Incorporating circular economy and resilience principles in the water sector

Session 2. Presentation of case studies and examples of good practices

SCHEDULE AND CONTENTS

TIME	SESSION
9:00 – 10:30	**Session 1. Overview of the principles of circular economy and resilience in the water sector** ▪ Presentation of the Water In Circular Economy and Resilience (WICER) Framework ▪ Is your project WICER? Use the WICER quick assessment online tool ▪ Discussion by table and reporting to the whole group
10:30 – 11:00	Coffee break
11:00 – 12:30	**Session 2. Presentation of real case studies and examples of good practices** ▪ Presentation of cases showcasing different approaches to circular economy ▪ Discussion by table and reporting to the whole group
12:30 – 13:30	Lunch break
13:30 – 15:00	**Session 3. Interactive session to prioritize and apply the WICER principles** ▪ Presentation to set up the scene ▪ Hands-on exercise to prioritize WICER interventions to solve a challenge working in teams
15:00 – 15:30	Coffee break
15:30 – 16:45	**Session 4. The importance of the right Policy, Regulation and Institutional Environment and Stakeholder engagement** ▪ Presentation to set up the scene ▪ Presentation on the Australian example ▪ Hands-on exercise on PIR and stakeholder mapping exercise.
16:45 – 17:00	Closing and next steps

Improving Resiliency, Sustainability and Efficiency in Uruguay´s National Water Supply and Sanitation Company

Uruguay OSE (State Water Utility) Sustainable and Efficient Project

CIRCULAR ECONOMY ACTIVITIES

Enhancing Resilience:

- rebuilding two water treatment plants to protect against periodic floods
- Enhancing the water intake at a third plant by increasing redundancy and incorporating preventive features into the existing system.
- An asset management system and water safety plans were developed, and risk management incorporated in daily operations.

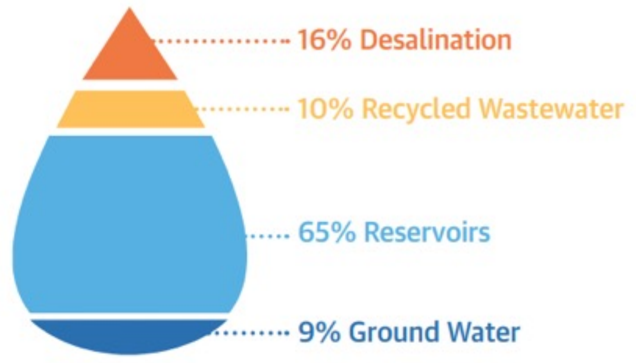
Improving Energy Efficiency & Reducing NRW:

- Cumulative savings of: 89.3 million cubic meters of water and energy savings of nearly 26,250 megawatt hours over the lifetime of the project.

Recovering resources:

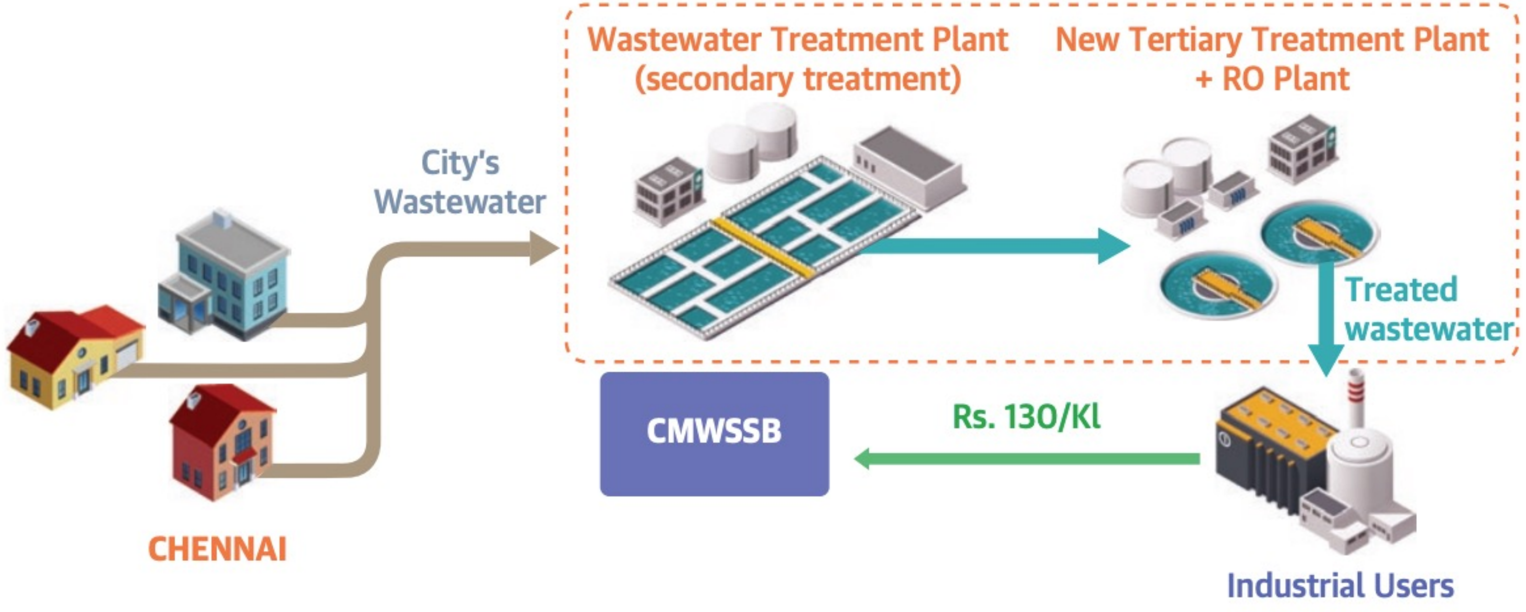
- a prototype for biosolid drying and a process for applying biosolids to fodder crops was developed.

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



Source: CMWSSB, 2020.

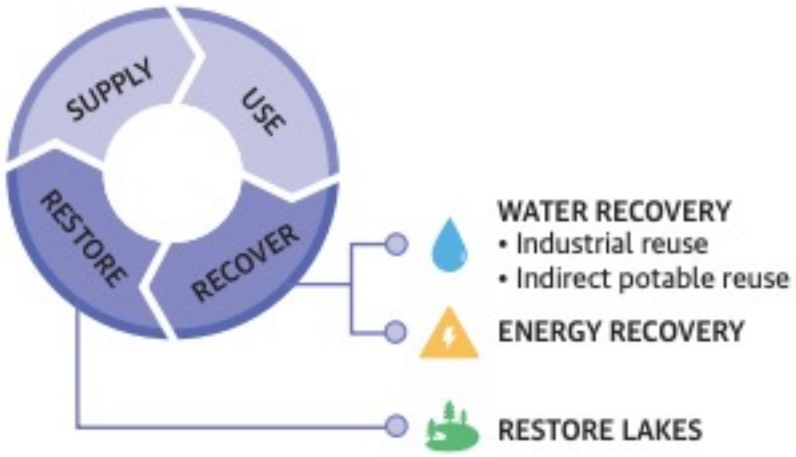
Benefits:
- Tariff for water reused in industry covers O&M costs
- Lower operating costs and decreased risks of water scarcity for industrial users
- Recovering energy in WWTP –50 % of the energy needs of all the plants



