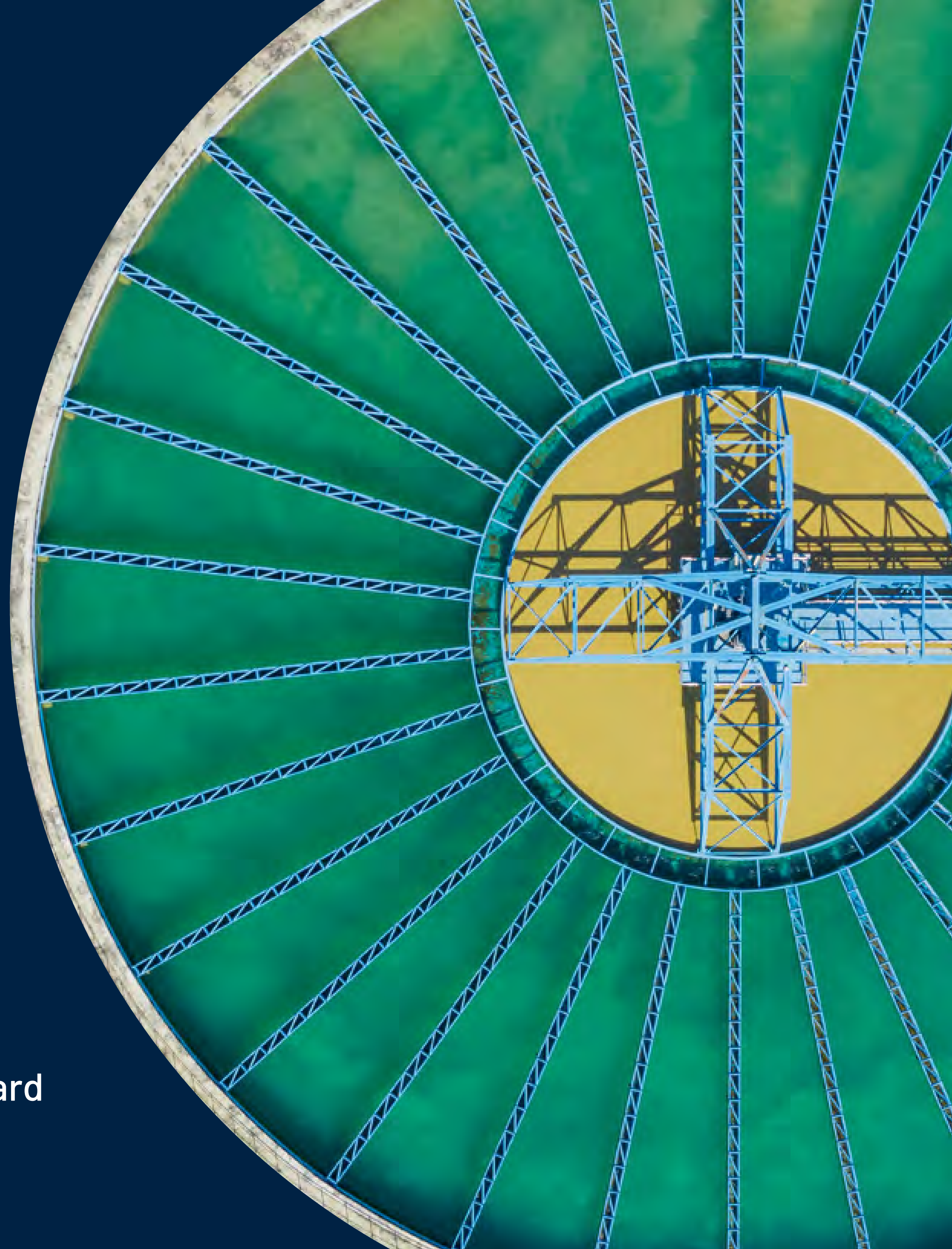
WORLD BANK GROUP

Scaling Water Reuse:

A Tipping Point for Municipal and Industrial Use

Rochi Khemka and Rolfe Eberhard



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FOREWORD

Water reuse is no longer a marginal consideration; it is a strategic necessity. Around the world, cities and industries are under growing pressure from water scarcity, pollution, and climate stress. The treatment and reuse of used water offers a powerful and practical response—a dependable source that enhances water security, supports economic development, and strengthens climate resilience.

Cities and industries generate nearly 1 billion cubic meters of used water each day, much of it untreated and discharged into the environment. Capturing and purifying this water to meet municipal and industrial needs can reduce pressure on freshwater sources, lower pollution, and unlock new investment opportunities. With the right policies and financing structures in place, used water can become a cornerstone of a more resilient and circular water economy.

This report, *Scaling Water Reuse: A Tipping Point for Municipal and Industrial Use*, is the result of a joint effort by the World Bank, the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA). It reflects close collaboration with various institutions and builds on extensive consultations with governments, utilities, private water users, and financiers. Together, these partners are shaping a common vision for embedding reuse into national and local water strategies, anchored in strong public leadership and supported by private sector expertise and capital.

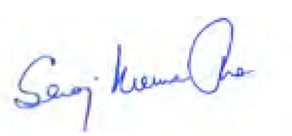
The case for scaling reuse is compelling. It is often more cost-effective than desalination or long-distance transfers, especially where collection and treatment infrastructure exists and where used water is available close to the point of reuse—such as for urban centers and industrial parks. As such, reuse should be considered part of a broader portfolio of water solutions, in conjunction with other demand-side and supply-side water management solutions. When water is properly valued and full lifecycle costs for various supply alternatives are considered, reuse stands out as both an economically sound and environmentally sustainable solution. Moreover, reuse as a solution can be promoted across the public sector and private sector, as well as at the national, municipal, and local levels.

Yet current adoption remains limited. As of 2024, global reuse across all applications accounts for only 12% of municipal freshwater withdrawals, and just 3% of potable and industrial use. Moving from isolated projects to sustained, large-scale programs will require a significant shift in how reuse is financed, delivered, and governed.

This report identifies five key transitions to enable that shift: (1) appropriately valuing clean water; (2) prioritizing high-value applications; (3) normalizing the creation and use of 'new' water; (4) advancing programmatic, platform-based approaches; and (5) mobilizing private innovation and finance. Taken together, these actions could unlock up to US$340 billion in investment and increase reuse capacity eightfold by 2040.

Realizing this ambition will require a coordinated effort. Governments must provide regulatory clarity, establish economic incentives, and invest in the enabling infrastructure. The private sector plays a vital role as a user, financier, and solution provider. Through policy engagement, technical assistance, and financial instruments, the World Bank Group is committed to helping bridge these efforts, building the conditions for viable, scalable reuse markets.

This report comes at a critical moment. Water reuse is not a solution of the future—it is a solution for today. With the right frameworks and partnerships in place, it can become a defining feature of how we secure clean, reliable water for generations to come.



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PREFACE

This report makes a case for scaling investments in the treatment of used water[1] to make it fit for purpose for municipal and industrial use, turning 'waste' water into valuable 'new' water. The report sets out the business case for these investments and outlines roadmaps for governments and the private sector to achieve this transition to sustainable water use.

Investments in 'new' water[2] are critical to support water service delivery to all sections of the population and to enable job creation and economic development in municipal and industrial contexts. This document aims to advance such investments through the efforts of the public and private sectors, and, where appropriate, those of the World Bank Group.

It focuses on the creation and shaping of markets by the public sector to unlock private sector investments in and contributions to 'new' water, encompassing the role of the private sector as water users, solution providers, and financiers. This requires key public sector contributions toward setting and enforcing rules related to water abstraction, discharge, and water quality; creating financial and economic incentives through the design of markets and pricing; and investing in public infrastructure to shape the supply side of the market.

A core focus of the report is on the generation of 'new' water for municipal water systems and industrial users. This is because the business case for reuse is strongest when used water is available close to the point of use, which tends to be the case for urban centers and industrial parks. Agricultural reuse may be relevant in specific contexts with cost-reflective irrigation tariffs and where such use is planned in close proximity to the availability of used water. However, this is not the focus of this document.

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1 This 'used' water is conventionally called 'wastewater,' suggesting it has no value. This report has adopted new terminology to emphasize the intrinsic value of this source of water.
2 'New' water refers to purified used water.

ACKNOWLEDGEMENTS

This report is co-authored by:

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It is a joint output of the **World Bank, International Finance Corporation,** and **Multilateral Investment Guarantee Agency.**

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The report has received editorial support from **Natasha Skreslet and Amanda Green** (Communications Consultants, World Bank) and stakeholder coordination support from **Ekaterina Ghosh** (Junior Professional Associate, World Bank WRG).

The team is grateful for external support from **Christopher Gasson,** Publisher, Global Water Intelligence. In addition, Singapore's Public Utilities Board served as a co-contributor to the case study on Singapore. In addition, the team consulted **various national, state, and municipal governments, water utilities, financial institutions, industrial water users, multilateral development banks,** and others in the process of developing the document, along with over 20 task teams across the World Bank Group that have engaged on reuse initiatives.

The peer reviewers for this activity included technical specialists across the World Bank Group and an external client, to whom the team expresses its sincere appreciation (in alphabetical order):

- **Canan Yildiz,** Senior Water Resources Management Specialist, World Bank
- **David Savage,** Manager, MIGA
- **Klaus Oppermann,** Senior Economist, World Bank
- **Markus Pohlmann,** Senior Counsel, World Bank
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Ministry of Finance Hungary

The team expresses its appreciation to the Governments of Hungary and Japan for their support to this activity.

KEY MESSAGES

1. **Cities and industries are already at risk** from an insecure water supply, **impacting livelihoods, jobs, and economic growth.**
2. Reuse can serve as an **insurance strategy** against water insecurity.
3. As such, reuse should be **considered part of a portfolio of options** for water security, alongside other water demand and supply-side management strategies.
4. Yet the **current levels of potable and industrial reuse** (at 53 million cubic meters per day) represent **only 3% of freshwater withdrawals for the municipal sector.**
5. **Reuse is at a tipping point:** accelerating **investments in reuse** can **develop the market, drive down costs, and spur innovation and commercial finance.**
6. **Impact at scale** can unlock **investments of up to US$340 billion over 15 years,** with **reuse capacity** for potable and industrial use **growing annually at 14%.**
7. The World Bank Group can support the **standardization of approaches** to drive scale, similar to Scaling Solar, through the **Scaling ReWater package of support.**

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LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BRL	Brazilian Real
CO_2	Carbon Dioxide
DBFOT	Design-Build-Finance-Operate-Transfer
DBO	Design-Build-Operate
DPR	Direct Potable Reuse
DWS	National Department of Water and Sanitation (South Africa)
EFR	Environmental Flow Requirements
EIP	Eco-Industrial Park
EPC	Engineering-Procurement-Construction
ESG	Environmental, Social, and Governance
ETS	Emissions Trading Scheme
EU	European Union
GDP	Gross Domestic Product
GW	Gigawatt
GWI	Global Water Intelligence
HAM	Hybrid Annuity Model
IBRD	International Bank for Reconstruction and Development
ICAP	International Carbon Action Partnership
IDA	International Development Association
IEA	International Energy Association
IFC	International Finance Corporation
IPR	Indirect Potable Reuse
ISTP	Independent Sewage Treatment Plant
JV	Joint Venture
kl	Kiloliter
km	Kilometer
kWh	Kilowatt Hour
l/s	Liters per Second
M^3	Cubic Meters
ML	Megaliter
MIGA	Multilateral Investment Guarantee Agency
NHFO	Non-Honoring of Financial Obligations
O&M	Operations and Maintenance
PCG	Partial Credit Guarantee
PFAS	Per- and polyfluoroalkyl Substances
PMR	Partnership for Market Readiness
PPP	Public-Private Partnership
SLF	Sustainability-Linked Financing
SPV	Special Purpose Vehicle
STP	Sewage Treatment Plant
UPW	Ultra Pure Water
US$	United States Dollar
WRC	Wastewater Reuse Certificate
WRG	2030 Water Resources Group

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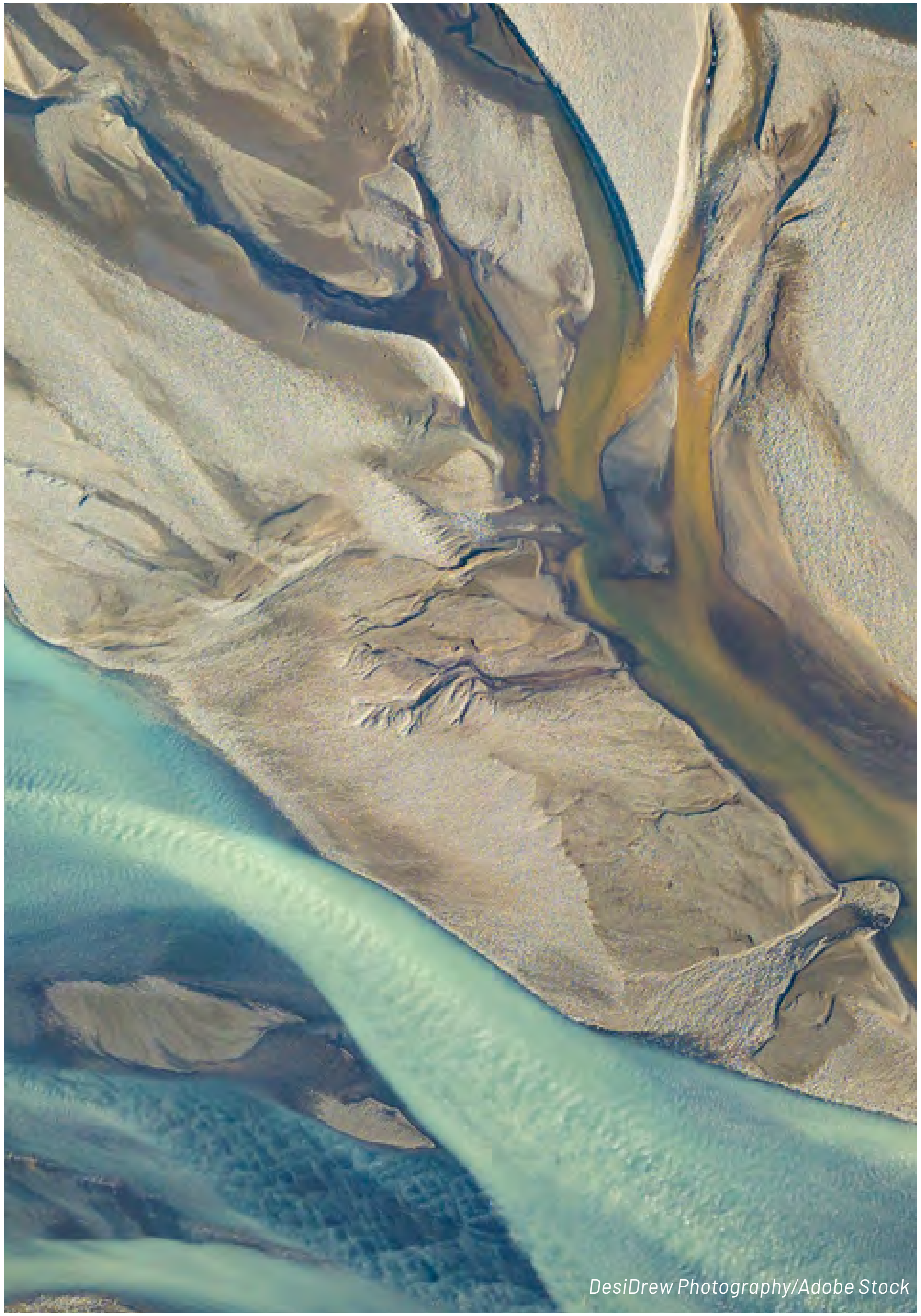

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Executive Summary

Piotr Krzeslak/Adobe Stock

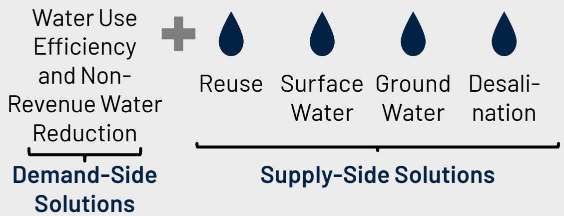
Used water has tremendous unrealized value...

Cities and industry produce a large volume of used water every day. Turning this used water into new water could create a more water-secure future for more than a billion people living in cities and facing increasing levels of water stress. Moreover, many industrial facilities globally face water supply insecurity, which can be mitigated through the use of new water.

...offering insurance against water insecurity...

As a **rainfall-independent source, reuse provides insurance against increasing climate and water stress** and should be considered within a portfolio of water security solutions.

FIGURE 1: Portfolio of water security options



...and a triple benefit for each cubic meter of water reused.

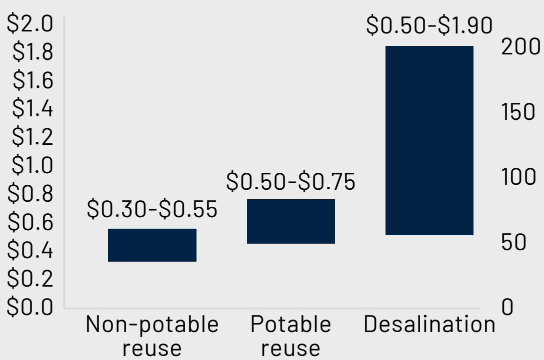
Turning used water into new water offers three benefits in one:

1. Recovery of **valuable water**,
2. Recovery of **energy and other scarce resources**, and
3. Recovery of the **environment** through reduced freshwater abstraction and reduced pollution.

Reuse has a strong business case...

Reuse makes good economic sense **where collection infrastructure is in place** and the **treatment facility is close to the point of reuse**. In addition, where the cost of alternatives reflects full costs, rather than a subsidized price of water, investments in reuse are attractive.

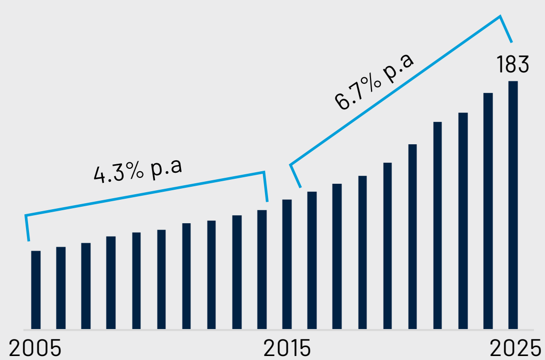
FIGURE 2: Cost per m³ of water (US$)



...yet the extent of reuse is low...

Global installed reuse capacity at the end of 2024 was only **183 million cubic meters per day.**

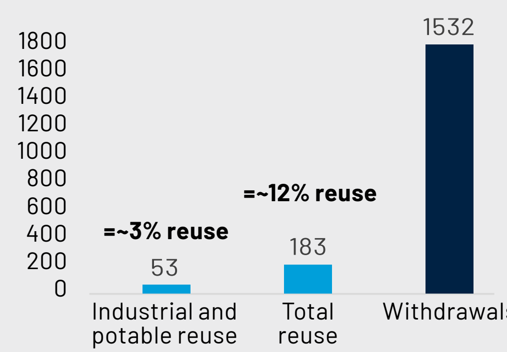
FIGURE 3: Global installed reuse capacity (million m³/day)



...at 12% of municipal freshwater withdrawals.

Moreover, industrial and potable reuse of 53 million cubic meters per day in 2024 amounted to only 3% of freshwater withdrawals for the municipal sector.

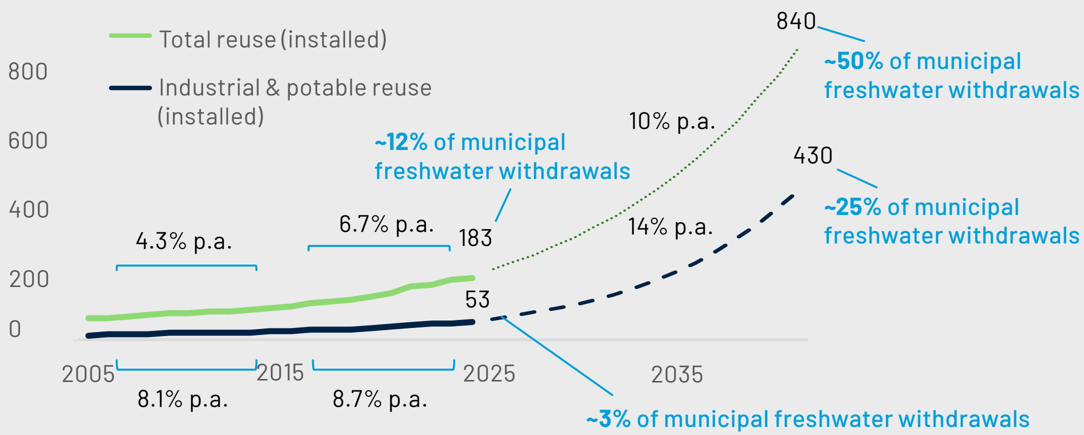
FIGURE 4: Reuse as a % of freshwater withdrawals for the municipal sector (million m³/day)



Nonetheless, reuse is at a tipping point...

Reuse programs are being actively implemented in 22 countries, with a shift toward higher-value applications, particularly through potable and industrial reuse. The **pace of investment in reuse has increased from ~4% per year (2005–14) to ~7% (2015–24).**

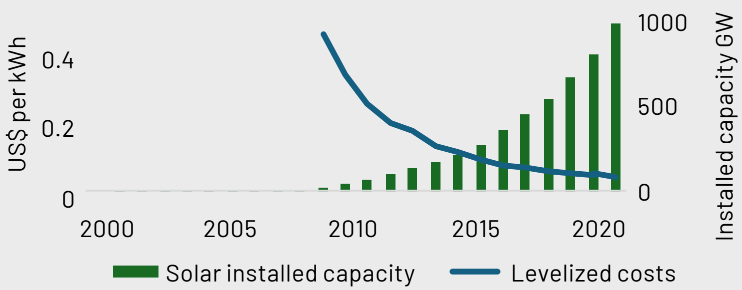
FIGURE 5: Reuse potential by 2040 (in million m³/day and as a % of municipal freshwater withdrawals)



...and urgent investments can reduce costs through economies of scale, unlocking up to US$340 billion in investments.

The investment required to achieve impact at scale is between **US$170 billion and US$340 billion over 15 years**, representing an annual growth in reuse capacity of 14% until 2040 for potable and industrial reuse. This investment could achieve an **eightfold increase** in treatment capacity for highly purified water and result in reuse for industrial and potable use at a **scale of 25% of municipal freshwater withdrawals from the current level of 3%.**

FIGURE 6: Solar levelized costs (US$ per kWh) and installed capacity for 2000–23 (GW)



This ambition is achievable, as the experience of the renewable energy sector highlights.

Renewable energy achieved an 18-fold increase in installed capacity over the last 15 years. Annual investment in wind and solar—in just one year (2022)—was close to US$500 billion. This was achieved through **ambitious policy goals and programs, and a dramatic reduction in unit costs**, enabled by scaling and leveraging private sector innovation and financing. In reuse, cost reductions will also require adopting fit-for-purpose standards and treatment, combining reuse with resource recovery, and shortening the length of distribution to enhance viability.

Five transitions will support the creation of new water at scale.

	Fully Appreciating the Value of Clean Water	Moving to Higher-Value Applications	Normalizing New Water	Supporting Programmatic, Platform Approaches	Mobilizing Private Sector Innovation and Financing
Transitions	**Value clean water appropriately,** recognizing the critical role it plays to support a livable planet. New water cannot compete against free or heavily subsidized freshwater.	Shift to high-value applications for purified new water, **matching willingness to pay with the cost of creating clean water,** reducing reliance on subsidies.	**Normalize the practice of creating new water** from used water, achieving widespread acceptance for new water. Mainstreaming new water requires **core investments in used water treatment** in many geographies as a first step.	Shift from one-off projects to **programs at scale** to create new water at low cost and low risk.	Leverage private sector innovation and financing to achieve **significant cost reductions through scale,** replicating achievements in other sectors. **Core public funding** may be needed for used water infrastructure, which if **used efficiently,** can crowd in private capital.
Instruments	**Cost-reflective pricing** and clear **regulations**		**Stakeholder engagement** and trust building	**Programmatic approaches** drawing on **finance platforms and market instruments**	Bankability of projects using appropriate **delivery models and financing instruments,** including blended finance, building on **efficient use of public funding for treatment and reuse**

The main audiences for this report are national and state governments, municipalities, utilities, and the private sector.

This report makes a case for why scaling investments in reuse is essential, along with pathways to achieve scale. It highlights **practical delivery and financing mechanisms,** which—when **harnessed programmatically,** with appropriate reforms to the regulatory environment and pricing—can support the **achievement of ambitious goals**. Guidance on scaling reuse investments for the different audiences is articulated in the form of **easy-to-implement roadmaps,** building on **possible World Bank Group support** through technical assistance and financing to develop and implement new water programs at national and state levels.

SCOPE OF DOCUMENT AND DEFINITIONS

References to 'total reuse' in this report include industrial and potable reuse, agricultural irrigation, landscape irrigation, urban non-potable reuse, and recreational or miscellaneous reuse.

FIGURE 7: Categories of water reuse

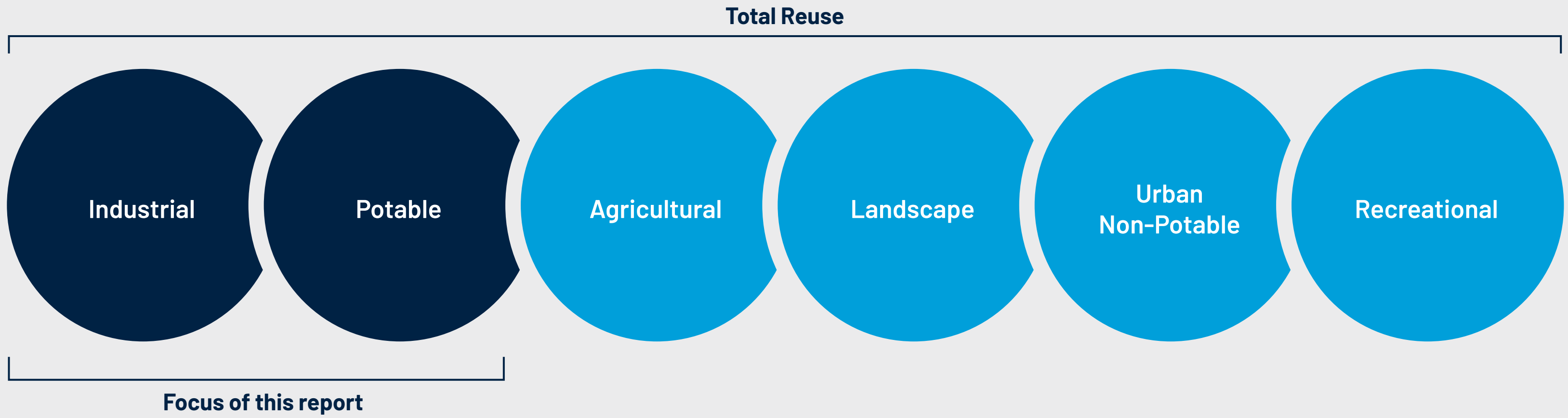
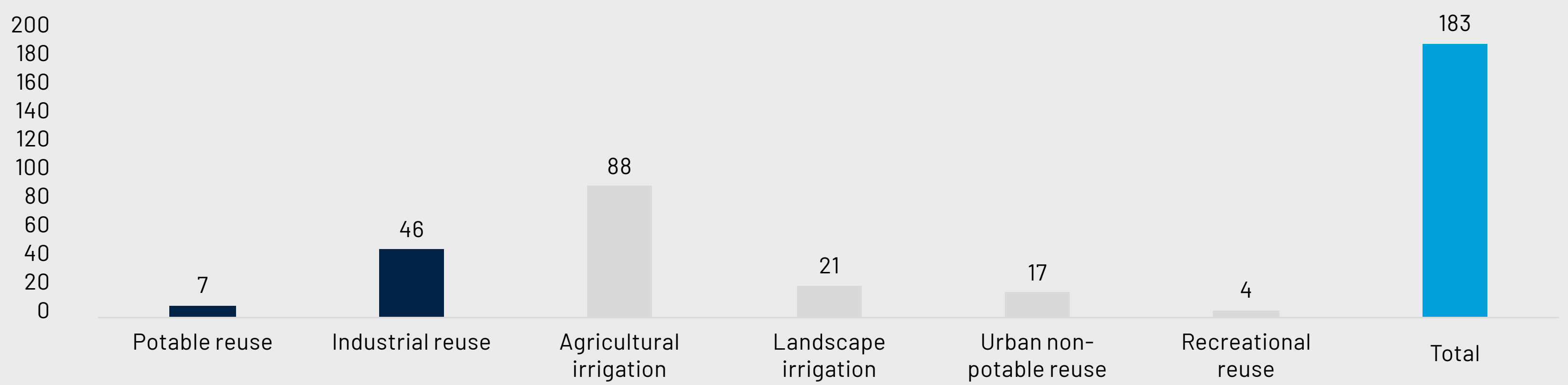
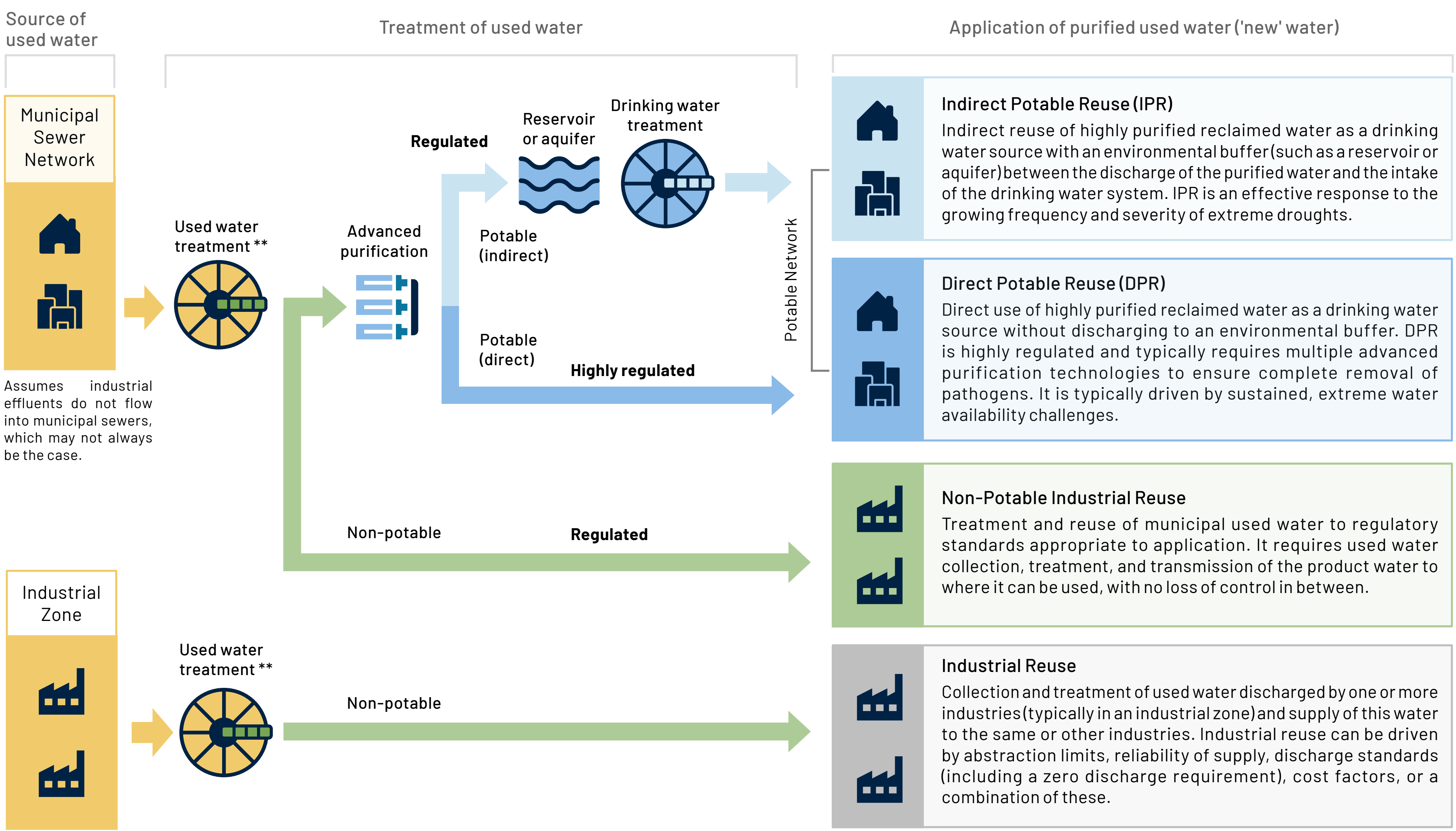


FIGURE 8: Breakdown of installed reuse capacity across different categories in 2024 (million m³ per day)



SCOPE OF DOCUMENT AND DEFINITIONS

FIGURE 9: Sources of used water and application and definitions of purified used water ('new' water)*



* **Exclusion**: This report does not address: (1) Non-potable reuse for agricultural purposes and landscaping; (2) De facto reuse; (3) Reuse of seawater and brackish water; and (4) Decentralized reuse. See additional definitions in Annex 1. ** Typically called wastewater treatment. This report does not consider used water to be 'waste' water.

ROLES OF THE PUBLIC AND PRIVATE SECTOR

The public and private sector have complementary roles in scaling investments in new water.

While investments in new water can and do take place in the absence of enabling government policies and regulations, this does not negate the fact that national and state government actions and inaction have a strong influence on new water investments and market creation. On the other hand, municipalities can commission reuse capacity, sell used water, and influence demand through pricing and local regulations. In addition, the private sector can support market creation in its role as a water user, solution provider, and/or financier.

National and State Governments

Set Regulations

Establish regulations related to water abstraction, discharge, and water quality, as well as frameworks for trading recovered resources.

Shape Incentives and Markets

Shape financial and economic incentives through market design and pricing, particularly with the aim of delivering water services, and supporting job creation and economic development.

Provide Core Funding

Supply public funding and/or undertake direct public investment in infrastructure that shapes the supply side of the market, including alternatives, and hence changes relative costs between alternatives.

Support Programmatic Approaches with Private Sector Participation

Use public resources efficiently to create programmatic approaches, with bankable projects that can attract commercial financing and private sector expertise for delivery.

Municipalities and Utilities

Commission Reuse Capacity

Incorporate reuse in city-level water security strategies and commission reuse capacity to meet such goals.

Support Applications of 'New' Water

Assess opportunities for the sale of used water and recovered resources to provide revenues for treatment of used water.

Plan Land Use with Reuse in Mind

Enable industrial zones and parks to be located in the vicinity of used water treatment plants, with the level of treatment adapted to the type of reuse application.

Facilitate Stakeholder Acceptance and Education

Engage in stakeholder education and consultations, including with citizens and industry, to normalize the use of new water.

Private Sector

WATER USERS: Purchase New Water

Support reuse in direct operations and/or indirectly through supply chains.

SOLUTION PROVIDERS: Provide Expertise and Innovation

Where appropriate, support the design, construction, and operation of advanced used water treatment and reuse facilities through public-private partnerships in various forms of design-build-finance-operate-transfer (DBFOT) and/or engineering-procurement-construction (EPC) contracts.

Accelerate innovations in treatment technology and reuse infrastructure to bring down costs over time and promote the scaling of reuse.

FINANCIERS: Finance Reuse Investments

Support financing for reuse through appropriate financing instruments and partnerships with the public sector.

1. WHY reuse

bereta/Adobe Stock

1.1 Benefits of Reuse

Increasing water stress and pollution require urgent alternative solutions, which reuse can provide, serving as a much-needed resilience and climate adaptation strategy.

Water resources around the world are under increasing stress, affecting livelihoods, the economy, and the environment.[1] Four billion people face severe water scarcity for at least one month each year, with half a billion experiencing water scarcity year-round.[2] This water stress is projected to increase. Moreover, 10% of global gross domestic product (GDP) comes from regions of high water risk (Figure 10), potentially increasing to 46% by 2050 due to climatic and socioeconomic changes.[3] In addition, 430 million cubic meters of untreated 'waste' water is discharged into the world's rivers, lakes, and aquifers every day,[4] and poor water quality could reduce economic growth by one-third.[5] In this context, water reuse can serve as a climate-proofing approach to mitigate against the risks of water stress, as well as to support fit-for-purpose treatment.

Scarcity

- Creating clean water from used water can **free up freshwater for other uses** and reduce the pressure on scarce resources, particularly in coastal areas.[6]
- Moreover, reuse provides a **reliable supply** in conditions of scarcity and drought.

Pollution

- Reuse can provide the **impetus to treat used water**, while generating **revenues from the sale of new water and resources recovered**, which can defray some of the costs of treatment.

Efficiency

- Reuse improves **resource efficiency** by increasing the value added per unit of water used and can improve **cost efficiencies** compared to alternatives, such as desalinated water and the construction of new dams.

Climate Mitigation and Adaptation

These approaches support **resilience and climate adaptation** at the city, basin, and national levels against variability in freshwater availability and contamination of freshwater sources.[7]

Reuse is more energy-efficient than desalination. Although overall emissions from reuse systems depend on the energy requirements for pumping and treatment, **sludge digestion and biogas** captured through the process of treatment can reduce methane emissions.

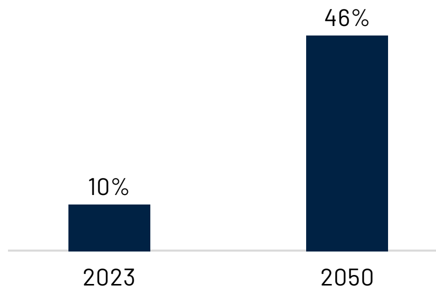
1 Fan Zhang et al., "Water for Shared Prosperity," (Washington, DC: World Bank, 2024).
2 Edward R. Jones et al., "Country-Level and Gridded Estimates of Wastewater Production, Collection, Treatment and Reuse," Earth System Science Data 13, no. 2 (2021): 237–54.
3 Dalberg Advisors, *High Cost of Cheap Water: The True Value of Water and Freshwater Ecosystems to People and Planet* (Gland, Switzerland: WWF, 2023).
4 Calculation based on data from Jones et al. (2021).
5 Richard Damania, et al., *Quality Unknown: The Invisible Water Crisis* (Washington, DC: World Bank, 2019).
6 Not all reuse applications result in additional water available. Where the 'waste' water is already being used through de facto reuse, such reuse in effect substitutes de facto reuse with formal reuse. See definition of de facto reuse in Annex 1.
7 City water systems also need to be designed to be resilient.

1.2 Urgency of Reuse

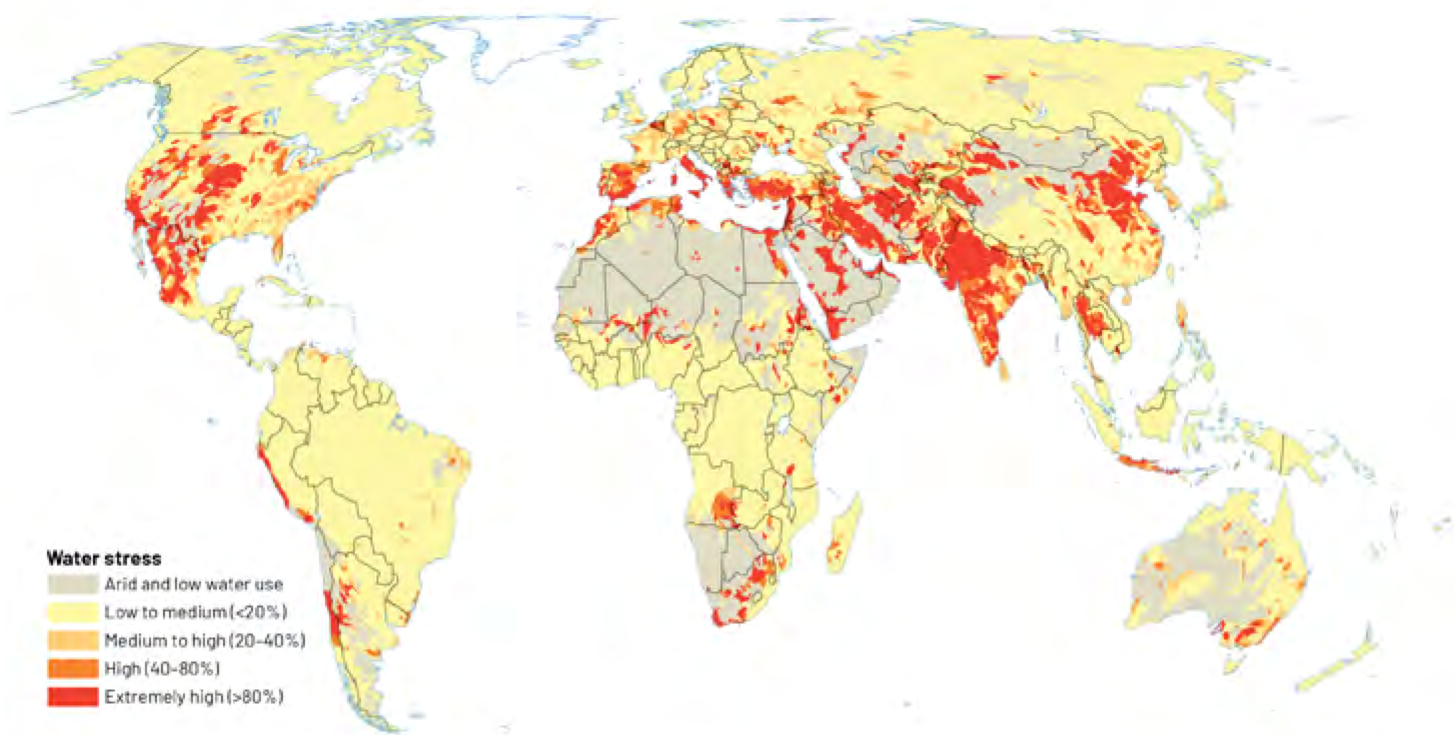
Water stress is one of the main drivers for reuse. Most reuse activities take place in basins with high and extreme water stress.

Countries and regions with high levels of water stress are more actively engaged in reuse activities. The United States and China have the largest reuse markets. There is extensive reuse in the Middle East and North Africa, as well as in Southern Europe. Reuse investments are growing fast in India, and there are reuse activities in Mexico, South Africa, and other water-stressed countries. Within countries, reuse is concentrated in areas of high water stress (Map 1), such as the Western and Southern United States and the northern parts of China, and in the water-stressed parts of countries that have abundant water resources, such as Brazil.

FIGURE 10: Share of global GDP from regions of high water risk[2]



MAP 1: Current water stress at the sub-basin level[1]



1 Water Resources Institute, Aqueduct 4. Baseline water stress for the period 1979 to 2019.
2 WWF Water Risk Filter.

Water scarcity and stress provide the most pressing and urgent reason for water reuse at a city level.

With an increasing number of cities facing perennial and seasonal water scarcity, reuse can support resilient pathways for reducing the gap between water demand and supply.

By 2050, 70% of the global population will be living in cities (Figure 11), driving up demand for water.[1] The number of large cities with a population over 1 million exposed to water risks is expected to rise from 193 in 2023 to 284 by 2050 (Figure 12), including 20 megacities (Map 2). In these cities, 2 billion people—half of the global urban population—will be affected by water-related challenges. With an increasing gap between water demand and water supply, cities can support reuse to meet growing municipal and industrial requirements.

