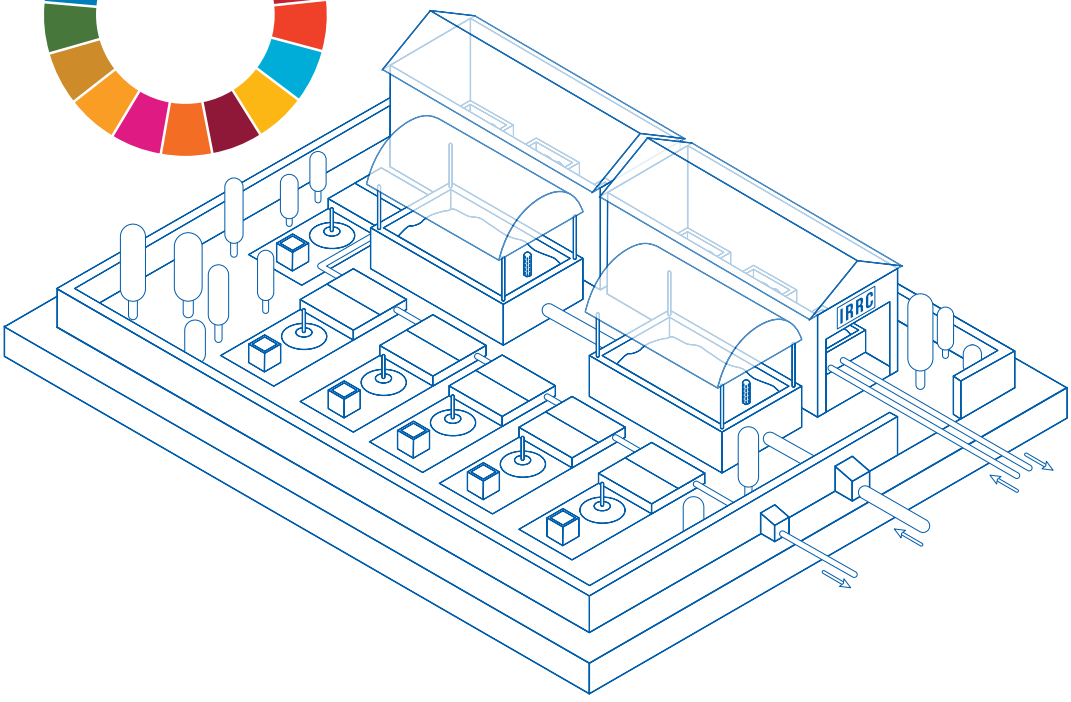
Sustainable Development Benefits of Integrated Waste Management

Integrated Resource Recovery Centers



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Acknowledgements

ESCAP, with technical support from Waste Concern, has assisted local governments in member States to establish and operate Integrated Resource Recovery Centers (IRRCs). ESCAP established IRRCs in 2007, one in Quy Nhon City in Viet Nam and another in Matale City in Sri Lanka. From 2009, ESCAP enhanced the regional implementation of IRRCs under its project on "Pro-poor and Sustainable Solid Waste Management in Secondary Cities and Small Towns in Asia-Pacific" which was funded by Bill and Melinda Gates Foundation. Through this project, ESCAP has provided financial support and technical capacity building assistance for the IRRC implementation in seven cities, and advised the local governments on policies and regulations to support sustainable municipal solid waste management.

This publication shares the key lessons from a decade of IRRC implementation to improve municipal solid waste management, and explains how the contributions of IRRCs can support the implementation of important global and regional agendas for sustainable development: the 2030 Agenda for Sustainable Development; the New Urban Agenda; the Paris Agreement under the United Nations Framework Convention on Climate Change; the Regional Road Map for the 2030 Agenda in the Asia-Pacific region; and the Ministerial Declaration on Environment and Development in the Asia-Pacific region. The publication also provides policy recommendations for promoting sustainable municipal solid waste management in secondary cities and small towns in the Asia-Pacific region.

This publication was prepared under the overall guidance of Stefanos Fotiou, Director, Environment and Development Division (EDD) and Curt Garrigan, Chief, Sustainable Urban Development Section (SUDS), EDD. The publication team was directed by Ram Tiwaree, Economic Affairs Officer, SUDS, EDD. The team includes Rahul Teku Vaswani, Batu Krishna Uprety, Jong II Chyun, Sam Johnson, and Alejandra Quevedo. ESCAP acknowledges the technical inputs of Waste Concern, and that of its project implementation partners in its member States. Last but not least, ESCAP expresses its profound gratitude to Bill and Melinda Gates Foundation for the generous funding to the project. Without the Foundation's support, preparation of this publication would have been not possible.