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

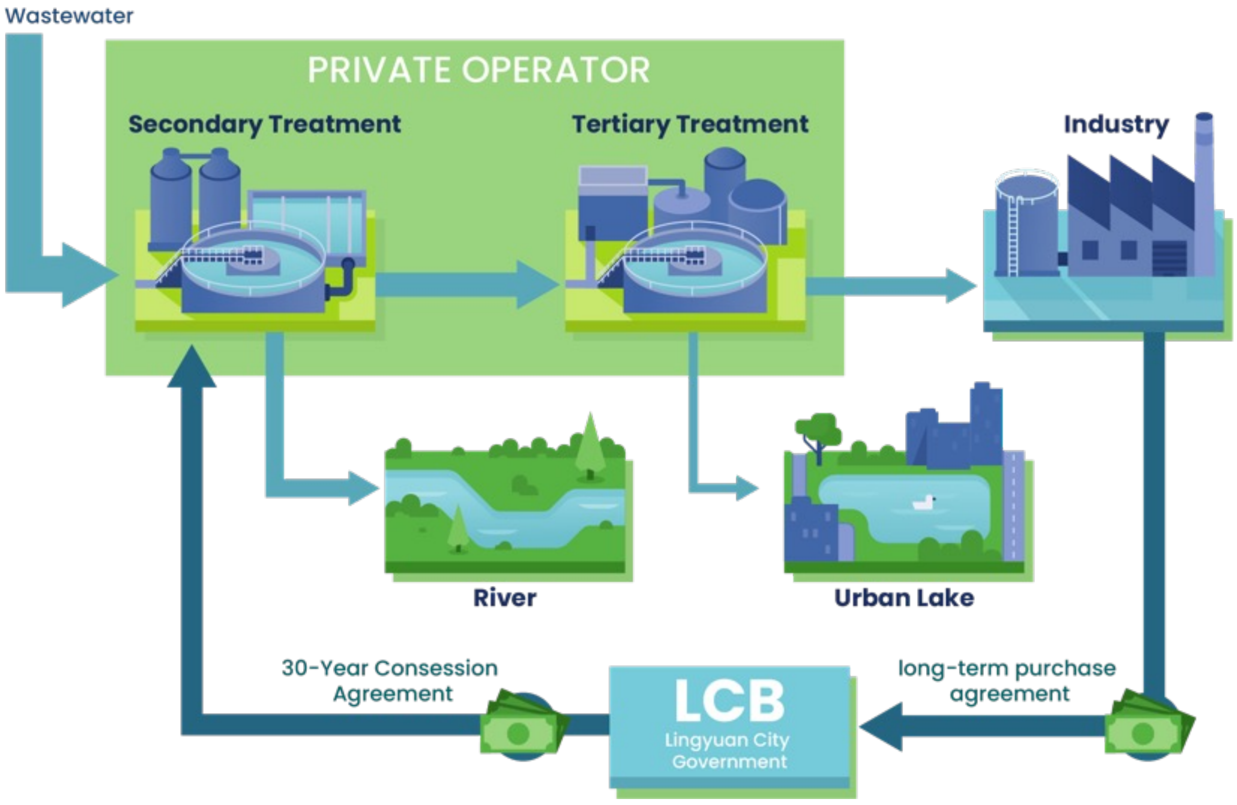
http://www.worldbank.org/wicer

CIRCULAR ECONOMY ELEMENTS



Reusing treated wastewater for industrial purposes and restoration of ecosystems in Lingyuan City, China

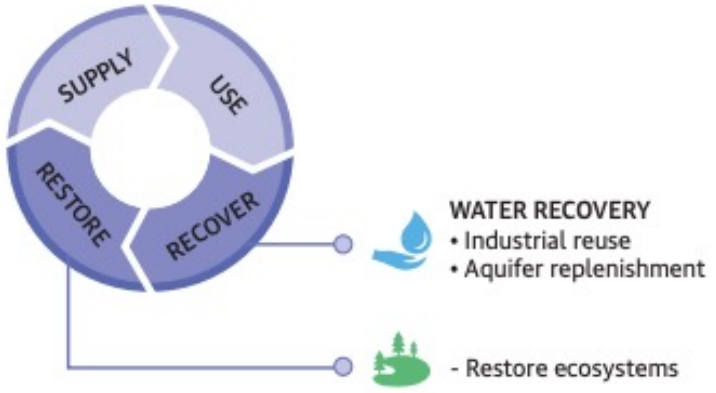
Liaoning Coastal Economic Zone Urban Infrastructure and Environmental Management Project



Benefits:

- Sold treated wastewater covers O&M for municipality
- Lower water tariff for industrial users
- Aquifer protected
- Enhanced urban lake that used to be polluted and dry most of the year – improved biodiversity
- Improved city livability

CIRCULAR ECONOMY ELEMENTS



Uruguay OSE Sustainable and Efficient Project

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Targeted green infrastructure for source-water protection
The case of Espirito Santo, Brazil

The Watershed Management and Restoration of Forest Cover project

Challenges: erosion and sediment pollution, which were spoiling the watershed.

- Identification nature-based upstream solutions
- Implementation of a payment-for-ecosystem services (PES) scheme.
- At the cost of USD 16.2 million, the project paid upstream landowners to reforest, conserve, restore, and manage their land in ways that curbed erosion and kept sediment loads from being deposited into the watershed.

Benefits:

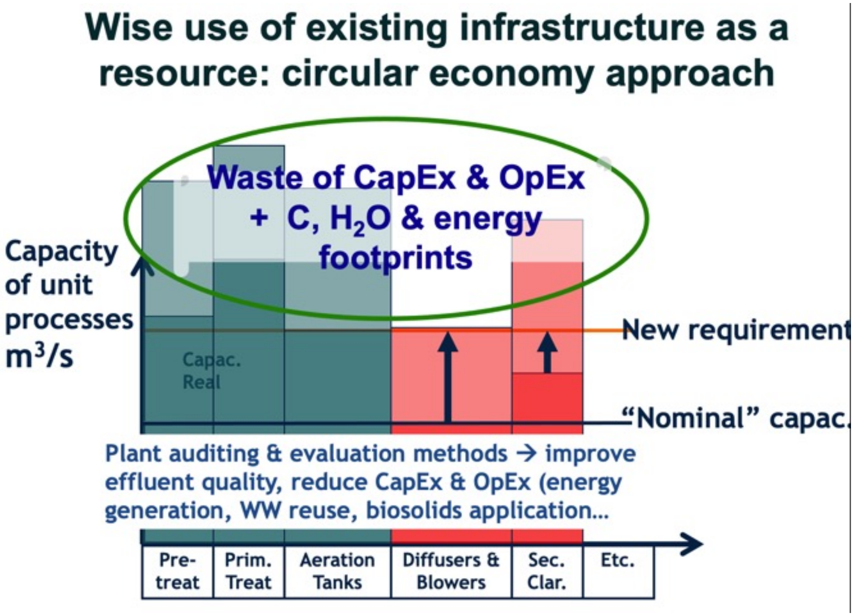
- The estimated economic benefits of these interventions range from USD 13 million to USD 18 million, with an internal rate of return ranging from 12.7 percent to 16.8 percent.
- The water utility CESAN will save a total of R$ 15.5 million over 30 years in avoided costs for new filtering equipment and maintenance.
- Landowners benefit from the PES, from regulatory compliance, and from higher income gained through productive practices.
- The port of Vitória downstream avoids the need for costly new dredging operations.

Optimization of existing wastewater treatment plants in Sāo Paolo, Brazil

- Partnership with the utility's metropolitan sewage unit and WRG
- Implementation of a program to optimize the performance of four major wastewater treatment plants:
  - Instead of investing in expanding or building new plants to increase capacity, the program is conducting a series of audits to define priority actions and investments to eliminate bottlenecks and maximize the efficiency of the treatment process at each plant.

Benefits:

- Improved water quality
- Investments delayed: Optimization of the plants allows the utility to postpone investments in tertiary treatment and reduce investments in physical expansion.
- Improved performance of WWTP
- Preliminary results show enormous savings for the utility, SABESP



Tunisia: Increase of treated wastewater reuse in Tunis, Tunisia

Northern Tunis Wastewater Project

- Improved quality of treated wastewater reused for irrigation at Borj Touil
- Successful pilot at Sidi Armor (vegetated filter and maturation tank), laboratory and demonstration site
- Agreement signed: clear roles and responsibilities to manage TWW and infrastructure
- Plans for reuse towards green space irrigation (golf course and gardens) in new urban development

Maturation tank of TWW at Sidi Armor.

Farmer irrigating his agricultural plot with TWW.

Rose garden irrigated with TWW.

