CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems
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11

Financing Resource Recovery and Reuse in Developing and Emerging Economies

ENABLING ENVIRONMENT, FINANCING SOURCES AND COST RECOVERY

Anita Lazurko, Pay Drechsel and Munir A. Hanjra

About the Resource Recovery and Reuse Series

Resource Recovery and Reuse (RRR) is a subprogram of the **CGIAR Research Program on Water, Land and Ecosystems (WLE)** dedicated to applied research on the safe recovery of water, nutrients and energy from domestic and agro-industrial waste streams. This subprogram aims to create impact through different lines of action research, including (i) developing and testing scalable RRR business models, (ii) assessing and mitigating risks from RRR for public health and the environment, (iii) supporting public and private entities with innovative approaches for the safe reuse of wastewater and organic waste, and (iv) improving rural-urban linkages and resource allocations while minimizing the negative urban footprint on the peri-urban environment. This subprogram works closely with the World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), United Nations University (UNU), and many national and international partners across the globe. The RRR series of documents present summaries and reviews of the subprogram's research and resulting application guidelines, targeting development experts and others in the research for development continuum.

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The authors

Anita Lazurko holds a BSc in Civil Engineering from the University of Calgary and an Erasmus Mundus MSc in Environmental Sciences, Policy, and Management from the Central European University, Lund University, and the University of the Aegean. Anita gained experience with civil engineering consulting in Canada (CH2M; now Jacobs) and in the field of water governance in Malawi with Engineers Without Borders (EWB Canada). During her graduate studies, she visited the International Institute for Sustainable Development (IISD) and International Water Management Institute (IWMI). Anita is currently working as a consultant with IWMI in Pretoria, South Africa. She continues her involvement with EWB Canada, and was a member of the Young Scientific Programme Committee of the Stockholm World Water Week in 2018, supporting the scientific seminar on innovative financing for ecosystem management.

Pay Drechsel holds a PhD in Environmental Sciences and is a principal researcher and research division leader at the International Water Management Institute (IWMI), based in Colombo, Sri Lanka. Pay has 25 years of working experience in the rural-urban interface of developing countries, coordinating projects addressing the safe recovery of irrigation water, nutrients and organic matter from domestic waste streams for agriculture, with a special interest in business models. Pay has authored over 300 publications, half in peer-reviewed books and journals. He has worked extensively in West and East Africa, and South and South-East Asia. In 2015, Pay received the Development Award for Research from the International Water Association.

Munir A. Hanjra holds a PhD in Applied Hydrology from the Charles Sturt University in Australia, and an MSc and BSc in Agricultural Economics. He worked as Economist for the International Water Management Institute (IWMI), as Senior Research Fellow (Climate Change and Water Policy) at the Charles Sturt University, and as Water Policy Analyst at CSIRO Australia. He has over 25 years of professional experience on issues related to water resources such as global and regional water scarcity, water quality, food security, economics and poverty reduction. Dr. Hanjra has been involved in research and development programs in Australia, China, Canada, South and Southeast Asia, and Eastern, Western and Southern Africa. He has authored more than 150 publications, largely in the form of scientific research papers in peer-reviewed journals and as book chapters.

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Front cover photograph: Co-composting in Ghana through a public-private partnership (photo: Hamish John Appleby/IWMI).

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SUMMARY

Resource recovery and reuse (RRR) of domestic and agro-industrial waste has the potential to contribute to a number of financial, socioeconomic and environmental benefits in developing and emerging economies. Despite the proven benefits and increasing political will to recycle nutrients, water and energy, barriers to meeting up-front capital requirements, engaging the private sector, and achieving sustainable, pro-poor cost recovery continue to limit the widespread adoption of RRR. A systematic understanding of the enabling environment, public and private funding sources, risk-sharing mechanisms and pathways for cost recovery can help to identify opportunities to improve the viability of RRR solutions. This report uses a conventional definition of finance as the provision of funding with expectation of repayment, and of funding as a broad term to include both finance and non-repayable monies.

An **enabling environment** governed by a public policy and regulatory framework is required to encourage more rapid uptake of RRR while ensuring public safety. This includes regulations and policies that remove disincentives for RRR and clarify different forms of waste as potential resources for business and public sector entities. Market forces and economic incentives play a role in supporting supply chains to prioritize recovered resources as feedstock rather than encouraging the 'make-take-dispose' model, overcome competition with other resources and drive demand. Lastly, stakeholder capacity and engagement are critical to change negative public perception and improve project feasibility at the household, community and government level.

Access to diverse **public and private funding sources** for capital and operational costs is also critical for financing RRR. RRR solutions have unique characteristics that introduce challenges to financiers, including high up-front costs, a range of project scales, long payback periods, lack of track record, limited technology diffusion and challenges valuing non-economic benefits. The developing country context introduces additional challenges including the lack of local capital markets, external factors like geopolitical risk and poor governance frameworks, financial capacity, the need for pro-poor policies, and mismatched expectations of financiers and RRR. This has limited the involvement of certain stakeholders in financing RRR, though potential to diversify financing sources to include a range of options has been demonstrated around the world. Examples include concessional or asset finance, green and climate-aligned bonds, institutional investors interested in environmental, social and governance investment criteria, and hybrid finance.

Supporting RRR in low- and middle-income countries requires **addressing risk** through blending and structuring finance. Blended finance strategically uses development and philanthropic funds to mobilize private capital flows. Various financial structures and mechanisms exist including public-private partnerships, project aggregation, multilateral investment guarantees, results-based financing and revolving funds.

Beyond funding capital costs, a critical challenge for RRR is finding resource pathways for operational **cost recovery**. The system for collecting user fees, tariffs, sales revenue or taxes for an RRR product or service must be situation- and industry-specific to overcome challenges with low collection rates and low taxes or ability to pay. Greater economic and resource efficiency in the value chains upstream and downstream of an RRR project can also improve cost recovery. Diversifying revenue streams beyond sales of the recovered resource to include recovered process energy or heat, registered greenhouse gas emission reductions, or payments for ecosystem services may also improve the long-term viability of a project. The government may also have an important role by improving the value proposition by making advance market commitments or using its own land or equipment as part of the RRR project.

1. INTRODUCTION

The recovery of resources for reuse from domestic and agroindustrial waste in developing and emerging economies can contribute to numerous financial, socioeconomic and environmental benefits (Drechsel et al. 2015; Velenturf and Purnell 2017). Resource recovery and reuse (RRR) refers to solutions that recover and reuse nutrients, water or energy from solid waste or wastewater in support of a circular economy (Pan et al. 2015; Lacy and Rutqvist 2016). Despite proven benefits and increasing political will, RRR projects have yet to reach widespread adoption and scale in most developing and emerging economies due to the complex challenges associated with financing high up-front capital costs, incentivizing private sector participation and facilitating cost recovery in a pro-poor context. These constraints stem from several challenges, including financial challenges common to many developing countries and the unique financial and institutional needs of nascent RRR projects (Hanjra et al. 2015a, 2015b).

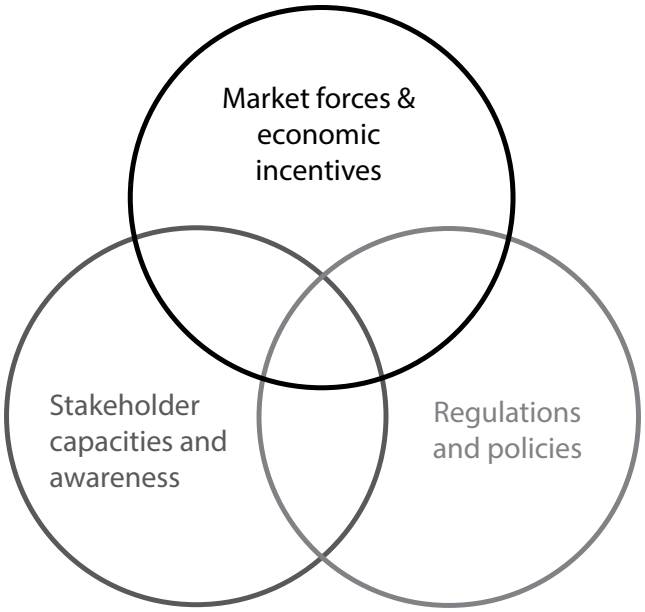
Solutions that begin to overcome these financial and institutional barriers are emerging and must be creatively used to support more effective uptake of RRR projects. First, an **enabling environment** governed by public policy and a regulatory framework must be established to facilitate more rapid uptake of RRR projects while ensuring the safety of public and environmental health. Market forces and economic incentives can be used to reduce competition of recovered resources with other products, stimulate supply chains to use recovered resources as feedstock and drive demand for the recovered product. All stakeholders must increase their awareness about the benefits and risks associated with RRR, prioritize the long-term perspective in planning and implementation of RRR, and support innovative financial arrangements for sustainable solutions. Given the intersectoral nature of RRR operations, an enabling environment must be cross-disciplinary and integrated, requiring coordination among governments, the private sector, international institutions and the public. Second, the full range of potential **public and private funding sources** should be considered based on unique project and context characteristics. This report highlights some emerging sources, including green finance and subsidy schemes. Third, **addressing risk** through blending and structuring of funds is possible, through methods such as public-private partnerships (PPPs), project or financial aggregation and results-based financing. Lastly, resource pathways for long-term **cost recovery** must be considered from the institutional and end-user perspective. This report explores these four issue areas (Figure 1), providing a background, case studies and innovative financial solutions to enable RRR to flourish.

FIGURE 1. MAJOR CONCEPTUAL ELEMENTS OF INNOVATIVE FINANCIAL SOLUTIONS FOR RRR IN DEVELOPING COUNTRIES.

2. ENABLING ENVIRONMENT FOR INVESTMENT IN RRR

RRR solutions provide multiple benefits to society. There are several technology options to facilitate a circular economy for nutrients, energy and water. Successfully implementing these solutions requires an enabling environment or a set of interrelated organizational, fiscal, informational and political conditions that improve the capacity of actors to engage in effective and sustainable development and financing of RRR solutions (Bekchanov 2017; Di Mario et al. 2018). Although there are exceptions, a weak enabling environment is inhibiting the implementation and scaling up of RRR solutions in developing and emerging economies, and current approaches tend to support the traditional, more wasteful patterns of resource consumption and disposal. The enabling environment for RRR can be divided into the three categories (Figure 2). Each category is further described in the following sections according to three themes of influence: principles, policy rules and project priorities.

FIGURE 2. THE ENABLING ENVIRONMENT FOR IMPLEMENTING RRR.



2.1 Regulations and Policies

Policies, regulations and guidelines play a major role in the viability of RRR projects. The World Health Organization's guidelines (WHO 2006a, 2006b) and Sanitation Safety Planning Manual for the reuse of water in agriculture (WHO 2015) are the main sources of policy guidance for developing countries, but they are limited in scope and cater to local resource streams and local contexts. The European Union Waste Framework Directive, the phosphorus recovery and recycling policy in Switzerland, and emerging policies in the UK and some states in the USA (Mayer et al. 2016) demonstrate progress in developed contexts. Other contexts lack clear national-level legislation to support wastewater and fecal sludge treatment for reuse. For example, in Argentina, the use of biosolids is permitted by law but no specific reference is made to fecal sludge (Ingallinella et al. 2002).

Strict national environmental and public health regulations can act as a disincentive for RRR. Unclear policy mandates or missing regulations can limit business start-ups and financing solutions, although several contexts, including Australia and several European Union (EU) countries, are expected to shift legislation to support biosolids as a renewable fuel (Christodoulou and Stamatelatou 2016). In addition, compliance and enforcement of existing regulations may be low in developing countries due to budget and capacity limitations. Beyond the policy and legislative frameworks that must be in place to allow RRR products to enter the market legally and safely, high transaction costs and other administrative barriers can hinder governments from registering new products or RRR businesses.

2.2 Market Forces and Economic Incentives

Market forces and economic incentives can play an important role in supporting supply chains to preferably use recovered resources as feedstock, driving demand for recovered resources and overcoming competition with other resources. On the supply side, fluctuating commodity prices and systems that favor the channeling of feedstock to other uses perpetuate the status quo 'make-take-dispose' model. Incentives for source segregation of waste to encourage organic waste management, or landfill tipping fees that incentivize individuals to seek RRR alternatives, can be effective forces to increase reuse and improve the uniformity and timing of feedstock supply.