MAP 2: Cities in perennial and seasonal water scarce areas[2]

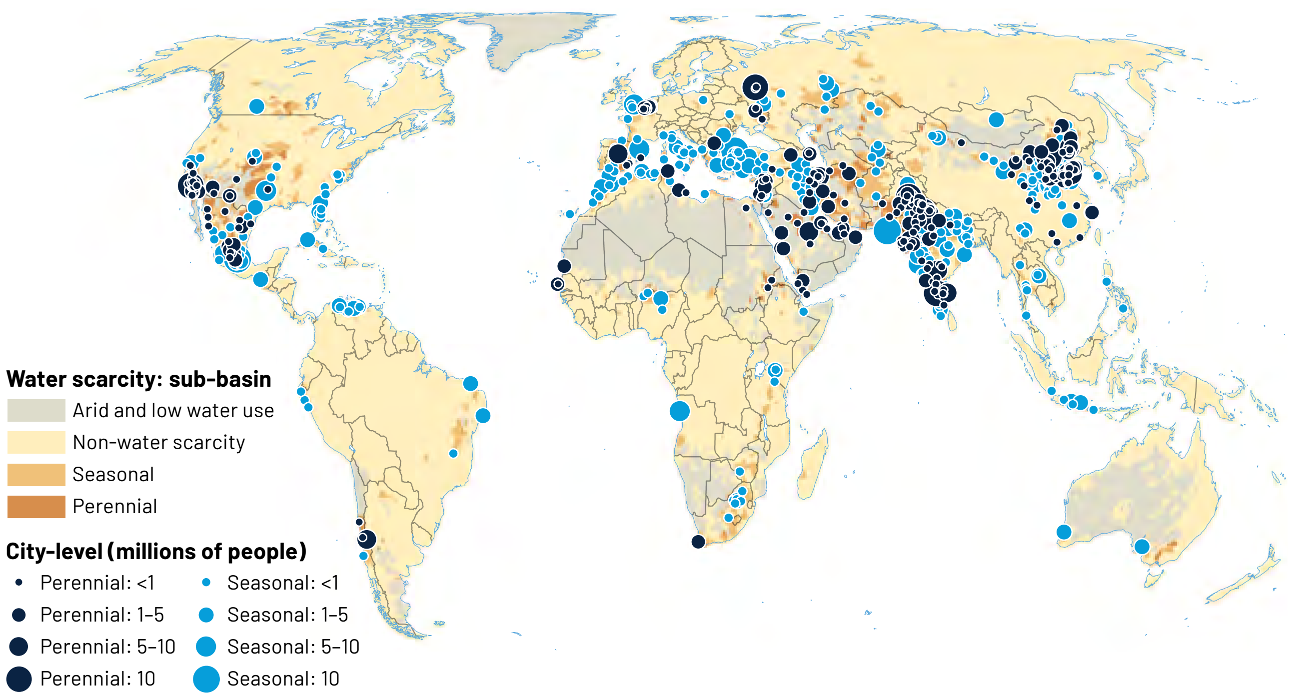


FIGURE 11: Share of the population living in urban areas[1]

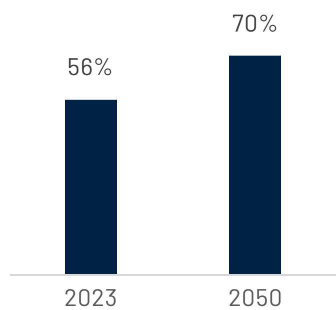
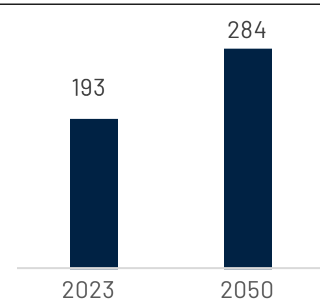


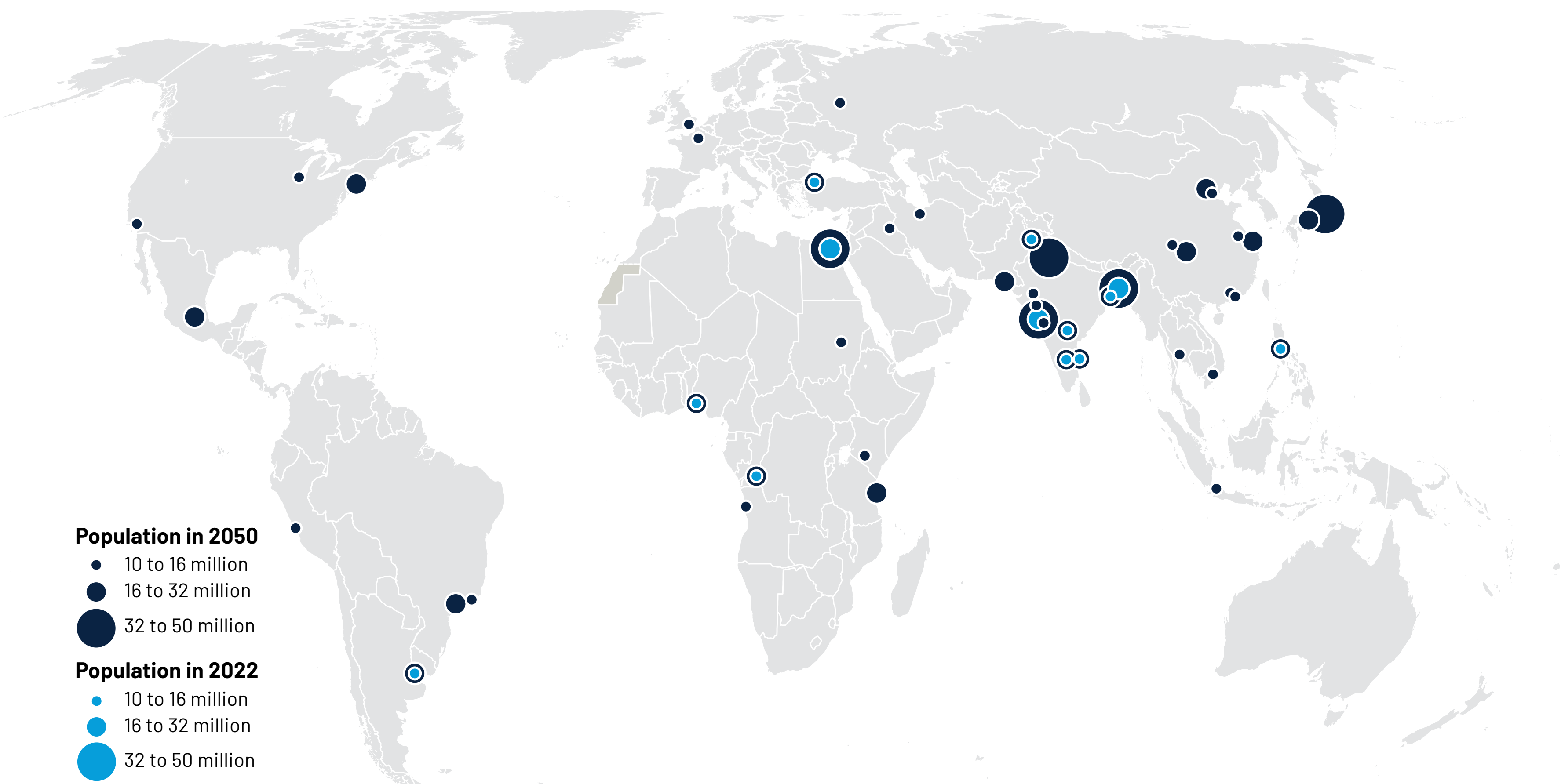
FIGURE 12: Number of cities with population over 1 million exposed to water risks[2]



1 World Bank estimates accessed Jan 31, 2025.
2 Chunyang He et al., "Future Global Urban Water Scarcity and Potential Solutions," *Nature Communications* 12, 4667 (2021).

By 2050, the number of megacities with a population over 10 million is expected to increase, putting additional pressure on scarce water resources and enhancing the case for reuse.

MAP 3: Megacities (with a population over 10 million) in 2024 and 2050[1]

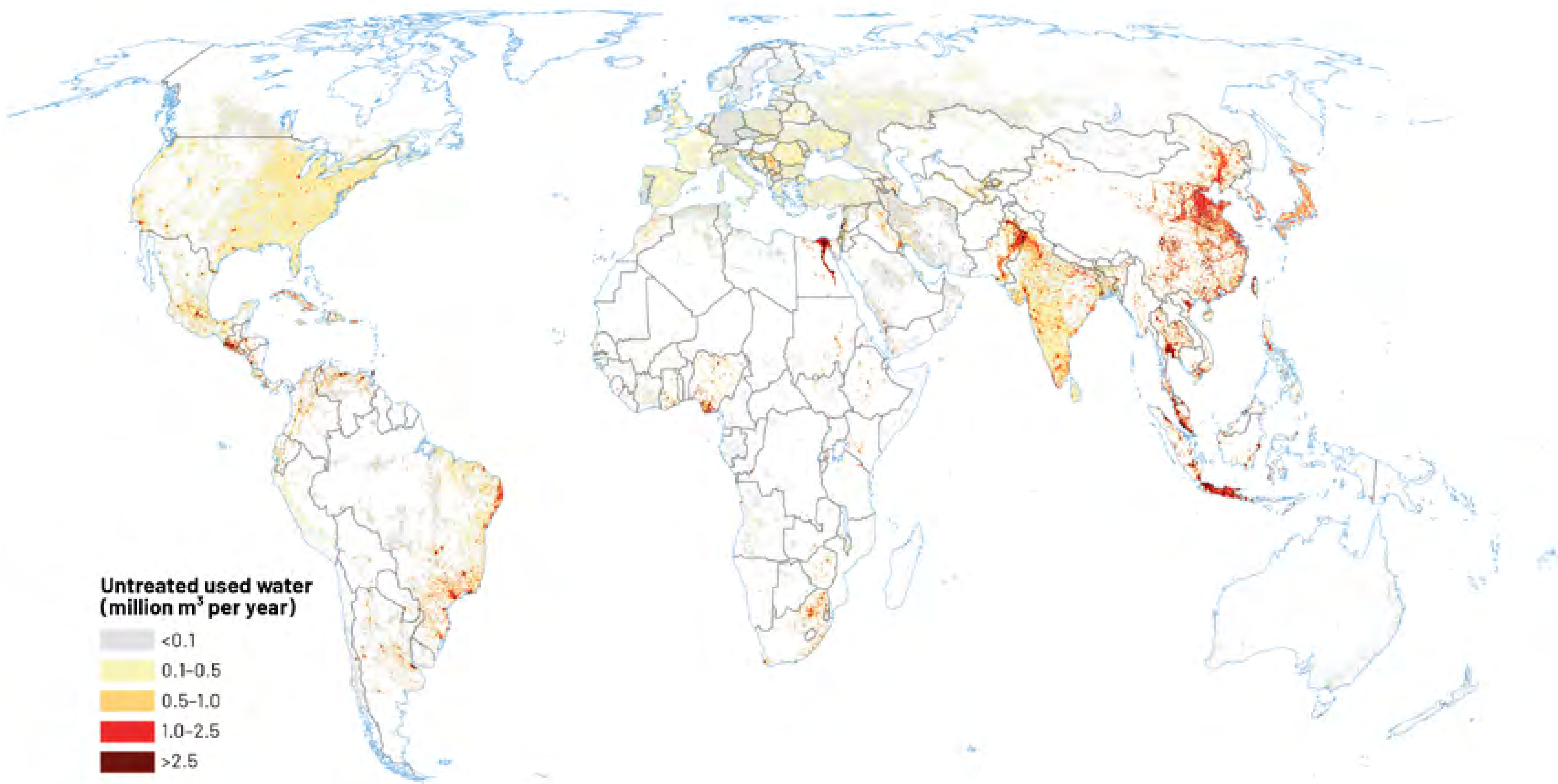


1 Oxford Economics, Global Cities, November 2023.

With untreated used water harming human health, ecosystems, and economies, water reuse can provide an impetus toward greater treatment.

The health consequences of untreated used water are severe, with 395,000 children under five dying each year from illnesses linked to unsafe water, sanitation, and hygiene.[1] Meanwhile, used water systems contribute 5–8% of global emissions of methane,[2] a potent greenhouse gas with 80 times the warming potential of carbon dioxide (CO_2) over 20 years, making it a major driver of near-term warming (Map 4).

MAP 4: Untreated used water flows to the environment[3]



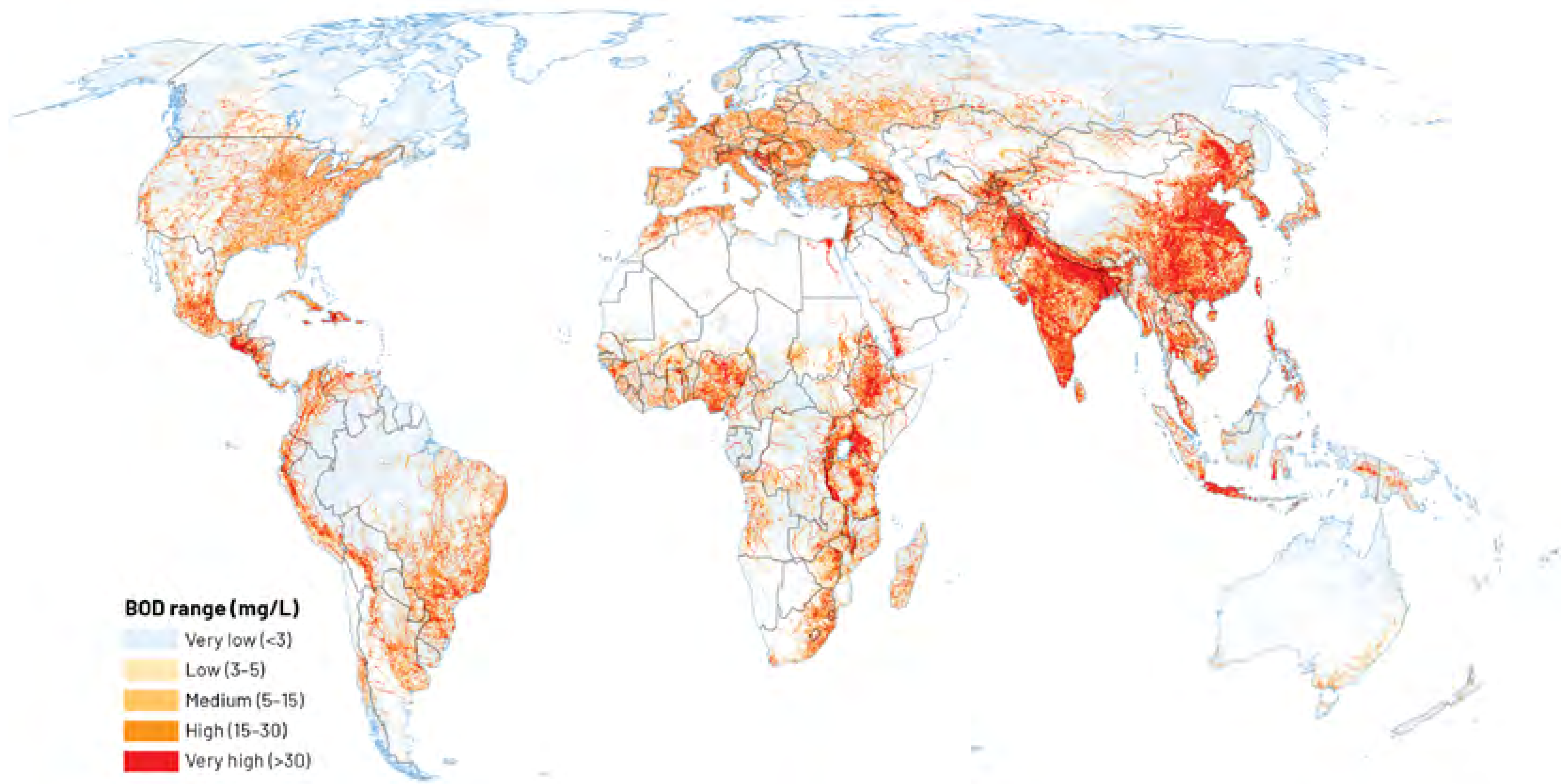
1 World Health Organization, "Executive Summary," in *Burden of Disease Attributable to Unsafe Drinking-Water, Sanitation and Hygiene: 2019 Update* (World Health Organization, [2019]),.
2 Cuihong Song, et al., "Methane Emissions from Municipal Wastewater Collection and Treatment Systems," Environmental Science & Technology. 57, no. 6 (2023): 2248–61.
3 Jones et al. (2021). Used water is typically referred to as wastewater in this context.

High levels of biological oxygen demand—an indicator of polluted water—show the impact of untreated used water on the environment.

Jones et al. (2022) report that "a substantial proportion of rivers stretches across populated areas of all continents experience moderate-to-high organic pollution" and that domestic and industrial used water are key sources of this pollution (Map 5).[1]

MAP 5: Water quality, biological oxygen demand[1]

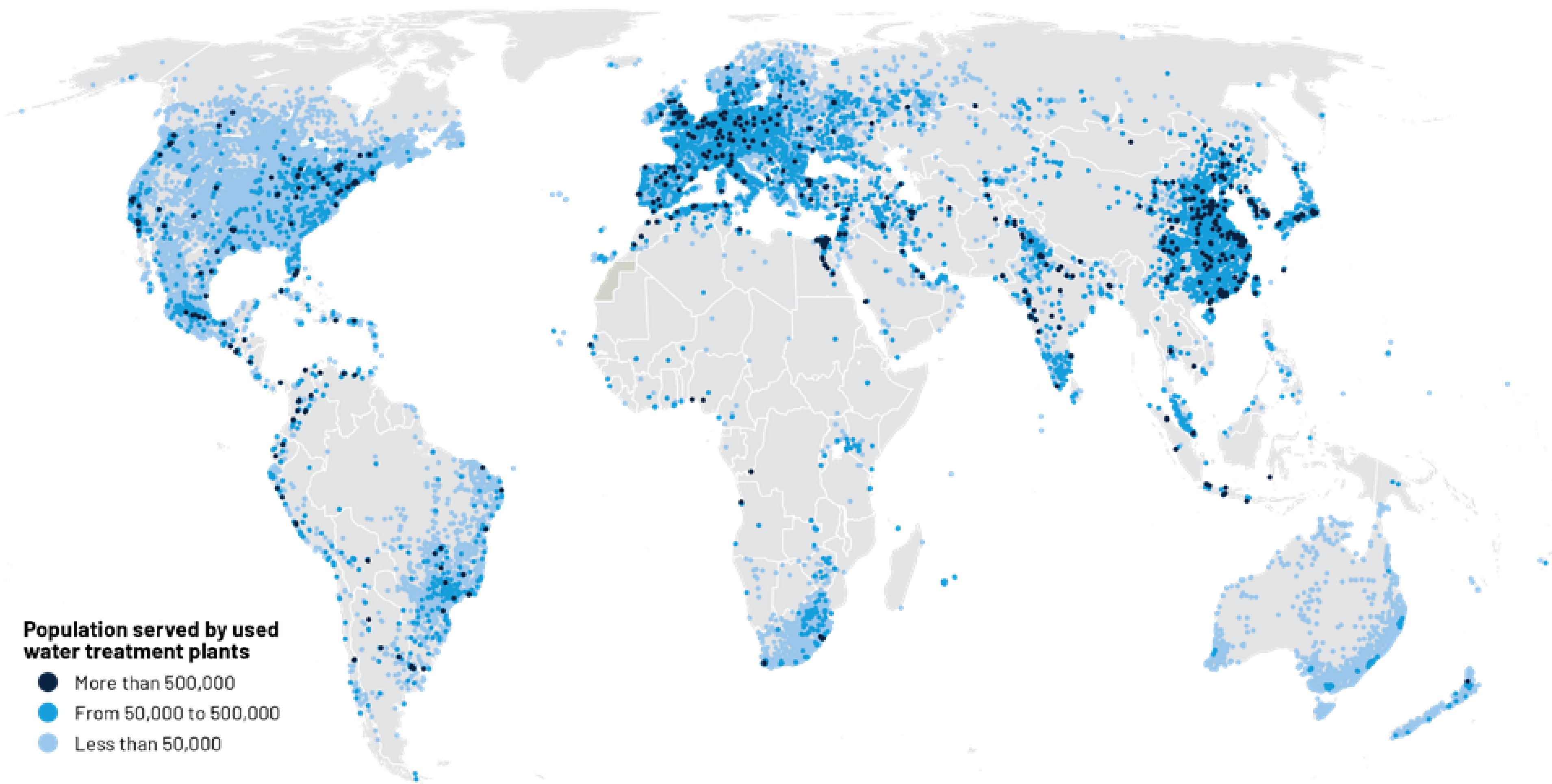
Biological oxygen demand (BOD) measures the amount of dissolved oxygen consumed by microorganisms to decompose organic matter in water over five days at 20° Celsius (BOD_5). Sources of this type of contamination are sewage, food waste, agricultural runoff, and industrial effluents.



1 E.R. Jones et al., "Global Hydrology and Water Quality Data from 1980–2019, Derived from the Dynamical Surface Water Quality Model (DynQual) at 5 Arcmin Spatial Resolution," *Geoscientific Model Development* 16 (2022): 4481–4500, Zenodo. The information corresponds to 2019.

Existing used water treatment infrastructure offers the potential for accelerated reuse.

MAP 6: Existing used water treatment plants[1]



1 HydroSHEDS, HydroWASTE Database.

Reuse is a critical element in a portfolio of water security solutions that cities, governments, and corporates should consider in a context of increasing water scarcity and climate-related water stress.

Water security strategies can no longer afford linear pathways, assessing one solution at a time. A portfolio approach is needed in the context of increasing variability in climate-related risks, with extreme events such as droughts becoming more frequent. In this context, investments in reuse are complementary to other water demand reduction and supply augmentation strategies and not a substitute. This is because reuse increases reliability of supply in cases of scarcity (Figures 13, 14).

FIGURE 13: Reuse as insurance against climate and water stress[1]

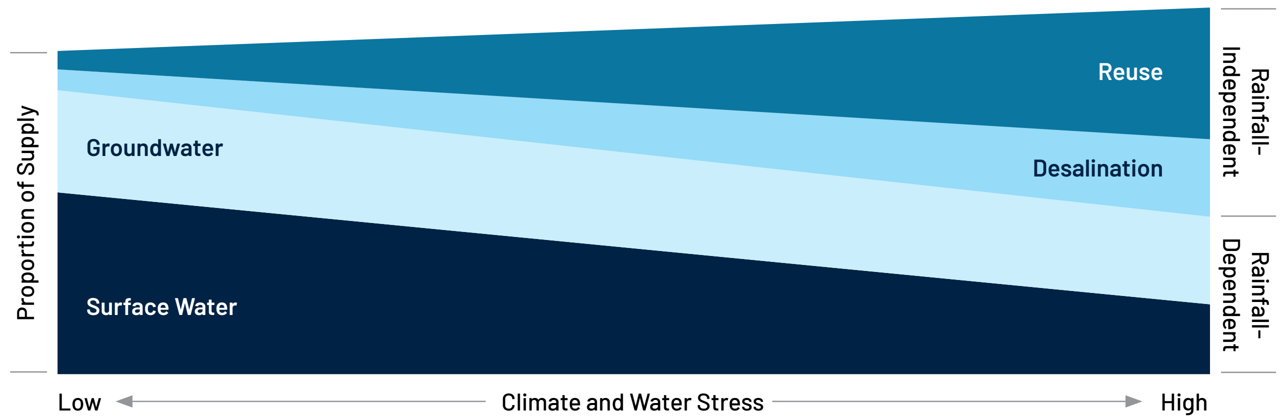
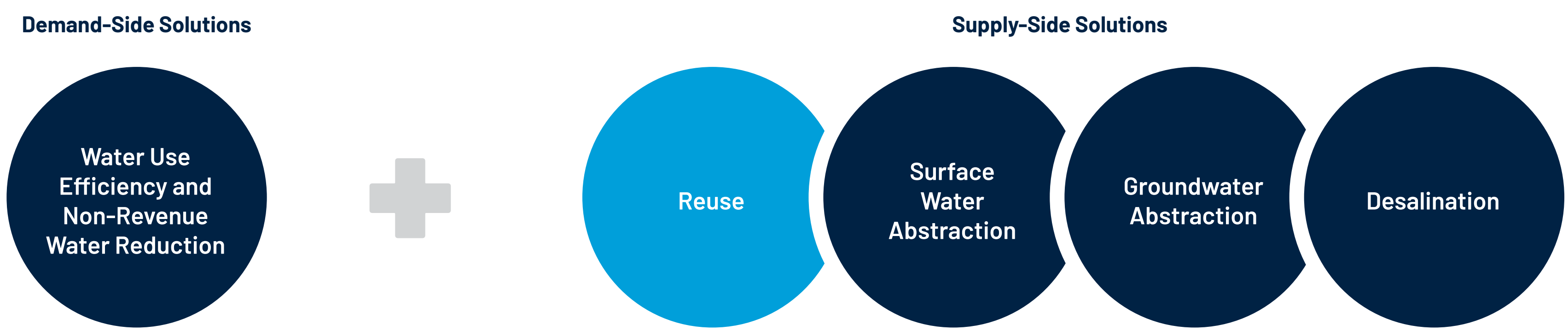


FIGURE 14: Reuse in a portfolio of water security options



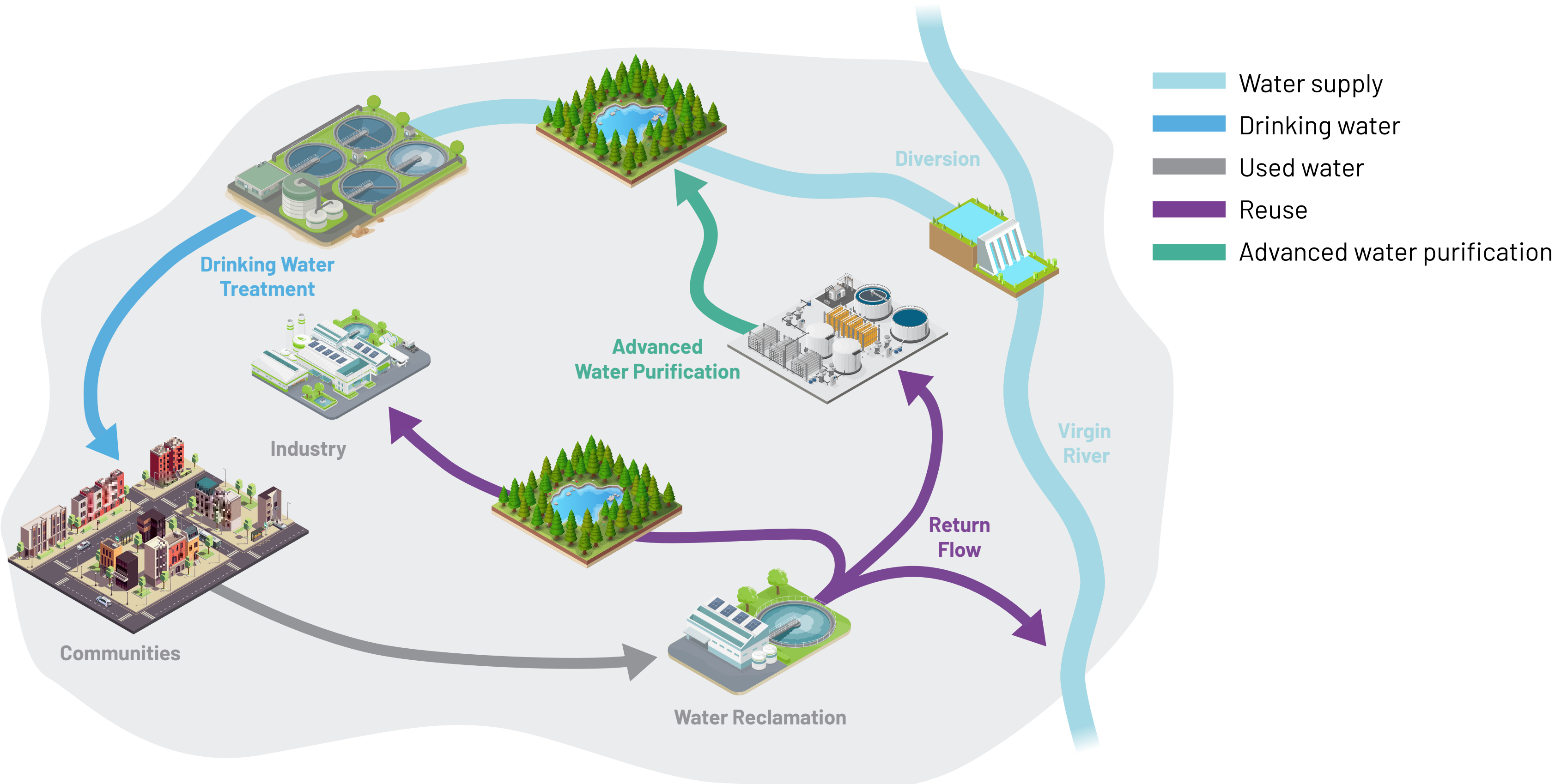
1 Authors' visualization. The relative proportions of supply from different sources are illustrative only. Actual proportions will vary depending on the context.

Water reuse needs to be planned within an overall context of water resource management and allocation, adopting a systems approach and ensuring social equity.

In coastal areas, water reuse offers a net addition of freshwater into the system from used water that would otherwise flow out to the sea. In inland areas, reuse may result in a substitution in how water is used, moving from de facto reuse to planned reuse. Such reuse may have an impact on downstream water users.

Reuse plans need to be integrated within overall water allocation planning at the basin level, taking into account the effect of reuse on return flows to the environment and any existing rights of users to this water, including informal use by small-scale irrigators, which occurs in some part of India, for example.

FIGURE 15: Reuse reduces return flows to freshwater systems in inland areas[1]



1 Authors' visualization based on Washington County Water Conservancy District, "Regional Reuse Purification System."

1.3 Economics of Reuse

Reuse can make good economic sense where collection infrastructure is in place and the treatment facility is close to the point of reuse; yet global installed capacity remains low, at 12% of withdrawals for the municipal sector.

Where used water collection infrastructure is in place and the treatment facility is close to the location of reuse, reuse may present a strong business case compared to developing new water sources—such as constructing new dams, reservoirs, or desalination plants. The cost per cubic meter of non-potable reuse water, based on levelized water costs for treatment, ranges from US$0.30 to US$0.55, while potable reuse costs US$0.5 to US$0.75—significantly lower than desalination, which ranges from US$0.50 to US$1.90 per cubic meter (Figure 16). Despite its advantages, global installed reuse capacity in 2024 stood at 183 million cubic meters per day. Installed reuse capacity has tripled over the past 20 years and grew at a rate of 6.7% per year over the period from 2015 to 2024, compared to an annual growth rate of 4.3% over the period from 2005 to 2014 (Figure 17). Even with this growth, however, reuse was only 12% of total municipal freshwater withdrawals in 2024 (Figure 18), highlighting the untapped potential for scaling up.

FIGURE 16: Cost per m³ of water (US$)[1]

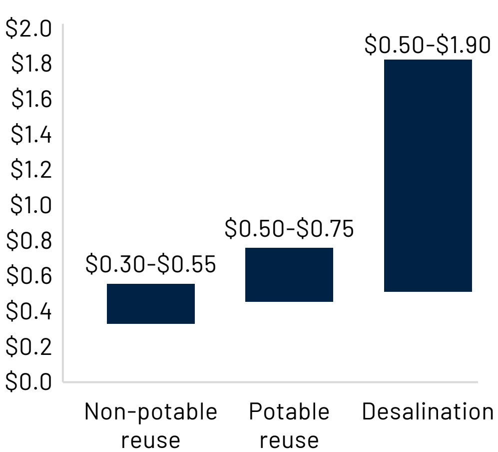


FIGURE 17: Total global installed reuse capacity (million m³/day)[2]

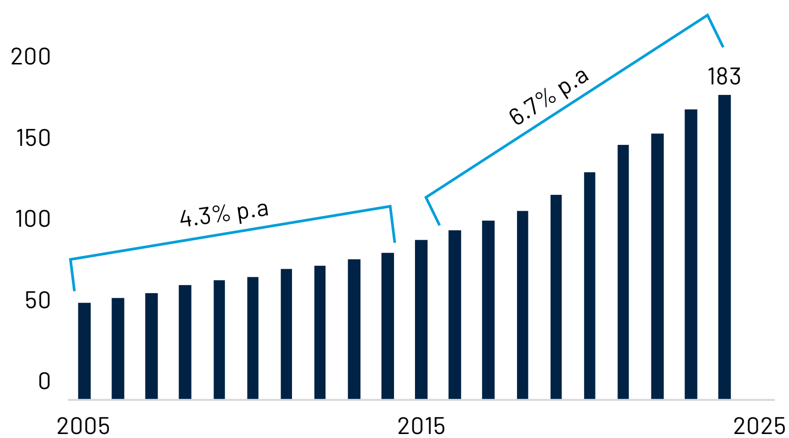
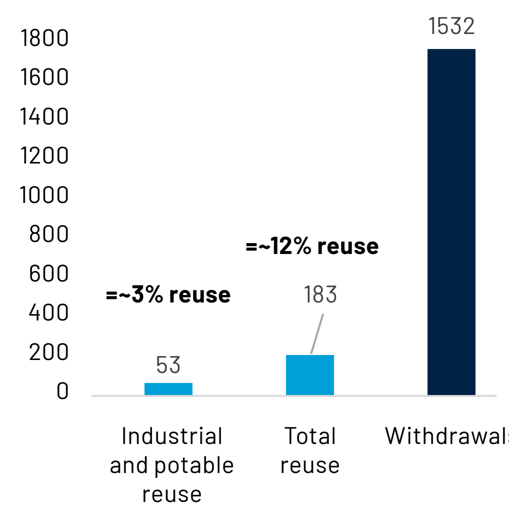


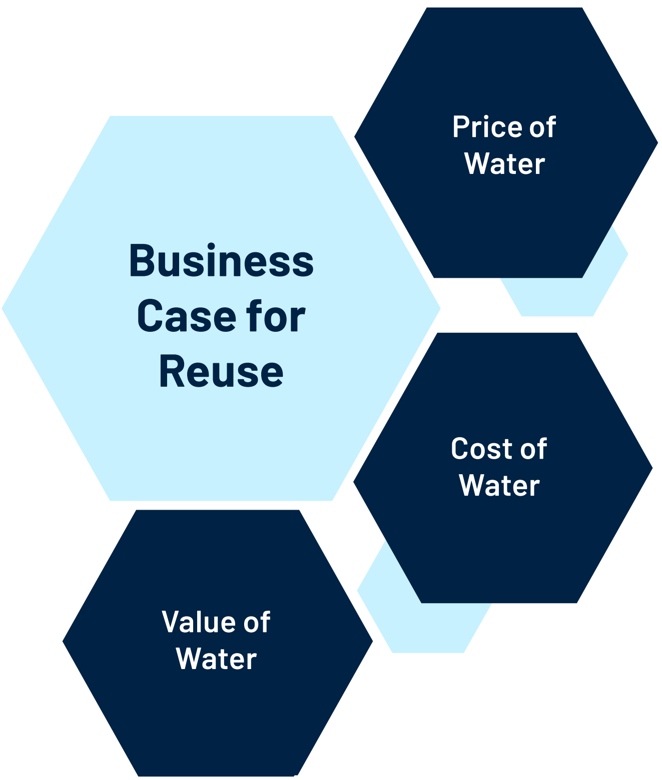
FIGURE 18: Reuse as a % of freshwater withdrawals for the municipal sector (million m³/day)[3]



1 Levelized water costs from World Bank and IFC treatment plant project data and GWI project data; excludes collection and distribution infrastructure costs. Levelized water costs include the cost of capital and depreciation, as well as operating costs.
2 Global Water Intelligence, *IDRA Desalination and Reuse Handbook 2024–2025* (Oxford: GWI, 2024). Excludes water reuse labelled as environmental enhancement in the dataset.
3 Municipal freshwater withdrawal from AQUASTAT, 2021 data escalated to 2024 at 2% annual growth, and GWI data for installed reuse capacity.

1.4 Business Case for the Public and Private Sectors

The business case for reuse is strongest where water is valued, costed, and priced appropriately.



When the price of water reflects its full costs, including the cost of displacement and contamination of water from its natural state, reuse will present a compelling case in many situations, especially in the context of water-scarce and polluted environments.

The cost of reclaimed water should be compared to the true lifecycle costs of alternative sources, not the price of subsidized water. These costs should include:

- Abstraction costs
- Treatment costs
- Pollution abatement costs
- Energy costs
- Opportunity cost (scarcity)
- Capital costs, depreciation, and renewal costs
- Operations and maintenance costs
- Environmental externalities

Reuse is an economically and socially compelling option when the value of water incorporates these important dimensions:

- **Economic:** Growth of agriculture, industry, urban development
- **Social:** Universal right to access clean and safe drinking water and sanitation
- **Environmental:** Ecological flows and protection of water sources for current and future generations
- **Cultural and spiritual:** Values placed on water by different sections of the community and cultures

Investments in reuse will be financially attractive to both governments and businesses when the marginal cost of reuse is less than the alternatives.

Reuse investments are more favorable where:

- **Used water collection and treatment infrastructure is already in place** to meet standards for environmental discharge, and only incremental treatment costs need to be incurred to facilitate reuse.
- **Used water is available close to the point of use,** which tends to be the case for urban centers and industrial parks, lowering costs for distribution infrastructure.
- **The cost of alternatives reflect full costs,** and not a subsidized price of water.
- **Reuse applications have high value,** combined with a willingness to pay. This is the case for industrial as well as potable water use. In addition, where **water scarcity risks are pronounced,** stakeholders may have a higher willingness to pay for assured supply.
- **Treatment of used water is combined with resource recovery** (for example, phosphorus, nitrogen, metals, and energy), as well as biosolids management.

Corporates can support reuse to address a combination of water-related risks: physical, regulatory, and reputational.

Among listed equities, 69% are exposed to water risks, estimated at US$225 billion.[1] Water scarcity, evolving regulations, and stakeholder expectations are increasing pressure on businesses to manage water more sustainably. Reuse offers a practical approach to mitigating physical, regulatory, and reputational risks while enhancing resilience and operational efficiency (Figure 19). Furthermore, global companies may choose to signal more sustainable production practices to their customer base, making reuse applications an attractive option.

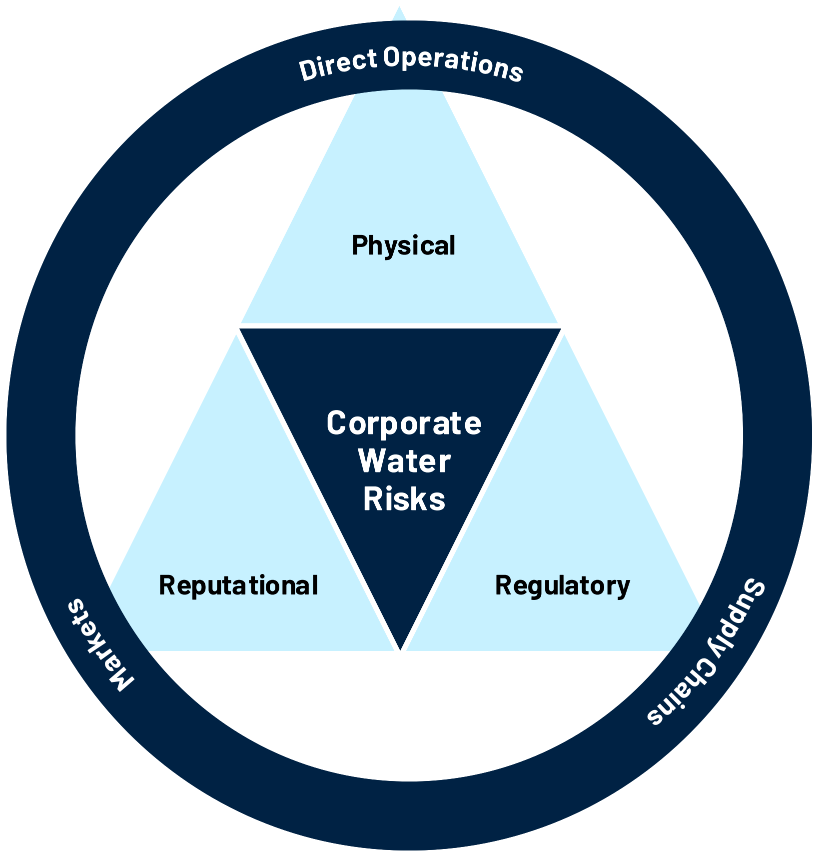
FIGURE 19: Corporate water risks[2]

Reputational

Risk: Threats to a company's social license to operate through reduced stakeholder esteem (real or perceived), arising from negative water-related impacts, for example:

- Abstraction of water from a water-stressed basin.
- Perception of environmental pollution by consumers.

Opportunity: Demonstration of sustainability-focused strategy through reuse.



Physical

Risk:

- Lack of water availability or reliability for business operations, with the risk of stranded assets.
- Excessive pollution leading to higher energy, water, insurance, and other costs.

Opportunity: Reclaimed water as an assured source of water supply of consistent quality for operational and supply chain use, where available in close proximity to business operations.

Regulatory

Risk: Imposition of caps on water allocation and set discharge standards.

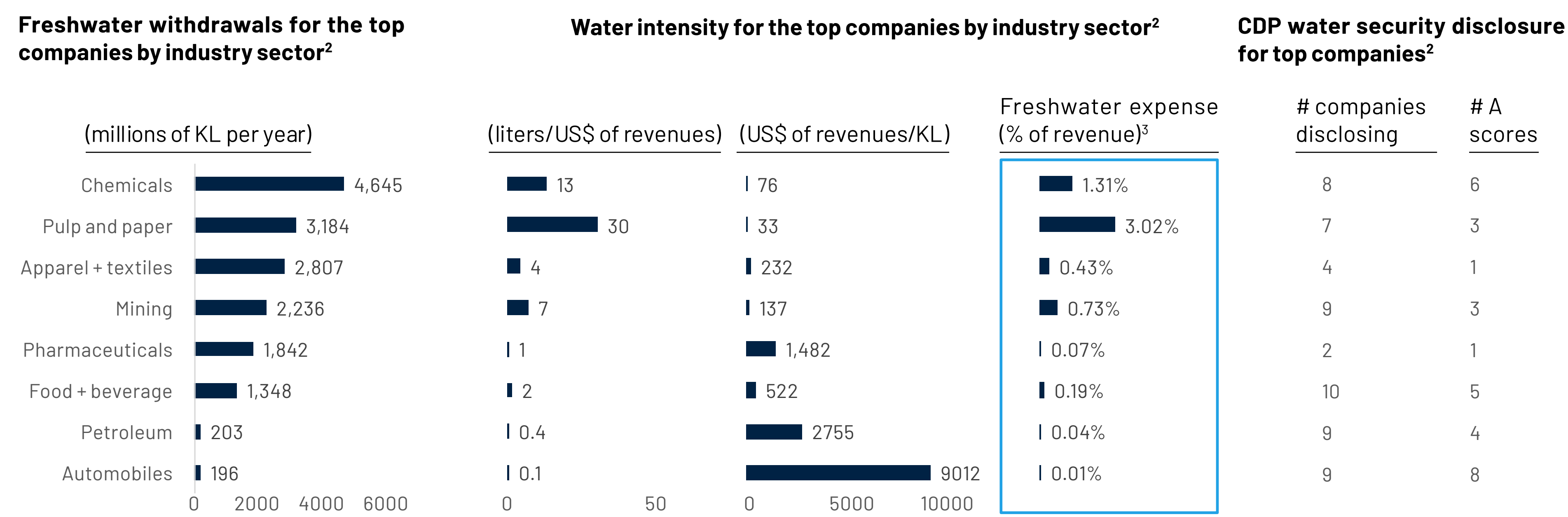
Opportunity: Reuse as a mechanism to reduce the need for freshwater as intake water and to meet discharge requirements.

1 CDP disclosure, as reported in CDP, *High and Dry: How Water Issues Are Stranding Assets* (London: CDP, 2022).
2 Authors' visualization; built on BlueRisk's articulation of risks.

While freshwater costs as a percentage of corporate revenues remain low, the high level of water disclosure by the top companies across most sectors indicates the importance of good reputational standing, which reuse can reinforce.

This trend underscores the growing recognition that sustainability practices, including water reuse, can reinforce public trust and align with stakeholder expectations in an increasingly water-stressed world. High water withdrawal intensity in sectors like chemicals, pulp and paper, and apparel and textiles highlights their reliance on water for revenue generation, while their comparatively low economic efficiency points to significant opportunities for improvement. When direct costs to businesses from water tariffs are low, the primary drivers for adopting reuse strategies often stem from addressing physical water risks, regulatory risks, and reputational risks (Figure 20).

FIGURE 20: Freshwater tariffs and corporate revenues – the role of water reuse in strengthening reputational standing[1]



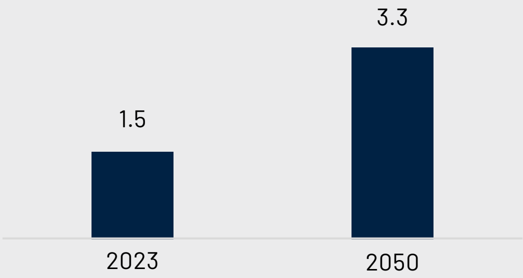
1 Figures are based on authors' own estimates; these build on CDP disclosure reporting, supplemented with company-level environmental, social, and governance (ESG) reporting; selection of industries is based on annual revenues. In many cases, actual abstraction costs will be lower, especially for water intensive industries such as pulp and paper. Companies also incur costs for the treatment and discharge of used water.
2 Top 10 companies per sector, except for chemicals and pulp and paper, which cover the top 8 companies.
3 Freshwater expenses calculated with an abstraction cost of US$1 per cubic meter.

The rapid growth of data centers is placing increasing pressure on water resources in water-stressed regions, which could be alleviated through reuse.

Global power use from data centers is forecast to double to 945 terawatt-hours in the period between 2025 to 2030, with the United States and China accounting for the largest share of this increase.[1] Data centers will account for nearly half of electricity demand growth between 2025 and 2030 in the United States and by 2030 will consume more electricity than the production of aluminum, steel, cement, chemicals and all other energy-intensive goods combined.[1]

The International Energy Association (IEA) estimates that data centers use about 1.5 million cubic meters of water per day on average and that this could more than double to 3.3 million cubic meters per day by 2030 (Figure 21). According to the IEA, an average 100 megawatt hyperscale data center in the United States consumes around 2 million liters per day for both direct and indirect use. Direct water use varies significantly by data center, depending on the cooling technology and the local climate. Indirect water use also depends on the source of electricity supply and the manufacturing location of semiconductors.

FIGURE 21: Data center water demand (million m^3/day)[1]



In **Malaysia**, for example, there are concerns around the adequacy of water resources and the Malaysian water regulator has proposed to raise water tariffs significantly for data centers.[2] Requiring data centers to use non-potable water sources has also been suggested.[3]

A partnership between a private company and the state-owned company Johor Special Water was recently announced to jointly develop a recycled water supply facility to supply data center campuses in the state of Johor. This will be the largest reuse plant of its kind in Malaysia.[4]


Production Perig/Adobe Stock

1 International Energy Association (IEA), "Energy and AI," (Paris: IEA, 2025).
2 Kamarul Azhar, "Nationwide Water Tariff Hikes in the Works, with New Category for Data Centres," The Edge Malaysia (March 24, 2025).
3 Zunaira Saieed, "Malaysia Water Regulator to Set Strict Water Rules for Data Centres as Number Grows," The Straits Times (February 10, 2025).
4 Vaughan O'Grady, "Can Malaysian Water Reuse Scheme Address the Challenges of Data Centre Growth?" Developing Telecoms (April 7, 2025).

2. WHEN
is the tipping point for reuse?

samael334/Adobe Stock

2.1 Constraints to Reuse

Even with compelling benefits, reuse remains low due to weak pricing incentives and the ready availability of cheap freshwater.

The Case for Reuse

Cost Competitiveness

Reuse is economically favorable relative to various sources of new water, particularly desalination and long-distance water transfers

Insurance Against Water Scarcity

As a hydrologically independent source, reuse offers a steady source of water from treatment facilities

Valuable Resource

Used water that flows out to the sea is essentially a wasted resource, which could otherwise be tapped for valuable social and economic purposes

Constraints to Reuse

Free Access to Freshwater
Freshwater, even where limited, is made readily available for municipal and industrial use in many geographies, undermining the move toward used water.

Lack of Regulations and/or Enforcement
Regulations linked to freshwater abstractions and discharges of used water in many markets are either missing or not enforced. In addition, there is often an absence of appropriate regulations and standards enabling the use of new water and lack of clarity around the rights to such water.

Weak Pricing Incentives
Freshwater supply in municipal and industrial contexts is often heavily subsidized, curtailing the growth of the reuse market.

Weak Institutional Coordination
Different line ministries are often involved in water and used water investments, with limited coordination across them.

Cultural and Behavioral Constraints
Public acceptance of reuse, particularly potable reuse, remains challenging in many contexts.

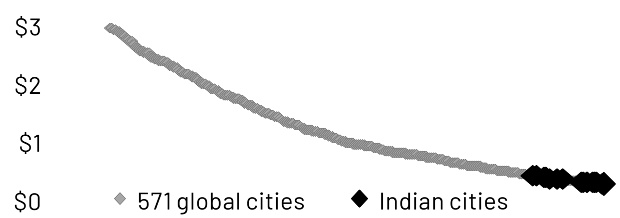
Failed Attempts to Support Reuse

Reuse investments are hard to finance where tariffs are low and where regulations are either not reuse-friendly or not enforced.

India
Installed reuse capacity in India of 4.3 million cubic meters per day is less than 3% of municipal freshwater withdrawals. Even though many of India's states have regulations requiring industries to use 'new' water, enforcement is weak. Water tariffs in India's cities are among the lowest in the world (Figure 22).

Brazil
The absence of hard abstraction limits for industries means that it is cheaper for industries to abstract freshwater than to use new water. Consequently, some attempts to implement industrial reuse have failed.

FIGURE 22: Water tariffs in Indian cities (US$/m³ for 15 m³), compared to international cities[1]



1 Authors' assessment based on Global Water Intelligence, *Global Water Tariff Survey 2022* (Oxford: GWI, 2022).

2.2 Lessons from the Renewable Energy Sector

The renewable energy market has scaled rapidly through supportive policies and cost reductions arising from innovation, scale, and competition, offering lessons for reuse.

