Under the Patronage of His Excellency **Eng. Abdulrahman bin Abdulmohsen AlFadley**
Minister of Environment, Water & Agriculture

منتدى المياه السعودي
saudi water forum SWF 2024

Enhancing water security, sustainability, and resilience through water reuse

29 April – 01 May 2024

Hilton Riyadh Hotel & Residences
Riyadh, Saudi Arabia

Prof. Akiça Bahri

Former Minister of Agriculture, Water Resources and Fisheries - Tunisia

Organized by

وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture

Organizing Partners

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Water security

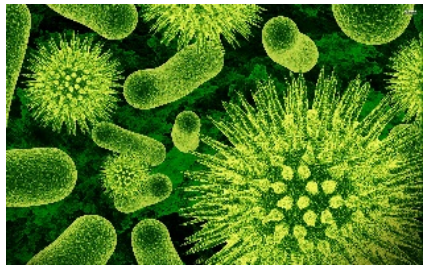
- **Water security** is at the heart of every aspect of our development and well-being. We need enough water, of the right quality, to keep us healthy, sustain our livelihoods, grow our economies, ensure protection against pollution and water-related disasters, and protect our ecosystems in a climate of peace and political stability. This also means having the proper economic, social, and political institutions
  - 113 countries classified as "water insecure“ **+** 24 countries in a situation of critical water insecurity
  - 5.6 billion people affected by water insecurity (4.3 billion people in the Asia-Pacific region, and 1.3 billion across Africa)
  - 1 in 4 cities worldwide experience water insecurity
  - 50-70% of urban water demand projected to increase by 2050
  - 80% of wastewater flows back untreated into the environment - 1.8 billion people are exposed to contaminated drinking water sources
- **The largest global investment issue over the next ten years will be "water security,"** with current projections indicating that **investments will be needed between US$6.7 trillion by 2030 and US$22.6 trillion by 2050**. Significant increase in **water reuse spending** expected in the coming years

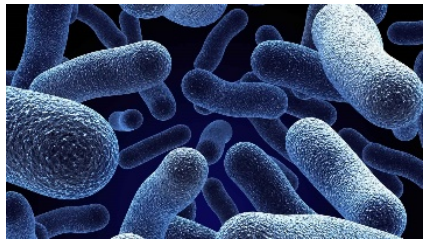
Water Reuse

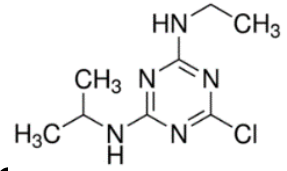
- Plays a crucial role in enhancing **water security** by providing a reliable, sustainable water supply that complements traditional freshwater sources
- Helps build **resilience to water challenges** and ensures the long-term **sustainability of water supplies** by maximizing the efficient use of available water resources and promoting sustainable water management practices

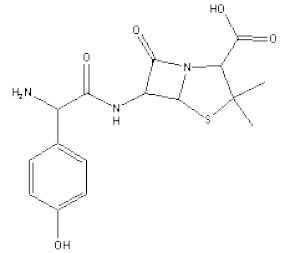
Water quality issues

- *Microbial risks*:
  - Pathogens: Helminths, Bacteria, Viruses, Protozoa
  - Antibiotic resistance genes (ARG) and antibiotic-resistant bacteria (ARB)
- *Agronomic risks*:
  - Salinity, sodicity, B, trace elements and toxic ions management
- *Environmental risks: receiving bodies, soils, groundwater*
  - Salinity, Na, NO_3, B
- *Chemical risks*:
  - Trace elements: Cd, Pb, Hg
  - Organic compounds: pesticides
  - Trace organic chemicals: pharmaceuticals, hormones and endocrine disruptors, antibiotics, and personal care products
  - Microparticles - microplastics