Policies in sectors extraneous to waste and water management may create unfair competition for the recovered resources, affecting market entry and cost recovery (Matter et al. 2015). For example, chemical fertilizer subsidies limit compost sales and low freshwater tariffs limit sales of treated wastewater. To maximize the value chain within the RRR project, users of the final product must be willing to pay, consumers must take up the project or service and the timing of production and demand must be coordinated. For the private sector to be attracted to RRR projects, there must be proven demand and profitability for the reuse products, not simply a potential market. This requires an investigation of value added along the supply chain. The trade-offs of competing policies and the opportunities presented by well-structured economic incentives point to the need for better integration among multiple stakeholders within the public sector, both horizontally among ministries for agriculture and environment, finance and budget processes, and vertically among local, regional and national levels of government.

2.3 Stakeholder Capacities and Engagement

Public perception of recovered resource products and attitude towards waste management in general can influence market demand and the overall feasibility of RRR solutions (Drechsel et al. 2015). For example, household-level behavior changes for effective source segregation can enhance the viability of organic waste management solutions, such as segregated household waste as feedstock for community biogas plants and slurry as compost. Some communities have numerous low-income households with livelihoods that rely on informal waste management activities, which are generally accepted by the public. Governments can enhance source segregation and increase market demand for recovered products through public awareness programs (Kan et al. 2008), training informal workers or integrating them with formalized systems (Yang et al. 2018). The private sector may also have perceptions about the challenges of entering RRR markets based on previous experience. The compost sector has witnessed several unviable government- or donor-funded projects being unable to recover costs over the long term due to inappropriate technology selection, a short-term planning perspective and slack demand in the compost market (Kaza et al. 2016).

The institutional environment and the capacities of various stakeholders also determine the ability to choose and implement effective RRR solutions. Scarce resources and multiple development priorities of local and national authorities continue to accord low priority to RRR solutions. The lack of policy enforcement erodes public trust in new solutions and attitude towards the safety of recovered products, introducing more barriers to market entry and cost recovery. Governments must integrate waste management policies with other sectors to support RRR, protect public health and adapt to future changes. Local actors must have the capacity to execute individual roles within the broader RRR system. Private sector participants must also have the capacity to critically assess the situation and choose solutions that are appropriate to their circumstances and local context.

3. PUBLIC AND PRIVATE FUNDING SOURCES FOR CAPITAL AND OPERATIONAL COSTS

Many RRR solutions face high up-front costs, including the costs of technology development and implementation, market research, equipment, machinery, land acquisition and on-site infrastructure. Finding investment capital for RRR solutions in the developing context can be challenging due to constraints in the financing environment and the unique project characteristics in the RRR sector. Despite these barriers, there are several options for governments and enterprises to access funding for RRR projects in the developing country context. A brief description of the characteristics of RRR that challenge traditional financing is followed by an overview of the major financial stakeholders in the RRR domain by identifying their interests and experience. This is followed by an examination of public and private funding sources for capital and operational costs, highlighting both traditional and emerging financing solutions. The unique challenges of financing RRR projects and general challenges to financing in the developing country context are presented in Tables 1 and 2.

3.1 Stakeholders in the Financing Environment

Financing RRR involves a wide set of stakeholders, from local-level implementers and small- and medium-size enterprises (SMEs) to national governments and international institutions. Specific entities that provide financing have varying degrees of experience in RRR. For example, waste-to-energy projects are often driven through a stronger commercial value proposition, supported by bank loans, venture capital, government programs for environmental initiatives and carbon markets (Di Mario et al. 2018). Meanwhile, wastewater reuse projects in developing countries rely more heavily on public financing with support from foreign loans or grants but require more innovative methods for engaging the private sector and institutional investors (Kaza et al. 2016).

Figure 3 shows the major stakeholders involved in financing RRR projects, including those that directly fund projects and services using the financing mechanisms examined in subsequent sections of this report. Each stakeholder's interests for investing in resource recovery and reuse options are driven from two possible perspectives: supporting sustainable development objectives and the potential profit or gain expected from the support. Figure 3 provides a qualitative assessment of the current state of the stakeholder's financial involvement in RRR based on the literature (e.g. Drechsel et al. 2018) and case studies, and the stakeholders' experience in providing financing in the developing country context. Multilateral development banks, international finance institutions, non-governmental organizations (NGOs) and governments have the most significant presence along both scales, while institutional investors have the least presence. However, if the diagram in Figure 3 depicted the relative potential of each of these stakeholders in emerging financing opportunities, it would look very different. A more detailed description of the financial stakeholders and the reasons for their relative location on the scales in Figure 3 are included as Appendix I.

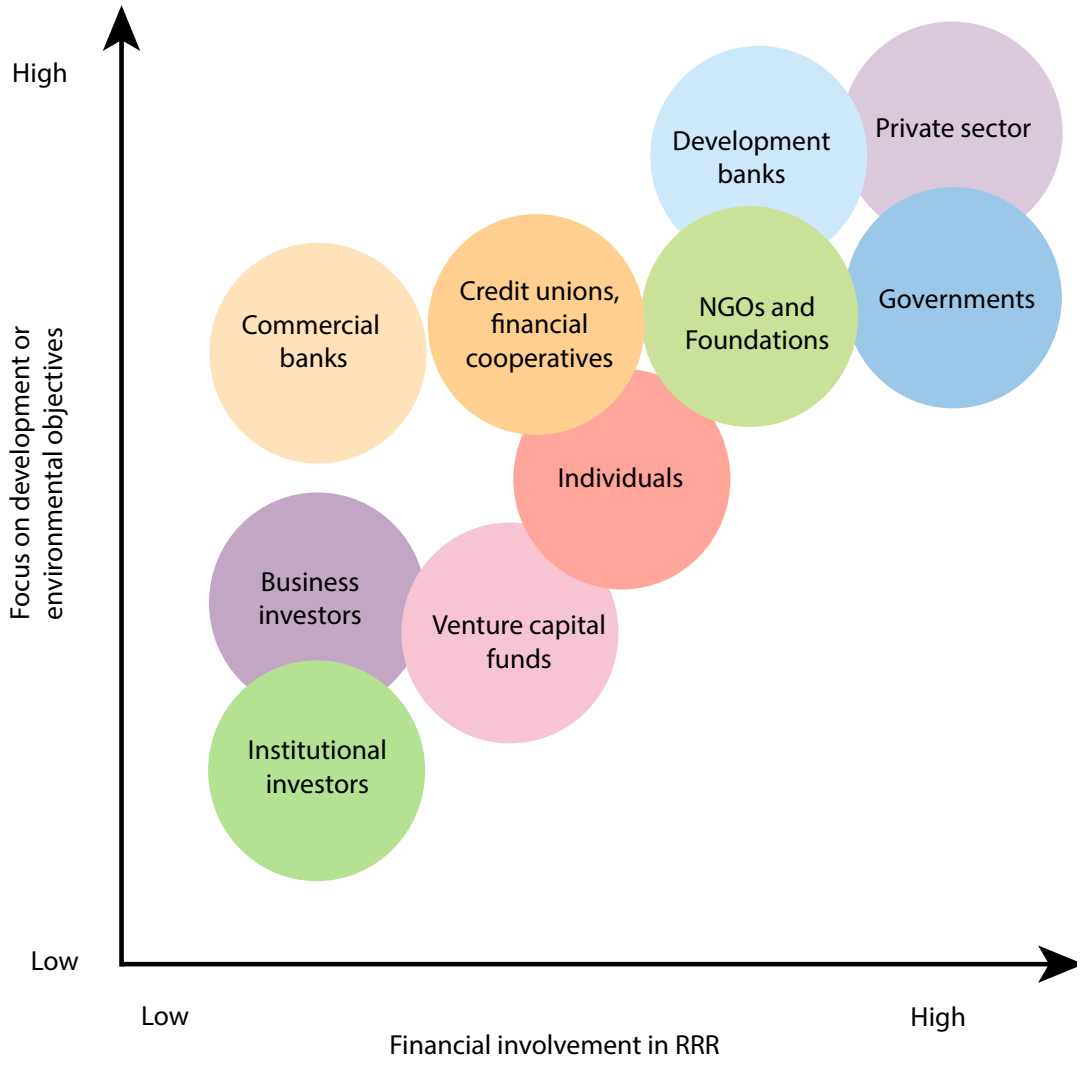
TABLE 1. CHALLENGES TO FINANCIERS OF RRR PROJECTS.

Project scale	The scale of an RRR project tends to range from a small, decentralized community project or local start-up business to a large-scale centralized treatment plant. If the project scale is too small, it may not achieve sufficient economies of scale, resulting in insufficient business returns and higher risks for financiers. If the project scale is in the mid-range, it may be too large for microfinancing and too small to achieve economies of scale that can attract external investment. Some projects may simply be too large for the financial means of a government.
Liquidity risk and long payback period	RRR projects may present liquidity concerns to financial institutions and the private sector. Large-Scale infrastructure investments, such as composting plants or wastewater treatment and reuse systems, require capital to remain tied up for long periods of time, reducing liquidity flows and introducing financial risk (ADB 2011b). The exception is energy recovery projects, in which payback periods can be less than three years (Barry 2007). Levelizing the costs of new technologies and business approaches can reveal the most economical solutions over the long term, but this does not negate the need for up-front capital financing and successful cost recovery (Cusmano 2015).
Lack of track record	Attracting financing for new business start-ups venturing into the RRR sector is difficult because of the lack of track record. Inadequately proven business models can act as a major deterrent for investment (IFC 2013) and smaller enterprises with great potential to demonstrate RRR solutions, such as waste-to-compost and bioenergy projects, struggle due to their low credit history and limited capacity to present bankable projects (Di Mario et al. 2018). Governments have an opportunity to take the lead by developing an enabling environment for early stage equity financing (Beltramello et al. 2013).
Technology diffusion	Inadequately proven technologies or technology that does not match resource and capacity can also hinder project success and drive away financing. For example, urban or peri-urban land availability, operation and maintenance (O&M) capacity, irregular energy supply and other factors can dictate project success or failure.
Valuing non-economic benefits	Most RRR projects generate significant socioeconomic and environmental benefits, but the failure to account for them in the financial systems of governments and investors exacerbates the challenge of establishing well-rounded value propositions for RRR projects (IFC 2013).

TABLE 2. CHALLENGES TO FINANCING IN THE DEVELOPING CONTEXT.

Lack of local capital markets	Underdeveloped local capital markets create bottlenecks for scaling up RRR solutions (Muspratt 2016).
External factors	Many external factors influence the lending risk in developing countries, namely geopolitical risk, political uncertainty and poor governance frameworks as well as the risks associated with insufficient investment processes (IFC 2013).
Financial capacity	Mechanisms to overcome lending risk, such as risk guarantees or local experience that could validate potential savings, are often missing in developing contexts (Kaza et al. 2016). Low creditworthiness is a major financial constraint for governments and private companies operating in risky or low-resource environments. Developing countries may not have an official credit rating system and local financial institutions may lack experience using emerging financial mechanisms.
Need for pro-poor policies	The need for pro-poor policies in developing countries affects levelized costs and 'affordability for the price' because user charges and service fees must be kept low to ensure basic services for all.
Mismatched expectations of financiers and RRR	Developing country governments require flexible financing arrangements and patient capital to overcome some of these risk and credit-related challenges, which do not match well with the principle of fiduciary duty and expected returns required by some potential financiers. In addition, low pricing of water and sanitation services as well as the final recovered product, such as treated wastewater or compost, and inadequate fiscal transfers from central to local governments, do little to solve this issue.