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Acronyms and Abbreviations

3R	reduce, reuse, and recycle
CO_2eq	carbon dioxide equivalent
ESCAP	Economic and Social Commission for Asia and the Pacific
GHG	greenhouse gas
IMHEN	Institute of Meteorology, Hydrology and the Environment
IRRC	Integrated Resource Recovery Center
MCED	Ministerial Conference on Environment and Development
MRV	monitoring, reporting and verification
MSW	municipal solid waste
MSWM	municipal solid waste management
NAMA	nationally appropriate mitigation action
NDC	nationally determined contribution
NUA	New Urban Agenda
OECC	Overseas Environmental Cooperation Center
SDG	Sustainable Development Goal
SUWM	sustainable urban waste management
SWM	solid waste management
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar

Executive Summary

As the region experiences rapid urbanization, cities in Asia and the Pacific are generating increasing quantities of waste. Local governments, especially those of secondary cities and towns have limited resources and capacities to properly deal with their waste challenges. Cities in the region need appropriate sustainable waste management solutions that are low-cost and locally appropriate, provide sustainable development benefits, and ultimately create transformational change towards low carbon, resource efficient, resilient, and sustainable societies.

A large fraction of the solid waste generated by the cities, primarily the cities in low-income and middle-income countries in the region is organic. Therein lies the potential for recovering useful economic and ecological value from the low-cost treatment of organic waste. Since 2009 ESCAP in partnership with Waste Concern, a Bangladesh-based Social Business Enterprise, have launched a project on "Pro-poor and Sustainable Solid Waste Management in Secondary Cities and Small Towns in Asia-Pacific" and have piloted decentralized Integrated Resource Recovery Centers (IRRCs) that are locally appropriate and pro-poor facilities to recover economic and ecological value from waste resources. An IRRC uses simple, low-cost, and non-mechanized processes to produce a range of recovered waste products from segregated municipal solid waste and faecal sludge: compost, biogas, plastics, biofuels, and refuse-derived fuel (RDF).

The implementation of an IRRC is built on an inclusive process that engages and facilitates the building of partnerships among various local and national stakeholders, and leverages their capacities and resources. Effective IRRC implementation helps to improve national-local coordination on urban development and waste management policies and programmes, as well as to enhance public awareness and adoption of 3R (reduce, reuse, recycle/recover) practices. The active participation of waste producers in segregating and reducing waste, as well as of waste collectors is important to the success of the IRRC.

An IRRC provides a range of sustainable development benefits that contribute to the achievement of global and regional agendas for sustainable development and climate change mitigation: the 2030 Agenda for Sustainable Development and the Regional Road Map for Implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific; the New Urban Agenda; and the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC).

To enhance the sustainable development benefits of IRRCs, national, sub-national and local government actors need to implement coordinated policies, programmes and regulations for improving waste segregation and collection; regulate payments for improved waste services and fiscal incentives for establishing IRRCs through public-private partnerships; integrate the IRRC approach for participative and decentralized sustainable urban waste management in sustainable urban development programmes and policies; and actively decentralize fiscal and administrative authority to local governments, so as to build local capacities and sustainable waste management.

I. Waste management challenges in secondary cities and small towns in Asia-Pacific

The Asia-Pacific region is experiencing rapid urbanization. The rate of urbanization in many developing countries outpaces national population growth,[1] and it is expected that more than 50% of the population of the region will be living in urban areas in 2018.[2] The urban population is growing fastest in secondary cities and small towns.[3]

An adverse impact of rapid urbanization is an increase in the generation of urban solid waste. According to the Global Waste Management Outlook 2015, a collective effort of the United Nations Environment Programme and the International Solid Waste Association (ISWA), globally 2 billion tons of municipal solid waste (MSW) is generated annually,[4] and a broad grouping of urban wastes that includes MSW, commercial and industrial waste, and construction and demolition waste is estimated around 10 billion tons annually. As waste generation increases, it results in greater demand for both waste collection and locally appropriate waste management solutions. The goal of municipal solid waste management (MSWM) which deals principally with household waste, but includes commercial waste generated in municipal areas is to treat the waste in an environmentally and socially acceptable manner, using appropriate and available clean technologies. Inefficient urban waste management can multiply environmental and public health hazards, and economic losses.

The causes and impacts of inefficient urban waste management in secondary cities and small towns are interrelated (Figure 1). Usually local governments in these cities lack the resources and capacities for effective MSWM. As a result, these cities implement short-term end-of-pipe solutions that involve partial collection (ranging 50%-60% of collection of the total urban waste), transportation, and disposal into unsanitary dumpsites or landfills. This approach only spatially displaces the waste, often outside the cities into rural areas, concentrates soil and water pollutions, aggravates greenhouse gas (GHG) emissions, and increases the difficulty of final treatment of the waste. This linear path of disposal is resource intensive and inefficient. Cities in South Asia spend between USD 10 to 30 to collect, transport, and dump each ton of waste,[5] accounting for 20%-50% of municipal expenditures. There is also a lack

1 The average annual rate of urbanization in the regions is 1.5% annually, whereas the average annual population growth is 1.182%. See: https://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf(8); https://data.worldbank.org/indicator/SP.POP.GROW

2 See "The State of the Asian and Pacific Cities 2015 report" http://www.unescap.org/sites/default/files/The%20State%20of%20Asian%20and%20Pacific%20Cities%202015.pdf

3 See the UN Habitat World Cities 2016 report, http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf (8-9)

4 Global Waste Management Outlook (2015), United Nations Environment Programme (UNEP) and International Solid Waste Association (ISWA)

5 Zhu D., and Asnani P. U. (2008). "Improving Municipal Solid Waste Management in India: A Sourcebook for Policy Makers and Practitioners", The World Bank, Washington, D.C.

of awareness about efficient waste recovery processes and minimization practices. This is often accompanied by inadequate or ineffective policies for MSWM: waste producers are not tasked with the responsibility for waste separation, while taxes for urban services such as waste collection and disposal are low, and local governments are constantly in need of capacity building and financial resources to improve MSWM.