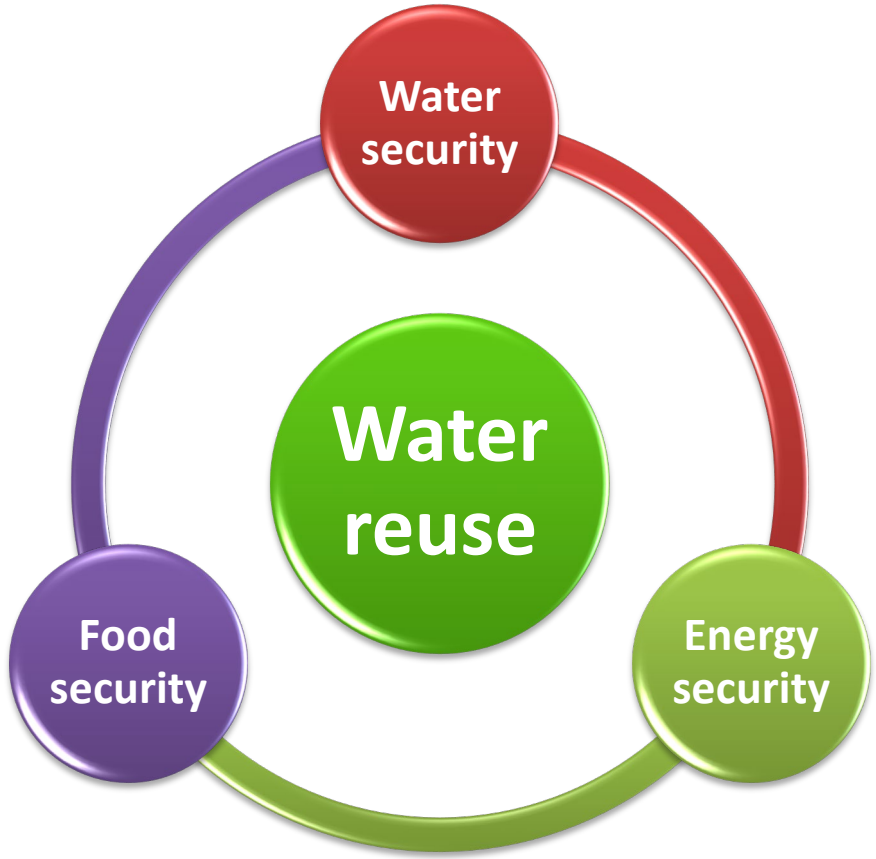


Source: Adapted from Drewes, 2017

Untapped potential for resource recovery and reuse from wastewater

380 billion m^3/year of municipal wastewater could theoretically:

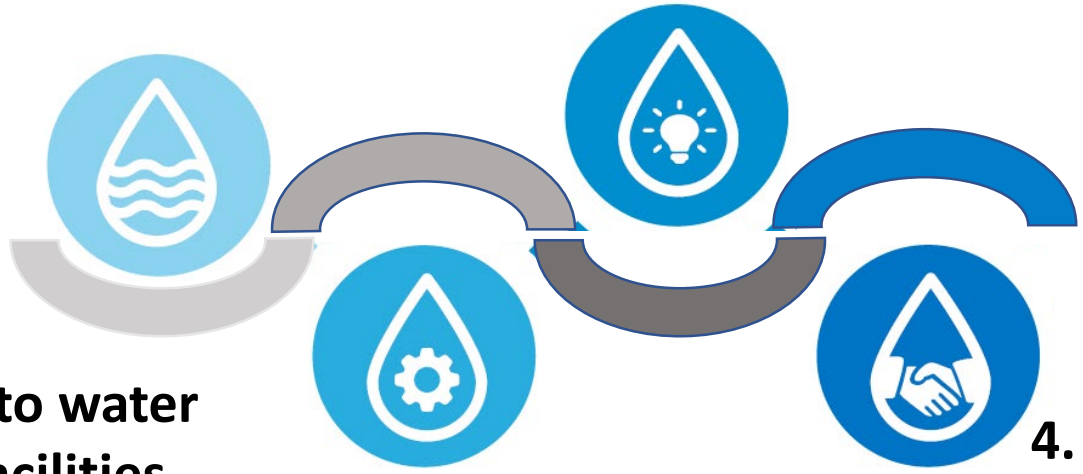
- Irrigate more **than 47 million hectares (**8000 m^3/ha/yr)
- Provide 'free' fertilizer application in the order of **322 kg N/ha/yr and 64 kg P/ha/yr**
- Provide **electricity for about 130 million households** (3500 kWh/HH)
- Wastewater production **expected to increase by 24% by 2030 and 51% by 2050**



Source: Wichelns et al., 2015

Key actions to boost the wastewater management sector and contribute to the achievement of the SDGs

1. **Plan wastewater reclamation and reuse to improve efficiency and resource allocation, and engage stakeholders**



2. **Move from WWTP to water resource recovery facilities. Recognize the real value of wastewater and the potential resources that can be extracted from it**

3. **Implement innovative financing and business models**

4. **Work on policies, institutions and regulation to facilitate a shift towards reuse and resource recovery, and a circular economy**

Source: Adapted from World Bank, 2020

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Developing a National Water Reuse Master Plan

A phased approach to water reuse development in Tunisia – <60 years

Pilot phase 1962-1980

- **1st WWTP in Tunis (1929)**
- **Early 60's, first water reuse scheme** to irrigate 600 ha of citrus fruit orchards at La Soukra (8 km from Tunis)
- **1975 Water Law forbidding irrigation of vegetables with RW**
- **Extension of WWT to all urban areas**

Planned reuse 1981-2000

- **Political will and commitment**
- **Experimental research** programs that provided the basis for the **institutional, legal, and regulatory frameworks: 1989 Decree, Quality standards, General reuse conditions**
- **Water reuse policy** launched in early 1980s
- Treatment and reuse coordinated from planning stage to implementation studies

