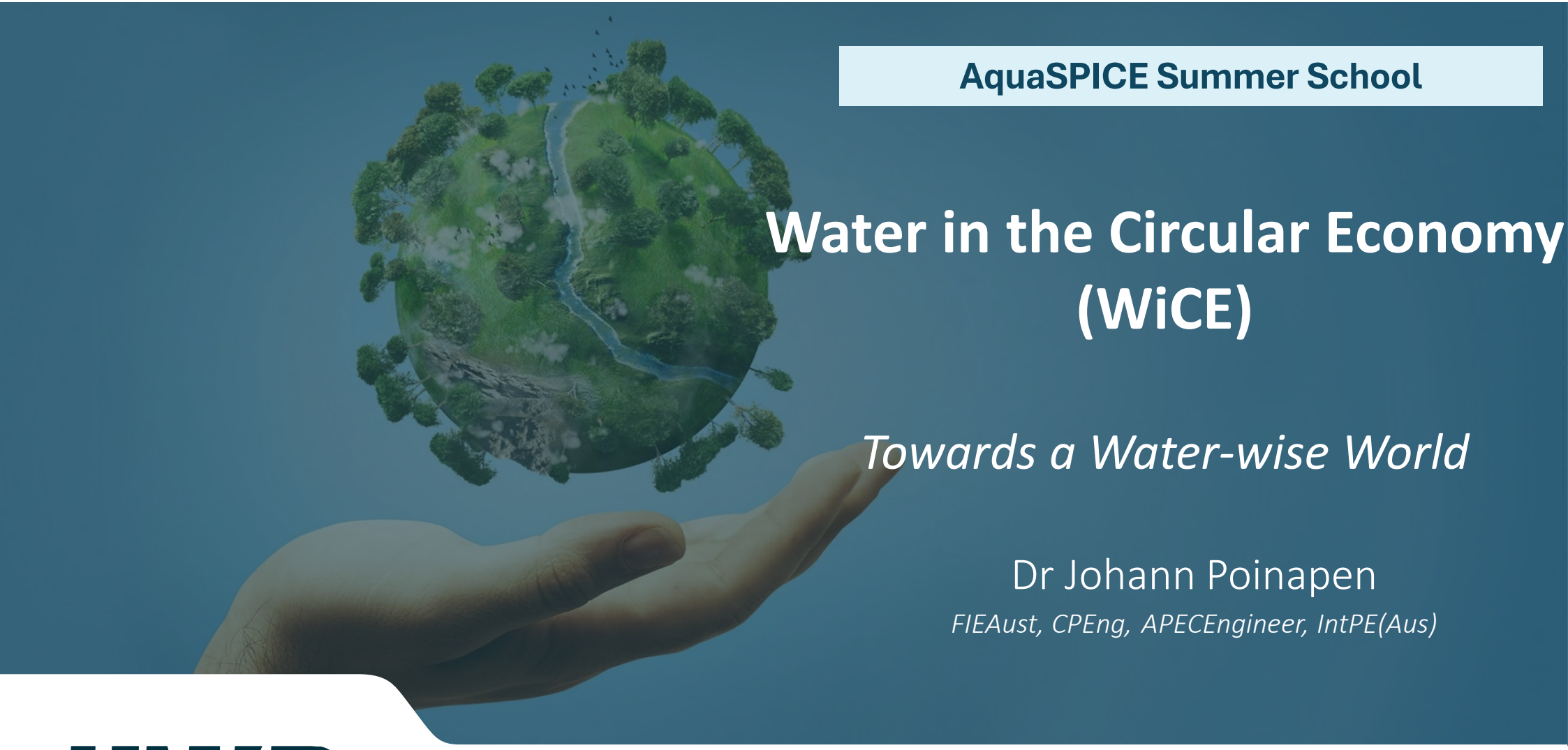


AquaSPICE Summer School

Water in the Circular Economy (WiCE)

Towards a Water-wise World

Dr Johann Poinapen

FIEAust, CPEng, APECEngineer, IntPE(Aus)