WICER in practice

the example of Senegal

- Upstream analysis
- Policy dialogue
- Existing practices
- Scale up through investment

WATER SECURITY KEY FACTS IN SENEGAL

Senegal is already water stressed and current water withdrawals are projected to increase by 30 to 60 percent by 2035

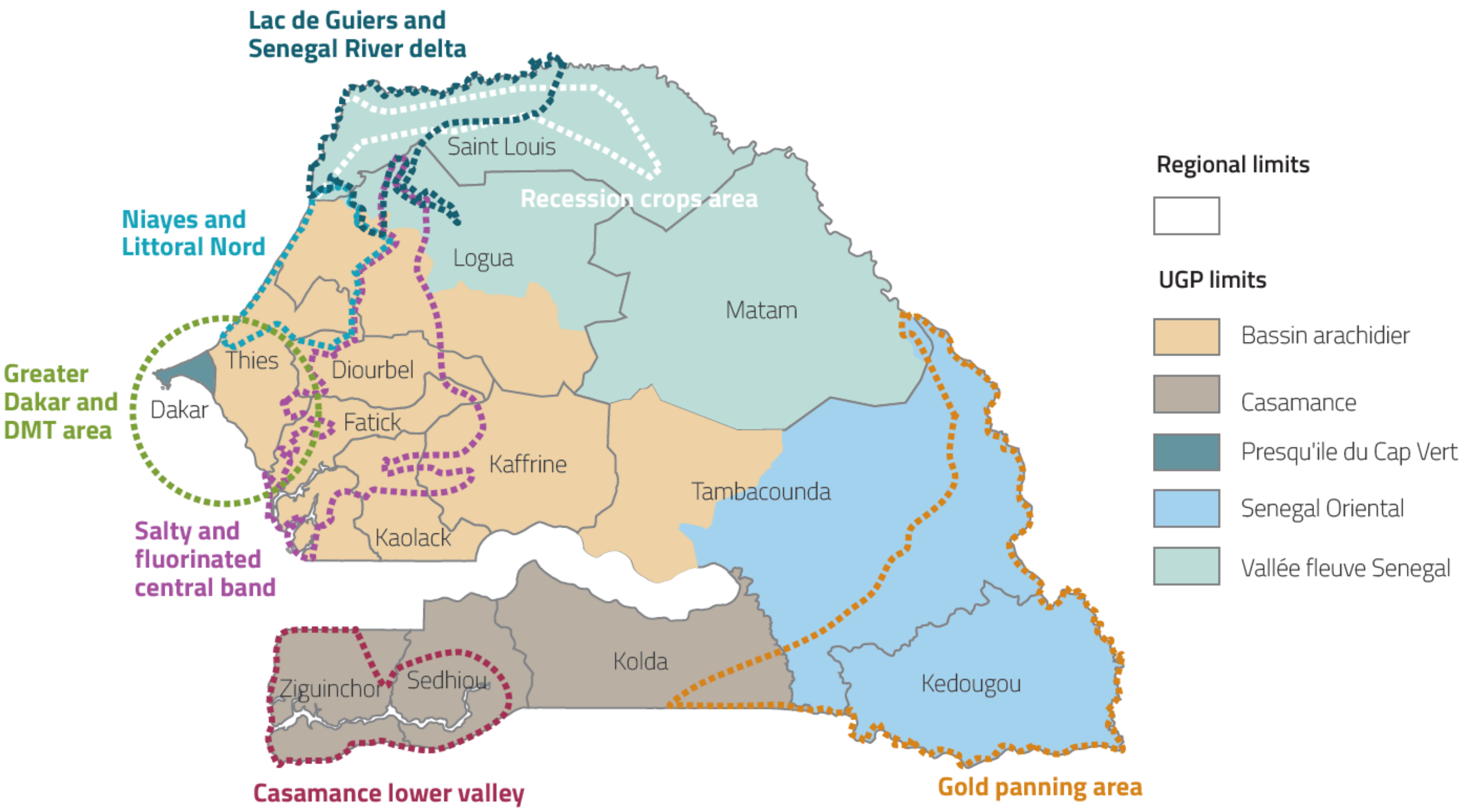
Water-related extreme events and pollution already cost Senegal over 10 percent of GDP every year, **threatening the country's ambition to become an emerging country**, even more so following the COVID-19 pandemic

The Dakar area is especially at risk, concentrating 50 percent of Senegal's GDP production and close to a third of its population, and will need to diversify water sources and improve cross-sectoral coordination

Senegal urgently needs to prioritize water security to achieve and sustain its development objectives (PSE)

Upstream analytical work

Senegal Water Security Study



CIRCULAR ECONOMY FOR WATER SECURITY IN GREATER DAKAR

Increase access to safely managed WSS services

(Opportunities to capitalize on good experiences with PPPs in urban water)

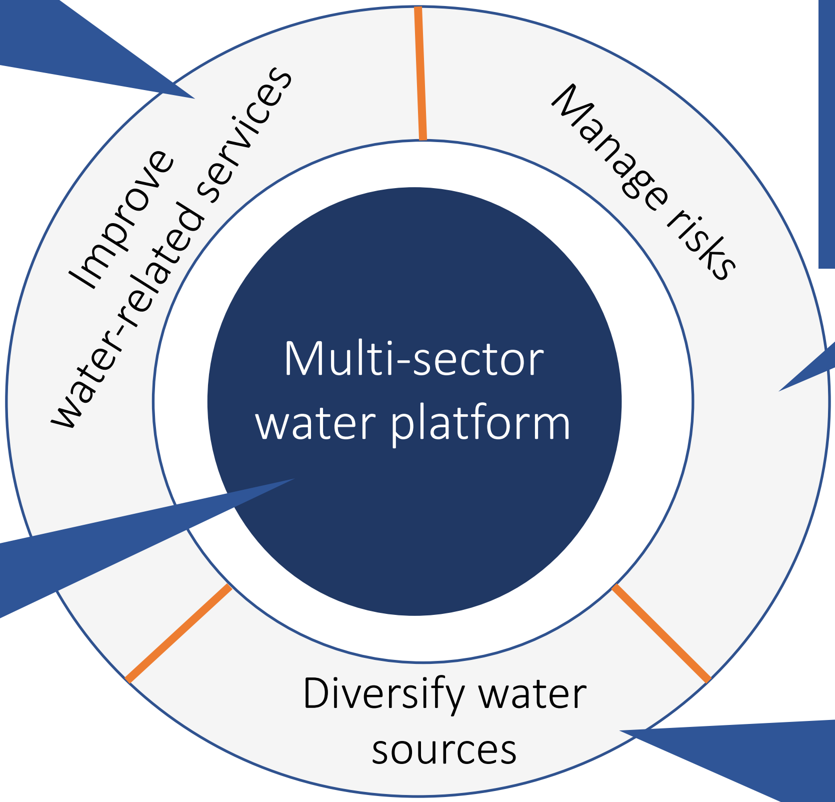
Safeguard important irrigation areas

Urban planning

Flood management

Wetlands protection

Drought mitigation



Without clearer regulation, circular economy principles cannot be applied successfully

Demand management

Protection of existing resources

Wastewater reuse

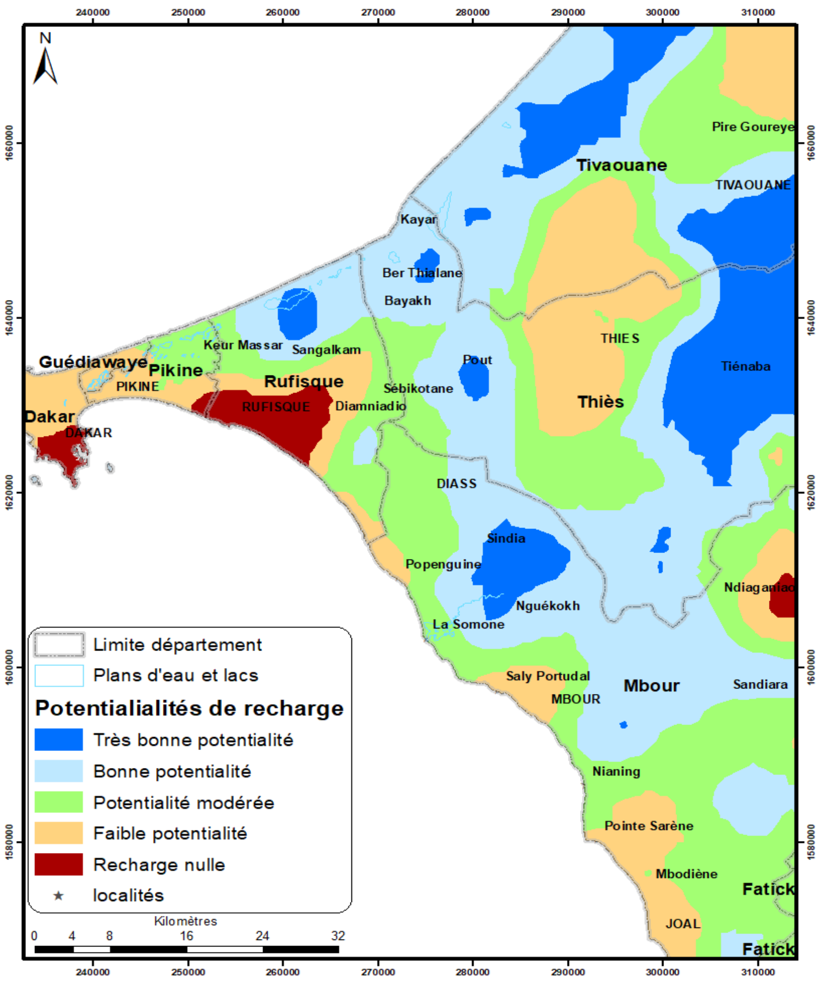
Desalination

Groundwater protection

Water security in Greater Dakar also depends on the implementation of the institutional measures recommended at the national level.