Reuse development 2001-2010

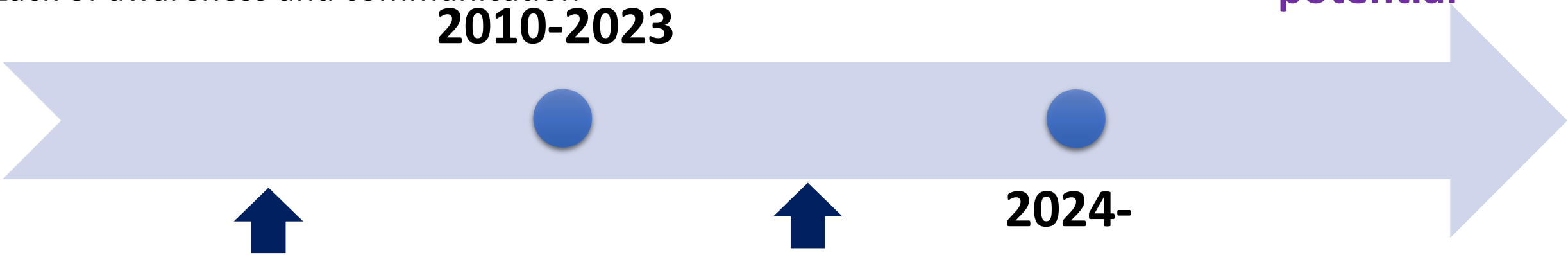
- **Water reuse integrated in WR planning**
- Agricultural Irrigation: 8000 ha (75% of treated effluent)
- Landscape Irrigation: 570 ha - golf courses and hotel gardens (25% of treated effluent)
- Groundwater recharge (pilot scale)

WASTEWATER TREATMENT AND REUSE

Challenges faced by water reuse operations

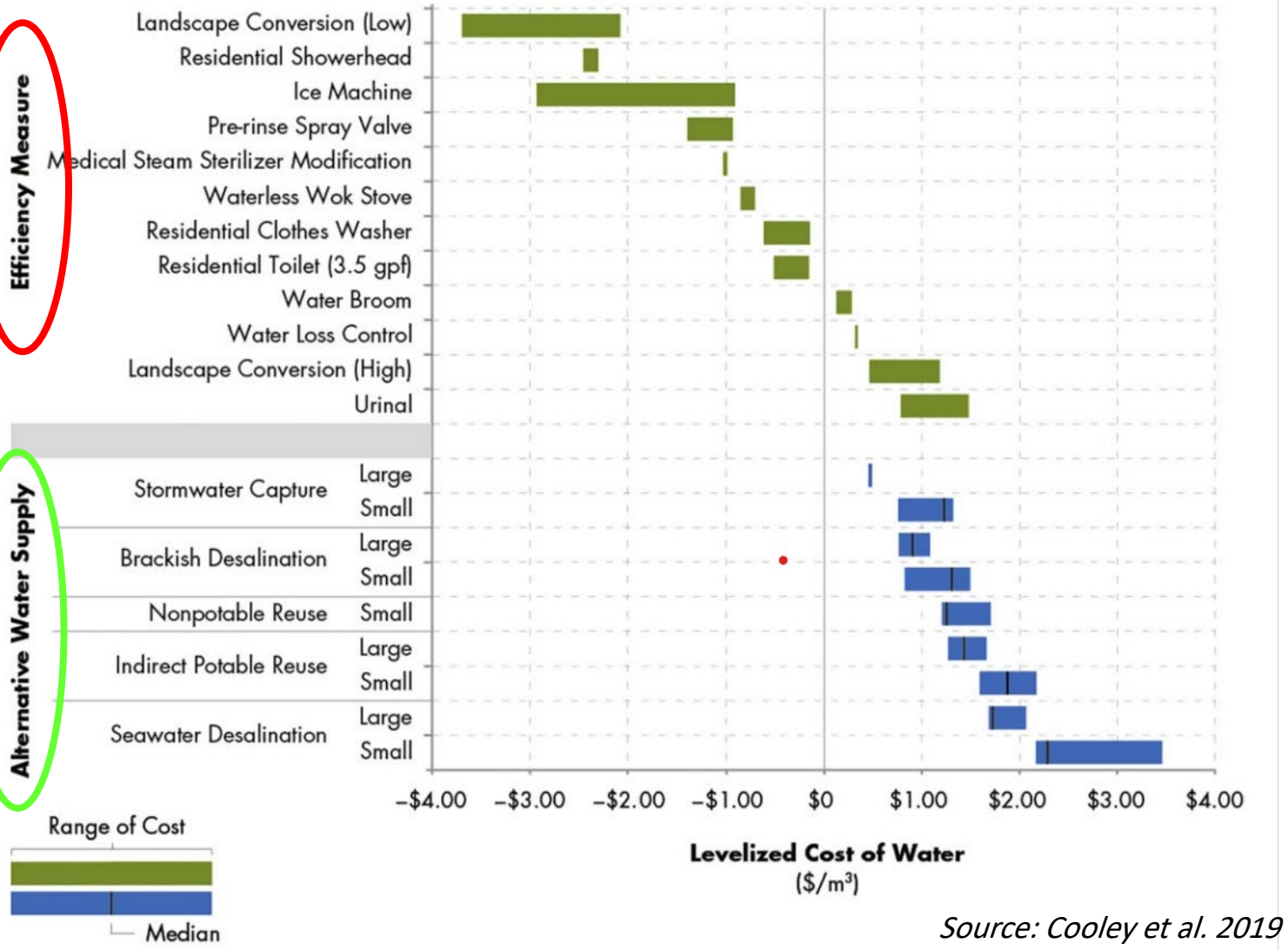
- Aging infrastructure and water quality issues (O&M)
- Lack of storage
- Cost recovery issues
- Fragmentation of the institutional framework, lack of clear distribution of responsibilities and insufficient coordination
- Restrictive regulation
- Lack of demand-driven water reuse projects
- Lack of transparency, information sharing and involvement of the users
- Lack of awareness and communication