Clear Ambition

Governments have implemented ambitious renewable energy policies and targets, which have played a crucial role in driving investment.

For instance, **China's** renewable energy targets under its 14th Five-Year Plan have significantly boosted solar and wind installations, with China accounting for a substantial portion of global renewable capacity additions in recent years.[1] Similarly, the European Union's REPower EU Plan and the Green Deal Industrial Plan have accelerated solar and wind deployment in **Europe.**[2] By 2023, 28 countries had developed gigawatt-scale solar markets.

Increase in Investments

Investment in renewables has accelerated as a result of supportive policies and lower costs. The share of renewables in global electricity generation has increased significantly since 2010, reaching close to 30% by 2023.[3]

Reducing Costs

Solar photovoltaic and wind installed capacity grew at 24% per year since 2000, linked to substantial reductions in cost, driving large-scale adoption (Figures 23, 24).

By 2023, 81% of new renewable capacity additions were producing electricity at costs lower than fossil fuel alternatives, making them an attractive option.[4]

FIGURE 23: Solar levelized costs (US$ per kWh) and installed capacity for 2000–23 (GW)[5]

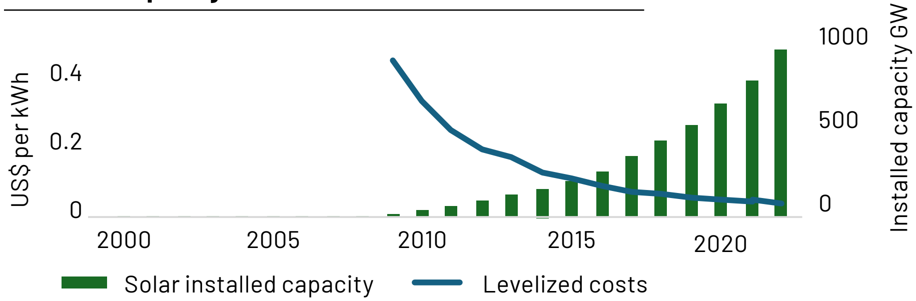
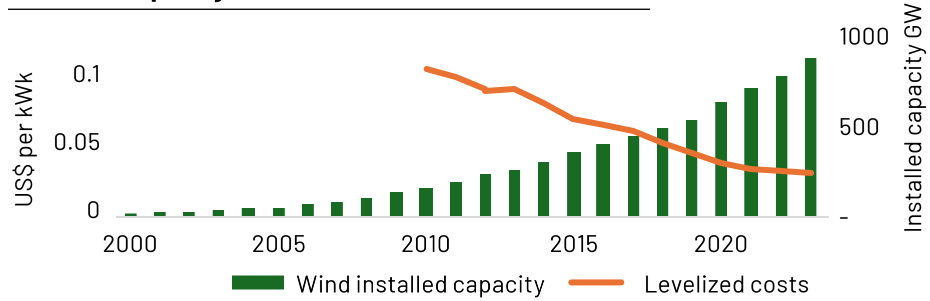


FIGURE 24: Wind levelized costs (US$ per kWh) and installed capacity for 2000–23 (GW)[5]



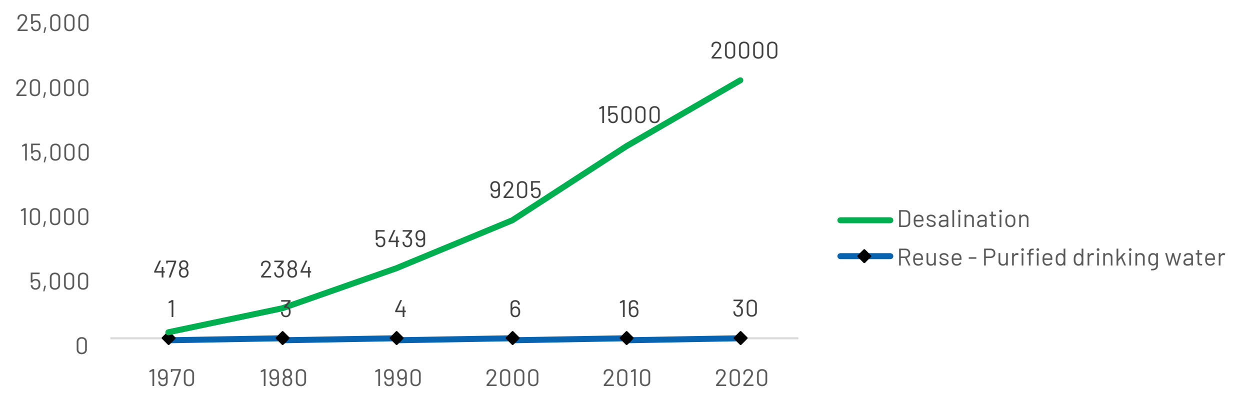
1 See 14th Five-Year Plan: Modern Energy System Planning (2021-2025).
2 European Commission, "REPowerEU at a Glance."
3 International Energy Agency, "Global Overview," Chapter 1 in Renewables 2024: Analysis and Forecast to 2030 (Paris: IEA, 2024).
4 Energy Institute, *Statistical Review of World Energy*, 73rd Edition (London: Energy Institute, 2024).
5 Authors' visualization based on International Renewable Energy Agency, *Renewable Power Generation Costs in 2023* (Abu Dhabi: IRENA, 2024).

While cost reductions for reuse are not expected to be as dramatic as those achieved for renewable energy, certain common principles still apply as investments in reuse scale.

FIGURE 25: Common principles across investments in renewable energy, desalination, and reuse

Competitive pressure through price discovery of levelized treatment costs in long-term contracts	Renewable energy has been developed and financed by the private sector based on long-term supply contracts. This has the advantage of enabling competitive bids based on a levelized cost of energy. A similar approach has been adopted for desalination, with the structuring of long-term contracts through various forms of design-build-operate (DBO) contracts becoming common practice. Price disclosure for reuse investments can create similar competitive pressures on costs.
Clear policy goals	Renewable energy investments were driven by a carbon constraint and clear policy goals related to this. Freshwater faces a similar supply constraint, together with reliability and quality challenges. These warrant governments setting clear policy goals, particularly in water-stressed contexts.
Reduced risk premiums across the full project and financing lifecycle as the market matures	The potable reuse market is still immature, with a small number of projects, high costs, and large cost variance (Figure 26). Risk premiums associated with projects will decline as the market for reuse matures. Risk premiums can make up 30% of total costs. The maturing desalination market had reduced this risk premium to 10–20% of total costs by 2012 and has achieved even greater reductions in recent years.[1]
Project optimization through a programmatic approach	There are significant cost efficiencies to be gained through a programmatic approach, with reduced transaction costs and greater speed of implementation, in a similar way to that achieved for renewable energy.

FIGURE 26: Number of plants set up for potable reuse vs desalination from 1970 to 2020[2]

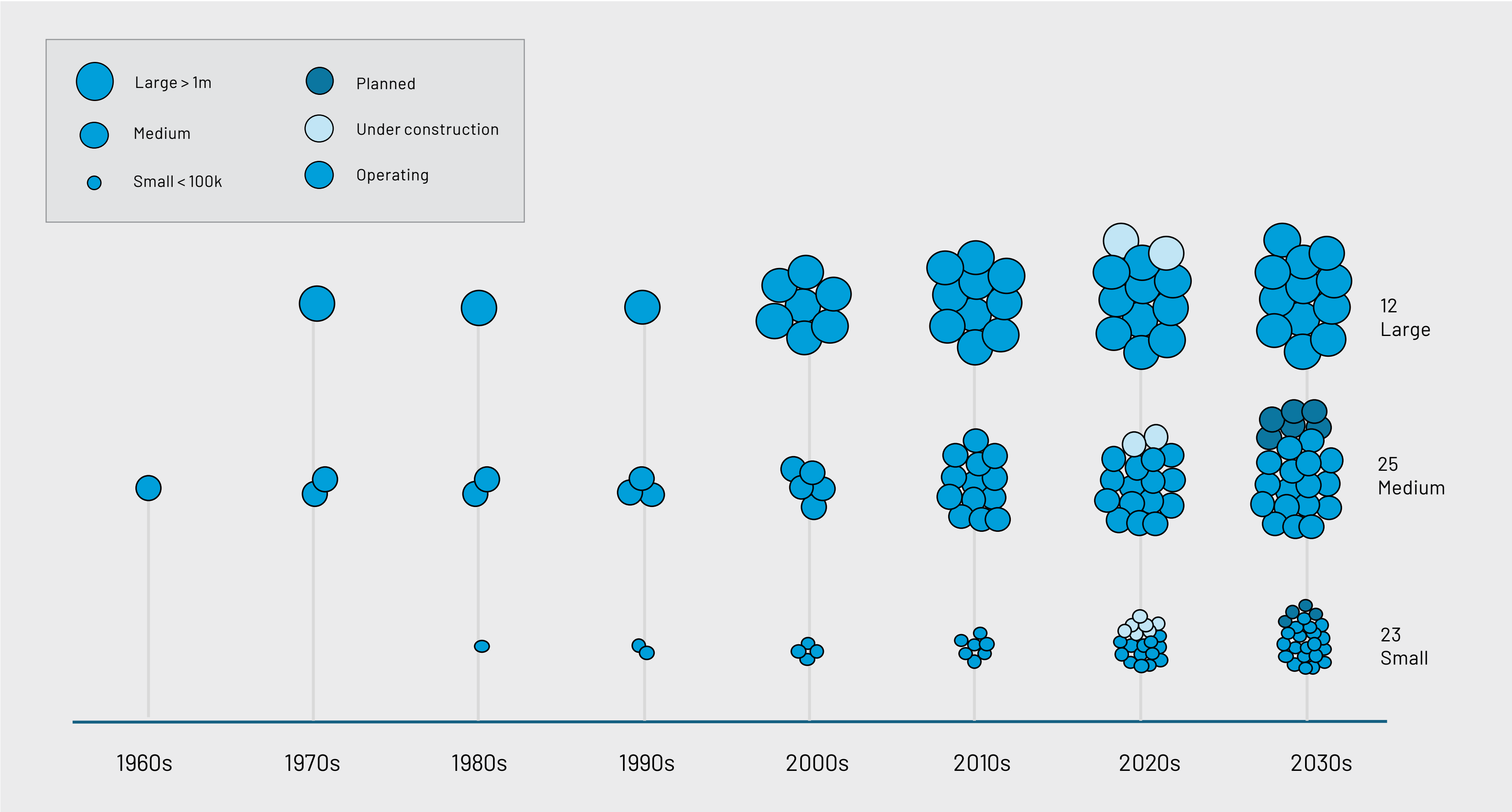


1 WateReuse Association, "Seawater Desalination Costs White Paper," (Alexandria, VA: WateReuse, September 2011, revised January 2012); Mordor Intelligence, "Desalination System Market Analysis: Industry Report, Size, and Forecast (2025–2030)."

2 Pacific Institute, "The World's Water. 2006-07 Data. Table 22."; GWI desalination project tracker data; Water360, "WSAA Purified Recycled Water Maps Package 250315."

The market for purified drinking water is still small. Scaling of this market could support standardization of technologies and processes, and thereby the optimization of costs.

FIGURE 27: Evolution of purified water projects by settlement size (1960s to 2030s)[1]



1 Authors' visualization, based on Water360 data.

In addition, reuse investments present certain unique factors, linked to technology, energy use, process optimization, and resource recovery.

FIGURE 28: Cost factors specific to reuse

Market maturity curve for infrastructure intensive services	• Reuse is expected to follow a similar market-maturing trajectory to that achieved in desalination, which now has more than 20,000 plants in operation (Figure 26) and has experienced significant cost reductions through contract design, learning by doing, and higher prevalence of larger-scale projects (Figure 25).[1]
Lower energy intensity compared to desalination	• Moreover, reuse is much less energy-intensive and does not have expensive sea-intake infrastructure requirements. All things being equal, reuse is expected to be significantly less costly than seawater desalination.[2]
Process innovation[3] • Reducing **membrane costs** • Breakthroughs in real-time, **low-cost water quality monitoring** • **Lower energy costs** through energy recovery and reducing renewable energy costs • Lower unit costs through **standardization and process optimization,** and application of **artificial intelligence**	• The market for reuse membranes is small, offering room for innovation and scale to reduce costs, particularly with respect to biofouling. • Breakthroughs in real-time, low-cost water quality monitoring, which reduce quality risks, could be a game changer for reuse. • Improving energy recovery efficiencies and the use of renewable energy—while also reducing costs—can make reuse more cost-effective. • Unit costs for reuse can reduce further through the standardization and optimization of processes, as the industry scales, and through the application of artificial intelligence.
Resource Recovery	• Mineral and metal recovery through reuse offers opportunities to improve the viability of reuse and promote the circular economy.

1 Beatriz Mayor, "Multidimensional Analysis of Nexus Technologies I: Diffusion, Scaling and Cost Trends of Desalination," International Institute for Applied Systems Analysis Working Paper WP-18-006 (June 2018).
2 See case studies on Singapore and Cape Town.
3 For a summary description of some recent innovations in used water treatment, see Aquacycl, "13 New Technologies That Are Changing the Wastewater Treatment Landscape," (December 22, 2023).

2.3 Tipping Points for Reuse

Transitioning through five tipping points will accelerate reuse investments at scale.

FIGURE 29: Five tipping points for the creation of new water from used water at scale

	Current Status	Tipping Point	Desirable Future	
Freshwater is overexploited and polluted without any consequences for users.	Available freshwater is undervalued	Value of Clean Water →	Clean water is appropriately valued	Clean freshwater is appropriately valued, incorporating its scarcity value, and polluters bear the cost of polluting freshwater.
Used water is only reused in exceptional circumstances, such as severe water scarcity.	Reuse is supported in special circumstances	Market Penetration & Size →	Reuse is normalized as a routine application	Use of new water is considered normal and routinely included in municipal and industrial water security strategies.
Each project is considered to be uniquely challenging, with high risks.	Bespoke applications	Market Scale & Maturity →	Standardized applications	All projects comprise standardized components with well-defined delivery and pricing models, and with well-managed risks.
Most treated used water is allocated to low-value applications, such as landscaping.	Low-value applications	Application →	High-value applications	Preferential use of new water in high-value applications, particularly for industrial and potable use.
Reuse is publicly funded, and new water is heavily subsidized.	Reuse is subsidized & publicly funded	Delivery & Financing →	Private innovation & financing	Reuse costs are reduced through competition and price disclosure, and private financing is unlocked through the design of bankable projects.

The pace of investments in reuse is accelerating globally.

22 countries are implementing reuse

+

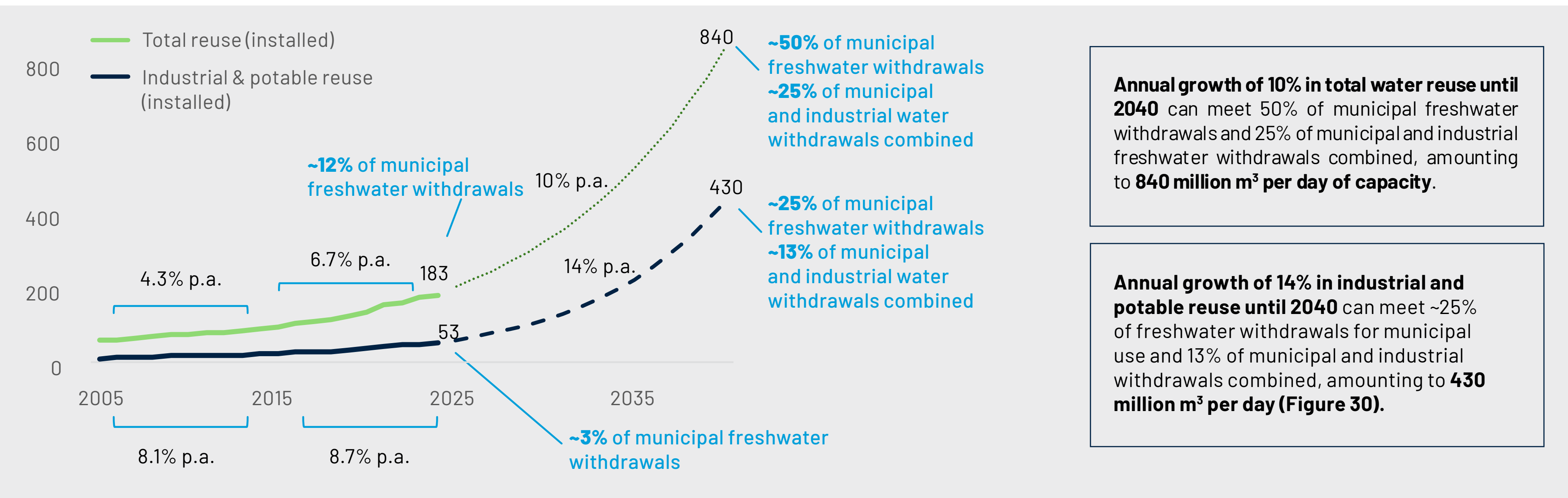
Reuse investments are growing at a faster pace

+

There is a shift toward **higher-value applications**

- **More than 20 countries have active reuse programs** in the form of supportive policies, regulations, and/or investment initiatives.
- **Installed reuse capacity grew at a rate of 6.7% per year over the period from 2015 to 2024**, a significant increase over the annual growth of 4.3% between 2005 and 2014 (Figure 30).
- **Reuse investments are shifting toward high-value applications,** which are more sustainable and easier to finance. While low-value reuse applications, such as agricultural irrigation and urban non-potable use dominate the existing installed capacity base, **industrial reuse** is growing rapidly, driven largely by legislation in China and India.
- **Potable reuse has greater acceptability and the potential to be mainstreamed.** Potable reuse is expanding, as utilities face the impact of worsening water scarcity. This is particularly evident in the United States. Indirect potable reuse, in particular, appears to be gaining wider acceptance. The number of projects producing potable water is growing rapidly (Map 8).
- **Reuse is less energy-intensive and lower cost compared to desalination**, making it attractive from both cost and climate perspectives.

FIGURE 30: Reuse potential by 2040, in million m³/day[1, 2]



Notes: Installed capacity from GWI data; municipal freshwater withdrawals assumed to grow at 1% per year.

1 Authors' estimates.

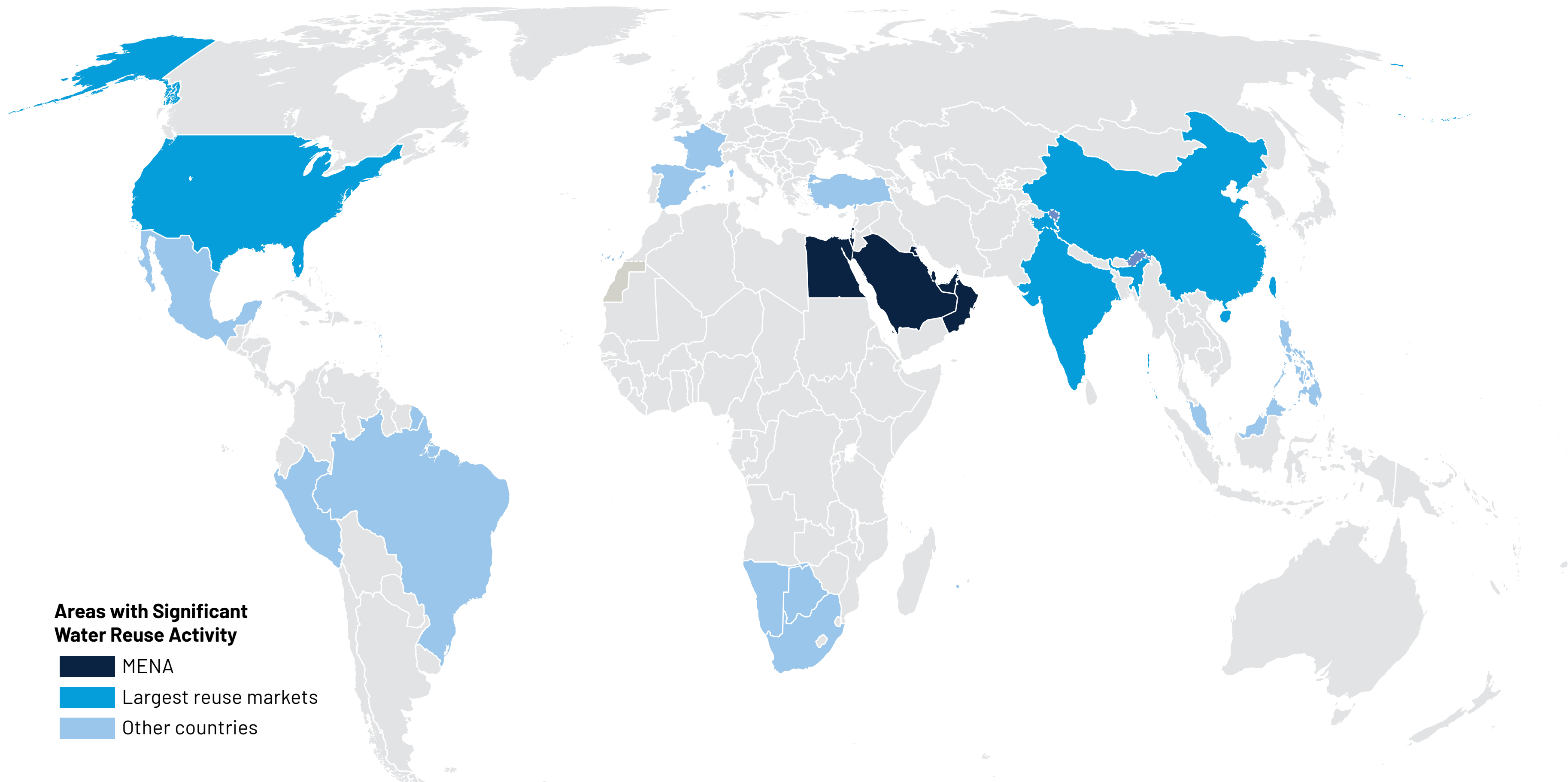
2 In addition to industrial and potable reuse, total reuse includes agricultural irrigation (amounting to 88 million cubic meters per day in 2024), landscape irrigation (amounting to 21 million cubic meters per day in 2024), urban non-potable reuse (17 million cubic meters per day in 2024), and recreational/miscellaneous reuse (4 million cubic meters per day in 2024).

2.4 Countries with Significant Water Reuse Activity

Several countries are mainstreaming reuse in their water security strategies.

China, the United States, and India represent the three largest markets for reuse. In addition, there is significant reuse activity in the Middle East and North Africa region, particularly in Egypt, Israel, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Various other countries, such as Brazil, Chile, France, Malaysia, Mexico, Peru, the Philippines, Singapore, South Africa, Spain, and Taiwan are investing in new water infrastructure.

MAP 7: Countries with significant water reuse activity[1]

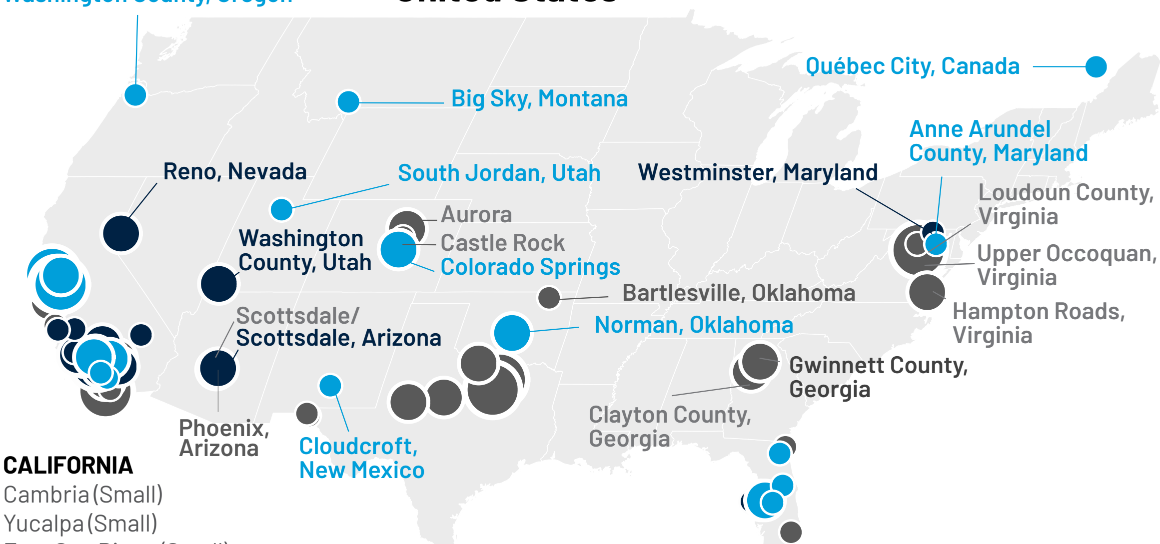


1 Authors' analysis, based on GWI and other data.

The United States represents one of the largest markets for potable reuse, with significant activity in other countries, such as South Africa.

MAP 8: Global new water locations[1]

United States



CALIFORNIA

Cambria (Small)
Yucalpa (Small)
East San Diego (Small)
El Segundo (Small)
Santa Cruz (Small)
Santa Monica (Small)
Highland (Medium)
Monterey (Medium)
Oceanside (Medium
San Diego (Large)
Orange County (Large)
Pico Rivera (Large)
Long Beach (Large, Two)

Los Angeles (Medium)
Conejo Valley (Medium)
South Orange (Medium)
Antelope Valley (Medium)
Pure Water Southern (Large)

Carpinteria (Small)
Morro Bay (Small)
Central Coast (Small)
Inland Empire (Small)
Burbank (Medium)
Ventura (Medium)
San Jacinto (Medium)

Camp Pendleton (Small)
Laguna (Small)
Tri-Valley (Medium)
Los Angeles (Medium)
Rancho California (Medium)
Santa Clara (Large)
San Francisco (Large, three)

TEXAS

El Paso (Small, two)
Abilene (Medium)
Big Spring (Medium)
Wichita Falls (Medium)
Tarrant (Large)
North Texas (Large)

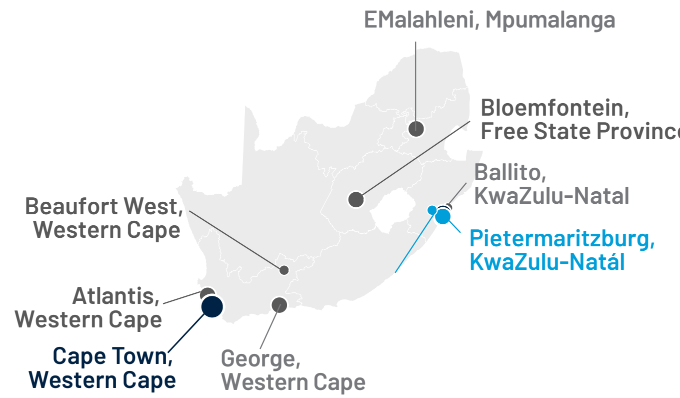
FLORIDA

Jacksonville (Small)
Palm Beach (Small)
Hillsborough (Medium)

Clear Water (Small)

Polk (Small)
Clay county (Small)
Altamonte Springs (Small)
Plant City (Medium)

South Africa



CURRENT • Small
PLANNED ● Medium
FUTURE ⬤ Large

Global

Notes: Current refers to operating or in construction plants, planned to planned locations, and future to exploring or educational locations. Small are plants that serve less than 100,000 people, medium serve between 100,000 and 1 million people, and large serve more than 1 million people.

1 Authors' visualization based on work by Water Services Association of Australia

3.WHAT is the investment opportunity?

ENGINEER - STUDIO/Adobe Stock

3.1 Market Size for Reuse

Facilitating potable and industrial reuse of 25% of municipal freshwater withdrawals represents approximately an eightfold increase in reuse over current levels.

Expanding water reuse presents a major investment opportunity. Increasing total reuse from the current 12% to 50% of freshwater withdrawals[1] for municipal use by 2040 represents a 4.6-fold increase (Figure 31). On the other hand, the expansion of potable and industrial reuse from the current 3% to 25% of total freshwater withdrawals for municipal use represents an 8.1-fold increase (Figure 32).

FIGURE 31: Total reuse in 2024 vs future reuse potential in 2040 of 50% as a fraction of total freshwater withdrawals for municipal use (million m³/day)[1]

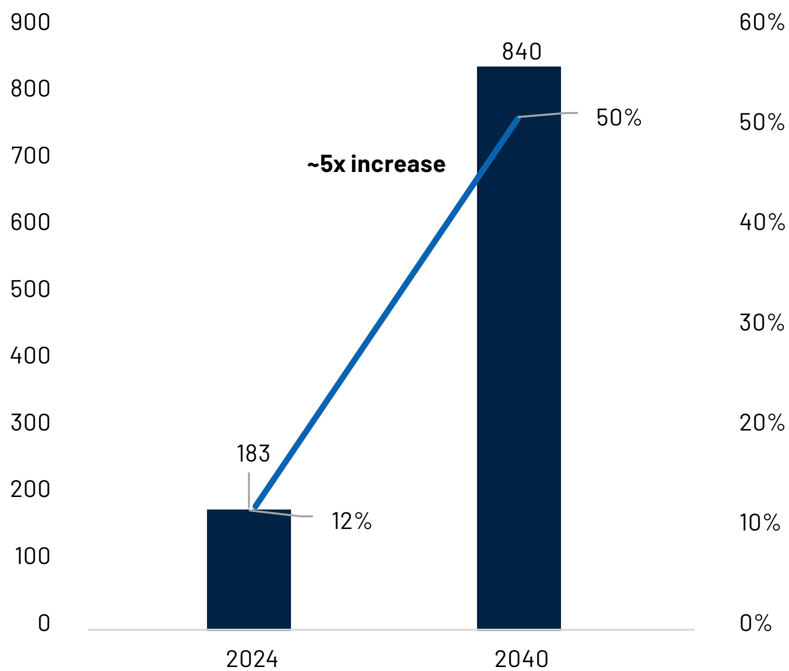
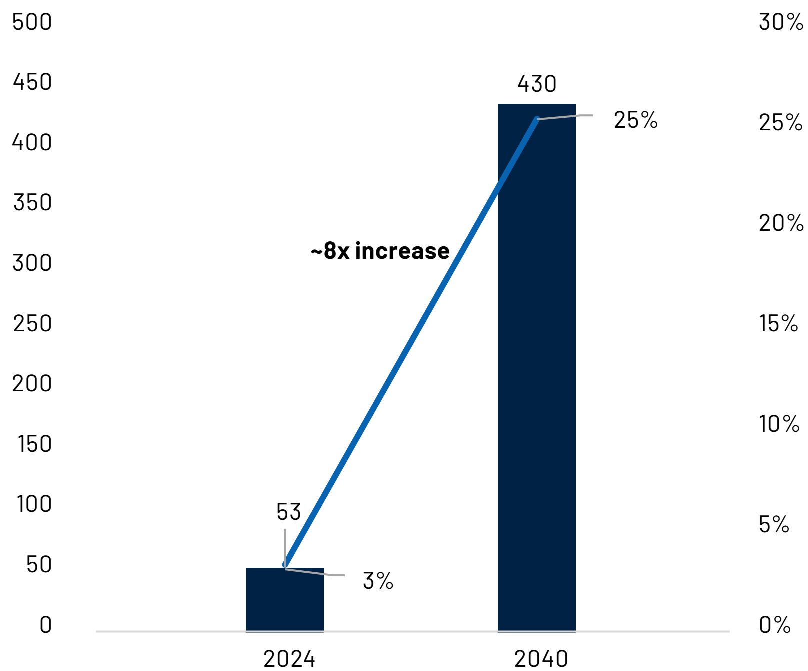


FIGURE 32: Potable and industrial reuse in 2024 vs future reuse potential in 2040 of 25% as a fraction of total freshwater withdrawals for municipal use (million m³/day)[1]



1 Authors' estimates. The Global Commission on the Economics of Water advocates for a reuse ambition of 50%.

Market maturity is needed to **optimize reuse costs.**

The current reuse market has limited price disclosure, resulting in wide variance in reuse costs. When more competitive bids are structured on a levelized cost basis with price discovery, the market opportunity will become more defined (Figure 34 and Section 2.2). Investments will scale as reuse opportunities become cost-competitive relative to the alternatives on account of reducing costs, creating a reinforcing positive investment cycle (Figures 33 and 34).

FIGURE 33: Current reuse investment landscape

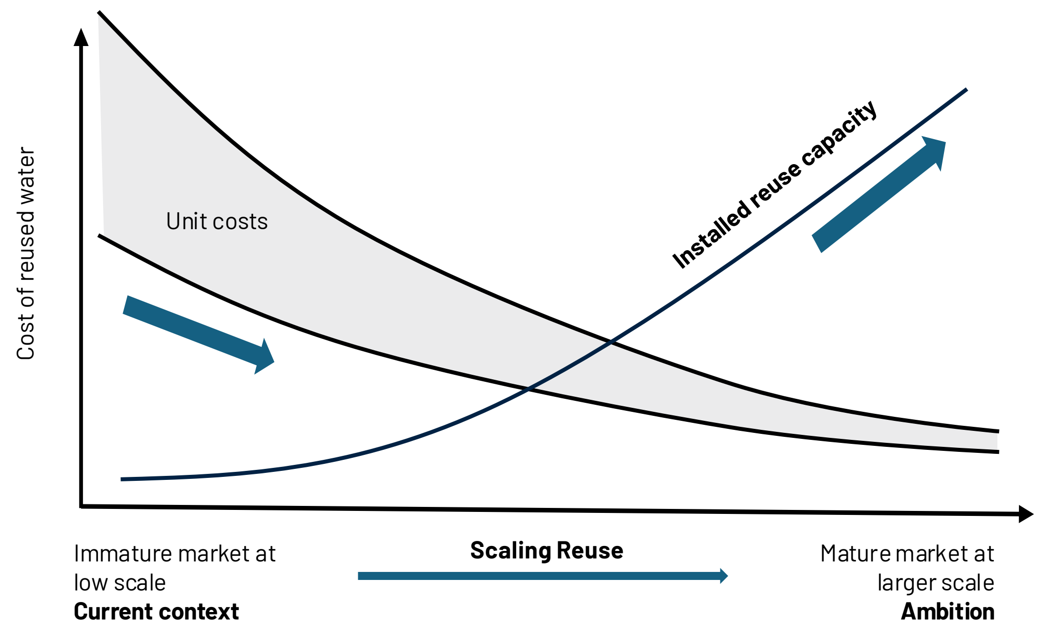
Limited Price Discovery

The scale of investments in triple-barrier treatment is small, with limited price disclosure. There is both limited data and a wide distribution in reuse costs for existing projects, characteristic of a nascent global market.

High Costs

High costs are a barrier to scaling investments because the marginal cost for reuse is often higher than the available alternatives.

FIGURE 34: Future reuse investment landscape with cost transition through scale[1]



1 Authors' conceptual framing.

Investments to meet the reuse ambition will depend on economies of scale and cost reductions achieved and could range from US$170 to US$340 billion.

Learning from experience in renewable energy (Section 2.2), the desalination market (Figure 35), and the impact of price disclosure for used water treatment (Figure 36), an appropriate ambition could be to reduce the cost of reused water to 50% of that for desalination, which is much more energy-intensive.

Investment estimates are uncertain because of the immaturity of the market and the high variance in costs. Assuming unit capacity costs in the range of US$400 to US$800 per cubic meter per day of capacity added for triple barrier treatment, and excluding collection and distribution costs, the investment opportunity to scale reuse is of the order of US$170 to US$340 billion (Figure 37). These estimates will be refined as the market develops. Knowledge transfers from one country to another can also help with market maturity and technological improvements.

FIGURE 35: Reduction in seawater desalination costs with market maturity[1]

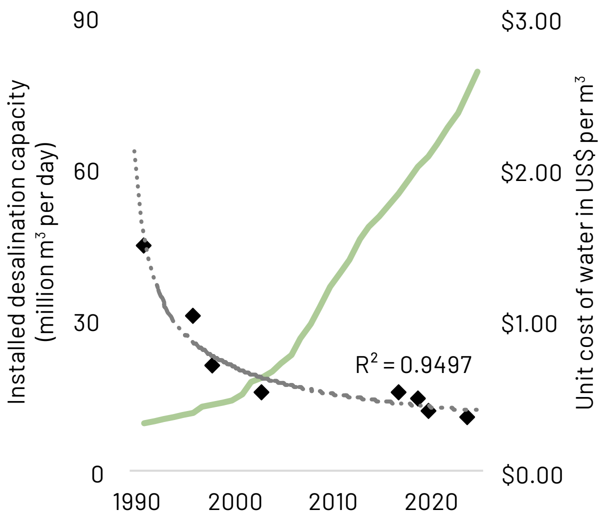


FIGURE 36: Price disclosure for used water treatment in Saudi Arabia (levelized costs per m³)[2]

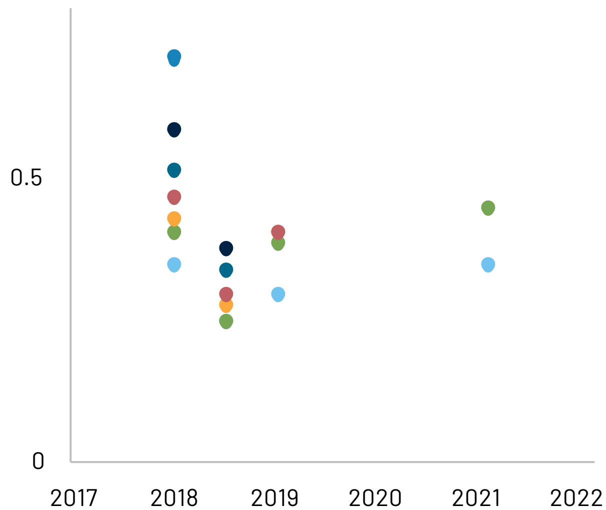
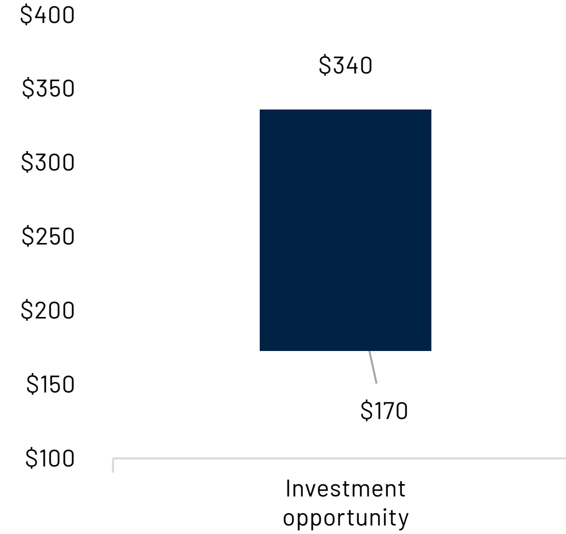


FIGURE 37: Investment opportunity for 430 million m³ per day of reuse capacity by 2040 – capital expenditure estimates (US$ billions)[3]



1 GWI data (low bids).
2 Public data on contract bid prices, from GWI.
3 Authors' estimates.

3.2 Financing Instruments for Reuse

Unlocking investments in reuse requires a combination of upstream sector reforms and the design of bankable projects with derisking.

Higher risk ⟷ Lower risk

1 Upstream
Support for Sector Reforms

Strengthening **Regulations, Pricing, and Incentives**:

- Establishment of **clear goals** for reuse, with associated institutional accountability
- **Transparent financial management** (tariff-subsidy reforms), allocation of funding to reuse, and **strategic use of public resources to crowd in the private sector** (for example, guarantees, contingent financing)
- Focus on improved sector planning for **collection and treatment systems for used water**, including utility-level master plans

+ 2 Midstream
Leveraging Private Sector Expertise and Innovation

Improving **Operational Efficiency and Financial Sustainability**:

- Mobilization of private sector expertise and innovation to support **efficiency and innovation for 'new' water**
- **Optimization** of operating costs and facilitation of investments in the circular economy (for example, biosolids management, resource recovery for additional revenue)
- **Utility turnaround** strategies to support creditworthiness for tapping private capital for infrastructure investments
- Application of **different private sector models for used water treatment and reuse**, adapted to the context (for example, performance-based contracts, concessions)
- **Project preparation** and **capacity building** of municipalities
- **Price discovery and derisking** under public-private partnerships (PPPs)

+ 3 Downstream
Finance Facilitation with De-Risking

Delivering Reuse Services and Infrastructure, including Private Capital Mobilization:

- Creation of **blended models of financing and hybrid PPPs,** combining public and private capital
- Use of **programmatic PPPs and platform approaches** for financing
- **Strategic use of guarantees for de-risking**
- Development of **risk sharing facilities**
- **Assessment of investor interest** for green, blue, and sustainability-linked financing
- Use of new financing solutions to unlock additional capital (for example, **asset recycling** to monetize the capital in existing infrastructure for new infrastructure creation)

Water reuse may require core public funding to incentivize investments and get to scale.

Considering the multiple benefits of reuse, governments need to allocate core budget to support reuse programs to enable them to get to scale, including investments in used water collection and treatment. Such funding could stem from different sources:

Financing backed by revenues from tariffs and user charges, including:

- Water and used water tariffs that recover costs;
- Abstraction fees and water resources fees that reflect the scarcity value and opportunity costs of water; and
- Discharge fees that include the full cost of pollution.

Funding from taxes: In the absence of revenues from customer fees for used water treatment and reuse, there may be a need for tax revenues to be contributed from central or local government.

Public funding could **incentivize reuse programs through viability gap funding**, where needed, in order to make reuse projects viable, as the case of Fonadin in Mexico highlights. For the Atotonilco wastewater treatment plant project, Fonadin subsidized 49% of the initial PPP project costs, reducing perceived risks for investors.[1]

Limited public funding should aim to create conditions in which private finance can be mobilized to enable scaling.


Anton/Adobe Stock

1 World Bank, *Wastewater: From Waste to Resource - The Case of Atotonilco de Tula, Mexico,* (Washington, DC: World Bank, 2018).

Private capital mobilization for reuse projects remains low to date.

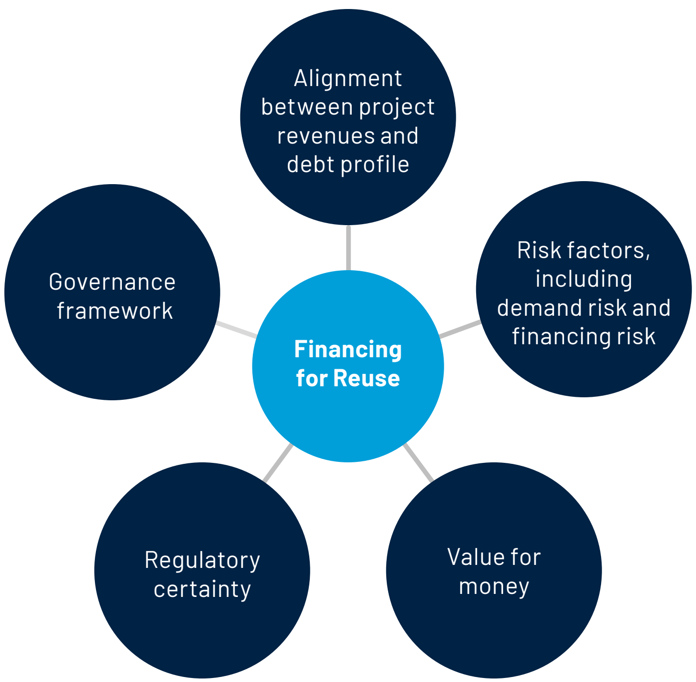
Financing for reuse investments may be undertaken through **traditional debt instruments (bonds and loans)**, drawing upon a suite of infrastructure finance options.

For example, **municipal bond issuances** present a standard instrument to support infrastructure investments and upgrades at the municipal level.

Traditional debt financing for reuse requires **formalization of governance** and either: (1) **long-term offtake agreements and/or enforceable guarantees** from a creditworthy entity (public or private); or (2) **hybrid approaches, which combine private water purchase agreements with public guarantees**.

The choice of financing is influenced by a number of factors (Figure 38).

FIGURE 38: Factors influencing the choice of financing



Considering the size of investments needed to facilitate 25% reuse of municipal freshwater withdrawals, public funding may be insufficient to support the scaling of reuse, necessitating the mobilization of concessional and commercial financing.

Nonetheless, private investment in the treatment of used water and creation of purified new water is hindered by a number of factors:

Affordability:
- Multiple jurisdictions suffer from the lack of willingness to charge for the treatment of used water; collection and treatment charges could be covered in water bills.
- Willingness to pay for the treatment of used water is another constraint, often lower than for water supply, with resultant tariffs unable to cover even operating expenditure.

Bankability:
- Low tariffs and the subsidized price of water impact the bankability of projects.
- In addition, the low creditworthiness of utilities constrains the ability to raise capital, coupled with a currency mismatch between the local currency-denominated water tariffs and hard currency financing of international lenders in many markets.

Capacity Constraints:
- Absence of capacity, efficiency, and scale in local governments to develop and negotiate PPPs limits market and investor interest.

Project-Specific Factors:
- Difficulty in developing long-term water purchase agreements with larger offtakers impacts the development of bankable reuse projects.
- Moreover, the lack of reliability in raw water quality affects the possibility of supporting reuse projects.

Multiple financing instruments could be applied to reuse.

Various financing mechanisms could be applied to reuse investments (Figure 39).

As a first step, public and concessional resources should be prioritized for reuse, while ensuring efficiency in their use to crowd in private capital. Where missing, public funding may be needed for investments in used water collection and treatment to enable reuse.

Private capital may be mobilized through traditional infrastructure (debt) financing; joint ventures; blended finance instruments that make use of climate finance; a variety of green, blue, and sustainability-linked financing and outcome bonds; as well as asset recycling.[1]

The specific financing instrument chosen will depend on a number of factors:

- **Underlying Risk Profile of the Investment:** Where reuse investments are not fully commercial, there may be a need to apply blended finance approaches, which make use of climate finance, considering the core contribution of reuse to adaptation and resilience.
- **Asset Ownership:** Where the public and private sector intend to pool equity and expertise, joint ventures may be preferred.
- **Investor Preferences and Potential Premiums:** Certain capital market players may offer premiums for green and blue financing, where such investments meet core investment strategies. Others may prefer outcome bonds and sustainability-linked financing, which align with their sustainability vision.
- **Presence of Existing Treatment Infrastructure:** In cases where there is an existing used water treatment plant, the capital in such infrastructure may be monetizable through asset recycling, supporting additional reuse infrastructure and associated revenue streams.

FIGURE 39: Funding and financing options for reuse

- Core Public Investments in Reuse
- Infrastructure Debt Financing
- Joint Ventures
- Blended Finance, including Use of Climate Finance
- Green, Blue, Sustainability-Linked Financing and Outcome Bonds
- Asset Recycling

tuastockphoto/Adobe Stock

1 PPPs and concessions offer another route for capital mobilization. This is covered under Section 3.3 on Delivery Models for Reuse.

