GWSP
GLOBAL WATER SECURITY & SANITATION PARTNERSHIP

Wastewater Reuse in Circular Economy

Anna Delgado, Water Specialist
World Bank
www.worldbank.org/wicer

WORLD BANK GROUP
Water

Water challenges

Too little

Too much

Too polluted

Globally

2 billion people

lack access to safely managed drinking water.

3.6 billion people

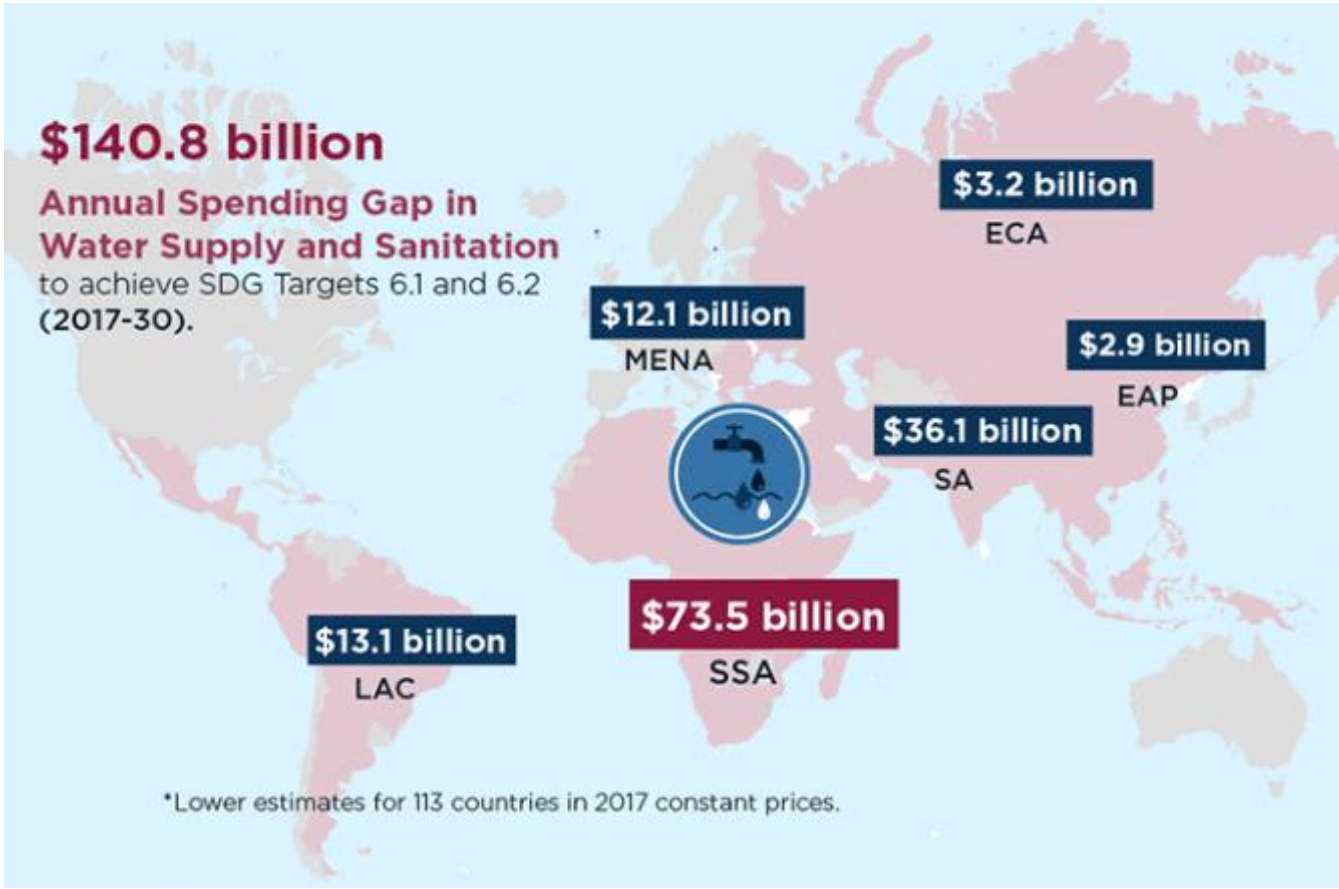
lack access to safely managed sanitation facilities

48% of global wastewater production is released into the environment untreated

Funding challenges in the sector

New WB report, "Funding a Water-Secure Future: An Assessment of Public Spending"

- To achieve the SDG targets for universal access to safe water and sanitation, the world is experiencing an annual spending shortfall of **between US$131.4 billion and US$140.8 billion**
- About 91.4% of total spending in the sector comes from the **public sector**
- Despite large funding gap, the water sector is **not able to spend all the allocated budget.** The annual budget execution is about 72%.
- **Only 35%** of the utilities in the International Benchmarking Network (IBNET) database **fully cover their operations and maintenance (O&M) costs** of service provision



Can circular approaches help with these challenges?

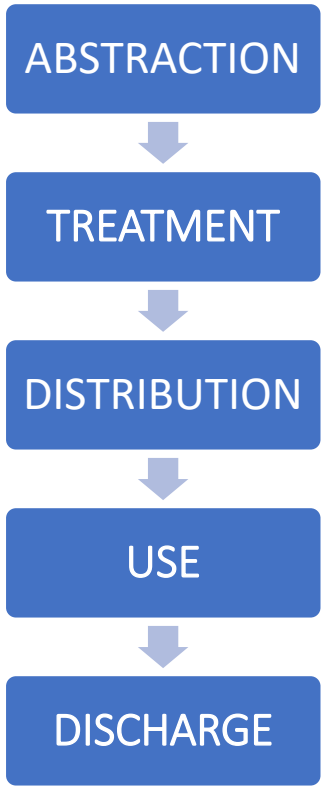
- ✓ Create new revenue streams for a heavily subsidized sector?
- ✓ Create opportunities to invest in new business models?
- ✓ Create opportunities to attract private sector?
- ✓ Create a path for financing from other sectors (such as from climate)?
- ✓ Improve the efficiency of utilities?

And at the same time…

- ✓ Improve water services and water quality?
- ✓ Help restore degraded land and watersheds?
- ✓ Reduce GHG emissions by the sector?

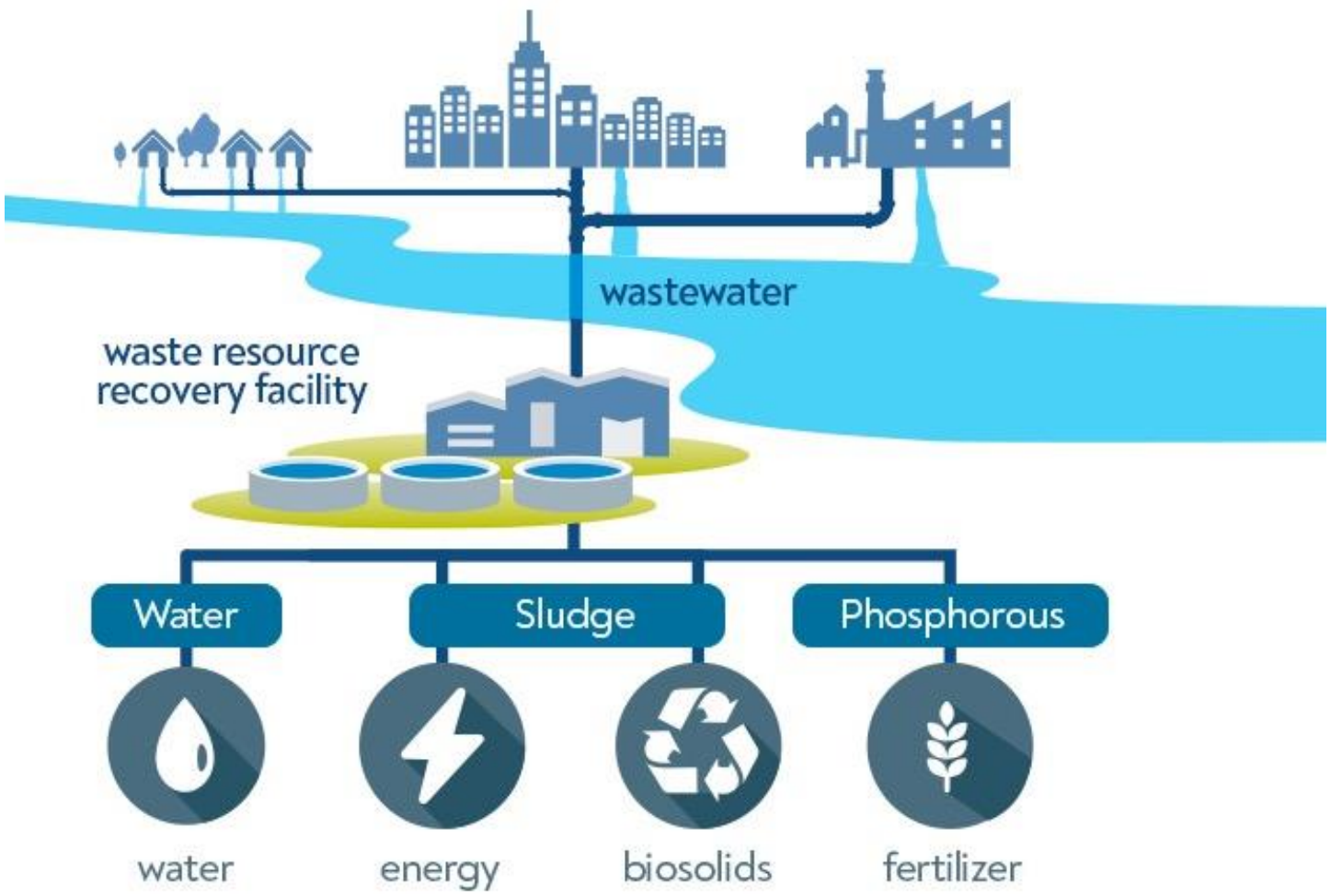
TO ADDRESS THE CHALLENGES AND GLOBAL COMMITMENTS WE MUST SHIFT FROM …..