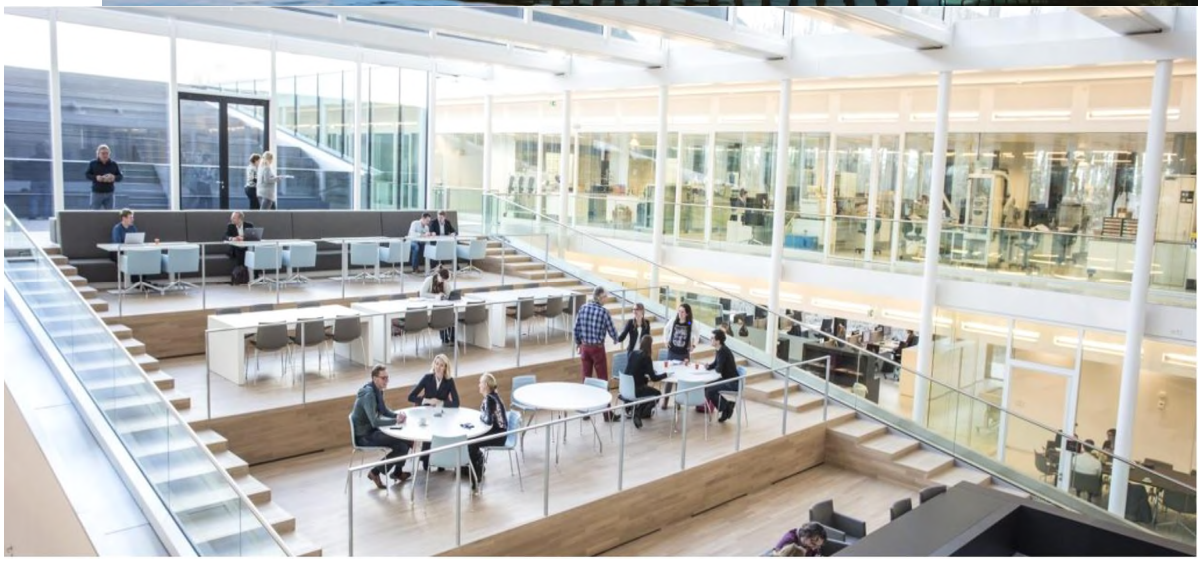
KWR

Bridging Science to Practice

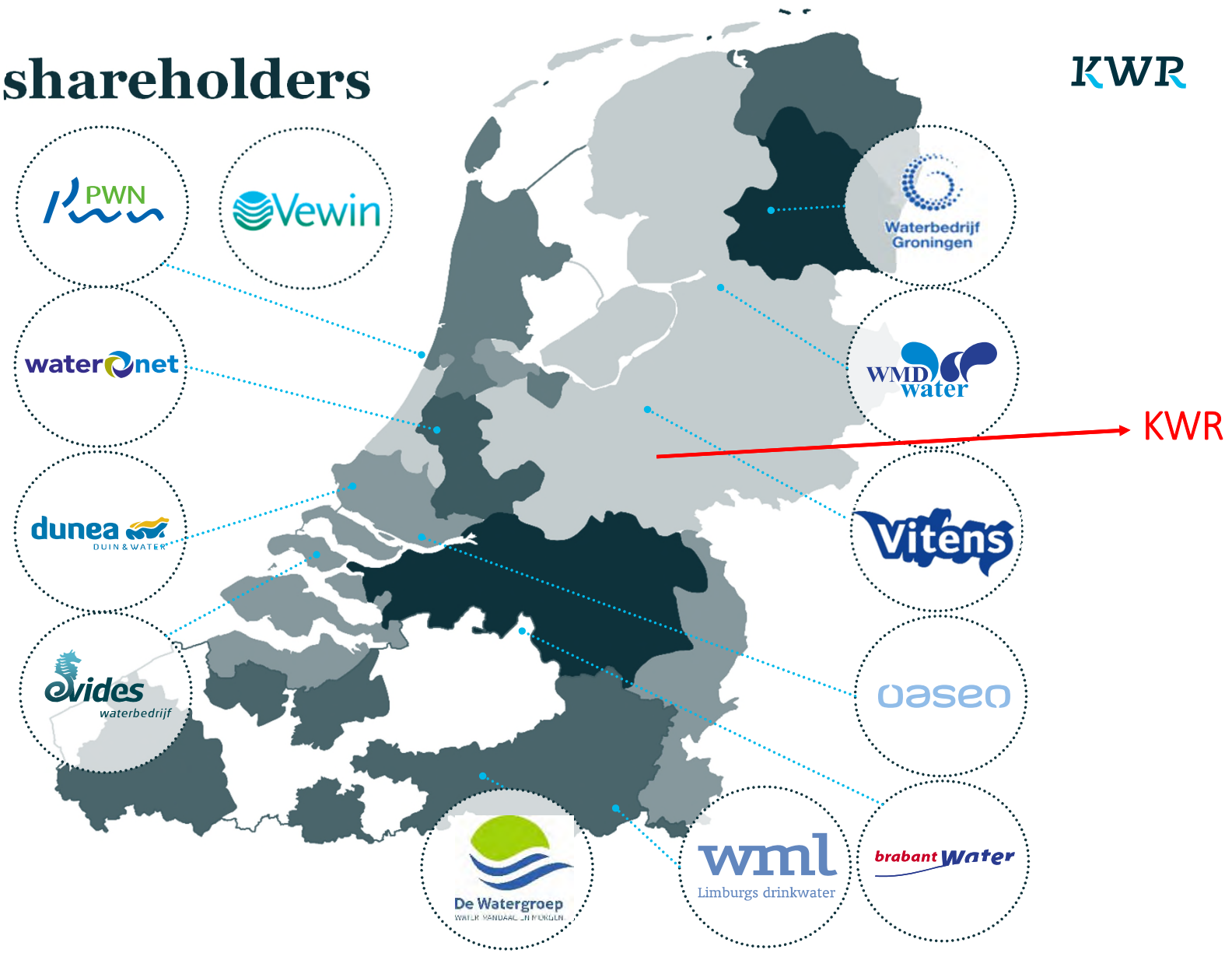
KWR Water Research Institute

Bridging Science to Practice

- Research Institute since 1973
- Independent not-for-profit entity
- ~220 scientists/researchers/specialists
- Main goal: sustainable water provision in the entire water cycle
- KWR considers waste and wastewater as a source of sustainable energy, resources and clean water.
- This fits in with the societal transition to a circular economy.
- KWR is a WHO Collaborating Centre on Water Quality & Health



KWR's shareholders

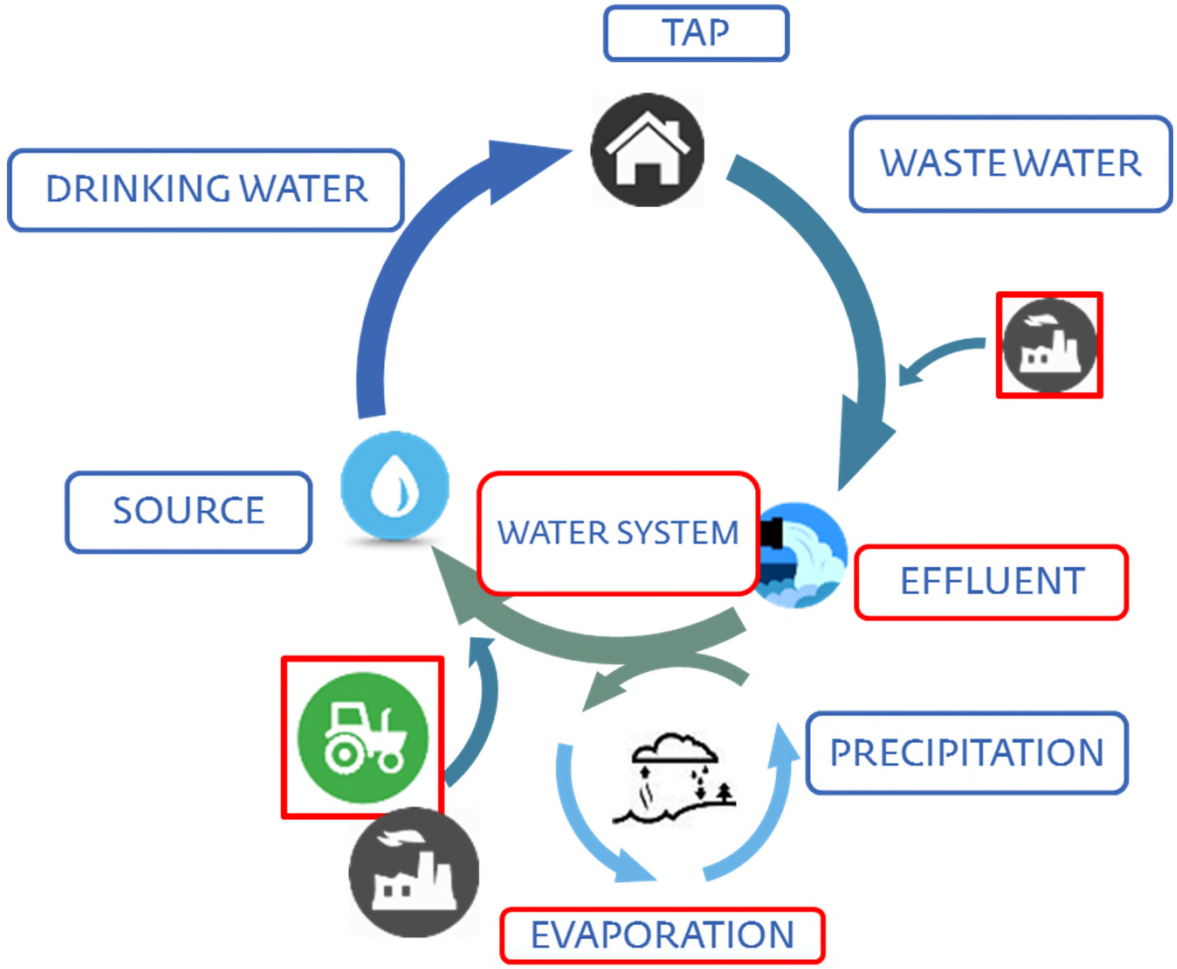


Water in the Circular Economy (WiCE)

- WiCE - Contributes to meeting the societal challenges regarding the circular economy, climate adaptation and the sustainable energy transition.

(i) Wastewater Reuse – A Global Perspective

(ii) Resource Recovery from WW



Definition of Circular Economy

- Physical dimensions (like substance flows)
- Socio-economic values (like efficient, socially responsible, quality of life)

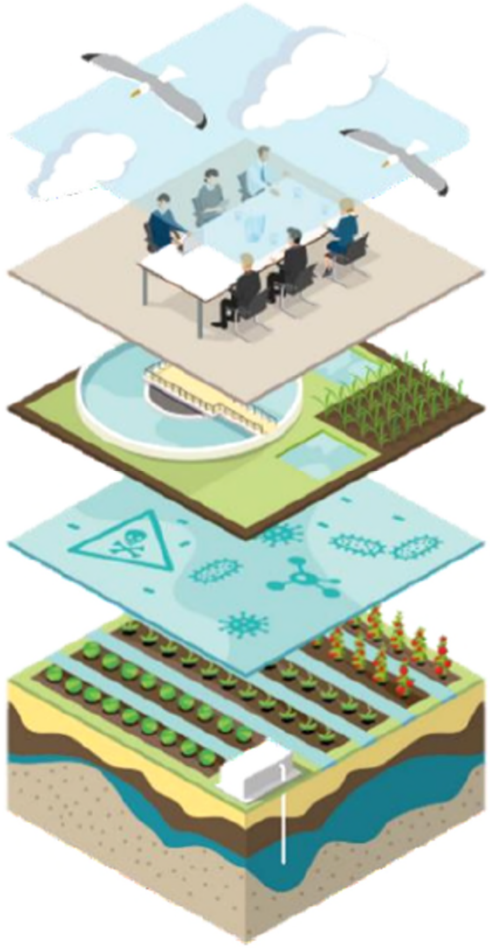
Definition of Circular Economy according to the SER*:

An economy that handles products, materials and resources efficiently and in a *socially responsible* manner *within ecological preconditions*, so that future generations also retain access to material prosperity.

*The Social and Economic Council of the Netherlands: An advisory body in which employers, employees and independent experts (Crown-appointed members) work together to reach agreement on key social and economic issues. (https://www.ser.nl/en/SER/About-the-SER/What-is-the-SER, Sociaal-Economische Raad (2016) Advies Werken naar een circulaire economie: geen tijd te verliezen, p. 11)

