From Waste to Resource

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

Background Paper V:

Financial incentives for the development of resource recovery projects in wastewater

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1. Introduction

The World Bank is working with partners around the world to ensure that wastewater's inherent value is recognized. Energy, clean water, fertilizers, and nutrients can be extracted from wastewater and can contribute to the achievement of the Sustainable Development Goals (SDGs). Wastewater can be treated up to different qualities to satisfy demand from different sectors, including industry and agriculture. It can be processed in ways that support the environment, and can even be reused as drinking water. Wastewater treatment for reuse is one solution to the world's water scarcity problem, freeing scarce freshwater resources for other uses, or for preservation. In addition, by-products of wastewater treatment are potentially valuable for agriculture and energy generation, making wastewater treatment plants more environmentally and financially sustainable. Improved wastewater management thus offers a double value proposition if, in addition to the environmental and health benefits of wastewater treatment, financial returns can cover operation and maintenance costs in part or in full. Resources recovered from wastewater facilities—such as energy, reusable water, biosolids, and nutrients—represent an economic and financial benefit that contributes to the sustainability of water supply and sanitation systems and the water utilities operating them. Reuse and resource recovery (R&RR) could transform sanitation from a costly service to one that is self-sustaining and adds value to the economy.

This background paper is one of several supporting materials for the report "From Waste to Resource: Shifting Paradigms for Smarter Wastewater Interventions in Latin America and the Caribbean", a product of the World Banks' Global Water Practice Initiative Wastewater: From Waste to Resource.

Its main objectives are to provide guidance on effective strategies for the financing of wastewater treatment and reuse, and to elaborate on financial structures that facilitate the sustainable adoption of R&RR. It includes a discussion of subsidies, their relevance, and how they might be justified and calculated. The paper then focuses on the predominant financing structure for wastewater recovery: public-private partnerships (PPPs). The paper concludes with a discussion of conventional and new financing options.

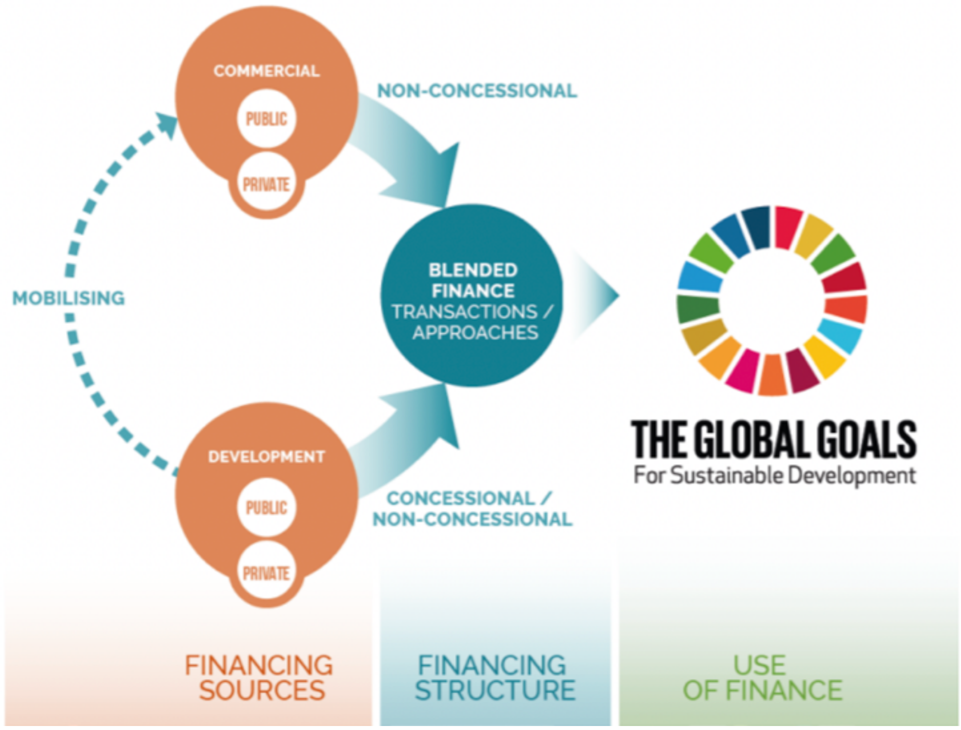
2. Subsidies and blended finance

In Latin America and the Caribbean and other developing regions around the world, the financial resources required to achieve the 2030 SDG targets in the water sector are usually beyond what national governments can afford. The investment of the private sector is therefore crucial, particularly in wastewater treatment, which is highly capital intensive. Revenues from R&RR can play a role in project financing, but the up-front costs of R&RR technologies add to the initial capital requirements. The private sector can assist with raising the finance that is required, as well as the capacity to operate R&RR technologies, some of which require technical and managerial skills.

Project financing will invariably have to be a mix of public and private. Given the public policy context in in most developing nations the concept of blended finance is appropriate for R&RR. Blended finance is the strategic use of concessional finance to leverage commercial finance, and is particularly relevant to the pursuit of the Sustainable Development Goals in developing countries.

As illustrated in figure 1, the commercial finance component could be supplied by the public sector as well as the private sector. Besides direct investment in wastewater companies, the private sector's contributions could be in the form of guarantees, syndicated loans, credit lines, or shares in collective investment vehicles.

Figure 1. Using blended finance to achieve the SDGs



Source: OECD 2018b.
Note: SDG = Sustainable Development Goal.

Public-private partnerships (PPPs) offer an example of blended finance. They use public finance to leverage private capital to invest in public infrastructure and/or services. Although specific arrangements vary, under a PPP most of the demand and/or financial risk will be borne by the governmental authority, while the private sector bears the technology, construction, and operation risks.

Investment in wastewater treatment and R&RR will typically require subsidization. This could be in the form of outright grants or various forms of finance that have a high degree of concessionality.

There are 2 aspects that can justify subsidies in wastewater treatment and R&RR projects:

- ***Economic justification of subsidies:*** there are public health benefits, as well as environmental factors and other externalities which would justify wastewater projects, particularly those involving R&RR, being subsidised.
- ***Practical justification of subsidies:*** water tariffs in many countries are below full cost recovery levels. To increase these would be politically difficult, especially in time to cover the up-front costs of large wastewater infrastructure projects.

Subsidies may also be required for operational or capital costs. But it should be noted that the requirement for R&RR subsidies is likely to decline over time. In the early stages of market development, reused water and recovered products need to be priced at a low level. Recurrent costs may need to be directly subsidized, or, where practical, there may need to be a cross-subsidy between the tariffs for water and R&RR products. Once users grow accustomed to these products and are confident that the regulatory system is operating satisfactorily to ensure adherence to hygiene and safety standards, the prices can then rise to eventually match their production costs. Costs will also reduce as a result of technological improvements and economies of scale. Meanwhile, any increase in water scarcity will drive up demand for, and hence the price of, reused water.

3. Determining subsidy and financing requirements

Recognizing that subsidies are necessary does not mean that indiscriminate levels should be provided. The level of subsidy that is warranted may be determined by an economic and financial analysis of context-specific wastewater projects.

3.1 Basinwide analysis

It is essential that the economic analysis be carried out at the basinwide level. This is because wastewater treatment and water supply are part of the same system. Considering them separately could lead to solutions that, while least-cost for the sector being considered, are not least-cost when interactions between the two are taken together. Importantly, a basinwide analysis will also help identify which solutions are the most environmentally beneficial. A river basin organization has the advantage of coordinating the development of basin-level plans. Its work may include an economic analysis of wastewater investments, as well as research into financing options.