Water quality improvement and development of the water reuse potential



National Water Reuse Action Plan (WRAP) (US EPA, 2020)

A wide range in the price of water supply alternatives in California



Source: Cooley et al. 2019

- Water efficiency is the least expensive water supply option, followed by stormwater capture, brackish desalination, and recycled water
- Seawater desalination is the most expensive option

Source: Pacific Institute, 2023

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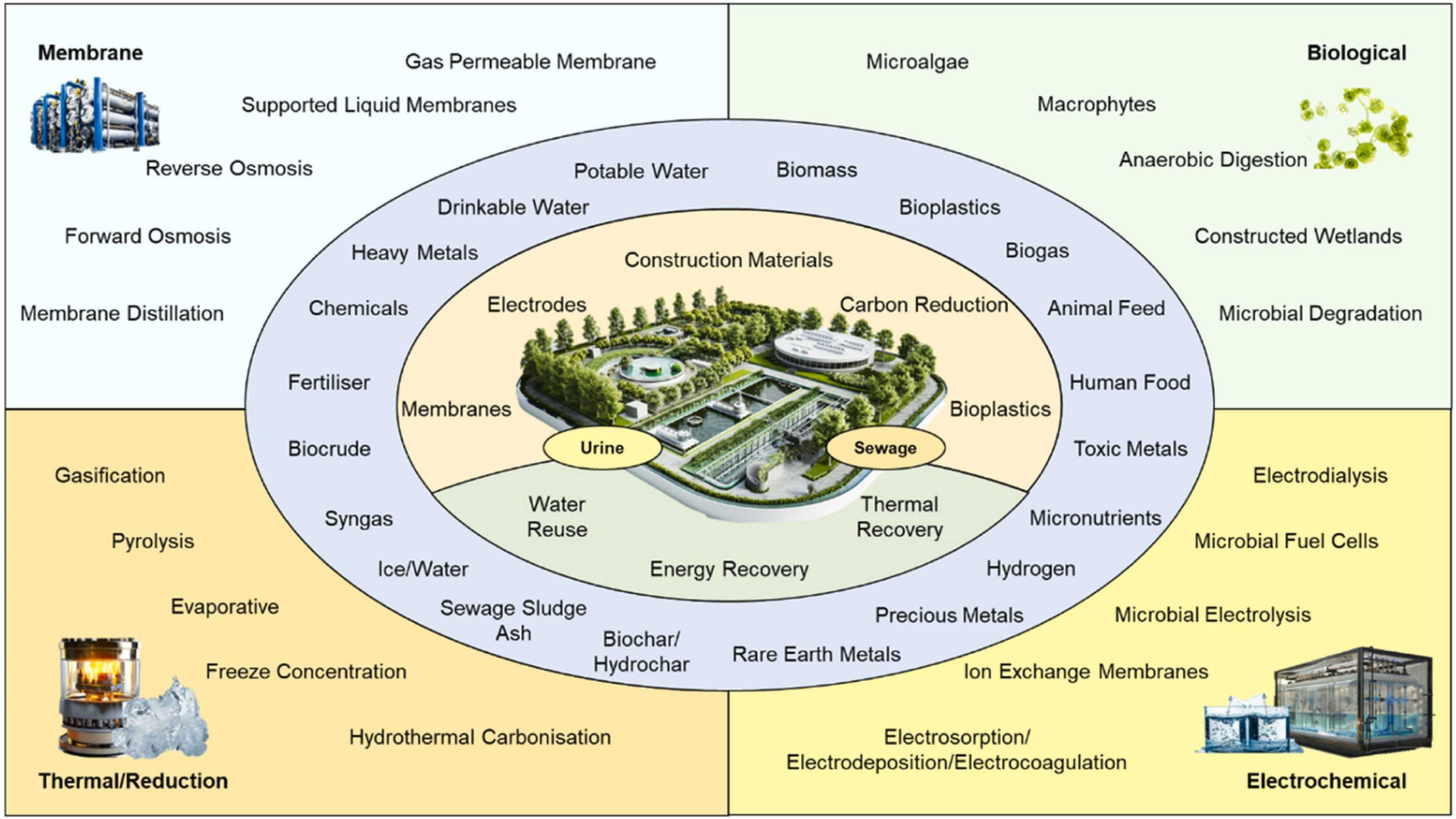
Enhancing circular water economies