LINEAR



CIRCULAR

WASTEWATER: FROM WASTE TO RESOURCE



From Waste to Resource

Shifting paradigms for smarter wastewater interventions in Latin America and the Caribbean

Diego J. Rodriguez, Hector Alexander Serrano, Anna Delgado, Daniel Nolasco and Gustavo Saltiel

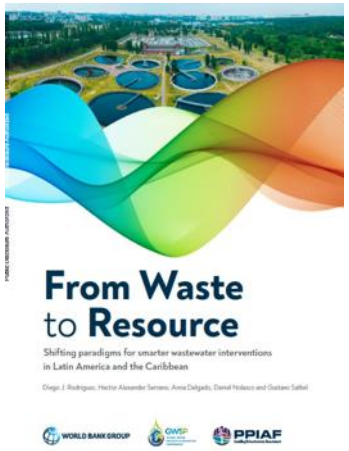
Main Report + 4 background reports

www.worldbank.org/wastetoresource

WORLD BANK GROUP Water

Expand beyond wastewater to enhance benefits

To really embrace circular principles, we needed to look beyond wastewater



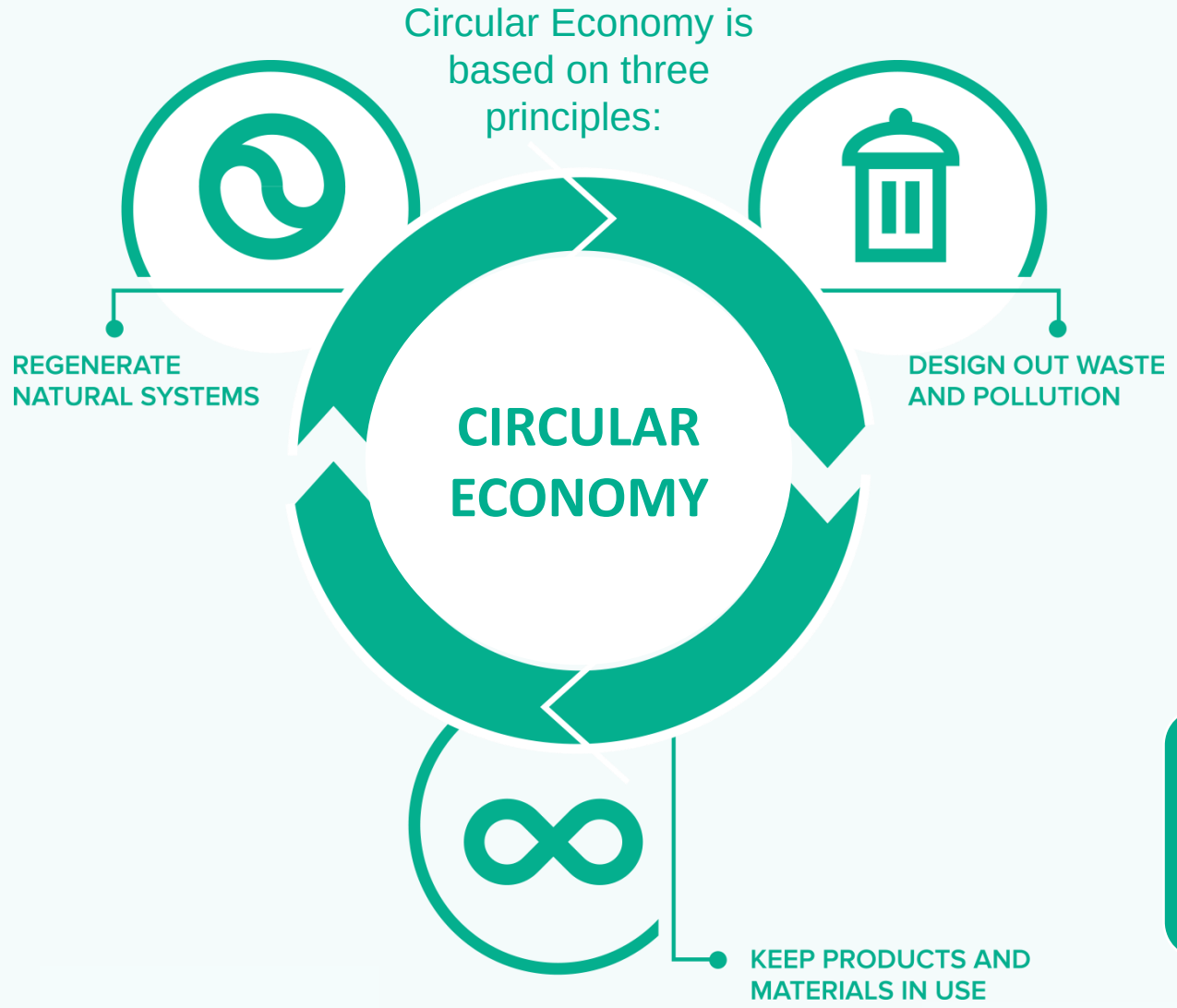
Entire WATER CYCLE

Include RESILIENCE

Ensure INCLUSIVENESS

Proactively RESTORING NATURE

What are the principles of Circular Economy?

