demo cases



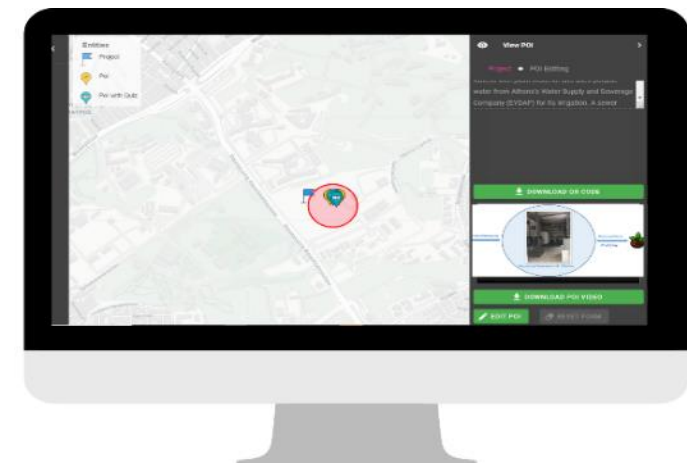
Clear instructions of how to download and install the AR app



The view from the AR app next to the Athens sewer mining bioreactor



The view from the AR app next to the drainage ditches of Gotland

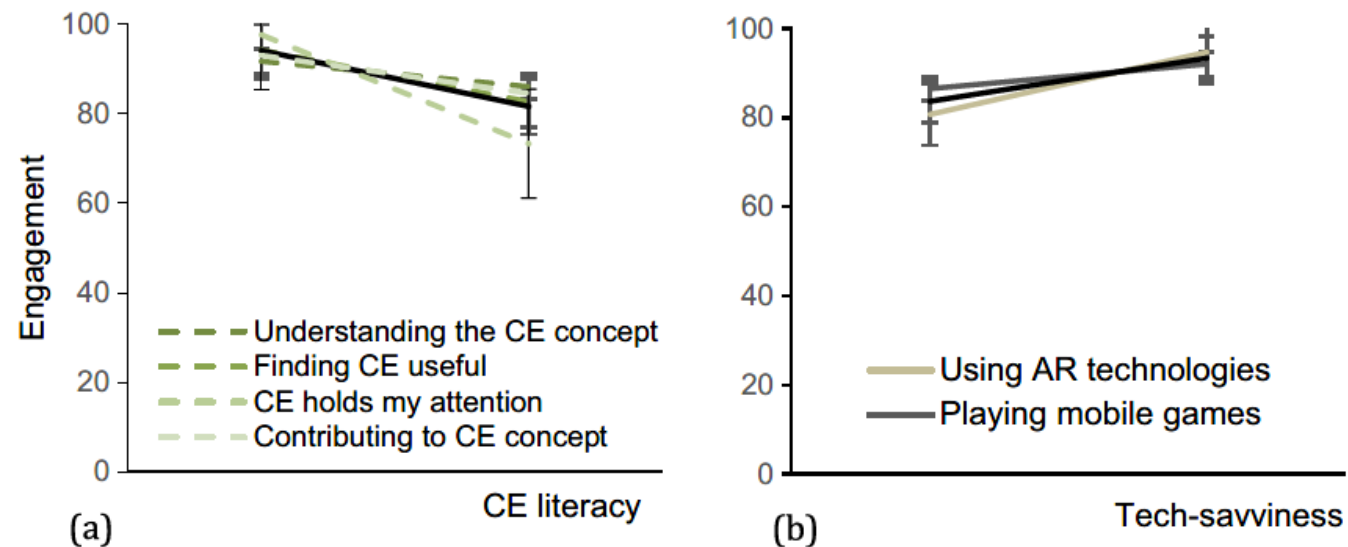


Content uploaded to the AR CMS for the Athens demo case



# AR user engagement

- A web survey among 127 citizens, showed that CirculAR positively fosters citizen engagement for new and rather unknown topics such CE
  - 86% better understanding of CE principles and ability to apply them in real life
  - more appealing to novice practitioners
- Younger people and citizens more used to IT technologies, reach high engagement and motivation towards CE through CirculAR



Katika et al. (2022) Circular Economy and Sustainability



# Conclusions

- Stakeholder engagement is essential for further upscaling and transition of circular water solutions.
- Devising innovations in its institutional context will benefit from social learning processes in stakeholder collaboration.
- Virtual visualisation platforms in which the general public can experience circular water solutions contribute to citizen engagement and public acceptance.





# Acknowledgements

## Authors:

- J. Frijns\*, D. Bouziotas\*, L. Bengtsson\*\*, E. Lind\*\*, S.. Filipsson\*\*, K. Baker\*\*\*, M. Khoury\*\*\*, B. Evans\*\*\*, T. Katika\*\*\*\*, D. Tsiakou\*\*\*\*, L. Vamvakeridou-Lyroudia\*/\*\*\*

\* KWR, \*\* IVL, \*\*\* Univ. Exeter, \*\*\*\* ICCS

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