Joint ventures between public and private companies, with strategic offtake of the treated water by a large player as one of the core enablers, can support the mobilization of capital.

In the face of growing water scarcity and increasing environmental concerns, the **development of reliable water sources has become a critical priority for industrial companies, making them a natural partner of water utilities** for the development of water reuse projects.

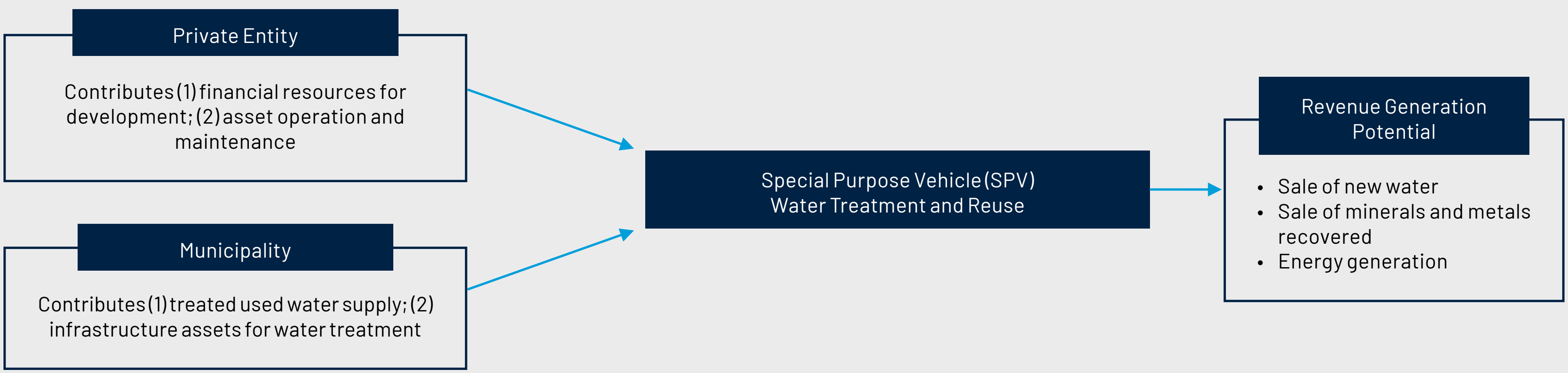
By leveraging the strengths and resources of both private and public sectors, these collaborations can create robust platforms for the development and implementation of water reuse projects.

A key component of these partnerships is the joint investment of equity and the collaborative effort to raise finance. Both private and public partners can contribute capital, sharing the financial burden and risks associated with large-scale water reuse projects. This joint investment not only enhances the financial viability of the projects but also fosters a sense of shared responsibility and commitment to their success.

The private sector partner, typically an industrial entity, plays a crucial role by offering a guarantee of offtake, committing to purchasing a specified amount of the treated water and thereby providing a reliable revenue stream for the project. This guarantee of offtake is essential for securing financing, as it assures investors of a steady demand for the water produced, thereby reducing financial risk.

On the other hand, the public utility guarantees the supply of raw water to the treatment facilities, ensuring that the water reuse project has a consistent and reliable source of water to treat and recycle. The public utility's involvement is vital for the operational stability of the project, as it leverages its existing infrastructure and expertise in water management to support the initiative.

By pooling resources and expertise, both sectors can optimize the use of available water resources, reducing waste and enhancing sustainability.



While the treatment and reuse of used water addresses climate change mitigation and adaptation, current levels of global climate finance flowing to reuse remain low.

FIGURE 40: Global climate finance mobilized (US$ billions)[1]

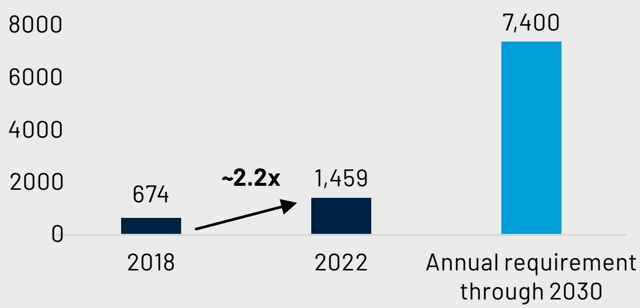
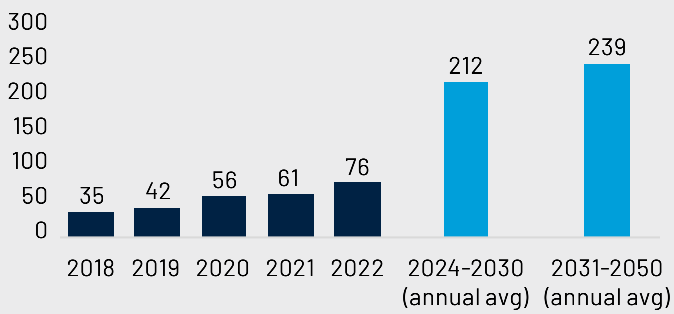


FIGURE 41: Global adaptation finance flows vs needs (US$ billions)[1]



Overall, annual climate finance has more than doubled between 2018 and 2022, from **US$674 billion to US$1.46 trillion**. Nonetheless, this **falls short of the US$7.4 trillion required per year through 2030 under a 1.5° Celsius scenario** (Figure 40), with current climate finance representing only **1% of global GDP.**[1] Moreover, 90% of climate finance goes to mitigation, with very low levels of adaptation finance.[2]

Adaptation finance reached US$76 billion in 2022, more than doubling from US$35 billion in 2018. **In addition, the water and 'waste' water sector received 44% of all adaptation finance**, directed toward projects for enhancing water supply and used water treatment. Nonetheless, current levels of adaptation finance remain insufficient. Developing countries alone have estimated needs of US$212 billion per year in adaptation finance up to 2030, and US$239 billion per year between 2031 and 2050 (Figure 41).

The private sector contributes 40% of overall climate finance for both mitigation and adaptation in emerging markets and developing economies, a figure that must rise to 80% to meet climate investment needs in these geographies.[3] With respect to adaptation finance, the public sector accounts for 98% of all such finance, indicating the possibility of tapping much higher levels of private capital.

The treatment and reuse of used water can make an important contribution to climate change mitigation and adaptation but does not yet attract the levels of climate finance commensurate with this contribution. With appropriate structuring of climate finance, the investment gap to support higher levels of reuse can be closed, while mobilizing private capital.

1 Baysa Naran et al,. *Global Landscape of Climate Finance 2024: Insights for COP 29* (San Francisco, CA: Climate Policy Initiative, October 2024).
2 International Monetary Fund, Global Financial Stability Report: Financial and Climate Policies for a High-Interest-Rate Era (Washington, DC:IMF, October 2023).
3 Barbara Buchner et al., *Global Landscape of Climate Finance 2023* (San Francisco, CA: Climate Policy Initiative, November 2023).

Climate finance could be used for structuring blended finance solutions, in turn making reuse projects viable, where needed.

Unlocking blended finance for water reuse requires a multi-pronged approach, including deepening capital markets and improving sector fundamentals to lower the cost of capital.

Blended finance uses grants, concessional resources, and development finance strategically to crowd in additional capital, particularly commercial finance. Such solutions can help:

- **Leverage limited public and philanthropic capital** with private capital
- **Reduce costs** to make projects financially viable
- **Ensure affordability**
- **Enhance impact** by using public resources to meet core development objectives for the poor and vulnerable, while leveraging the private sector to bring in efficiency, innovation, and scalability.

Blended finance can provide quick-win solutions and support to create long-term sustainable markets. In particular, blended finance instruments can make **reuse projects viable while the market is still developing and ensure that such investments are affordable.** Such blended finance solutions can in turn make use of climate resources.

Blended finance for reuse projects should assess the following factors:

Financial Case for Blended Finance:

Supporting projects where investments would not be viable in the absence of blended finance.

Commercial Sustainability:

Assessing the ability of the project to crowd in private capital and pave the way for commercial sustainability.

Risk-Return Profiles:

(1) Combining different types of capital, including concessional resources, debt, equity, and guarantees, to optimize risk-return profiles and (2) aligning financial incentives.

Justification for Climate Finance:

Demonstrating scientific evidence of climate impact

Programmatic approaches could include a one-stop shop to help interested municipalities with support on regulations, guidelines, transactional support, as well as blended financing models, which make use of climate finance.

Sustainability-linked financing and outcome bonds can support specific results and outcomes tied to water reuse.

Green and blue financing adopts a use-of-proceeds approach linked to climate outcomes that qualify for a green or blue label. Green or blue loans, typically facilitated through private transactions, are somewhat smaller in size than green and blue bonds.

Sustainability-linked bonds and loans (sustainability-linked financing, or SLF) are debt instruments structured to incentivize issuers to achieve certain sustainability targets, independent of the specific use of proceeds. These are typically structured with a coupon step-up as a penalty against the achievement of agreed targets, and a coupon step-down in case of over-achievement of set targets. Given its outcome focus, as opposed to a use-of-proceeds focus, SLF rewards implementation of multifaceted approaches to achieve ESG goals. **Such financing can be tied to key performance indicators linked to reuse.**

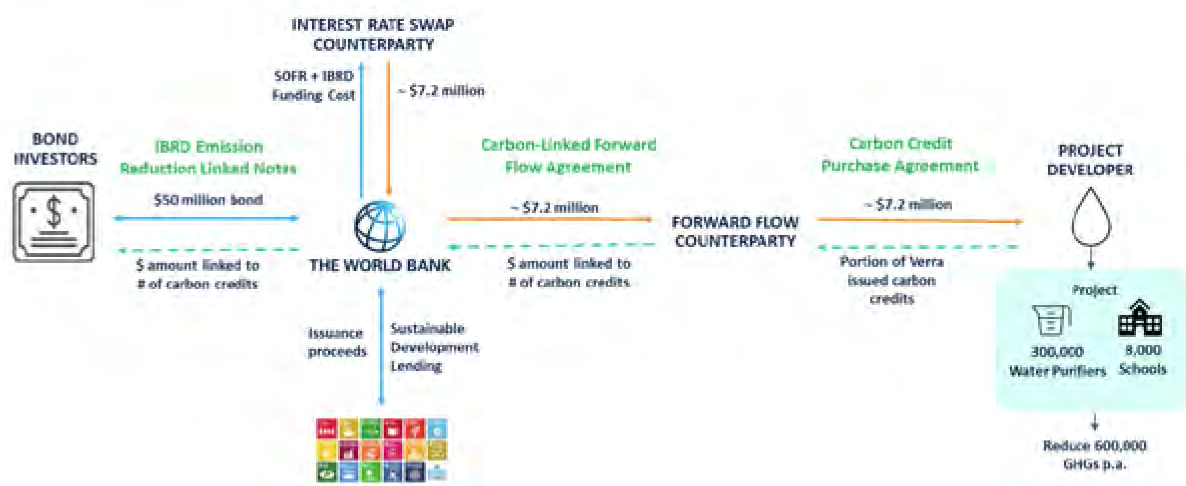
Outcome bonds provide investors the opportunity to support specific development outcomes, harnessing private capital and transferring project performance risk to investors, who are rewarded if the underlying activities are successfully concluded. Such outcome bonds could be adapted to the reuse space, linked to the generation of carbon credits for mitigation outcomes, as well as potentially used water reuse credits. The Vietnam Emission Reduction-Linked Bond offers a possible template for financing climate-friendly solutions (Figure 42).

The Vietnam Emission Reduction-Linked Bond raised financing for a climate-friendly project. Key features included:

- **100% principal protected bond,** with investors receiving the return of principal plus a minimum return at maturity
- **Use of foregone ordinary bond coupons** (monetized through an interest rate swap) **to make upfront financing available to a climate-friendly project** that will generate carbon credits in the future
- **By securitizing the future carbon credit sales revenue**, bond investors earn coupons linked to the number of verified carbon credits generated by a project

The bond was privately placed with three institutional investors and the structure has the potential to serve as a model for replication to support other climate-friendly projects, including **reuse investments**.

FIGURE 42: Structure of the Vietnam Emission Reduction-Linked Bond



Asset recycling can monetize the capital in existing infrastructure to support new infrastructure creation.

Promotion of reuse investments may be supported through asset recycling as a way of unlocking the value of capital invested in existing infrastructure (brownfield assets), including investments in the treatment of used water, without increasing the government's debt levels and/or taxes.

The proceeds from asset recycling can be reinvested into the development of new infrastructure (greenfield projects), covering the operations and maintenance costs of existing infrastructure and supporting solutions such as reuse. Asset recycling can support better utilization of assets through the creation of additional revenue streams and risk mitigation associated with design, development, and construction, thereby attracting more investors.

Generally, three monetization models can be applied: (1) direct contractual arrangements, such as brownfield concession agreements, operations and maintenance concession agreements, or long-term public-private lease agreements; (2) **divestment,** where the public sector sells its interest in the asset to the private sector; and (3) **structured finance instruments** like pooled investment vehicles, which enable asset owners to monetize their assets by integrating various revenue-generating assets under a single entity via a trust structure.

Asset recycling can generate revenues in a number of different ways. Under direct contractual agreements, where public sector entities monetize brownfield infrastructure assets without losing ownership of the underlying asset, a private sector concessionaire may engage to provide the public service for a specified period against payment of an upfront concession fee. In such situations, the concessionaire may further develop or expand the asset to enhance its revenue generation capacity. Private sector participation could also support operational efficiency gains, along with improved service delivery resulting in new revenue streams. In the case of used water treatment assets, private sector participation may support the sale of treated used water, metal and mineral recovery, as well as energy co-generation, which could offer additional revenues.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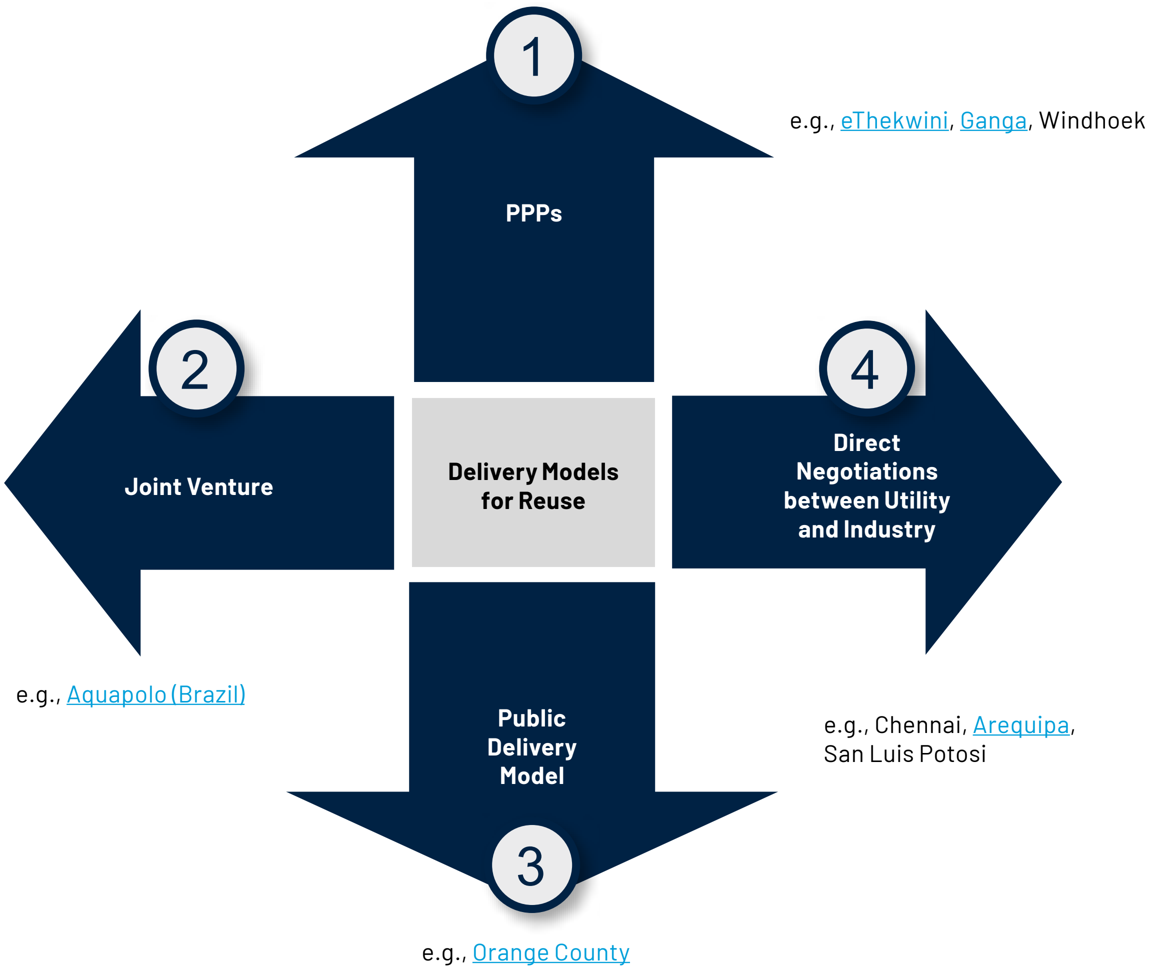
3.3 Delivery Models for Reuse

Water reuse projects can be delivered through various combinations of public and private sector participation

FIGURE 43: Reuse delivery models



The choice of instrument deployed for water reuse (Figure 43), particularly between public procurement and private sector participation, could include the following considerations:

- **Upfront Costs by Authority:** While in public procurement, the government incurs the entire capital cost up front, in a PPP, capital expenditure may be financed in part by the private sector, recovered through performance-linked payments over the concession period. In a joint venture, the private entity may bring the majority of the capital requirement for the Special Purpose Vehicle (SPV).
- **Operational Efficiency:** In a PPP and joint venture, the operator's incentives could be designed to support quality and efficiency of operations and maintenance, as payments may be linked to performance.
- **Lifecycle Costing Approach:** A private sector operator may be incentivized to consider lifecycle costs in the design, construction, and maintenance of the asset, ensuring efficient and long-lasting assets.

The private sector can play an important role in the treatment of used water and creation of new water, as both solution providers and financiers.

The financing, development, and operation of facilities to treat used water and create 'new' water are well-suited to long-term PPPs, considering the long-life, capital-intensive asset base, with the potential for ring-fenced responsibilities removed from retail service provision, and performance-linked payments. Understanding the appropriateness of a PPP to support used water treatment and reuse requires an analysis of value for money, affordability, fiscal commitments and contingent liabilities, and commercial viability for the transaction to attract developers and lenders. In addition, it requires an assessment of which components of the project are best suited to be delivered through the private sector, covering design, construction, operation, maintenance, and financing across a number of infrastructure assets, including greenfield or brownfield used water treatment plants, the water reclamation facility, and the reclaimed water storage, conveyance, and distribution infrastructure.[1]

Advancing reuse projects may require additional measures to enhance bankability. For example, payment security may be improved through the ring-fencing of revenues for corporatized entities and escrow arrangements, and the use of fiscal transfers in cases where tariffs fall below costs and do not yield sufficient returns to recover investments.[2]

cherryandbees/Adobe Stock

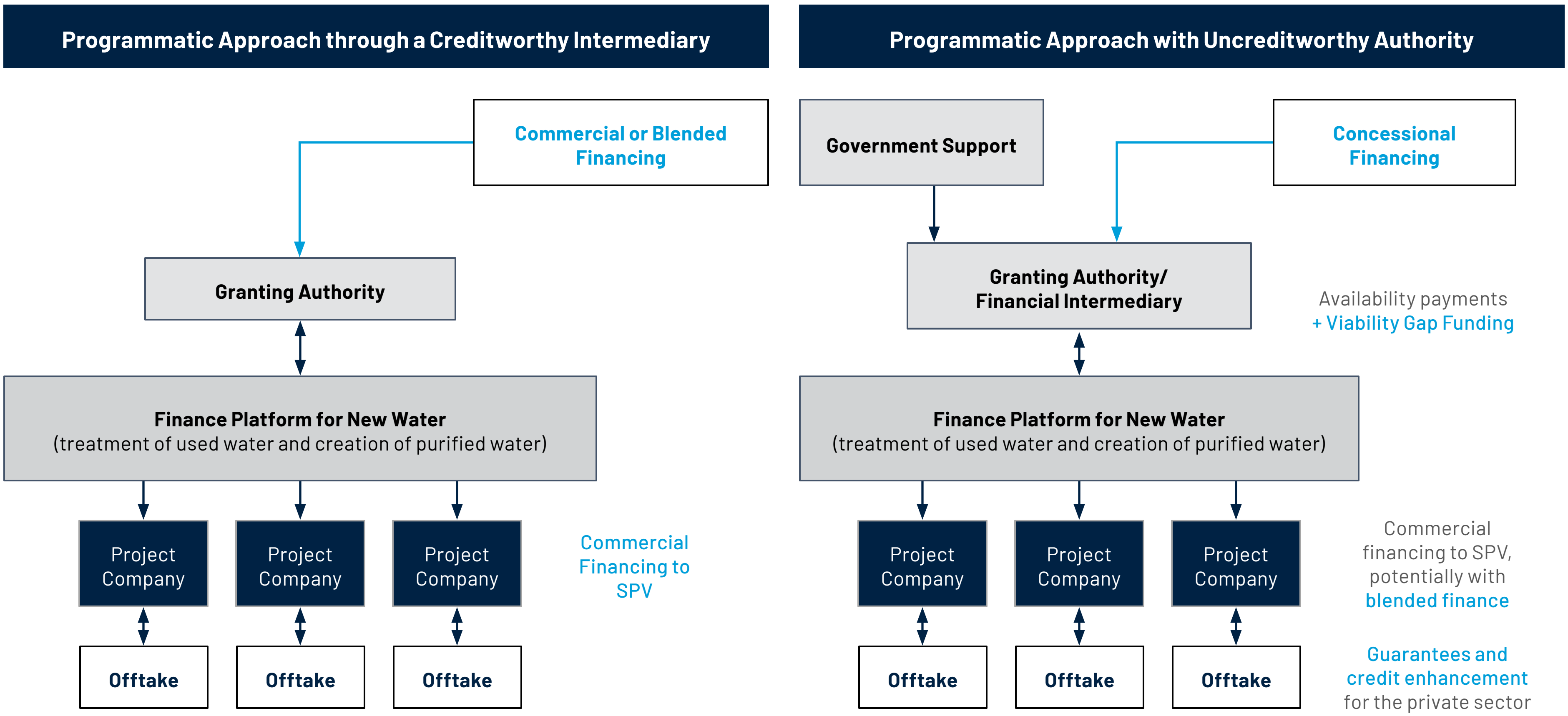
1 Rochi Khemka, et al., *Scaling up Finance for Water: A World Bank Strategic Framework and Roadmap for Action* (Washington, DC: World Bank, 2023).
2 Ibid.

Governments can enable scale through the development of national programs and structured long-term partnerships with the private sector that support price discovery.

Individual new water projects can be transaction-intensive. Governments can reduce time and costs, achieve scale, and attract international investor interest through a programmatic approach (Figure 44), structuring long-term partnerships with the private sector in the form of PPPs. A programmatic platform approach can create price discovery on the unit costs of creating new water, bring down costs, and achieve scale, similar to the trajectories of the desalination and renewable energy sectors. This also offers economies of scale to investors, lowering the cost of finance.

Where granting authorities and intermediaries are creditworthy, commercial financing can be mobilized in various ways, including through programmatic or project-based SPVs. In other cases, the mobilization of commercial financing might require one or more of the following elements: (1) concessional financing for the financial intermediary to support viability gap funding, along with commercial financing for the project SPV, and/or (2) potential payment guarantees to the private sector.

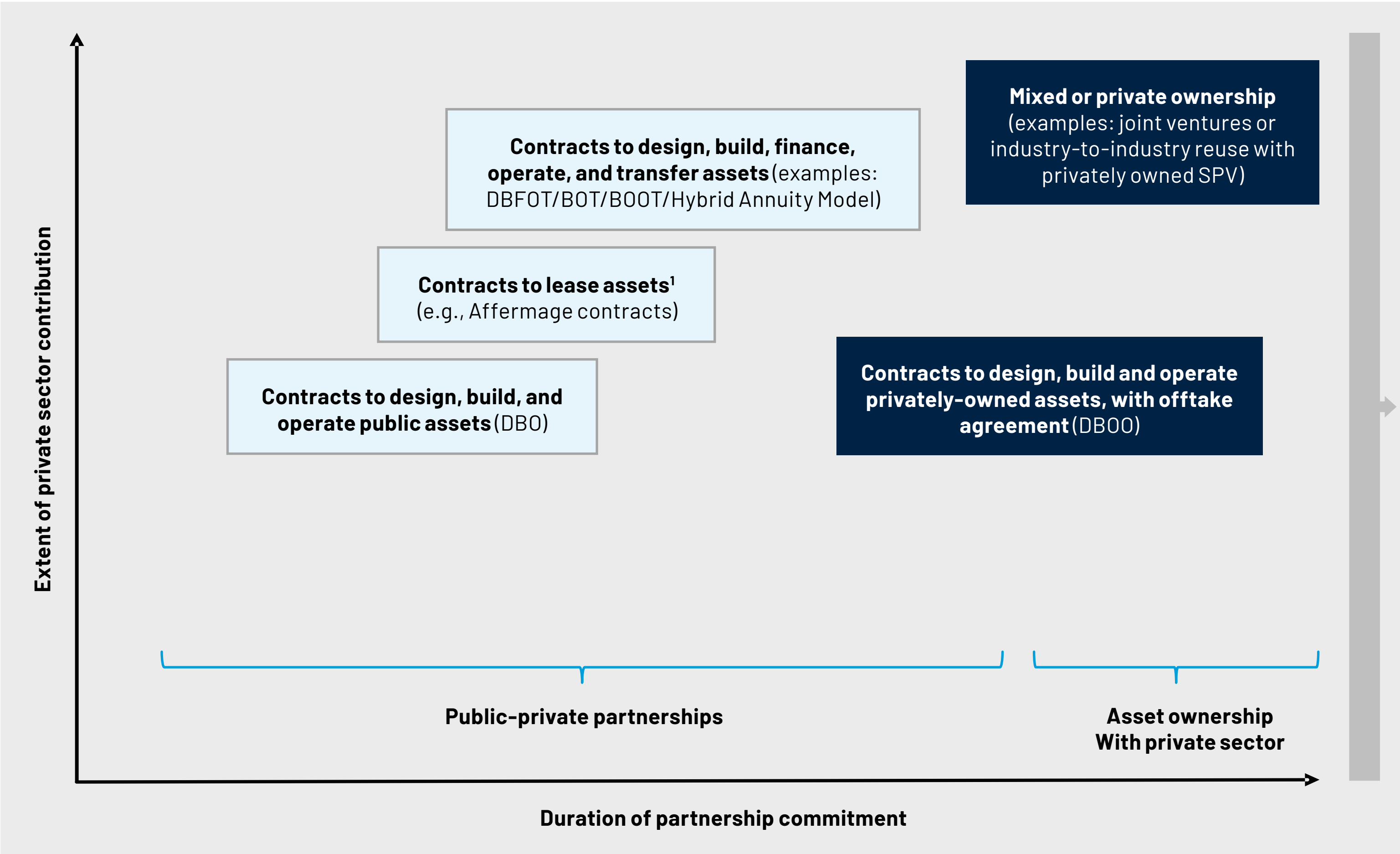
FIGURE 44: Programmatic approaches to support the mobilization of private financing for new water creation



There are various ways in which partnerships with the private sector can be structured.

PPP contracts are procurement models that enable the effective harnessing of private sector expertise, stimulate innovation, and achieve cost reduction through competitive price disclosure of the full levelized costs of new water creation. The actual choice of PPP contract model (Figure 45) will depend on many factors. These include, for example, the extent to which governments and industrial players intend to mobilize private or off-balance-sheet financing, the availability of public funding, and the degree of risk transfer.

FIGURE 45: Options for partnerships with the private sector on reuse



Select Examples of PPP Structures Used for Water Reuse:

- **Hybrid Annuity Model:** Clean Ganga
- **BOT End User Contract:** Nagpur and MahaGenCo
- **BOOT Contract:** eThekwini Water Recycling
- **DBOT:** Windhoek Water Reclamation Plant

Notes: O&M: Operations and Maintenance; DBO: Design-Build-Operate; DBOO: Design-Build-Own-Operate; DBFOT: Design-Build-Finance-Operate-Transfer; BOT: Build-Operate-Transfer; BOOT: Build-Own-Operate-Transfer; SPV: Special Purpose Vehicle; DBOT: Design-Build-Operate-Transfer.

1 Lease contracts are primarily applied for used water treatment infrastructure.

The key characteristics for contracts with the private sector will depend on the contracting goals and source of finance.

The DBO, DBOO, DBFOT, and BOT models (Figure 46) have the advantage of price disclosure of the full levelized cost of treated or sold water. In the context of transparently tendered projects, this can create competitive price pressures, driving innovation and efficiency. The Hybrid Annuity Model has the advantage of being able to mobilize public and private capital for the development of capital-intensive infrastructure, in contexts where end-use tariffs do not recover costs and/or affordability is a primary concern.

FIGURE 46: Key characteristics of different contract types with the private sector

	Lease[1] (Affermage)	Design-Build-Operate	Design-Build-Operate-Own	Design-Build-Finance-Operate-Transfer	Hybrid Annuity
Major contribution by the private sector	Operational expertise	Design, construction, and operational expertise	Financing, innovation and levelized-cost price discovery in addition to DBO contribution		
Source of funds for capital expenditure	Public sector		Private sector	Public and private sector	
O&M risk transfer	Partial risk transfer (dependent on assets)	Full transfer of O&M risk			
Primary bid parameter	Lowest operator tariff per m^3	Lowest levelized cost of water per m^3		Lowest annuity or viability gap funding	
Revenue to private partner	Operator tariff times volume of water treated/sold	Availability charge for fixed costs; variable payments linked to volume of water treated/sold. Could be supported by a minimum payment guarantee.		Annuity	Construction-linked payments/annuity
Tariff	If tariffs are less than operator's tariffs, government pays the gap, and if greater than operator's tariff, government receives revenue share	Tariff can be independent of what the government pays to the PPP. The bid tariff recovers the full levelized cost of water.			

1 Lease contracts are applied primarily for used water treatment infrastructure.

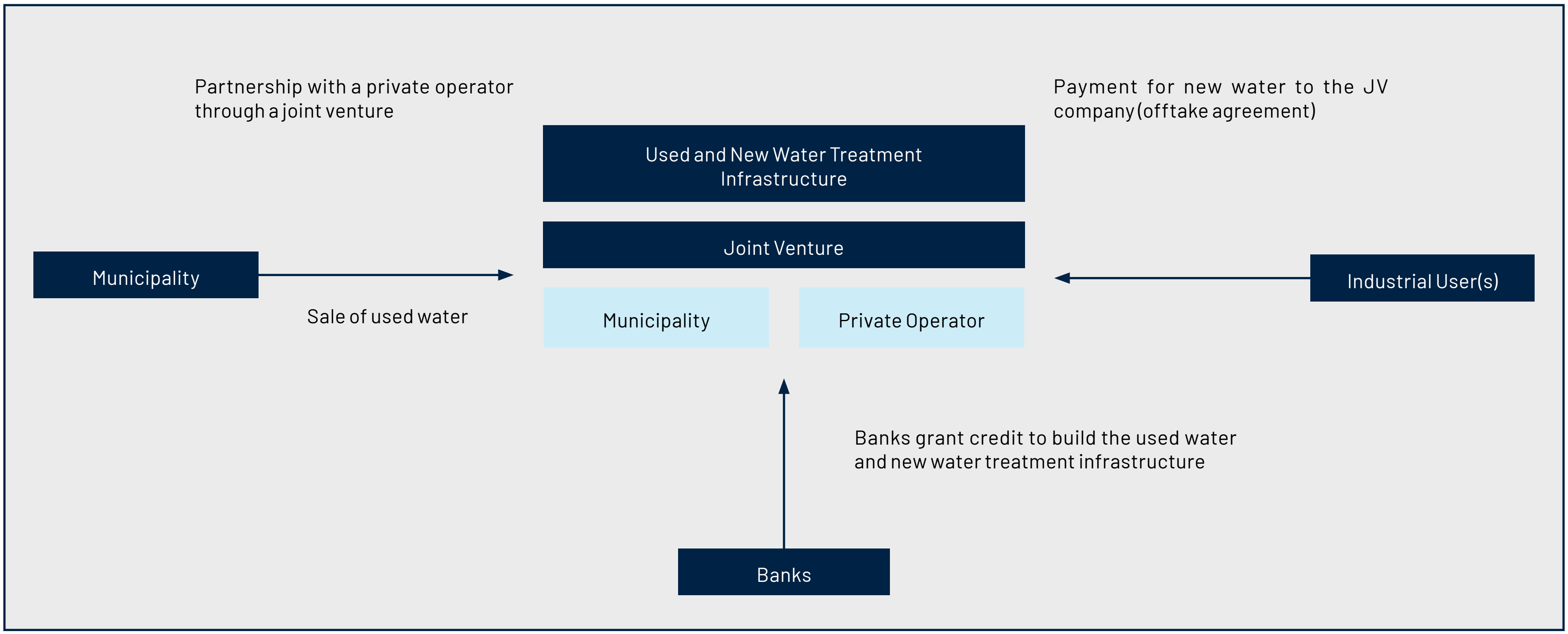
A joint venture between municipal government and private sector can support the establishment of companies that deliver 'new' water from used water.

Municipalities or their utilities can partner with a private operator through the establishment of a joint venture company to undertake the treatment of used water and creation of 'new' water.

The joint venture could be structured so that a municipality would receive: (1) income from the sale of used water to the joint venture (JV) company and (2) dividends from profits of the JV company. The JV company or private operator could raise debt from commercial banks, with the JV company guaranteeing payment through revenues from the sale of new water, structured as a take-or-pay agreement. The JV company's mandate could extend to the rehabilitation and operation of existing used water treatment plants and/or construction of a new plant for the treatment and sale of new water to industrial users.

This model (Figure 47) builds on the experience of Aquapolo (Annex 3) and is currently under exploration in Chihuahua, Mexico; Malaysia; and other geographies around the world.

FIGURE 47: Possible structure of a joint venture to create and sell new water



Direct negotiations between utilities and industry can customize the level of treatment required based on the reuse application and respective capacities.

Industrial water reuse can be implemented through various models that depend on the level of treatment provided and the capacity of municipal utilities or private industries to manage further treatment (Figure 48). These models highlight the collaboration required between utilities and industries to promote sustainable water management. Long-term water purchase agreements with offtakers can support project bankability, similar to those used in renewable energy projects, which rely on power purchase agreements.

FIGURE 48: Applicability of reuse models

Model	Example	Applicability	Demand Creation
Sale of **Tertiary Treated Water** by Utility to Industrial End User	E.g., **San Luis Potosi, Mexico** with new water used for cooling purposes in a thermal power plant	**Strong capacity at the municipal level** to operate tertiary treatment facilities	The core driver of industrial demand for reuse in these contexts is: (1) **water scarcity**, driving a move toward resilience through the use of municipal used water, and (2) **water security**, ensuring reliability of supply.
Sale of **Secondary Treated Water** by Utility to Industrial End User with Further Treatment by Industry Onsite	E.g., **Chennai, India**, with provision of 30 megaliters per day of secondary-treated used water for 3 petrochemical industries	**Financial capacity of the private sector** to facilitate further treatment on site	
Provision of **Raw Sewage** to Industry for Treatment and Reuse	E.g., **Arequipa, Peru** with the mining company, Cerro Verde, operating the used water treatment plant	**Locations with a large industrial water user** with the ability to pay for treatment of used water	

Where the public sector has adequate capacity, it can support the delivery of new water projects through public funding, ownership, and operation.

Key Considerations for Public Sector Delivery

Technical Capacity	Financial Capacity	Ability to Serve End Users
Capacity to design, build, own, operate, and maintain treatment and reuse infrastructure	Adequacy of public funding to meet investment requirements	Capacity for structured engagement with users (e.g., major industrial users) and citizens (e.g., for potable reuse)

Creditworthy utilities may tap commercial financing to fund reuse projects.

Examples

Orange County, California, USA

Indirect Potable Reuse

The State of California provided 54% of capital cost through grants (US$10 million) and low-interest public loans (US$481 million). The remainder was funded by local water agencies (Orange County Water District and Orange County Sanitation District) via their own public funds and bonds.

Beaufort West, South Africa

Direct Potable Reuse

Implemented by the Beaufort West municipality during a severe drought, with the entire construction paid for with South African government emergency funds. The national treasury provided roughly R24 million (about US$1.3 million) to cover construction costs in 2010. Implementation was through a long-term PPP contract.

4. HOW can investments in reuse be scaled?

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4.1 Mechanisms to Support Reuse

A wide array of mechanisms and instruments are available to support investments in reuse.

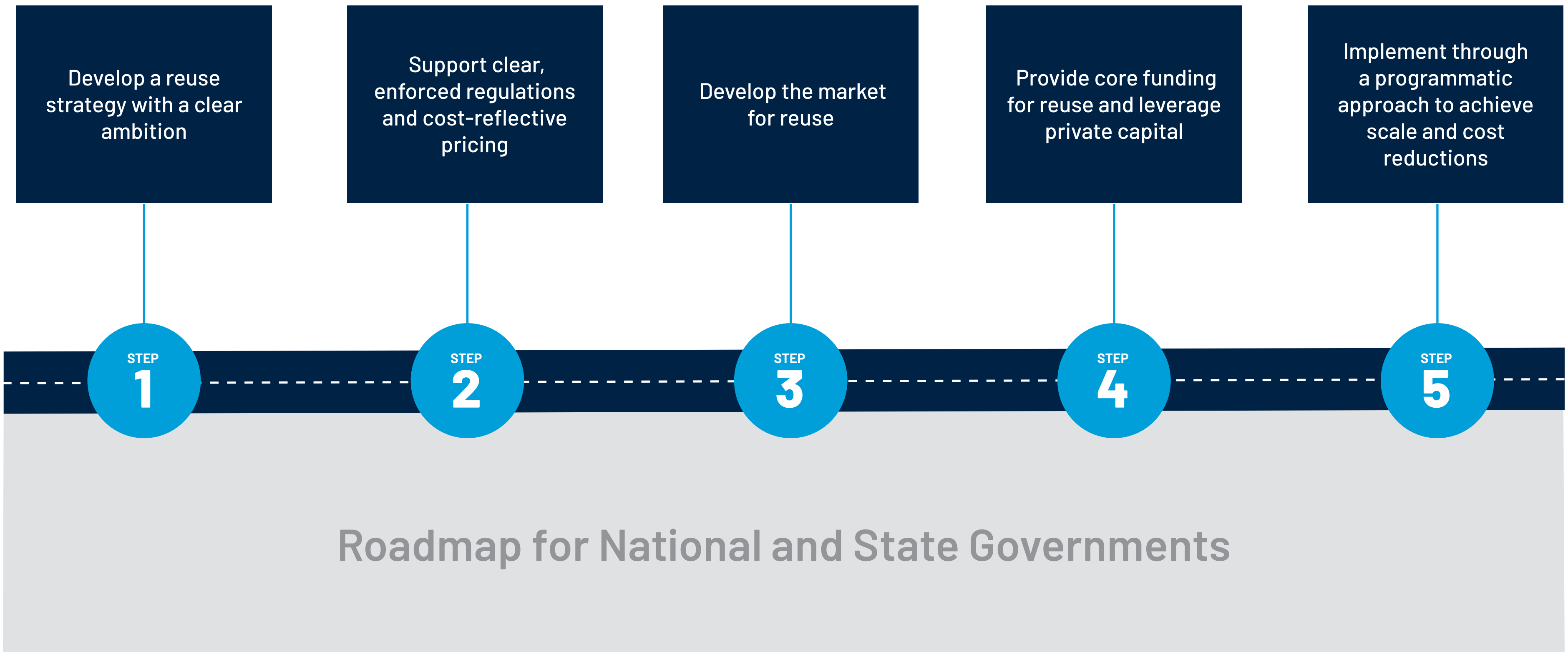
This section outlines roadmaps for national and state governments, municipalities and utilities, and corporates and industries to support reuse. The mechanisms to accelerate reuse available to different stakeholders vary, as highlighted under the various roadmaps, with a few cross-cutting themes, as included below.

Cross-cutting elements

National/State Governments	Municipalities/Utilities	Corporates/Industries
Reuse ambitions, strategies and goals, integrated planning		
Regulation through discharge & abstraction licenses (and limits)	Land-use planning and bylaws	Internal water fee
Pricing and resource charges	Taxes and local pricing	Internal water markets
Cap and trade instruments	Industrial zone management	Disclosure
Baseline and credit instruments	Stakeholder engagement	Cap and trade instruments (voluntary settings)
Tax credits		
Multi-project pipelines (programs and programmatic PPPs)		
Reuse in industrial parks and economic zones		
Financing instruments		
Public-private platform approaches		

4.2 Roadmap for National and State Governments

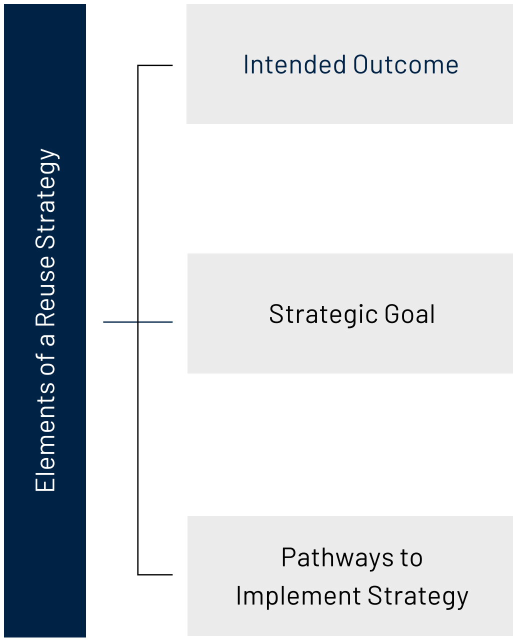
National and state governments can support reuse through a clear strategy, market creation, and programmatic approaches.



Note: Activities can proceed in parallel.

STEP 1: DEVELOP A REUSE STRATEGY WITH A CLEAR AMBITION

The first step in driving reuse is to define a clear reuse strategy, articulating the core drivers for reuse and the desired outcomes, as part of an integrated national water strategy.



Countries and regions that have achieved high rates of reuse capacity have done so through the development and implementation of water reuse strategies, articulating a **well-defined ambition.** This should be part of a broader and integrated water resources strategy that addresses the overall allocation of water resources, balancing economic, social, and environmental interests and associated rights.[1]

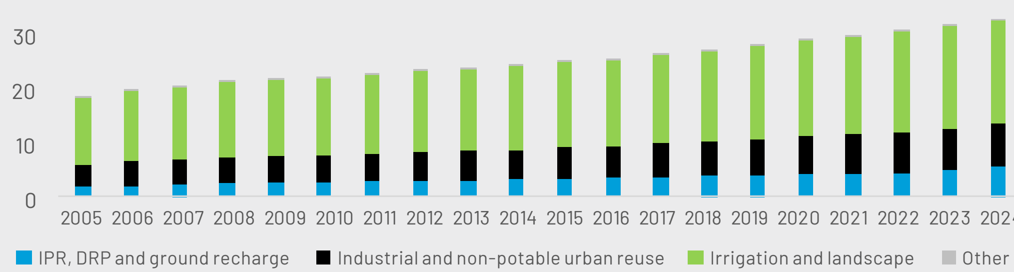
The strategic goal and drivers for reuse may vary depending on the context, for example:

- **Water Security:** In the case of **Singapore**, water security was a key driver of reuse. Singapore had limited internal freshwater resources and was reliant on imported water. The need to reduce dependence on imported water led to the development of reuse capacity as part of a comprehensive water strategy. Singapore had an initial goal to supply 40% of its water needs from reused water and subsequently increased this target to 55%.
- **Water Scarcity:** The **United Arab Emirates**, with extremely limited water resources, developed a comprehensive water security strategy that included a target of reusing 95% of their 'waste' water by 2036.
- **Water Pollution**: In the State of **Haryana, India**, a combination of scarcity and pollution is driving the reuse agenda. The Haryana State Government issued a policy in 2019 on the treatment and reuse of used water, with the goal of achieving 50% reuse of treated wastewater by 2025 and 80% by 2030.

The strategy should also address the question of "how" reuse can be implemented by outlining the policies, institutional arrangements, legislation and associated regulations, plans, funding, financing, and implementation mechanisms to support reuse.

Potable reuse is being actively explored in the western United States (including **California**) as insurance against an increasingly unpredictable freshwater supply, and in the context of growing competition for freshwater resources. In a context of constrained surface water resources, the cost of reuse for coastal cities should be compared to the next best alternative, desalination. All things being equal, reuse projects are expected to be less costly compared to desalination.

FIGURE 49: Installed reuse capacity by major application in the United States (million m³ per day)[2]



1 For discussion on water allocation, see Zhang et al. (2024).
2 Data from GWI project tracker database (as of March 2025).

STEP 2: SUPPORT CLEAR, ENFORCED REGULATIONS AND COST-REFLECTIVE PRICING

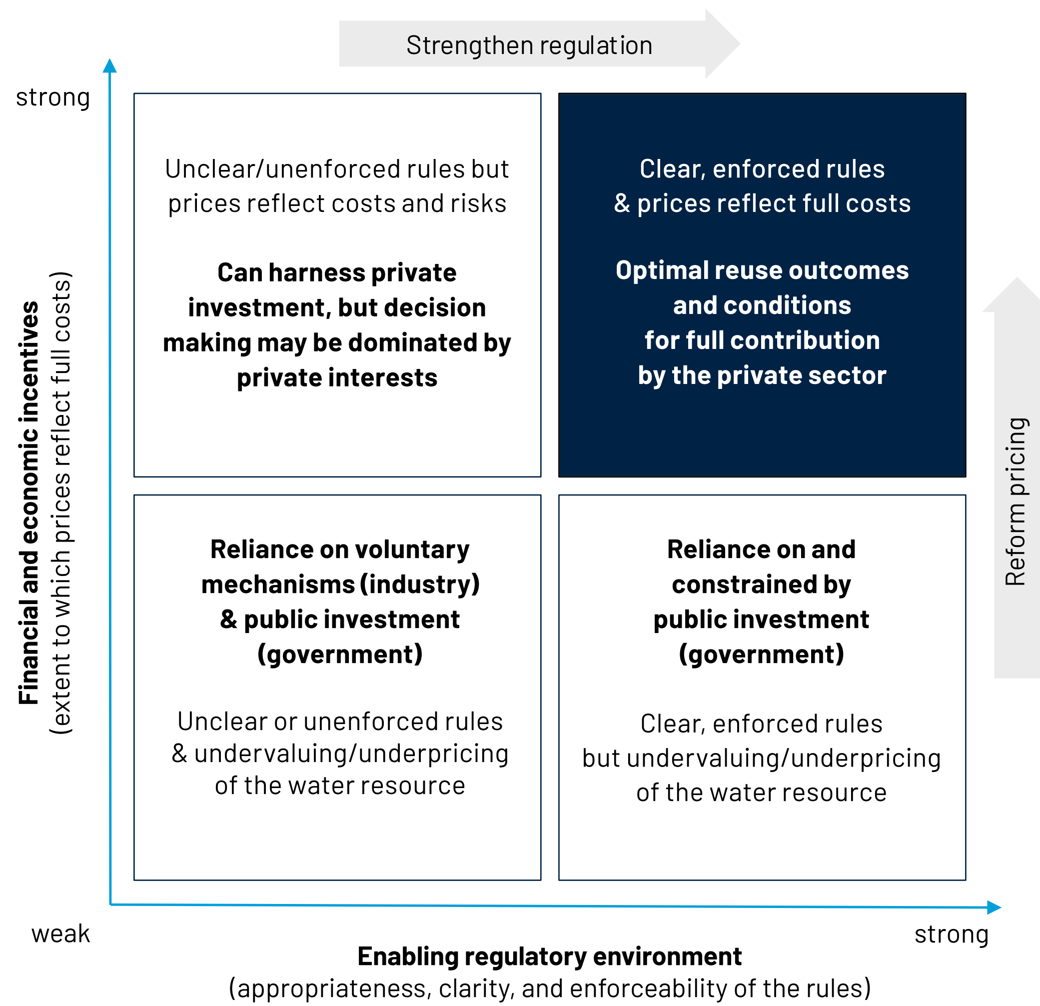
Regulations and pricing are central pillars for reuse investments. With weak pricing, investments are constrained by public funding, and with weak regulations, scalability is hampered.