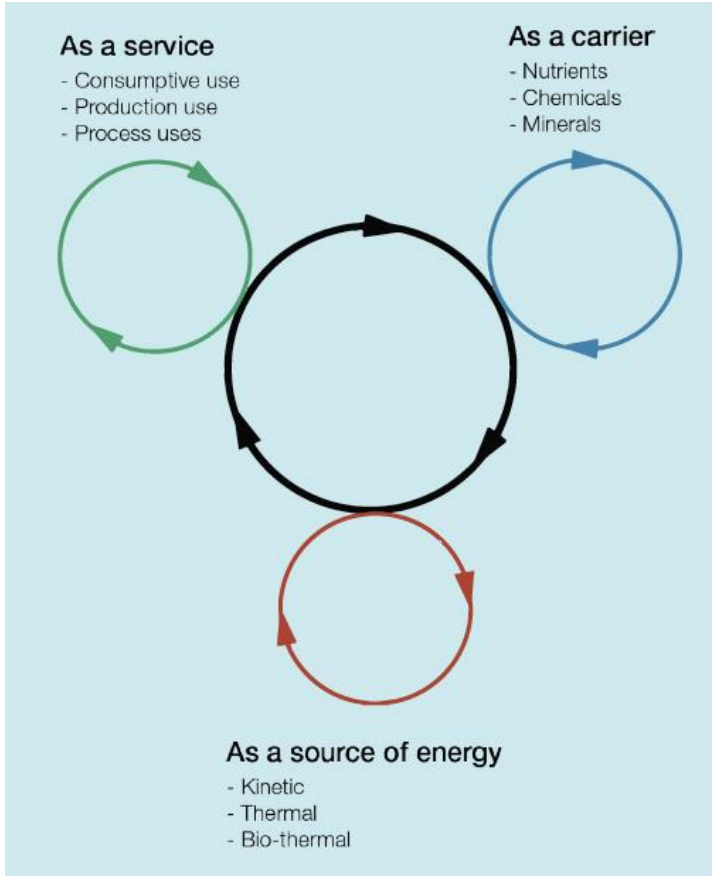


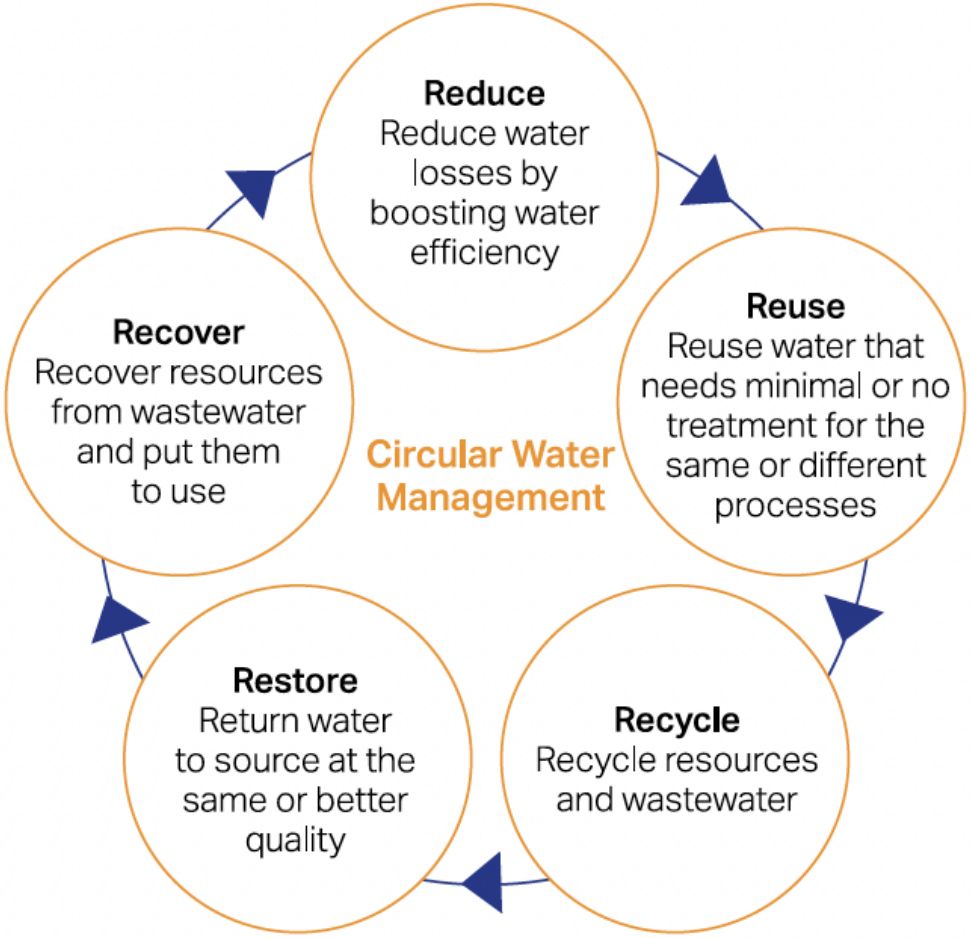
- decoupling economic activity from the consumption of finite resources and from environmental degradation
- restoring and regenerating ecosystems by intention and design,
- eliminating waste through superior design—of materials, products, systems, and business models
- not a synonym of recycling (recycling should be the last resort)

a circular model builds economic, natural, and social capital

Source: Ellen MacArthur Foundation

Circular economy in water





SOURCES

- **International Water Association (IWA), 2016.** "Water Utility Pathways in a Circular Economy." London.
- **World Business Council for Sustainable Development, 2017.** "Business Guide to Circular Water Management: Spotlight on Reduce, Reuse and Recycle." Geneva.
- **Ellen MacArthur Foundation, ARUP, and Antea Group. 2018.** "Water and Circular Economy." White Paper

WORLD BANK GROUP Water

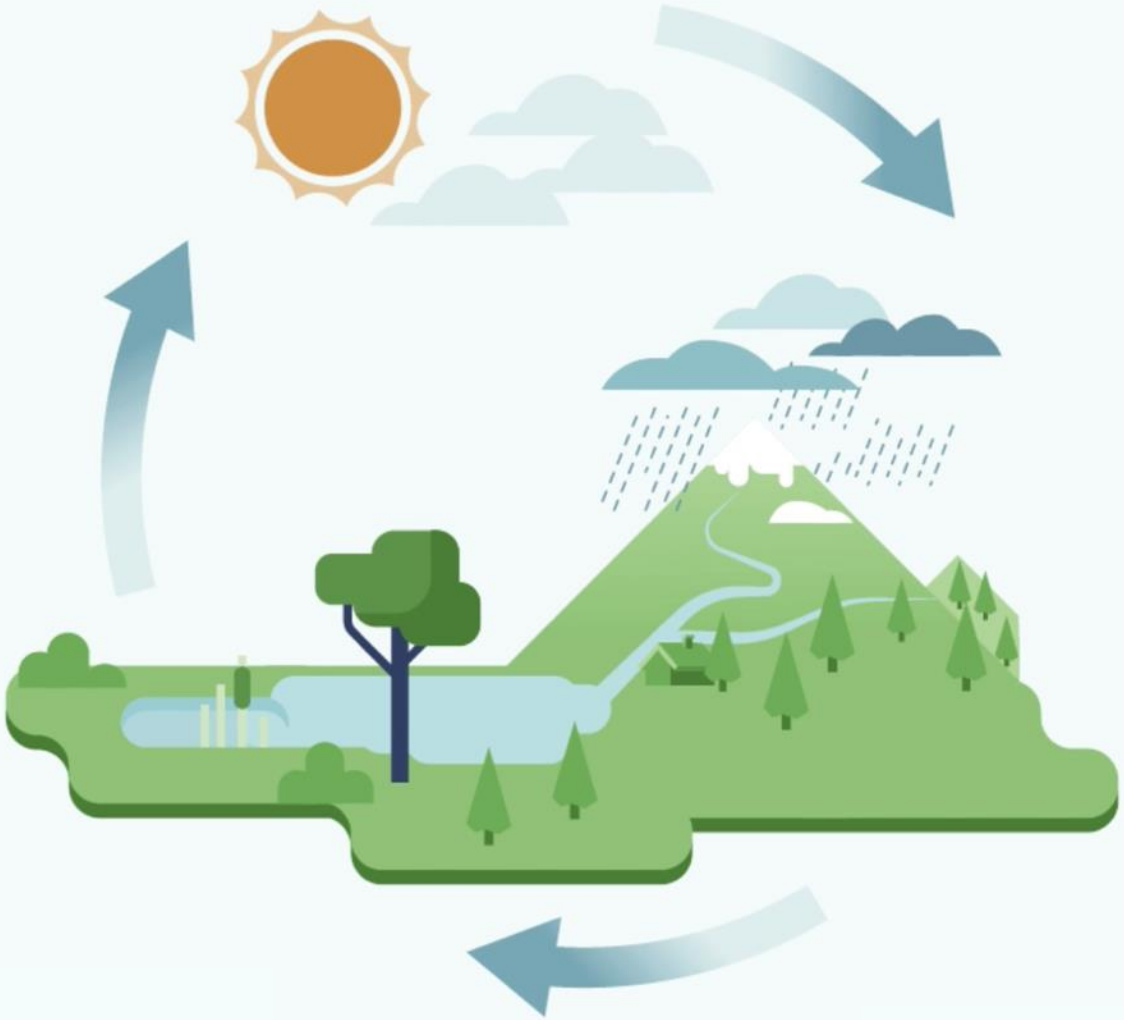
Implementing Circular Economy principles offer opportunities for climate mitigation and adaptation

Circular Economy principles can help countries meet the targets of the Paris Agreement.

For example, in the water sector, the circular economy:

- **Contributes to GHG emissions reduction by minimizing waste and preserving resources.**
  - For example, reducing NRW also reduces GHGs emissions associated with the treatment
- **Advocates for the utilization of renewable energy sources and for energy efficiency,** reducing reliance on fossil fuels and mitigating the impact of climate change.
  - For example, recovering and using biogas from WWTP
- **Places emphasis on resource efficiency** by promoting product life extension, reuse, and recycling, and by using less resources to achieve the same output. This not only reduces the demand for raw materials but also helps conserve natural resources, resulting in an overall reduction in the carbon footprint.
  - For example, using less chemicals for treatment, reusing wastewater
- **Encourages proactively restoring ecosystems.**
  - For example, green infrastructure solutions, such as green roofs, rain gardens, and wetlands for stormwater management and treatment, sequester carbon and reduce the need for energy-intensive conventional infrastructure.