FIGURE 3. THE STATE OF RELATIVE FINANCIAL INVOLVEMENT AND EXPERIENCE OF VARIOUS FINANCING STAKEHOLDERS IN **RESOURCE RECOVERY AND REUSE** (RRR) IN THE DEVELOPING COUNTRY CONTEXT (SEE ALSO TABLE A1: IN APPENDIX 1)

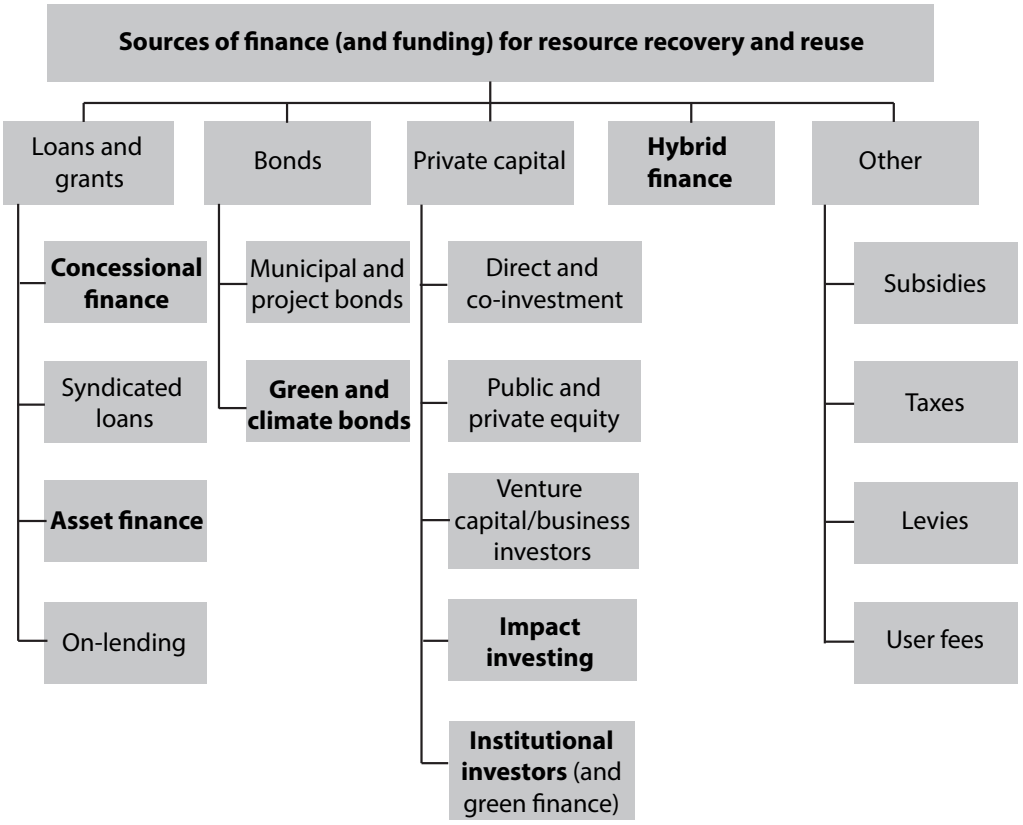


There is a wide range of funding sources for RRR. A comprehensive list, though not exhaustive, is presented in Figure 4. All possible sources are introduced briefly, but those indicated in bold are noteworthy or emerging funding sources that are explored in more detail in the following sections.

3.2 Loans and Grants

Loans and grants are a common source of funding for developing country governments and enterprises implementing RRR projects in all sectors. Loans can be provided by multilateral development banks (MDBs), international financial institutions (IFIs), commercial banks or governments at various project scales, from small microloans provided by commercial banks or other local financial institutions to concessional loans provided by MDBs to national governments (Table 3). Grants, a non-debt financial award distributed to an enterprise or government by a higher level of government or IFIs, are typically funded with tax dollars or reserves. Grants are usually packaged into the loan to improve the financial viability of the project.

FIGURE 4. INSTRUMENTS FOR FINANCING RRR.



A concessional loan provides an implicit subsidy directed to developing countries or RRR projects with public service benefits from an MDB or foreign government (see Box 1). This type of loan is generally provided as part of a 'loan softening program' – longer loan terms, lower interest rates and repayment holidays where capital and interest repayments are not due until the project becomes profitable (IFC 2013). Concessional loans are effective in attracting private investment by improving the financial status of a project and lowering costs/fees, thereby supporting solutions into less commercially proven areas (IFC 2013). A syndicated loan, in which a group of lenders offers a loan to a large entity like a national government, large project or company, reduces the risk on investors (for example, As Samra wastewater treatment plant, Amman, Jordan).

BOX 1. LOANS FOR CAPITAL COST FINANCING: COMPOSTING IN INDIA AND WASTEWATER TREATMENT AND REUSE IN THE PHILIPPINES.

The municipality of Berhampur in India sought a PPP concession to implement an effective solid waste management system, including collection, transport, segregation and establishment of a compost plant for organic waste management. To improve the financial viability of the project set-up and reduce tipping fees to an affordable level, a capital grant and concessional loan transaction were introduced during the construction phase of the project. The grant and concessional loan, fixed at 25% of the initial project cost, were provided by the Odisha Urban Infrastructure Development Fund. The private partners were concerned about the payment risk of the municipality, so a third party/holding account was set up, including a three-month reserve and automatic monthly release of funds upon receipt of the invoice (IFC 2013).

A peri-urban housing area in Bayawan City, the Philippines, built a hybrid constructed wetland system to treat wastewater, which is collected and pumped into a storage tank for use in irrigation, firefighting, home gardening and construction. The construction cost of about EUR 160,000 was mainly financed by a loan from the World Bank. Technical assistance from the Department of the Interior and Local Government - German Technical Cooperation Agency Water and Sanitation Program covered costs of community preparation, social mobilization, workshops and an international consultant. The city administration paid the O&M costs of EUR 3,500 per year. Individual households pay tariffs for water and electricity, but do not pay for wastewater treatment. Users of treated wastewater have access to the resource at no cost (ADB 2014).

TABLE 3. GRANTS AND LOANS IN FOCUS.

Type	Description	Project scale	Risk	Relevant variations
Transaction lending (traditional loans)	Traditional type of lending by larger institutions, which uses hard data to determine the creditworthiness of the borrower	All project scales possible, although easier to obtain for medium- to large-scale projects	The lender may require the borrower to have a minimum credit rating, demonstrate a cash flow to debt ratio of 1.5 times the value of a loan, or to provide detailed pro-forma and business plans, and financial statements	**Syndicated loan** (offered by a group of lenders to lower risk) **Concessional loan** (loan on concessionary terms to improve project viability)
Relationship lending (soft loans)	Based on a combination of hard data and qualitative data to determine the ability of the borrower to repay the debt, but the lender engages in a more thorough relationship with the borrower (Memmel et al. 2008)	Often provided by smaller banks to small-to medium-size enterprises	Several mechanisms exist that transcend this binary distinction, allowing borrowers with short financial track records, low creditworthiness or no credit rating at all to access funds	**Asset finance**
On-lending	Occurs when an institution such as a national government borrows funds and on-lends these funds to a second, smaller scale institution such as a local government, which then redistributes the funds to local actors (IFC 2013)	Depends on the original source of funding, but typically used to deploy funds received from national or regional governments to local governments	Avoids large transaction costs associated with dispersing large loans, by taking advantage of existing clientele of local financial institutions (see Box 2)	On-lending for water and sanitation projects, such as FINDETER, a mixed economy public corporation, in Columbia (ISF-UTS 2014)
Grants	A non-debt financial award given to an entity, such as a local government or RRR enterprise, for financing a specific project	All scales in developing countries, often used to deploy funding from higher levels to lower scales	Risk is not a consideration once funding is deployed	**Viability grant funding**

Traditional financiers generally view SMEs as 'high risk' for lending as they demand higher levels of investment security, making it difficult for SMEs to access funds for working capital requirements, growth, restructuring or refinancing (Mullen 2017). Asset-based Lending (ABL) is an umbrella term for an increasingly popular form of commercial debt finance directed to SMEs that struggle with low creditworthiness and relationship lending metrics. Rather than traditional lending based on overall creditworthiness, ABL provides lending based on the liquidation value of assets and the overall amount borrowed (Cusmano 2015) or the firm's cash flow. The firm receives a special type of loan based on the value of its property, equipment or other assets, due to a relationship between the lender and borrower that considers the ease of selling off the asset in the case of payment default. ABL is the most common form of asset finance, but the term also encompasses factoring, purchase order finance, warehouse receipts and leasing. Many people perceive ABL as a method for funding enterprises with good business models (Box 2), positive net present values, skilled entrepreneurs and growth potential, but lack financial resources and are too small to attract traditional finance (de la Torre et al. 2008). In addition, the lending terms of ABL are often more flexible than traditional lending terms, enabling the use of revolving funds (see below) and other unique financing arrangements (Cusmano 2015). In principle, ABL can be a solution for commercial banks to better serve SMEs in the developing context, where SME lending is typically backed by a firm's collateral. However, this may not be realistic for many SMEs in the developing context in which companies may not be able to provide reliable financial reports and projections to the banks. In addition, the focus of ABL on asset valuation rather than ability to repay presents a risk in the developing contexts (FSD Kenya 2015).

Viability Gap Funding (VGF) is a type of grant funding from a donor/government that reduces the upfront capital costs of private infrastructure investments targeted toward low-income populations. The VGF 'gap' is the difference between the revenues necessary to make a project commercially viable and the revenues that are likely to be generated by the government and user fees. VGF targets projects that may have high economic and social benefits, particularly over the long term, but have high costs and the low incomes of beneficiaries make it infeasible to cover costs. Grant funding is provided at the time of financial close, but it can be used during construction when the need for capital cost is high. This makes projects more commercially viable for investors and attracts more investment from the private sector in pro-poor development projects. Box 3 describes a successful hybrid PPP for a large-scale wastewater treatment plant that used VGF to improve financial viability.

BOX 2. ASSET-BASED LENDING FOR SEAWEED HARVESTING AND FERTILIZER PRODUCTION IN THE UK.

Uist Asco, an innovative sustainable business in the UK that harvests seaweed from around the country, dries and uses it for organic animal feed and fertilizer. The company was provided with a hire purchase facility (arrangement by which the company buys a good by making installment payments over time) over a seven-year term. To finance the business through the initial start-up, ABL allowed it to purchase the essential plant and machinery required. Later, the company was in transition and arranged an invoice factoring in the facility (an arrangement in which the company sells its accounts receivable to the third party at a discount) to meet its cash flow needs (Mullen 2017).

BOX 3. AS SAMRA WASTEWATER TREATMENT PLANT, AMMAN, JORDAN.

In 2012, the Government of Jordan signed a 25-year build-operate-transfer contract with SUEZ international for a 364,000 cubic meters (m^3) day^{-1} wastewater treatment plant. This expansion contract increased water line capacity by 37%, sludge line capacity by 80% and added mechanical dewatering. The result was a plant that is 90% energy self-sufficient and provides the cheapest treated wastewater for irrigation in the lower Jordan Valley. The project was co-financed by the United States Agency for International Development (USAID) and VGF by the United States Millennium Challenge Corporation (MCC). Financing (total USD 267.7 million) was provided as follows:

- Ministry of Water and Irrigation Jordan + MCC: USD 93.3 million;
- Lenders' syndicate (banks in Jordan, a 20-year commercial loan): USD 146.0 million; and
- Sponsors' equity: USD 28.2 million.

This project provides a template for VGF but also hybrid finance for its combination of private, government and donor financing, the first of its kind in the Middle East. VGF allowed financial viability of the plant by bringing down overall capital costs. Thus, the government pays volumetric water treatment fees to the treatment plant company and local people benefit through improved service delivery and expanded sanitation network coverage within and around Amman. Because the MCC could not enter into a direct contractual relationship with sponsors or lenders, the stakeholders had to innovate a new financing structure by establishing a local private entity called the Samara Waste Water Treatment Plant Company (SPC) to run the plant and achieve 100% private ownership structure (De Pazzis 2017); Drechsel et al. 2018.

3.3 Bonds

Bonds are a common form of debt financing used by governments or authorized entities and may be the most straightforward and cheapest option (Griffith-Jones et al. 2012). Bonds are a popular method for financing government infrastructure projects and enterprise growth (Table 4). Bonds are relevant for RRR because they can be structured uniquely for projects or businesses with higher risk. Full credit guarantees (see section 4.3) are often offered by insurers to support bonds to cover the full amount of debt. For example, the Philippines Local Government Unit Guarantee Corporation provides credit guarantees to municipalities that seek to finance infrastructure projects through bonds (Di Mario et al. 2018). Bonds may be used as the primary source of funding and, in conjunction with other instruments, for leveraging or additional subsidization of private sector participants (see Box 4).