Investments in reuse are strongly influenced by the regulatory environment and the cost of water abstraction/purchase and discharge, relative to the alternatives. This means that regulatory frameworks need to be fit-for-purpose and enforceable, matched to the local context and capacity, and that water prices need to reflect costs. These actions can support a conducive environment for expansion of reuse through private investment.

- **Where the regulatory environment is weak and water is underpriced (bottom left quadrant)**, investments in reuse will depend on government funding and voluntary mechanisms by industry.
- **Where the regulatory environment is weak, but prices reflect actual costs, perhaps because self-investment is the only way to secure reliable water (top left quadrant),** investments in reuse could be financed by the private sector. However, these investments may be transactional and may not achieve scale.
- **Where the regulatory environment is strong, but prices don't reflect costs (bottom right quadrant),** investment is reuse will be heavily reliant on public funding and may be constrained by the availability of such funding.

In these cases, the pathway to scaling reuse in a sustainable way is to improve regulation and/or move towards cost-reflective pricing, depending on the starting point, to get to the upper right quadrant.

FIGURE 50: Pathways to scaling reuse through regulatory and/or pricing reforms



STEP 2: SUPPORT CLEAR, ENFORCED REGULATIONS AND COST-REFLECTIVE PRICING

Pricing reforms can create revenue flows and incentives for reuse, while clarity and enforcement of regulations can support the achievement of intended reuse outcomes.

Pricing-related actions that governments can take to get results:

Water or Used Water Tariffs	Abstraction Fees	Discharge Fees	Matching Willingness to Pay and Value of Use	Pricing Reforms
Recovering the costs of treatment through a water and/or used water tariff will support greater investments in collection and treatment of used water, which is an important first step and key enabler of water reuse.	**Setting abstraction fees** to reflect the scarcity of water and its opportunity cost (value in next best alternative use) will influence industry investment decisions and make water reuse more attractive relative to the alternatives.	**Setting discharge fees** to incorporate the full cost of pollution on the environment will result in increased investment by industry in pretreatment before discharge and/or in water reuse, as is demonstrated in the case of Mongolia.	**To achieve better and more sustainable allocative outcomes**, it is not viable to provide relatively high-cost treated used water for free as this is dependent on ongoing government subsidies. It is more efficient to sell this water closer to where it is treated for potable and industrial water use where willingness to pay is much higher.	**Enable the mobilization of private capital** by improving the bankability of projects and the creditworthiness of water utilities and service providers. Such reforms need to be coupled with a focus on improving the operating and financial efficiency of service provision to ensure willingness to pay on the part of consumers.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STEP 2: SUPPORT CLEAR, ENFORCED REGULATIONS AND COST-REFLECTIVE PRICING

Regulatory actions that governments can take to improve impact:

Set clear and enforceable abstraction and discharge limits to facilitate reuse	Adopt fit-for-purpose guidelines and standards for reuse	Cluster industries
Where freshwater resources are limited and where there is a possibility for reuse of water, freshwater availability should be curtailed to promote the market for reuse. Abstraction quantity and conditions should be clearly defined, with the onus on the abstractor to measure and report on compliance (using a third party), with periodic random auditing and strong consequences for false reporting, and with all data accessible to the public. In addition, discharge quantity and conditions should be clearly defined and measurable.	Standards should address the main applications of used water. A one-stop shop can offer capacity to set and manage standards.	Industries should be clustered according to the nature of effluent to ease the management and regulation of discharges.

Mobilization of private finance through regulation

Municipalities and national governments play a crucial role in promoting the adoption of water reuse practices among industrial and commercial clients. By implementing a combination of incentives and regulations, they can create demand for municipal water reuse facilities or encourage businesses to develop their own facilities to treat effluent from municipal treatment plants. Moreover, government can implement financial incentives to make private projects that use municipal treated water bankable, thereby facilitating the mobilization of financing.


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STEP 3: DEVELOP THE MARKET FOR REUSE

Market creation for reuse can build on innovative approaches, ranging from stakeholder engagement platforms to baseline-and-credit and cap-and-trade instruments.

Governments can facilitate reuse market development through a number of mechanisms (Figure 51, Annex 2).

FIGURE 51: Market mechanisms for reuse

Promote Public-Private Platform Approaches

Facilitate market creation through **'pre-competitive' discussions under a public-private platform,** ensuring stakeholder engagement, trust building, as well as the creation of enabling conditions for reuse.[1]

Enable Reuse in Industrial Parks and Economic Zones

Locate industrial parks and economic zones in the **vicinity of municipal used water treatment plants** to enable reuse.

Support Baseline and Credit Instruments

Build on the learnings from carbon markets to facilitate baseline-and-credit market-based instruments such as **Wastewater Reuse Certificates (WRCs).**[2] The mechanism supports the establishment of a water reuse target for each user. Those users that exceed their target earn credits in the form of WRCs, which can be traded with users that fall short of their targets. In addition, the reduced methane emissions from used water systems can support the **generation of carbon credits.**

Use Cap-and-Trade Instruments

Introduce **limits to water abstraction and allocation** to provide the impetus for stakeholders to invest in water recycling and reuse. Capping water allocations can lead to a market for reclaimed water, where new water is sold for industrial processes or other uses.

Facilitate Tax Credits

Introduce tax credits, where appropriate, with dollar-for-dollar reductions in federal income taxes linked to investments in water reuse, or through accelerated depreciation allowances. Through such mechanisms, industrial facilities reusing municipal used water could lower their operating costs as well as tax liabilities, thereby spurring private investment.

1 The World Bank's 2030 WRG (www.2030wrg.org) has extensive experience with public-private platform development and success factors associated with establishing such platforms.
2 Rochi Khemka et al., *Wastewater Reuse Certificates as Tradeable Permits: A Handbook for Roll-out*, (Washington, DC: World Bank, 2023), http://documents.worldbank.org/curated/en/099062823132542170.

STEP 4: PROVIDE CORE FUNDING FOR REUSE AND LEVERAGE PRIVATE CAPITAL

Scaling reuse requires core funding from the government, which can be used strategically to crowd in private capital.

Government funding is unlikely to be sufficient to support investments in reuse at a scale necessary to achieve the desired goals. Therefore, public funding should be structured in a way to crowd in rather than crowd out private capital, making use of existing debt instruments, as well as other credit enhancement and financing options, as outlined in Section 3.2.

The mobilization of private capital for reuse investments requires a focus on certain elements:

Mobilizing Public Subsidies for Bankability

- In view of high upfront capital expenditure requirements for used water infrastructure and the absence of full cost recovery through tariffs in many contexts, **public subsidies may be required to make projects bankable** through the provision of viability gap funding.

Tapping Institutional Investors

- Institutional investors such as **pension funds and wealth funds** are increasingly investing directly in used water and new water projects, as well as indirectly through capital markets, considering the risk-return profile of such projects. Several examples are under implementation in Peru, Chile, and Brazil. For example, pension funds from the United States and Canada serve as shareholders of Brazil's SABESP. Structured approaches with stable governance frameworks and clear financing requirements may unlock this capital base.

Results-Based Financing through a Fund Structure

- **Public or concessional resources in the form of loans** may also be provided to finance reuse projects under a fund structure, with the initial capital returned to the fund as the loan is repaid by the borrower. Such financing options are suited for projects which are viable in the long run, but which have large capital outlays in initial phases, such as for water treatment and reuse.

PPP Models for Off-Balance Sheet Transactions

- PPPs could support partial or total financing of treatment and reuse projects as off-balance sheet transactions for the public agency. Such projects may require the **strategic use of public resources in the form of guarantees or credit enhancement instruments**.

- **Risk sharing facilities and hybrid models with public and private financing** may also be supported.

STEP 5: PROMOTE PROGRAMMATIC APPROACHES TO REDUCE COSTS AND ACHIEVE SCALE

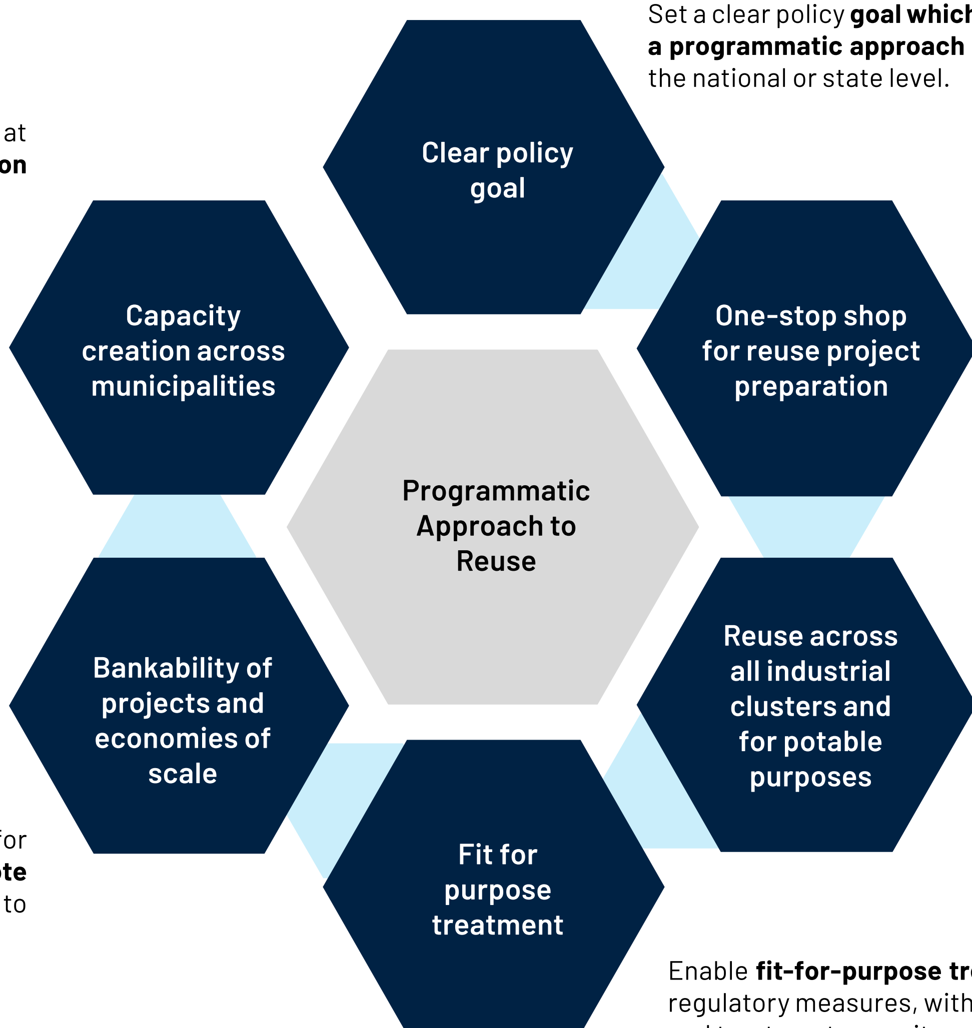
Programmatic approaches can provide economies of scale and bankability, while reducing costs.

FIGURE 52: Elements of a programmatic approach

Set a clear policy **goal which promotes a programmatic approach** to reuse at the national or state level.

Support capacity creation on reuse at the municipal level for the **preparation and structuring of reuse projects.**

Develop **standardized bidding documents, templates** for reuse project development, structures for bankable projects, and other resources under a one-stop shop resource center to facilitate municipal and industrial reuse (see also the World Bank Group's 'Scaling ReWater' package of support under Section 4.5).



Facilitate **platform approaches** to enable the bankability of projects across multiple cities, with the provision of **viability gap funding and the structuring of guarantees** and credit enhancement, as needed.

Develop **industrial zone** guidelines to enable water reuse through:

- **Location of industrial zones** closer to municipal used water treatment plants
- **Clustering of industry** with homogeneous effluents to enable reuse

Promote **potable reuse** through clear goals and the **establishment of relevant capacity.**

Reduce transaction costs for individual projects and **promote price discovery,** which helps to bring down costs over time.

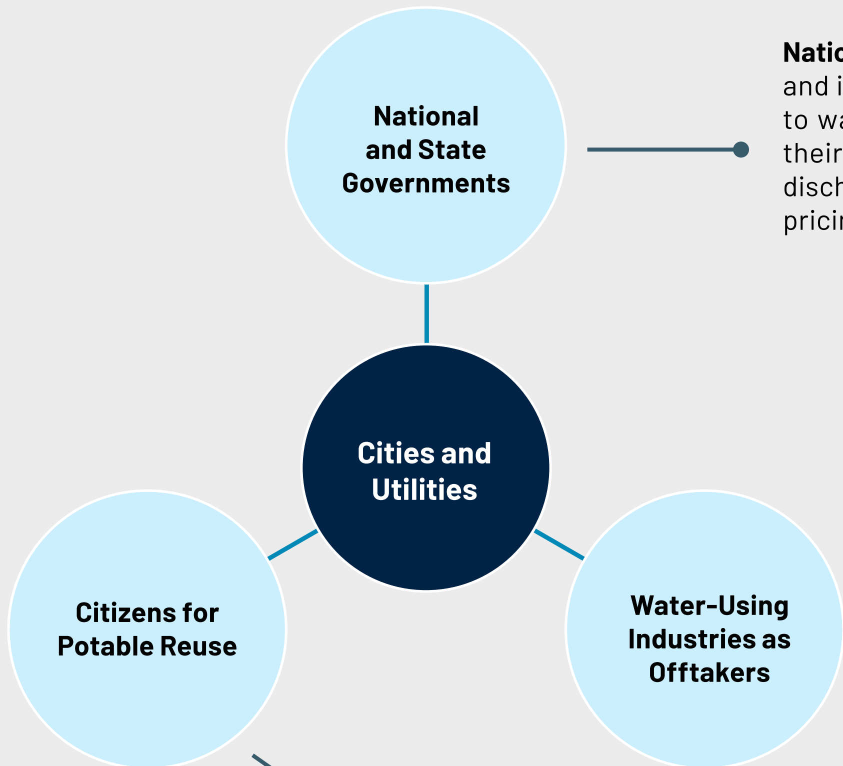
Enable **fit-for-purpose treatment** through policy and regulatory measures, with the aim of **optimizing costs** and treatment capacity creation.

Programmatic approaches require adequate resources for preparation, which could be supported through a funding facility.

4.3 Roadmap for Municipalities and Utilities

The role of local governments and water utilities in reuse is closely linked with that of national and state governments, industrial users, and citizens for potable reuse.

FIGURE 53: Interconnected role of cities and utilities with other stakeholders

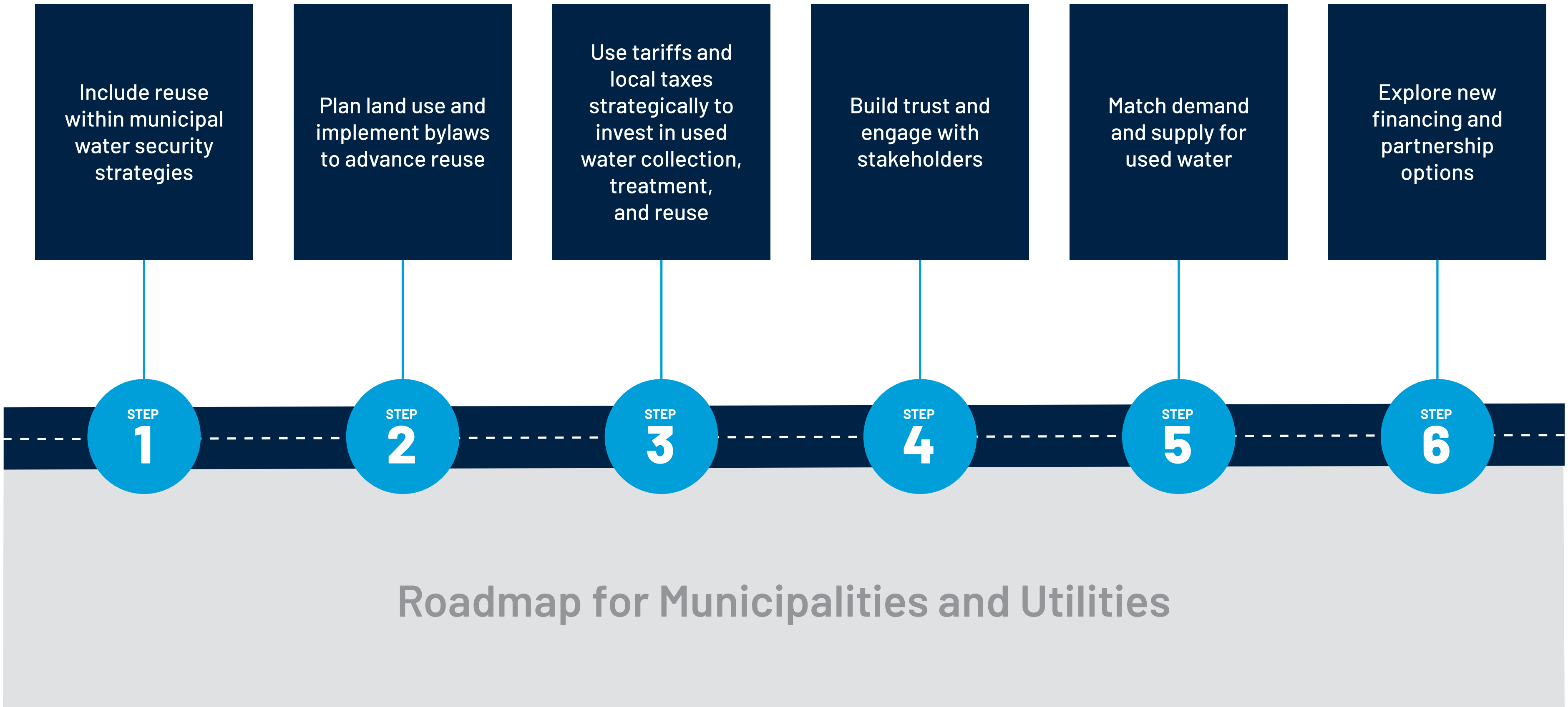


National and state-level policy, legislation, regulations, standards, and investments have an important influence on the approach to water reuse that can be adopted by city governments and their utilities. Of particular importance are: (1) abstraction and discharge-related regulations, (2) water quality standards, and (3) pricing policies (Section 4.2).

The location, volume, and nature of industrial water use and used water discharge in the city-region, and how these relate to the city's used water treatment works, will determine strategies to promote industrial reuse in cities. Multinational corporations with local offices, industrial facilities, and markets may have incentives to invest in reuse from a reputational, operational, or supply chain and market perspective, and these should be considered in city reuse strategies (Section 4.4).

Citizen perceptions on direct and indirect potable reuse also shape the market for potable reuse. Local governments need to support stakeholder engagement to create demand for potable reuse.

Municipalities and utilities can support reuse infrastructure through planning, funding, financing, and matching of demand and supply of wastewater.



Note: Activities can proceed in parallel.

STEP 1: INCLUDE REUSE WITHIN MUNICIPAL WATER SECURITY STRATEGIES

Cities and utilities need to incorporate a clear focus on reuse in their water security strategies, which can guide resource and infrastructure planning.

FIGURE 54: Reuse as a part of municipal water security strategies

Cities in water-stressed regions would be well advised to develop a **water security strategy** together with the government agencies responsible for regional or national water planning. **Water reuse** could be an explicit component (Figure 54) within this broader strategy (see, for example, Cape Town's water strategy, "Our Shared Water Future).[1]

A **reuse strategy** would clarify the market for reuse and set clear targets, linked to the core driver for reuse. In the case of Singapore, Perth, Cape Town, and Orange County, for example, water security has been the key driver.

Reuse then needs to be integrated into regional, city, and local level plans. This planning would encompass long-term water resource planning, land-use planning, and infrastructure planning. Perth offers an example of an integrated planning approach.

When developing a water reuse strategy, a municipality could consider the following potential drivers of reuse from a municipal perspective:

- **A secure and reliable water supply for households, businesses, and industries is fundamentally important as a foundation to support investments, economic growth,** job creation, and the well-being and livelihoods of a city's citizens. The importance of this is highlighted in its absence. Cape Town faced an existential crisis when it nearly ran out of water in 2018. Other cities, including São Paulo, Chennai, and Bogota have faced similar crises, and more are likely to follow.
- **Reuse can make an important contribution to a city's water security agenda.** Reuse offers a largely climate-independent supply of water and is increasingly being considered as an important component of a portfolio of options to increase water security for cities.
- **Reuse improves resource use efficiency** and can provide revenues to the city through the sale of used water, and/or reduce costs by substituting treated used water for more expensive alternatives such as desalination of freshwater from distant geographies. In Cape Town, for example, reuse is proceeding before desalination for reasons of cost efficiency.
- **Investments in treatment and reuse will improve the quality of water in the environment.** Polluted water bodies and rivers have a negative effect on the economy and people's livelihoods.

1 City of Cape Town, "Our Shared Water Future: Cape Town's Water Strategy," (2020).

STEP 2: PLAN LAND USE AND IMPLEMENT BYLAWS TO ADVANCE REUSE

Local governments can influence land use management and associated regulations, which are key to reuse.

Separation of Industrial and Domestic Effluent

Separation of industrial and domestic used water and the **prevention of toxic waste entering the domestic used water system** can reduce water treatment costs and risks, influencing the market for reuse.

+

Zoning Laws and Location of Water-Using Industries within Industrial Zones

Local governments can locate water-using industries within industrial zones in close proximity to treatment facilities, which reduces infrastructure costs. As the case of Singapore highlights, the supply of non-potable new water to industries can form a key part of a city-level water reuse strategy.

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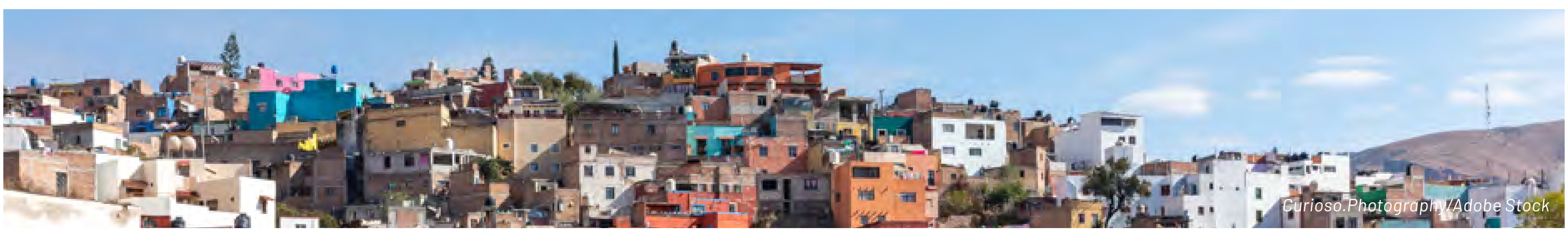
Infrastructure Planning for Water Reuse

This incorporates the collection, treatment, and distribution of used water. Such approaches might require reuse-sensitive infrastructure planning, aligned with the proposed reuse application.



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STEP 3: USE TARIFFS AND LOCAL TAXES TO SUPPORT INVESTMENTS IN USED WATER COLLECTION, TREATMENT, AND REUSE

Cities and/or their utilities are typically responsible for the collection and treatment of used water and have two primary sources of revenue to support investments: taxes and tariffs, in addition to possible transfers from national or state governments.

Reuse is typically only feasible where there is a used water collection network and treatment facility. While national or state governments can, and often do, provide grants to support investments in these facilities, these are seldom sufficient to meet the investment requirements. Appropriate pricing of water (which could include a used water collection and treatment surcharge), or separate tariffs or charges for used water collection, are therefore an important building block to enable reuse. In addition, differentiated tariffs for freshwater and used water can encourage industry to use new water, as the experience in **Malaysia** highlights.

The sale of used water can be used to defray the costs of treatment. Pricing of used water may need to take into account the relative price of treated potable water. See examples below.

In **Singapore**, the cost of the sewer collection network and used water treatment is paid from government tax revenues.

The national water agency offers new water at a discount to treated potable water to encourage industries to use this water.

In **Cape Town**, the cost of the sewer collection and used water treatment infrastructure is covered largely through wastewater tariffs that are related to the volume of water purchased by customers.

New water is sold to industry at a discount compared to the price of potable water.

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STEP 4: BUILD TRUST AND ENGAGE WITH STAKEHOLDERS

Municipalities and utilities need to build trust with industry and citizens to support industrial and potable reuse, respectively.

User acceptance is a critical element for successful reuse investments, as demonstrated by the experiences of Singapore, Orange County **(United States), and** Cape Town **(South Africa).**

FIGURE 55: A framework for stakeholder engagement

Key Considerations for Stakeholder Acceptance of Reuse	Trust Building with Industry	Trust Building with Citizens
Reliability of Volume and Quality	**Reliability of supply** of used water, both from a volume and quality standpoint are key concerns for industry. Where there are variations in either, there may be limited appetite from industry to offtake used water.	For potable reuse, particularly direct potable reuse, trust in the **quality of drinking water supplied** is a core consideration for citizens. Oftentimes, this trust is linked to the capacity of the utility or agency providing such reuse.
Relative Cost Considerations	**Relative cost of reuse versus freshwater supply** is a core consideration for industrial demand for used water. Industrial reuse projects have failed where cheaper alternatives are readily available (for example, Brazil, India).	Where direct or indirect potable reuse may add to the cost of service provision, and if there are **tariff implications** for such solutions, these need to be communicated to stakeholders upfront.
Clear and Transparent Communications	Building industrial demand for used water may require communications around increasing water risks and the potential for **used water to provide assurance of water supply**. In addition, any variations in volume and quality require transparent communication, if possible, with real-time data provision through dashboards and other tools.	Initiatives to implement potable reuse schemes, both successful and unsuccessful, have shown that **trust, capability, and a sense of urgency** are important ingredients in achieving public acceptance. Clear communications can help to articulate all three.
Regular Stakeholder Engagement	Cities and utilities need to establish **regular channels of engagement** with industry and citizens on used water programs. This may be achieved through targeted stakeholder engagement strategies and/or platforms, along with **communications campaigns**, awareness building through **reuse resource centers**, and so on.	

STEP 5: MATCH DEMAND AND SUPPLY FOR WASTEWATER

Cities and utilities can play a key role in market creation through a systematic assessment of reuse opportunities and the structuring of long-term contracts with industries.

FIGURE 56: Actions to match demand for new water with the supply of used water

Supply of used water

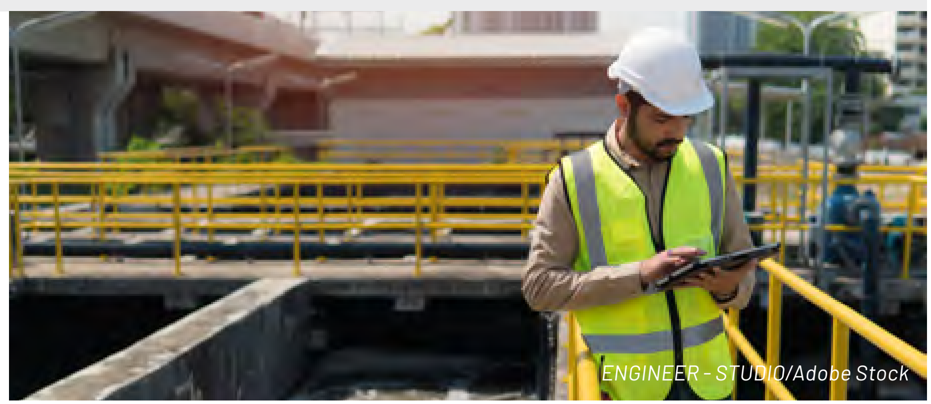
- **Assess location and reliable volumes** of used water
- **Develop contracts for the long-term assured supply** of used water
- **Assess opportunities to sell new water as an additional revenue stream** for the municipality and utility

Demand for new water

- **Assess potential demand for new water by water-intensive industries**
- **Assess demand close to the source of used water** (used water treatment plants) to minimize investments and costs
- **Assess willingness to pay for new water**
- **Structure long-term purchase contracts** through take-or-pay agreements with industrial clients

Attend to the regulatory environment and price incentives to ensure that they support reuse, for example, zoning schemes, bylaws, treatment standards, and permitted uses of used water.

The eThekwini Water Reclamation Project was anchored on **20-year water supply agreements with two industrial clients:** MONDI, a paper facility, and SAPREF, a refinery (Annex 3).



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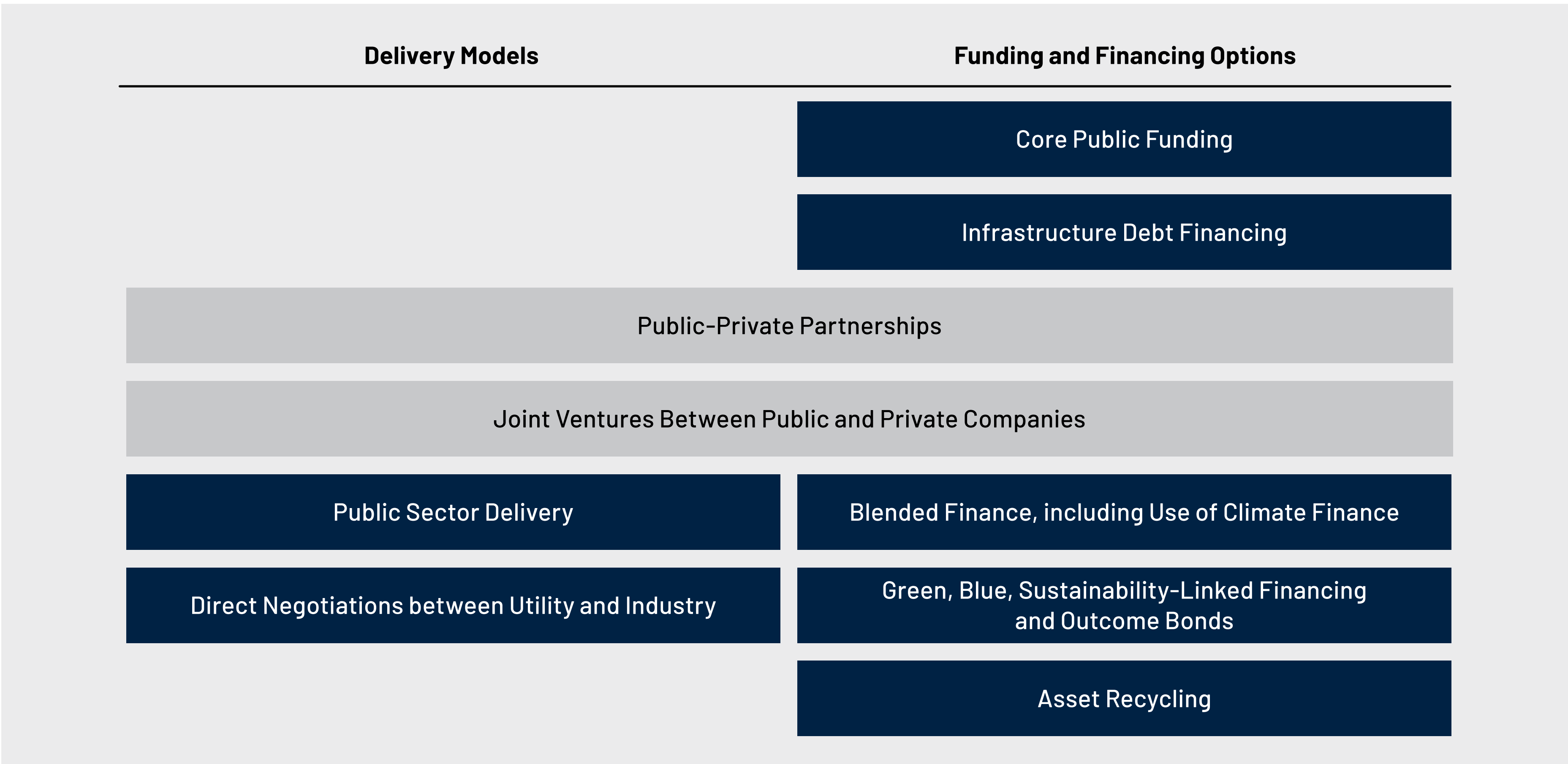
STEP 6: EXPLORE NEW FINANCING AND PARTNERSHIP OPTIONS

Depending on the type of reuse application and the bankability of projects, municipalities and utilities can support a range of financing and partnership options.

The choice of delivery and financing instrument will depend on the fundamentals of the project and the interest of the private sector as solution providers and financiers to engage on the project. Section 3.3 provides further detail on the delivery models and financing options outlined below.

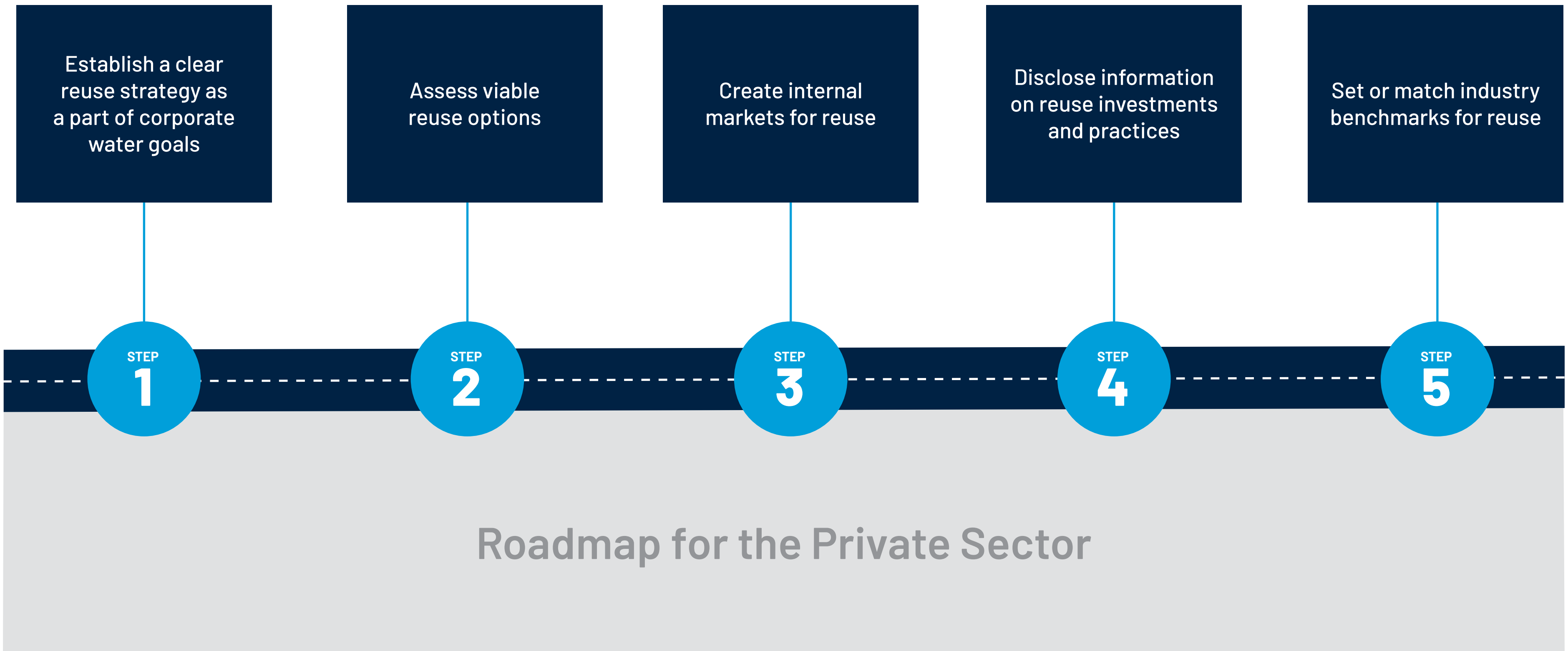
FIGURE 57: Delivery, funding, and financing models for reuse



Note: Can serve as both a delivery mechanism and a financing instrument.

4.4 Roadmap for the Private Sector

Corporates and industrial players can support reuse as users of new water, as well as by facilitating internal reuse market creation and establishing industry benchmarks.



Note: Activities can proceed in parallel.

STEP 1: ESTABLISH A CLEAR REUSE STRATEGY AS A PART OF CORPORATE WATER GOALS

Corporates can commit to a clear program on reuse in their water strategies and goals.

Corporate actions and strategies for reuse can encompass two levels:

1. **Global Level – Goals for Sustainable Sourcing through Reuse Investments:** At the global level, corporates could support clear commitments to reuse, where technically and financially feasible, in direct operations and supply chains, articulated in corporate water strategies and goals. Currently, reuse does not feature in the majority of corporate water goals as a mechanism to support improved water management, nor is it seen as a core solution in water replenishment strategies. Investments in reuse are more cost-effective than primary supply augmentation in many instances, yet reuse is not evaluated as a core solution unless mandated by regulation, as in China. Such investments also offer reputational benefits.

2. **Local Level – Strategies for Reusing Water as Offtakers:** In addition, in specific cities and industrial parks, industrial players could establish goals that support the reuse of water, mitigating risks to business continuity and providing a source of assured water supply in conditions of climate variability, particularly droughts.

STEP 2: ASSESS VIABLE REUSE OPTIONS

The private sector can assess relevant reuse options by engaging with the public sector and other private sector partners in pre-competitive dialogues.

Source of Used Water

Municipal Source

Industrial Source

Corporate options for substituting freshwater with new water may arise through two options:

1. **Municipal sources,** where industries are located in the vicinity of urban centers and municipal treatment plants for used water
2. **Industrial sources,** where facilities are located in industrial parks

Depending on the volume of new water available and the volume of intake water required by the private sector company, such reuse projects may involve individual offtake agreements with a single industrial partner, or multiple such agreements with different players. Enabling reuse in this way requires pre-competitive leadership of individual corporates with other partners to assess reuse options. The constitution of a multi-stakeholder platform at the city, industrial park, or catchment scale, which involves the participation of city governments and utilities, and/or economic zone authorities, could serve as the vehicle to develop and decide on appropriate collective reuse arrangements (see also Section 4.5 on the Role of the World Bank Group and associated country and city platforms).

STEP 3: CREATE INTERNAL MARKETS FOR REUSE

Corporates can develop an internal water fee mechanism, based on the water footprint of business units, to incentivize reuse and improve water management, serving as a market creation strategy.

Multinational corporates and large private sector companies could create the business case for reuse through internal reuse markets. Such markets could enable reuse transactions through an internal water fee (shadow price for water) which internalizes the cost of contamination and displacement of water from its natural state, and/or wastewater reuse certificates and credits.

Internal Carbon Fee

Companies, such as Microsoft, have developed an **internal carbon fee** based on the company's carbon footprint to support decarbonization efforts and raise funding for initiatives to reduce and/or remove carbon emissions.

Such a carbon fee covers various aspects:

1. **Scope 1 emissions:** Direct emissions from sources owned and controlled by the organization
2. **Scope 2 emissions:** Indirect emissions from purchase of electricity, steam, heat, etc.
3. **Scope 3 emissions:** Indirect emissions from the value chain and product use

Each year, this information on emissions is aggregated across the company to charge business groups a carbon fee, aimed at incentivizing a shift toward more carbon-friendly outcomes.

Internal Water Fee

A similar approach to the carbon fee could be adopted for water, whereby **companies assess the water footprint of different business units** and levy a **water fee to support improved water management.**

The water footprint could assess the water footprint across direct operations, supply chain, and product use, similar to the carbon experience across scope 1, scope 2, and scope 3.

The water footprint could cover both:

- **Freshwater use,** with a higher fee charged for freshwater use in water-scarce basins
- **Used water discharge,** with the fee linked to the volume and load of discharge

Both elements of the fee could **create an incentive for reuse** within the corporate entity, as business units work towards minimization of the payment of the fee.

STEP 4: DISCLOSE ON REUSE PRACTICES AND INVESTMENTS

Corporate disclosure on reuse can support trust building with partners, facilitate access to capital, and provide reputational benefits to corporate sustainability efforts.

Corporate water disclosure refers to companies' reporting to stakeholders on the state of their current water management, along with the implications for business, and strategic responses. Currently, prevailing water disclosure questionnaires do not prioritize reuse, with reuse seen predominantly as a measure to reduce demand.

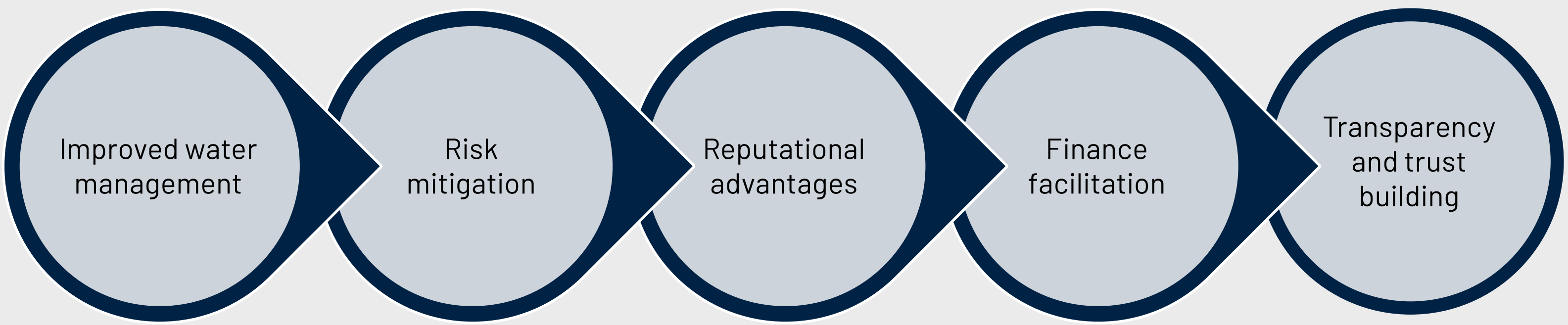
For improved water management as well as clear and transparent communication with investors, customers, suppliers, and others, disclosure on reuse can support corporates outline their approach to reuse and provide details on reuse investments supported (Figure 58).

FIGURE 58: Advantages of incorporating reuse in corporate disclosures

Disclosure on reuse can **surface inherent water-related risks**, both related to scarcity and pollution, and facilitate measures to address these

In addition, it can support **benchmarking of water use** with other water users and **enable collaborative approaches**

Disclosure can **raise additional capital**, as it is used by investors to assess corporate performance and commitment to transparent governance



Through disclosure, corporates may **improve their own understanding** of different water-related risks and opportunities

Disclosure can demonstrate the **implementation of good practices** to stakeholders

Disclosure helps **build trust and accountability**

STEP 5: SET OR MATCH INDUSTRY BENCHMARKS FOR REUSE

Establishing industry benchmarks for reuse can support a move towards more sustainable water management across industrial subsectors.

Corporates could engage with relevant partners and stakeholders to shape industry standards on reuse for each industrial sub-sector (e.g., chemical, pulp and paper, technology companies), thereby defining best practices and benchmarks in industrial reuse and ensuring the achievement of these standards across their own operations and supply chains.

Such engagements may offer additional benefits as outlined below:

Development of a Common Vocabulary	Industry partners could work together to develop a common vocabulary on reuse, specific to water reuse practices in that sub-sector. This would help clarify terminology and align stakeholder perspectives on reuse for that industrial subsector.
Research and Innovation	Benchmarking could also support private sector investments and collaboration on research to advance water reuse technologies and practices, making them more economically feasible and efficient.
Sharing of Best Practices	Companies can contribute to the development of best practices for water reuse and participate in knowledge-sharing initiatives.

4.5 Role of the World Bank Group

A combination of IBRD/IDA, IFC, and MIGA instruments and solutions can support reforms and investments to promote greater water reuse.