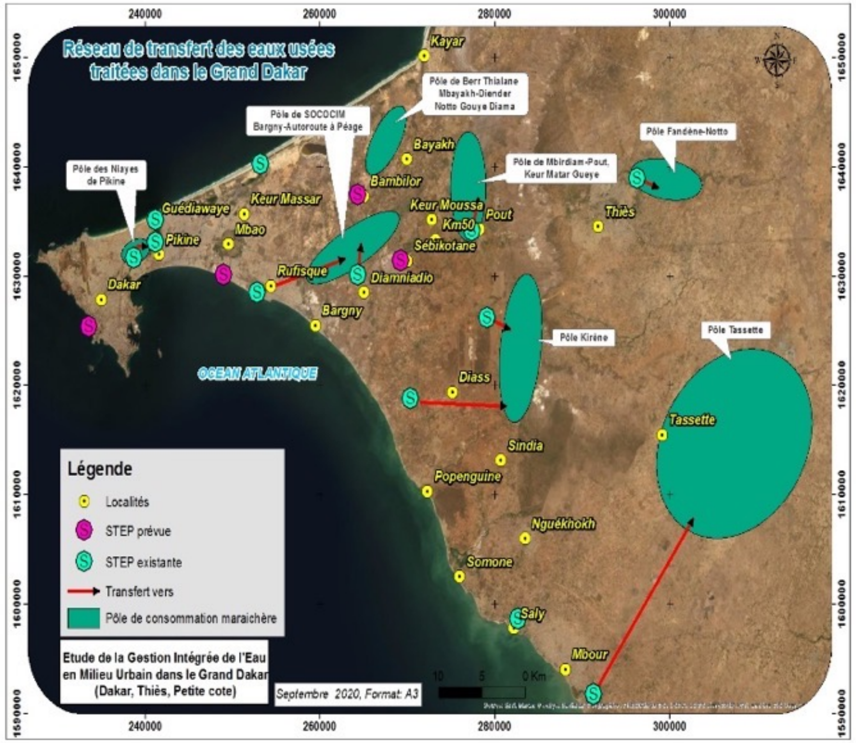
PROPOSED SOLUTIONS FOR WATER SECURITY BY 2050

Areas with artificial recharge potential (treated wastewater)



Water transfer scenarios (15 to 20 m^3/s) between 2035 and 2050

Treated wastewater reuse strategy



Policy dialogue and enabling environment

Advice to on revision of Water and Sanitation Codes

Dialogue on regulating reuse and scaling up existing pilots

Engagement with different stakeholders across water, sanitation, agriculture and industry