TABLE 4. BONDS IN FOCUS.

Type	Description	Project scale	Risk	Relevant variations
Municipal (government) bonds	Bonds issued by a municipality or other government entity to finance public infrastructure	Medium to large scale Small-scale projects if bundled	Attractive to investors because of federal guarantees, specific yield and tax exemptions	**Green or climate-aligned bonds** Covered bonds
Project bonds	Bonds issued by a government entity or consortium to finance a specific project	Medium to large scale	Subject to fewer regulations compared to municipal bonds	Performance bonds
Corporate bonds	Bonds issued by a corporation to finance expansion or ongoing operations	Medium to large scale	High yield but also higher risk than government bonds	**Green or climate-aligned bonds**

BOX 4. FINANCING WASTEWATER TREATMENT AND REUSE WITH BONDS AND WATER TARIFFS IN SINGAPORE.

Singapore sought to reduce its dependence on imported water by building its supply of reclaimed and desalinated water. Singapore's National Water Agency issued a bond to raise USD 400 million, in addition to setting water tariffs at a rate to allow cost recovery including capital cost. The water tariff was set on the volume of water used, including a water conservation tax to reinforce the need to conserve (30%, above 40 m^3 at 45%), and a fixed sanitary appliance fee based on the number owned.

There are several types of bonds that reduce risk and support the borrower or investor. Covered bonds are debt securities collateralized against a pool of assets that the issuer can use to cover the claims in case of failure. They may be created by a group of loans that have been purchased, such as mortgages. The financial institution packages the purchased loans or assets and issues bonds covered by the cash flowing from the investments, giving them higher yield and lower costs than other types of bonds (Damerow et al. 2012). Performance bonds include guarantees that the contractor will satisfactorily complete all obligations in the contract according to the terms and conditions. These assurity bonds may help financiers and borrowers achieve a desirable level of risk and reward. Performance bonds can usually cover 100% of the contract price in RRR projects, and if cashed by the principal, the payment amount is recovered by the guarantor from the RRR contractor. For example, performance/assurity bonds can be used for student placement at foreign universities and institutes for training in RRR programs.

Green bonds and climate-aligned bonds are emerging financial instruments that can be used in RRR projects. Green bonds can be issued by green banks, or MDBs, government agencies, municipalities, financial institutions and private enterprises, and are marked 'certified by a third party'. Green bonds are like conventional bonds, but the proceeds must be used for green projects to achieve verifiable performance outcomes related to the environment. Green bonds can be general obligation bonds, where proceeds of the bond issuance must be used for green products and guaranteed by all the financial resources of the issuer; revenue bonds, where bond proceeds are used for green products and backed by the revenue generated by the issuer; project bonds, where bond proceeds are used for specific green projects and are secured by the assets and revenue stream of specific projects; and securitized bonds, where proceeds are used for green projects and are backed by assets that have been grouped as collateral (Cochu et al. 2016). Box 5 presents a global financing overview.

BOX 5. FUNDING GAPS IN CLIMATE FINANCE AND GREEN BONDS.

Many studies have recognized a disconnect between investors seeking projects and projects seeking funding, due to perceived lack of opportunities and challenges in sourcing bankable projects (Clark et al. 2018). In 2014, total climate financing was USD 361 billion, of which USD 141 million was provided by the private sector, while climate investment opportunities to 2030 are estimated at USD 1.6 trillion per year – more than four times the current global investments of USD 361 billion. Bridging funding gaps denote the potential of private finance (Clark et al. 2018):

- Global climate finance: USD 361 billion current investment, USD 1.6-3 trillion required investment;
- Sustainable Development Goals: USD 132 billion current known investment, USD 5-7 trillion required;
- Conservation initiatives: USD 52 billion current investment, USD 250-350 billion required investment; and
- Green bonds: USD 118 billion labelled green bonds, USD 90 trillion current global bond market.

In Europe, only 5.6% of green bonds is used to fund waste and pollution mitigation, 9.3% for water initiatives, with the majority allocated to renewable energy, energy efficiency and low carbon transport (Cochu et al. 2016). For RRR, the United Nations' Clean Development Mechanism (CDM) and waste-to-energy (WTE) projects may have the most obvious potential for entry into the green bond market. Climate bonds present greater opportunity for RRR projects with climate adaptation or mitigation potential. For example, the San Francisco Public Utilities Commission (SFPUC) issued a bond certified by the Climate Bonds Initiative for stormwater management and wastewater projects as part of Phase 1 of the SFPUC Sewer System Improvement Plan (WaterWorld 2016).

Cities in emerging economies have a unique opportunity to tap into the green bond market by issuing municipal bonds (Oliver 2016). Johannesburg was the first city in South Africa to list a green bond (USD 140 million) to fund green initiatives, and in December of 2016 Mexico City became the first city in Latin America to issue a green bond, which is being allocated toward water infrastructure, transportation upgrades and energy-efficient lighting (Swope 2017). Since then, Cape Town and other municipalities have joined the trend. Combining green bonds with guarantee instruments or bringing in a cornerstone buyer like a development finance institution may help to overcome constraints for developing country cities in accessing local capital markets (Oliver 2016). Though bonds are a well-established traditional financing mechanism, green bonds still present unique opportunities for developing countries in the RRR sector if established effectively and as part of a larger green finance strategy (see Box 6).

BOX 6. GREEN BANKS.

Green banks are financial entities with specific offerings that directly target green finance. They have specialized capacities that directly address the risks associated with RRR and green investments in developing countries by providing special credit conditions, mechanisms to aggregate smaller projects to reach an attractive scale, set up of innovative finance products and structures, and expanded market share by disseminating information to various stakeholders. The main focus is leveraging various types of public funds to attract private investment into green projects. Possible products of green banks include (Coquelet et al. 2016):

- Concessional direct, long-term loans;
- Structured investment funds;
- Subordinated debt;
- Investment in existing funds;
- Bond issue to refinance bank investments; and
- Credit enhancement (insurance or guarantees).

3.4 Private Capital

Private capital includes a broad range of investing in equity, debt securities or private companies (Table 5). Equity-based investments can be advantageous for RRR enterprises if successful, as repayments to investors depend wholly on success and earnings. However, equity inherently requires that RRR enterprises share control of their strategies and earnings. Enterprises with a high market-to-book ratio can raise equity finance at lower costs than companies with tighter cash flows and lower market-to-book ratios (OPM 2002).

Middle- and low-income countries generally have small stock and bond markets, and if legal structures are weak, regulatory changes lead to high transaction costs when trying to access public equity markets for finance (OPM 2002). Governments may offer interest subsidies, though some believe this may simply increase the financing gap for governments in developing countries. Emerging public asset classes like YieldCos attempt to attract yield-based investment capital into the renewable energy sector (Matlock and Byers 2015). Green markets and equity finance also present exciting opportunities for RRR and emerging economies (Box 7).

Venture capital investing, business investing and social impact investing are more niche forms of private equity that require more intentional pairing of the investor's business motives and RRR enterprise or project requirements. Venture capital and business investing have the potential to support innovative technologies and provide mentorship to early-stage business owners. Social impact investing and crowdfunding are mechanisms that may attract capital for sustainable development projects like RRR or other social investment criteria associated with the widely-shared outcomes of the RRR enterprise like clean water, low emissions and so forth. Impact investing is a type of equity investment with the additional criteria of values' alignment, positive social or environmental outcomes, intrinsic motives for socially impactful businesses and socioenvironmental sustainable operations. These investments can be directed toward established, large-scale enterprises or early-stage ventures depending on the goals of the investors (Rotenberg and Bonsey 2016). Though not yet common in RRR, impact investing is increasing rapidly in different forms, from firms targeting early-stage impact investments alongside technical assistances to large pension funds allocating a portion of their investment portfolio to environmental and social goals. Similarly, equity crowdfunding may emerge as an emerging form of upfront or transition financing for SMEs and more established companies in RRR. Crowdfunding uses social networks to sell shares of a privately-held company to the public to increase awareness, seek funds and gain recognition. Through this process, buyers may also acquire membership (Cusmano 2015). Yet, reaping the rewards of crowdfunding requires resources and marketing capacity, and it might not be suitable for all RRR initiatives in low-income countries where literacy and Internet connectivity are low.

3.5 Hybrid Finance

Hybrid finance is a more specific term used to describe financial instruments with both equity and debt characteristics, such as the structure used to finance the As Samra wastewater treatment plant. Mezzanine finance is an overarching term to describe two or more investment instruments that are sold to investors as a single entity, wherein the mix can be tailored to the needs of the investors and the RRR firm. For example, a simple mezzanine could include a few categories of subordinated debt, a success fee that allows the investor to receive a share of the company earnings and an equity tranche in which the investor receives payment contingent on the rise in value of the company (Cusmano 2015). Box 8 presents an example of a mezzanine agreement in RRR.

TABLE 5. PRIVATE CAPITAL IN FOCUS.

Type	Description	Project scale	Risk	Relevant variations
Public equity	Shares of a company are sold to individuals or organizations through public float	Established enterprises	Small stock and bond markets and regulatory changes in some developing countries Require strong legal structures to avoid high transaction costs	Institutional investors Interest subsidies New structures (e.g. YieldCos for renewable energy)
Private equity	Equity is purchased through an underwriter (e.g. an investment bank) that sets the price and handles the sale	Varied sizes that attract investors, usually targeting 100% ownership	Varied and targeted toward accredited investors that can handle losses (Dumon 2015)	**Impact investing** (to generate a measurable, beneficial social/environmental impact alongside a financial return)
Direct/co-investment	An individual or private equity firm invests directly into an enterprise to gain some control over management (10% or more of the stake)	Varies. Some local ownership laws may act as safeguards against foreign control that limit investments	Long-term and hands-on commitment Co-investment lowers risk usually as secondary to main financial sponsor (Cusmano 2015)	**Impact investing** **Business investors** Sponsor equity
Venture capital	A form of equity investment that supports prelaunch, launch and early-stage business development	Varied, early stages	High risk, but lower than business investing as the product has been test-marketed and shown viability	**Impact investing** **Business investors**
Informal/seed direct investing	Equity investing by affluent, high net worth individuals for a business start-up, seed capital, for convertible debt or ownership equity	Varied, new concepts, for seed capital, early stage companies	High risk Once a company reaches a high stage of maturity individual sells shares and invests in a new venture (Cusmano 2015)	**Business investors** **Seed investors**

BOX 7. ACCESSING CAPITAL MARKETS THROUGH INSTITUTIONAL INVESTORS AND GREEN FINANCE.

Institutional investors control a dominant portion of private capital in global markets. However, developing countries and RRR have historically received little benefit from these markets due to the regulatory mismatch, low-risk tolerance and the financing environment for RRR in developing countries. Many countries in Sub-Saharan Africa have hit a demographic 'sweet spot' for pension funds because they have a rising labor force, younger population, low dependency ratios and the impact of aging has not hit their pension systems unlike in most developed countries (Sy 2017). Significant reforms are required for developing countries to fund infrastructure through pension funds. For example, the 2011 revision of Regulation 28 of the Pension Fund Act in South Africa integrated guidelines for incorporating analysis of environmental, social and governance information into its pension fund investment decision-making process, opening up new opportunities for targeted investments that promote sustainable development across Africa (Wood 2013).

There is also a potential match between RRR in developing countries and the investment portfolios of institutional investors in developed countries, particularly through green investments. RRR projects are at different stages of maturity, which require different financial vehicles, whereas pension funds are only interested in low-risk investments that can provide steady income streams. To date, allocation of pension funds to green finance and RRR is low because of low policy support, market liquidity, inappropriate investment structures and poor knowledge, track record and expertise within the financial system regarding the associated risks. To develop this market, host governments can take several actions, including ensuring that adequate, investment-grade deals reach the market, providing public finance alongside private finance, providing loan guarantees and other mechanisms (Della Croce et al. 2011).