Transforming "wastewater treatment plants" into “water resource recovery facilities”

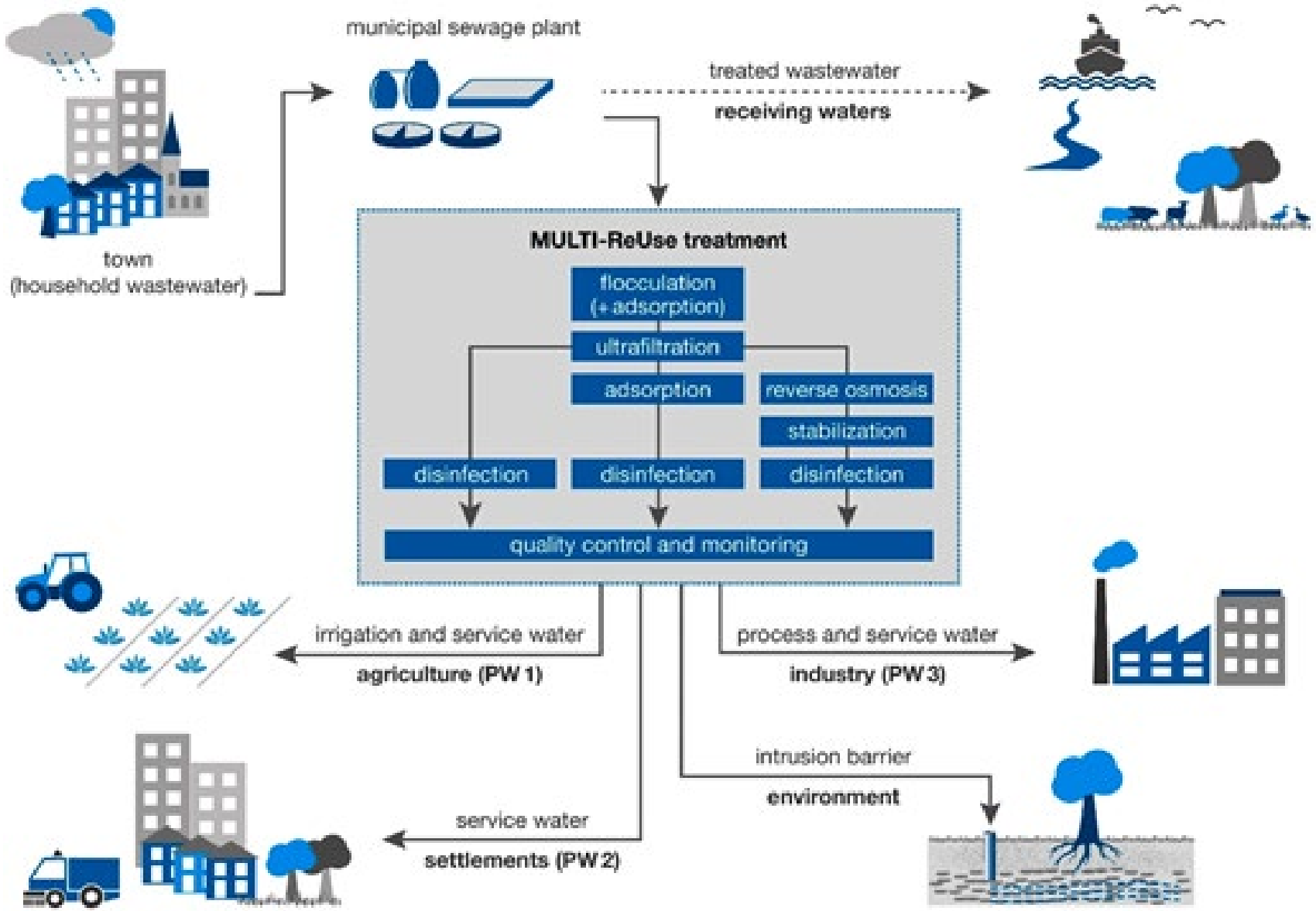
Multiple product recoveries across urine, sewage, municipal and industrial wastewaters



Industrial and municipal WWTP CE resource recovery technologies Source: Soo et al., 2024