Planned development of a circular economy strategy

Documenting existing practices - GREATER DAKAR, SENEGAL

Over 1/3 of Senegal population

Contributes over half of GDP

Produces 60% of horticulture for export

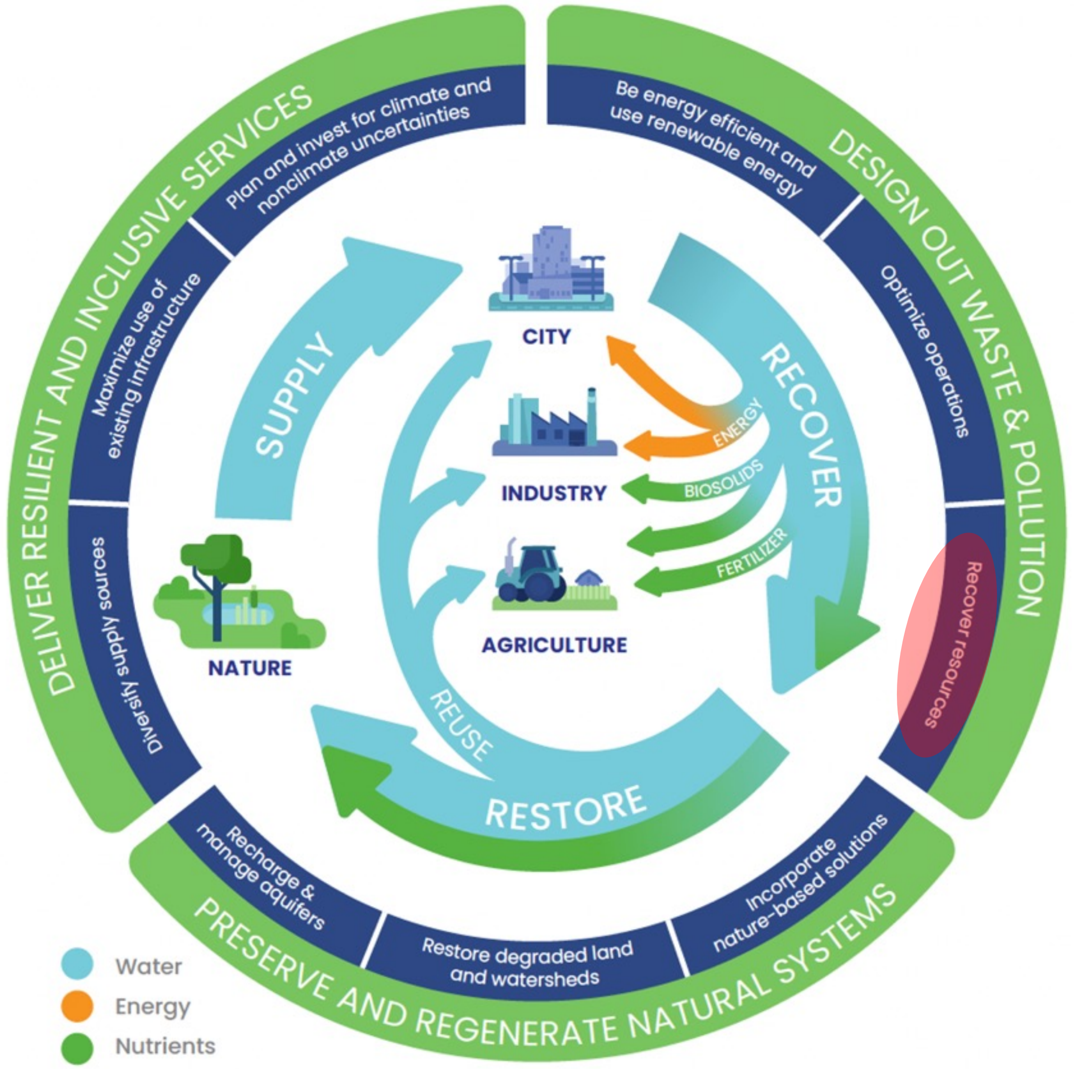
Facing growing water scarcity

Only 28% of wastewater is treated

WASTEWATER REUSE FOR HORTICULTURE

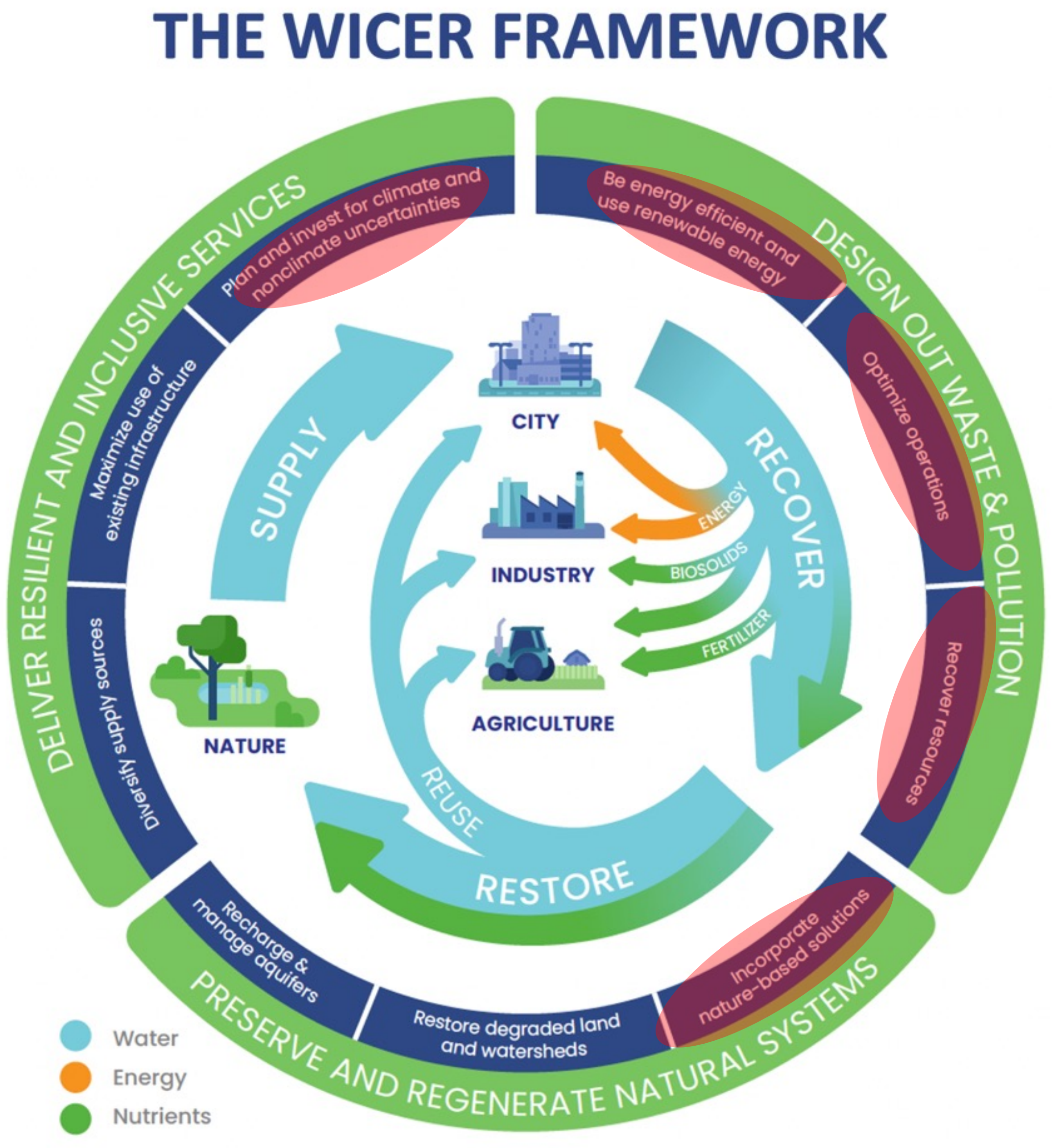
- Growing water shortages in horticulture area
- 5,700 m3/day receive tertiary treatment at Cambérène WWTP
- 3,000 m3/day sold to
  - Private companies ~US$ 0.40/m3
  - Several hundreds of market gardeners ~US$ 0.10/ m3
- Islamic Development Bank (IsDB) project 11,000 m3/day capacity

THE WICER FRAMEWORK



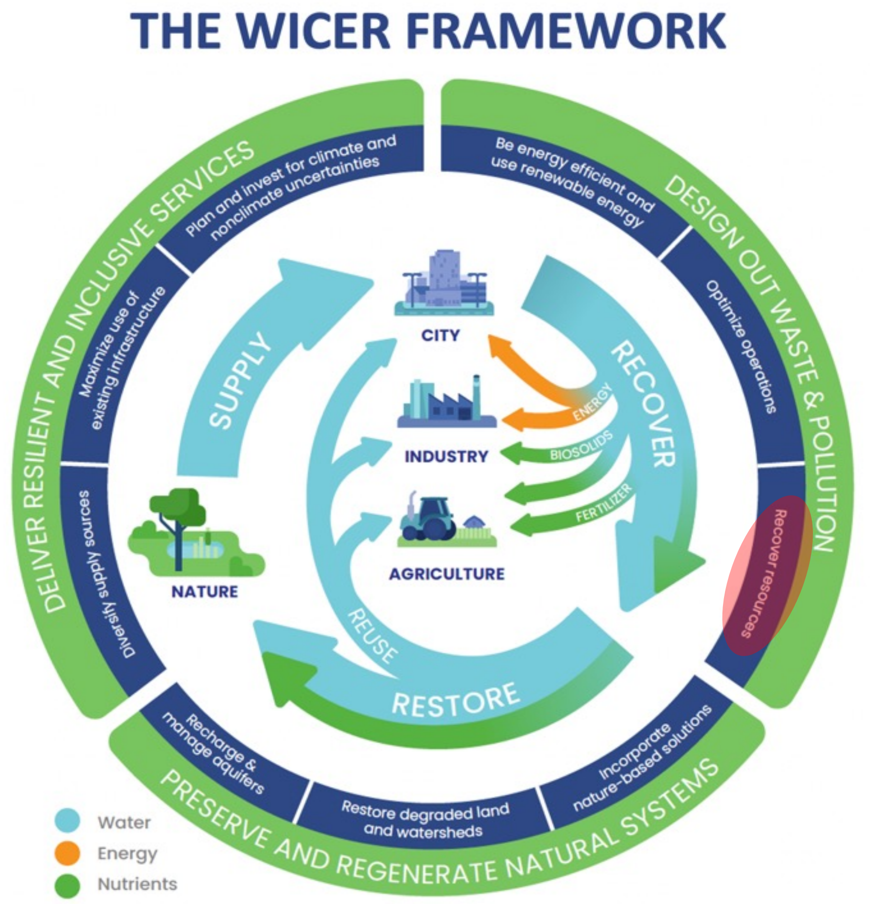
ENERGY PRODUCTION FROM BIOGAS

- Energy costs 12% of production costs
- 35% of biogas collected from WWTP sludge digestion is used to generate electricity
- Currently covers 25% of WWTP energy needs
- IsDB project will expand capacity to 3200 KW
  - Cover over 60% of energy use
  - ~US$ 720,000 per year in potential savings



VALORIZATION AND SALE OF FECAL SLUDGE

- Stabilized sludge is used as soil amendment for green spaces or sold to farmers and flower growers.
- Fecal sludge (FS) reuse included in delegation contract for FSTP management
- Sold ~US$ 1/kg and the profitability threshold has not yet been reached
- Leverage co-location of WWTPs and FSTPs







Senegal Water Security and Sanitation Project

Objective: To promote water security in priority hotspots of Senegal.

Component 1: Diversifying and developing water resources and water availability

Component 2: Improving sanitation and water supply services within a circular economy

Component 3: Improving the provision of irrigation services

Component 4: Strengthening citizen engagement, sector reforms and project management

OTHER CASE STUDIES

CASE STUDY – Integrated wastewater reuse

San Luis Potosi, MEXICO

Challenge and Objective

Challenge:

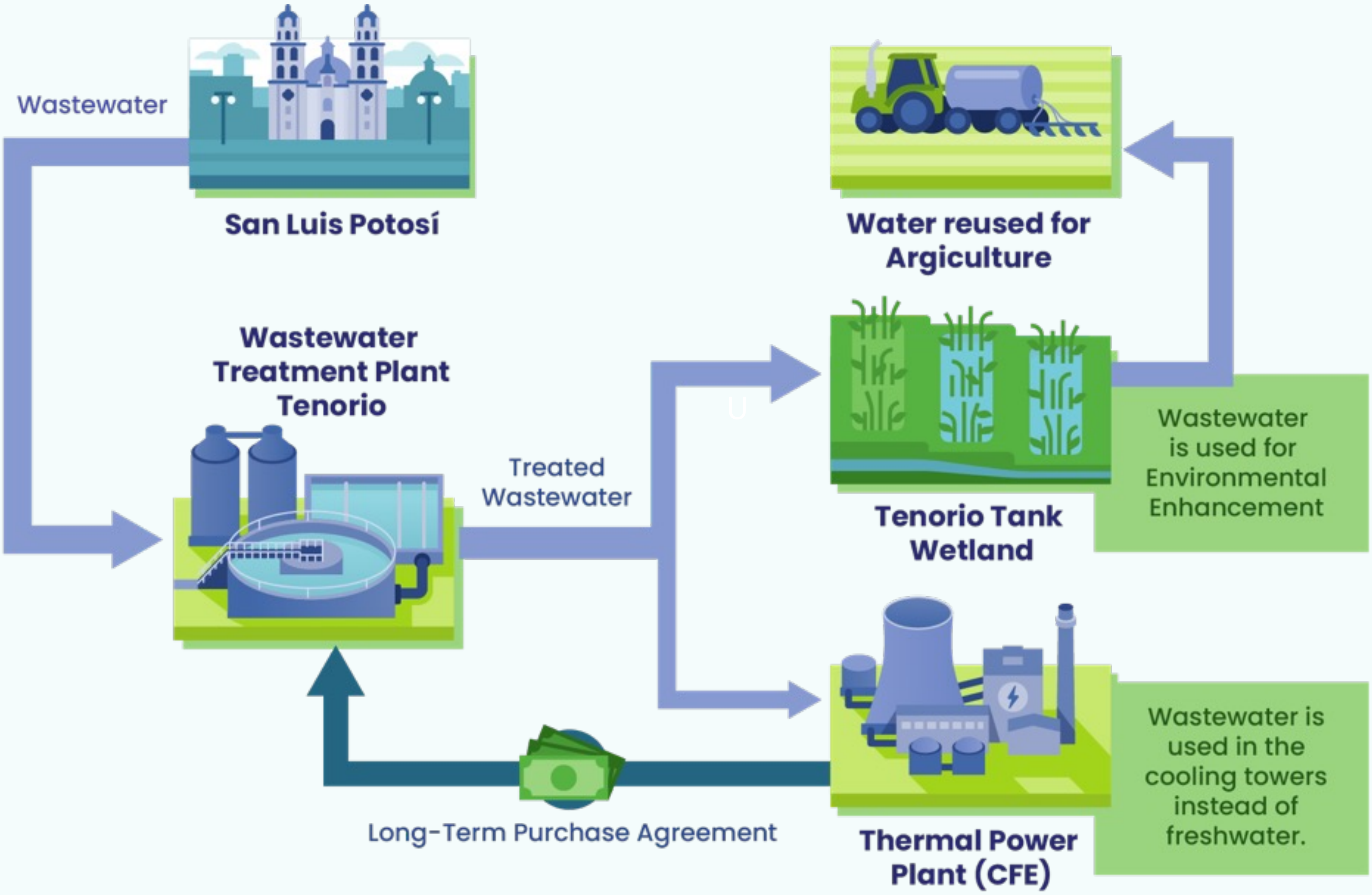
Over-extraction of the aquifer (double of its natural recharge). The economic development and social stability of the area depend on the aquifer.