Even where the basinwide approach is utilized, it is important for planners to also consider larger, macroeconomic trends and their implications, whenever possible (See box 1 for the case of Zimbabwe.)

Box 1. Zimbabwe's experience with basin planning

In the 1980s and 1990s, water use planners in Zimbabwe saw an opportunity to make wastewater treatment plants fulfil a dual purpose—treat urban effluents and provide reclaimed water that could be blended into the input supply, thereby avoiding the infrastructure investment costs for additional freshwater catchment projects. The approach adopted was one of indirect potable reuse, whereby the reclaimed water is added to a drinking water source with an environmental buffer that precedes extraction for drinking water treatment.

If the wastewater treatment plants had been appraised as stand-alone investments, low-cost, established technologies would have been chosen. In adopting a basinwide planning approach, planners saw that the technology of choice was biological nutrient reduction (BNR). Plants utilizing this technology had relatively high up-front capital costs and were more demanding of technical skills during operations. Operating costs were also higher, with electricity being particularly important. Despite this, BNR plants appeared, at the time, to be a cost-minimizing solution that would simultaneously expand wastewater treatment capacity and augment existing supplies of municipal water.

However, their installation was followed by a period of hyperinflation. The real value of electricity and water revenues plummeted, and electricity and water supply systems collapsed due to lack of maintenance. The BNR plants were highly dependent on constant supplies of electricity, and when load shedding became a regular occurrence, the BNR plants become inoperable.

Instead of introducing treated wastewater into the upstream water supply of cities that included the capital, Harare, raw sewage now was being discharged without treatment. This greatly increased the problems of treating the water when it was extracted downstream, at precisely the same time as the water treatment plants were suffering from lack of maintenance, unavailability of chemicals, and regular power cuts.

One important lesson from this case is that the risks associated with reuse and resource recovery need to be analyzed in the planning stage. The changes that took place in Zimbabwe were extreme, and could not really be mitigated, but for more normal levels of risk it is important to analyze possible outcomes and include mitigation measures in the project design. In this way, the sustainability of reuse and resource recovery projects can be assured.

Source: ECA 2019

3.2 Financial analysis and tariff considerations

The levels of subsidy required are normally estimated using a financial model of costs and revenues, with the gap between these defining the needed subsidy. A financial model also allows the assessment of options (including financing structures) and potential risks (e.g., changes in demand levels). Where the required subsidy levels cannot be met, the project design has to be reconsidered, starting with a review of the targeted quality standards.

The tariffs needed to calculate the revenues in the model will be determined from market conditions for reused water and resource recovery products, and, where there is a regulatory framework in place for the water sector, by the regulated tariffs for water and charges for wastewater services. These tariffs might include an approved cross-subsidy to R&RR (See box 2)—if needed to help build market demand for reused water and resources recovered from wastewater.

Box 2. Tariffs for recycled water in New South Wales

Amid droughts and water scarcity, water utilities in New South Wales, Australia, are required to invest in water recycling infrastructure. In those areas where recycled water is available, the charges for it are set below those for potable water to encourage the use of recycled water for nonpotable uses.

Water utilities are to separately calculate the cost of service for recycled water, and if the resulting tariffs are higher than for potable water, a portion of the recycled water costs can be recovered from the broader customer base.

The recycled water program includes a mandatory scheme, whereby customers are mandated to use recycled water for a portion of their water consumption, and a voluntary scheme, whereby customers can choose to connect to and use recycled water. The recycled water charges under the mandatory scheme are regulated and are not allowed to rise above potable water charges. However, recycled water charges under the voluntary scheme are negotiated between the water utility and the customer, allowing some form of cross-subsidization between the schemes to ensure that the water utility recovers its costs.

Source: IPART 2006.

Where cross-subsidies are required (as in the face of negative public perceptions of wastewater byproducts), their level can be reduced and probably eventually eliminated over time. An example from Jordan is provided in box 3.

Box 3. Overcoming negative public perceptions through incentive-based pricing: An example from Jordan

Residents of the Wadi Musa area in Jordan were initially skeptical about the use of treated wastewater for growing food crops. A big effort was made by the government to explain the processes and safeguards that were in place to ensure safety. This was accompanied by deliberately low prices for the treated wastewater to encourage farmers to use it for irrigation purposes.

A subsequent report observes: "The trust relationship that was built with the farmers accompanied by the provision of economic incentives have changed the attitude of the local community from hesitation in the use of treated sewage for irrigation to competition for an important resource."

Source: SWIM 2013.

For a project's implementation to be smooth, the design of the financing structure, the level and origin of subsidies (if present), and the tariffs that will be applicable need to be acceptable to a variety of different stakeholders. Appropriate project designs can be arrived at through a consultative process managed by river basin organizations. Strong institutions are in the best position to provide appropriate incentives for project financing.

In order to understand the potential financial contributions from R&RR projects, the financial analysis needs to be assessed over the life of the project. The present value of the revenue that is generated from R&RR needs to exceed the present value of the additional capital and operational costs required by the R&RR activities. Where the nature of the R&RR activities is such that subsidies are justified (by substantial environmental benefits, for example), the PV of the subsidies added to the PV of revenues should exceed the PV of costs. Moreover, R&RR products need to compete with alternative sources of supply, or else be subsidized to address some externality. For example, in the case of electricity generation from biogas extracted from wastewater, the cost per kilowatt-hour may often be higher than the tariff for electricity supplied from the grid. A subsidy might be forthcoming, however, if producing power from wastewater would result in a net reduction in greenhouse gas emissions.

3.3 Green output-based revenue enhancers

The financing costs of R&RR can be reduced by tapping into various sources of green finance, which have explicit or implicit subsidies intended to encourage either reductions in greenhouse gas emissions or broader goals of environmental sustainability. Green bonds are a good example (See section 5.3). However, there are also subsidiary mechanisms that involve output-based payments, which are characterized as green revenue enhancers, rather than as fully fledged financing options. Such mechanisms include the following:

- **Feed-in tariffs (FiTs).** In the past, many governments encouraged investment in renewable energy by offering FiTs at levels that offered attractive rates of return for investors. A disadvantage for electricity consumers, however, is that these FiT projects involved long-term power purchase agreements in which high energy purchase prices were locked in, in a sector where rapid technological change and mass production was resulting in rapidly falling costs. FiT schemes have thus become less widespread in recent years, with auctions increasingly used to procure renewable energy generation. Nonetheless, their use may still be found to be appropriate, such as for biogas generation from wastewater. Box 4 describes a FiT program in California that has a specific wastewater biogas component.

Box 4. Feed-in tariff for waste-to-energy projects in the state of California

The California Public Utilities Commission approved a resolution pertaining to tariffs and standard contracts for both public water and wastewater facilities. This resolution led to the creation of the Bioenergy Market Adjusting Tariff (BioMAT) in 2016, which is a feed-in-tariff program created by a Senate Bill, ordering 250 megawatts of procurement for electricity from bioenergy projects.

The BioMAT program uses a standard long-term contract and a market-based mechanism to arrive at offered contract prices for eligible projects. The procurement is allocated across distinct bioenergy technology categories among which are biogas from wastewater treatment, municipal organic waste diversion, food processing, and codigestion.

Source: CPUC 2018.

- **Carbon markets.** Following the Kyoto Accord of 2007, the Clean Development Mechanism (CDM) pioneered the use of carbon trading to meet global climate change goals. Other carbon market instruments followed, many linked to the European Union Emissions Trading Scheme. A number of wastewater projects have taken advantage of the CDM, as described in box 5.