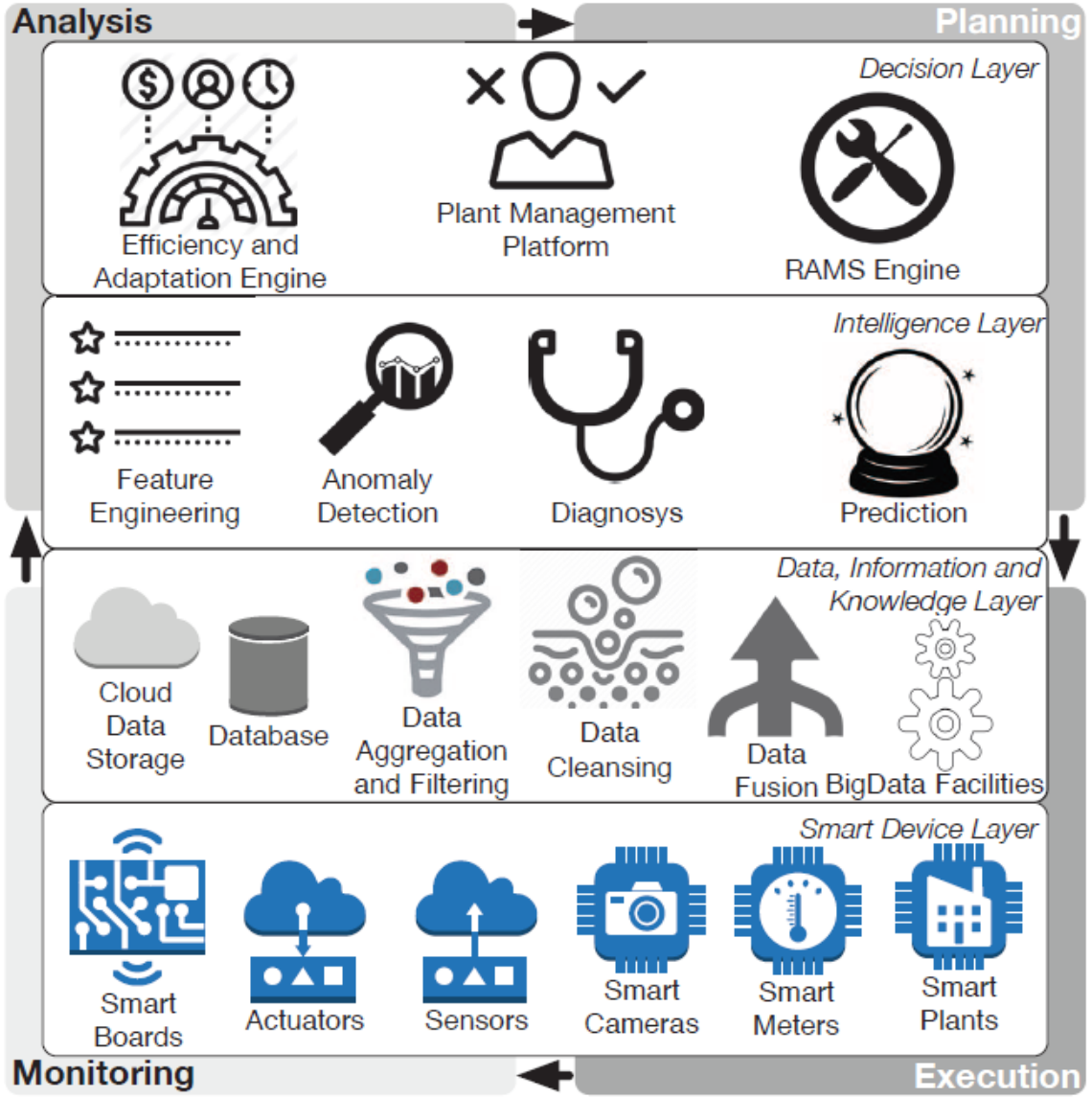
Concept Multi-Reuse - West Basin Water Recycling Facility

Process Diagram of MULTI-ReUse Processing Technologies and Applications (adapted from Becker et al. (2017))



Using artificial intelligence and data analytics in water reclamation and reuse projects

- AI has potential in wastewater management from **monitoring and forecasting to managing demand and decision-making**
  - track the efficiency of water usage
  - help identify water quality issues through real-time monitoring and operation of collection and distribution systems
  - monitor and control wastewater treatment processes and water reuse operations to make them more resilient and affordable
  - provide greater understanding of data
  - optimize the operation of reuse applications
  - Control water quality and identify potential contaminants
  - improve regulatory compliance and public confidence