Low wastewater treatment capacity

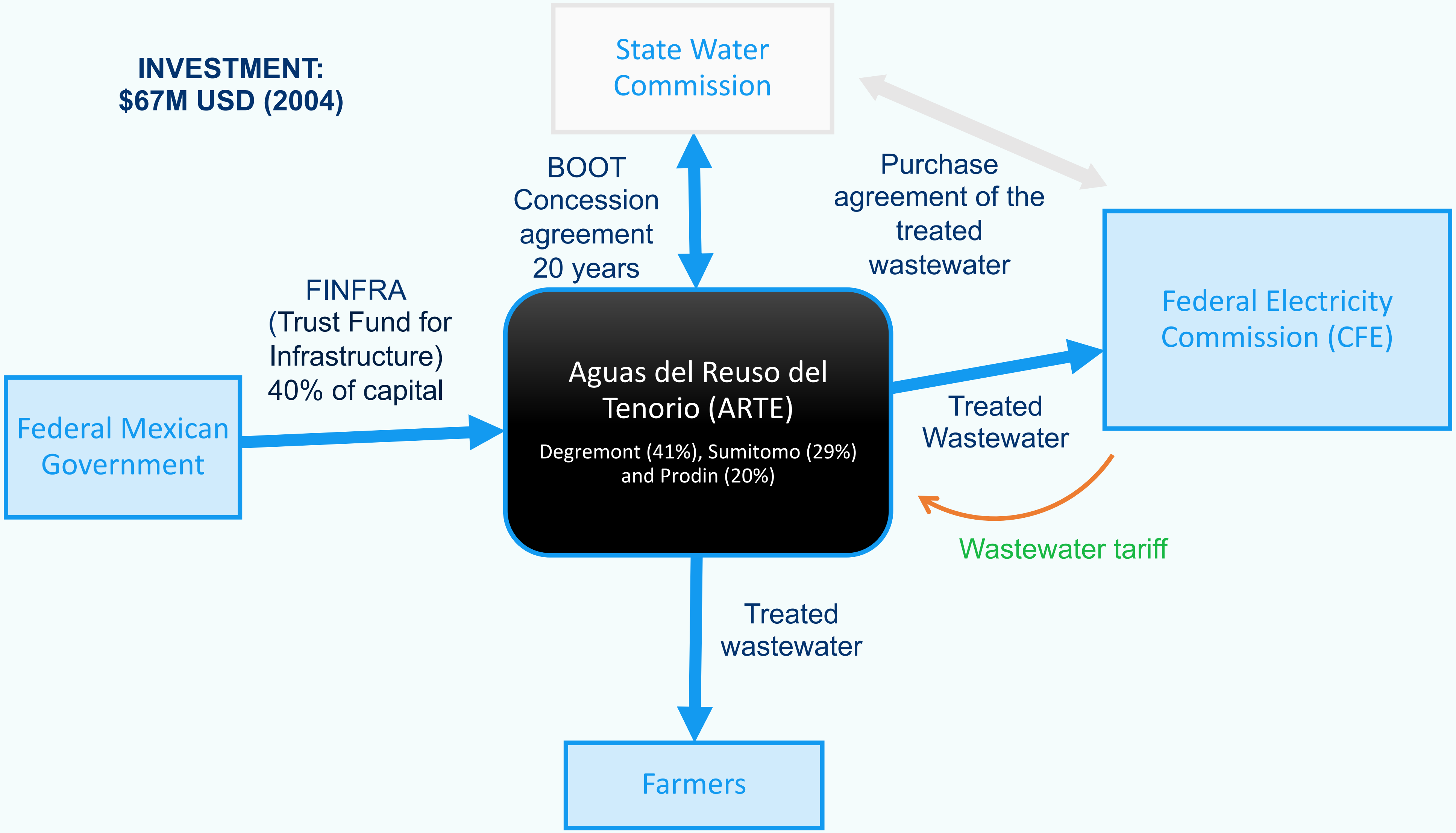
OBJECTIVE:

- Restore the aquifer
- Diversification of water sources – Use of treated wastewater for non potable uses – REUSE
- Increase the amount of wastewater treated
- Health improvement of citizens
- Improve water efficiency in agriculture

Solution: Integrated wastewater management for reuse



Financing and Contractual Arrangements



Benefits

Economic:

- *For the power plant:* The treated wastewater is 33% cheaper, more consistent (quality and quantity) and more sustainable than the groundwater that the power plant used. The power plant has saved $18M in 6 years.
- *For WWTP:* The extra revenue stream covers almost all O&M costs.
- *For the farmers:* Better water quality→ agriculture production increase + crop diversification or higher value crops.

Environmental and Social:

- Aquifer has been restored: Net reduction of groundwater extractions - Preserving 14 Mm3/ year,
- Stabilization pond has been rehabilitated into a natural wetland, preserving biodiversity and providing habitat for wild birds and other animals.
- Wastewater treated - Improved living standard for the population
- Reference case of wastewater reuse, encouraging other industries to explore wastewater reuse

Lessons Learned – Success factors

- Government support and leadership:
  - Federal and State level policies that promote and regulate the use of treated wastewater
  - Local water prices for industry reflect the cost and scarcity of the area incentivizing the use of alternative sources
- Collaboration between different government agencies (energy, water, and different government levels)
- Design of treatment plant with reuse in mind - Multi-quality of treated wastewater tailored for the different uses (fit to purpose)
- Education and raising awareness of uses of treated wastewater

CASE STUDY -
Energy Neutrality, retrofitting an existing WWTP

Ridgewood Village, USA

CONTEXT

- Energy is one of the highest costs for WWTPs
- Electricity costs are usually between 5 to 30 percent of total operating costs (in developing countries it can go up to 40 percent or more).
- Energy efficiency and energy recovery can reduce operation costs and reduce the carbon footprint of WWTPs.
- Biogas generated in WWTPs can be used to produce electricity onsite and therefore reduce electricity costs (especially in places where the price of electricity is high)
- If co-digestion is implemented, energy neutrality in WWTPs can be reached

WWTP in Ridgewood, NJ, USA

Opportunity: methane gas from digesters was previously burned and released into the atmosphere

Goal: Improve the anaerobic digesters and use the biogas to produce enough electricity (renewable energy) to satisfy the power demand of the plant.

Outcome: Improve affordability, resiliency and sustainability of wastewater treatment plant

Solution: retrofit of existing infrastructure through a PPP

The village made a "request for proposal" to design and implement a project that would convert excess methane into usable electricity. Ridgewood Green was chosen.

Ridgewood Green financed and installed liquid waste holding tanks and a biogas generator, and retrofitted the plant's two anaerobic digesters

The methane is collected, cleaned, compressed and pumped into a biogas engine to produce electricity. The excess heat from the engine is used in the anaerobic digester, increasing the plant's efficiency.