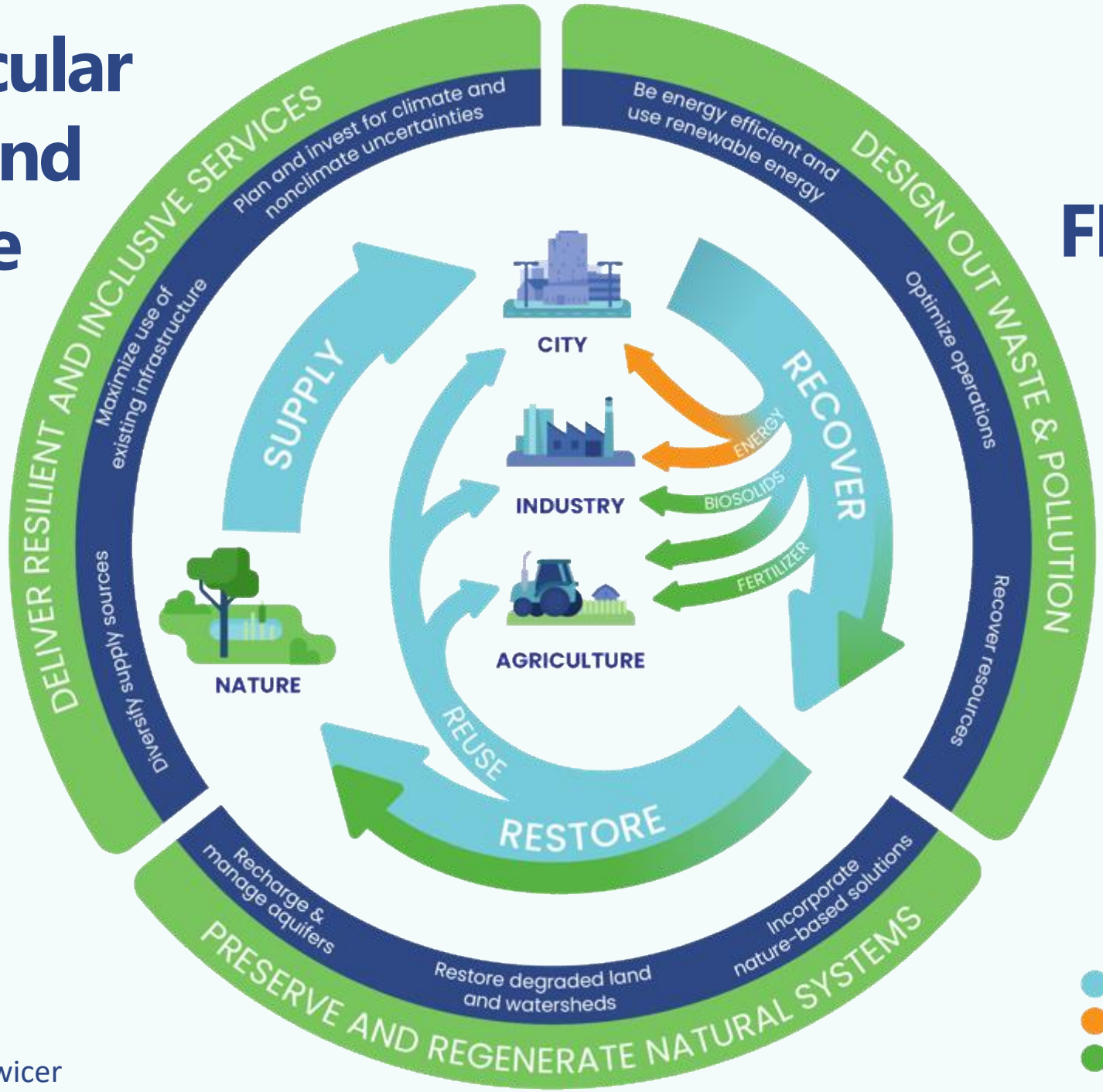
Inspired by the circularity of the water cycle in nature…



+ resilience

+ inclusitivity

Water in Circular Economy and Resilience (WICER)

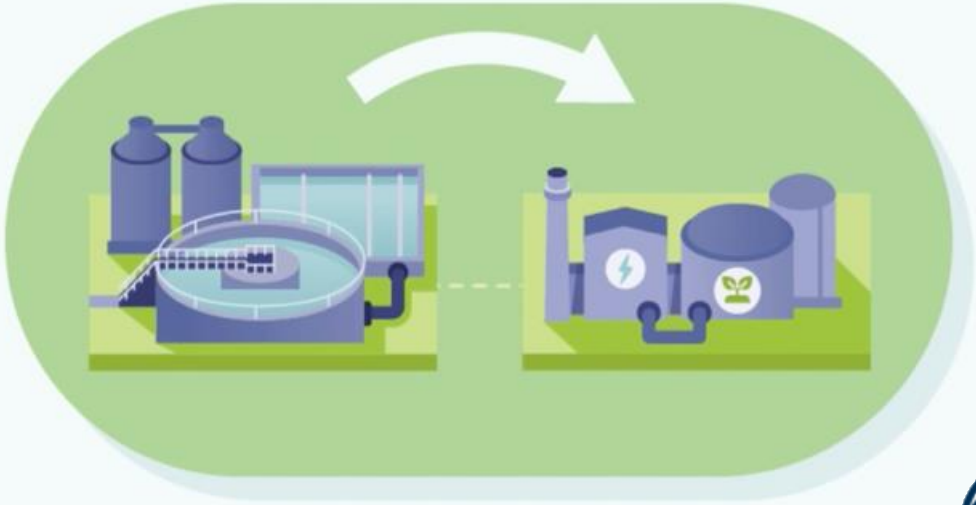


THE WICER FRAMEWORK

Water
Energy
Nutrients

http://www.worldbank.org/wicer

Maximize, value and optimize the use of existing infrastructure



Optimize operations

- Reduce NRW
- Increase overall efficiency of processes
- Optimize the amount of energy, minerals, and chemicals used in the operation of water systems

Diversify supply sources

- Diversification of water supply sources (water balance)
  - including sources with different risk and cost profiles, and low vulnerabilities)
- Protecting those water supply sources
- Including integrated water storage

Full case study here: http://hdl.handle.net/10986/35659

Recover resources from water and wastewater and explore additional revenue streams

Energy

Water

Nutrients

Recover resources from water and wastewater and explore additional revenue streams

Water

Industrial processes (paper, textile, etc.)

Irrigation (agriculture, parks, etc.)

Replenish aquifers

Recreational use

Cooling water (power plants)

Indirect potable water

biogas

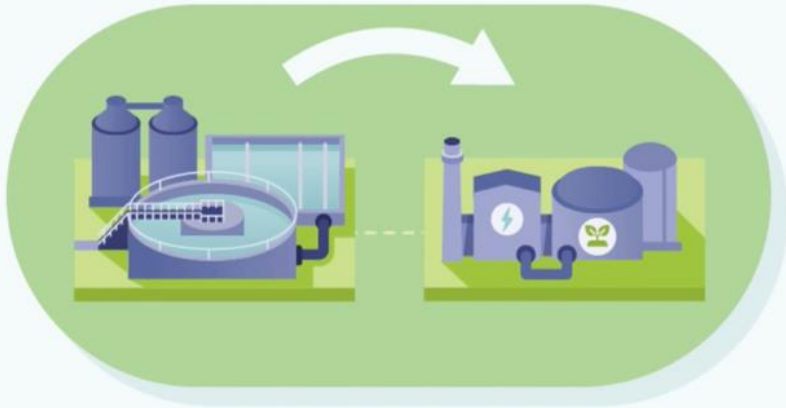
phosphate fertilizer

bricks

cellulose

Biofuels (algae)

Be energy efficient and use renewable energy, reducing GHGs of the sector: beyond biogas



Be energy efficient and use renewable energy, reducing GHGs of the sector: beyond biogas

Recovering and using biogas. La Farfana, Chile

Solar panels in roof of Recycled Water Treatment Plant Tuncurry, Australia

Solar panels in WWTP Lianyungang, China

Floating Solar panels in WWTP Kraaifontein, South Africa

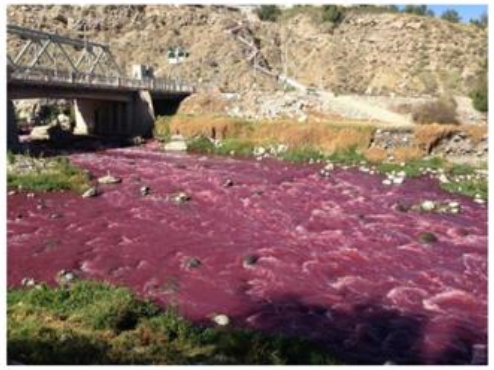
PRESERVE AND REGENERATE NATURAL SYSTEMS

Including NBS, managing and recharging aquifers, restoring regraded lands

Sponge cities

Upstream reforestation

Constructed wetlands as part of the wastewater treatment



Fotos: Jose Luis Valverde

Recover degraded watersheds and land

Green roofs

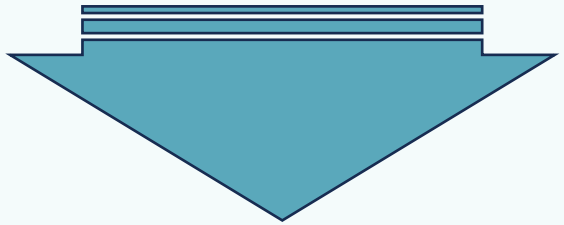
Cross-cutting Issues

- Manage water demand & decrease water use
- Leverage the power of digitalization
- Create the right Policy, Institutional and Regulatory (PIR) environment
- Ensure solutions are inclusive
- Funding and financing
- Stakeholder engagement + social acceptability