FIGURE 59: World Bank Group support to reforms and investments

Foundational Reforms and Analytics

- **Technical assistance for policies, institutions, and regulatory** frameworks to promote reuse
- Support for the **structuring of market mechanisms for reuse**
- **Analytical support** to assess reuse potential
- **Strategic and efficient use of public and concessional resources to crowd in private capital** for treatment and reuse investments
- Support for **strengthening of environmental regulations and their implementation**, structuring of **systems approaches**, and **subsidy reforms** to promote reuse
- **Capacity building and learning events** on reuse

Sector Turnaround with Private Sector Participation

- Support for **financial sustainability and creditworthiness of utilities**
- Structuring of **performance-based contracts for water and used water investments**

Private Capital Mobilization for Reuse Investments

- **Structuring of blended finance solutions**, combining IBRD and IDA concessional funding, IFC investments, commercial debt financing, with MIGA guarantees and credit enhancement instruments
- **IBRD and IFC support for the development of projects that mobilize private capital** (such as PPPs, joint ventures, and market mechanisms) to promote water reuse
- **Structuring of green, blue, and sustainability-linked financing** for water reuse

Support for **programmatic approaches**, with a focus on enabling **countries and cities to tap private sector expertise and capital** to meet reuse ambitions, where possible

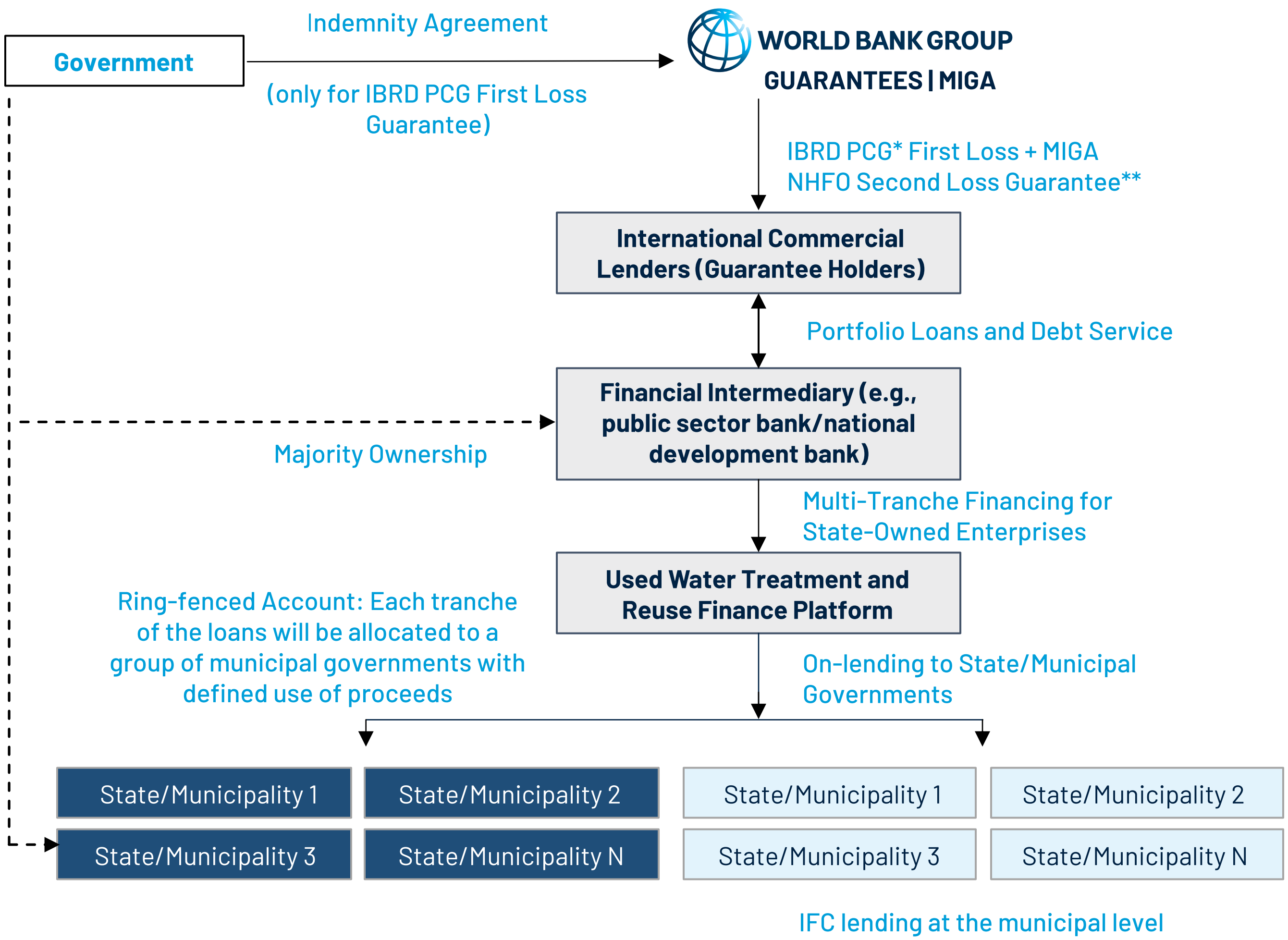
The World Bank Group's Scaling ReWater offers a standardized package of support to mobilize public funding and private capital for reuse initiatives, while ensuring affordability.

FIGURE 60: Focus areas of Scaling ReWater

Areas of Support		
Creating supportive policy, institutional, and regulatory incentives	• Support to reuse-related **policies, institutions, and regulatory frameworks**, along with the creation of **actionable roadmaps** • Assessment and support for the development of **PPP frameworks**	**Standardized package** of support, combining World Bank, IFC, and MIGA instruments
Supporting project planning, preparation, and design to incorporate circularity	• Identification of **reuse opportunities** • Alignment of reuse programs and projects with **national strategies** • Assessment of **affordability, value for money, and commercial and financial viability** • **Market sounding** and **identification of investor interest** • Development of technical, economic, environmental and social, financial, and legal and institutional **due diligence and structuring of projects** for market-readiness	
Supporting balanced risk allocation and credit enhancement	• **Development of a financial plan**, along with identification of concessional financing and credit enhancement mechanisms • Support for balanced risk allocation and the use of credit enhancement instruments to **lower financing costs, deliver sustainable projects, and ensure affordability in tariffs**	
Providing transaction advice and streamlined tendering	• **Use of template documents** for the tender process and concession agreements to **reduce negotiation delays** and to facilitate **timely financial closure**	
Providing financing and insurance solutions	• **Financing for public investments** through SLF, green financing, and blended financing models • Facilitation of private capital through blended finance structures, **viability gap funding, first-loss provisions, and guarantees**	

The World Bank Group could support a platform approach to accelerate private capital for reuse investments.

FIGURE 61: World Bank Group support to a reuse finance platform



In countries looking to advance reuse investments across multiple states and municipalities, an innovative finance platform might mobilize private and commercial finance at scale.

While the structure of finance facilitation will vary depending on the context, **large volumes of financing might be mobilized through a financial intermediary**, with **on-lending to state and municipal governments.**

Such a financial intermediary should be rated on par with the sovereign, with adequate resources and technical capacity.

The platform could be supported with World Bank Group credit enhancement instruments, for example, which combine IBRD partial credit guarantee first loss (minimum of 20%) with MIGA's non-honoring of financial obligations second loss guarantee (remaining 80%). This could help: (1) **minimize sovereign guarantee needs**, (2) **reduce transaction costs**, and (3) **diversify risks** across states and municipalities. IFC can provide lending at the municipal level to support reuse investments.

Notes: PCG: Partial Credit Guarantee; NHFO: Non-Honoring of Financial Obligations. Under this product, MIGA can cover sovereign, sub-sovereign, and state-owned enterprise payment risk, provided the borrower meets credit rating requirements (BB - and above) and passes the creditworthiness test.

In addition to finance platforms, the World Bank Group could support stakeholder engagement platforms, bringing together the public sector, private sector, and civil society.

The World Bank's 2030 Water Resources Group has significant experience in designing stakeholder engagement platforms that promote innovations in financing models, economic instruments, and delivery mechanisms for water security (Figure 62).

FIGURE 62: WRG stakeholder platforms and select innovations

WRG Engagement Steps

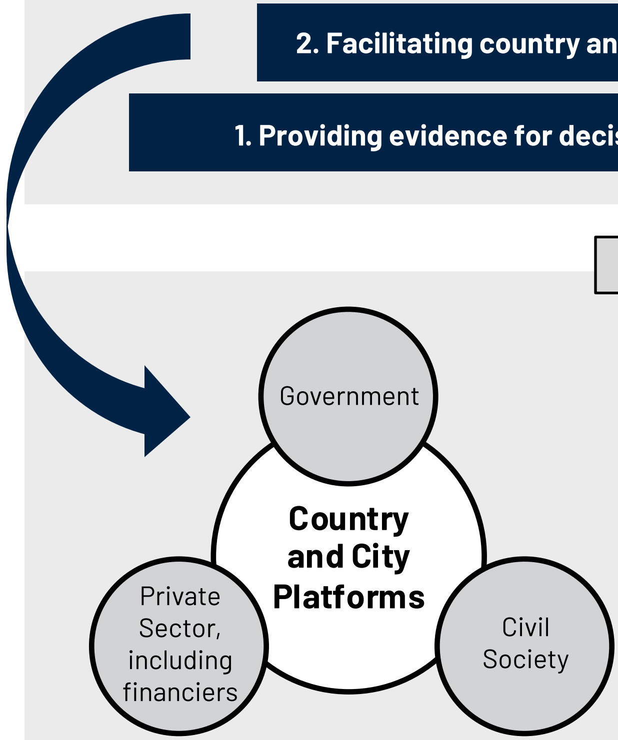
4. Enabling scale — Scaling of impact through **alignment with World Bank lending operations** and **World Economic Forum convening**

3. Supporting implementation — Design of scalable solutions at the **interface of technology, markets, and financing**

2. Facilitating country and city platforms — **Structured platforms to translate stakeholder priorities into impact**

1. Providing evidence for decision-making — **Tailored upstream assessments supporting public-private collaboration** at the country level

Platforms and Select Innovations



Chaired by government

Co-chair from private sector and/or civil society

Cross-sectoral, bringing together stakeholders from water, climate, agriculture, urban, finance, rural, environment etc.

Balanced participation (no single stakeholder type with majority)

Select Innovations Emerging from WRG Country Platforms

- **PPPs for Municipal Used Water Treatment and Reuse** in the Ganga Basin through a new Hybrid Annuity Model
- **Mongolia Water Pollution Fee Law**, supporting investments in used water treatment and reuse
- **Conceptualization of Wastewater Reuse Certificates** as a baseline-and-credit instrument

5. CONCLUSIONS

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5.1 Conclusions

Reuse is a core element of the circular economy...

Reuse investments offer triple value through: (1) the recovery of valuable freshwater, (2) the recovery of energy and scarce resources, and (3) environmental restoration through pollution abatement and reduced freshwater abstraction.

...and is at a tipping point.

The speed of investments in reuse is accelerating, driven by the attractiveness of higher-value applications of reuse, increasing water scarcity, and the business case of circularity.

Reuse becomes increasingly attractive and cost-competitive as water stress and scarcity increase. In addition, as reuse scales and the market for reuse investments matures, costs will come down further.

Core public resources may be needed to support treatment and reuse...

Public and concessional resources should be prioritized for reuse, while ensuring efficiency in their use to crowd in private capital.

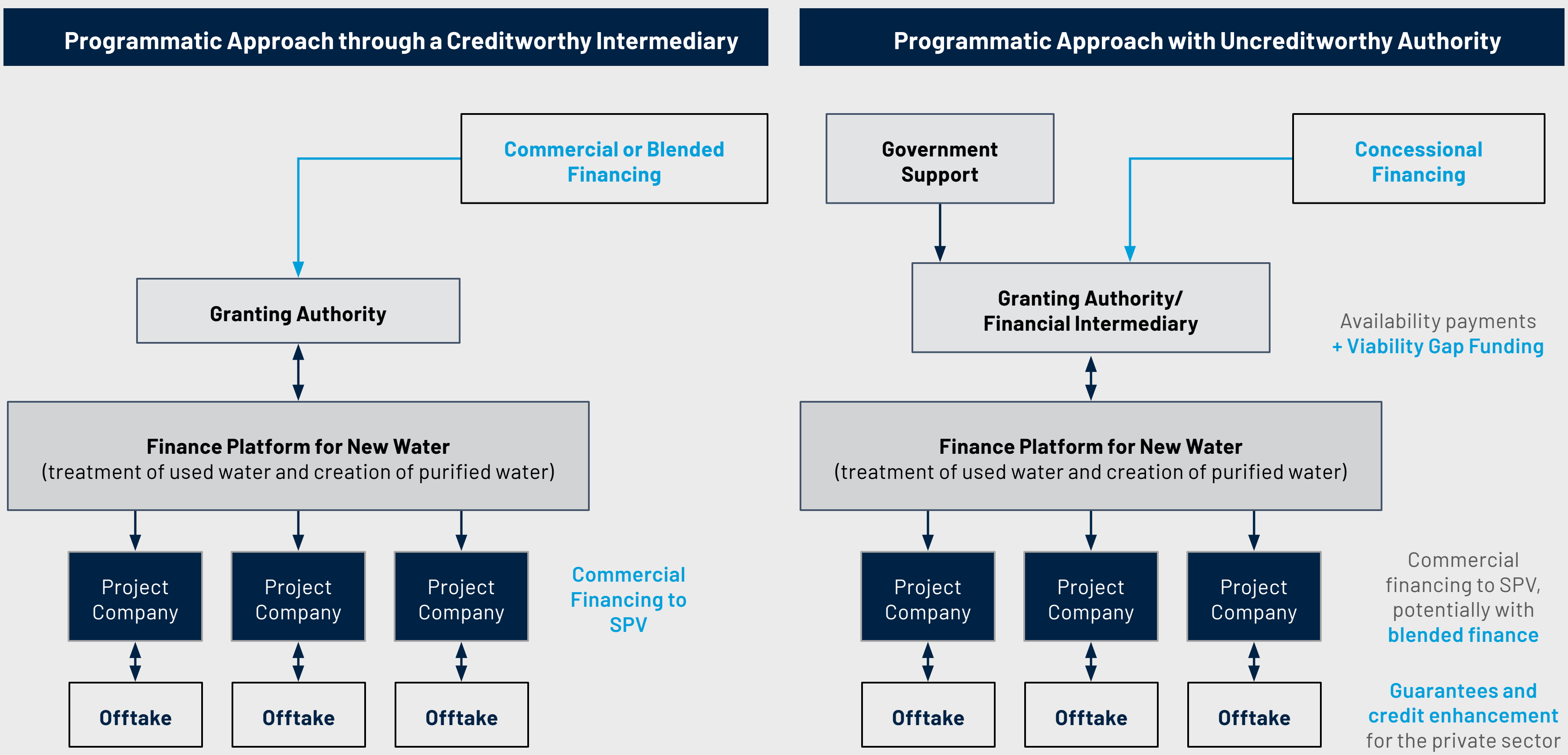
In addition, an acceleration in reuse investments may require reforms to the enabling environment to create the conditions for private sector participation.

...which can unlock private capital through relevant financing instruments and programmatic approaches.

Private capital may be mobilized through several options, including traditional infrastructure debt financing; joint ventures; blended finance instruments that make use of climate finance; a variety of green, blue, and sustainability-linked financing and outcome bonds; and asset recycling.

Programmatic approaches to reuse can reduce time and costs and attract investor interest. The resultant economies of scale can also reduce the cost of finance. Creditworthy granting authorities may be able to tap commercial financing under such approaches, while uncreditworthy entities may require the use of concessional financing and/or payment guarantees to attract private sector interest.

FIGURE 63: Programmatic approaches to support the mobilization of private financing for new water creation

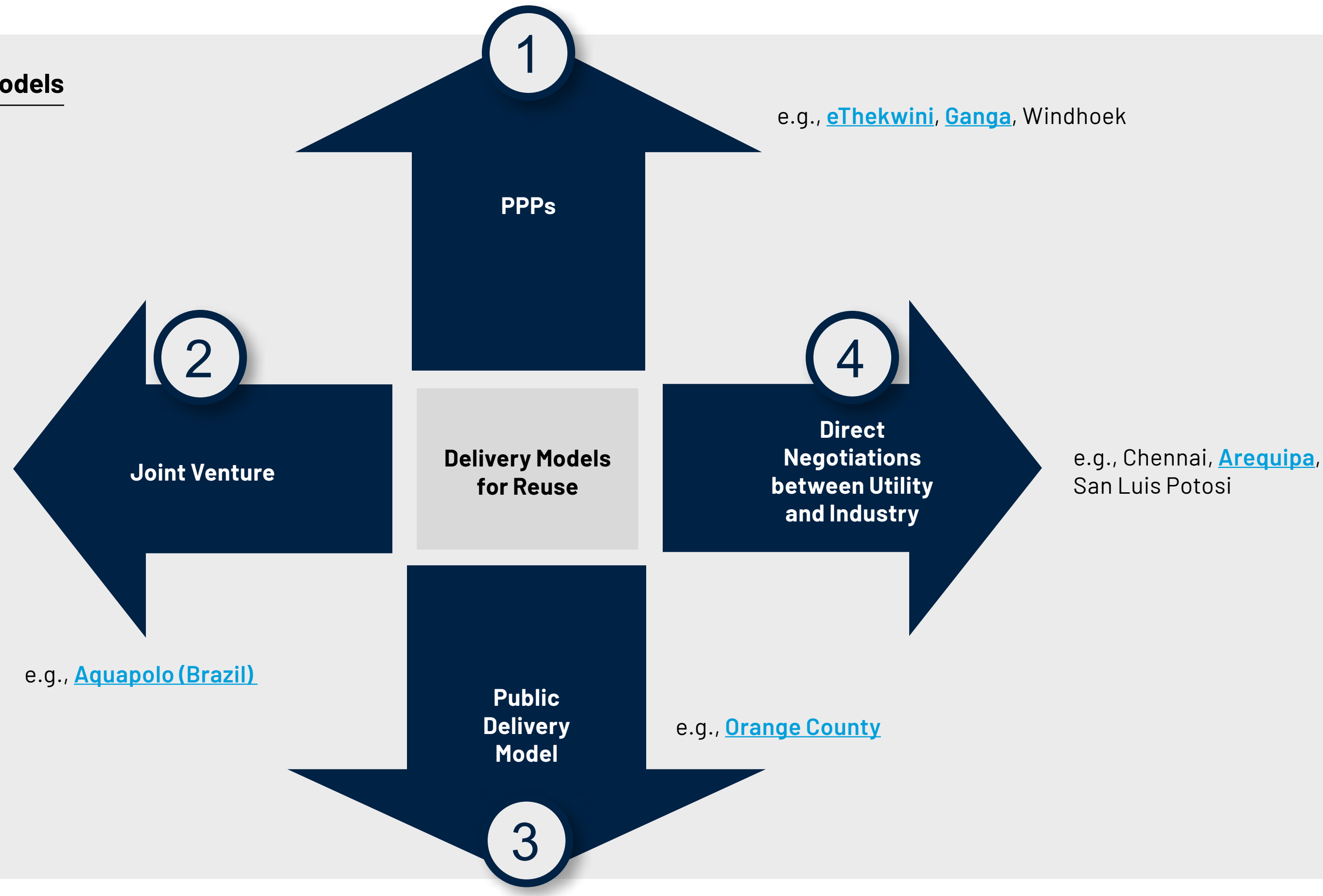


Moreover, various delivery models can be applied to reuse.

The choice of delivery model depends on various factors: (1) the respective capacities of the public and private sector, (2) affordability considerations, (3) the extent to which stakeholders wish to mobilize private or off-balance-sheet financing, (4) the availability of public funding, and (5) the allocation of risk between parties.

For example, **PPP structures, such as DBFOT and BOT models,** may support price disclosure of the full levelized cost of treated or sold water. In the context of transparently tendered projects, this can create competitive price pressures, driving innovation and efficiency. **Joint ventures between the public and private sector** may support the joint investment of equity and a collaborative effort to raise finance. Where the public sector has adequate technical and financial capacity, **public sector delivery models** may be preferred. At the municipal level, there may be **direct negotiations between the utility and industrial offtakers** through long-term water purchase agreements, which also support bankability.

FIGURE 64: Reuse delivery models



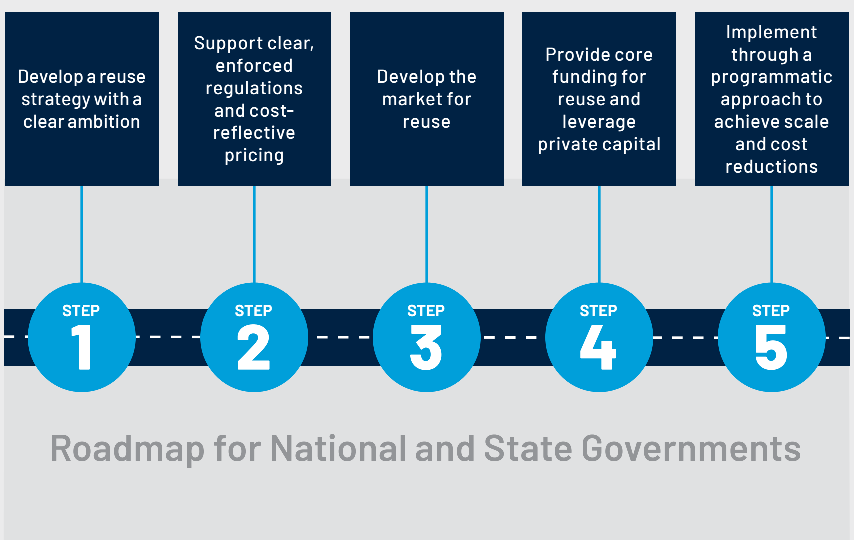
Scaling reuse requires synergistic collaboration across various levels of government and the private sector...

While national and state governments, and municipalities and utilities, need to **set clear reuse goals** as a starting point, the different instruments and levers at their disposal to facilitate reuse vary.

National and State Governments

Federal and state agencies can influence **pricing and regulations**, which can address two of the main constraints to reuse in most contexts. The subsidized and unregulated availability of freshwater has been the single biggest bottleneck to the scaling of reuse globally. In addition, national governments can support **programmatic approaches**, which can enable economies of scale and cost reductions over time. **Public resources** can also facilitate the mobilization of private capital.

FIGURE 65: Roadmap for national and state governments



Municipalities and Utilities

Local government and water utilities can support **land use planning** with reuse in mind, locating industrial parks in the vicinity of municipal used water treatment infrastructure. **Tariffs and local tax instruments** can promote investments in used water collection, treatment, and reuse. **Stakeholder acceptance and communications** is a core role that municipalities can support, which can enable the development of a **market for reuse.**

FIGURE 66: Roadmap for municipalities and utilities

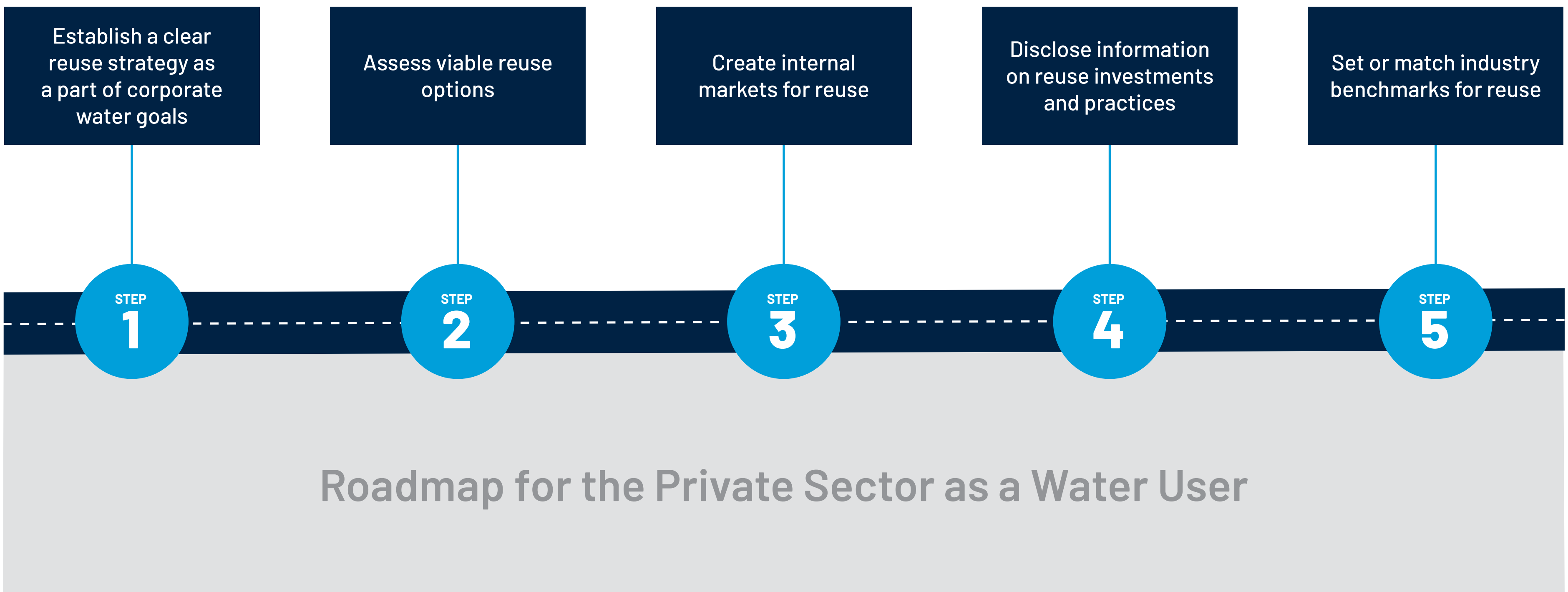
...with private sector water users shaping the demand side of the reuse market.

The private sector, as a water user, can influence reuse through both: (1) **global corporate water strategies**, and (2) **local offtake of new water** in specific geographical locations.

The establishment of **internal water fees** based on the water footprint of business units can support the creation of reuse markets. In addition, corporate **disclosure on reuse practices and investments** can foster trust and support finance facilitation, besides offering reputational benefits.

Moreover, corporate efforts to **set or match benchmarks for reuse** can promote best practice adoption and encourage more research and innovation in the sector.

FIGURE 67: Roadmap for the private sector as a water user



6. ANNEXES

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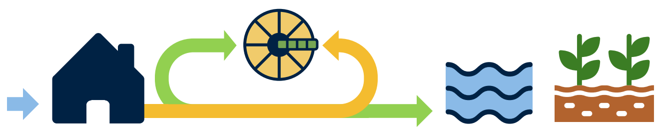
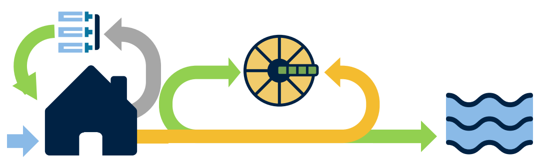
Annex 1: Additional Definitions



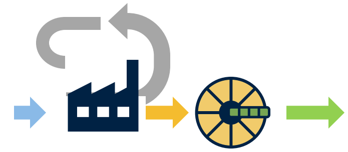
Non-potable reuse for agriculture and landscaping: Treatment and reuse of municipal used water to regulatory standards for agriculture and landscaping. It requires collection and treatment of used water, and transmission of the product water to where it can be used, with no loss of control in between.

Informal water reuse: Direct application of used water without treatment, typically in contravention of regulations. It is considered a public health risk.

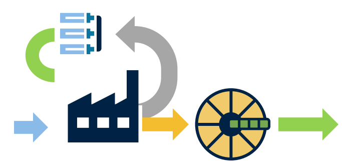


Gray water recycling: On-site reuse of domestic wash water for non-potable domestic use. Can be promoted through the building code. More contaminated water is discharged to the sewer for treatment and disposal.

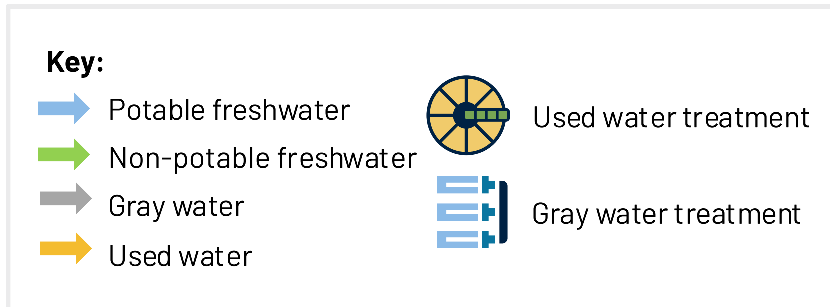
De facto reuse: Discharge of treated or untreated used water into the environment, with downstream abstraction for a variety of uses, including for treatment to potable standards. Frequently unregulated.



Recirculation: On-site reuse of industrial process water without treatment. Some industrial water users refer to recirculation as reuse, to distinguish it from recycling, or reclamation. After a certain number of cycles, the used water (blow down) is treated and discharged. Most industrial water users aim to maximize water recirculation—particularly in cooling systems—for economic reasons.



Industrial water recycling: Use of some of the rejected water from one industrial process to another on site, with treatment to deliver the required water quality. The used water is eventually treated and discharged. An example of industrial recycling might be condensate polishing in a power plant. It is often driven by economics.



Annex 2: Market Mechanisms for Reuse

A number of market mechanisms can support the creation of reuse markets.

With the right regulatory framework in place, governments can support reuse market creation through different instruments, creating demand for treated water, and in turn enabling investments (Figure 68).

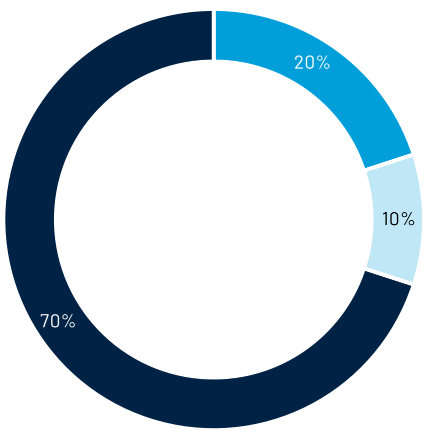
FIGURE 68: Mechanisms to facilitate market creation

1	**Reuse in Industrial Parks and Economic Zones**	• **Greenfield industrial parks** could be promoted in the vicinity of urban centers to facilitate the reuse of new water from municipal sources by industry. • **Brownfield industrial parks** could be encouraged to establish central effluent treatment plants, where appropriate, to drive reuse.
2	**Baseline and Credit Instrument** Wastewater Reuse Certificates	• **Baseline and credit instruments**, such as wastewater reuse certificates, are a compliance+ instrument to create a market for reuse. In regulatory contexts, this is linked to reuse targets set by the regulator/water authority.
3	**Cap and Trade Instrument** Water Rights Regimes and Caps to Water Allocation	• **Caps to water allocation** can also spur reuse markets and technological innovation. These can be coupled with existing water rights regimes and allocation frameworks, creating the demand for municipal reuse.
4	**Tax Credits**	• **Tax credits** can support reductions in taxation, commensurate with investments in reuse.

1. REUSE IN ECONOMIC ZONES AND INDUSTRIAL PARKS

Governments can locate industrial parks in the vicinity of municipal used water treatment plants to enable reuse; in addition, industrial park authorities can encourage reuse through central effluent treatment plants for homogeneous industrial clusters.

FIGURE 69: Water withdrawals by sector (%, 2024)[1]



Industrial parks and economic zones offer the potential for market making through: (1) aggregation of industries, and (2) intermediation by industrial associations and government authorities responsible for such zones.

Overall, industrial water constitutes just under 20% of global freshwater withdrawals (Figure 69).[1] On the other hand, **water demand is projected to increase 20-25% globally by the year 2050.**[2] In this context, reuse can provide assured water supply to industry to meet its growth plans.

Industrial parks and economic zones offer a strong potential for reuse due to:
- **Clustering** of industry, leading to lower costs of water distribution and associated energy requirements.
- **Potential for co-location of homogeneous industrial sectors**, with potentially similar water quality requirements.

The circularity of solutions can strengthen the competitiveness of industrial parks and economic zones through innovative business models and technological upgrades. In particular, **eco-industrial parks (EIPs)** can promote a combined focus on circularity in:[3,4]
- **Water** (business models for improved water and wastewater management)
- **Energy** (renewable energy use, CO_2 recovery plants, and cogeneration using biogas)
- **Material and waste heat** (utilization of recovered material or waste heat from the production process of one plant as raw material or fuel for production processes in another plant).

The industry park developers and authorities could support common solutions, such as:
- Water and **used water performance monitoring systems**
- **Access to finance for tenant firms to invest in common green infrastructure, including central effluent treatment plants for reuse**
- **Joint testing of new solutions** and technologies.

In addition to efficiency in water use, solutions that support advanced biological treatment and recovery of metals can minimize used water generation and facilitate greater reuse. In addition, there is evidence suggesting that matching a water reuse system to its location can support savings in water and energy.[5,6]

1 United Nations, *The United Nations World Water Development Report 2024: Water for Prosperity and Peace* (Paris: UNESCO, 2024).
2 Samantha Kuzma, et al., "25 Countries, Housing One-Quarter of the Population, Face Extremely High Water Stress," (World Resources Institute, August 16, 2023).
3 World Bank, *Circular Economy in Industrial Parks: Technologies for Competitiveness* (Washington, DC: World Bank, 2021).
4 Xuefeng Li, et al., *Green Development Model of China's Small and Medium-Sized Cities*, (Singapore: Springer, 2018).
5 Jonathan R. Bailey et al., "Renewable Energy Generation and GHG Emission Reduction Potential of a Satellite Water Reuse Plant by Using Solar Photovoltaics and Anaerobic Digestion," *Water* 13, no. 5 (2021): 635.
6 Pablo K. Cornejo et al., "Carbon Footprint of Water Reuse and Desalination: A Review of Greenhouse Gas Emissions and Estimation Tools," *Journal of Water Reuse and Desalination 4, no. 4* (2014): 238–52.

2. BASELINE AND CREDIT INSTRUMENTS:

Wastewater reuse certificates represent a market-based instrument to promote reuse, which governments and private sector can adapt to both municipal and industrial contexts.

Wastewater Reuse Certificates

- The World Bank's WRG conceptualized the WRC, an innovative baseline-and-credit market-based instrument to promote reuse.
- A **target-based system**, it is designed to **support reuse for large water consumers**, such as industrial entities and municipalities, as well as across economic zones and industrial parks.
- The mechanism supports the **establishment of a water reuse target for each user**. Those users that exceed their target earn credits in the form of WRCs, which can be traded with users that fall short of their targets (Figure 70).
- This mechanism is being **piloted in the textile sector in India**.
- Step by step guidance on the implementation of this approach across different use cases is included in the **Handbook on Wastewater Reuse Certificates.**[1]

- **The trading of WRCs is based on differing marginal abatement cost curves for each participating firm or entity** (Figure 71).
- **The difference in cost curves provides the basis for trading** among firms.
- Entities with higher marginal abatement cost curves can buy credits from those with lower costs.

For example, as illustrated below, it is assumed that a regulator distributes 100 units of allowances equally across two firms, with 50 allowances per firm. Each allowance represents the right to pollute one unit. In this case, the firms will trade their allowances until their marginal abatement costs are equal, represented by point Z in the figure below. Firm A would implement pollution reduction measures and trade surplus allowances in the market up until the point where the cost for abatement equals the selling price of the allowance in the market—that is, at 80 units of abatement—with a surplus of 30 units, which it will sell to Firm B. The area XYZ represents the total cost savings under the WRC trading system.

FIGURE 70: Wastewater Reuse Certificate trading mechanism

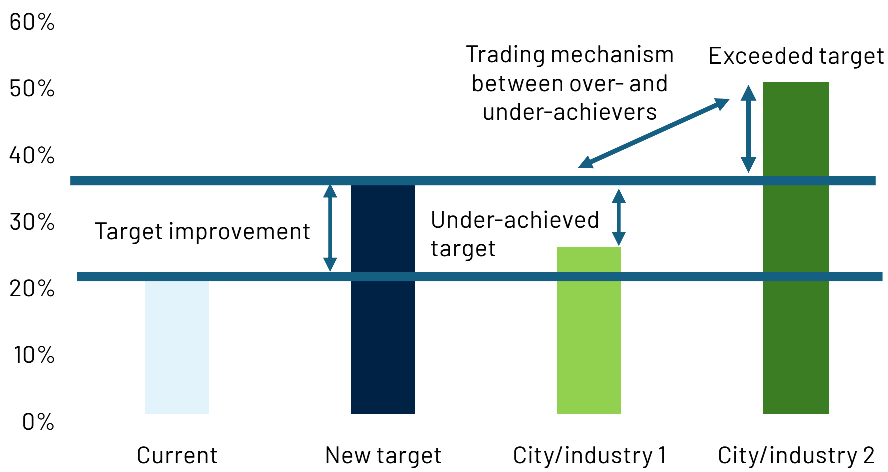
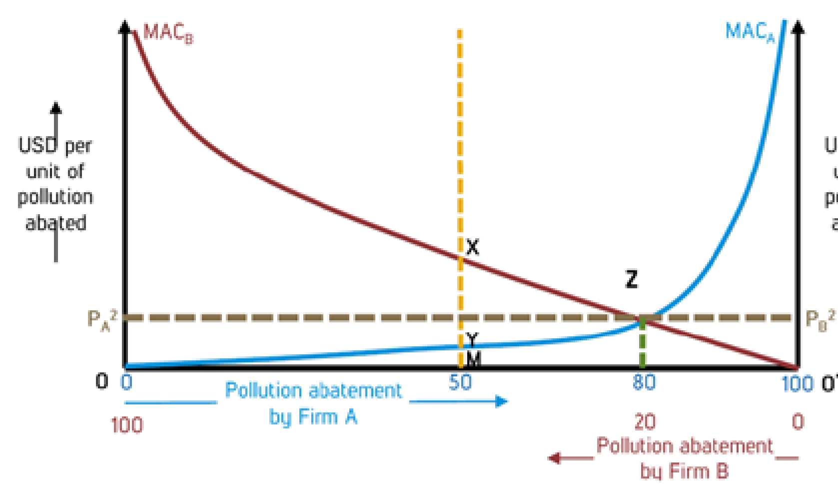


FIGURE 71: Marginal abatement cost curves as basis for WRC trading



1 Rochi Khemka et al. (2023).

3. CAP AND TRADE INSTRUMENTS:

Cap-and-trade instruments can be applied to the water sector by capping the extent of freshwater abstraction permissible.

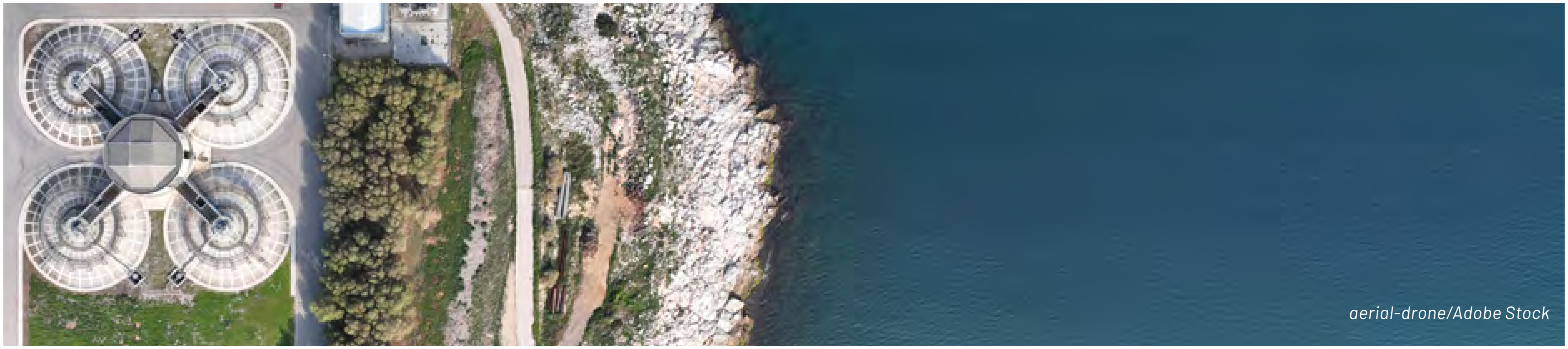
Cap-and-trade instruments, such as Emissions Trading Schemes (ETS), are widely used for the reduction of carbon emissions[1]

- Cap-and-trade policy instruments, such as emissions trading schemes, represent a **form of direct carbon pricing** that provides a clear price signal for supporting reductions in greenhouse gas emissions.
- **An ETS imposes a cap on total emissions** in chosen sectors of the economy, with the regulator **issuing tradeable allowances** within the limit of the cap.
- **Relevant entities covered by the system trade such allowances**, which determines the market price for the allowances.
- **For example, the European Union's (EU) ETS, launched in 2005, is one of the world's first carbon markets**, aimed at reducing emissions, while providing revenues to finance the green transition. It covers approximately 40% of the EU's greenhouse gas emissions.

Cap-and-trade can support water reuse as follows:

Cap the amount of freshwater abstraction permissible.

A similar approach could be applied to freshwater abstraction through water rights and entitlements. A water rights system is a framework indicating which users have the right to use water from specific sources. By capping the overall allocation of water in a context of increasing demand, the water rights framework can encourage greater reuse and the adoption of innovative technological solutions.



aerial-drone/Adobe Stock

1 Partnership for Market Readiness (PMR) and International Carbon Action Partnership (I CAP), *Emissions Trading in Practice: A Handbook on Design and Implementation* (Washington, DC: World Bank, 2016).

Water rights regimes and caps to water allocation could support water reuse.

In addition to the development of reuse targets, the introduction of limits to water abstraction and allocation can provide the impetus for stakeholders to invest in water recycling and reuse. Capping allocations can lead to a market for reclaimed water, where new water is sold for industrial processes or other uses. This not only generates revenue for utilities but also reduces the demand for freshwater. Caps to water allocations are often combined with strict used water discharge regulations, encouraging reuse.

Setting Abstraction Limits Based on Data

This requires the **establishment of clear limits** to freshwater abstraction, based on usage patterns, freshwater availability, climate change scenario planning, and ecological needs.

Periodic Adjustment of Caps

Changes in environmental conditions, **technological advancements**, and shifting **demand patterns** require adjustments to the imposed caps.

Regular Monitoring

Standardized protocols for data collection, coupled with **smart metering** and digital technology to monitor consumption patterns and anomalies, such as leaks and excessive usage, would ensure adherence to the caps, as well as monitoring of reuse.

Tucson, Arizona[1]

The City of Tucson, Arizona, plans to build a new DPR facility. It aims to do so by trading 69 million cubic meters of its Central Arizona Project entitlements, covering the period 2026 to 2035, in exchange for up to US$86.7 million in federal funds for establishing the facility.

California[2]

Due to drought conditions, and aligned with its Sustainable Groundwater Management Act, the state of California has imposed caps on water allocations, encouraging water reuse with the goal of recycling 1.8 million acre-feet of water annually by 2040. This is encouraging municipalities to invest in recycled water projects as an alternative source of supply.

1 GWI, "Tucson Joins Rush for Reuse under Colorado River Deal," (January 13, 2025).
2 California Water Boards, "Water Supply Strategy Implementation: Planned Recycled Water Projects," (Division of Water Quality, December 2023).

4. TAX CREDITS

Taxation can also be used as an incentive in the form of investment tax credits.

Tax credits represent dollar-for-dollar reductions in federal income taxes linked to investments in water reuse. Through such mechanisms, industrial facilities reusing municipal used water could lower their operating costs as well as tax liabilities, thereby spurring private investment.[1]

Examples

In the energy sector in South Africa, a **125% first-year tax deduction for renewable energy projects** (wind, solar, hydropower) commissioned by businesses in South Africa led to an acceleration in private-sector grid contributions, addressing the twin goals of greening energy production and reducing generation constraints.

The United States expanded tax credits for wind and solar projects, electric vehicle charging infrastructure, and green hydrogen production, aiming to **cut emissions by 40% by 2030.**

An **Advancing Water Reuse Act**, recently introduced in the United States congress, aims to catalyze the use of recycled water by manufacturers, data centers, and other industrial entities by establishing an investment tax credit for industrial water reuse.[2]

PhotoImage/Adobe Stock

1 WateReuse, "Investment Tax Credit for Industrial Reuse."
2 WateReuse, "WateReuse Association Applauds Introduction of Industrial Water Reuse Tax Credit Bill."

Governments and cities can use water and used water fees as a means to prevent polluting behavior and encourage water reuse.


kozorog/Adobe Stock

Fees for high water use and pollution can influence consumption patterns, while internalizing the environmental costs associated with such abstraction and contamination.[1]

In the used water sector, such solutions are based on the imposition of a predetermined price, which **users pay for every unit of pollution.**

To minimize the payment of fees, **water users work towards reducing their water footprint and evaluate alternative solutions**, such as reuse.

Moreover, **any fees collected generate revenues** for the water authority, providing capital for environmental protection measures.

Water pollution-related fees are similar to a carbon tax, providing an economic signal and allowing polluters to decide whether to:

1. Discontinue the polluting activity
2. Decrease pollution
3. Continue polluting by paying the requisite fees and taxes

Water fees can internalize polluter-pays principles, similar to carbon taxes.[1]

A carbon tax provides a price on carbon by defining a tax rate on greenhouse gas emissions or on the carbon content of fossil fuels. This is usually expressed as a monetary unit per ton of carbon dioxide equivalent. It is grounded in the **polluter pays principle**, indicating that **entities responsible for the generation of pollution should bear the costs.**

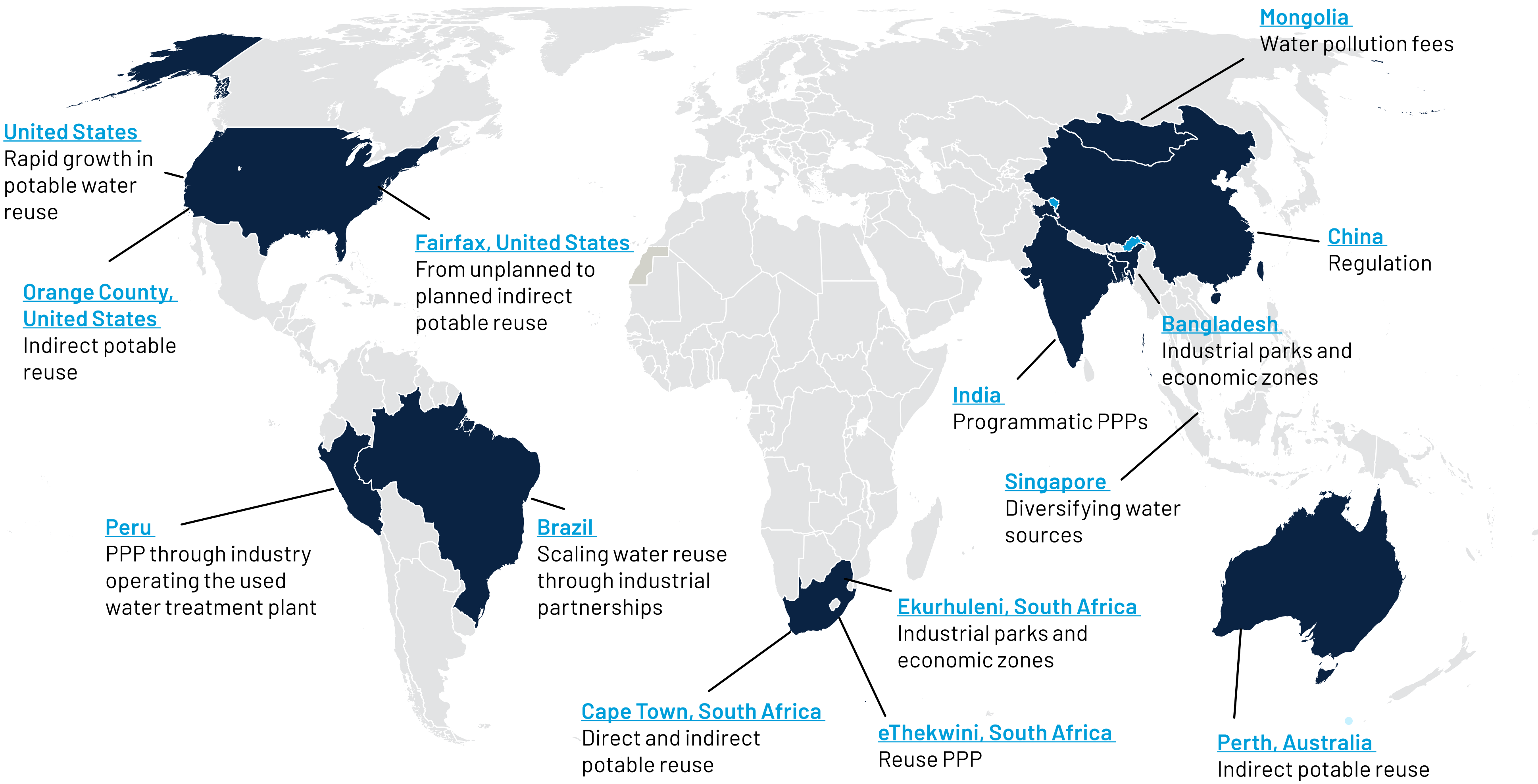
Such taxes offer various lessons for water reuse:

- **Behavior change:** Carbon taxes send a price signal to emitters to shift to less emissions-intensive ways of production. The actual amount of reduction in emissions is linked to the response of the emitting entities to the price set. With respect to water reuse, the core lesson which emerges is to **establish the fee structure such that it internalizes the cost of contamination of water** from its natural state and supports a shift towards less polluting behavior.
- **Use of revenues:** The use of fee revenues can support different outcomes. In general, governments use carbon tax revenues to support programs for climate mitigation, as an offset to lower taxes in other domains, or as general government income. With respect to water reuse, such revenues could support the operation of used water treatment plants or other water infrastructure.