Figure 1. The causes and impacts of inefficient urban waste management in secondary cities and small towns in Asia and the Pacific.[6]

These challenges are compounded by the lack of available land in most cities for solid waste disposal, and the increasing costs of MSWM due to unplanned urban development and disaster risk management. Local governments are therefore increasingly looking for more environmentally, socially, and economically sustainable MSWM methods. One resource efficient way to improve MSWM is to enhance resource recovery from municipal organic wastes using 3R (reduce, reuse, recycle/recover) approaches. Recovering economic value by recycling inorganic materials from MSW is a well-developed activity of the informal recycling sector in developing countries. Recovering value from the treatment of organic wastes,

6 ESCAP observation from the project: Pro-poor and sustainable solid waste management in secondary cities and town in Asia-Pacific

however, remains a largely untapped activity with significant economic potential, and socially and environmentally beneficial outcomes. In most secondary cities and small towns MSW generally has a large organic component, ranging from 50% to 80%. In South Asia (India, Bangladesh, Sri Lanka and Nepal), 33.46 million tons, close to 67%, of the total annually generated municipal waste of 50.4 million tons is organic.[7]

When assessing locally appropriate solutions for the recovery of organic waste in MSW, it is important to understand the difference found in quantity and quality of waste produced between low-income countries, middle-income countries and industrialized countries (Table 1). The waste streams in developing countries are typically higher in density, moisture content, and organic composition, and lower in calorific value, than that of high-income or industrialized countries. Because the bulk portion of the waste in developing countries is organic and has high moisture content, waste incineration is not cost effective. However, there is significant economic potential in recovering the organic portion of the waste through low cost biological processes, such as aerobic composting.

Table 1: Composition and characteristics of waste in countries according to their level of income (global).

	Low-Income countries	Middle Income Countries	Industrialized Countries
Waste generation (kg/cap/day)	0.4 to 0.6	0.5 to 0.9	0.7 to 1.8
Waste densities (wet wt basis–kg/m^3)	250 to 500	170 to 330	100 to 170
Moisture content (% wet weight at point of generation)	40 to 80	40 to 60	20 to 30
Composition (% by wet weight)			
Paper	1 to 10	15 to 40	15 to 40
Glass, ceramics	1 to 10	1 to 10	4 to 10
Metals	1 to 5	1 to 5	3 to 13
Plastics	1 to 5	2 to 6	2 to 10
Leather, rubber	1 to 5	-	-
Wood, bones, straw	1 to 5	-	-
Textiles	1 to 5	2 to 10	2 to 10
Vegetables/food	40 to 85	20 to 65	20 to 50
Miscellaneous	1 to 40	1 to 30	1 to 20

Source: Cointreau, Sandra. *Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide*. World Bank Urban Development Technical Paper No. 5. Washington: World Bank, 1982.

Note: Low-income countries include countries having a per capita income of less than US$ 360 in 1978; Middle-income countries include countries having a per capita income of more than US$ 360 and less than US$ 3,500 in 1978.

7 ADB (2011), Towards sustainable municipal organic waste management in South Asia – A guide for Policy makers and Practitioners. Manila, Philippines.

Centralized approaches to waste management that focus primarily on the collection and sanitary or unsanitary disposal of waste are not necessarily focused on building the capacities and environmental awareness of waste producers. Without adequately informing and involving waste producers in implementing solutions for waste management, it is not possible to change wasteful behaviors and minimize waste production. Moreover, urban poor communities have inordinately high risks from improper waste management.

Secondary cities and small towns can benefit from decentralized, inclusive, pro-poor, and sustainable approaches to urban waste management that are appropriate to the size and capacities of the cities.

II. The Integrated Resource Recovery Centers Approach to Sustainable Urban Waste Management

1. The IRRC Model

Middle-and low-income countries in the Asia-Pacific region have the potential to change the narrative of MSWM, where waste can become a resource for efficiently generating economic value and not an economic burden for local governments. To demonstrate this, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in partnership with Waste Concern launched in 2009 a regional project to promote decentralized Integrated Resource Recovery Centers (IRRCs) in secondary cities and small towns of the Asia-Pacific region. The IRRCs demonstrate a cost effective and environmentally sustainable approach for MSWM, which is based on local community participation and adoption of 3R practices, and facilitates multi-stakeholder partnerships to achieve benefits in all three dimensions of sustainable development.