Implementing circular economy principles also makes economic and financial sense

Circular economy offers the opportunity to:

- Create additional revenue streams
- Reduce O&M costs
- Offer a better return on investment in a sector heavily subsidized



- Potential to create more innovative business models
- Potential to attract the private sector (PPP)
- Potential to tap into other sector's financing (green/climate bonds, environmental impact bonds, etc)

Investments in nature-based solutions such as upstream reforestarion, can reduce treatment needs and costs

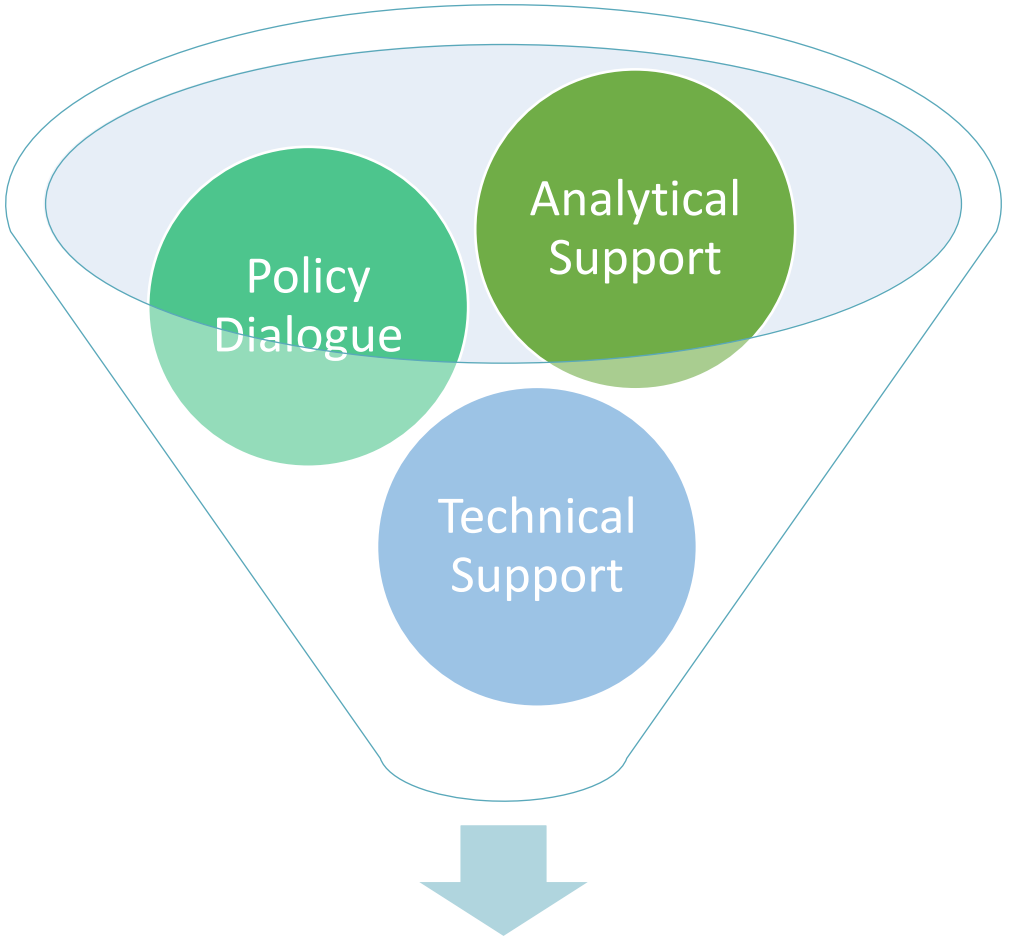
Investments in energy efficiency and reducing NRW can be recovered in less than 3 years

Self-generating renewable energy can reduce energy costs, increase system resiliency and lower GHGs

Utilities can create additional revenue streams to cover O&M costs by selling wastewater bypro

WICER in practice - How is World Bank working with clients to promote a WICER approach?

WICER



Operational Support

Policy Dialogue

Advice to Senegal on revision of Water and Sanitation Codes

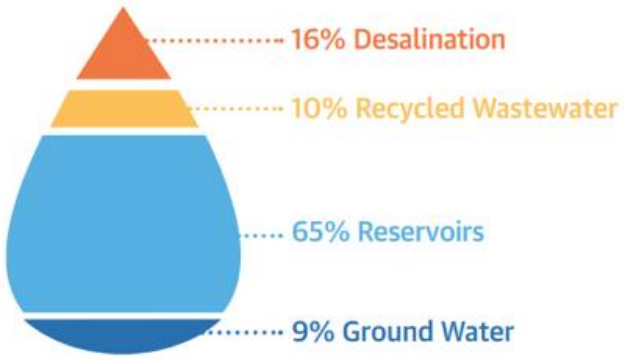
Dialogue on regulating reuse and circular economy in Colombia & Peru

Workshop to identify top priorities in Botswana

Policy, Institutional and Regulatory (PIR) assessment to promote unconventional sources of water in South Africa

Targeted project activities and investments

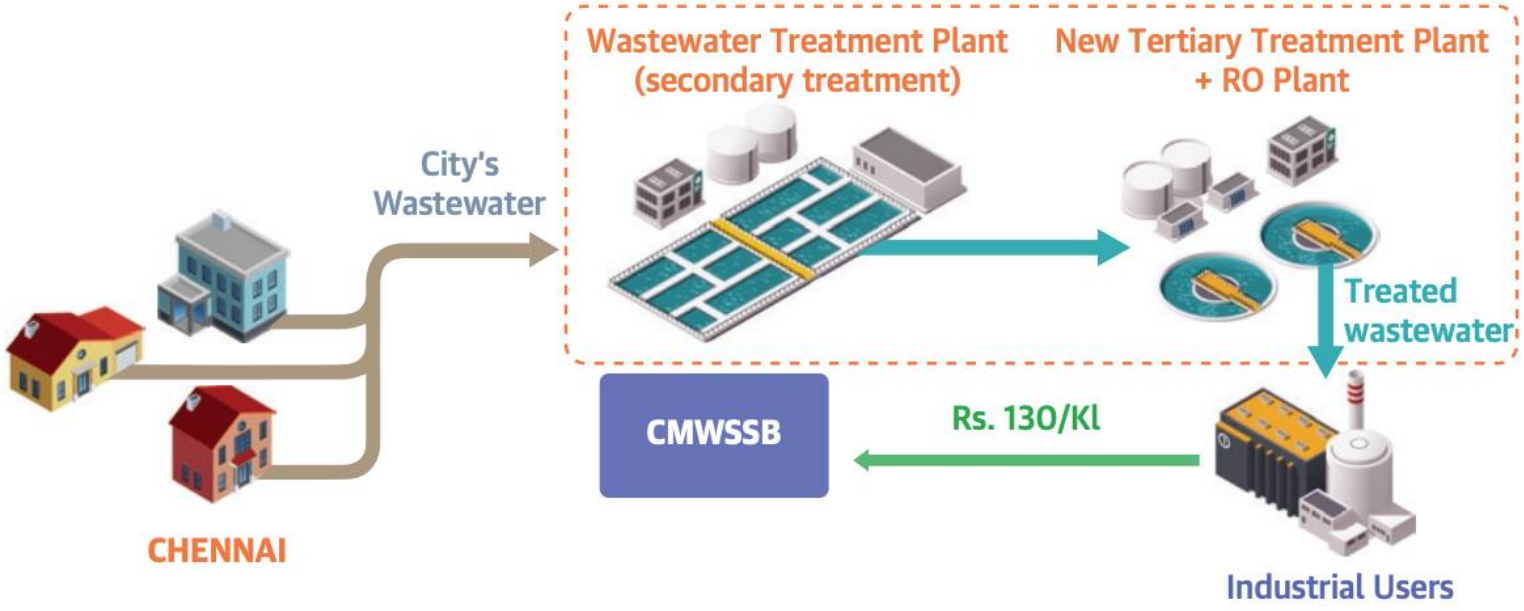
Applying circular economy principles in Chennai, India. The Tamil Nadu Sustainable Urban Development Project



Source: CMWSSB, 2020.

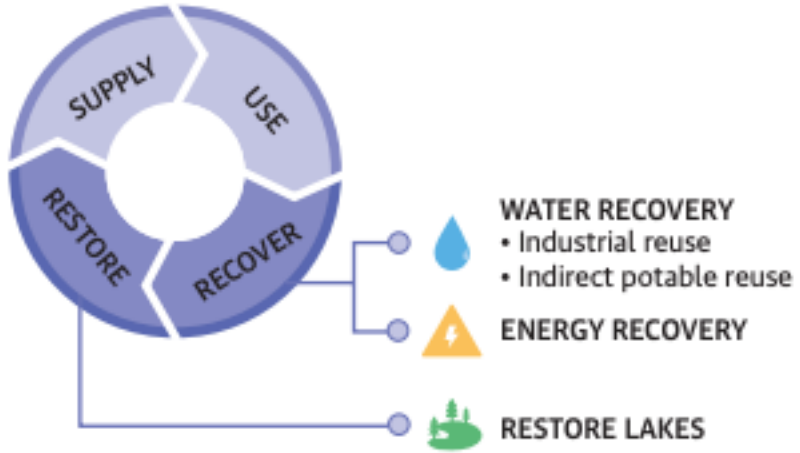
Benefits:

- Tariff for water reused in industry covers O&M costs
- Lower operating costs and decreased risks of water scarcity for industrial users
- Recovering energy in WWTP –50 % of the energy needs of all the plants



Notes: CMWSSB = Chennai Metropolitan Water Supply and Sewerage Board; RO = reverse osmosis.