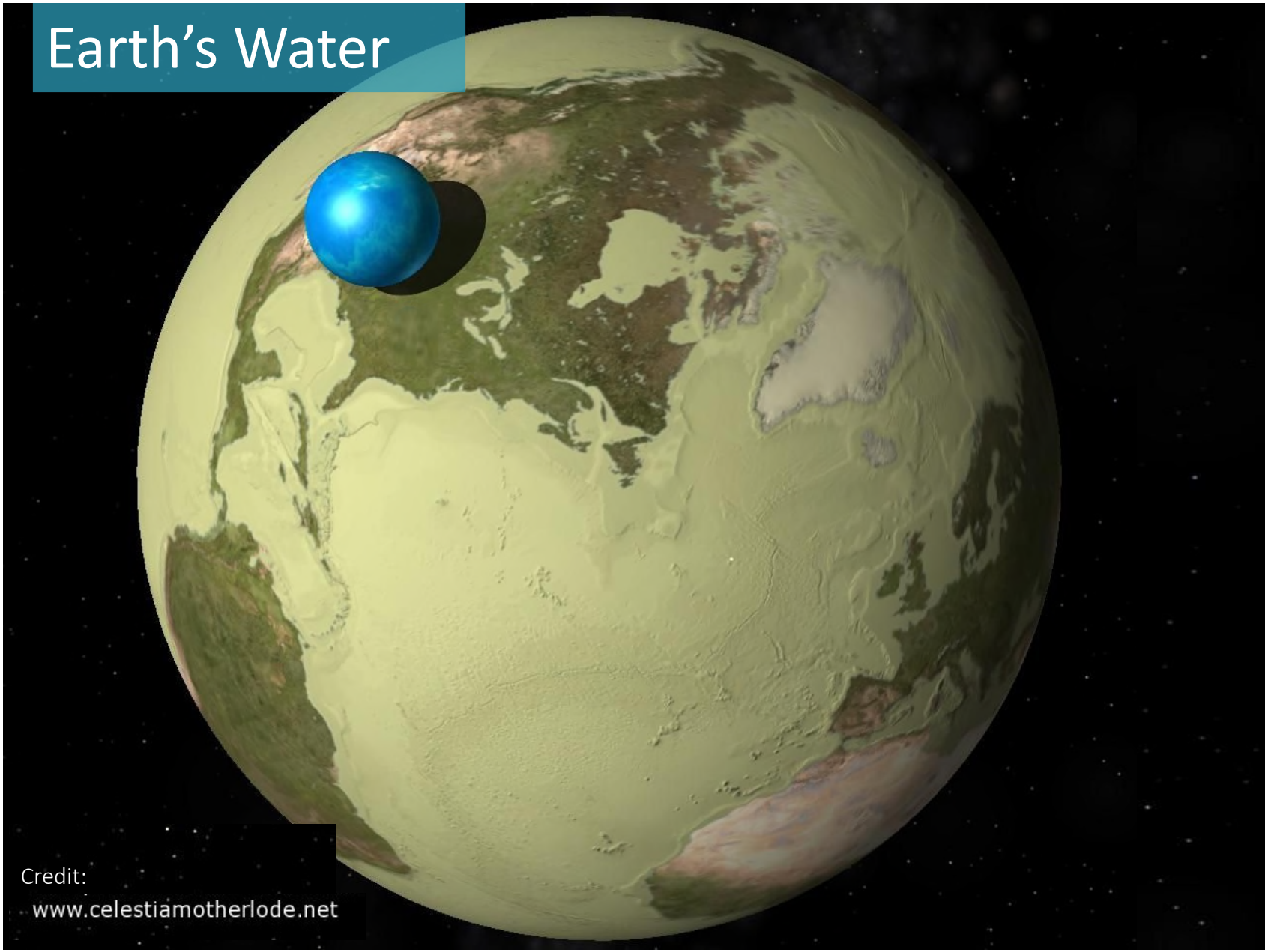
Water in the Circular Economy (WiCE)

- Our society and economy are dependent on natural resources, such as raw materials, water and energy.
- Today, these resources are under severe pressure all over the world.
- To safeguard long-term welfare and liveability, we need another economic model; a model that differs from the current linear system, in which raw materials and water are discarded as waste following single use.
- The circular economy is a ‘different’ economy. It is an economy that is premised on the reusability of products and raw materials, and on the restorative capacity of natural resources.
- The transition can also have a variety of impacts on the water sector, and on the position of the water utilities and water end-users in society.

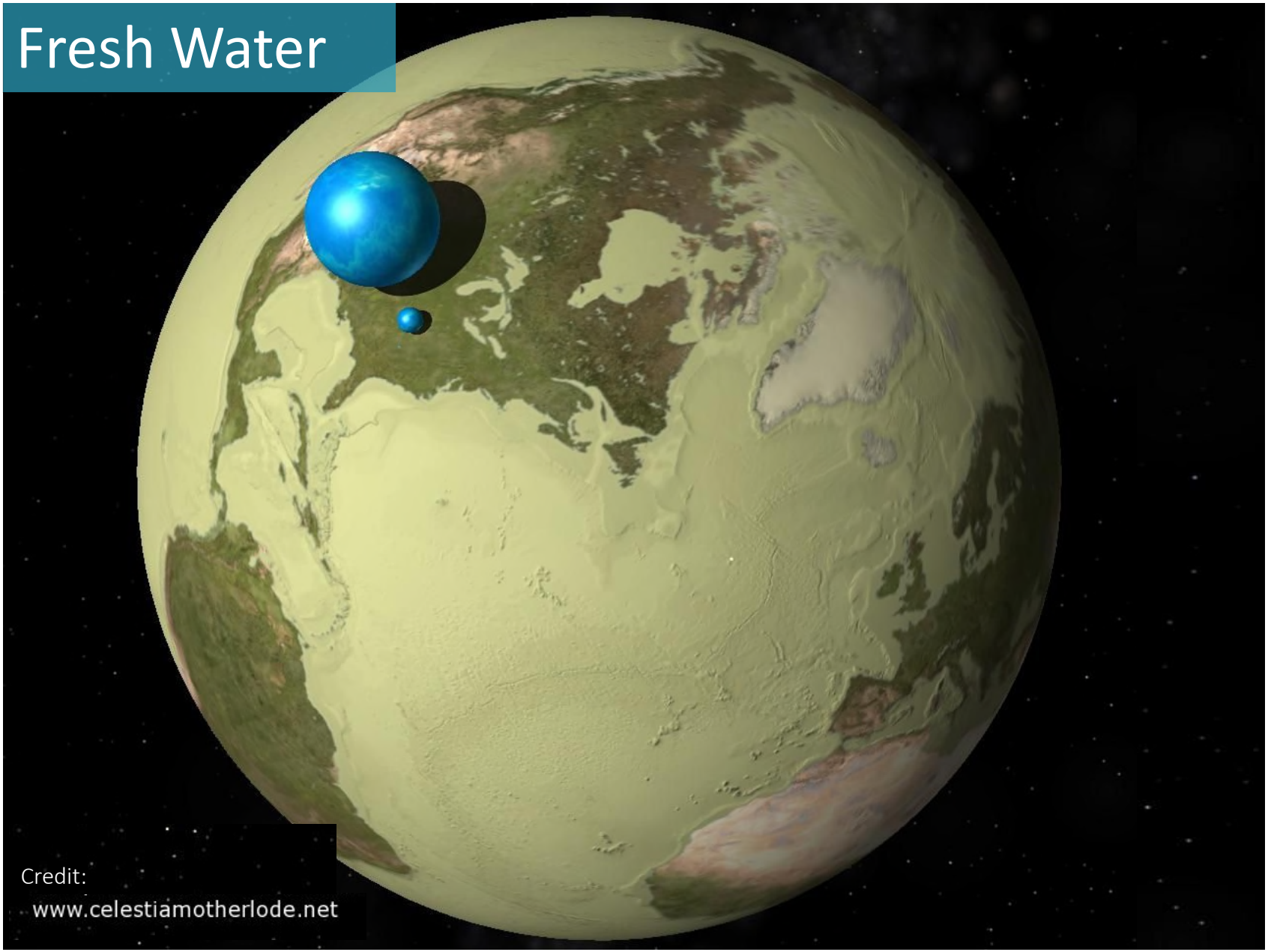


The Blue Planet?