Box 5. Examples of wastewater projects involving the Clean Development Mechanism (CDM)

In Fiji, the Kinoya Sewerage Treatment Plant captures methane emissions generated from decomposing organic sludge. The project was able to prove its CDM eligibility. Up-front capital expenditures were co-financed by the Asia Pacific Climate Finance Fund and the Asian Development Bank, in exchange for the ex post purchase of CDM instruments (Certified Emission Reduction certificates).

Another example is the Khorat Waste to Energy (KWTE) plant in Nankorn Ratchisma, Thailand. Carbon credits provided sufficient revenue to make the KWTE project economically viable. KWTE is a 3 megawatt biogas plant that generates electricity from wastewater treatment. This displaces the use of fuel oil in generating electricity (9,506 tons of fuel oil per year replaced by biogas) and has other positive environmental impacts (including improved water quality in existing ponds). The plant results in the removal of organic material from the wastewater, thus reducing the chemical oxygen demand and subsequent fugitive methane emissions from the existing open lagoon.

Sources: ADB 2011; UNFCCC 2006.

Under the Paris Climate Change Agreement, CDM is to be replaced but the details of a new system of international emissions trading remains to be deliberated and agreed upon.

- **Payments for Ecosystem Services (PES)** are provided to agents who preserve or sustainably manage land, water, and other natural resources (UNDP n.d.). Payments may be made:
  - *Directly* by (private) beneficiaries, for example, by Nestle (formerly Vittel) to stop farmers using chemicals in northeastern France or by the City of New York to protect watersheds in the Catskill mountains.
  - *Indirectly* by the intermediation of a public authority that—on behalf of the wider public—disburses a compensation for conservation, as with China's Conversion of Cropland to Forest and Grassland Programme or Costa Rica's Environmental Services Payment Programme.

To ensure flexibility, a system to facilitate the trading of ecosystem service credits can be established (described in box).

Box 6. Ohio River Basin Water Quality Trading Project

The Ohio River Basin Water Quality Trading Project stands out as a success story featuring Payments for Ecosystem Services (PES) made for reuse and resource recovery. The aim of this project was to reduce the nutrient loading in water by connecting power plants, wastewater utilities, and over 200,000 farmers. It was started as a voluntary trading mechanism for its participants to exchange water quality credits for nitrogen and phosphorus.

The project allows permitted dischargers (i.e., thermal plant operators) to purchase nutrient reductions from another source (i.e., farmers) and at lower costs. PES trading therefore promotes a cost-efficient approach to wastewater treatment, since discharge requirements are met by the party that can meet them the most cost-effectively.

Source: EPRI 2014.

4. Public-private partnerships

Countries promoting wastewater R&RR projects to service large metropolises are likely to seek private sector participation. Typically, the projects will be structured as PPPs, rather than being privately financed, owned, and operated. Among the case studies in developing countries investigated here, the majority of large wastewater projects, particularly those that involve R&RR from the outset, have been implemented through various forms of PPP.

PPPs in wastewater R&RR address many key challenges, as shown in table 1.

Table 1. Private sector participation: Mechanisms to address key challenges

Key Challenges	How the Private Sector Can Help
Low capacity and technical expertise and experience in municipalities/public sector	Private firms can bring in new technologies for wastewater treatment and R&RR, and can transfer knowledge to the public sector throughout the duration of the contract. In Egypt, private sector engagement increased operational efficiency while importing into the country the latest technology and expertise (see published case study [World Bank 2018a]).
Unclear roles and responsibilities in wastewater service provision and R&RR	Contracting private entities to perform a certain function within the wastewater R&RR activities can clarify the roles and responsibilities within the sector. For example, a private firm can be contracted to operate and maintain the wastewater R&RR assets, while the municipalities continue to provide wastewater collection services (as in Windhoek, Namibia (Box 7)).
Lack of funds for capital investment	Private funds can supplement public funds when there is a lack of capital, ensuring that the wastewater infrastructure is built and can include R&RR assets. In the case of existing wastewater treatment plants, private investment may be for specific wastewater R&RR assets (as in Windhoek, Namibia).
Low affordability of wastewater services	Revenues generated from wastewater R&RR assets can potentially be used to supplement operational costs of wastewater treatment, reducing costs to customers. However, the potential revenue stream from R&RR needs to be treated with caution, as it is imperative that this revenue should first and foremost cover the cost of the R&RR investment, before being used to essentially subsidize the cost of providing wastewater treatment services.
Lack of political will to invest in wastewater management infrastructures	Successful wastewater R&RR investment that is commercially viable can create political incentives to develop and scale up wastewater R&RR assets and services.

Source: ECA 2019

Note: PSP = private sector participation; R&RR = reuse and resource recovery.

Box 7. Private sector participation in wastewater reuse: An example from Namibia

Windhoek, in Namibia, is one of the first cities in the world to have potable water supply from treated wastewater. Namibia has a strong national policy to overcome water scarcity by reusing treated wastewater, and the City of Windhoek adopted this policy and implemented the project based on the city's needs. The first wastewater reuse treatment plant was commissioned in 1968 and has subsequently been upgraded and expanded. In 2002, the City of Windhoek contracted a private partner to operate and maintain the wastewater treatment system. The operations and maintenance contract allocates technology and performance risk to the private partner and demand risk to the City of Windhoek.

Source: Lahnsteiner et.al. 2013

PPPs often involve the formation of a special purpose vehicle (SPV), which allows several private sector bodies with the different expertise and experience required for a project, and different levels of financial commitment, to bid for the PPP concession as a single entity. An example of an SPV used in a PPP arrangement is that of a wastewater treatment plant in New Cairo, summarized in box 8.

Box 8. A special purpose vehicle for wastewater treatment in Egypt

The Government of Egypt, through the New Urban Communities Authority (NUCA), required the New Cairo Wastewater Treatment Plant to treat wastewater to a level whereby it could be reused for irrigation purposes and green urban areas. That is, treated water, eventually reentering the river system, would need to meet the prescribed environmental standards.

Aqualia (from Spain) and Orascom (from Egypt) formed a special purpose vehicle for the project. This arrangement brought together technological knowledge regarding wastewater treatment and reuse (from Aqualia) and in-depth knowledge of the Egyptian market (from Orascom).