CIRCULAR ECONOMY ELEMENTS



Example of World Bank projects with circular economy components:

- India: Tamil Nadu Sustainable Urban Development Project - reuse for industry
- China: Liaoning Coastal Economic Zone Urban Infrastructure and Environmental Management Project - reuse for industry and environmental restoration
- Uruguay: Uruguay OSE Sustainable and Efficient Project - Improving Resiliency, Sustainability and Efficiency in Uruguay´s National Water Supply and Sanitation Company
- Brazil: The Watershed Management and Restoration of Forest Cover project - Targeted green infrastructure for source-water protection
- Senegal: Water Security and Sanitation Project - recovering resources from wastewater and fecal sludge (biosolids, water and energy)
- Türkiye Water Circularity and Efficiency Improvement Project
- Countries with interest: Peru, Botswana, Barbados...

Developing Knowledge Exchange and Capacity Building Workshops:

Next workshop planned for October 2024

Site visits

- Treatment plants
- Discussions with end users of recovered resources and other stakeholders

Group discussions, exercises, knowledge sharing

Lectures and presentations by international experts

Developing knowledge, Tools and Frameworks

Online quick assessment WICER Tool:

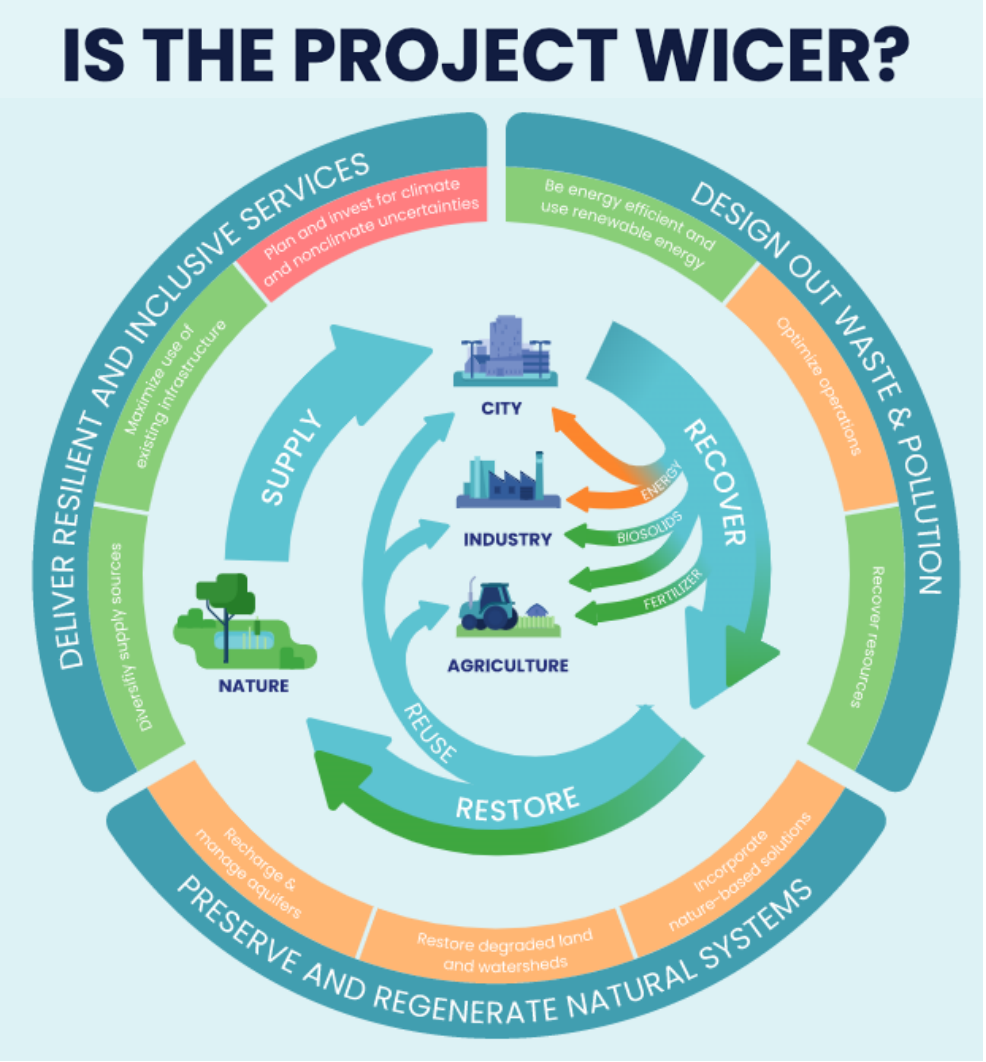
Visual results with colors (traffic light) to assess whether the project or city is circular and resilient – is your project WICER?

- To continue
- To improve
- To start doing/exploring

www.wicer-tool.com

Quantifying Economic and Financial Benefits of WICER vs linear system

Guidance Note "Making the Economic and Financial Case for Circular Projects in Water"



Documenting relevant case studies

www.worldbank.org/wicer

www.worldbank.org/wastetoresource

Circular Economy projects:

- Any Scale: Big and Small
- Centralized and Decentralized Solutions
- Nature based and “Grey”
- Beyond reuse: reusing biosolids as fertilizers, Reducing NRW, Energy efficiency, using nature based solutions..

Common Success Factors and Lessons Learned
from Case Studies on wastewater reuse

Reuse Case Studies

- Atotonilco, Mexico
- Chennai, India
- Durban, South Africa
- Lingyuan City, China
- Nagpur, India
- San Luis Potosi, Mexico
- Other…

1. Stakeholder Engagement Early in the Process to identify end users and ensure social acceptability

2. Clear Regulatory Framework for reuse or/and Clear Roles, Rights, Responsibilities via Contracts

3. Innovative business models to ensure the financial Viability of investment: Create Additional Revenue Streams for Operators & explore private sector participation

4. Parallel investments in improving the efficiency of water and wastewater operations and infrastructure

Case Studies from the WB Water Practice and from:
Wastewater: from waste to resource Initiative
Water in Circular Economy and Resilience (WICER) Initiative

Stakeholder Engagement - examples

- **Information and awareness campaigns** on: the benefits of using treated wastewater to mitigate water scarcity, safety of consuming vegetables irrigated with wastewater, etc.
- **Stakeholder engagement workshops at the basin level to inform project design and implementation**
  - **Identify end users and quality required** (type (farmers, industry, other private sector users), location, quality of wastewater needed, etc.).
  - **Choose the location of the WWTP and treatment technology according to the end users (** fit to purpose – to reduce costs (for example, if end user grows non-edible crops such as cotton, treatment requirements might be lower, lowering capital and O&M costs).
  - **Identify opportunities and challenges** and/or initiate needed actions to promote wastewater reuse and resource recovery
  - **Communicate** benefits, risks and mitigation measures of using treated waster water.
- **Legal Agreements to supply treated wastewater**
  - Clarify roles and responsibilities for each party (water monitoring, tariff, water rights, CAPEX and OPEX, etc).

International Examples

Atotonilco de Tula, Mexico

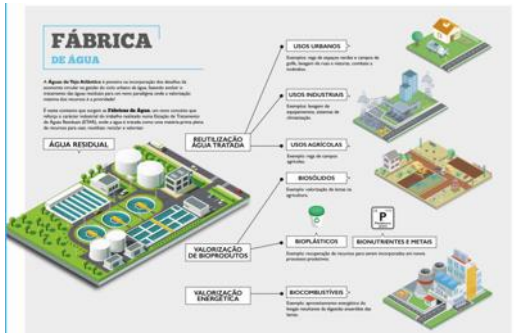
- The farmers valued the untreated wastewater and saw using wastewater as their right
- Some farmers believed that the untreated wastewater and its nutrients led to higher-than-average yields.
- Many farmers feared that the utility would make them pay high prices for the treated wastewater and that their crop productivity would decrease.
- the national water commission (CONAGUA) put in place several **stakeholder engagement programs** to (a) clarify the issue; (b) explain the new opportunities that will arise from using treated wastewater (such as switching to higher vale crops); and (c) enable the farmers to use drip irrigation to optimize water use. A fideicomiso **(trust)** was created (Fideicomiso de Infraestructura Ambiental de los Valles de Hidalgo) to enable proposals on integrated management of water resources, advanced irrigation, and agricultural industrialization, among others.