Village of Ridgewood

Operates and owns WWTP

Sends sludge to the co-digestion system operated by Ridgewood Green

Buys electricity from Ridgewood Green cheaper than market rates

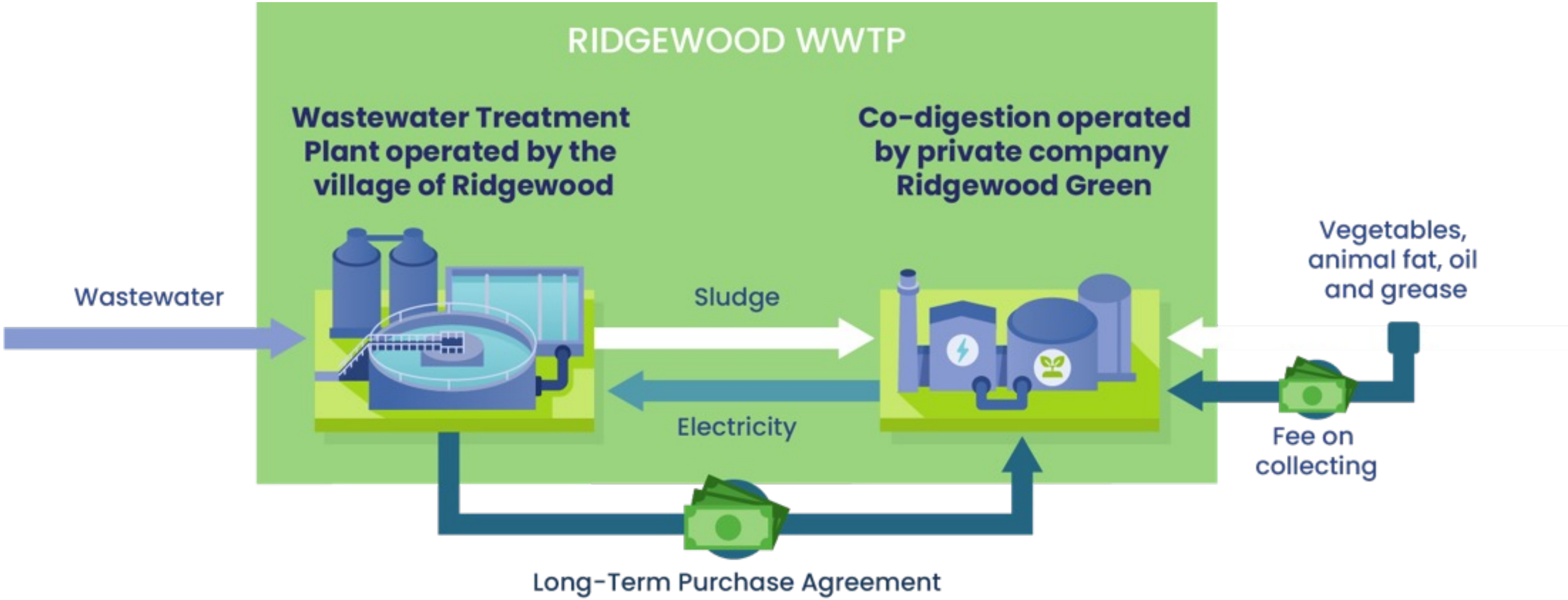
Ridgewood Green

Operates co-digestion and electricity generation system

Financed and installed liquid waste holding tanks and a biogas generator, and retrofitted the plant’s two anaerobic digesters

Collects additional material for the co-digestion system

Gets revenue from electricity sales and tipping fees



Financial and Contractual Agreements

Financed through a PPP between the village of Ridgewood and Ridgewood Green

- Ridgewood Green made the up-front capital investment to retrofit the plant (cost zero and minimum risk for the village of Ridgewood)
- 20 year agreement between RGRME and the village of Ridgewood:
  - The power purchase agreement set a fixed increase rate, establishing the village's price and Ridgewood Green's revenue for the duration of the contract.
  - Ridgewood Green owns the new equipment from investment and the village of Ridgewood owns and operates the plant with technical support from Ridgewood Green
- Revenue model for RGRME (expects to recover investment + reasonable ROI):
  - Selling electricity to the Village of Ridgewood
  - Selling all the renewable energy certificates (RECs) to 3Degrees, a leader in the renewable energy marketplace under an agreement of several years
  - Tipping fees assessed when haulers deliver vegetable and animal fats, oil and grease (FOG) to feed the anaerobic digesters. Proximity incentivizes haulers to dump FOG at Ridgewood's water plant rather than the traditional destinations

Benefits

For the Village of Ridgewood:

- Renewed infrastructure (state-of-the-art)
- No capital Cost to taxpayers
- Savings: Lower operating costs for the WWTP
  - Lower sludge hauling costs
  - Lower electricity costs
- More resilient – not affected by electricity price surges (locked price for 20 years)
- Lowers the Village carbon footprint

For Ridgewood Green:

- Showcase solution as an example of sustainability in WWTP (won the Biogas Project of the Year by the American Biogas Council and Environmental Achievement Award)
- Risk mitigation: The power purchase agreement set a fixed increase rate, ensuring Ridgewood Green's revenue for the duration of the contract.

For the environment:

- reduction of GHG emissions

Success – Key Factors

Stakeholder engagement

- 20-year partnership: lowering risks and ensuring revenue for the capital investor (Ridgewood Green)
- Ridgewood Green was formed to leverage each organization's respective financial capacities and technical expertise: Natural Systems Utilities (NSU), Middlesex Water Co. (MSU), and American Refining and Biochemical

Technical innovation:

- Re-use of existing infrastructure
- optimization of the anaerobic digestion process with the addition of an enzyme product which increases biogas production
- Co-digestion: the production of electricity is enhanced when food wastes such as fats, oils and grease are introduced into the process.
- Use of solar panels to achieve 100% renewable energy use in the plant

Creative and diversified new revenue streams:

- Revenue from: electricity sales to WWTP, fees from haulers and renewable energy certificates (RECs) to 3Degrees

CASE STUDY -
Wastewater reuse for industry - mining

Arequipa, Peru

Context: Arequipa, Peru

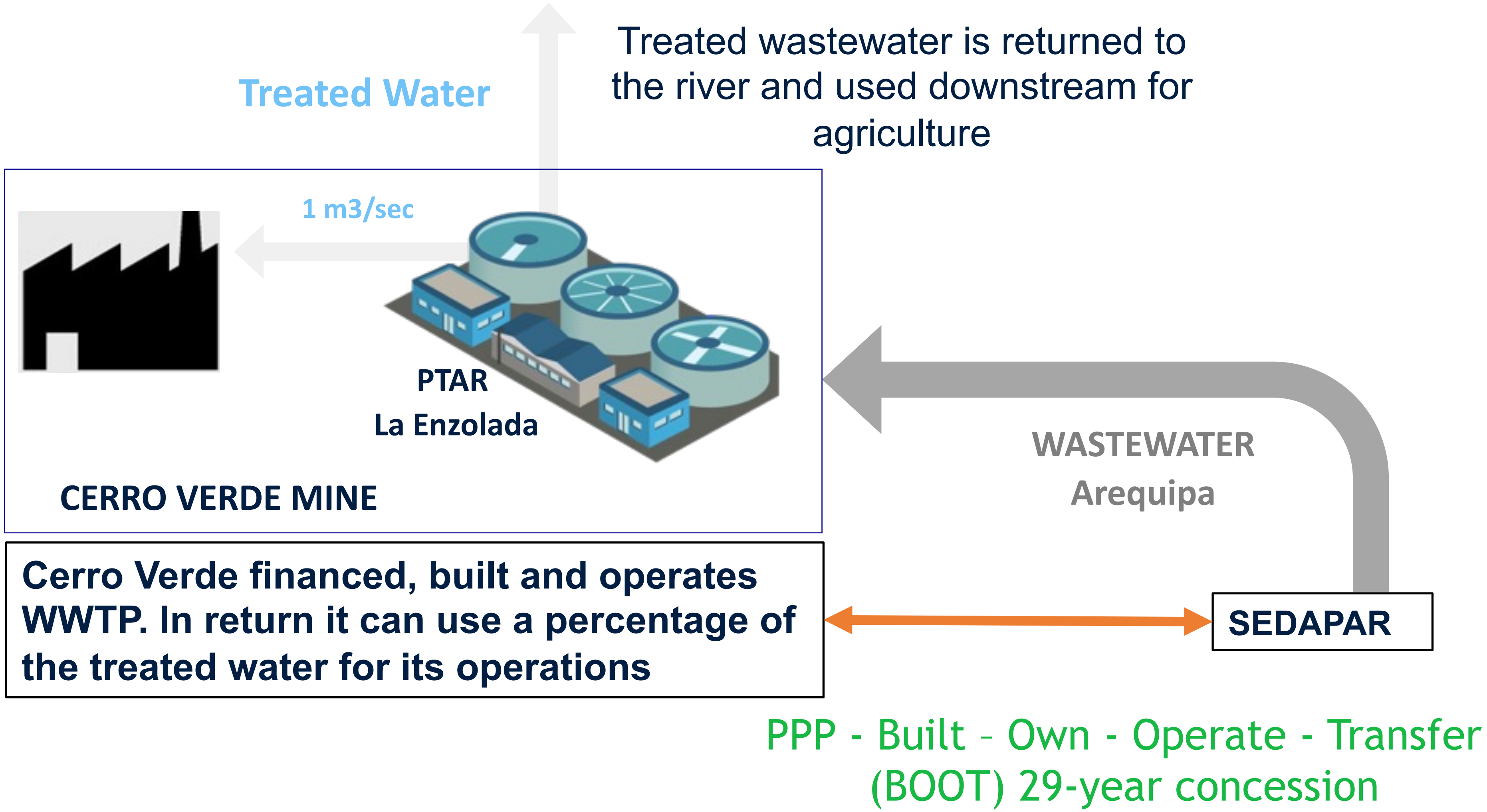
Challenge:
- Water scarce region
- Wastewater from Arequipa untreated and polluting the river Chili
- Cerro Verde, the largest copper mine in Peru, was planning a large-scale expansion that required access to additional water supply.