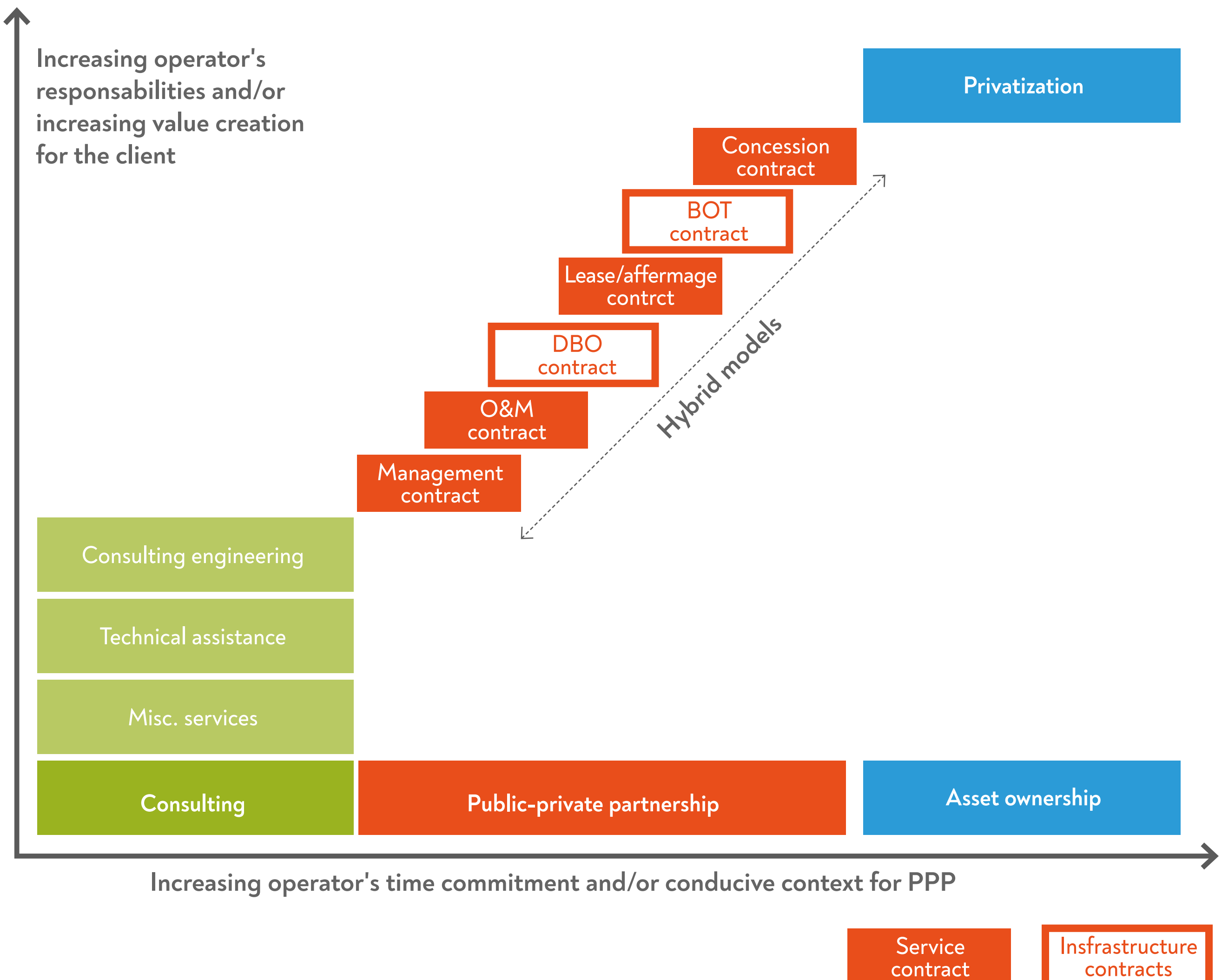
Source: World Bank 2018a

PPPs are attractive for the public sector entity contracting the SPV to the extent that they reduce financing requirements, ensure efficient operation, and crucially reduce the risks to be taken on by the public sector. The following principles should apply:

- **Fair allocation of risks.** Risks are to be allocated to those actors best placed to manage them.
- **Strong stakeholder participation, dialogue, and transparency throughout the project cycle.** This should involve not just the contracting parties, but other stakeholders such as local communities.
- **Strong governance and monitoring framework.** This is to be agreed between the public and private partners and used to monitor performance according to specified indicators, and resolve disputes.

Figure 2 illustrates the range of PPP hybrid models that could be used, while examples of specific PPP arrangements in wastewater R&RR are summarized in table 2. This shows the responsibilities and functions of the private partner, what risks are typically allocated to the private partner, and who usually owns the assets.

Figure 2. Range of PPP arrangements in wastewater management



Source: Fridegotto 2017.
Note: BOT = build-operate-transfer; DBO = design-build-operate; O&M = operation and maintenance; PPP = public-private partnership.

Table 2 differentiates operating assets, which include (i) assets needed to operate and maintain the facilities, such as equipment and minor replacement parts; and (ii) infrastructure assets, which include the treatment plant, sewer networks and pipes, and other large infrastructure. Infrastructure assets require large capital investment at the beginning of the project, while operating assets, if and when they need to be replaced, can be part of the operating cost of the facility.

Table 2. Examples of PPP arrangements used in wastewater R&RR

PPP Arrangement (and project example)	Typical Duties of Private Partner	Typical Profit Function of Private Partner	Typical Risks Borne by Private Partner	Owner of Operating Assets	Owner of Infrastructure Assets
Design-build-finance-operate-transfer (DBFOT) ***New Cairo Wastewater Treatment Plant*** *(20 years)*	Finance, design, and construct infrastructure but not own infrastructure assets. Run the business, employ staff, operate and maintain assets, finance and manage investments.	Revenue from contracting authority based on performance. Additional revenues from sale of wastewater products.	Financing and commercial, operational, and performance.	Private partner	Contracting authority
Operation and maintenance (O&M) ***Windhoek Water Reclamation Plant*** *(20 years)*	Run the business, employ staff, operate and maintain assets, retain fee not equal to customer tariffs based on volume of reclaimed water sold.	Reclaimed water price based on volume treated, paid by the contracting authority.	Operational and performance	Contracting authority	Contracting authority
Build-own-operate-transfer (BOOT) contract ***Durban Water Recycling*** *(20 years)*	Finance, design, and construct infrastructure but not own infrastructure assets. Run the business, employ staff, operate and maintain assets, finance and manage investments.	Revenue from recycled water supply contract with two large industrial customers.	Financing and commercial, operational, and demand	Private partner	Contracting authority
Build-operate-transfer (BOT) end user contract ***Nagpur and MahaGenCo***	Construct and operate infrastructure. Run the business, employ staff, operate and maintain assets.	Revenue from operations and maintenance fee	Operational and performance	Contracting authority, in this case MahaGenCo	Contracting authority, in this case MahaGenCo

Source: ECA, based on table 1.1 in World Bank (2006).
Note: This list is for illustrative purposes, and is not exhaustive.
MahaGenCo = Maharashtra State Power Generation Company.

Under the umbrella of blended finance, the funding of PPPs is typically a mix of:

- Subsidies/concessional finance from the national government and cooperative partner sources; and
- Private equity and debt finance, largely commercial in nature, to be recovered through user tariff revenues.

Guidelines on how the subsidy level is to be determined are given in section 3. To ensure that subsidies will not impair efficient performance, the subsidy schemes should be incentive based, as described in section 5.4.

4.1 Incentives to promote resource recovery through PPP structuring

Incentives can be designed into PPP procurement processes, as well as in the financing structure of a PPP project, as discussed below.

4.1.1 Incentives created through PPP procurement processes

PPP projects initiated by the public sector are usually competitively tendered. In this case, where a PPP contract is tendered for wastewater systems, an R&RR component that would not be financially viable can be mandated. This should only be done if the R&RR component provides net economic benefits.

In order to ensure that the social benefits of a wastewater project are realized, the question of subsidies can be addressed in the bid processes for competitively tendered PPP contracts. For example, the winning tenderer would have to show technical and managerial capabilities that include R&RR, and offer the lowest subsidy requirement.