Arequipa, Peru

- **Farmers using untreated wastewater initially were opposed to the project** thinking they would lose their water resources and complained to the local authorities
- A key factor in the success of the project is the ongoing engagement of stakeholders, including those directly influenced by the environmental impacts of the project. Cerro Verde (private sector operator of the wastewater treatment plant) implemented a **community relations program** that gathered municipal and other community leaders to identify the major problems observed in the affected areas and potential ways to address them. They also engaged with the farmers, who saw themselves as rightful owners of untreated wastewater.

Link to case studies:
- Peru: https://openknowledge.worldbank.org/handle/10986/33110
Mexico: https://openknowledge.worldbank.org/handle/10986/29493

Portugal: example of a strong communication and awareness campaign on circular economy



VIRA, a brand of craft beer created by Tejo Atlântico made from **água+**, with complementary treatment through ozonization and reverse osmosis, subject to the most rigorous quality tests

100% secure.

VIRA was created to change mindsets and raise awareness of the importance of reuse as a way to preserve our most precious resource, water.

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An enabling policy, institutional, and regulatory (PIR) environment is needed to achieve full circularity and resilience in water

Currently there are many barriers

- **No clear policy goals or targets** (on circular economy, efficiency in the water sector, restore ecosystems, etc) → Lack of support to municipalities/utilities
- **No clear regulations or guidelines** on the use and sale of resources recovered from wastewater → discourages municipalities and specially the private sector to develop projects with circularity in mind (too much risk)
- **Low tariffs for freshwater or energy** → no incentives to make efficient use of water, reuse treated wastewater, generate energy in wastewater treatment plants or implement energy efficiency measures
- **Low wastewater discharge fees or pollution charges, or lax enforcement** → no incentives by industries to minimize water pollution

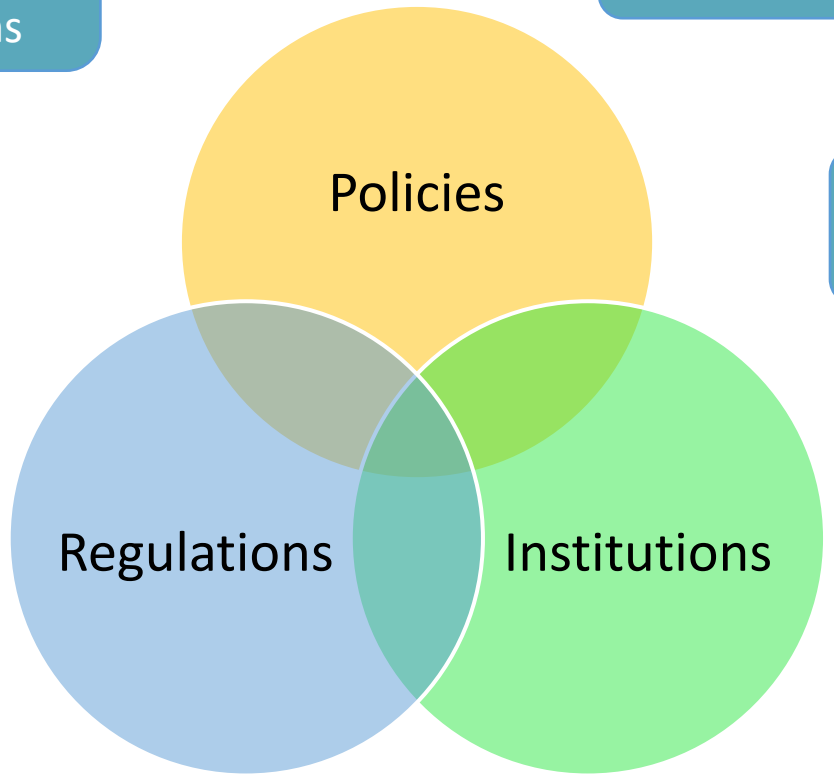
Example of an enabling environment

Guidelines for resource recovery, clarifying risks, roles, opportunities, regulations

National targets for efficiency in the water sector

Clear water discharge standards

Clear policy goals regarding circular economy and water



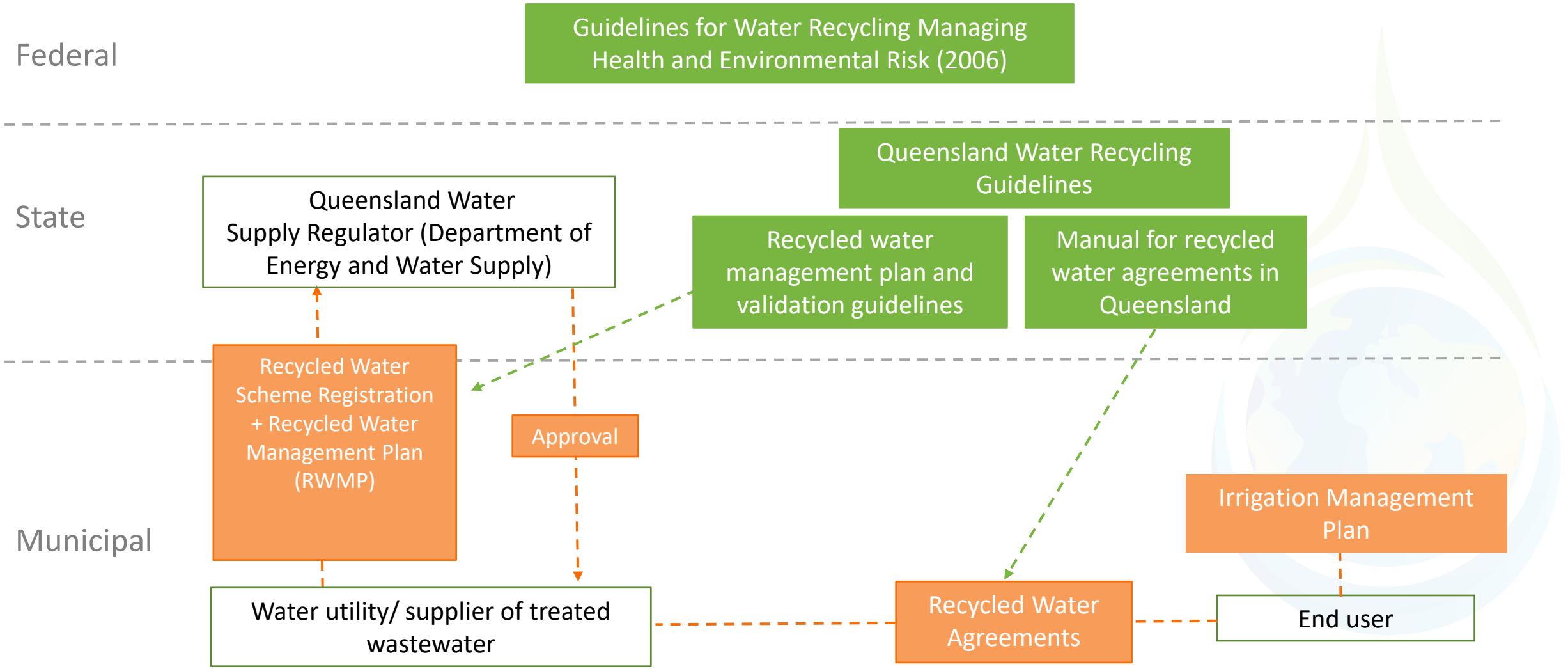
Clear regulations and legal framework for:
- Reuse of wastewater
- Biosolids and other byproducts
- Energy generation in the water sector

Strong capacity to enforce water quality standards and other relevant regulations

Coordination mechanisms and accountability between different sectors and different levels

Right tariffs for water

The Case of Australia



Clear responsibilities/rights, accountability & risk mitigation strategies

How to operationalize this?

LONG TERM

Develop clear guidelines and regulation specifically for wastewater reuse at the national level. Ideally, eventually expand the regulation to cover resource recovery in WWTPs (energy, biosolids).

- Collaboration needed between Environment, Energy, Agriculture and Health Ministries

SHORT TERM

Clear long-term contracts and agreements between stakeholders can be incorporated into the project implementation arrangements to mitigate some of the issues when there are PIR gaps

- International examples show that a specific risk associated with reuse is **variable demand.** To mitigate this risk, a well-designed contract between the parties is essential. For example, long-term agreement between utility and industry or farmers associations to ensure treated wastewater demand (check Mexico Case: San Luis Potosi)
- The contracts or agreements should also clarify the roles, responsibilities and rights of each party

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Explore the potential for wastewater reuse for industry in combination with irrigation

Why is this important?