Before the launch of this project, the predominant approach for managing the organic component of the MSW involved designing and establishing large scale, centralized, and mechanized plants for converting the organic waste into compost. These plants had high operational and maintenance costs, and low quality of compost resulting in difficulties in selling the compost.[8]

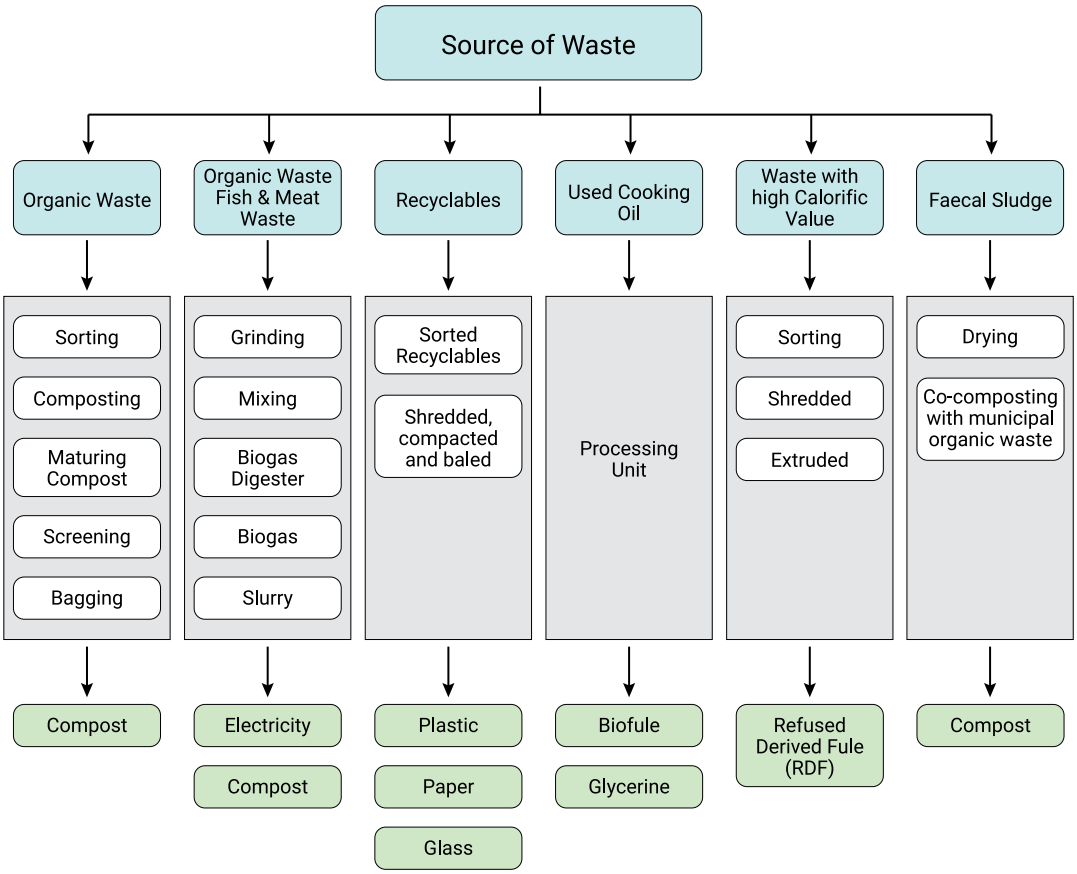
An IRRC is a decentralized, small-scale waste recovery facility having a processing capacity of 2 to 20 tons of waste per day, which receives segregated or non-segregated municipal waste and uses low-cost processes to recover resources from the waste. An IRRC is constructed according to local needs and capacities. Depending on the quantity and quality of local waste generation, the local waste management needs, and the available local technical and financial capacities, an IRRC can have integrated facilities for the following (Figure 2 and Figures 3.a to 3.c) which:

- Convert the organic component of waste into compost using aerobic composting process, or into biogas using anaerobic digestion in biodigesters. The biogas can also be used to generate electricity through a gas generator.
- Co-compost faecal sludge along with the organic fraction of municipal solid waste, and using a cocopeat filter to clean the faecal water to a quality where it can be discharged into the soil for groundwater recharging.
- Recover and sort recyclable materials, such as plastics, metals, papers, and glass for direct sale in the market.

8 ADB (2011), Towards sustainable municipal organic waste management in South Asia – A guide for Policy makers and Practitioners. Manila, Philippines.