1 PMR and ICAP (2016).

Annex 3: Case Studies

Explore case studies at the national, city, and corporate levels.



Australia › City of Perth › Indirect Potable Reuse

The city of Perth, Australia, has invested in IPR through groundwater replenishment as part of its strategy to respond to water scarcity and mitigate climate risks.

In response to an 80% reduction in streamflow into its surface water reservoirs, the city adopted its Water Forever strategy in 2009, focusing on diversifying water sources (Figure 72). The city's water utility, Water Corporation, has since reduced reliance on surface water by expanding both desalination and groundwater replenishment initiatives (Figure 73). In 2017, Perth became the first city in Australia to implement a groundwater replenishment scheme, where highly treated used water is purified and recharged into deep aquifers for future potable use. Located in the city's northern suburbs, the project expanded in 2022, doubling the capacity of the Advanced Water Recycling Plant from 14 billion to 28 billion liters per year. This approach, with a capacity cost of A$2,700 per m³ per day compared to A$4,300 per m³ per day for desalination, provides a more cost-effective solution (Figure 74), enhancing Perth's long-term water security while mitigating climate-related risks.

FIGURE 72: Annual inflows into Perth's dams

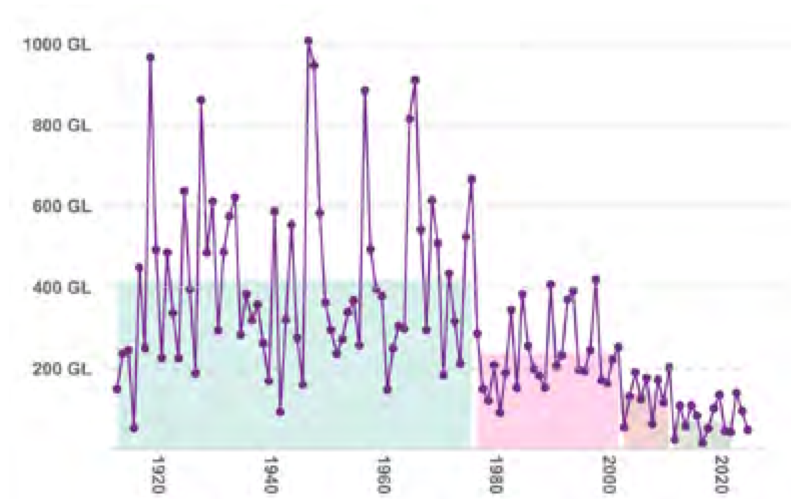


FIGURE 73: Perth's water sources (2022–23)

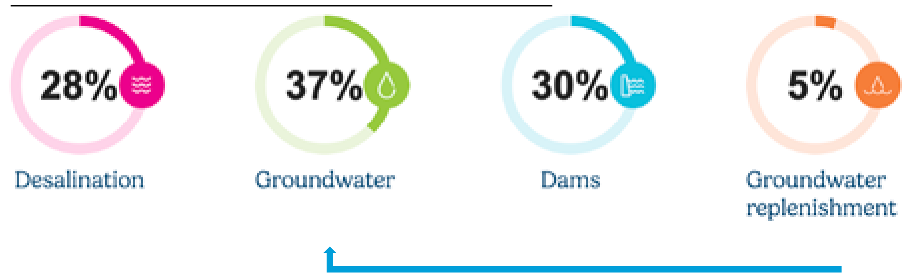
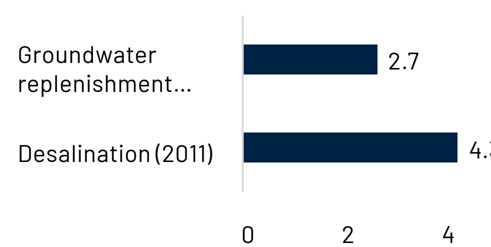


FIGURE 74: Capacity cost (A$ million/000 m³/day)



Source: Australia Water Corporation.

Bangladesh's 100 economic zones offer the potential for supporting replicable models of reuse at scale.

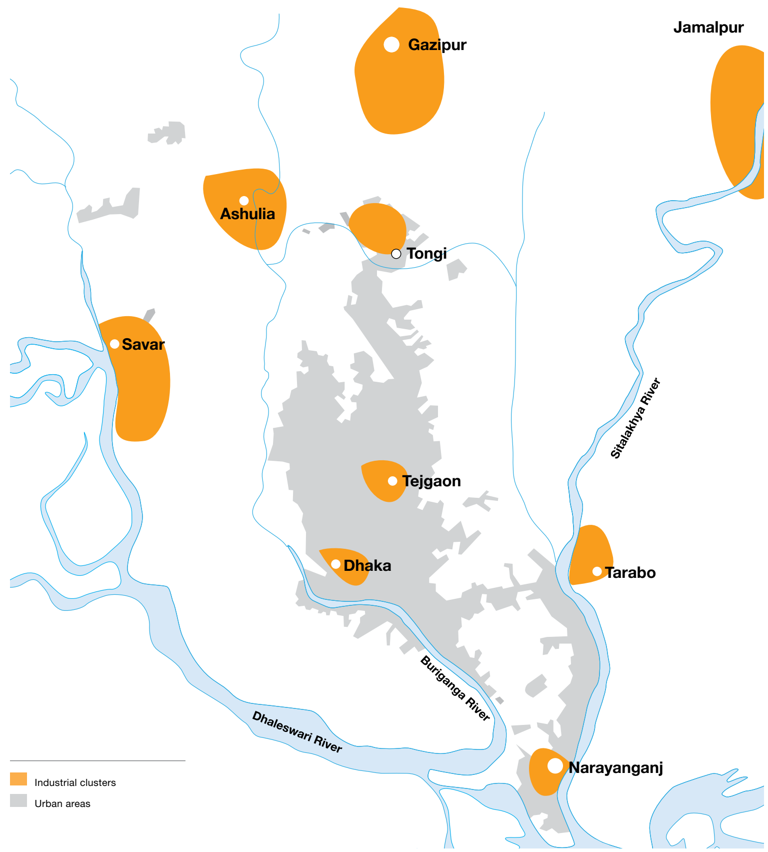
Bangladesh faces major water challenges including unsustainable freshwater withdrawals and seriously deteriorating water quality. Industrial water demand has grown rapidly, and untreated industrial effluent is a major source of pollution, impacting rivers and posing health risks to nearby communities. Water pollution costs Bangladesh an estimated US$2.8 billion annually, with the textile sector a major contributor. By 2040, the funding gap for managing water pollution is expected to reach US$6.6 billion, far exceeding the capacity of public funding.

The National Water Policy (1999), Bangladesh Water Act (2013), and Bangladesh Water Rules (2018) offer a framework for regulating both abstraction and discharge, but enforcement capacity is weak and public funding limited. A draft Industrial Water Use Policy sets out a clear vision of water-secured industrial growth with two primary policy objectives: optimize industrial water use and reduce water pollution from industrial effluents.

Fortunately, industries in Bangladesh are clustered into one hundred economic zones and these offer the opportunity for cost-effective interventions to increase industrial used water treatment and reuse (Map 8), especially where zones have industries with similar used water characteristics, such as clustering within the apparel industry. Bangladesh is among the world's largest exporters of ready-made garments with a global market share of about 5%. The sector currently accounts for more than 80% of Bangladesh's export earnings and more than 10% of the GDP. Global corporates are sensitive to reputational risks and are willing to work with governments to find more sustainable water treatment and reuse solutions.

WRG is collaborating with the Bangabandhu Sheikh Mujib Shilpa Nagar Economic Zone to develop a **hybrid annuity PPP model** for the **first centralized effluent treatment plant** in an industrial zone. Successful implementation could pave the way for the replication of this model across the 100 economic zones in Bangladesh.

MAP 9: Industrial clusters in the Greater Dhaka Area



Sources: Thomas Sagris et al., "An Analysis of Industrial Water Use in Bangladesh with a Focus on the Textile and Leather Industries," (Washington, DC: World Bank, 2015); Rebel, "Options Study for Implementation of Industrial ETPs in Urban Areas through PSP/Circular Economy Options [in Bangladesh] (2021); World Bank, "Bangladesh Water Sector Diagnostic: Priorities for the New Decade," (Washington, DC: World Bank, 2020).

Public-private partnerships to secure industrial water supply.

Aegea, Brazil's largest private water concessionaire, has achieved a significant breakthrough in water reuse through a long-term partnership with Braskem, a leading petrochemical company.

The agreement, signed in early 2025 through Aegea's industrial water subsidiary Apura, will supply Braskem's Duque de Caxias plant in Rio de Janeiro with 100% of its water demand— around 20,390 cubic meters per day—using new water. This 30-year offtake deal not only secures a sustainable water supply for Braskem but also aligns with both companies' circular economy and climate resilience goals.

The partnership marks a critical step toward sustainable industrial water management in Brazil, a country where climate change has had a growing impact on water resources in populous states like São Paulo and Rio de Janeiro. A global mapping of Braskem's operations identified the Duque de Caxias plant as particularly vulnerable to water risk, making this reuse project vital to its long-term viability. The treated industrial effluent will be blended with municipal used water at Aegea's treatment plant, which will be supported by an additional purification plant using ultrafiltration and reverse osmosis technologies, expected to become operational by 2029.

This project also supports Aegea's goal of meeting Brazil's sanitation law targets ahead of schedule. In 2021, Aegea secured two concession blocks in Rio de Janeiro, where used water collection in Duque de Caxias was just 13%. The additional revenue from the Braskem partnership will enable Aegea to achieve 90% used water coverage by 2029—four years ahead of the mandated 2033 deadline.

Aegea has demonstrated a similar approach with Petrobras, signing an agreement in 2023 to supply 86,400 cubic meters per day of new water. These initiatives showcase the potential of integrating industrial and municipal water reuse to enhance resilience while meeting critical infrastructure targets. By leveraging synergies between public and private sectors, Aegea is setting a precedent for scaling water reuse across Brazil.

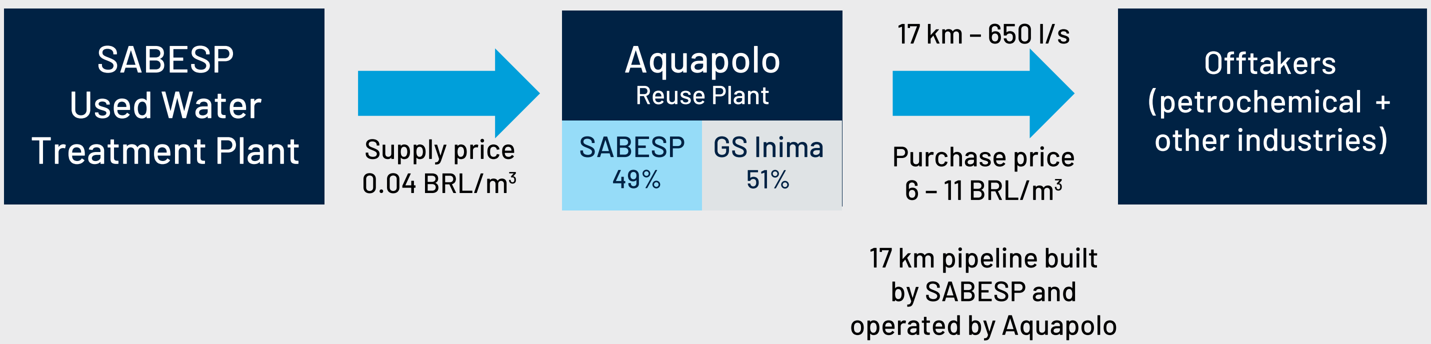
Ekaterina Belova/Adobe Stock

Source: Mariana Quaresma, "Aegea Secures Brazilian Reuse Breakthrough in Braskem Deal," (GWI, March 18, 2025).

Aquapolo represents a form of joint venture between the public and the private sector.

Aquapolo is one of the largest industrial reuse projects in Latin America and one of the world's largest, with the capacity of producing up to 1,000 liters per second (l/s) of recycled water for industrial purposes. Located inside SABESP's sewage treatment plant in the ABC Paulista region, Aquapolo is the result of a **partnership between SABESP and GS Inima.** Aquapolo collects secondary treated sewage from SABESP, which then treats it to the standards required by petrochemical industries and others and delivers it through a 17-kilometer (km) pipeline.

A critical element ensuring success of the project is a **long-term treated water purchase agreement between Aquapolo and industry,** providing assurance that industry will buy the treated water up to 2054. The project is ensuring the collection of sewage goes up, industrial water demands are met through sustainable mechanisms, and the supply of drinking water for households is secured.



Government commitment, together with a clear regulatory framework, can accelerate reuse at the national, city, and corporate scales, as the experience of China shows.

A large and fast-growing reuse market in China: China's market for reuse accounts for **40% of all installed capacity worldwide**, and 80% of this capacity has been awarded within the last decade. The market is growing three times faster than the rest of the world due to aggressive government targets and regulatory pressures supporting reuse by both utilities and industries (Figure 75).[1]

FIGURE 75: Evolution of reuse commitment and regulation in China

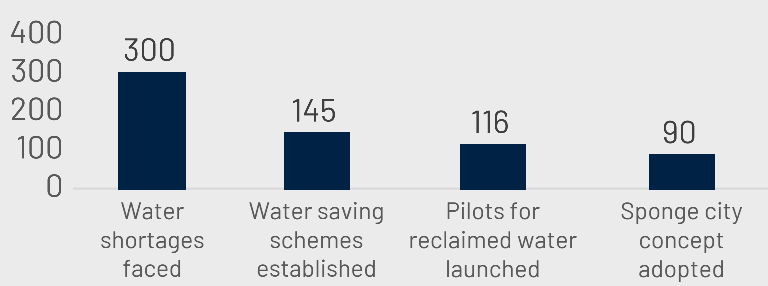
2015 Action Plan + **2021 National 14th Five Year Plan** + **2024 National Water Conservation Regulation**

2015 Action Plan: Set water reuse rates by 2020 of:[2]
- 20% in water scarce cities
- 30% in Beijing-Tianjin-Hebei region
- 15% in other cities

2021 National 14th Five Year Plan: Specified a reduction of 16% in net water consumption, driving industrial reuse

2024 National Water Conservation Regulation: Provides quotas for water use for industry, services, and various crops[3]

FIGURE 76: City-level engagements in China (# cities)



Reuse Drivers in China

Water Scarcity (Figure 76):

- **National Level:** The primary underlying growth driver for reuse is water scarcity and the need to curtail water use within an absolute water resource limit.
- **City Level:** Up to 300 cities suffer from varying degrees of water shortages.
- **145 national water-saving cities** established, where reuse is strongly promoted.
- **116 cities** have supported pilot projects for reclaimed water, with an average reuse rate achievement of 29 percent.
- **90 cities** have promoted the "sponge city" concept, which emphasizes flood management through green infrastructure, achieving natural purification of rainwater and enhancing local rainwater resource utilization.

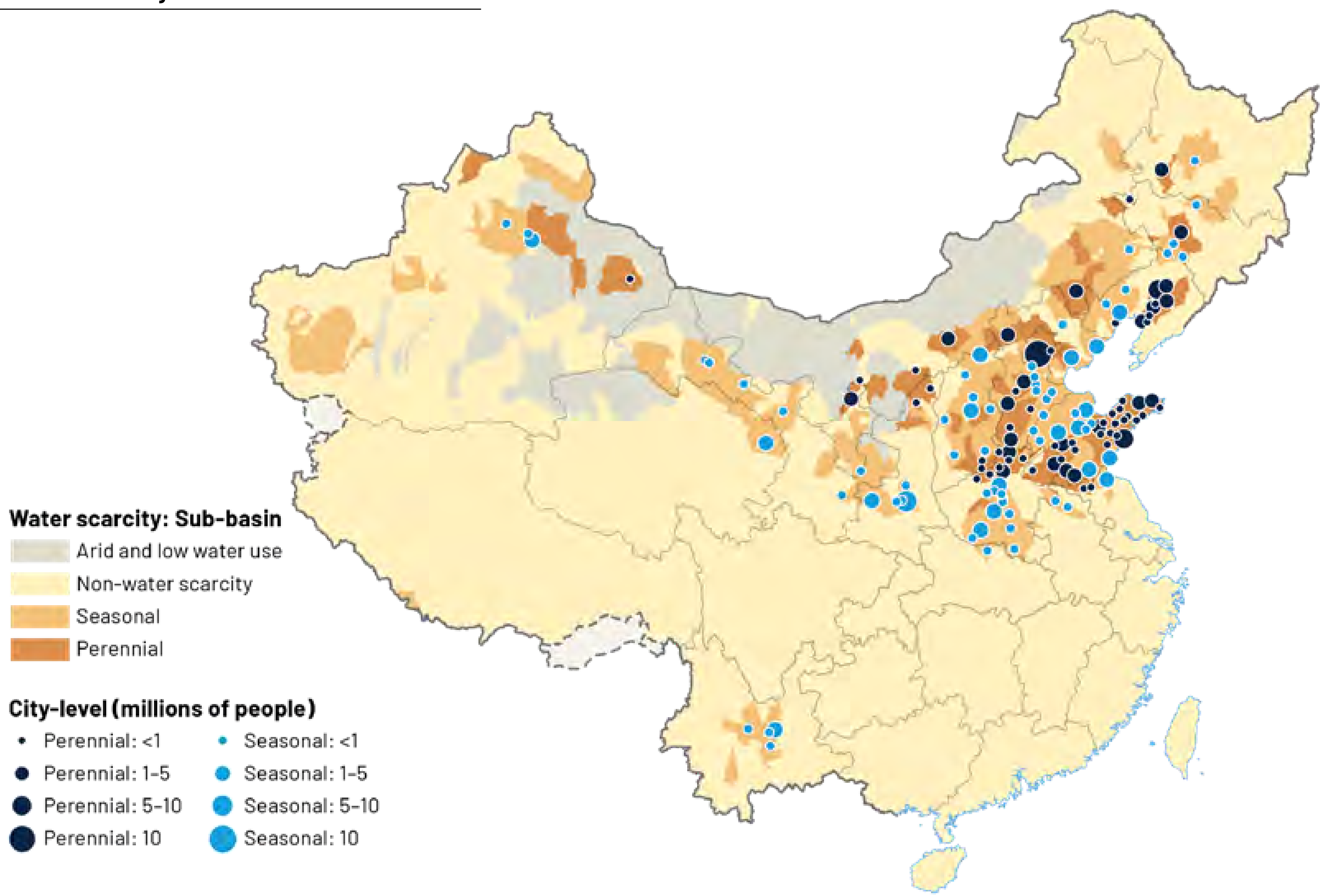
Water Resources Tax to Increase Allocative Efficiency:

- Starting from December 1, 2024, China is implementing a water resources tax nationwide, replacing the current water fee charging mechanism, designed to "strengthen the management and protection of water resources and promote the conservation, intensive and safe use of water resources."
- The tax is **levied on abstraction volume**. Higher tax rates are required for groundwater extraction and water use in areas with severe water shortages.
- Although the introduction of this tax **does not increase the overall tax burden**, for high water-consuming industries and enterprises operating in over-exploited areas, the shift from water fees to water taxes may increase their water usage costs.

1 GWI, "Market Focus Deck: Desalination and Reuse," (October 2023), GWI (2024).
2 "The Action Plan for Prevention and Control of Water Pollution," as reported in Zhuo Chen et al., "Water Reuse in China: Current Status, Policies, and Experience," in *Handbook of Water and Used Water Purification*, edited by Josef Lahnsteiner (Cham: Springer, 2024): 1239–54.
3 National Regulation on Water Conservation, Order No. 776 (March 2024).

Water stress is a significant driver of water reuse in China's major cities, particularly in the north.

MAP 10: Water scarcity in China at the sub-basin level[1]



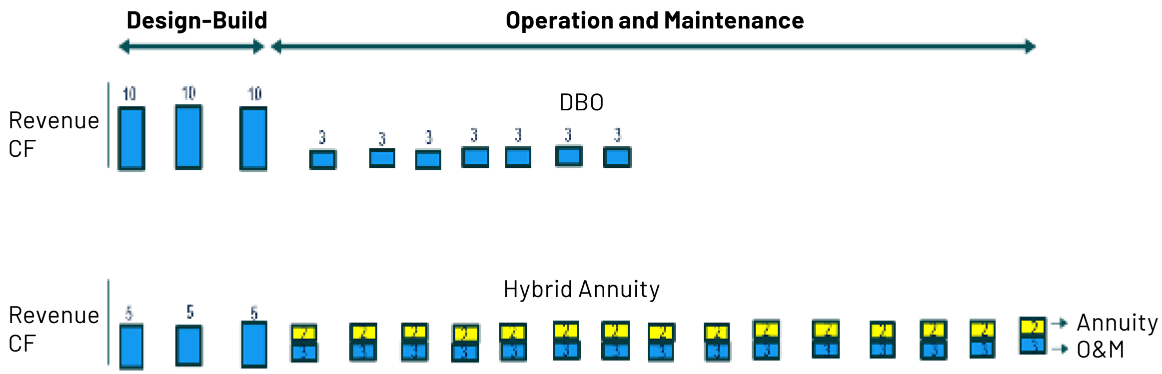
Source: He et al. (2021).

Used water treatment and reuse projects in the Ganga basin, which have unlocked US$650 million in private capital to date, represent an example of programmatic PPPs.

Context:

- The Ganga basin is the world's most populous river basin, covering 860,000 square kilometers across 11 states in India. More than 600 million people—close to half of India's population—live within its boundaries, and the region generates over 40% of the country's GDP.
- Along the river's mainstem—home to about 50 major cities—an estimated 3 billion liters of untreated sewage flowed into the river every day. Domestic sewage accounted for the majority of the pollution load, with industrial effluents and poorly managed solid waste adding further pressure. Many existing treatment plants were not functioning effectively or lacked adequate maintenance.

FIGURE 77: Comparison of Payment Flows – DBO vs. HAM



Programmatic PPP Approach:

- The World Bank-supported National Ganga River Basin Project began strengthening institutions and financing infrastructure investments in the five mainstem states—Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. The project focused on building and upgrading sewage treatment plants, laying new sewer networks, improving environmental governance, and establishing reliable water quality monitoring systems.
- Within this broader initiative, the World Bank Group—including the World Bank, IFC, and 2030 WRG—conceptualized and developed a **hybrid annuity model (HAM) as a public-private partnership structure** for used water treatment in the Ganga basin.
- Under HAM, the government pays **40% of the project's capital costs tied to construction milestones**, and the **remaining 60% over 15 years, contingent on the treatment plant's performance.** As a result, the private sector recovers part of the project costs over 15 years, subject to the achievement of set water quality parameters, thereby driving performance (Figure 77).
- This approach incentivizes the private sector to maintain long-term operational standards and shifts some of the financial risk away from the public sector. It sought to address a persistent challenge: ensuring that treatment plants, once built, continue to function effectively over their entire lifespan.
- The initial pilots, launched in Mathura and Vrindavan, as well as Varanasi, and Haridwar, tested the feasibility of this model, which was then **scaled across 30+ towns in the basin, unlocking US$1.5 billion in project costs, with US$650 million in private capital.**
- Mathura was one of the projects under this initiative that supported reuse through offtake by the Indian Oil Refinery, with the costs split 50-50 between the refinery and central government.

India's reuse market is small but growing fast with huge potential, particularly for industrial reuse.

Industrial reuse is the largest application of new water in India and is growing fast. While coming off a small base, water reuse capacity has more than doubled over the last five years from 7 to 15 million cubic meters per year (Figure 78).[1]

Regulation is driving the increase in industrial reuse. Within the National Framework on Safe Reuse of Treated Water, growth in reuse is primarily for industrial use, driven by federal initiatives and state regulations (related to water scarcity and water pollution), court actions (typically related to river pollution) and industry clustering with centralized treatment and zero liquid discharge objectives. New, more stringent rules are proposed (Box 1). Various states and cities are investing in reuse and some examples are presented below:[1,2]

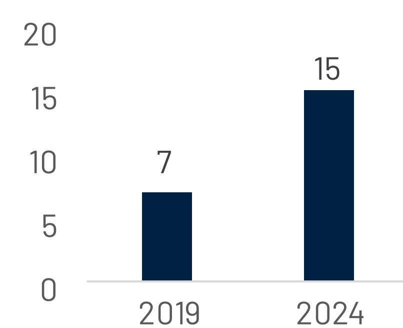
- **Indore** was declared as India's first **'water plus city'** and is consequently mandated to **reuse a minimum 25% of used water** as per the Swachh Bharat Mission **Water Plus Protocol.**
- In **Maharashtra**, the State Water Resources Department requires all local governments (and their utilities) to ensure 100% treatment of used water by 2023, reuse of at least 30% of the recycled water by 2023, and **reuse of 100% recycled water by 2030.**
- **Gujarat's reuse policy mandates industrial parks and large industrial units to reuse new water.** The requirement for individual industrial units applies to all industries consuming more than 0.1 megaliters per day and at a distance of less than 50 kilometers from used water treatment plants.
- The **Supreme Court** of India has issued specific orders since 1999 to prevent the discharge of untreated industrial effluents into the heavily polluted Yamuna River. In 2021, it recognized that pollution-free water is a basic right under the constitutional framework, prompting increased focus on the reuse and recycling of used water.
- In the state of **Haryana**, the government's textile park must upgrade the existing centralized treatment works, with only secondary treatment, to a zero liquid discharge treatment facility to meet the supreme court directive of banning the discharge of effluent into the Yamuna River.
- 32 cities practice reuse, and 15 cities have more than 50% reuse.[3]

BOX 1: New regulations could transform water reuse in India

The Government's proposed "**Liquid Waste Management Rules**" (October 2024) regulate the generation, collection, treatment, reuse, and disposal of used water and incentivize the reuse of new water by imposing penalties on failure to meet minimum reuse targets.

The rules will require urban local bodies to develop and implement action plans addressing all aspects of used water management. The rules underscore financial sustainability through user fees and the adoption of digital technologies to improve the efficiency and transparency of liquid waste management in cities.

FIGURE 78: Contracted reuse capacity in India (million m³/year)[1]



1 GWI (2023a).
2 KPMG, India Wastewater Reuse Opportunity Mapping (2021).
3 Kirti Goyal et al., "A Comprehensive View of Existing Policy Directives and Future Interventions for Water Reuse in India," *Water Policy* 24, no. 7 (July 5, 2022): 1195–1207.

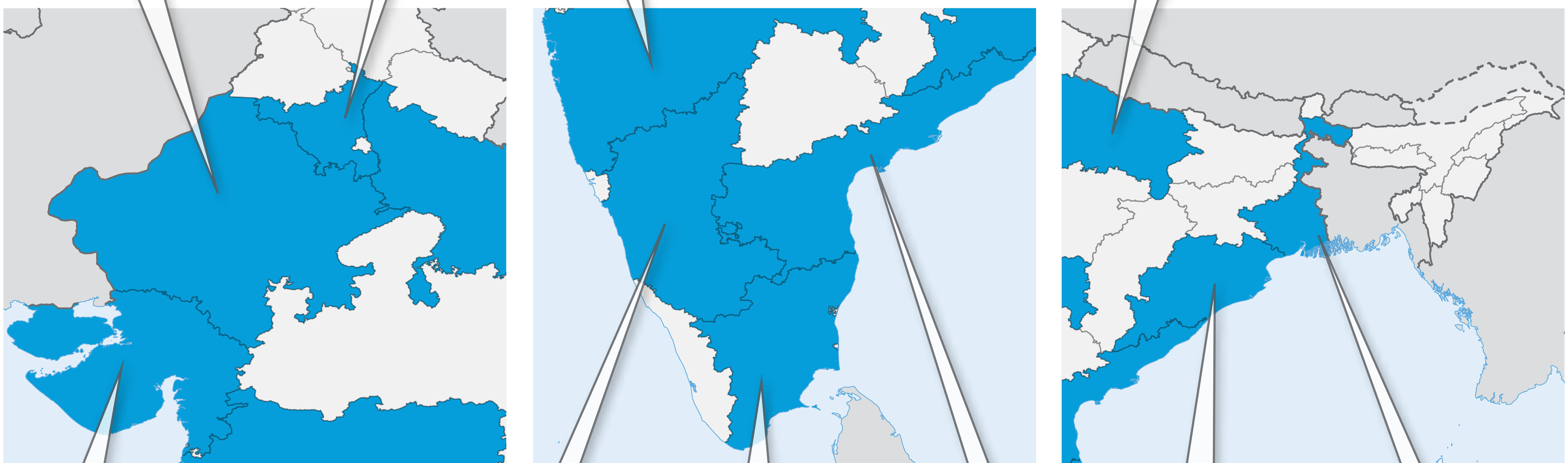
Reuse in India is driven by state policies and regulations...

Haryana targets 80% reuse by 2030, focusing on industrial and construction sectors

Rajasthan requires 50% reuse by 2026, focusing on industrial and municipal applications

Maharashtra State Water Policy (2019) requires a minimum of 30% reuse to reduce freshwater demand in the next 5 years. The state requires industries within 50 km of STPs to use new water

The **Uttar Pradesh** Urban Wastewater Treatment (recycle, reuse, disposal) policy aims to address water scarcity and promote sustainable water management by prioritizing new water as a resource. It aims to achieve 100% reuse of treated used water in all cities



Gujarat mandates 100% reuse of used water by 2030, requiring industries within 50 km of sewage treatment plants (STP) to use new water

Karnataka targets 50% reuse of used water by 2030, with industrial estates within 30 km of STPs prioritized

In **Tamil Nadu**, industries within 50 km of STPs must use new water

Andra Pradesh aims to reduce freshwater demand by 30-50% in water-stressed regions by prioritizing industrial and agricultural reuse. Industrial reuse is mandatory for industries within 20 km of sewage treatment plants

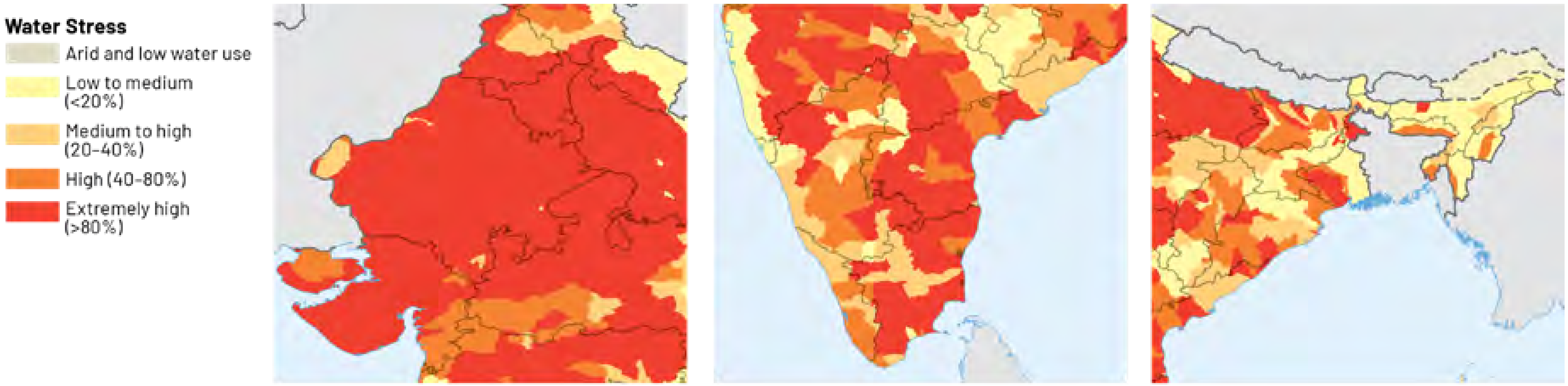
Odisha encourages industries to adopt zero effluent discharge

West Bengal aims for 80% reuse by 2030, focusing on non-potable applications

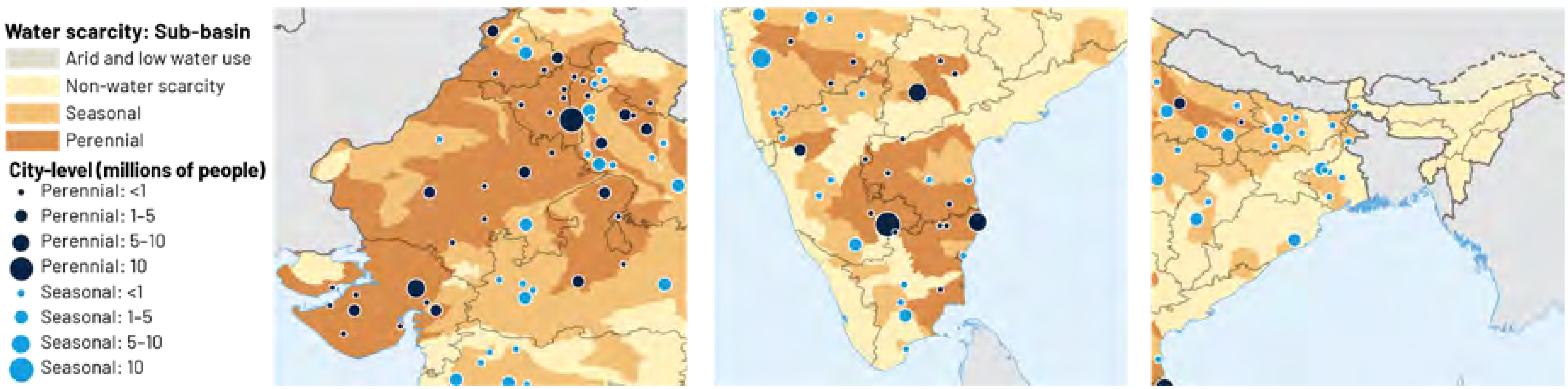
Source: Goyal et al. (2022).

...and increasing levels of water stress.

MAP 11: Current water stress at a basin scale[1]



MAP 12: Current water scarcity in cities in India[2]



1 World Bank estimates using information from AQUEDUCT 4, World Resources Institute.
2 He et al. (2021).

Mongolia | Nationwide | Water Pollution Fees

Water pollution fees, which internalize the cost of degradation of water, can support reuse across sectors, as the experience of Mongolia highlights.

Context

52 entities were producing **76% of the daily effluent volume** in Ulaanbaatar, which could be treated before discharge to sewers

Most industry segments with **large discharges** were found to be **highly polluting,** such as spirits, wool and cashmere, and tanneries

Such large units could **afford their own treatment plants**, and could be charged higher pollution fees and compensation rates to incentivize treatment

In Mongolia, the World Bank's WRG developed a new **Water Pollution Fee Law** to address water pollution from municipal and industrial sources. Grounded in the **polluter pays principle**, the law requires industrial and commercial entities to pay water pollution fees based on the volume and quality of used water discharged. The fee structure under the law was established to incentivize such large entities to pre-treat their effluent before discharge.

Fee Structure

All entities discharging water into central sewers must pay two types of fees:

(1) Pollution Fee: If the effluent meets discharge standards

(2) Compensation Fee: If the effluent exceeds discharge standards, with the rate dependent on volume and pollution load

This law was coupled with national standards for reuse across different reuse categories, as well as supporting guidelines on discharge permits and contractual arrangements with basin authorities, among others. The law has resulted in the following impacts:

Impacts

Pre-Treatment of Effluent:
The implementation of the law has resulted in pre-treatment of effluent by eight industrial sectors and avoidance of 61.2 million cubic meters of inadequately treated effluent into the Tuul river.

Revenue Collection:
The revenues collected through this mechanism are supporting the **operating costs of the central used water treatment plants** operated by the Ulaanbaatar Water Supply and Sewerage Authority.

Acceleration of Reuse Investments:

- WRG's assessment of specific projects for reuse of new water by the central heat and power plants in Ulaanbaatar unlocked US$97.8 million in financing from the Millennium Challenge Corporation under its Second Compact Agreement.
- In addition, multiple industrial units are actively supporting reuse to capitalize on the pre-treatment infrastructure they put in place as a result of the law.

Public-private partnerships between cities and industry can address water scarcity and the quality of water in the environment through reuse projects.

The City of **Arequipa, Peru**, implemented an innovative solution to address water scarcity and expand used water treatment through a public-private partnership between SEDAPAR, the local water utility, and Cerro Verde, a large copper mine.

Cerro Verde needed additional water to expand mining production and proposed treating Arequipa's used water, in exchange for a portion of the treated water. A water resource recovery facility, La Enlozada, was designed, financed, built, and operated by Cerro Verde under a 29-year PPP agreement. The facility, using energy-efficient trickling filter technology, can treat 1.8 m^3/second of used water, with planned expansions to 2.4 cubic meters per second by 2036. Cerro Verde receives 1 m^3/second for mining operations, while the remaining treated water is returned to the Chili River for downstream use.

This solution brought substantial benefits. SEDAPAR saved over US$615 million in construction and operation costs, while Cerro Verde secured a cost-effective water source. Environmentally, the project improved water quality in the Chili River, leading to the return of aquatic life. Socially, it increased used water treatment coverage to over 95% for Arequipa, reduced waterborne illnesses, and improved irrigation water quality for farmers.

The success of the project has been attributed to its economic viability, together with good stakeholder engagement and enabling PPP regulations: the case study shows that **reuse is economically viable in water-scarce areas**, especially where the cost of tapping the nearest water source is high. It is estimated that for an alternative scenario (desalinization and pumping), the cost of water for Cerro Verde would be in the range of US$2.5 per cubic meter, in comparison with US$0.68–0.80 per cubic meter for reuse. Given the opportunity costs, Cerro Verde was ready to pay the capital and operation costs of the used water treatment plant in full.

Aerial view of La Enzolada wastewater treatment plant.
Source: Cerro Verde, 2018.

Source: World Bank, *Wastewater: From Waste to Resource - The Case of Arequipa, Peru* (Washington, DC: World Bank, 2019).

Singapore is a world leader in building water resilience by employing a strategy of diversifying sources and reusing water.

WHY? Singapore's Water Security Imperative

Water security is a national priority for Singapore. Despite high rainfall, the country lacks sufficient space for natural storage and imports water from Malaysia. The country's rapid economic and population growth after independence heightened the urgency of securing a sustainable and secure water supply.

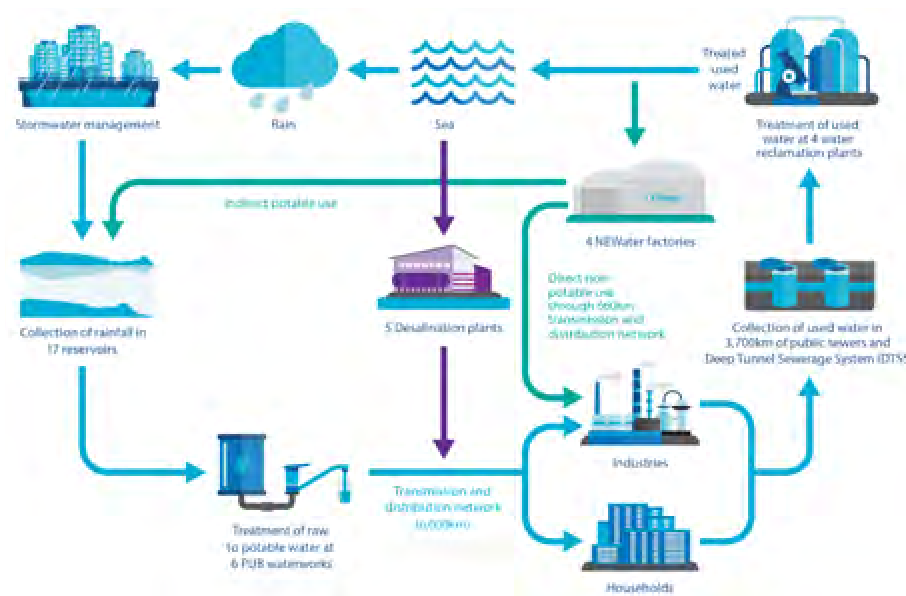
WHAT? A Diversified Water Strategy with NEWater

To address its water security needs, Singapore developed an integrated water management system with diversified water sources known as the Four National Taps: local freshwater, imported freshwater, desalinated water, and NEWater. NEWater is highly purified water reclaimed from used water. NEWater's genesis dates back to the 1970s, when the Singapore Government commissioned a study to determine the feasibility of producing reclaimed water.

While the technology at the time had not yet matured and remained expensive, the national water agency, PUB, continued to conduct research and monitor the landscape as technology evolved. The reverse osmosis membrane technology eventually became cost-effective, efficient, and reliable in the 1990s. Following a successful demonstration plant, PUB opened the first two NEWater factories in Bedok and Kranji in 2003. Today, NEWater represents a key pillar of Singapore's water security system, enabling the country to close the water loop and reuse water sustainably.

Slated for completion in 2027, the 206-kilometer Deep Tunnel Sewerage System (DTSS) is a massive underground superhighway that will use gravity to convey all used water from industries and households to centralised water reclamation plants. After treatment at the water reclamation plants and further purification at NEWater factories, the high-grade reclaimed water will be distributed through a dedicated pipe network for non-potable industrial use (Figure 79).

FIGURE 79: Closing the water loop with NEWater



Because NEWater is ultra-clean, its biggest users are fabrication plants for semiconductor wafers, which require water quality at even more stringent standards than those for drinking water. In addition, during dry spells, a small amount is blended into reservoirs for indirect potable reuse. A weather-independent water source, NEWater strengthens water security in the face of exacerbating climate change.

PUB currently operates NEWater factories at Kranji, Ulu Pandan, and Changi. From 2016 to 2023, NEWater sales averaged 142 million cubic meters per year, or 21% of total water sales of 662 million cubic meters per year.[1] The country's NEWater production capacity will expand with the completion of Changi NEWater Factory 3 in the next three years and Tuas NEWater Factory by 2027.

Singapore's long-term planning and water management strategy, incorporating NEWater and three other National Taps, aims to strengthen the country's ability to meet current and future growth in water demand. This approach has supported economic growth while bolstering water resilience. Between 1965 and 2019, per-capita GDP increased 40-fold, while total water consumption grew sixfold,[2] reflecting the success of this strategy in securing supplies, together with measures to increase water use efficiency and manage demand.

The advantages of NEWater

Why has Singapore pursued a strategy to develop NEWater as a National Tap?

Producing NEWater is more energy-efficient and cost-effective than desalinated water. The energy consumed in producing NEWater amounts to between 0.6 and 0.8 kilowatt hours per cubic meter in the same plant—less than a quarter of the 3.5 kilowatt hours per cubic meter used in desalination.[3]

PUB reports that there are ongoing efforts to further enhance energy efficiency in NEWater production, including the development of biomimetic membranes for municipal applications. The technology uses nature-based protein water channels within a filtration membrane, which facilitates high water flow while minimizing energy consumption. Demonstration plant trials have shown promising results, achieving a 20 percent reduction in energy consumption.[4]

1 Plant capacity data and dates of commissioning and decommissioning from Michele Y.C. Chew et al., "The Challenges in Singapore NEWater Development: Co-evolutionary Development for Innovation and Industry Evolution," *Technology in Society* 33, no. 3: 200–11 (2011). PUB press releases (for example, on Singapore's NEWater Journey), PUB Annual Reports, and the Legislative Council Secretariat's NEWater Fact Sheet. Water sales data from Singapore Government Data Portal and Ministry of Sustainability and Environment.
2 United Nations Conference on Trade and Development (UNCTAD), *Aligning Economic Development and Water Policies in Small Island Developing States* (Geneva: United Nations, 2021).
3 PUB Singapore, "Desalinated Water."
4 PUB Singapore, "Singapore NEWater Journey," Press Release (September 27, 2024). See also PUB Singapore, "Virtual Introduction on PUB Water Reclamation Process & Technology Outlook."

HOW? Key Factors Behind NEWater's Success

1. Political Leadership

- Water security is of national significance, and Singapore's water strategy is anchored in strong governance and management. PUB manages the entire water cycle, from collection to treatment and supply. Long-term investments in large-scale infrastructure, including the DTSS, ensure that all used water can be collected and treated for reuse.

2. Developmental Approach: Research and Piloting Before Scaling

- Singapore's water reuse strategy followed an incremental, evidence-based approach, starting with research and pilot plants before full-scale implementation. Universities and private sector partnerships have played a crucial role in advancing membrane technologies, energy efficiency, and process optimization. PUB dedicates funding to continuous innovation, ensuring that technological advancements keep pace with evolving challenges. PUB has supported more than 770 research and development projects, with a total value of about US$918 million over the 22-year period from 2002 to 2024.[1]

3. Regulation and Wastewater Management

- Singapore's regulatory framework ensures that used water is safely collected, treated, and reused. Strict industrial discharge regulations, backed by the Sewerage and Drainage Act (1999), protect the used water system. To manage rising non-domestic demand, PUB introduced mandatory water recycling in 2024 for new wafer fabrication, electronics, and biomedical projects consuming more than 60,000 cubic meters each year. These industries account for 17% of non-domestic water demand, making recycling mandates key to sustainable water management.

4. Smart Water Management and Digitization

- Singapore has fully digitized its water management system, integrating real-time environmental monitoring, predictive modeling, and digital twin technology to optimize resource allocation, efficiencies, and environmental protection.

5. Public-Private Partnerships and Industry Engagement

- PPPs have been essential in scaling Singapore's water reuse program. While early investments were made in-house, large plants were contracted through DBOO models and 25-year concessions. These have enabled private investment in Singapore's water infrastructure to supplement investments by both the government` and PUB, the latter from tariff revenues. Singapore's water industry includes 350 companies, contributing to both domestic and global markets.