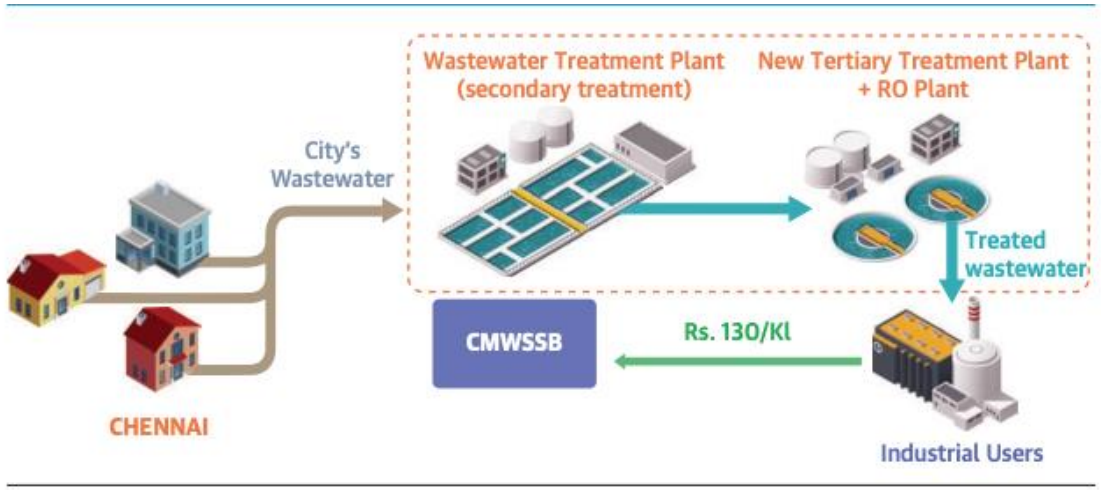
- **Financial & environmental sustainability:** International examples on reuse show that the sale of treated water to industry can help cover O&M costs of the WWTP, making the project more financially sustainable and freeing up (or subsidizing) water resources for irrigation. There are also cases of industrial users buying secondary treated WW and treating it further onsite, substantially lowering treatment costs for the municipality.
- **Big polluters and water users:** The industrial sector is also a big water user and polluter and could afford to pay a higher tariff for treated wastewater, making the system more financially sustainable.
- **Transport costs:** Cost of transporting water to end user is usually lower compared to irrigation associated costs, since it is usually one industrial user or a cluster of industries – the WWTP can be located near.
- **Easier monitoring of water quality** – less users and less points of delivery, lower health risks

* Cases from “waste to resource” and “WICER” initiative

Involving industry as end user allows for more innovative business models

Note: CMWSSB = Chennai Metropolitan Water Supply and Sewerage Board.

- Secondary treated wastewater sold to industrial user
- User further treats water onsite to their desired quality



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- Tertiary treated wastewater sold to industrial user at a higher tariff meeting their quality needs.

Case study: Arequipa Peru
Financing of infrastructure by private end user

SOLUTION: PPP for wastewater reuse

Treated wastewater is returned to the river and used downstream for agriculture

Treated Water

1 m3/sec

PTAR
La Enzolada

CERRO VERDE MINE

WASTEWATER
Arequipa

SEDAPAR

Cerro Verde financed, built and operates WWTP. In return it can use a percentage of the treated water for its operations

PPP - Built – Own - Operate - Transfer (BOOT) 29-year concession

Case study: Arequipa Peru
Financing of infrastructure by private end user

Benefits

- **For SEDAPAR (municipal utility):**
  - Avoided the costs of constructing and operating the wastewater treatment plant (US$ 540M capital investment + O&M costs)
  - More than 95% of the city's wastewater is now treated at no cost to taxpayers
- **Cerro Verde:**
  - Savings: Treated wastewater is cheaper than the next available option
  - Reduced risk related to water availability (quantity, quality and cost stable for the next 29 years)
  - For Cerro Verde was able to take most of the risks (technical, financial, construction, and operation), which together were smaller than the losses of not expanding the mine operations
- **Social and Environmental:**
  - Decontamination and restoration of the river Chili
  - Farmers can also use the better-quality water for irrigating their crops, potentially allowing them to switch to higher-value crops.

Full case study here: worldbank.org/wastetoresource

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Case Studies from the WB Water Practice and from:
Wastewater: from waste to resource Initiative
Water in Circular Economy and Resilience (WICER) Initiative

SABESP, Brazil: Optimizing WWTPs in São Paulo

With increasing wastewater collection networks and the mission to universalize wastewater collection and treatment by 2033, there was an **urgent need to expand the wastewater** treatment capacity and improve the quality of effluents discharged**.**

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Considers conventional wastewater treatment project

- Option B

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CIRCULAR

Optimization of the current WWTPs w/o new infra

This would entail focusing on priority actions and investments to identify and eliminate bottlenecks and maximize efficient treatment processes at each plant.

Benefits: Savings and delayed investments

Brazil: Optimizing WWTPs in São Paulo

Compared interventions	Required investment in CapEx (Million USD)	Savings achieved by implementing only the interventions identified in the audit (Million USD)
Conventional expansion (secondary treatment)	548	228
Tertiary treatment	2,399	2,079
Optimization Audit	320	-

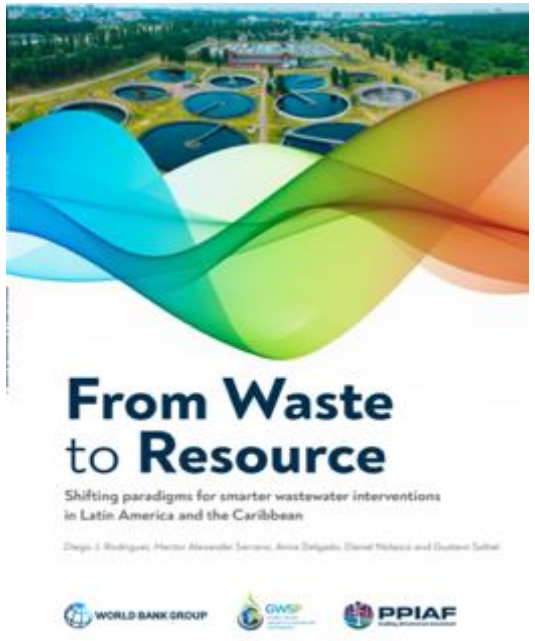
Full case study here: "World Bank. 2021. Water in Circular Economy and Resilience: The Case of Sao Paulo, Brazil. © World Bank, Washington, DC. http://hdl.handle.net/10986/36245

Key Takeaways

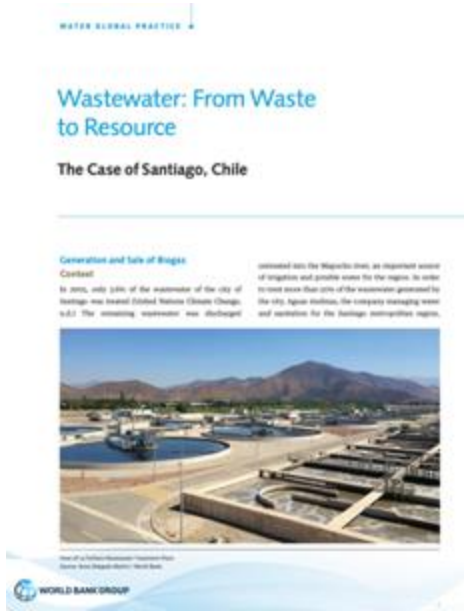
1. **Water circularity goes beyond reusing and recovering resources from wastewater**, and it requires a more holistic approach for water and sanitation services, actively restoring and enhancing ecosystems, considering a water basin approach and including resiliency principles, climate mitigation strategies and be inclusive
2. **Implementing circular economy principles also makes economic and financial sense** and can help enhance the financial sustainability of utilities and help attract the private sector by creating innovative new businesses.
3. **Water circularity is not an end in itself,** but a means to achieving higher outcomes, such as, restored ecosystems, more sustainable resources, job creation and shared prosperity, climate mitigation and adaptation, and ultimately progress towards universal access.
4. **Cross-cutting interventions** such as demand management, enabling policies and regulations and stakeholder engagement will be crucial to move towards circular approaches.

To learn more….

Reports with examples and guidelines to implement the concepts in the water sector



Several case Studies



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Anna Delgado, Water Specialist
adelgado@worldbank.org

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Thank You!

Anna Delgado, Water Specialist
adelgado@worldbank.org

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WORLD BANK GROUP
Water

THE CURRENT WATER CRISIS IS ONE OF THE GREATEST CHALLENGES OF OUR TIME

THE CHALLENGE

Increasing population, economic growth and shifting consumption patterns have driven a rapid rise in demand for water resources, while 36 percent of the world's population already lives in water-scarce regions.

Water is essential for socioeconomic development and it links with nearly every Sustainable Development Goal. Nevertheless, water is undervalued, and water resources are used inefficiently.

Water pollution resulting from human activities has clear health, socioeconomic and environmental impacts, and further threatens the sustainability of water supplies.

Climate change is challenging the sustainability of water resources, which are already under severe pressure in many regions of the world.