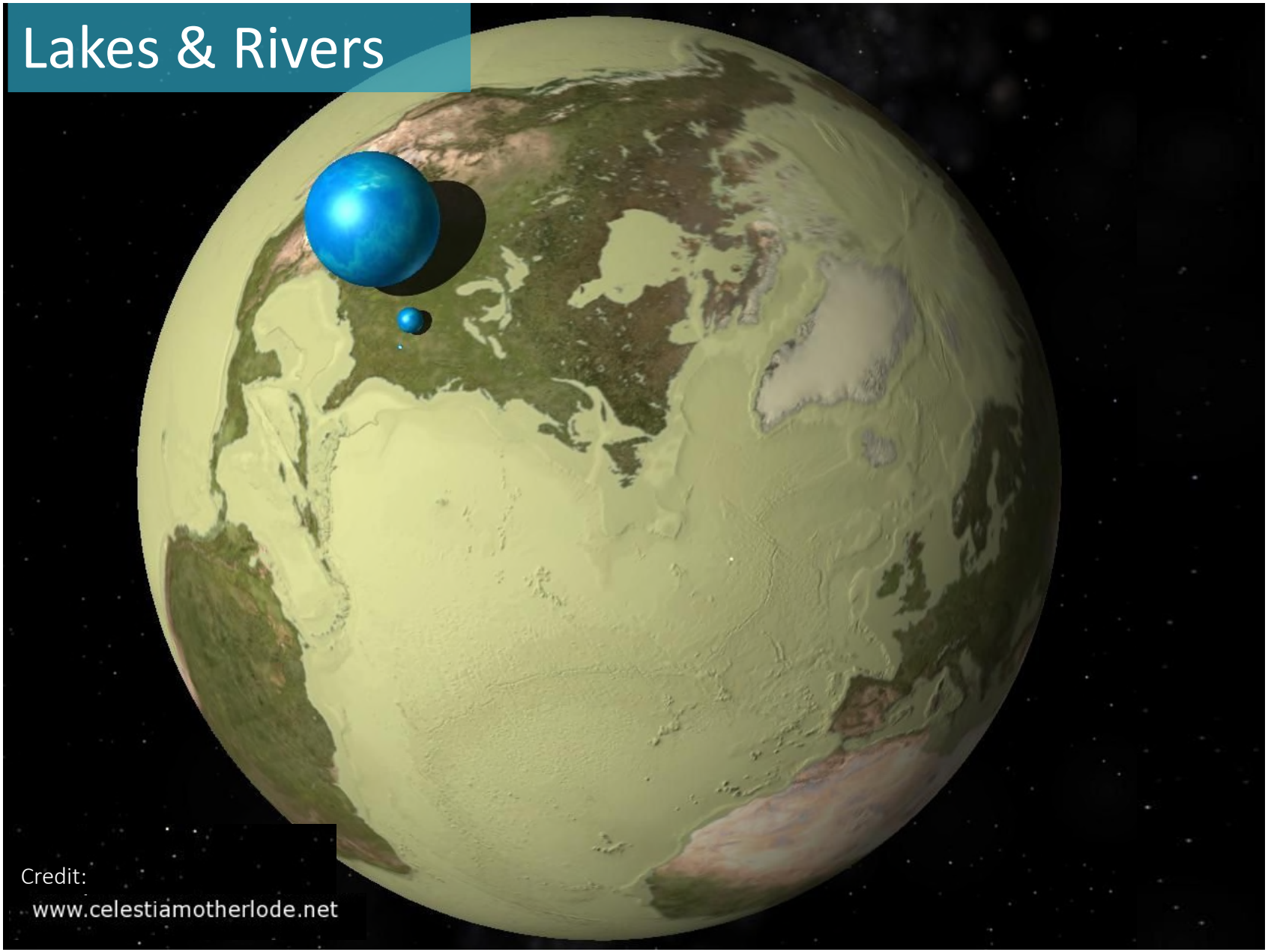
Earth's Water



Fresh Water



Lakes & Rivers



WHY WASTE WATER?

OVER 80% OF OUR WASTEWATER FLOWS BACK TO NATURE UNTREATED.

REDUCE: improve wastewater treatment to reduce pollutants entering the ecosystem.

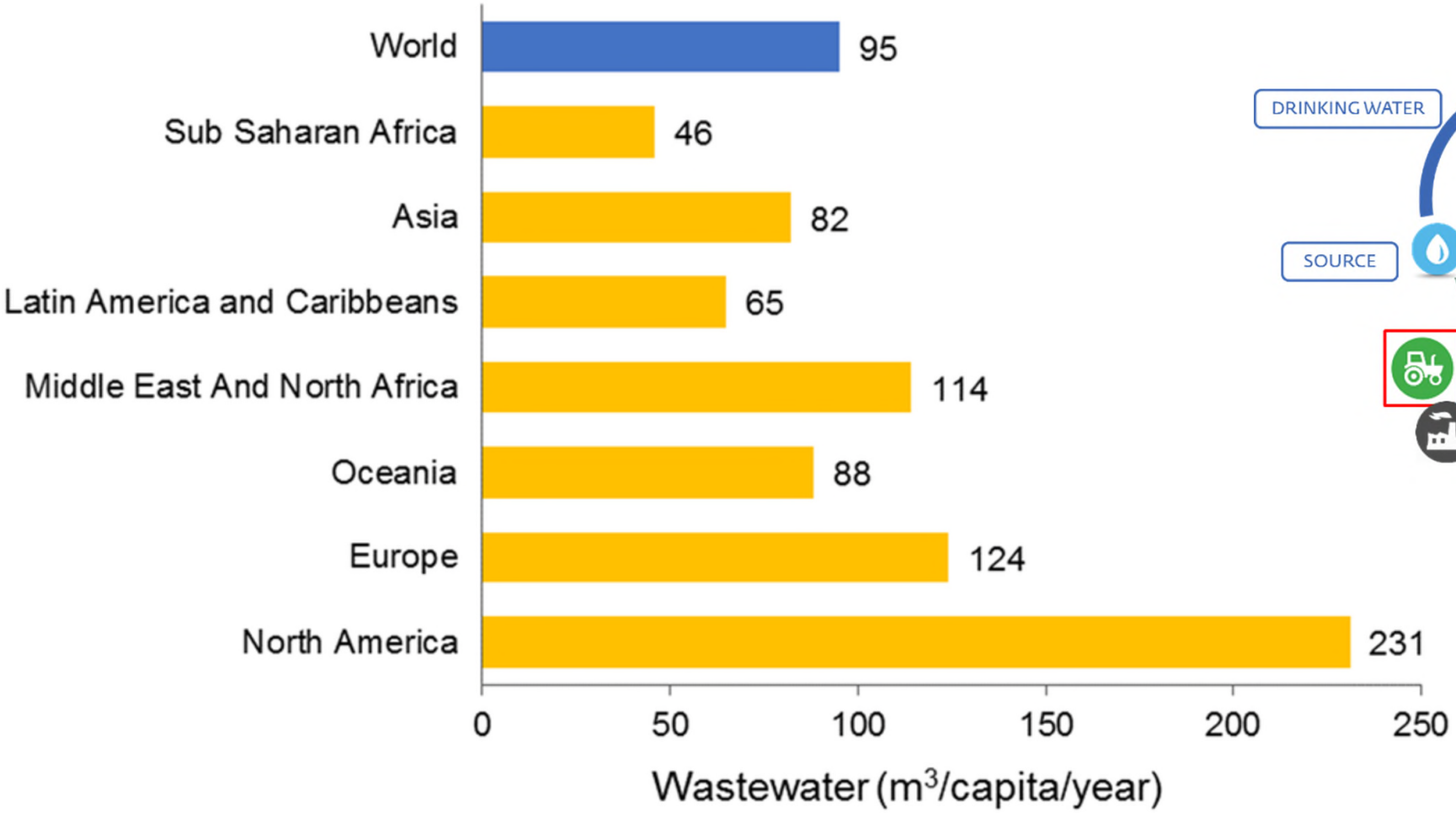
REUSE: treat and use wastewater for green space irrigation and municipal cleaning.