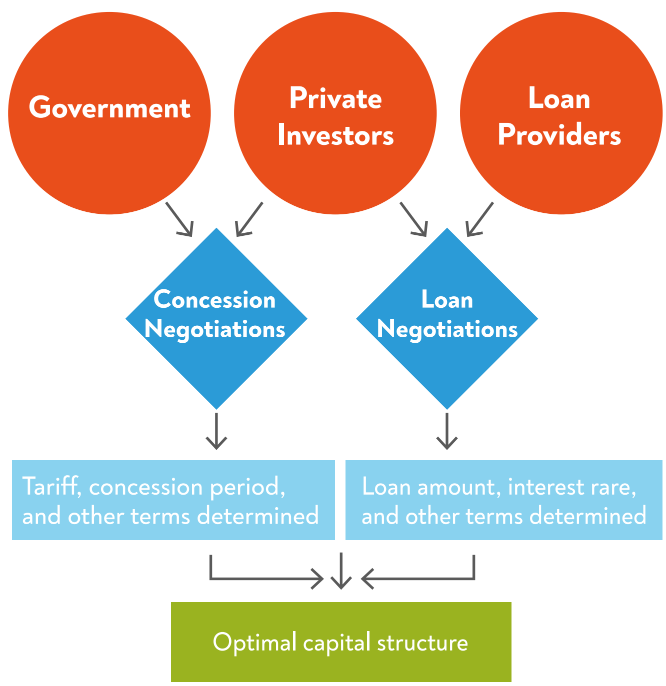
A PPP contract can also be negotiated directly with a single private entity. In most cases (but not all), direct negotiations are the result of an unsolicited proposal from the private entity. The same principle should apply in direct negotiations, regardless of who initiated the negotiation. That is, the private entity should be required to provide the R&RR component with the wastewater investment and propose the minimum amount of subsidies required (if any) to cover the capital and operating costs of the R&RR component.

In general, PPPs are funded in the form of project finance and will be accompanied by mechanisms to ensure good governance. These mechanisms can be designed into the procurement process as bid conditions, such as a minimum debt service coverage ratio, debt-to-equity ratio maximum values, a letter of commitment regarding the government's future procurement, and clear guidance on the distribution of the dividends.

4.1.2 Incentives created through the financial structure of PPP projects

PPP structures are flexible and can be designed with a range of financing options. Figure 3 shows that PPP negotiations can be used to arrive at a workable capital structure likely to be financed. Although specific arrangements vary, under a typical PPP most of the demand and/or financial risk will be borne by the governmental authority, while the private sector bears the technology, construction, and operation risks.

Figure 3. Interrelations between a concession contract and loan agreement



Source: Chen, Mao, and Hu 2015.

The ideal capital structure should provide a balance between (i) the amount of public funding used to incentivize private investment and (ii) the private debt and equity financing used for the remainder of the project. Figure 3 shows that:

- **Concession negotiations** between the government and the private investor will determine the level of revenue the private investor may receive from tariffs and user charges in relation to the assets.
- **Loan negotiations** will be conducted between the private investor and the loan provider to determine the debt-to-equity ratio. This needs to balance the cost of the investment with the risk that the private investor is taking. The risks need to be carefully allocated so that the investment will provide value for money for the public sector, affordable services for consumers, and a reasonable return on investments for the private investor.

In the New Cairo example (World Bank 2018a), the debt-to-equity ratio was 70:30. The loans were supported by a sovereign guarantee from the government, and a payment method that protected the private firm from demand risks and some operational costs (such as electricity costs). The combination of a 30 percent equity contribution, and a risk allocation that was regarded as fair, provided lenders with security that the project company will be able to repay their loan.

4.1.3 Incentives created through the PPP payment method

Further incentive-based payment systems can also be designed into the PPP arrangement. For example, where ongoing subsidies are needed, these could be disbursed on the basis of the level of sales of reused water and recovered resources. If some or all of the R&RR opportunities are commercially viable, there would be no need for subsidies, but the contract award criteria could include requirements for R&RR.

Payment methods under a PPP can be designed to protect private partners from demand risks and/or other risks that are best handled by the public sector. For example, in the New Cairo case, the payment to the private partner included a fixed component that is independent of demand (or volume of wastewater as input). This ensures that fixed operational costs and most of the investment costs can be repaid, regardless of the volume of wastewater. Similarly, in Windhoek, the private partner is protected from demand risks, as the reclaimed water treated by the private operator is sold to the public utility, which then takes on the demand risk by selling blended water to customers. In India, the national government's PPP policy allows for a hybrid payment model, which has a performance-based element for 60 percent of the capital and O&M costs, as outlined in box 9.

Box 9. Hybrid annuity public-private partnership model, India

India's National Mission for Clean Ganga seeks to ensure efficient and sustainable wastewater investments along the Ganges River through a long-term public-private partnership, whereby technological innovation, construction, and operation and maintenance are provided by the private sector while the government ensures the timeliness of payments.

Private actors are responsible for designing, constructing, commissioning, and operating wastewater treatment plants for a period of 15 years. The assets will then be transferred back to the state water authorities at the end of the concessions term.

According to the hybrid annuity model, 40 percent of the capital costs will be paid by the central government on completion of the construction process, while the remaining 60 percent will be paid as annuities over the life of the project, along with operation and maintenance expenses. Annuity and operation and maintenance payments would be linked to the performance of wastewater treatment plants to ensure their continued performance, monitoring, and accountability throughout the project.

Source: IFC 2018.

4.2 End-user reuse PPP model

Another model that can be applied resource recovery projects is that of the end-user reuse PPP (described in box 10).

Box 10. A general outline of the end-user reuse public-private partnership model

In this model, the end user is an industrial firm or power plant that is a bulk consumer of water and takes responsibility for the project. The typical contractual parties are the:

- Water utility / municipal department, which supplies wastewater to the end user.
- End user that will be using all (or part of) the treated wastewater. This could be a private firm that also takes responsibility for the construction and operation of the conveyance system and treatment plants, or this intermediate function could be contracted out.

Figure B9.1 Diagram of the end-user reuse model

Source: PwC 2016.
Note: STP = sewage treatment plant; STW = secondary treated water.

These projects are not necessarily awarded on a competitive basis, but may be on a nomination basis. The end-user industry enters discussions with the wastewater utility regarding the supply of wastewater and the charges to be paid. The end user also pays the technology providers a service fee for the operation and maintenance of the treatment plants and service mains.

This type of contract ensures that the end user has a secure supply of water, while the utility or municipality receives additional revenue from the sale of raw wastewater.

The most significant challenges, however, are due to the limited number of such large customers and their location, often far away from cities, which increases conveyance costs and slows down project execution. Another key challenge is choosing the appropriate technology design.

Source: PwC 2016; FICCI Water Mission and 2030 WRG 2016.

Examples of the application of this model, or variants of this model, are provided below:

- **Nagpur, India**. The requirements for a secure supply of cooling water for the Maharashtra State Power Generation Company (MahaGenCo) provided the basis for the establishment of a build-operate-transfer (BOT) 30-year concession for the transportation, treatment, and reuse of the wastewater effluent from the municipal sewerage system. The concession contract was developed with a specialist water treatment entity to ensure a regular source of water to the power plant (the recycled water), while providing the municipality with a constant stream of revenue (the raw wastewater fee) (World Bank 2019).
- **Durban, South Africa**. In this case, the end users of reclaimed water are a paper factory and an oil refinery. A 20-year water supply agreement with them formed the basis for the establishment of the Durban Water Recycling (Pty) Ltd, a private company operating under a concession that supplies reclaimed water to the end users while providing a regular income stream to the local water company that supplies it with wastewater (World Bank 2018c).
- **San Luis Potosi, Mexico**. The Federal Electricity Commission provides the anchor demand for reclaimed water used for cooling in its thermal power stations. The wastewater treatment company, established as an 18-year build-own-operate-transfer (BOOT) project (Aguas del Reuso del Tenorio), also supplies farmers with reclaimed water (World Bank 2018d).