Subordinated bonds and loans are allocated by secured or senior creditors and are fully paid before the interest or principal is paid. They are suitable hybrid finance instruments for financing RRR in low- and middle-income countries, as they add an additional layer of risk protection and may be attractive to affluent senior investors who would not normally consider investing in RRR (Cusmano 2015). Participating loans are unique in that their remuneration depends on the results of the borrower, rather than being fixed as in a conventional loan (Cusmano 2015) and are therefore useful only for profit-making RRR projects. Similarly, silent participations allow individuals to purchase equity in the company without assuming liability to the creditors. Thus, the silent partner is a limited partner because overall liability is limited to the amount invested in the company (Cusmano 2015). Convertible debt has a maturity date and repayment terms that include the option to convert the debt into a different financial instrument, like on-debt or stock, so the overall value of a convertible bond is the traditional value of the bond plus the value of the option. Many of these hybrid finance instruments are at experimental stages and might have not yet been adopted in middle- and low-income countries.

3.6 Other Funding Sources

Subsidies are implied in many of the funding mechanisms discussed in this report. Concessional finance, like payment holidays and soft loan terms, include an implicit subsidy borne by the government or the financier. VGF is a subsidy directed towards closing the financial feasibility gap that is borne from the inability of users in low- and middle-income countries to pay a user fee that can reflect full cost recovery. Grants from donors/governments to RRR projects to incentivize private sector participation are also a form of subsidy. Government support through subsidies is commonly used to facilitate cost recovery and is explored in more detail in section 5.

Taxes can be used in multiple ways to fund projects: tax holidays, low import taxes, matched investments/ tax credits or other tax incentives can encourage private sector participants to enter a specific market or sector like RRR; additional taxes can act as a disincentive that create a barrier for the competing project or sector like chemical fertilizer; and externality pricing mechanisms to 'get the price right'. Bangladesh issued a five- to ten-year tax holiday on waste plants, reduced import taxes and instituted no value-added or sales tax to incentivize private sector participation (Kaza et al. 2016). Various forms of tax holidays have been used for PPPs in the USA's waste management sector for decades. For example, in some states WTE investment had shorter depreciation schedules to incentivize investment (US EPA 1990). Tax abatements or reduced property tax have also been used in the USA. Land provisions may also act as a tax-related incentive to increase financial feasibility and reduce outlays on leasing and property tax. China's national and local government provided land for its compost plan, whereas Bekasi, Indonesia, acquired the land on a lease basis with a price of 20% of the tipping fee, paid by the entity generating waste (provincial government) to the entity taking in the waste (the Bekasi city government) (Pandyaswargo and Jagath Premakumara 2014). Taxes may also be used directly to facilitate cost recovery (see section 5).

Levies and end-user fees are commonly used by government entities to provide working capital and facilitate cost recovery over a project's life time. For example, while households do not pay directly to the As Samra WWTP, the government pays a bulk volumetric charge for the treated wastewater but recoups the costs through water and sanitation fees levied to the households. Levies and user fees can be used in multiple ways. An entity can charge the end-users directly for using a water and sanitation service or charge user fees to curb polluting activity and promote private investments to achieve zero-discharge targets, like agroprocessing, or new regulations requiring treatment and on-site use of all wastewater from building complexes in some developing countries. Levies and user fees are explored in more detail in relation to cost recovery in section 5.

BOX 8. MEZZANINE FINANCE AGREEMENT FOR WTE PROJECTS IN SOUTH ASIA.

In December of 2013 Sindicatum Sustainable Resources, a developer and operator of clean energy projects, signed a USD 30 million mezzanine facility agreement, supported by investment instruments from a development bank, and development finance institution based in the EU. The agreement has a seven-year maturity and will be used to expand bio WTE and landfill gas-to-energy projects in South Asia (Sindicatum 2013).

4. ADDRESSING RISK THROUGH BLENDING AND STRUCTURING FINANCE

To support RRR in low- and middle-income countries, multiple investment streams can be structured in a manner that attracts greater investment, facilitates cost recovery and spreads risk. Blended finance refers to 'the strategic use of development finance and philanthropic funds to mobilize private capital flows to emerging and frontier markets'. Blended finance typically has three characteristics: leverage, or the use of donor

and development funds to attract private capital into well-packaged deals; impact, or investments that drive progress toward greater human well-being; and returns, or financial returns for private investors that align with market expectations (OECD 2015). PPP arrangements can be considered a subset of blended finance, but governments and businesses can also use other innovative financial structures and arrangements, including project aggregation, results-based financing or revolving funds (Table 6).

4.1 Public-private Partnerships

PPPs can leverage private participation in RRR projects. For example, PPPs use delivery payments for new RRR assets or performance payments for existing RRR assets. PPPs are emerging as the preferred institutional arrangement and financial structure for waste and wastewater management in some developing countries (Box 9). PPPs are structured with the intention of managing multiple types of risk and leveraging multiple benefits, including improvements in service delivery and attracting external investment to close the funding gap for governments in some cases. The PPP model provides flexibility in financial options and implementation processes, and private sector participation provides managerial and technical capacity to the project.

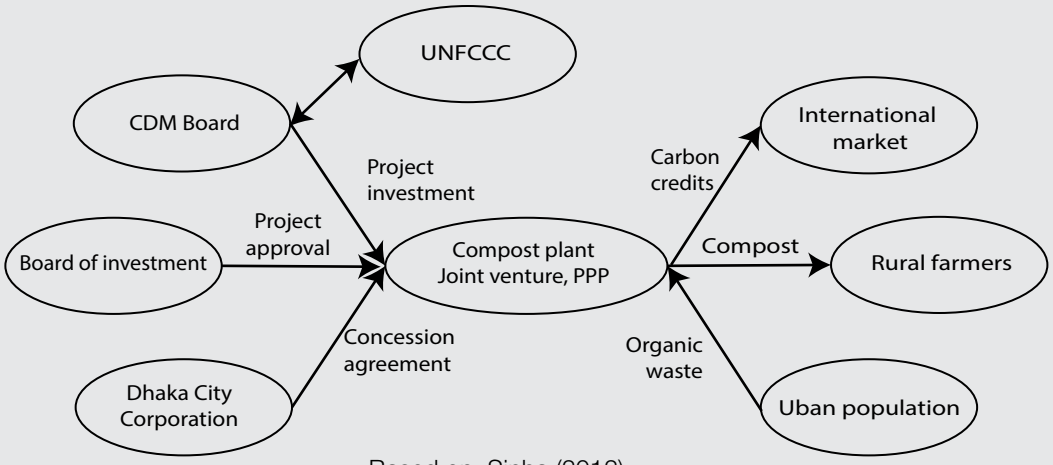
Yet, PPP arrangements in which the cost of using a service is completely borne by the end-users may not be realistic in some contexts. PPPs can assist in arrangements when capital investment is made by the private partner and other financiers, based on a contract with the government to provide the service. In these arrangements, the actual cost of the service is borne by the government and/or end-users, while taking advantage of the technical expertise and liquid capital attracted by the private sector. The government may also contribute by transferring existing assets such as land, subsidizing capital costs with a subsidy that may attract other capital investors or by providing tax breaks or guaranteed revenues for a specified period.

TABLE 6. BLENDING AND STRUCTURING FINANCE ROUNDUP.

Type	Description	Project scale	Risk	Relevant variations
PPPs	Long-term contracts among government entities and private parties, for providing a public asset or service (PPPIRC 2015)	Varies	Renumeration is linked to the agreed outcome such that the private party bears significant risk and management responsibility	Build-operate-transfer Design-build-operate Rehabilitate operate transfer Others
Aggregation	An arrangement in which a group of projects is consolidated under one financing structure	Small to medium	Arrangement intended to spread and reduce risk The act of aggregation reduces risk for financiers and provides more flexibility to governments	
Multilateral investment guarantees	International or regional financial institutions underwrite debt repayments to mitigate risk and provide credit enhancement guarantees	Varies	Meant to reduce various types of risk: institutional, political, credit, financial, non-commercial and *force majeure* (Hebart-Coleman 2017)	Numerous
Results-based financing	A range of public policy tools where rewards, incentives or subsidies directed to entities are based on the verified delivery of predefined results (World Bank 2014)	Varies	Reduces performance and delivery risk and increases government control as parties are contractually obligated to perform before disbursement	Feed-in-tariffs for waste energy Output-based aid Output-based disbursement Payments for ecosystem services (PES) Carbon finance

BOX 9. PPP AND CARBON FINANCE FOR DECENTRALIZED COMPOSTING IN DHAKA, BANGLADESH.

Waste Concern in Bangladesh implemented a decentralized composting system in Dhaka, using a PPP model and carbon financing. The system uses forced aeration composting, producing 1/5 ton of compost and 1/2 ton of greenhouse gas (GHG) reductions per ton of organic waste. The PPP arrangement is complex and is depicted in the figure below. In addition to showing how innovative projects can be financed through multiple streams and stakeholders, this example also shows the importance of government policy coherence. The project is the result of intentional cooperation as well as coordination between five government ministries: the Ministry of Local Government's Division for Development Research & Cooperation, the Ministry of Environment and Forests, the Ministry of Agriculture, the Ministry of Finance and the Ministry of Information (Sinha 2012).



Based on: Sinha (2012).

India has accumulated experience with PPPs for MSW management and sewage management, helping to reveal opportunities and challenges. Engineering aspects, such as the estimation of the quantity of MSW, were sometimes inaccurate resulting in inappropriate designs. Available technologies required some source segregation that was not possible for the context, requiring additional organic material to be added. Some project types, such as refuse-derived fuel or pellets had fragile or non-existent markets due to social taboos, threatening the viability of the PPP. Also, some technologies, such as waste combustion, required massive capital investment and actually had a severe impact on the air quality and surrounding environment (TERI 2015). India has also generated some successes that can inform future investments. For example, the sewerage sector in India is best served with two models of PPPs. The Build, Operate, and Transfer (BOT) model, also known as the End User PPP, in which the government authority/end-user is the ultimate operator and therefore the government owns and takes responsibility for the project upon eventual transfer. The Design, Build, Operate (DBO) model has a local government authority meet capital costs and brings in a private partner for its technology and managerial skills, which then operates the plant for five to ten years. The risk associated with technology, construction and operations is thus transferred to the private sector, while financial risk remains with the government (FICCI and 2030 Water Resource Group 2016). India uses a risk mitigation strategy that includes a three-level payment security mechanism, including ring fencing of sewage revenues by local government utilities, funding support from state governments and a guarantee facility from the government (FICCI and 2030 Water Resource Group 2016).

Water reuse remains a small portfolio of PPP contracts in water and wastewater sector PPPs, yet the reuse PPPs have increased, notably since 2005. Water reuse PPPs are typically awarded in middle- to high-income countries, and in areas with water stress. For example, about 77% of the contracts have been awarded in areas with high water stress and 5% in areas without water stress. The percentage of water reuse contracts awarded rose consistently from 0.4% in 1994-1999 to 5.7% in 2010-2014 (Owen 2016). This trend indicates that the impact of water reuse within water PPPs is set to continue to increase into the future.

Experiences from other settings can strengthen the PPPs by revealing systemic constraints. For example, a study on mobilizing finance for infrastructure in Kenya showed that private investment in the water sector is limited by an inability to charge water tariffs that reflect costs and a lack of developers with the skills needed to ensure projects are bankable (CEPA 2015). Low affordability and capacity-related challenges may make PPP arrangements difficult, meaning that development finance institutions can play a greater role in leveraging private finance by providing grants or technical capacity for project development.

4.2 Aggregation and Pooled Financing

RRR financing and cost recovery challenges may be partially addressed using the concepts of project and financial aggregation. In general, many RRR projects require patient capital in the form of soft loans or public funding in blended finance deals that incentivize private sector entities to participate in the project. Some RRR projects are too small in scale, or too decentralized, to attract funding from large financiers looking for low-risk investments. Project aggregation or pooled funds can provide a solution, as a group of projects that is consolidated to form a more economical and marketable entity for financiers (Box 10). Aggregation can decrease the overall cost of the project pool by reducing risk and reducing transaction expenses (Quesnel et al. 2016) because more projects or functions are on the same aggregation contract. For example, municipalities may aggregate several green projects under one umbrella to issue green bonds. In this case, the aggregation reduces risk for the municipality, via increased ability to mitigate changes to projected cash flows of different projects.