6. Public Acceptance & Stakeholder Engagement

- Public acceptance was key to NEWater's success. Wastewater was reframed as "used water" and NEWater was promoted as a safe, high-quality resource. Initial skepticism was addressed through education campaigns, branding, and outreach. An extensive public education program helped Singaporeans appreciate the safe technology behind NEWater. In addition, public trust was secured through stringent quality control, transparency, and public engagement, including formally introducing NEWater as Singapore's third National Tap, with over 60,000 Singaporeans raising a toast to NEWater at the 2002 National Day Parade.[2]

7. Investments in Learning and Partnerships

- PUB has collaborated extensively with industries and institutions of higher learning, including setting up the Singapore Water Exchange, a hub that houses local water companies together with PUB to form an ecosystem supportive of innovation and investment in water technologies. PUB also works closely with the Singapore Water Association, supporting the development of local industrials in the water sector.

1 PUB Singapore, "Annual and Sustainability Report 2023/4."
2 See, for example, Asian Development Bank, "Harry Seah: Making the Unthinkable Drinkable" (December 1, 2009) and George Madhavan, "Beyond Tap Water: NEWater Wins Public Confidence in Singapore."

Investment Finance and Pricing

Investments in Singapore's resilient water system have come from both the public and private sectors. Tariffs play an important role in recovering costs. Investments in the early phases of NEWater development were undertaken by the government. Private sector investments, primarily through long-term DBOO contracts, became more important as the technology matured, risks were reduced, and investments were scaled.

In Singapore, water is priced to recover the full cost of its supply and production and to reflect the cost of producing the next drop of water. Water pricing in Singapore reflects scarcity, contributes to cost recovery, and funds future infrastructure investments (Figures 80 and 81).

FIGURE 80: Water sales and tariffs

	Potable Water (Domestic)		Potable Water (Non-domestic)	NEWater	Industrial Water
Water Sales (2023)* (million m³)	300		209	145	14
Tariffs (2025) ($ per m³)**	0 - 40 m³	> 40 m³			
Tariff	$1.43	$1.81	$1.43	$1.28	$0.66
Water Conservation Tax	$0.72	$1.18	$0.72	$0.13	-
Waterborne Tax	$1.09	$1.40	$1.09	$1.09	$1.09
Total	$3.24	$4.39	$3.24	$2.50	$1.75

* As reported in PUB Annual and Sustainability Report for 2023/2024.
** Singapore Dollars, effective April 2025. See PUB, "Water Price."

FIGURE 81: Components of water price *

Water Tariff	Covers the costs of collecting, treating, and distributing potable water through Singapore's island-wide pipeline network. It is charged based on water consumption.
Water Conservation Tax (WCT)	Introduced in 1991, promotes water conservation by reflecting its scarcity value. Imposed as a percentage of the water tariff, it reinforces the importance of saving water from the very first drop.
Waterborne Tax (WBT)	Used water is collected through a separate sewer network and treated at water reclamation plants before being purified into NEWater or discharged into the sea. The Waterborne Tax (WBT), paid by all water users, helps cover the cost of treatment and maintenance of the used water system. It is charged based on water consumption.

* PUB, "Water Price."

Leveraging Green Finance for Water Reuse

PUB has incorporated green finance to support large-scale projects. In 2022, PUB issued a green bond in the amount of S$800 million, fully allocated to financing and refinancing the Tuas Water Reclamation Plant and Tuas NEWater Factory 1.[1] The bond finances project expenditures for sustainable water and used water management, specifically water treatment infrastructure. It covered 28.9% of the projected cost for Tuas NEWater Factory 1 and 22.8% for Tuas Water Reclamation Plant.

Future outlook: Innovation and scale

The DTSS was conceived in the 1990s to transform the country's used water management system. This vast underground project is designed to meet Singapore's long-term needs for used water collection, treatment, reclamation, and discharge. It "holds the key to enable PUB to reclaim and recycle water in an endless cycle," supporting Singapore's capacity to produce NEWater as a weather-resilient water source.[2] With the construction of the DTSS, Singapore's used water system will eventually be consolidated into three nodes, situated in the Eastern, Northern, and Western ends of Singapore, where a water reclamation plant will be co-located with a NEWater factory. The project involves decommissioning some of the older NEWater plants and making investments in new capacity using the latest available technology. Investments in research and innovation are ongoing. At Singapore International Water Week 2024, PUB signed eight memoranda of understanding to facilitate knowledge exchange and transfer between PUB and other organizations on innovation, energy-efficient water treatment, resource circularity, and climate resilience.[3]

Wesley Pribadi/Unsplash

1 PUB Singapore, "Green Bond Report for the Financial Year 2023."
2 PUB Singapore, "PUB Completes Tunneling Works for Second Phase of Deep Tunnel Sewerage System," Press Release (August 21, 2023).
3 PUB Singapore Annual and Sustainability Report for 2023/2024.

Scaling NEWater: Industrial adoption as a key driver

Industrial adoption has been a cornerstone of Singapore's strategy to scale water reuse. Since its introduction in 2003, NEWater has provided a high-purity, cost-effective water source for industries with stringent quality requirements, particularly the wafer fabrication sector. Convincing businesses to adopt reclaimed water required rigorous validation, strategic collaboration, and clear financial benefits.

From Skepticism to Confidence: Securing Industry Buy-In

The wafer fabrication industry, known for its high water consumption and strict purity standards, was among the first to adopt NEWater. Initial concerns centered on water quality, as ultra-pure water (UPW) production requires extremely low organic and mineral content. To address this need, PUB built a pilot UPW plant in consultation with wafer fabs. The plant demonstrated that NEWater could meet the industry's exacting specifications, with independent assessments confirming its reliability.

The Business Case: Lower Costs, Higher Efficiency

For industrial users, NEWater offered both quality assurance and economic advantages. Compared to PUB's potable water, NEWater required fewer treatment steps to reach UPW standards, cutting chemical costs by approximately 20% in the semiconductor industry.[1] In addition, it was priced lower than both potable and desalinated water, making it the most cost-effective option for industrial operations.

Beyond Semiconductors: Expanding Across Sectors

While wafer fabrication led the way, other high-tech industries followed. Today, NEWater is used in electronics, pharmaceuticals, petrochemicals, and data centers, all of which demand high-purity water for precision processes. The availability of a reliable, cost-efficient reclaimed water source strengthened Singapore's attractiveness as a manufacturing and technology hub.

Proving the Model: Sustainable Water Supply for Industries

Today, some of Singapore's key industrial sectors depend on NEWater. The collaboration between PUB and the wafer fabs, along with the demonstrated cost benefits and high water quality, underscore the potential of NEWater to meet the stringent demands of industrial applications while contributing to Singapore's water sustainability goals.

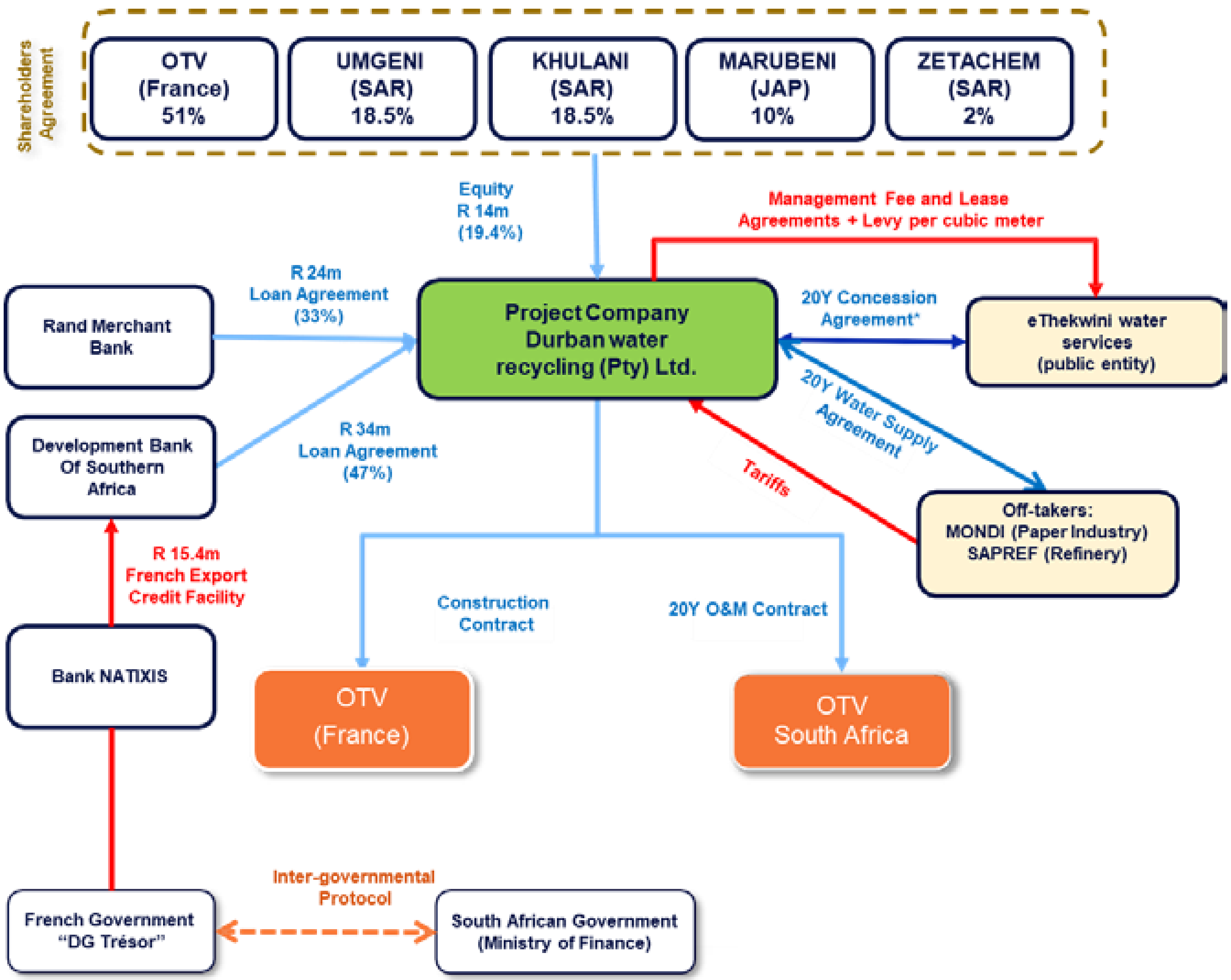
1 P. Tan et al., "Impact of NEWater as feedwater for the production of ultra-high-purity deionised water and manufacturing process," Future Fab International Issue 16 – Process, Gases, Chemicals, and Materials (as cited in Tan et al., 2009).

eThekwini represents a reuse PPP with private capital mobilization, where part of the debt is backed by the French Export Credit Facility.

The eThekwini Water Reclamation Project is a 20-year, US$12 million BOOT concession (Figure 83). Located in the grounds of Durban's Southern Wastewater Treatment Works, it has a treatment capacity of 47.5 million liters per day of domestic and industrial used water and was commissioned in 2001. The success factors of the project include **20-year water supply agreements with two industrial clients for reuse, namely MONDI, a paper facility, and SAPREF, a refinery.**

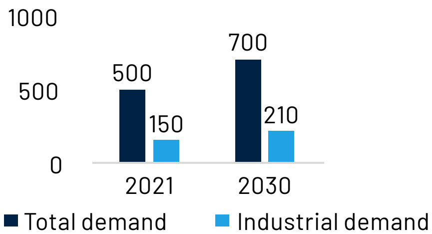
The project **mobilized private capital through debt (~81%) from Rand Merchant Bank and Development Bank of South Africa,** as well as equity (19%) from a consortium of partners. Part of the debt was backed by the French Export Credit Facility.

FIGURE 82: eThekwini Water Reclamation Project



Cities such as Ekurhuleni are looking at consolidating treatment works to support industrial reuse and tackle water supply disruptions.

FIGURE 83: Total and industrial water demand in Ekurhuleni, 2021 and 2030 (million liters per day)[1]



Ekurhuleni's total water demand is estimated at 500 million liters per day, projected to increase to 700 million liters per day by 2030. Industrial demand constitutes 30% of current water demand at 150 million liters per day.

With increasing disruptions to water supply in Ekurhuleni, the different levels of government—the National Department of Water and Sanitation (DWS), Rand Water (bulk water provider), and the municipality—are assessing the possibility of supporting the use of treated municipal used water by industry. The Ekurhuleni Water Care Company (ERWAT) has been engaged by the City of Ekurhuleni to manage its used water treatment works under a service delivery agreement. ERWAT ensures the sewage network and treatment infrastructure in the city can meet current and future demand.

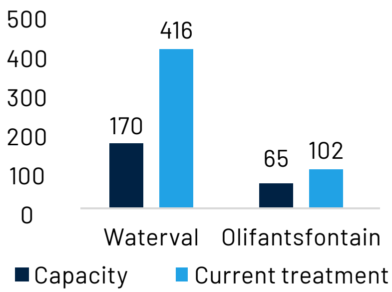
ERWAT is currently looking at consolidating 19 used water treatment plants into 10 centralized ones, with 5 bigger regional works and 5 smaller ones to facilitate reuse by industry.

Drivers for Reuse

Request for an increase in raw water abstraction limit for Rand Water declined by DWS, requiring ERWAT and Ekurhuleni to **reduce demand to meet future needs**

Sale of new water by ERWAT seen as a means of **improving financial sustainability** and thereby reducing reliance on municipal and central funding

FIGURE 84: Waterval and Olifantsfontein plant capacity vs current treatment (million liters per day)



Key Enablers for Reuse in Waterval and Olifantsfontein

Waterval and Olifantsfontein treatment plants, proposed to be revamped as 2 of the 5 regional plants, are both operating over capacity, indicating the availability of flows for reuse. Moreover, both encompass certain enabling factors, as outlined below:

- Adequate used water flows to support reuse
- Availability of land for the construction of reclamation plants
- Close proximity to industrial users

Potential additional enablers for the project under consideration include:

- A **waste discharge levy** to discourage the discharge of untreated used water
- Introduction of reuse **targets**
- **Reduced tariffs** for new water to encourage industrial offtake

Financing for the project may come through the Municipal/Regional Bulk Infrastructure Grant, loans from commercial and development banks, bond issuance through the Trans-Caledon Tunnel Authority, or some form of PPP.

1 DWS,"Water Quality and Supply Report, (Pretoria: DWS: 2021)); Ekurhuleni Metropolitan Municipality, "Integrated Development Plan 2021-2026 (2021); Ekurhuleni Metropolitan Municipality, "Future Water Demand Projections" (2022); Ekurhuleni Water and Sanitation Services, "Water Demand Management Report," (2022). Industrial water demand in 2030 is assumed to be 30%.

Cape Town is diversifying its supply mix through both direct and indirect potable reuse.

Dependence on rain, and water security. Cape Town, with a population of 4.6 million people, experienced a severe drought in the period from 2015 to 2018 and became known as the city that nearly ran out of water. At that time, Cape Town was almost entirely dependent on rainfed sources of water, with 95% coming from a regional surface water system.

Early experience with indirect potable reuse. In the 1970s, the national government had implemented a managed aquifer recharge IPR scheme with a capacity of 13,000 cubic meters per day in Atlantis, a satellite settlement north of Cape Town.[1] Treated domestic used water was infiltrated into a sandy aquifer, with a retention time of about two years, and from which water for domestic potable use was abstracted. The scheme, which had fallen into disuse due to cheaper freshwater alternatives, was rehabilitated and expanded during and after the recent drought.

A strategy to diversify water sources, including potable reuse. In response to the drought, the city developed a water strategy, "Our Shared Water Future," that committed the city to develop "new, diverse supplies of water including groundwater, water reuse, and desalinated water cost-effectively and timeously to increase resilience and substantially reduce the likelihood of severe water restrictions in future."[2] Guided by this strategy, the city is implementing both direct and indirect potable water schemes with capacities of 70,000 cubic meters per day and 55,000 cubic meters per day, respectively, in the first phase. When built, the Faure New Water DPR scheme will be one of the largest of its kind in the world.[3] Further phases of reuse are being evaluated that could generate up to 400,000 cubic meters of potable water per day from used water flows in the City by 2040 from 10 used water treatment plants, including DPR plants in the size range of 20,000 to 100,000 cubic meters per day.[4] The city has 25 used water treatment plants in total, posing some challenges for economies of scale. The investments in reuse have been supported by major upgrades to the city's used water treatment facilities.

Stakeholder engagement and communications. Cape Town has obtained ongoing advice from an expert panel on its implementation of the DPR and IPR schemes and adopted the view that "context, trust, accessible and transparent communication are critical factors that influence public acceptance of alternative water solutions."[3] Consequently, the city is implementing an intensive education and awareness program. As part of this effort, the mayor hosted a conversation in 2023 with mayors and officials from seven cities—Perth, Nairobi, Los Angeles, Wulpen, Windhoek, Beaufort West, and George—promoting knowledge exchange on water reuse practices.[3]

Reuse along with desalination. The city is proceeding with desalination in parallel with reuse for reasons of diversification. The DPR scheme is expected to cost roughly half of that for desalination per cubic meter of capacity, with lower operating costs due to its lower energy intensity.

The Mayor of Cape Town exchanging views on reuse with other cities[3]

1 Water360, "Atlantis—Cape Town—Atlantis Water Resource Management Scheme."
2 City of Cape Town (2020).
3 City of Cape Town, "Cape Town Water Outlook 2024 - Edition 11," Water & Sanitation Directorate (2024).
4 "Water Reuse Strategic Study," Presentation to Water Resilience Transversal Committee, City of Cape Town, (December 2022); City of Cape Town, "Where Does My Wastewater Go?" (2025).

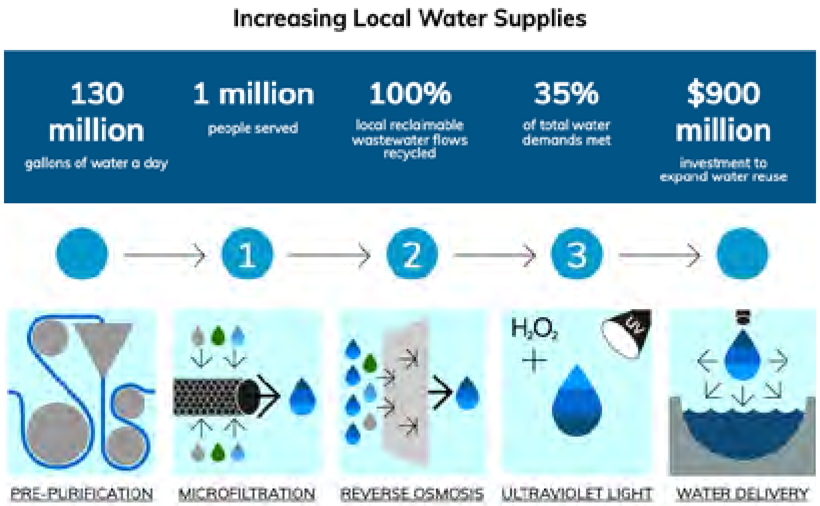
Orange County's experience highlights the feasibility of large-scale indirect potable reuse, with consumer acceptance.

Southern California is dry and drought-prone. The Orange County Water District (OCWD) was formed in 1933 by an act of the California legislature to manage the Orange County groundwater basin and protect Orange County's rights to the Santa Ana River water. The basin provides groundwater to 19 municipal and special water districts serving 2.5 million customers in north and central Orange County. It accounts for 77% of this area's water supply.

The OCWD manages the Groundwater Replenishment System (GWRS), a large water reuse scheme comprising a 491,000 cubic-meters-per-day advanced water purification facility that **takes treated used water that would otherwise be discharged to the ocean, purifies it to near-distilled quality, and then recharges it into the groundwater basin.** The system provides a source of water for 1 million people and meets 35% of total water demands. The system has been operational since January 2008, with an initial capacity of 265,000 cubic meters per day that expanded in 2015 and again in 2023. **This is the largest potable reuse facility in the world.**

The purified GWRS water is put back into the groundwater basin to blend with other water supplies. GWRS water is also injected into coastal barrier wells to keep seawater out of the basin. The treatment process includes microfiltration, reverse osmosis, and advanced oxidation. Orange County has made extensive use of an advisory panel, including leading experts in hydrogeology, chemistry, toxicology, microbiology, engineering, public health, public communications, and environmental protection. OCWD implements a proactive, diverse and comprehensive groundwater and surface water monitoring program to continually generate real-time data on water quality. OCWD also has an active communications and education program.

The reuse scheme has **multiple benefits**, in that it: (1) creates a new local water supply; (2) reuses a wasted resource that would otherwise end up in the sea; (3) increases water supply reliability; (4) costs less than alternative freshwater supplies and desalination; (5) uses half the energy of importing water and one-third the energy of desalinating seawater; and (6) improves the quality of water in the basin.



Sources: Updated and amended from City of Cape Town, "Water reuse – lessons for Cape Town from Orange County experience," Cape Town Water Exchange, Practice Note #4 (August 2022), prepared by Rolfe Eberhard. See also Orange County Water District, "New Water You Can Count On."

Fairfax, Virginia is an example of transforming unplanned de facto reuse into planned and quality-assured indirect potable reuse.

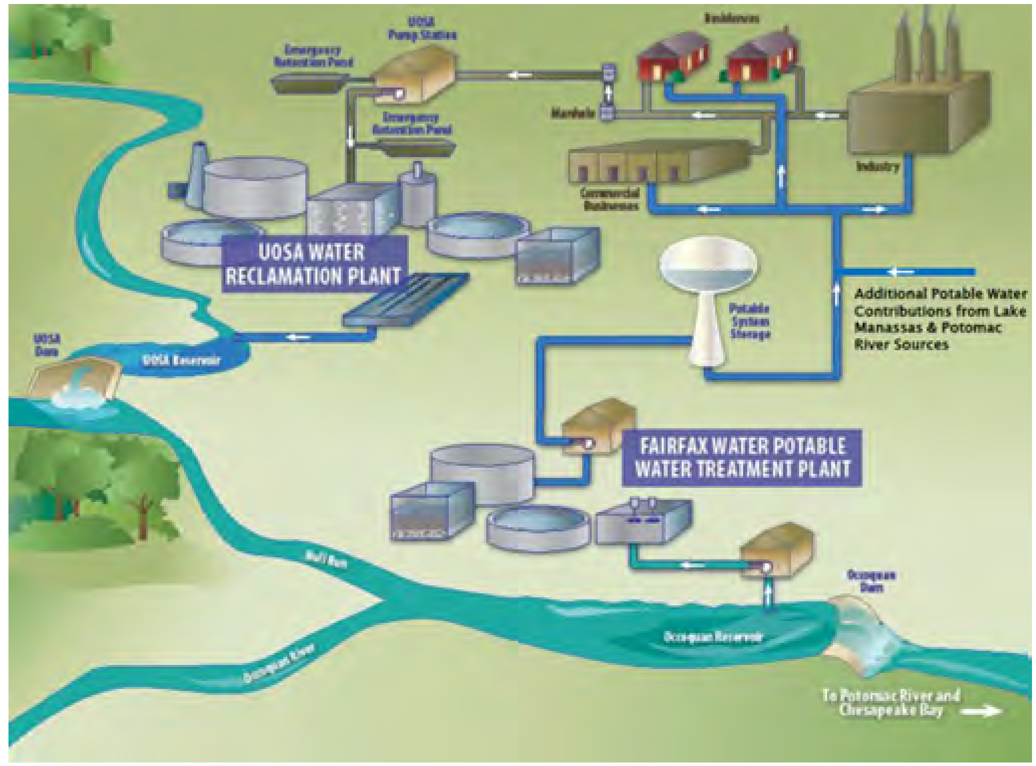
The Upper Occoquan Sewer Authority provides treated used water of suitable quality to the Occoquan Reservoir, which is owned by the water supplier, Fairfax Water. Fairfax Water relies on this contribution of treated used water as a key component of its water supply. These flows are particularly important during periods of low rainfall. The treated used water makes up only 9% of the annual inflows to the reservoir during normal periods, but its contribution may exceed 90% during periods of low rainfall.

This arrangement has been in successful operation for four decades. Before that, in the 1960s, unplanned de facto reuse was recognized as a problem, resulting in a deterioration in the quality of water used as a source for the potable water supply. It was proposed that this problem be addressed through a technically sound, planned IPR project. Although water quality was a major driver for the project, it was also recognized that directing treated used water flows to the reservoir would become a significant asset for future water supply needs.

Because the plan aimed to improve the quality of the raw water supply, public opposition was much lower than had been experienced with other potable reuse proposals. There was initial concern about the cost implications for rate payers, but this turned out not to be a significant issue.

A key lesson here is that, **because unplanned IPR is already prevalent in many countries due to the discharge of treated (and often untreated) used water into rivers and lakes,** plans to move from an unplanned and unregulated approach to improved and assured water quality is likely to be accepted by citizens if well communicated. This is because **a transition from unplanned to planned IPR will safeguard water quality in the future.**

FIGURE 85: Water Distribution System in Fairfax



Source: IFC, "Scaling Re-Water: DRAFT Market Assessment Report," May 15, 2020, prepared by Michael Norton Water Consultancy.

The United States has a large and fast-growing market in reuse.

Investments in reuse in the United States have been driven primarily by water scarcity, especially in the drought-prone southwestern states. Water discharge quality regulations, including stringent PFAS standards, may also increase investment opportunities.[1]

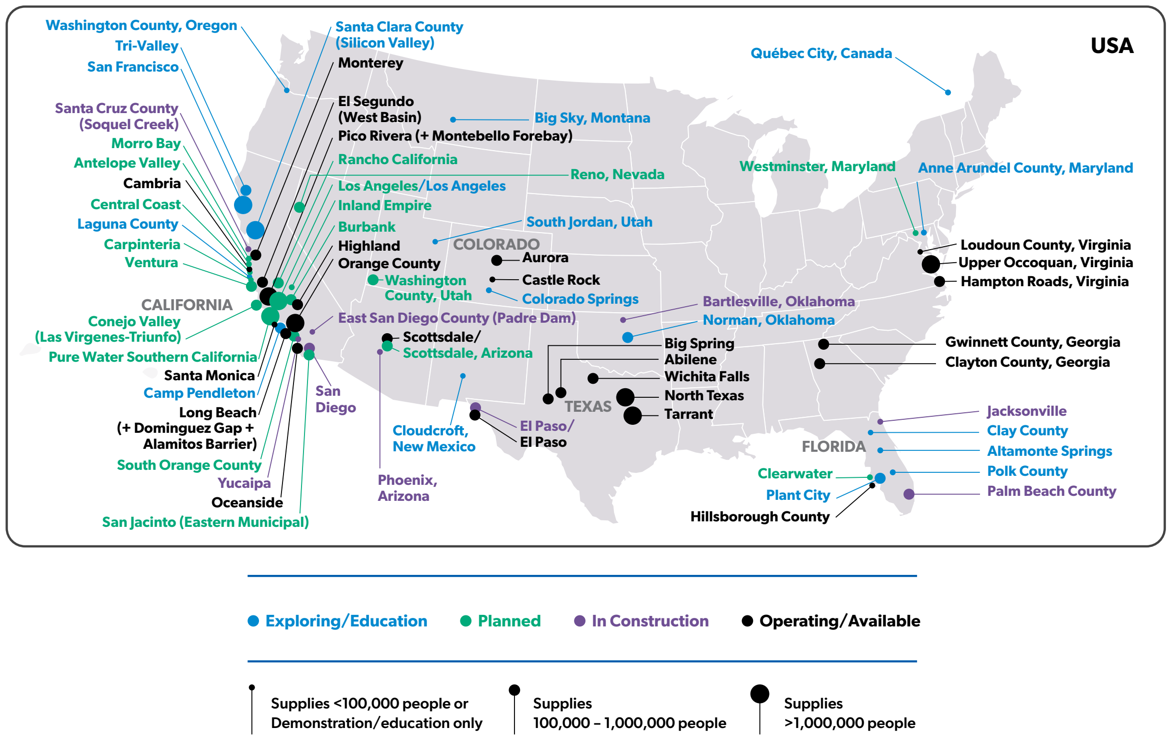
It has been estimated that 27% of public water supply could be supplied from used water discharged to the ocean. Orange County Groundwater Replenishment System in California is the world's largest indirect potable reuse scheme, with a capacity of close to 0.5 million cubic meters per day. California's 2022 Water Supply Strategy targets an additional 2.7 million cubic meters per day of recycled water capacity by 2030, and a further 3.4 million cubic meters per day by 2040. Direct potable reuse schemes are under consideration in several states, including Texas, Arizona, Florida, Colorado, California, and Maryland (Map 13).

Regulations for direct potable reuse are in place in Colorado (2022) and California (2024) and under consideration in several other states. Overly stringent regulations may dampen demand due to the resulting high costs.

Municipal-owned utilities are key investors in reuse, supported by rate payers and federal funds (e.g., a large-scale water recycling program with US$180 million in initial funding from the Department of the Interior). **Municipal-industrial partnerships,** in which an industrial user either purchases treated sewage effluent from a municipality or funds the expansion or upgrade of treatment infrastructure in exchange for a supply of treated effluent, are increasingly common.

Water prices are typically set to recover infrastructure costs, but the scarcity value of water is unlikely to be reflected in water prices in the absence of recent trades in water allocations.

MAP 13: Current and future purified recycled water locations[2]



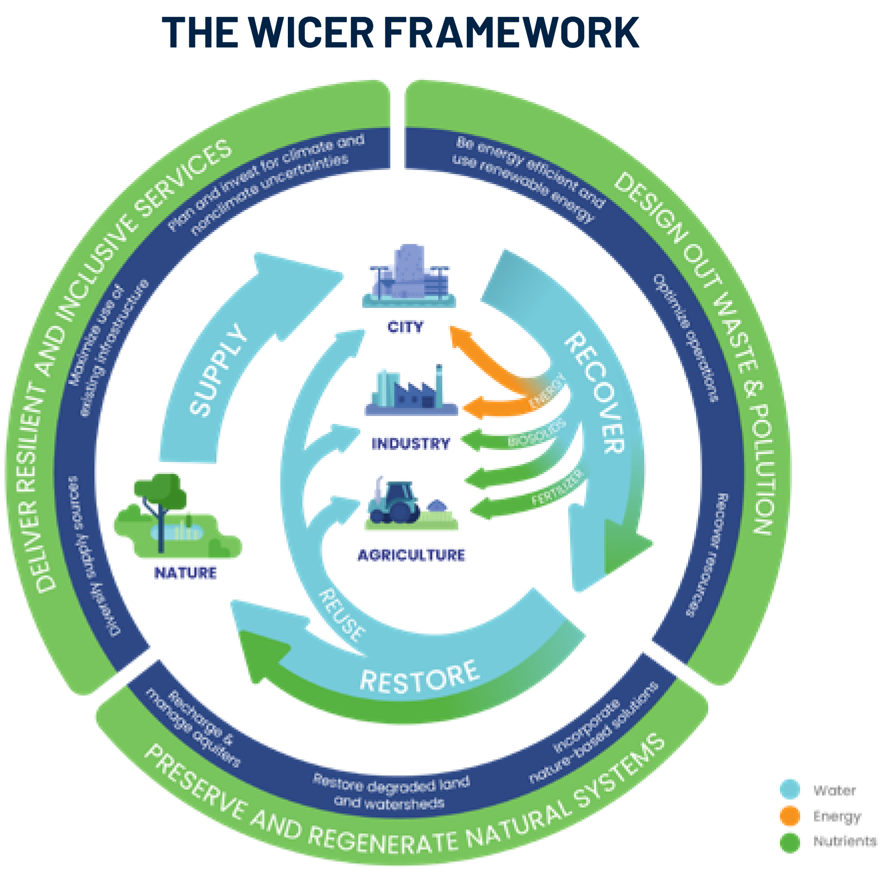
1 Information on reuse in the United States from GWI (2023a, 2024).

2 Water360, "WSAA Purified Recycled Water Maps Package 250315."

Annex 4: Past and Ongoing World Bank Reports on Reuse

The benefits of resource recovery and reuse, and its potential contribution toward water security, the Sustainable Development Goals, and climate goals are well documented in several World Bank Group-published reports and ongoing knowledge initiatives. These include guidance and tools for mainstreaming reuse and recovery of resources into water management strategies and policy frameworks.

FIGURE 86: The Water in Circular Economy and Resilience (WICER) Framework



For additional World Bank reports on reuse, please see Annex 6.

Summary of World Bank reports:

1. The WICER framework builds on the Waste to Resource report to explain circular economy and resilience principles in the water sector and provides guidelines for countries to integrate these principles into policies, planning, investment prioritization, and design.

2. The ongoing 'From Vicious to Virtuous: Climate-Resilient Urban Sanitation Policies and Pathways for People and Prosperity on a Livable Planet' emphasizes reuse for irrigation, industrial use, and groundwater recharge as a climate-resilient sanitation strategy.

3. The ongoing 'Governance and Economics of Desalination and Reuse' knowledge series will help public authorities and development professionals integrate reuse and desalination into water management strategies by providing tools and frameworks for project identification, feasibility assessment, and implementation. This includes volumes on: (i) Policies and Institutions; (ii) Institutional Setups; (iii) Economic Appraisal; (iv) Finance and Delivery Models; and (v) Delivery Models in Remote Poor Areas.

Annex 5: Current and Potential Markets for Reuse

Countries with Significant Reuse Activity

Botswana	In Botswana, assessment of bids for the 50,000 m^3/d Glen Valley water reclamation plant is still ongoing, amid allegations of corruption against the client.
Brazil	In Brazil, reuse is hindered by the country's low rate of used water treatment. A 17,280 cubic-meters-per-day project planned by the utility, Cesan, has secured an offtake agreement with steel maker, Arcelor Mittal.
Chile	In Chile, municipal reuse has been hindered in the past by disputes between treatment plant owners and downstream agricultural users over the ownership of new water. The 77,760 cubic-meters-per-day Antofagasta reuse project (initial capacity 25,920 cubic meters per day) has been re-tendered. The project is being procured under a BOT contract, and the client is working to secure offtake agreements, likely with the mining industry, to mitigate demand risk. The project could pave the way for other plants in coastal cities, where used water is currently discharged to the sea after primary treatment.
China	Largest installed reuse capacity (40% of global capacity). China's 14th Five-Year Plan of 2021 required water-scarce regions to raise the reuse rate to 25% by 2025 and urban areas, such as Beijing, Tianjin, and Hebei, to 35%. These targets have been surpassed, however, by more ambitious ones specified in regional plans released in 2022: Beijing set a target of 70% by 2035, while Tianjin and Hebei are targeting 50% and 45%, respectively, by 2025.
Egypt	Egypt has quadrupled its contracted reuse capacity in the last five years and now leads the region in installed and contracted capacity. The steep increase is due largely to three colossal treatment plants treating agricultural runoff for reuse in agriculture, of which the most recent—the 7.5 million cubic-meters-per-day Al Hammam plant, awarded in 2021—will be the world's largest reuse plant when commissioned. The immediate focus of current investment in Egypt, however, is increasing treatment coverage, with a strong pipeline of large-scale treatment plants that do not yet have a defined reuse element.
EU	The EU's new agricultural reuse regulation came into force in June 2023 and is expected to drive further uptake of reuse in the EU, particularly in countries like Greece and Italy where current regulations are complex.
France	In March 2023, the French government released a new national plan to combat drought, which included ambitious targets for reuse: 1,000 new reuse projects are planned, which would lift the rate of reuse of new water from 1% to 10% by 2027.

Source: GWI (2023a; 2024).

India

This is a large potential market for reuse. **Industrial reuse** is the main driver of reuse. State-level regulations require large industrial consumers near used water treatment plants to make use of any suitable effluent produced. Other applications for new water are also gaining traction, and the new National Framework for Safe Reuse, released in November 2022, is expected to drive wider uptake. In particular, there has been recent interest in **potable reuse**, with pilots underway for IPR in Chennai and DPR in Mumbai.

Israel

Legislation introduced in 2010 required all large treatment facilities to upgrade to tertiary treatment to produce effluent suitable for **unrestricted irrigation**. Over 90% of treated municipal used water is being reused for agricultural irrigation. Mekorot is investigating the possibility of **IPR**.

Kuwait

Kuwait has a significant installed base of reuse capacity serving agriculture and industry, including the 500,000 cubic-meters-per-day Al-Hayman project, awarded in 2020, which is the world's largest privately financed treatment plant. However, a 1 million cubic-meters-per-day project at North Kabd, announced in 2022, could be set to surpass it. The project is still in its infancy, but is likely to be procured as a BOT, with the new water to be reused for **agriculture and industry**. Meanwhile, bids were submitted in 2020 for the 400,000 cubic-meters-per-day Al Mutla'a treatment plant, which is being procured as a DBO, but is yet to be awarded.

Malaysia

Malaysia's national wastewater group, Indah Water Konsortium, is leaning on **municipal-to-industrial** reuse, having signed a memorandum of understanding in 2023 to explore the possibility of implementing reuse in the Penang region. It is also in talks with the government to create policies that will encourage industrial reuse.

Mexico

In Mexico, four projects with a combined capacity of 40,000 cubic meters per day near the Hondo River were expected to be tendered, after an environmental impact assessment was successfully completed in 2023. The projects will be procured as 20-year BOTs with industrial customers as offtakers.

Namibia

Namibia has pioneered DPR since the 1960s and is continuing to build new capacity. The latest project, the 20,000 cubic-meters-per-day Gammams DPR (often referred to as DPR2) plans to treat used water from two existing treatment plants. Design and procurement details were expected to be finalized by the end of 2023.

Oman

In 2019, Oman committed to a US$7 billion investment in treatment and reuse by 2040.

Peru

In Peru, expanding used water treatment coverage is the primary focus of Proinversion's PPP pipeline, but some projects may also include an element of reuse for agricultural irrigation.

Philippines

The Philippines is the first country in the Asia-Pacific region to implement **DPR**. Manila concessionaire Maynilad's Parañaque NEW WATER plant received its permanent operating permit in June 2023 after a year-long monitoring process to ensure compliance with drinking water standards. Maynilad plans to further increase its DPR capacity, first by tripling the capacity of the Parañaque plant to 30,000 cubic meters per day.

Qatar

The award of the 150,000 cubic-meters-per-day Al Wakra/Al Wukair independent sewage treatment plant (ISTP), Qatar's first used water PPP, marked a breakthrough for private finance in the sector. It will produce tertiary-treated effluent and is designed to accommodate expansion up to 600,000 cubic meters per day by 2045. The new water produced will be used for landscape and agricultural irrigation and low-level industrial applications, as well as potentially for groundwater recharge.

Saudi Arabia

The Saudi Irrigation Organization, which was handed responsibility for developing reuse in the Kingdom of Saudi Arabia in 2022, aims to reach 70% reuse by 2030. A major build-out of large-scale privately financed treatment plants (ISTPs) has been ongoing since 2020. These will provide substantial volumes of tertiary-treated used water suitable for reuse if a market for new water can be developed.

Singapore

In Singapore, reuse is the most important of the "Four National Taps." **Potable-grade treated used water**, branded NEWater, is used for industry and, in times of shortage, IPR, with 585 million cubic meters per year currently treated by four large-scale water reclamation plants. A fifth, the 800,000 cubic-meters-per-day Tuas Water Reclamation Plant, is under procurement.

South Africa

A 70-million-liters-per-day **DPR** program is planned in Cape Town. The National Strategy includes potable reuse. The Development Bank of Southern Africa's National Reuse Program was boosted by US$235 million in funding from the Green Climate fund, announced in July 2023. A planned 20,000 cubic-meters-per-day DPR unit at an existing plant in Durban is on hold following flood damage.

Spain

Spain is the dominant market for reuse in Europe, with over 7 million cubic meters per day of capacity installed and steady increases each year, serving mostly agricultural users. In May 2023, the government announced €224 million in funding for reuse projects as part of its long-term strategy to combat water scarcity, while Catalunya is planning €120 million in investment to double its reuse capacity.

Taiwan

Taiwan has accelerated its **municipal-to-industrial reuse** program. The latest project, the 105,000 cubic-meters-per-day Futian plant, was awarded in July 2023. The thriving semiconductor industry in Taiwan presents a significant source of demand; in October 2023, a tender was issued for a 70,000 cubic-meters-per-day plant in Nanzih that will supply a semiconductor fabrication plant, among other industrial customers. To encourage wider uptake of reuse among industrial users, which has previously been held back by the higher cost of new water compared to conventional sources, the government has approved an additional water tariff for large water consumers.

Türkiye

Türkiye achieved its goal of reusing 5% of treated wastewater in the first half of 2023 and aims to increase this to 15% by 2030.

United Arab Emirates

A large share (80%) of used water is reused. In October 2023, bids were submitted for Abu Dhabi's 700,000 cubic-meters-per-day Al Wathba water polishing plant, which will produce new water suitable for **unrestricted irrigation**. Heavy investment in new water infrastructure is also planned in Dubai over the next decade, and an ambitious target was announced in 2023 to reuse 100% of new water by 2030.

United States

California is home to the world's largest **IPR** project, the 492,000 cubic-meters-per-day Orange County Groundwater Replenishment System. There are at least a dozen potable reuse projects at various stages of planning and procurement. The 18,925 cubic-meters-per-day San Bernardino Clean Water Factory IPR was awarded in 2023, as was the demonstration facility for the planned 314,155 cubic-meters-per-day Pure Water San Diego program. In Virginia, procurement is underway for a large-scale aquifer recharge project known as SWIFT, which will treat 454,200 cubic meters per day of used water from seven treatment plants for reinjection into the Potomac aquifer.

There is growing interest in **DPR** in several states, including Texas, Arizona, Florida, Colorado, California, and Maryland. The planned Pure Water Southern California project would be the world's largest DPR facility to date, at 94,625 cubic meters per day (in addition to a 340,650 cubic-meters-per-day IPR), rising to 227,100 cubic meters per day in Phase 2. As DPR gathers momentum across the United States, regulations are beginning to catch up. In October 2022, Colorado became the first state to publish a statewide DPR rule, and regulations are being developed in several other states. It is expected that these regulations will drive further uptake of DPR. Potable reuse standards were published in California in late 2023. The Department of the Interior announced a large-scale water recycling program with US$180 million of initial funding under the Bipartisan Infrastructure Law.

Regions with Significant Reuse Potential

In addition to the three largest reuse markets (China, United States, and India, profiled in this report), there is also significant potential for expanding reuse investment in MENA, Europe, and Australia.[1]

Middle East and North Africa

Water scarcity is the driver of large investments in reuse in the MENA region. These investments are for agriculture and non-potable purposes. **DPR is not permitted** in MENA countries, although de facto indirect potable use occurs. **Egypt** dominates the regional reuse market with the largest reuse plants anywhere in the world, contracted through a BOT model as well as public-financed traditional EPC models. Water prices are well below cost, limiting the prospects for private financing. In **Israel**, all used water from treatment facilities (small ones exempted) must be treated to tertiary standards suitable for unrestricted irrigation. The **United Arab Emirates** Water Security Strategy 2036 includes a commitment to increase the reuse of new water to 95%. In **Dubai**, massive investment in collection, treatment, and reuse infrastructure is planned over the next decade, with a target of increasing the reuse of new water to 100% by 2030 and reducing operating expenditures and energy usage through the investment plan.

Europe

Water reuse is a growing market, particularly in the drier south. In Spain, for example, there is already extensive use of new water for agriculture (water reuse for potable purposes is not permitted except in emergencies). **EU standards for agricultural reuse** (effective 2023) are driving investments in upgrading used water treatment in Spain, Portugal, and other countries. Investments are almost exclusively public-financed in Spain.

Australia

National guidelines, which are the basis for most state regulations, provide a risk-management framework for reuse, with quality standards for a range of non-potable applications. There was significant interest in direct and indirect potable reuse during the millennium drought, but this did not translate into actual investments.[2] Investments in (indirect) potable use are still small, influenced by perceptions and risk aversion, but are likely to grow (see the Case Study on Perth, Australia in Annex 3). In addition, Sydney has established a 'Purified recycled water discovery center', with the objective to build social acceptance for the introduction of potable reuse schemes.[3]

Factors inhibiting accelerated and scaled investments in these regional markets

- **Regulations** prevent the uptake of indirect and direct potable use in many countries, based on perceived risk and public perceptions. For example, in Spain, reuse for potable purposes is only permitted in emergencies, and potable reuse is not permitted in MENA countries. Regulations may be overly onerous.
- **Public perception:** In Australia, public perception and risk aversion strongly influenced political decision-making related to investments in new water capacity, even during the severe drought, based on the so-called 'yuck' factor. However, the case of United States shows that this can change.
- **Pricing:** Public investment dominates in many of these markets, limiting available investment financing which could be unlocked through appropriate pricing and PPP structures.

1 Sourced from GWI (2023a) unless otherwise indicated.
2 Water360, "Australian Water Recycling Centre of Excellence, https://water360.com.au/11317-2/.
3 Sydney Water, "Purified Recycled Water," https://www.sydneywater.com.au/education/drinking-water/purified-recycled-water.html.

There is significant potential for the growth in combined greenfield investments in treatment and reuse in South and East Asia, Latin America, and Sub-Saharan Africa due to the large existing untreated wastewater flows. This offers the advantage of leap-frogging older treatment technologies and putting in place low-carbon facilities efficiently.[1]

Southeast Asia

In addition to China and India, there are large potential markets for reuse in Bangladesh, Indonesia, the Philippines, and Pakistan among other countries in the region. Investments in **Bangladesh and Pakistan** are driven largely by both water scarcity and water quality concerns, and reputational factors for multinationals active in the apparel industry. The focus here is on reuse for industry, with opportunities for aggregation through industrial zones, supported by appropriate PPP structures, regulation, and pricing. Opportunities for direct and indirect potable reuse also exist with the pioneering investment by Maynilad Water Services in a direct potable reuse in Manila, **Philippines**, offering a potential perception breakthrough in public perception in the region.[1]

Latin America

In Mexico, future investments in reuse are likely to be driven primarily by a combination of scarcity and water quality. The National Water Plan for 2024-2030 has a goal of expanding used water treatment to 90% and significantly reducing industrial effluent discharge, offering opportunities to replicate and expand reuse initiatives, such as the Project Tenorio in San Luis Potosí. Countries such as Brazil, Argentina, Peru, and Columbia, considered water-rich, also have arid regions or cities (for example, São Paulo and Bogotá) prone to periodic water shocks, where an investment case for reuse is strong.

Sub-Saharan Africa

The two largest markets in this region are South Africa and Nigeria. South Africa adopted a national reuse strategy in 2010 and Cape Town plans to invest in a large-scale DPR plant. Aggregated industrial reuse is being explore in Gauteng in a context of a regional demand deficit.

Accelerating and scaling investments in greenfield developments

- **Regulations:** Strong enforcement of industrial discharge standards will drive industrial reuse, as evidenced in Mexico.
- **Perception breakthroughs for potable reuse:** Large-scale direct potable reuse projects in South Africa and the Philippines have the potential to shift public perceptions on safety and the 'yuck' factor, opening up new markets for reuse.
- **Pricing and financing:** Reuse is more energy and cost efficient compared to desalination and was prioritized in Cape Town for this reason, as part of a resource diversification strategy to build climate resilience. Public budget constraints necessitate private financing and implementation through PPPs, provided pricing recovers costs.

1 GWI, "Maynilad Gets Serious About Potable Water Reuse" (August 3, 2023).

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