In each case, the end-user payments provide secure revenue streams for the public sector entities responsible for water supply and wastewater collection. The risks are taken on by the end users and/or the intermediary entities established to perform the additional treatment that is required. In the case of Nagpur, MahaGenCo contracted out this function. In the case of Durban, the concession was let through a competitive process by the local water company, eThekwini Water Services. Similarly, in San Luis Potosi, the state water company organized a competitive tendering process for the reclaimed water concession.

5. Conventional and new financing options

5.1 Established equity and debt instruments

The bedrock of wastewater treatment and R&RR projects remains the established equity and debt instruments that are the stock-in-trade of merchant banks specializing in infrastructure financing. A taxonomy of the instruments and vehicles commonly used for infrastructure financing is shown in table 3.

Table 3. Taxonomy of instruments and vehicles for infrastructure financing

Modes	Infraestructura Finance Instruments			Market Vehicles
Asset Category	Instument	Infrastructure Project	Corporate Balance Sheet / Other Entities	Capital Pool
Fixed Income	Bonds	Projects Bonds	Corporate Bonds, Green Bonds	Bond Indices, Bond, Funds, ETFs
		Municipal, Sub-sovereign bonds		
		Green Bonds, Sukuk	Subordinated Bonds	
	Loans	Direct/Co-Investment lending to Infraestructure project, Syndicated Project Loans	Direct/Co-investment lending to infrastructure corporate	Debt Funds (GPs)
			Syndicated Loans, Securitized Loans (ABS), CLOs	Loan Indices, Loan Funds
Mixed	Hybrid	Subordinated Loans/Bonds, Mezzanine Finance	Subordinated Bonds, Convertible Bonds, Preferred Stock	Mezzanine Debt Funds (GPs), Hybrid Debt Funds
Equity	Listed	YieldCos	Listed infrastructure & utillities stocks, Closed-end Funds, REITs IITs, MLPs	Listed Infrastructure Equity Funds, Indices trusts, ETFs
	Unlisted	Directi/Co-Investment in infraestructure project equity, PPP	Direct/Co-Investment in infrastructure corporate equity	Unlisted Infrastructure Funds

Source: OECD 2018a.
Note: ABS = asset-backed securities; CLO = collateralized loan obligation; ETF = exchange-traded fund; GPs = general partnerships; IIT =Infrastructure Investment Trusts; MLP = master limited partnership; PPP = public-private partnership; REIT = real estate investment trust.

5.2 Pension and sovereign wealth funds

Pension and sovereign wealth funds are significant long-term investors whose requirements align well with returns from wastewater treatment and R&RR. Sustainable and socially responsible impact investing is an increasingly important theme of these funds' investment strategies, as they allocate increasingly significant portions of their investment portfolios to environmental and social goals, such as the decarbonization of an economy.

There has been interest in recent years in pension funds investing directly in wastewater projects, rather than indirectly through capital markets. Pension funds have also joined forces with sovereign wealth funds to invest jointly in infrastructure projects. Such arrangements are known as coinvestment platforms, and the benefits expected include higher returns, better access to deal flow, diversification, governance rights, and reduced headline risk. South Africa provides a good example of pension funds being used directly for infrastructure projects (see box 11).

Box 11. A pension fund's green infrastructure investments: An example from South Africa

The South African Government Employee Pension Fund is Africa's largest pension fund with over $138 billion in assets under management. Five percent of the fund is allocated to infrastructure projects, with the aim of bringing positive economic, social, and environmental impacts while not unduly sacrificing the financial returns of its members. In 2010/11, the fund increased its allocation to development projects, including water infrastructure and alternative energy projects.

Source: Otoo and Drechsel 2018.

In Latin America and the Caribbean, pension funds have increased their share of investment in infrastructure projects. This was mainly achieved by supportive regulations and policies set by regional governments to attract private investments in transport, energy, and water industries. Reforms have included overhauling PPP and concession laws, with the aim of improving competitive bidding. This improved regulatory framework helped regional pension funds implement special investment vehicles to invest in the green infrastructure sector:

- Chilean pension funds have invested in infrastructure bonds to fund projects
- In Peru, the Pension Fund Administrators Association created the Infrastructure Investment Trust in 2009 (see box 12). This is managed by a separate company with representatives from the fund administration, allowing for the better management of projects they are involved in. The creation of the Infrastructure Investment Trust is an example of how debt-investment-related risks can be mitigated by the introduction of good governance principles as well as the pooling of funds.
- In Brazil, most infrastructure investments are channeled through one of two types of vehicles: either private equity funds that invest in infrastructure engineering companies or through an infrastructure company owned by the three largest pension funds: PREVI, Petros, and FUNCEF.

Box 12. Creation of an infrastructure investment fund trust in Peru

The Pension Fund Administrators (PFA) Association formalized the creation of an Infrastructure Investment Trust, which began with a contribution of $300 million (that further rose to $1.5 billion in the following years) by the four PFAs in the Peruvian private pension system (BVBA Research 2010). The trust works as follows:

- Each fund makes cash contributions in exchange for equity certificates. These contributions are effective once the investment alternatives are defined.
- Certificates are not negotiable by means of any centralized mechanism. The certificates are similar to "private equity" funds in that the value of the certificates correspond to the the proportional participation of the value of the assets in which the trust invests.

- The trust invest its funds mainly through debt structures. Profitability depends on the interest gained by debt structures within the trust. These will be "held to maturity," so there is a risk of unrealized incomes or losses.
- The fund is managed by a company (Banco de Crédito del Peru, Peruvian Credit Bank) which provides fiduciary services and is in charge of the assessment of investments.
- An Investment Committee is set up, made up of PFA representatives, to approve infrastructure investment decisions. Its main objective is to provide support to the PFAs during the investment process, through the selection of the best projects, the designation of shared sums, and monitoring and supervisory tasks.
- The trust works with due diligence financing advisors that support the PFA functions by standardizing the application process, defining investment objectives, counseling negotiators in financing structures, and valuing the project revisions and the development of internal policies and reports for the Investment Committee.

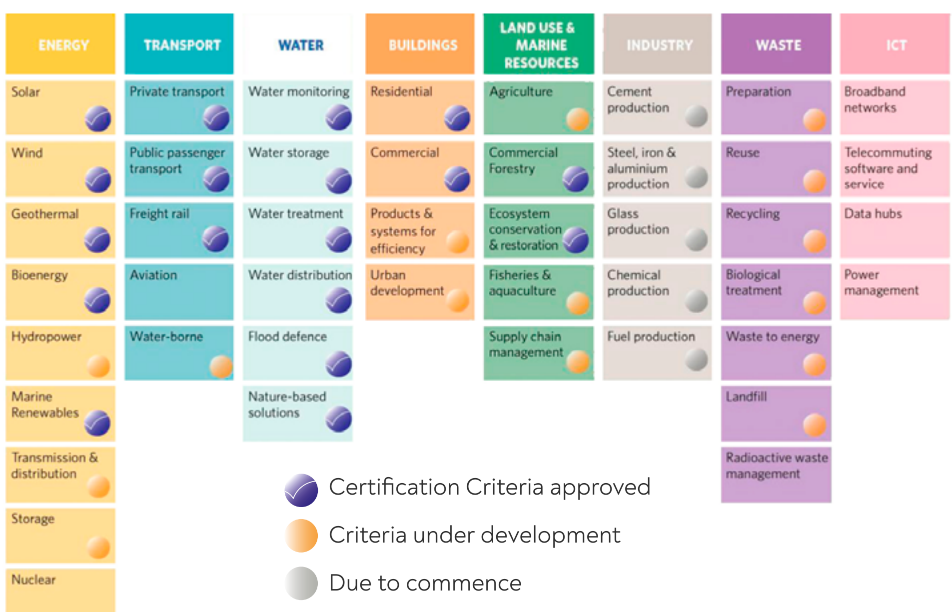
Source: Alonso et al. 2010.