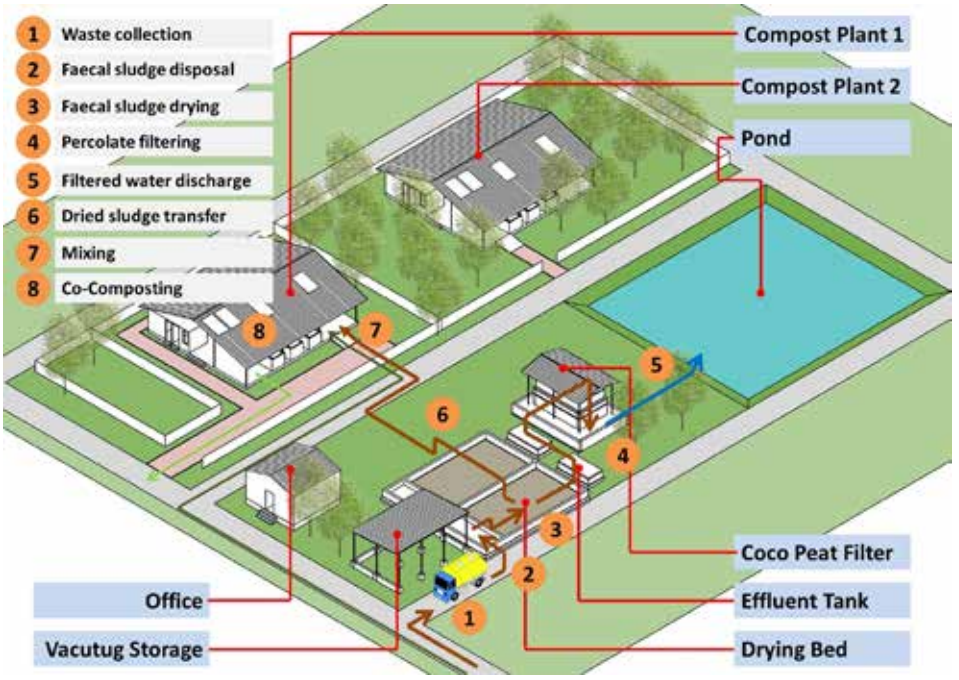
- Convert combustible waste materials into refuse derived fuel (RDF).
- Convert used cooking oils from homes and restaurants into biodiesel.

Figure 2. IRRC material flows and processes



Source: Waste Concern, 2017

Figure 3.a. Isometric view of IRRC in Kushtia, Bangladesh (with compost plant, faecal sludge treatment plant, and trickling filter for waste water treatment plant).

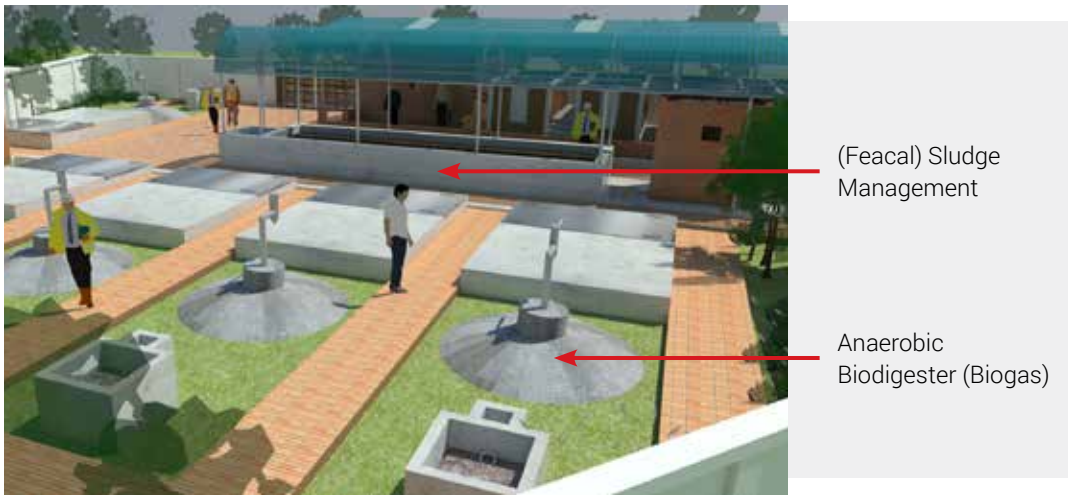


Source: Waste Concern, 2017

Figure 3.b. Plan of IRRC in Malang Regency, Indonesia (with compost plant, biogas plant, faecal sludge treatment plant, and trickling filter for waste water treatment plant).

Source: Waste Concern, 2017

Figure 3.c. Isometric view of IRRC in Malang Regency, Indonesia (with compost plant, biogas plant, faecal sludge treatment plant, and trickling filter for waste water treatment plant).



Source: Waste Concern

2. Suitability of an IRRC for Secondary Cities and Small Towns in Developing Countries

Compared to large scale urban waste management solutions that use expensive technologies such as Mechanical-Biological Treatment (MBT) or waste incinerators, the technologies employed in an IRRC are simple to construct and operate locally, mostly non-mechanized, and durable. The initial investment costs to construct an IRRC, calculated as the amount of monetary investment required per ton of waste processed, and the operational costs of the IRRC are comparatively low (Table 2), thus allowing for efficient decentralized operations of the IRRC by local governments, or private, or non-government entities. This makes the IRRC a pragmatic solution for secondary cities and small towns which have high fraction of organic waste in the municipal waste stream, and low financial resources and technical capacities.

2.1 IRRC: Modular, Scalable, and Replicable

An IRRC is modular by design, which means it can be easily scaled up, replicated, or integrated with larger waste management facilities. For example, an IRRC processing two tons of waste per day can be increased in capacity, by appropriate structural modifications or additions, to process five tons or ten tons of waste per day (Figure 4.a), while maintaining operational efficiencies and outputs.