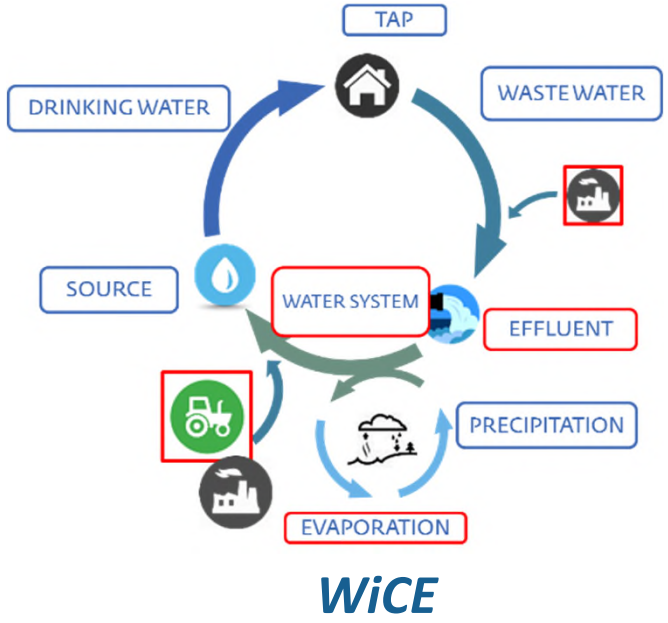
UN WATER

22 MARCH

WORLD WATER DAY

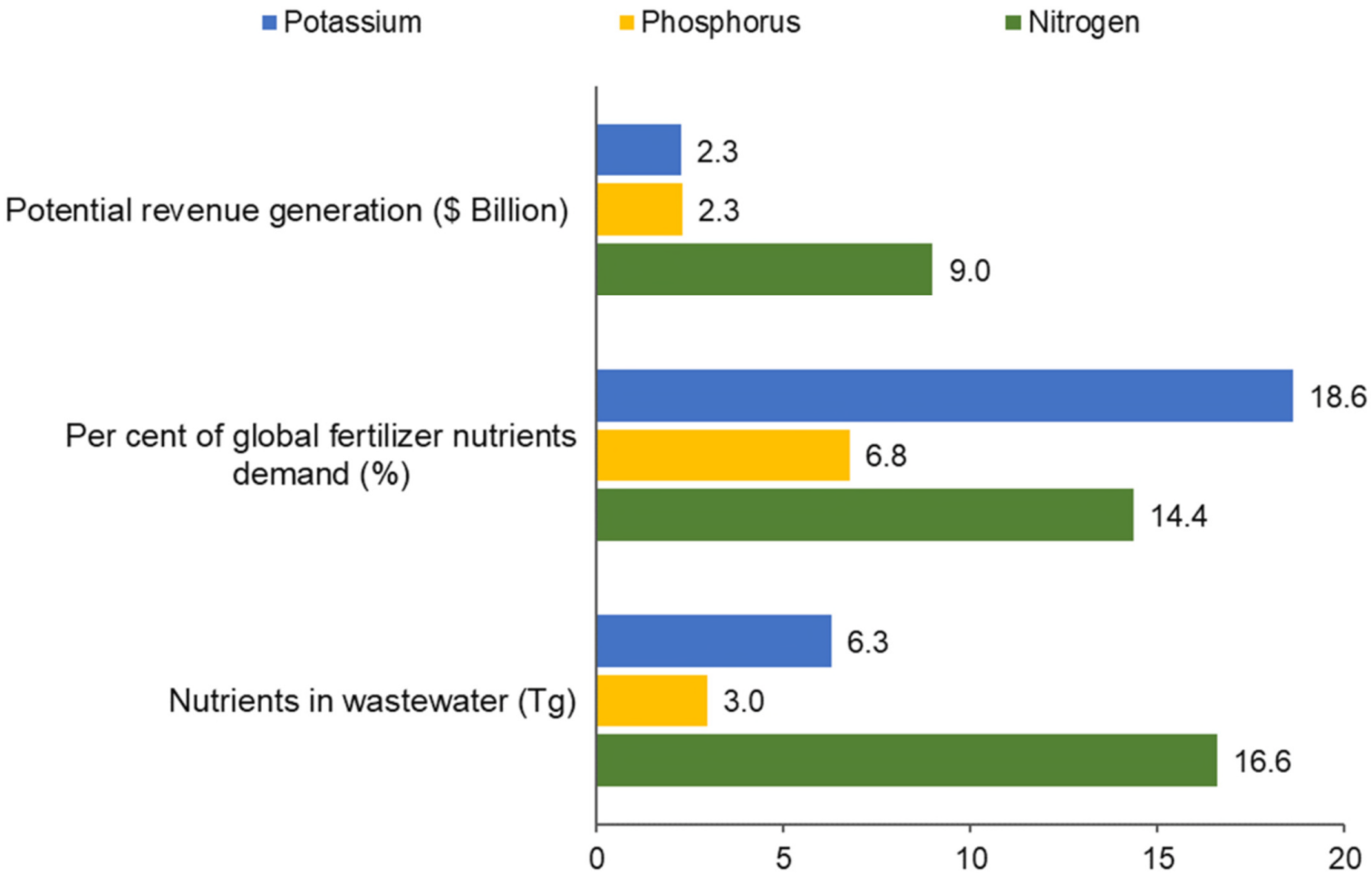
Per Capita Wastewater Production (Annual Volume)

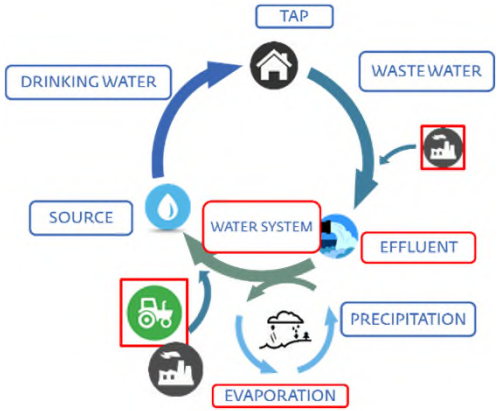




Source: Qadir, M. et al. In *Natural Resources Forum* (Vol. 44, No. 1, pp. 40-51). Oxford, UK: Blackwell Publishing Ltd.

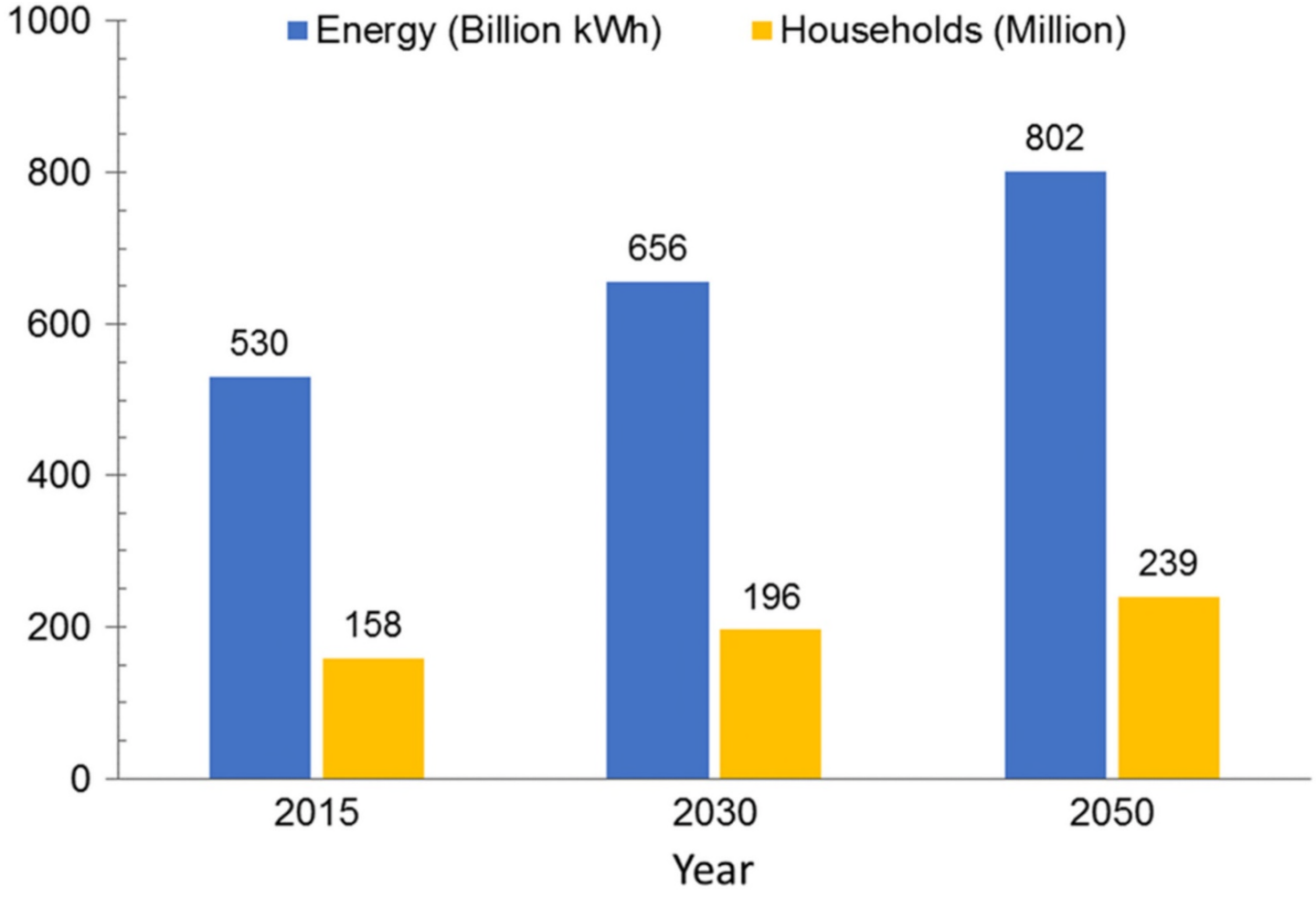
Levels of Nutrients in Wastewater
(Annual Volume)

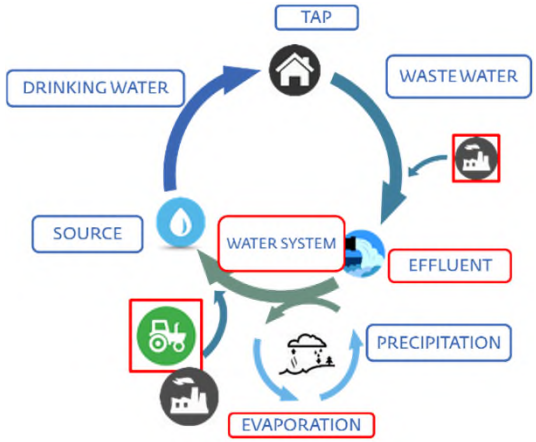




Source: Qadir, M. et al. In *Natural Resources Forum* (Vol. 44, No. 1, pp. 40-51). Oxford, UK: Blackwell Publishing Ltd.

Energy in Wastewater
(Annual Volume)





Source: Qadir, M. et al. In *Natural Resources Forum* (Vol. 44, No. 1, pp. 40-51). Oxford, UK: Blackwell Publishing Ltd.