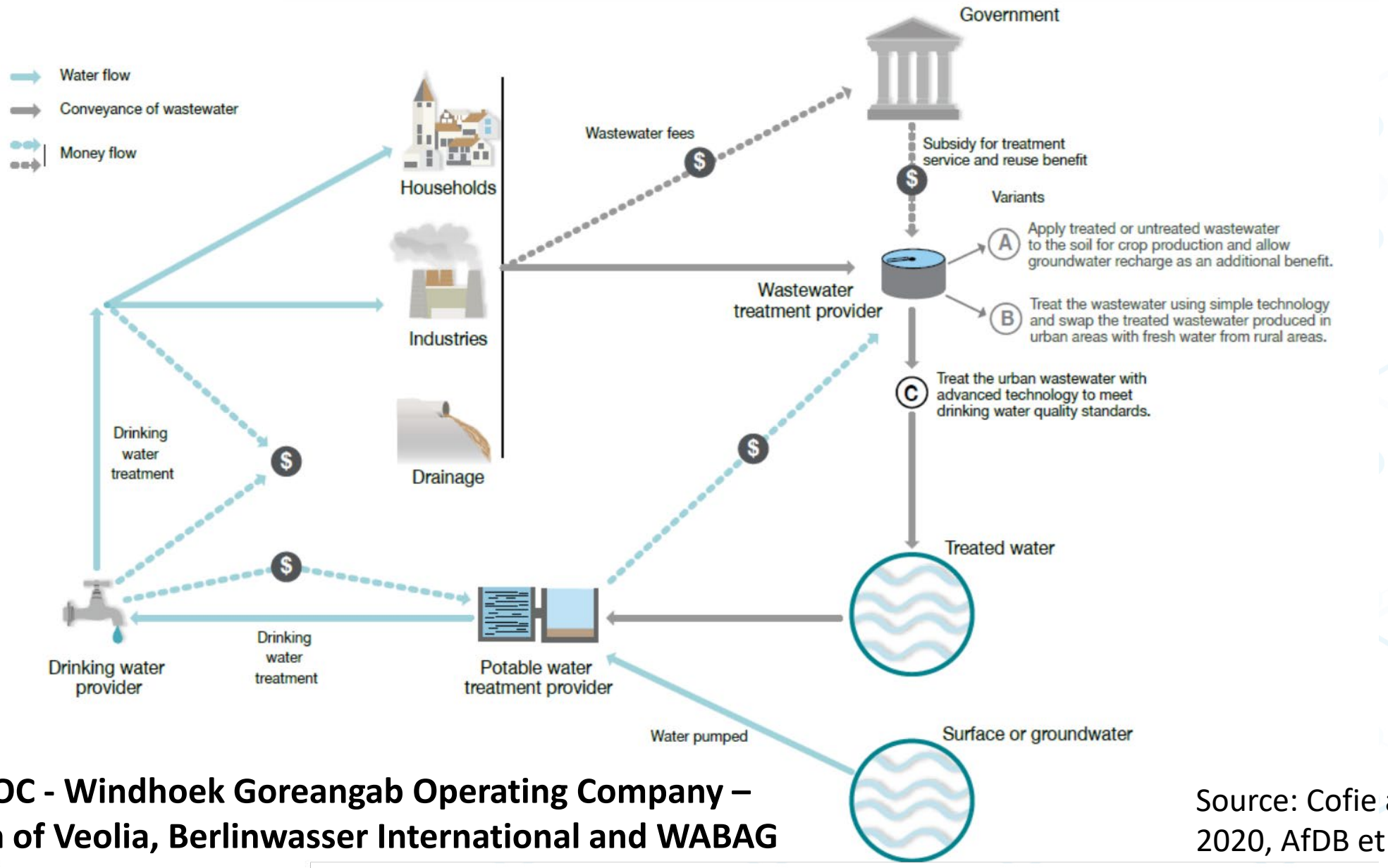


Source: Cicceri et al., 2021

Innovation in financing models

Public-private partnerships (PPPs) using a mix of public and private finance

Windhoek, Namibia - The World's First Direct Potable Reuse Plant
A model for innovative and sustainable water management and a successful PPP



PPP: WINGOC - Windhoek Goreangab Operating Company – consortium of Veolia, Berlinwasser International and WABAG

Source: Cofie and Nikiema, 2020, AfDB et al., 2020

The role of governments in water reclamation and reuse

Policies that promote water reuse

The role of government

Governments have an important role to play to promote water reclamation and reuse and deliver change through **institutional, social, economic, and regulatory reform**:

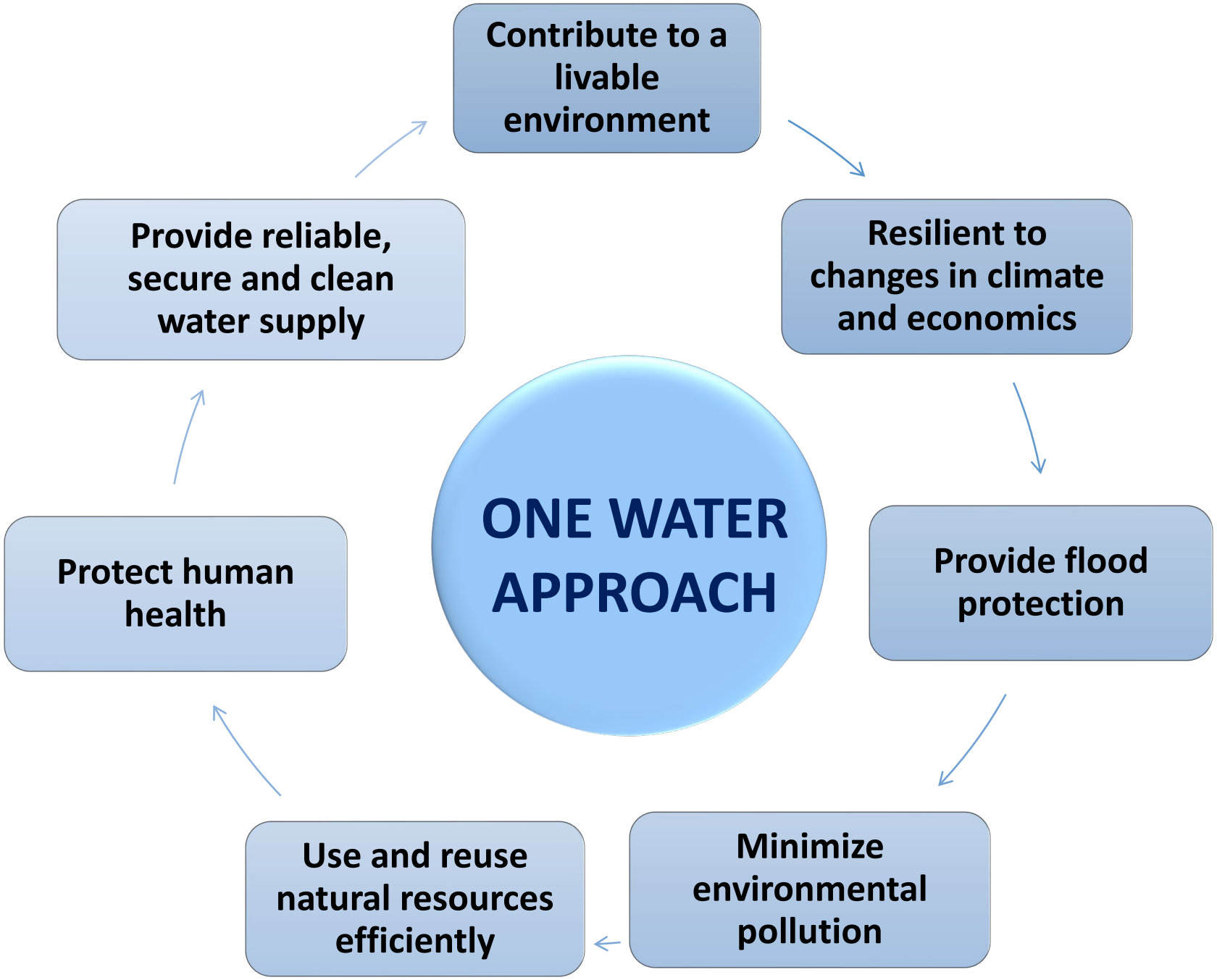
- Development of a **national strategy for water reclamation and reuse**
- **Institutional set-up and coordination** of the wide range of **stakeholders**
- Development of the **water reclamation and reuse infrastructure**
- Development of a **regulatory framework** for water reclamation and reuse and national water recycling guidelines
- **Policy instruments** that reduce water-energy-food nexus pressures and promote social and technological innovations that increase resource efficiency and conservation
- **Funding water reclamation and reuse projects**

Source: Taqi and Gu, 2022

Improving the acceptability of Water Reuse

Maximizing the Trust of Community Stakeholders

Source: IWMI, 2022


ONE WATER APPROACH
Contribute to a livable environment
Resilient to changes in climate and economics
Provide flood protection
Minimize environmental pollution
Use and reuse natural resources efficiently
Protect human health
Provide reliable, secure and clean water supply

Conclusion

1. **Achieving water security** requires the acknowledgement of the **interdependencies between water, energy, food, environment and socioeconomic development**
2. **Water reuse** is a **sustainable and complementary alternative** that plays a crucial role in **diversifying water sources** to achieve water security especially with a changing climate
3. **A paradigm shift** is required to transition from **waste streams to value streams**. **Resource recovery must be a strategic objective** from the very beginning of new investment planning
4. **Development of water reuse** will be driven by **innovative technologies**, **funding opportunities and increasing capital investment**, **strong policy support**, **community engagement**, **innovation and collaboration between the public and private sectors** and **new partnerships**
5. **Several innovations in water reclamation and reuse** are **enhancing water reuse efficiency and feasibility.** These innovations offer **new business models and market opportunities**
6. **Comprehensive efforts** are needed with **input from all stakeholders**, **increased investment in R&D and new training curricula**
7. **A systemic approach to issues and integrated public policies** in water, agriculture, bio-waste, energy, food systems, health, climate, etc. **are required**

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THANK YOU!

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