As the city or town grows in population, geographic area, and waste generation, an IRRC can be easily replicated in multiple parts of the city (Figure 4.b). This improves local participation and partnership in waste management, and creates a resilient network of urban waste centres by enhancing local capacities and efficiently distributing the risks.

An IRRC can also be integrated with an existing waste management facility, such as a mined landfill/dumpsite which processes and recovers resourcesfrom incoming municipal waste before ultimately disposing the non-recoverable waste into a sanitary landfill (Figure 4.c).

Similarly, an IRRC can be integrated in a total waste solution complex that includes facilities for greywater treatment, blackwater treatment, solid waste management (composting and biogas generation), and rainwater harvesting.

Compared to large scale and high cost solutions, national and local governments can thus make small investments, with limited financial risks, establishing locally aligned IRRCs that not only build local capacities and resilience, but help to locally distribute the recovered economic and ecological value from waste resources. Governments can also systematically create an integrated network of decentralized, climate-resilient IRRCs in growing cities, which can minimize the need for large landfills.

Table 2. Costs for implementing an IRRC[9]

Activity/Item	IRRC with composting and recovery of recyclables	IRRC with composting, anaerobic digestion (biogas), faecal sludge management, and recovery of recyclables
Land requirement	150-200 m^2 per ton of waste	400-500 m^2 per ton of waste
Waste required	High quality organic waste required; cost of segregation	High quality organic waste required; cost of segregation
Technical training & capacity building for establishing policies and programmes	USD 5,000 to USD 10,000 per 1 to 2 tons of waste	USD 5,000 to USD 10,000 per 1 to 2 tons of waste
Community awareness building, & waste separation advocacy programmes	USD 5,000 to USD 10,000 per 1 to 2 tons of waste	USD 5,000 to USD 10,000 per 1 to 2 tons of waste
Permits, surveys, assessments	USD 10,000 to USD 15,000	USD 10,000 to USD 15,000
Establishment of IRRC (Capital Expenditure - CAPEX)	USD 20,000 to USD 30,000 per ton of waste	USD 30,000 to USD 40,000 per ton of waste
Operation of IRRC (electricity, waste, staff, maintenance) (Operational Expenditure - OPEX)	5% to 10% of the capital expenditure	5% to 10% of the capital expenditure

9 Source: Waste Concern, 2017

Figure 4.a. Scalability of the IRRC to increase waste recovery or processing capacity.

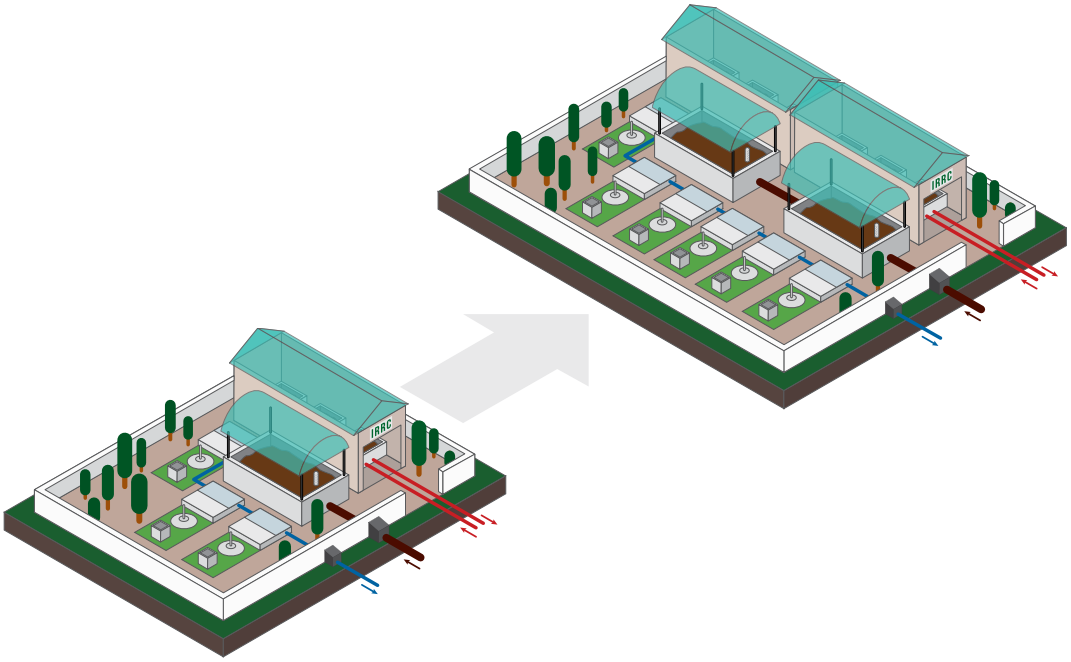


Figure 4.b. Replicability of an IRRC to enhance and integrate urban waste recovery solutions.