4.3 Credit Guarantees

Governments or international finance institutions can provide credit guarantees to financiers for enterprises, public entities or projects to enhance creditworthiness and lower risks for the financier (ISF-UTS 2014). In a credit guarantee, the third party underwrites the debt repayments, mitigating risk and providing credit enhancement guarantees to help the borrower access better terms for loans. Developing countries have an opportunity in attracting funding from the private sector using credit guarantees (Hebart-Coleman 2017), but the emerging RRR sector has not yet taken full advantage. There are several forms of credit guarantees, including partial credit guarantees, partial risk guarantees, political/non-commercial risk guarantees and policy-based guarantees (Box 11). To do so, guarantees must be tailored to the financial, social and political risks in waste management, and sector players must know which guarantee products may be used. Lastly, governments and companies can work to build a pipeline of bankable guarantee products that are ready if financiers are interested (Hebart-Coleman 2017).

4.4 Results-based Financing

Results-based financing (RBF) mechanisms are designed to lower fiduciary risk and to incentivize governments to improve their capacities, processes and planning for overall results for greater impact (UN CDF). RBF represents a range of public policy tools where rewards, incentives or subsidies are directed to entities based on the verified delivery of predefined results (World Bank 2014). RBF is attractive to funders because it ensures that the resources will be spent if the result is achieved. It creates clearer linkages of public or private expenditures to verifiable outcomes, also offering opportunities to improve cost effectiveness. RBF is also attractive to finance recipients (Box 12) because it broadens the scope for innovation by giving greater choice in deciding how results are to be achieved (Trémolet 2011).

RBF mechanisms range from macroscale contracts between donors and governments or subnational entities to microscale payments among local stakeholders. Output-based aid is an emerging form of aid disbursement that links the payment of aid to specific results like the number of people lifted out of poverty, enhanced food security or gender inclusion (GPOBA 2009). Emerging forms of RBF that help to facilitate cost recovery include feed-in tariffs for energy, output-based aid, output-based disbursement, PES and carbon finance. The most relevant of these are explored in the context of cost recovery in section 5.

4.5 Revolving Funds

A revolving fund is a fund that is continually replenished as withdrawals are made for investments and the organization replenishes the fund by repaying money with interest. The value of the revolving fund increases over time, and funds continue to accrue in perpetuity. Revolving funds have been used as a form of microfinance for community-based initiatives in water and sanitation (Box 13). Government and non-profit organizations use revolving funds to organize cash flows and direct funds to specific projects. The Global Environment Facility (GEF) set up a revolving fund via the Rural Energy Agency in Tanzania to directly support investments in WTE projects. The funds from the revolving fund were intended to provide soft loans for WTE projects in agroindustries at below market rates. To ensure sustainability, the project sought involvement from commercial banks and financial institutions once GEF support was completed (GEF 2012). For other examples at scale, see Box 14. The water sector has a history of using revolving funds for public sector projects, such as the Philippines Water Revolving Fund. RRR has additional potential for revolving funds, as some entities are promoting their use to leverage private sector finance for water reuse projects (Mattingly 2014).

BOX 10. PROJECT AGGREGATION FOR STORMWATER MANAGEMENT IN PHILADELPHIA, PENNSYLVANIA, USA.

Government authorities in Philadelphia, Pennsylvania, have used a stormwater fee program, grant program and project aggregation program together to encourage project aggregation. The program encourages private companies and property owners to pool their properties together for application to stormwater retrofit grants (Philadelphia Water Department 2011).

BOX 11. DONOR CREDIT GUARANTEES TO HELP MDBS CATALYZE ENERGY EFFICIENCY PROJECTS IN BRAZIL.

The Nordic Development Fund Energy Efficiency Guarantee Fund supports projects for energy efficiency and small-scale, self-supply renewable energy projects, including agricultural methane and biomass in Central America and the Caribbean. The fund provides two types of funding: 1) reimbursable funding to provide up to 25% first-loss guarantees to Strategic Climate Fund loans, and 2) non-reimbursable grant funding to reduce the transaction costs of engineering feasibility, environmental impact analyses and legal costs, to make small loans economically viable (Doyle 2014).

BOX 12. RBF FOR SOURCE SEGREGATION OF WASTE IN NINGBO, CHINA.

MSW in Ningbo, China is addressed via two WTE facilities and two sanitary landfills. The municipality faced many issues with source segregation, with 85% of residents not separating their waste at home, and 21% lacking the knowledge to do so. The municipality used an RBF approach to incentivize household waste separation with cash awards distributed to Neighborhood Residents Committees if households in their neighborhood successfully separated the waste. The payment amount was linked to the municipal cost-savings derived from better source segregation (GPOBA and WBG 2014).

BOX 13. REVOLVING FUNDS FOR COMMUNITY-BASED WATER AND SANITATION IN VIETNAM.

The Central Region Urban Environmental Improvement Project aimed to improve water and sanitation in coastal towns in central Vietnam, including infrastructure for wastewater and solid waste, stormwater drainage and flood control. Community Management Committees (CMCs), made up primarily of members of the local women's union, managed a community awareness program that ensured consistency of project guidelines and informed households about opportunities to access credit for household sanitation facilities. The project provided start-up financing for a revolving fund to provide household credit, with members of CMCs determining the loan terms and eligibility criteria. Standard credit terms included a loan of around USD 250 (about 80% of the cost of a proposed septic tank or connection to the sewage system), with 20% in-kind contribution by the household for labor. The loan was repaid over 24 months at an interest rate of 0.5% per month (ADB 2014).

BOX 14. REVOLVING FUND FINANCIAL MECHANISMS AND FIRST GENERATION WASTEWATER PROJECTS IN THE WIDER CARIBBEAN REGION.

The GEF and the Inter-American Development Bank (IADB) have used revolving funds for wastewater projects in several Caribbean countries. The objectives of the Caribbean revolving fund for wastewater (CReW) are to establish innovative financing mechanisms for cost-effective and sustainable financing of wastewater management and to strengthen regional and local capacity for wastewater management through policy, institutional and legislative frameworks. Emerging first generation pilot projects using GEF funding include:

- Jamaica: Credit enhancement facility, USD 3 million from GEF funds, rehabilitation of 13 existing WWTPs;
- Belize: Belize wastewater treatment revolving fund, USD 5 million, wastewater treatment plants in Placencia and Belmopan;
- Guyana: Guyana wastewater revolving fund, USD 3 million, PPP; and
- Trinidad & Tobago (T&T): T&T revolving fund, USD 2 million for rehabilitation of the Scarborough wastewater treatment plant.

Jamaica achieved better results where the National Water Commission used the CReW facility (USD 3 million) as a guarantee fund, and combined with the k-factor – monthly sewerage collection/treatment utility surcharge through project/user fees, to formalize a loan contract of USD 12 million with the national commercial bank in 2012. The k-factor with CReW together enabled the National Water Commission to secure its first commercial loan without a sovereign guarantee, raising USD 12 million with a ratio of 4:1 leverage of financial resources to carry out wastewater projects.

Source: Based on US EPA and UNEP 2018.

5. RESOURCE PATHWAYS FOR OPERATIONAL COST RECOVERY

Beyond financing capital costs, a critical challenge for RRR projects is the ability to cover operational costs and achieve cost recovery over the long term. Most RRR sectors, including wastewater reuse, agroindustrial waste management, fecal sludge and organic MSW, face significant challenges to cost recovery, which translate into project and financial risk (ADB 2011b; Bjornali and Ellingsen 2014). Five approaches for improving cost recovery in RRR have been identified and are shown in Figure 5.

FIGURE 5. PATHWAYS FOR IMPROVING THE COST RECOVERY OF RRR PROJECTS.

5.1 Collect Smart Fees

Ideally, waste recovery and reuse schemes should facilitate cost recovery through the collection of user fees, tariffs, sales revenue or taxes that are directly relevant to the product *and* service delivered. This can be challenging or simply impossible amid low taxes, user affordability, actual fee collection rates and pro-poor contexts, requiring government financial support or other revenue streams to facilitate cost recovery. Still, RRR businesses can strategically maximize their cost recovery potential. For instance, the compost sector may rely on the willingness of (a share of) households to separate their waste for organic waste management, the willingness of (a share of) households and businesses to pay fees for organics' disposal and realistic tipping fees and levies paid from the public sector to the waste management entity (Kaza et al. 2016). The wastewater reuse sector may face several tensions when setting rates for wastewater treatment and rates for selling the treated water for reuse. These tensions include public perception of using treated wastewater, the need to promote resource conservation in some contexts and the need to set the price of wastewater below the price of freshwater despite the higher treatment costs, greater reliability and adjustable nutrient content of reused water (Choudhury et al. 2016).

The possibility of designing smart fees to suit individual contexts and structuring and collecting user fees more efficiently is situation-specific. Agroindustrial waste and energy facilities are often operated by the private sector and may achieve better economies of scale, while charging per customer segment different and higher levies or energy prices. Organic waste management facilities can charge a lower levy for individuals and small businesses than for large-scale industrial waste processing. Market analyses and willingness-/ability-to-pay studies are needed to help determine possible but realistic user fees, tariffs and levies, and they can be structured according to a number of different principles (e.g. Niringiye and Douglason 2010). A tax scheme, such as the water conservation tax (see Box 4), can be used to incentivize the public to conserve resources, to increase demand for recovered resources or to reduce demand for a scarce alternative (ADB 2014). Similarly, general tax revenue can be directed toward wastewater reuse projects or waste management projects if included in a relevant government budget portfolio. Tariffs and levies for RRR services can be sourced from allocating resources from different government agencies based on outcomes relevant to their portfolios based on levels of consumption or the type of entity.

The actual fee collection rates may however be low. This can be due to an overestimated capacity to pay, lack of buy-in from locals, a prevalent informal sector or insufficient staff and lax laws. A study of the financial inefficiencies of a solid waste management system in Bahir Dar, Ethiopia, revealed that fee payment rates were around 50%. Lohri et al. (2014) suggested that the municipality could find ways to increase collection rates to improve the financial sustainability of the system. For example, household waste disposal charges could be linked to volumetric water consumption, and bill collections delegated to local community leaders in return for a fee, assuming that those who consume more water would also produce more waste. This type of solution goes beyond the 'polluter pays' principle to a cross-subsidy principle that forces larger, more affluent households and businesses to pay more (Lohri et al. 2014).

5.2 Focus on Value Chains

RRR relies on an upstream supply of waste and downstream sales of recovered resources. Cost recovery of an RRR business can be improved by influencing supply and demand and by adjusting the operations to effectively take in and produce feedstock and recovered resource commodities. For example, source segregation or strategically choosing feedstock suppliers can increase the efficiency of WTE plants. Adopting good housekeeping, energy efficiency and other broad cost efficiency measures in the production process can also cut long-term costs. Efforts to improve the supply side of value chains primarily focus on the quality of feedstock constituents, the rate levies and fees charged to entities for the resource recovery service and other competing services, and the reliability of supply over time.

RRR projects offer multiple forms of value along the value chain, such as wastewater, energy, nutrients and carbon credits as well as water swaps and futures. A supportive policy environment can place recovered resources on an even playing field with alternatives, such as compost with chemical fertilizers, or can cater the market towards resource recovery in pursuit of broader environmental or social objectives. For example, providing treated wastewater to farmers in exchange for the released freshwater for urban water supply aligns with resource recovery and water scarcity goals (Drechsel and Hanjra 2018; Winpenny et al. 2010). Pricing the recovered commodity requires consideration of available options that determine how RRR projects or businesses achieve their objectives. For example, reused wastewater can be directed toward agricultural irrigation, landscaping or industry and pricing can range for each of these entities in the value chain. Then, innovations within a value chain segment can further improve cost recovery. For example, wastewater reuse schemes can choose to charge a flat monthly charge for the purchase of recovered wastewater or a variable charge based on the volume of wastewater purchased. Variable charges may be structured uniformly or in a block format to achieve different goals. A declining block structure charges less per unit volume, promoting economies of scale and encouraging consumption and upscaling, while an inclining block charge charges more per unit volume once a predetermined consumption threshold is exceeded, promoting water conservation (Mayer et al. 2008). However, wastewater reuse is almost always priced at a rate lower

than freshwater to incentivize reuse. Governments may even choose to provide recovered wastewater for free, if it is warranted, based on the social or environmental benefits. Energy recovery presents a simpler market pricing scheme, as the recovered energy can facilitate cost recovery by supplying energy directly to plant operations (cost savings) or through feed-in-tariffs (revenue earnings) (Huenteler 2014). Agroindustrial waste management and organic MSW face a more competitive commodity market. Revenue can be increased by promoting the recovered products, building a reliable client base and catering the treatment process to market demand. For example, nutrient enrichment amendments may be added to compost that improve its value to the farmers. Securing one or more large, committed end-users of the recovered resource can also improve the reliability of revenue streams. Insufficient commitment to studying and influencing market demand has been one of the major causes of previous compost plant failures (Kaza et al. 2016). Expanding the business model to incorporate sales of secondary by-products also offers potential to earn headline revenue.