5.3 Green Bonds

Green finance is a relatively recent form of finance well suited to the wastewater sector. Green finance refers to any financial instrument or investment issued under contract to a public or private organization, in exchange for the delivery of positive environmental externalities that are additional to business as usual.

Green bonds represent a source of finance in this category for R&RR projects. In the wake of the Kyoto Protocol, green bonds emerged in 2007–08, and have gained prominence as an asset class since that time. Green bonds initially were issued by multilateral institutions, notably the World Bank and European Investment Bank, and these were used to finance projects of their clients. For water, $20 billion of green bonds relating to sustainable water management were issued in 2017, up from $13 billion in 2016. Overall, this sector represented 13 percent of all green bonds issued in 2017. Table 4 categorizes green bond issues by sector.

Table 4. A taxonomy of climate bonds



Source: Climate Bonds Initiative 2018.
Note: ICT = information and communications technology.

As in each sector, a set of standardized criteria for green bonds have been defined to provide assurance, in the water sector, of the climate and water sustainability credentials of water-related green bonds. These "water infrastructure certification criteria" apply to a wide range of water assets and projects and include:

- The increased *industrial water efficiency* of newly built or existing assets
- Water treatment for *reuse and resource recovery,* including water utility functions, aquatic ecosystem restoration and management, and water supply systems
- Assets and activities designed to ensure the *adaptation and resilience* of water systems

Green bonds show a promising route for investment in green infrastructure but the requirements for demonstrating eligibility can be demanding.

Although most green bonds have been issued by companies and governments of developed countries, this is not the only possibility. Kenya presents an interesting case study with the establishment of the Kenya Pooled Water Fund to target investments in the water industry, including projects in energy-efficiency and wastewater treatment (box 13).

Box 13. Green bonds for water infrastructure development: An example from Kenya

A nonprofit, donor-supported organization, the Kenya Pooled Water Fund announced plans in 2018 to issue a Kenyan shillings (K Sh) 1.5 billion ($15 million) bond to fund Kenyan water utilities. It planned to target Kenyan institutional investors, such as pension funds and insurance companies, and to raise K Sh 5–10 billion each year.

In its 2018/19 (July–June) budget, Kenya allocated K Sh 28.23 billion to water and sewerage infrastructure development, and the figure was expected to be K Sh 28.40 billion in the 2019/20 financial year.

Source: Reuters 2018.

5.4 Results-based financing

It was argued at the beginning of this paper that wastewater projects will invariably require subsidies. Any public funds used for subsidy purposes must be handled efficiently. One way to achieve this is for subsidy payments to be made only on the basis of outputs, with the results achieved being independently verified before payments are made.

Results-based financing (RBF) can be used to provide incentives for R&RR by specifying key performance indicators as the triggers for RBF payments. These could include:

- *Wastewater treatment:* Volume of wastewater collected at the plant and treated to meet the defined standards
- *Wastewater reuse*: Volume of wastewater reused for other purposes
- *Resource recovery:* Volume of productive resources generated, volume of biogas produced for
- transportation or electricity generation purposes, or tons of biosolids produced, depending on what resources are planned to be recovered from the wastewater treatment process

The most prominent RBF scheme that has been used to finance wastewater is PRODES in Brazil. Its essential elements are summarized in box 14 and described in more detail in a separate published case study (World Bank 2018b).

Box 14. Results-based financing for wastewater: PRODES in Brazil

PRODES is a financing scheme set up in Brazil primarily for depolluting important hydrological basins. Under the scheme, the federal government pays utilities to treat wastewater based on certified outputs. PRODES is notable for being a results-based-financing scheme operated on a large scale: the program has been running since 2001 and has reached over 6.8 million people, according to the Agência

Nacional de Águas. The results-based mechanism was designed to provide incentives for service providers to properly operate and maintain wastewater treatment plants.

Up to half the investment costs of wastewater treatment plants are eligible to be reimbursed on a quarterly basis over a period of three to seven years, provided that the quality of the wastewater discharged meets prescribed norms. Payments cease if performance targets are not met. The balance of the investment funding is generally provided by the municipalities.

The system provides strong incentives to properly operate and maintain wastewater treatment plants. A large part of PRODES financing has gone to basins with the most severe pollution problems.

Source: ECA 2017.

A general limitation of RBF mechanisms relates to the financing of initial capital costs. RBF schemes are based on the premise that the entity receiving the subsidy has the ability to prefinance the up-front capital investment with its own, or external, sources. The entity then typically faces a long lag from incurring costs to receiving revenue under the RBF scheme. But if most of the financing risk is transferred to private investors, this will undermine their willingness to provide the initial capital. Additionally, the need to obtain prefinancing via private loans with higher interest rates can raise the cost of providing the services.

In order to circumvent this prefinancing issue, the RBF authority could design the payment schedule in such a way as to split ex ante from ex post payments. Another option is to incorporate a loan agreement between a commercial bank and the RBF fund as an integral part of the RBF intervention. In Kenya, an RBF program incorporated an agreement with a local bank (K-Rep Bank) for a small-scale water supply project. K-Rep Bank agreed to prefinance up-front capital investments by the service providers at subcommercial rates or against subsidies transferred by the Global Partnership for Results-Based Approaches (an agency of the World Bank).

5.5 Revolving wastewater funds

Revolving funds incorporate the idea that public funding for wastewater need not be in the form of outright grants or subsidies but can instead take the form of concessional loans. In a revolving fund, loans are granted to finance projects, with the capital being returned to the fund as the loan is repaid by the borrower.

Revolving funds are usually provided by a public institution in charge of monitoring the capital investments in the sector and can be accessed directly by the private investor leading the project. Usually, state revolving funds are available to projects that are unable to access sufficient levels of traditional private financing but are financially viable in the longer term.

It is important to design the revolving fund facility so that there are incentives for the concessional finance to be accessed and used efficiently. This could be achieved by combining elements of the RBF approach, but even without an explicit RBF mechanism there is scope for access to the fund to be competitive.