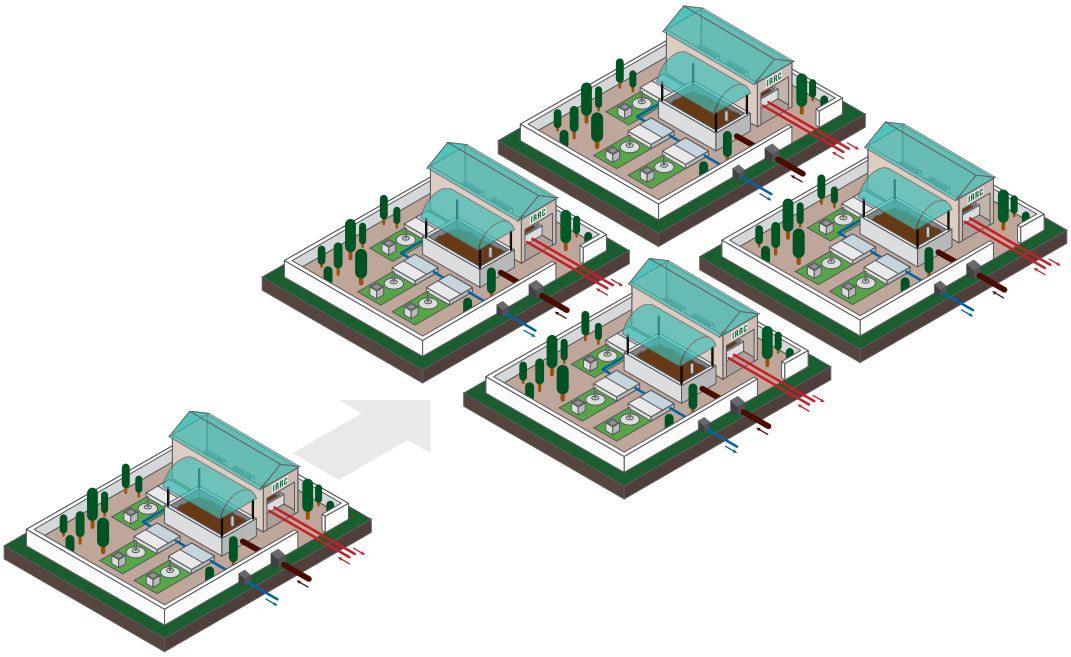
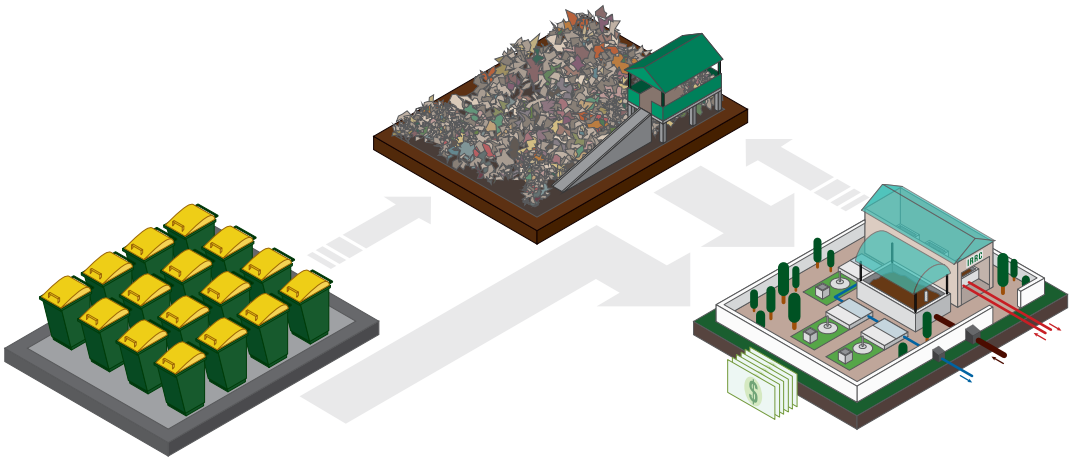


Figure 4.c. Integration of an IRRC into an existing waste management system to enhance waste recovery efficiency.



3. Key aspects of Implementing an IRRC

The process of implementing of an IRRC is aimed at enhancing local participation, partnerships, capacities, knowledge, and socioeconomic opportunities. The IRRC approach identifies and systematically addresses each of the local challenges associated with improving urban waste management (Figure 5).

Figure 5. Actions and results of IRRC approach to improving urban waste management[10]

10 ESCAP observation from the project: Pro-poor and sustainable solid waste management in secondary cities and town in Asia-Pacific

From the onset, the implementation process ensures that the participation of local and national governments, communities, non-government organizations, private enterprises, and other relevant local stakeholders is integral to the discussions on the vision, expected benefits, and operational requirements for an IRRC. Central to the discussions are considerations of the local social, economic, and policy related impacts of an IRRC, such as:

- Identification of the immediate beneficiaries from the IRRC and those that may be negatively impacted, and how any potential undesirable impacts can be minimized.
- Employment of vulnerable members of society such as informal waste workers, women and homeless people at the IRRC with stable jobs.
- Enhancement of public awareness of and responsibility in waste segregation and management.
- Levy of consumer fees for waste collection to provide improved waste management services.
- Identification and allocation of land for the IRRC and ascertainment of IRRC operational jurisdictions among local government entities.
- Redirection of local government funds and reorganizing available resources such as waste collection trucks and waste treatment equipment.
- Assessment of economic value chains and market variables for the recovered waste products.
- Ascertainment of availability and accessibility of national level support for local financial and technical capacity building.