Cerro Verde explored several options, such as using desalinated seawater or water from faraway aquifers.

Utilizing wastewater from the nearby city of Arequipa turned out to be the most sustainable and economical solution.

A potential Win-Win solution for the mine and Arequipa

SOLUTION: PPP for wastewater reuse



Benefits

- For SEDAPAR:
  - 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
- 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.

Lessons learned

Fotos: Jose Luis Valverde

- **Stakeholder Engagement is Key:** By working collaboratively with local stakeholders, Cerro Verde and SEDAPAR identified an opportunity to meet both a business and a social need.
- **Favourable National PPP Regulations can Foster the Development of Waste-to-Resource Projects.** The participation of private companies in waste-to-resource projects can reduce the economic and financial burden on local utilities and at the same time generate social and environmental benefits.
- **Water Scarcity Encourages Water Reuse** especially where the cost of tapping the nearest water source is high

CASE STUDY -
Generation and sale of biogas

La Farfana, Chile

Context: La Farfana, Santiago de Chile

Challenge in early 2000s

- Only 3.6% of the wastewater of the city of Santiago was treated
- Released untreated water polluted Mapocho river, an important source of irrigation and potable water for the region

LA FARFANA

- Largest WWTP in Latin America at that time
- Served Population: equivalent of 3.3 million people
- Capacity: 8.8 m^3/s
- Operated by: Aguas Andinas
- Treatment Type: Conventional activated sludge
- 8 anaerobic digesters

Background: La Farfana, Santiago de Chile

Generation of 25 million m^3/year of biogas

Biogas burned: 19 million m^3/year

OPPORTUNITY!
Available Biogas

Used biogas in the WWTP for boiler: 6 million m^3/year

2001
Construction of La Farfana starts

2002
MoU between Aguas Andinas and Metrogas

2003
La farfana opening

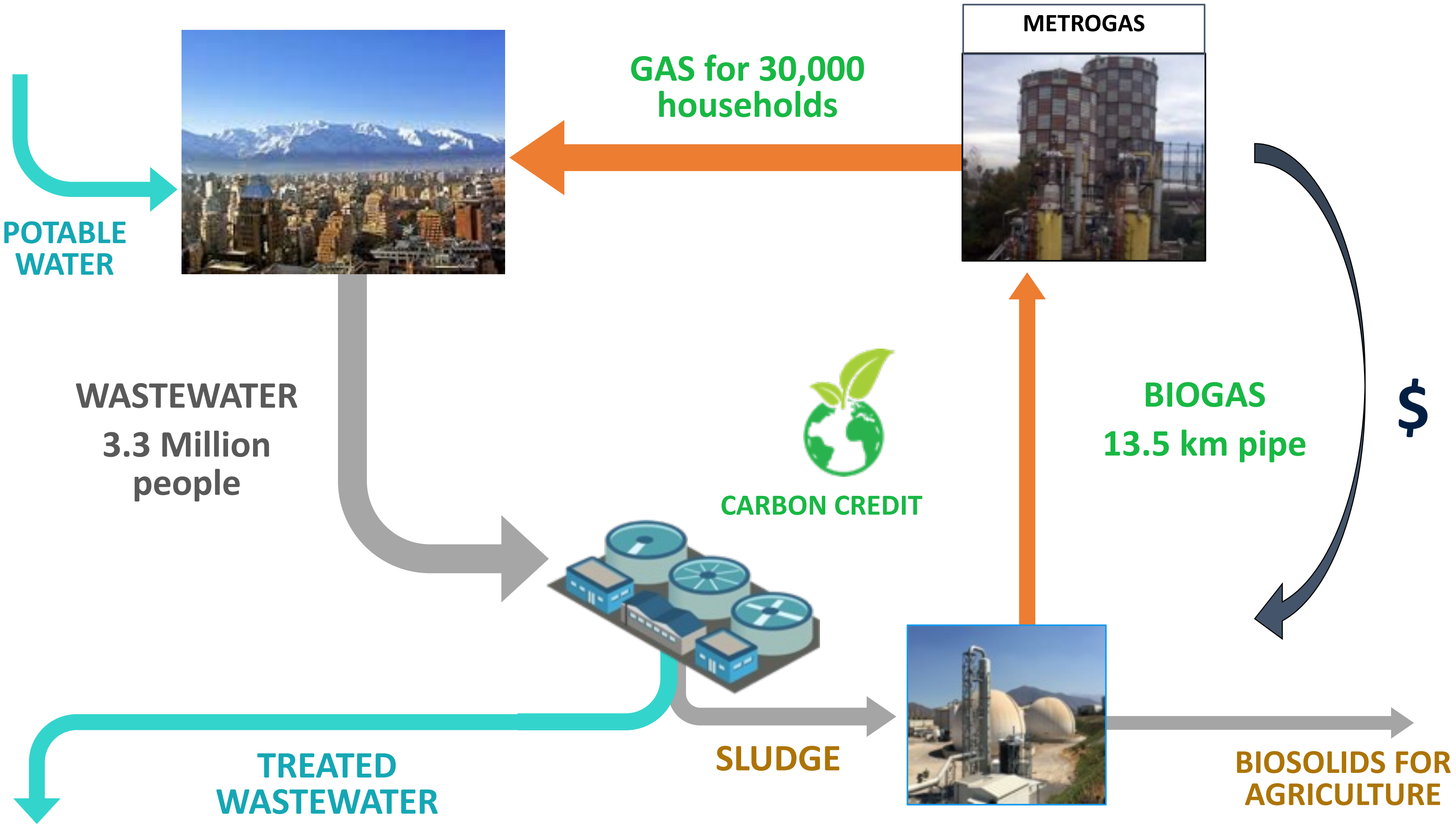
Feasibility and environmental impact assessment

2007
Joint Venture signed

Construction required infrastructure

2009
Biogas Project starts operating

Solution: Project Biogas



Financial and Contractual Agreements of the Project

Investment: total cost 6M USD, divided equally

- Grupo Aguas: investment to improve biogas catchment and treatment (treat sulphites and modify pressure, humidity and temperature)
- Metrogas: investment for the gas pipeline (13.5 Km) and biogas final treatment (to remove siloxanes)

Conditions of the Joint Venture Sale/Purchase Agreement in 2007 :

- Fixed price for the biogas, indexed to the price of oil
- The energy value of the biogas is measured in situ, to ensure its quality
- A minimum volume of biogas is guaranteed per trimester (take or pay contract)
- Agreement for 6 years, renewable

Fuente: SUEZ Environnement

Benefits

Economical:

- *For the WWTP*: additional revenue from biogas and carbon credits (investment recovered in less than 4 years), and allows it to access the green bond market
- *For the gas distributor:* biogas is cheaper and more sustainable and reduces the dependency on imports
- *For the farmers: using* biosolids has reduced the use of fertilizers by around 50%, reducing fertilizer costs.

Environmental and Social:

- Reduction of local pollutants (MP, NOx, COV, Az)
- Reduction of global pollutants: Reducing GHGs emissions by burning biogas, given that it replaces gas (with its transportation costs)
- Energy Sustainability
- Harnessing local resources
- Creation of “know-how”

Lessons Learned

- The Biogas Business Model Can Be Profitable for All Parties If Designed Correctly
- Water sector regulation can foster innovation
- Long-term agreement among stakeholders
- The Spill-Over Effect: The Biofactoria Concept

BIOFACTORIA

100% treated wastewater

0 waste

0 GHG emissions

0 environmental impact