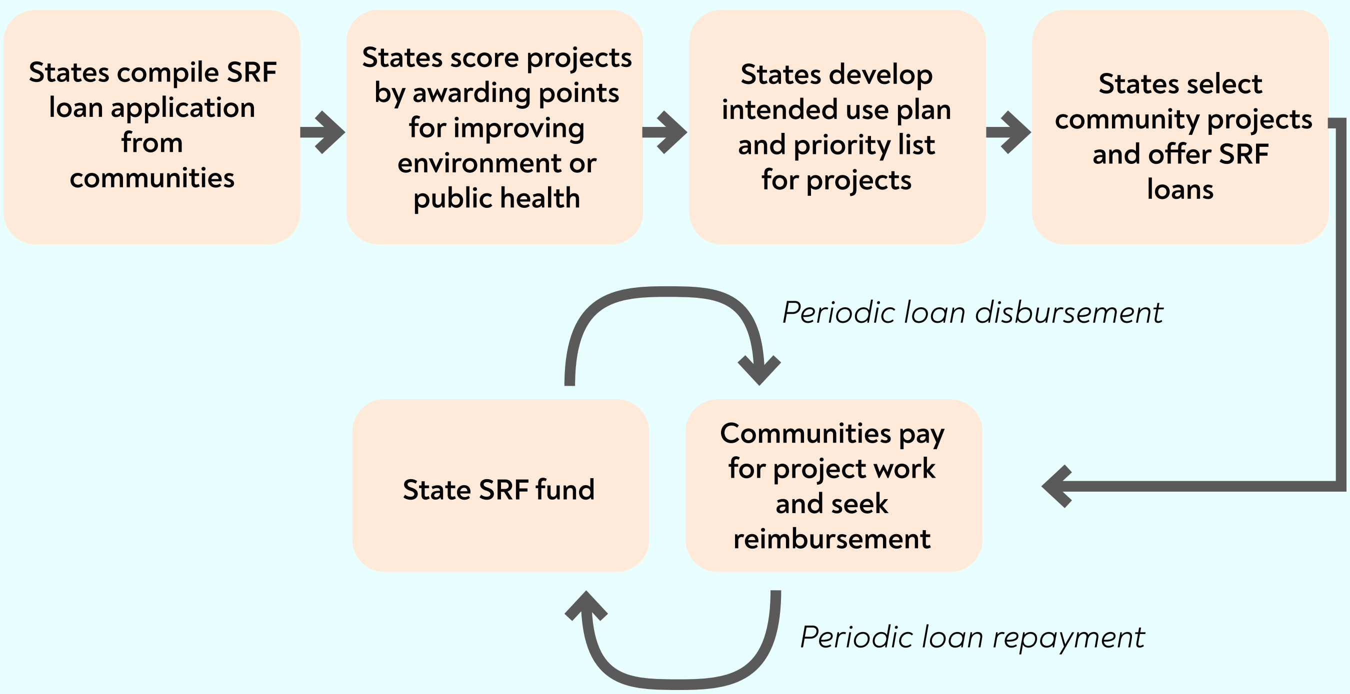
Box 15 describes the U.S. Clean Water State Revolving Fund (CWSRF), which has been used effectively to provide concessionary finance for wastewater treatment projects, with the repayments used to fund other projects.

Box 15. A revolving fund for wastewater infrastructure financing in the United States

In the United States, the Clean Water State Revolving Fund (CWSRF) provides national and statewide low-cost sources of financing for eligible projects benefitting the environment.

The CWSRF defined 11 criteria for program eligibility (among which are construction of treatment works, estuary programs, decentralized wastewater treatment programs, water reuse, energy efficiency, and technical assistance). Each state annually compiles State Revolving Fund (SRF) applications from communities. Each state then assesses projects on the basis of water infrastructure improvement goals, project costs, and each community's financial capacity to repay a loan.

States use information about communities' projects to develop an annual intended use plan that outlines how states' SRF funds are to be used in that year, and a priority list for projects. Once a state and community enter into an SRF loan agreement, the community pays for the project work and seeks reimbursement.



The CWSRF program is funded through national government contributions via the U.S. Environmental Protection Agency and matching state funds that are equal to 20 percent of national government grants.

This fund has numerous advantages compared to privately financed loans. In particular, it provides loans with lower interest rates, and repayments are directly recycled back into the program. This revolving process increases the number of wastewater treatment projects that can be funded.

Source: WWAP 2017; U.S. Government Accountability Office 2015.

The Caribbean Regional Fund for Wastewater Management (CReW) is similar. The funds from CReW aim at improving or rehabilitating existing sewer and/or water treatment plants and reuse systems. In order to be eligible, projects have to meet the country's policy objectives in wastewater management while addressing broader water access objectives.

The Global Environment Facility (GEF) presents an interesting example of how a revolving fund can be used to invest in R&RR projects. The idea behind the GEF fund is to cover for additional costs associated with transforming a normal infrastructure project into a project embedded with social and environmental benefits. The GEF's definition of eligible projects fits R&RR projects well.

In Tanzania, the GEF set up a revolving fund to promote waste-to-energy projects operated by the Rural Energy Agency (GEF 2013). Such projects were selected by the GEF due to their rapid scaling up and potential to reduce greenhouse gas emissions. This fund provided investment in one cogeneration and four biogas plants.

As an example of R&RR, the fund helped finance a biogas plant for the Zanzibar Sugar Factory located in Mahonda village on Zanzibar Island. The waste-to-energy plant was designed to use biogas from wastewater to create steam to be used in part for electricity production. The Zanzibar Sugar Factory was selected because of its importance to the island's economy, and because all its activities needed a consistent and quality steam supply. The fund was used to provide initial soft loans at preferred interest rates though syndicated loans involving commercial banks (CRDB Bank PLC) and public financial institutions (National Bank of Commerce and Tanzania Investment Bank). The involvement of commercial banks was intended to initiate a sustainable financing mechanism after GEF financing ceased.

To work, revolving funds need each individual project to generate sufficient revenues to repay the fund. The income generated depends on the tariff regimes in place. Jamaica's National Water Commission introduced a systematic way to organize loan repayments and pass through some of the costs of R&RR projects to end users (box 16).

Box 16. Incentivized repayment mechanisms: An example from Jamaica

Loans from the Caribbean Regional Fund for Wastewater Management in Jamaica are repaid through a surcharge (K-factor) to the water tariff. This K-factor is needed to finance "K-factor projects" to, for example, reduce nonrevenue water levels, promote energy efficiency projects, and expand sewage networks.

An X-factor was also introduced in order to account for efficiency gains that were driven by the investments in K-factor projects. The gains in efficiency are passed on to customers through this X-factor. In the first three years, the X-factor is set to zero in order for the National Water Commission (NWC) to fully recover the up-front investments. Subsequently, the X-factor gradually increases, but remains below the K-factor.

The rationale behind the X-factor is that returns on equity must be earned through efficiency gains. The proposal is that the NWC increases in delivery efficiency over the investment period until it reaches targeted returns on equity. When the target is reached, efficiency gains start to be passed on to customers through the X-factor reducing real tariffs.

The X-factor also builds up a demand-side incentive mechanism: one of the mandates of the NWC is to increase coverage, which cannot be achieved if low-income families cannot pay their bills. Moreover, low-income families currently have unauthorized connections to the NWC's system. It is essential to NWC's nonrevenue water reduction strategy that these households are converted into regular, paying customers. That can only happen if they are able to afford their water bills.

Source: NWC 2013.

To mitigate this risk, in Jamaica, the use of CReW is accompanied by a second incentive mechanism, a credit enhancement facility. The facility acts as an additional layer of cash-backed guarantee in order to reduce credit risk exposure, as shown in box 17.

Box 17. Using a credit enhancement facility as reserve account collateral in Jamaica

Over an extended period, Jamaica has successfully rehabilitated 13 wastewater treatment plants using funds accessed from the Caribbean Regional Fund for Wastewater Management (CReW). Other recipient countries, meanwhile, rehabilitated one or two plants. This high level of success in accessing funds from CReW can to a significant extent be attributed to the use of the credit enhancement facility (CEF) to reduce credit risk exposure.

The National Water Commission used a guarantee of $3 million as a cash-backed collateral fund from the CEF. This loan permitted formalization of a $12 million loan contract with the National Commercial Bank in 2012. In Jamaica, recurrent fund replenishment was realized with the establishment of the CEF to secure a commercial loan at low interest rates while enforcing the K-factor (a surcharge on the water tariff).

Source: ECA, 2019.

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