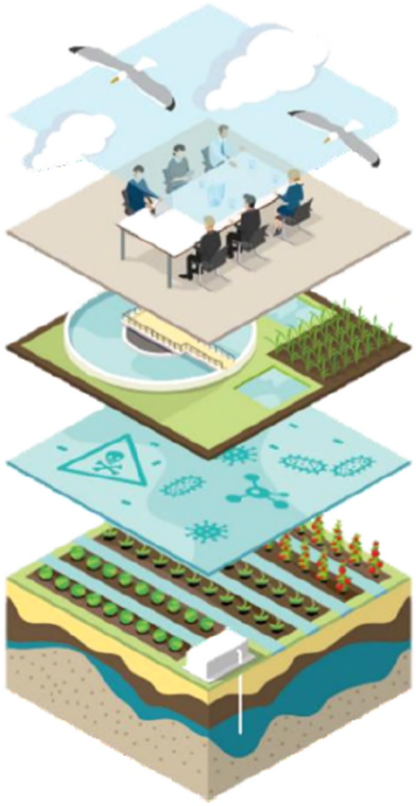
Harvesting the true value of wastewater

- An important paradigm shift towards **harvesting the true value of wastewater** is the ability to recognise and extract the valuable resources embedded in it.
- With the development of smart water solutions, end-users including the industrial sector are well poised to pursue intelligent wastewater reuse.
- Recent rapid advancements in process technology have amplified the potential applications of reclaimed water.
  - A high resource recovery rate can be achieved.
- This is especially prominent in water intensive sectors to encourage water reuse.

Responsible Water Reuse

KWR

SAFE WATER REUSE
REQUIRES AN INTERDISCIPLINARY APPROACH



Sustainability and environment (LCA)