5.3 Diversify Revenue Streams

Diversifying revenue streams can reduce revenue risk and improve cost recovery. RRR is well-positioned for using energy recovery to save operational costs or gain revenue from feed-in-tariff schemes. Energy recovery and carbon offsets present opportunities for GHG emission reductions, bringing in revenue from carbon markets. RRR lies at the intersection of water, agriculture, urban waste and environmental protection, offering opportunities to use innovative instruments like PES services.

Energy Recovery

The contribution of energy recovery to overall cost recovery of the plant depends on the technology, internal energy requirements and the type of waste processed. Energy cost savings can incentivize businesses to explore energy recovery (Box 15), while governments can also mandate energy recovery as part of a tender process for new projects. In 2016, the Government of India issued the River Ganga Rejuvenation, Protection, and Management Authorities Order. Two municipalities chose to develop two sewage treatment plants with a hybrid annuity PPP model. In the bidding process both biogas-based power and recycling and reuse of treated effluent were offered as options for developers. Though including RRR was optional, several bidders developed bids including one or both of these RRR measures (Gupta 2017).

Feed-in-tariffs (FIT) are gaining popularity for promoting renewable electricity generation. Power producers are able to sell electricity generated to the national power grid or an off-taker at a tariff that is predetermined for a specified time period. FIT systems provide investment security and stabilize the energy market for investors, thus mobilizing private resources. They are also meant to reduce the transaction costs associated with traditional electricity feedstock procurement systems that centralized grid systems depend on. In the context of RRR, FIT systems are useful for electricity generated from WTE systems such as fecal sludge feedstock, wastewater treatment plants or agroindustrial waste facilities. The revenues from FITs can serve as the primary or secondary source of revenue for an RRR system or input into another recovered resource commodity/service supplied to the market. The pricing of a FIT is usually based on the cost of the underlying technology and a variable cost of energy to incentivize renewable energy investments, while some remain independent of the electricity price (Couture and Gagnon 2010). For example, Tehran metro WWTP sells electricity generated (FIT) at four times the average power price.

Carbon Markets

Carbon markets are created when entities can trade their carbon emissions' allowances, in an effort for companies or nations to limit their GHG emissions. While cap-and-trade schemes in some countries are mandatory (the EU, Australia, New Zealand), many countries participate in voluntary carbon markets. The CDM is a global system of emissions' trading that was originally designed to help developing countries access new green technologies and has raised billions of dollars (Chapple 2008). However, the volatility of the price of carbon over time and its recent drop has shifted some attention away from the CDM (Petersen and Bollerup 2012). As a response to such challenges and to further stimulate development that reduces GHG emissions, the World Bank has recently launched the Pilot Auction Facility for Methane and Climate Change Mitigation (World Bank 2015). The PAF is a "results-based payment mechanism that sets a floor price for future carbon credits in the form of a tradeable put option, which is competitively allocated via auctions" (pilotauctionfacility.org).

RRR can take advantage of carbon markets (Box 16). Composting is considered carbon neutral and sometimes carbon negative, because it diverts organic waste that would otherwise produce methane during anaerobic digestion in landfills. Diverting organic waste to composting can thus generate carbon offsets for carbon markets. Many composting plants fail because of constraints in financing and operations, and carbon finance could help to close these gaps (Yenneti and Gamaralalage 2012). For example, Waste Concern in Bangladesh and the Temesi integrated resource recovery center in Bali each earned USD 1.5 million in carbon credits. The center in Bali had to pay USD 70,000 (about 5%) in upfront costs for registering and quantifying carbon credits with the CDM (Mitchell and Kusumowati 2013).

Sewage treatment plants, WTE plants, and some agroindustrial facilities also qualify for carbon credits by diverting waste or reducing consumption of non-renewable energy (see Box 9). For example, the Sapthip Wastewater

BOX 15. WTE BIOMASS PROJECT IN LIAN, THE PHILIPPINES.

In May 2015 GE Distributed Power and Aboitiz Power agreed to implement a waste-to-electricity project in Batangas province of the Philippines. The biomass facility uses organic waste from sugarcane and molasses from an alcohol distillery. In addition to energy, the plant produces by-products of CO_2 for sale to beverage companies and fertilizer for sale to farmers. The goal of the facility is to achieve zero-waste production, while generating power for 22,000 homes. At the time of the project launch, the feed-in-tariff allocation for biomass in the Philippines was just 250 MW, generating potential for biomass energy to increase its prevalence as a waste management tool (GE 2015).

BOX 16. CARBON SAVINGS FOR A SEWAGE TREATMENT PLANT IN FIJI.

The Kinoya Sewerage Treatment Plant was the first in Fiji to be registered with the CDM. The Asia Pacific Climate Finance Fund co-financed carbon savings with up-front payments against the purchase of carbon emissions' reductions. The Asian Development Bank also supported development of the project (ADB 2011a).

Management Project in Thailand received credits from the Danish Carbon Fund because of the reduced GHG emissions from fossil fuel use at its bioethanol plant, and from the methane produced from wastewater through recovery of methane at the plant. The recovered methane and solid fuel from the plant fed into operation as fuel (World Bank 2013). A study in Ghana also concluded that additional revenue from carbon markets can move projects from completely infeasible to feasible (Galgani 2012). However, registering a project in carbon offset schemes has high transaction costs that are not always feasible for small projects and businesses. Small RRR projects and municipalities can go for aggregation to enhance the carbon pool and minimize such costs, yet the cost of verification to monitor compliance requires the development of local mechanisms and regional capacity. The benefits of carbon markets have not been felt evenly across low- and middle-income countries, with Sub-Saharan Africa receiving a disproportionately minimal amount of carbon credits (Bryan et al. 2010). Steps must be taken to ensure that carbon markets, particularly voluntary carbon markets, work for the poor and consider the broader development context (Chapple 2008).

Payments for Ecosystem Services

PES are a direct conservation tool that aims to bridge the interests of landowners and outside beneficiaries through incentive payments to whoever preserves or sustainably manages land, water and other natural resources (Maraseni and Hanjra 2014). There are three major methods for incentive payments to entities associated with a PES scheme: The final users, such as households or businesses, can directly pay the ES providers. A business can pay the ES providers and then pass the costs on to clients. The government can also pay ES providers and pass on costs to the public or taxpayers (WWF 2007). The World Wide Fund for Nature (WWF) distinguishes five business models in this context. Most current PES schemes are state run in both developed and developing countries. Potential exists in the private sector and PES participants are likely to gain, particularly poor, remote rural dwellers. However, many field practitioners and prospective service buyers and sellers remain skeptical, e.g. in view of compliance and impact monitoring (Wunder 2005). RRR-related ES that stand out as having potential for PES include carbon sequestration, biodiversity conservation, watershed protection (and less water treatment cost), and landscape aesthetics. For example, coal-fired electricity producers could pay farmers to use compost or wastewater for afforestation that turns agricultural soil and trees into a carbon sink. Conservation donors could pay utility providers for avoided waste disposal via RRR. Downstream water users could pay for avoided excess erosion and reservoir siltation through improved land management by upstream farmers or reduced chemical fertilizer application. Tourism operators could pay a local community for adopting RRR principles in solid waste disposal for the avoided pollution and improved aesthetics gained.

5.4 Incorporate Government Support

The public benefits of RRR justify government support to improve the project value proposition or reduce risks. VGF is an example of a one-off or multiple support payment scheme that can close the cost recovery gap for PPPs. Governments can also support RRR through tax mechanisms, such as tax holidays or abatements. To deal with the nation's significant waste problem and to incentivize private sector participation, Bangladesh has issued five- to ten-year tax holidays on all waste plants, reduced import taxes and imposed no value-added or sales tax on recovered waste products

(Sinha 2012). Other mechanisms, such as shorter depreciation schedules for WTE investments in the USA during the late 1980s (US EPA 1990), can improve the cost recovery for such projects. Ghana has placed waste-based composts under its fertilizer subsidy program and India has encouraged the sale of waste compost together with industrial fertilizer (Di Mario et al. 2018). Similar support, including tax abatements, or reduced property taxes, have also been used elsewhere to assist with cost recovery.

Direct subsidy or tax support is not the only type of support governments can provide that reduces operational costs. Land provisions, in which governments provide land for a private sector project, can reduce administrative costs and lease or debt payments for land acquisition. Similarly, governments can share or lease equipment to private sector participants to further improve cost recovery. For example, in India where the government provided land for a very low price and let the participants use government trucks to collect waste.

Incorporating support for RRR projects has a dual value proposition from the government perspective: to support and implement a bankable project or business model, and to provide benefits to the public. Taking a broader policy perspective to cost recovery of some RRR projects in the private sector can help justify government support of projects with poor cost recovery profiles. For example, compost projects as a single entity may be financially unfeasible, but if the avoided costs or benefits to the broader society are considered, government support for the compost project becomes justified. The reduced budgetary costs of solid waste management associated with reducing the volume of waste entering the landfill or environment, the reduced transportation costs and the extended life of the landfill or avoided public health costs, can be directed toward subsidizing the compost sector. This can be further justified if the avoided future upgrades for meeting new regulations or an increase in waste generation are considered. Government also has a role in reducing the market uncertainty of input supply or market demand. Take-or-pay contracts and advance market commitments can provide the certainty required for the private sector to be involved in RRR projects.

Take or Pay

Take or pay is a provision, written into legal contracts between a local government authority and a private firm building a biological treatment facility, compost facility or incinerator. The local authority commits to providing an agreed-upon quantity of waste and has an obligation to either purchase a percentage of the RRR product at a certain price or to pay a certain amount of money per ton. These arrangements, also known as 'put or pay', reduce risk for the RRR firm in that the authority pre-commits to purchasing the services offered by the firm at a price that covers its average cost (Gorecki et al. 2010). This is an acceptable transfer of risk, as local government authorities are generally responsible for providing and managing these public services. In contrast, waste flow obligation contracts are also used to ensure a high rate of refuse flowing into a facility, such as a mixed waste processing facility. This type of contract binds local authorities to send all its waste and recyclables to a specific facility, which may actually be detrimental from a broader sustainable development perspective, as this is a disincentive for waste reduction or cost savings (DPPEA 1996). Take-or-pay contracts are a common contract tool used to incentivize private sector involvement in MSW management projects that may be unbankable or too risky in the short term without such guarantee.

Advance Market Commitments

Advance market commitments (AMCs) are binding contracts offered by a government or financial entity to guarantee a viable market for a product once it has been successfully developed. Generally, an AMC is appropriate when the cost of new product development is too high for it to be worthwhile for the private sector to invest in. AMCs provide an amount of funds to subsidize the purchase at a given price and are an innovative funding mechanism to incentivize private investors to produce suitable and new RRR products. The most common application of AMCs is in the medical field to incentivize the creation of vaccines and medications for diseases affecting developing countries (Berndt et al. 2006). AMCs could be applied to the development of useful products from wastewater, fecal sludge, refined compost streams or agroindustrial waste recovery and reuse facility by-products. For instance, municipal wastewater biosolids can be mined for high-value metals, such as gold, silver and titanium as well as other products including antibodies and lifestyle products, bioplastics and alginic acid (Mayer et al. 2016), if the appropriate enabling environment and financial factors are in place to reduce market uncertainty, deal with risk and overcome technological hurdles.

5.5 Improve Cost-effectiveness

An often overlooked process for improving the cost recovery of RRR projects is to examine the daily operations of the plant to find avenues to optimize value and reduce costs. For example, the solid waste management system at Bahir Dar, Ethiopia struggled with high transportation costs associated with poor road infrastructure, inefficient trucking routes and unreliable truck drivers that caused delays and unnecessary wear and tear on the vehicles (Lohri et al. 2014). There are several techniques for maximizing the value of the time and resources available to operate a facility. Cost effectiveness must also be proactively considered throughout the planning and capital construction stage. Siting the facility in a location that allows for efficient conveyance and choosing appropriate technology for the capacity and resources available for operations reap significant rewards over the long term. The

process of analyzing cost effectiveness must also take into account trade-offs. For example, placing satellite fecal sludge compost facilities closer to reuse locations can lower transport costs significantly. Similarly, wastewater treatment and reuse schemes may need to choose between the higher treatment costs of a fully advanced treatment system for direct potable use feeding into an existing conveyance scheme, and the lower treatment costs for agricultural/non-potable use with the additional costs of a dual conveyance system.

6. CONCLUSIONS

Resource recovery and reuse in developing countries occurs at the nexus of agriculture, waste management, water management and industry, and at the nexus of the public and private sector. Amid high cost and current funding gaps, financing remains a great challenge despite the numerous public and social benefits of RRR projects. A systematic understanding of the enabling environment, financing and funding sources, risk-sharing mechanisms and pathways for cost recovery can help to identify opportunities to improve the viability of RRR solutions. Governments and other players must take an integrated perspective to develop and implement regulations and policies that carefully balance opportunities and risks. Market forces and economic incentives can leverage feedstock supply and markets for recovered resources. Investing in the financing and resource recovery-related capacity of government and private sector players may help to improve implementation processes. Additionally, public awareness campaigns can allow RRR solutions to extract more value along the RRR value chains.

Governments and RRR start-ups with little experience might need technical assistance in accessing innovative funding streams or blending finance. In these contexts, working alongside local and international finance institutions can set up appropriate financial structures. This may open doors to funding sources beyond traditional concessional finance, to asset finance, green finance and social impact investing. These funding sources must work with blended finance that takes advantage of credit guarantees, gap funding, results-based financing and revolving funds that improve financial viability and reduce or share risks amongst parties. Governments subsidizing projects with poor cost recovery should also actively seek opportunities that leverage private capital and allow them to ‘do more with less’. As institutional financing capacity in developing markets evolves, these opportunities will become increasingly available. Many RRR projects have lower than potential cost recovery. This requires systematic analysis of different perspectives that consider smart fee collection, government support mechanisms, cost effectiveness of RRR operations, diversifying revenue streams and value chains. An integrated perspective and the right financial tools can enhance the economic and social sustainability of RRR projects for greater success.

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APPENDIX I

TABLE A1. SUMMARY OF STAKEHOLDERS INVOLVED IN FINANCING RRR.

Stakeholder	Mandate/ interests	Financial involvement in RRR	Developing country context
Development banks (DBs) *E.g. World Bank, Asian Development Bank, African Development Bank, Japan International Cooperation Agency*	To provide financial assistance, technical assistance, and policy advice to aid economic advancement in developing countries To leverage capital from donor countries and to maintain strong fiduciary responsibility	*Medium* - DBs are involved with providing loans, issuing bonds, structuring blended finance, for public sector projects and on behalf of private sector companies that support or implement RRR solutions	*High* - DBs focus on leveraging capital from developed country members in the developing country context
Institutional investors (II)	To act conservatively by seeking large, low-risk, liquid, long-term investments that deliver steady, inflation-adjusted streams Governed by the principle of fiduciary responsibility	*Low* – IIs are bound by legislation and risk-averse practices that drive them away from RRR projects that can be capital intensive with long payback periods or use yet unproven technologies *Potential for improvement* - Potential exists for IIs to support RRR if enabling environment and risk mitigation improves, particularly if social impact or green investments exist	*Low* – IIs traditionally focus on proven markets with low risk and strong institutions *Potential for improvement* – Appetite for portfolio of projects with climate resilience and green impacts is increasing, including when bundled with lower risk options.[1]
Non-governmental organizations (NGOs) **and philanthropic donors** *e.g. Bill and Melinda Gates Foundation, Rockefeller*	To contribute to achieving a certain social objective, often related to poverty alleviation, equity, advocacy for a cause, etc. To run projects, provide grants, advocate policy makers, etc.	*High* – NGOs and philanthropic donors are frequently involved in setting up and executing projects related to water and sanitation hygiene service delivery, wastewater treatment and reuse, etc., though much less experience driving private sector projects	High – NGOs have been increasingly concentrated on poverty alleviation in developing and emerging economies, often focused on marginalized, low-income communities
Commercial banks	To balance risk and profit by using customer deposits to give loans with interest rates above the rates they pay to depositors	*Low – medium* – Commercial banks are not driven by development objectives (like MDBs) but still have the potential to provide lending services to businesses in various RRR sectors when enabling environment exists. When adequate risk mitigation measures are put in place, commercial banks are willing to support RRR.	*Medium-high* –Commercial banks in developing countries are established, though the range of services and processes varies considerably *Potential for improvement* – Opportunities emerging for commercial banks to play a stronger role in development

(Continued)

[1] South African Government Employees Pension Fund allocates 5% of its portfolio to invest in development projects (IFC 2013)

TABLE A1. SUMMARY OF STAKEHOLDERS INVOLVED IN FINANCING RRR. (CONTINUED)

Stakeholder	Mandate/ interests	Financial involvement in RRR	Developing country context
Credit unions, savings institutions, and financial cooperatives	To provide services to members, and to use income generated to fund projects and services that benefit the community and interests of its members	*Medium* – Financial cooperatives have been used to finance local-level public sector RRR initiatives Less evidence exists of experience financing large-scale projects or private sector initiatives	*Medium-High* – Most financial cooperatives for public sector initiatives have been done in developing countries, though less evidence of experience with form credit unions and savings institutions Opportunities for more mature financing mechanisms exists
Governments *National government, regional government, municipality*	To direct the development of a nation, region, or locale in a manner that benefits its citizens To determine priorities and manage the budget	*High* – Governments issue bonds, provide grants, and use taxes, subsidies, or levies to support RRR solutions In the private sector, other financial mechanisms are being adopted to support SMEs, increase market demand for recovered resources, etc.	*High* – Governments in developing countries set priorities, allocate budgets, and working with DBs, IFIs, and the private sector to enable effective solutions
Private sector	To effectively offer a product or service to a market, in order to gain profit	*High* – Private sector involvement in RRR exists, particularly in agro-industry and organic waste management, but there is significant room for growth with an enabling environment and new business models Many manufacturing companies implement inside-the-fence RRR due to strong business case	*Medium* - Private sector in developing countries is growing, with new financing structures like PPPs opening new opportunities to private sector to close gaps in service sector
Business investors (early stage)	To support start-up businesses with a small investment that poses little risk To capitalize returns by selling startup shares and reinvesting in other startup ventures	*Low* – RRR SMEs face challenges with initial businesses cases - legislation may create barriers to growth, unproven technologies, etc.	*Low – Medium* – Early-stage business investors have a role to play in the developing context to fill the gap between venture capital firms and traditional finance institutions, but as they are informal it is difficult to trace the proportion of their role in supporting SMEs
Venture capital funds	To direct investment to a very specific profile – risky, early-stage ventures with a long investment horizon and high growth potential To bring knowledge and expertise to the companies in which they invest	*Low* – Private sector involvement in RRR is emerging, but growth potential is not viewed as high enough to attract venture capital funds	*Low – Medium* – Potential exists for venture capital funds to create and expand growth of SMEs in developing countries, most target larger, more established firms (with lower risk). See Divakaran et al. (2014).

(Continued)

TABLE A1. SUMMARY OF STAKEHOLDERS INVOLVED IN FINANCING RRR. (CONTINUED)

Stakeholder	Mandate/ interests	Financial involvement in RRR	Developing country context
Individuals	To support new businesses or initiatives that contribute to a goal they support	*Medium* – Individual contributions through wealth donor funds exist, and individual contributions may be indirect (donations through NGOs) Potential exists for SMEs to tap into networks for individuals through crowdfunding and other finance mechanisms (see also section 3.4).	*Medium – High* - Individuals in developed countries often contribute to development in developing countries by donating to NGOs and funding projects directly SMEs in developing countries often rely on family and friend networks for initial financing to start a new business

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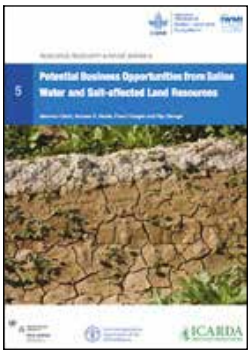

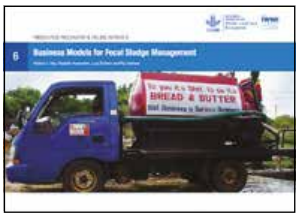

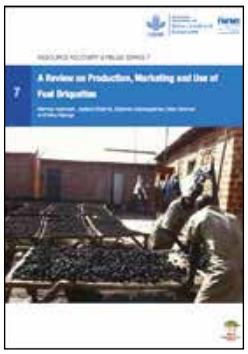

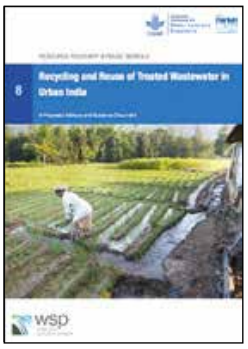

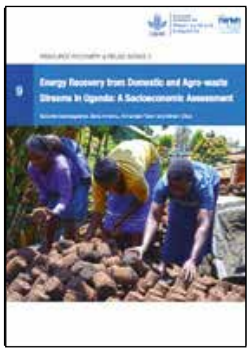

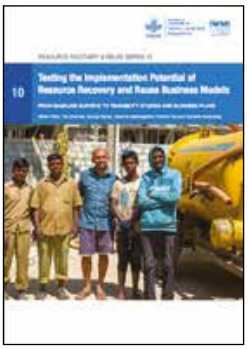

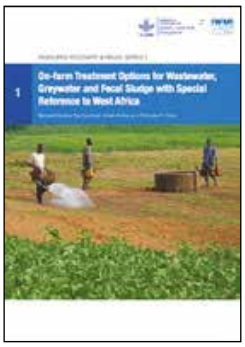

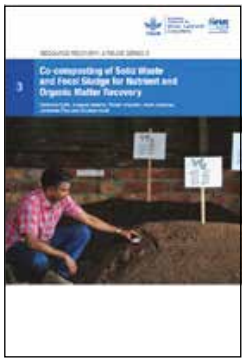

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The **CGIAR Research Program on Water, Land and Ecosystems (WLE)** is a global research-for-development program connecting partners to deliver sustainable agriculture solutions that enhance our natural resources – and the lives of people that rely on them. WLE brings together 11 CGIAR centers, the Food and Agriculture Organization of the United Nations (FAO), the RUAF Foundation, and national, regional and international partners to deliver solutions that change agriculture from a driver of environmental degradation to part of the solution. WLE is led by the International Water Management Institute (IWMI) and partners as part of CGIAR, a global research partnership for a food-secure future.

Resource Recovery and Reuse (RRR) is a subprogram of WLE dedicated to applied research on the safe recovery of water, nutrients and energy from domestic and agro-industrial waste streams. This subprogram aims to create impact through different lines of action research, including (i) developing and testing scalable RRR business models, (ii) assessing and mitigating risks from RRR for public health and the environment, (iii) supporting public and private entities with innovative approaches for the safe reuse of wastewater and organic waste, and (iv) improving rural-urban linkages and resource allocations while minimizing the negative urban footprint on the peri-urban environment. This subprogram works closely with the World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), United Nations University (UNU), and many national and international partners across the globe. The RRR series of documents present summaries and reviews of the subprogram's research and resulting application guidelines, targeting development experts and others in the research for development continuum.

CGIAR Research Program on Water, Land and Ecosystems (WLE)
International Water Management Institute (IWMI)
127 Sunil Mawatha, Pelawatta
Battaramulla, Sri Lanka
Email: wle@cgiar.org
Website: wle.cgiar.org
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