Legislation and regulations

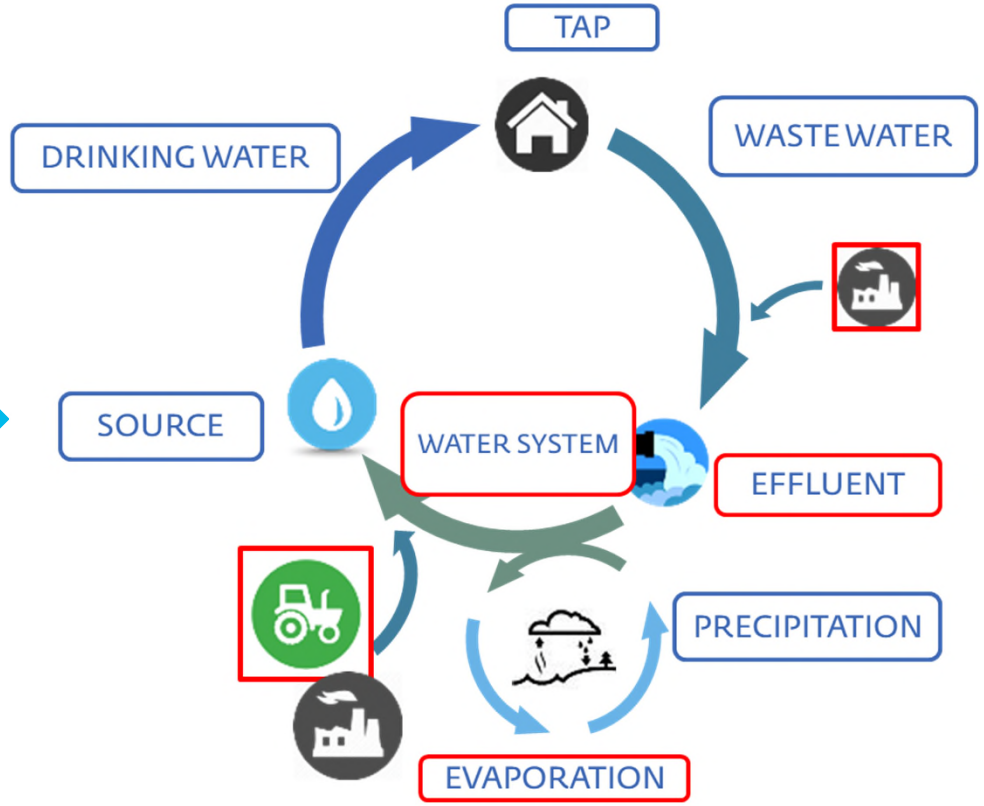
Water treatment technologies

Health and safety

Reuse in agriculture or industry

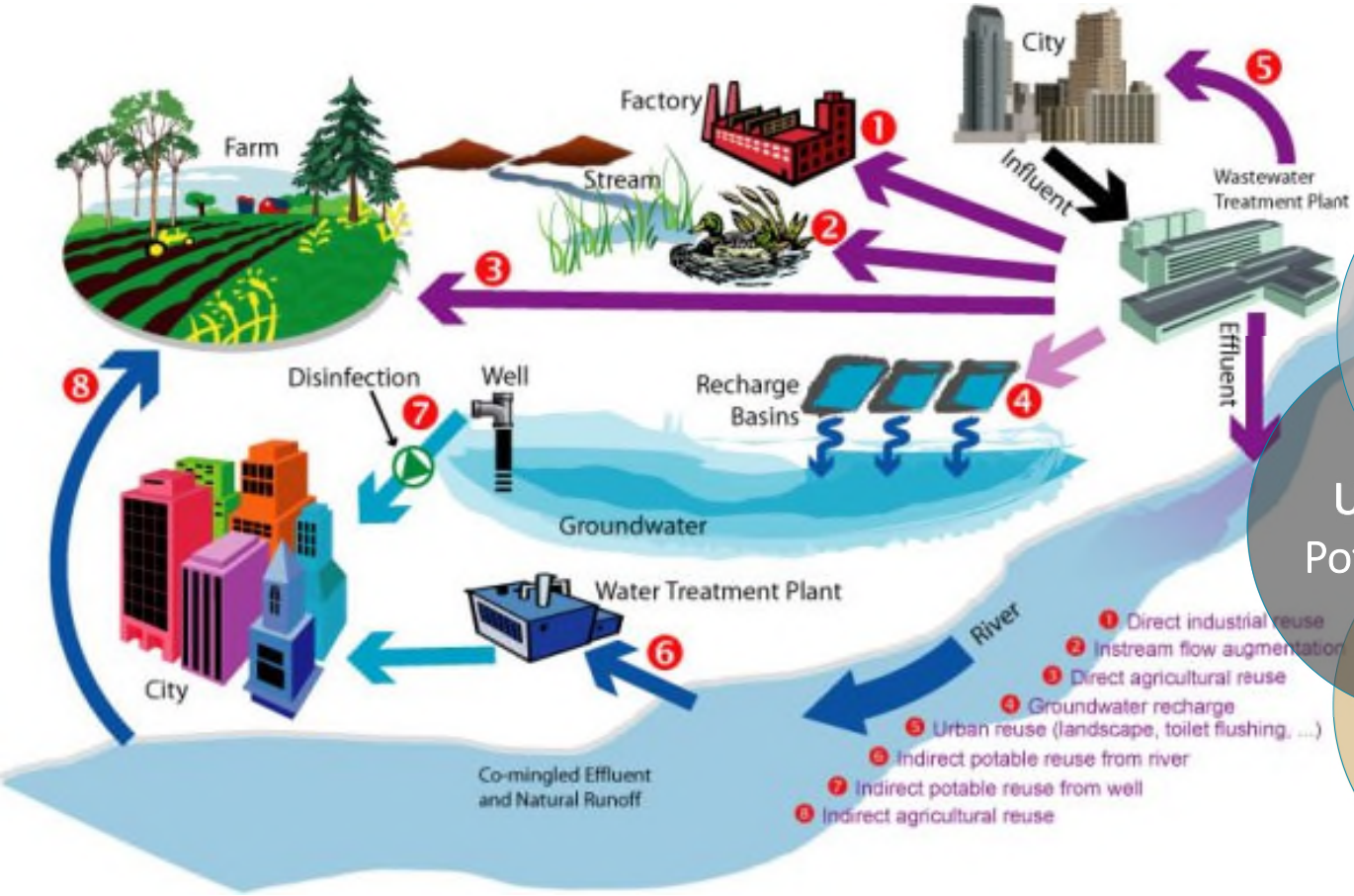
Subsurface water storage

INTEGRATING URBAN AND NATURAL WATER SYSTEMS

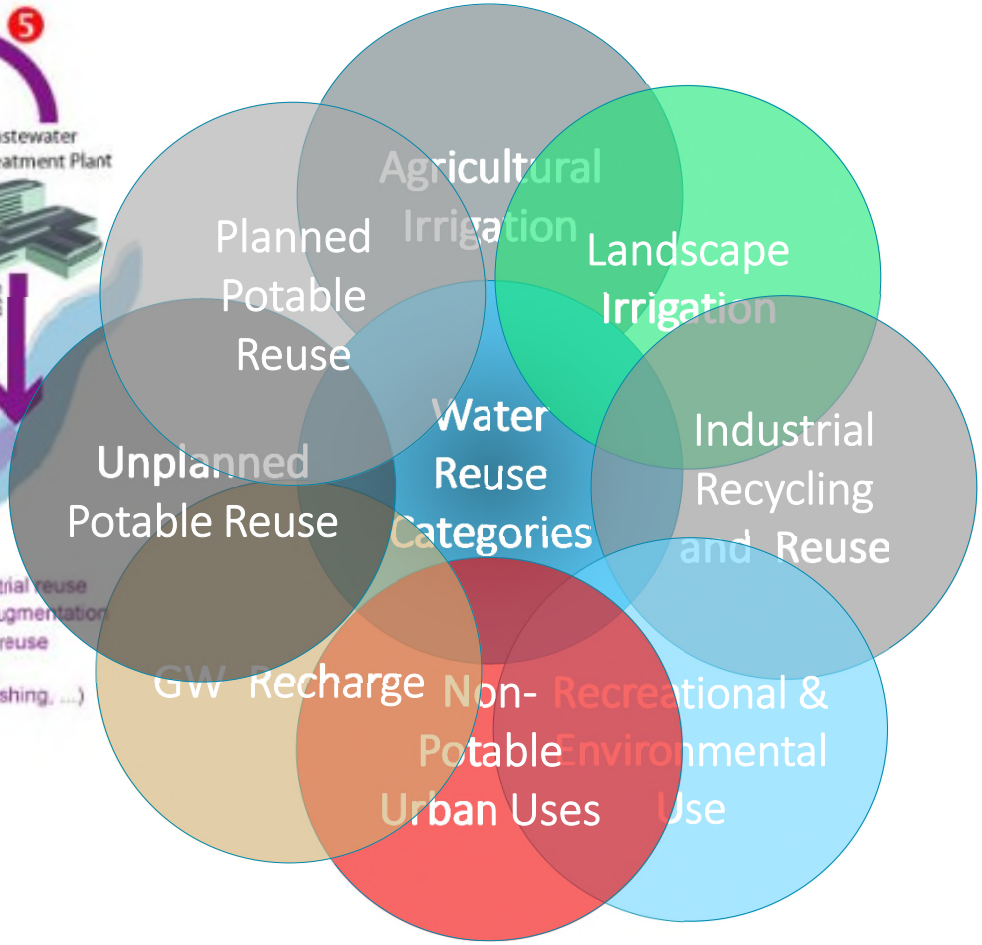


Water in the Circular Economy (WiCE)

Water Reuse Applications

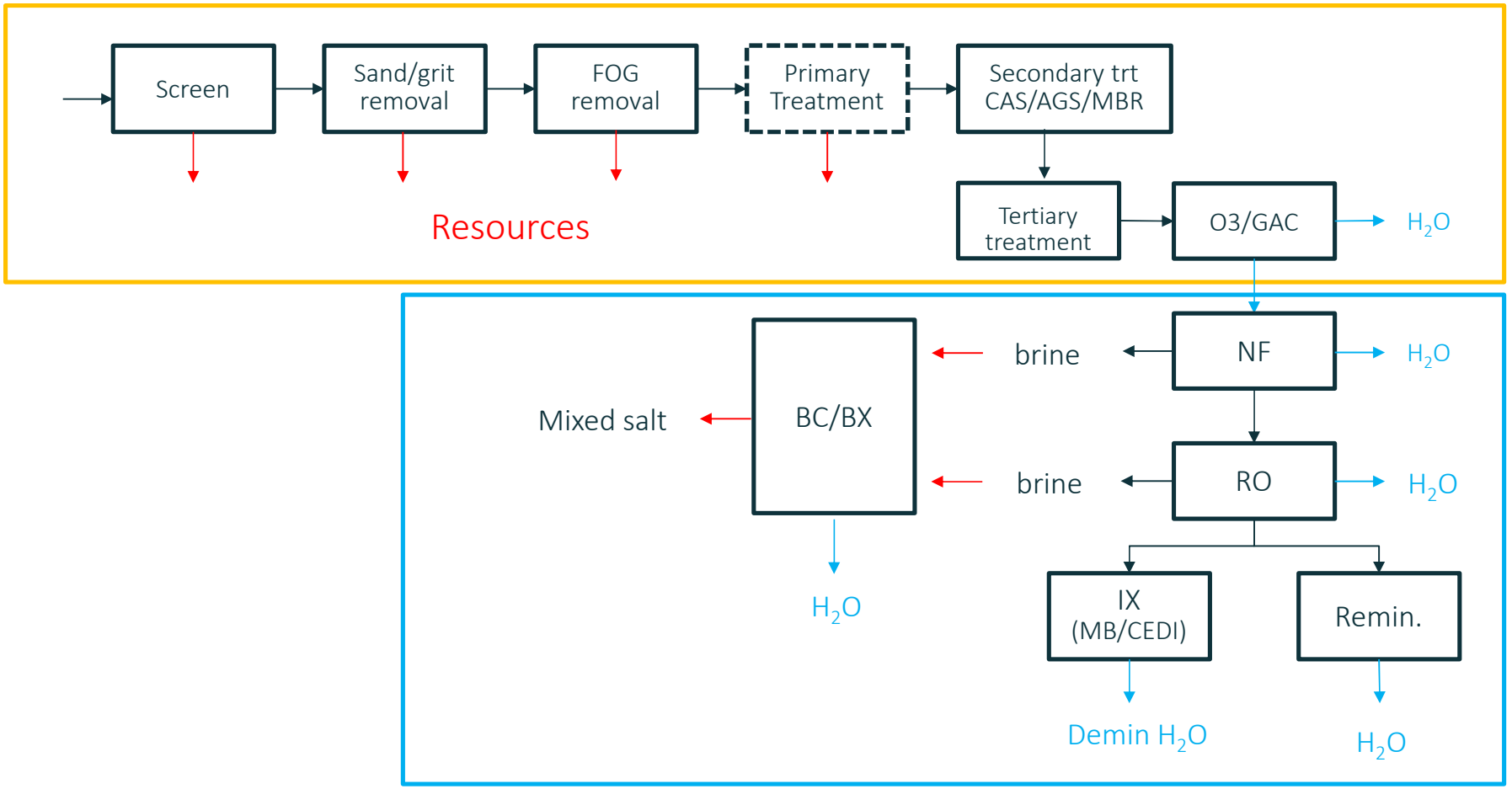


Source: https://equilibriuminsustainability.wordpress.com/2011/09/22/saving-water/

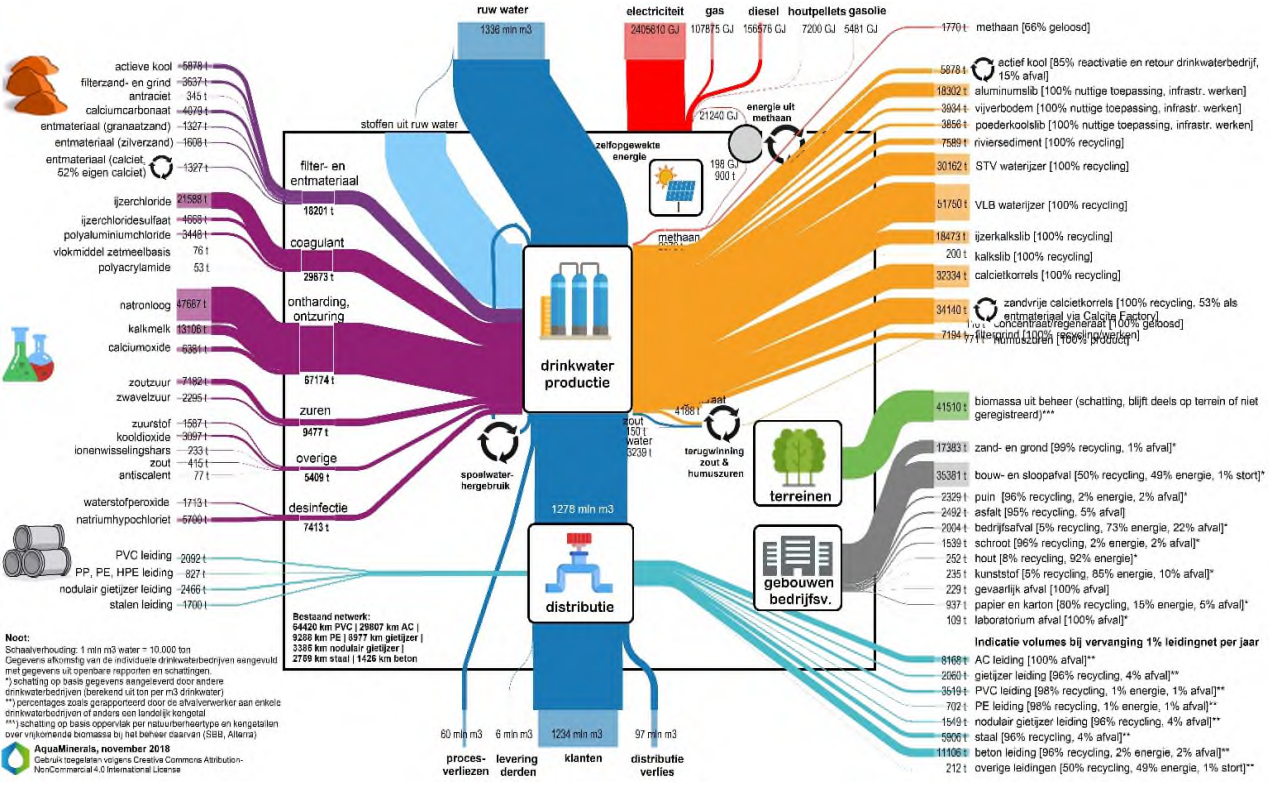


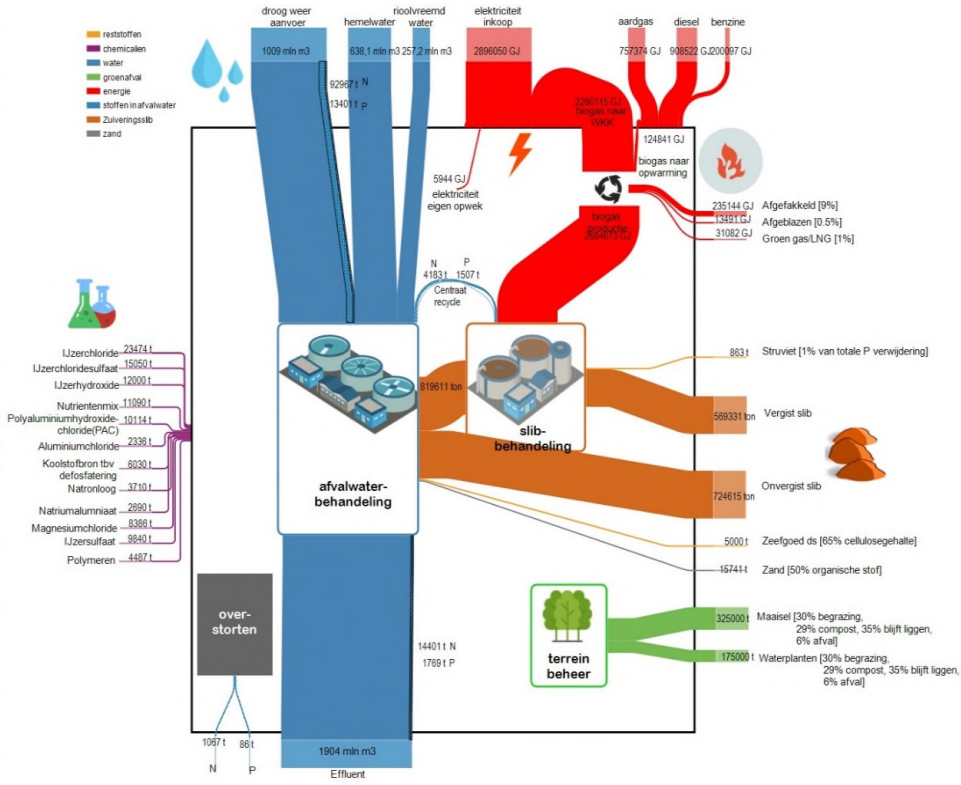
Source: Tchobanoglous et al. (2003)

Harvesting the Value of Water



Incoming and outgoing material flows in the Dutch water cycle





Some relevant resources from wastewater


fresh water


biosolids


energy


phosphorus


cellulose


biopolymers


proteins


organic matter


bioplastics

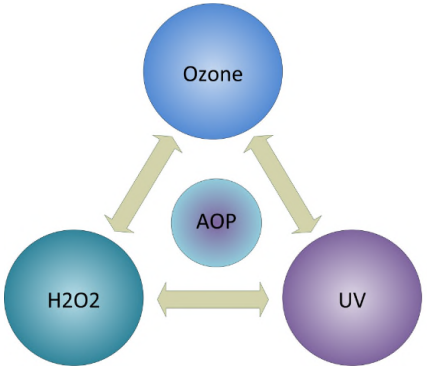
Most potential resources from wastewater

- Fresh water
- Nutrients
  - struvite (P)
  - vivianite (P)
  - nitrogen (N)
- Energy
  - electricity
  - heat
  - green gas
  - green hydrogen
  - Bio-oil
- Sand
- FOG (fat, oil & grease)
- Cellulose
- Biosolids
- PHA for bioplastics
- Biopolymers
- Proteins
- Organic matter
  - biochar
  - activated carbon
  - bitumen
  - biomethanol

Advances in water treatment technologies

Technology to make water treatment more efficient has been advancing in:

- Coarse particle filtration
- Ultrafiltration
- Reverse osmosis
- Ion exchange
- AOP



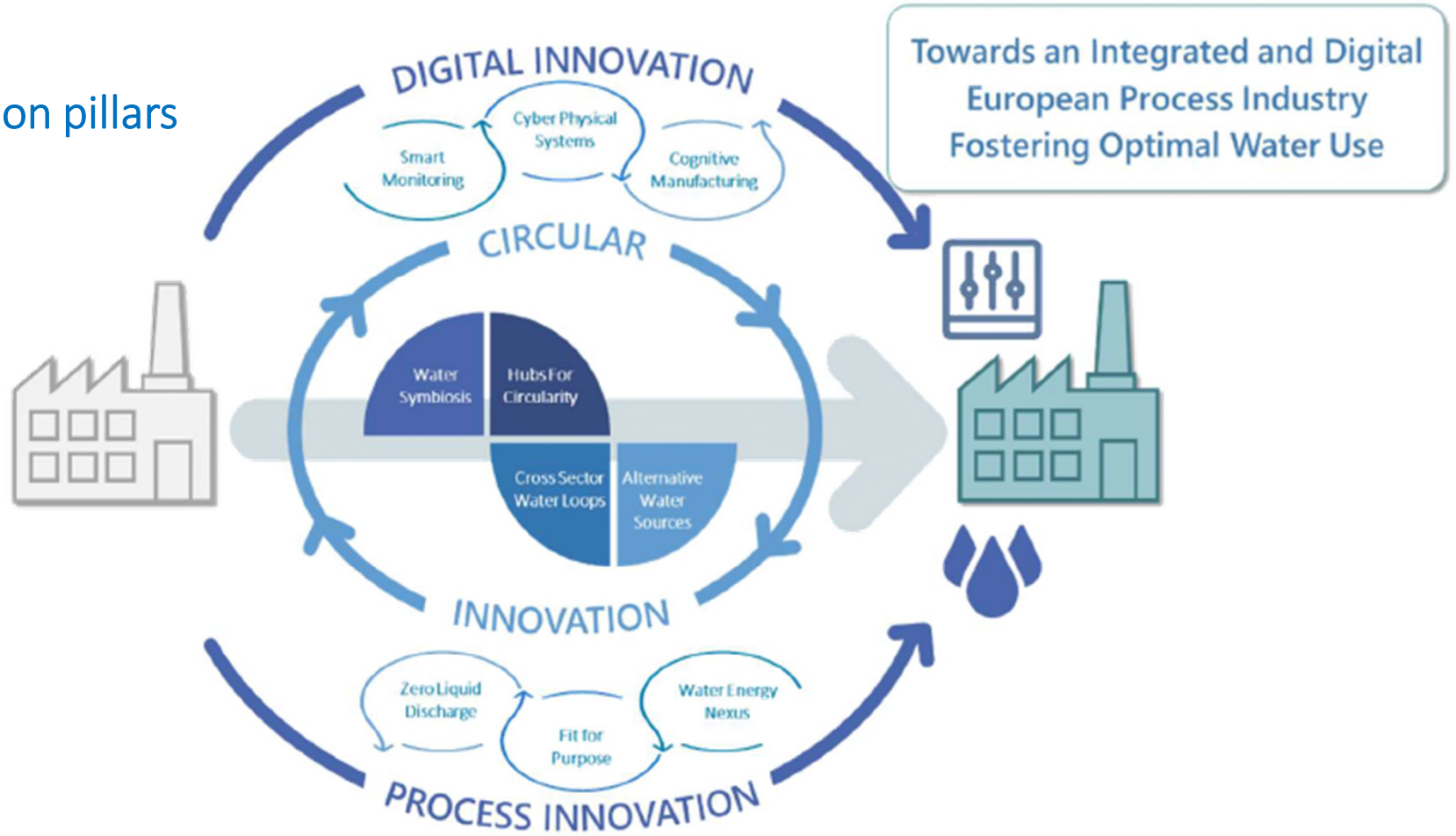
Each of these technologies continues to evolve to expand our collective capabilities to:

- reduce treatment system capital expenses
- lower energy costs
- improve durability and
- enhance operating ranges.

EU Project: AquaSPICE - Advancing Sustainability of Process Industries through Digital and Circular Water Use Innovations

KWR

3 innovation pillars



Take home messages

- **Preservation of freshwater** through the implementation of **circular and integrated solutions** which help to initiate a **powerful industrial-urban symbiosis** ensuring socio-environmental sustainability.

- Adopting **advanced & innovative technologies** can help to appropriately assess the different intervention options in technical, economic and ecological terms.

- Humanity will have to learn how best to **harvest the value of water** within the entire water cycle and its vital nexus with other sectors such as energy, food, health and climate.

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KWR International Strategy Development

Expertise

Innovative water/wastewater technologies
Circular water
Resource recovery
Water Process design