The implementation of IRRCs in six countries has shown that along with inclusive stakeholders' participation, there are five key aspects for successful IRRC implementation and operation:

a. Clear government commitment is required for establishing an IRRC within integrated local plans and programmes for sustainable development.

Strong local leadership drives a clear and long-term vision of sustainable waste management integrated within local sustainable development plans and programmes. In addition, the decisions for establishing, capacitating, and operating an IRRC should be formalized, so that the IRRC operation continues irrespective of changes in local government leadership. The efficacy of these decisions is, in turn, dependent on the implementation of complementary local policies and regulations for waste segregation, collection, and processing.

b. The participation of waste producers in segregating waste at source is elementary for good quality IRRC outputs.

Separation or segregation of waste at its source is elementary to the IRRC approach.

To divert waste from going to the landfill (downstream), and to recover economic and ecological value from the waste resources before they lose their utility and value, the IRRC model relies on segregation of waste at source and improved waste collection services (upstream).

The economic and ecological value that can be recovered from waste treatment in an IRRC is strongly linked to the quality and degree of separation of incoming waste. The segregation of waste at source prevents the organic waste from being mixed with inorganic waste and helps to provide a clean organic feedstock which is a prerequisite for producing good quality compost. Segregation of waste increases the profitability of recovering recyclables such as paper, glass, plastics, and metals, as they do not get soiled by the wet organic waste. Waste segregation also saves operational costs at the IRRC, as the workers spend less time sorting and cleaning the incoming waste.

The success of waste segregation at source is dependent on the commitment of the waste producers. It is important to build the capacity of communities, organizations, and local governments for participating in the process of segregating, collecting, processing and valorizing waste resources.

Waste producers can improve segregation as a result of awareness campaigns conducted by non-governmental organizations (NGOs), community-based organizations (CBOs), local government bodies and other local community networks, which are stakeholders in the process of implementing an IRRC. This can be accompanied by increased waste collection fees to make the IRRC operations financially viable, and the fees need to be justified by the local government or waste management organization by providing improved waste management services. The awareness programmes influence waste producers to not only adopt 3R practices, but also to become consumers of the recovered products from an IRRC, such as compost and biogas or electricity, thereby maintaining a circular economic loop that enhances resource efficiency and economic productivity, while reducing waste and its environmental impacts. Thus, an IRRC can create an intimate partnership between the waste producers and the waste managers.

c. A technically trained team is necessary to operate the IRRC efficiently.

The operational efficiency of an IRRC is linked to the quality of incoming segregated waste and the systematic plant operations. The composting, anaerobic digestion, and faecal sludge management processes require constant monitoring to improve and maintain high efficiencies which are necessary for increasing resource recovery. Higher efficiencies lead to lower waste recovery or conversion times and lower operational costs. The efficiency of the IRRC's biological and sorting processes, and the productivity and occupational health and safety of its workers is optimized by following and monitoring prescribed procedures and key performance indicators. It is therefore necessary for the IRRC staff to be appropriately trained, and where necessary receive refresher training. The experience of implementing IRRCs has shown that when the IRRC staffs are well trained, they can train new incoming staff; this is critical during changes of leadership in a local government which can lead to changes in IRRC staffs. Conversely, when the new IRRC staffs are unaware of correct operational procedures and methods to improve overall operational efficacy, the diminishing efficiencies of waste conversion processes and total outputs can lead to operational losses and low-cost recovery in an IRRC.

d. The financial sustainability of an IRRC is maintained by preparing and following a robust IRRC operational business plan.

The financial sustainability of an IRRC is dependent on its revenues. The IRRC model has been designed to operate in a financially sustainable manner by covering all operational expenditures and increasing the potential to generate limited profits. The three main sources of revenue for the IRRC are derived from: (a) the sales of compost, biogas or electricity, recyclables, and refuse derived fuel (RDF); (b) collection fee for waste collection services or a tipping fee; (c) government subsidies for providing waste management services.

Before the implementation of an IRRC, a business plan is developed that includes estimates of operational efficiencies and costs, revenues from IRRC products (compost, biogas or electricity, recyclables), waste collection fees and local grants/subsidies, and the time required for operational cost recovery for the IRRC. This plan needs to be updated depending on the quality and quantity of incoming waste and market conditions. In addition, the local government and the IRRC operators have to actively develop markets for selling the IRRC products to enhance cost recovery. For example, the IRRC can develop plant nurseries using its produced compost, or the local government can use the compost to improve urban green spaces. The electricity generated using the produced biogas in the IRRC can be sold to nearby home and markets. The financial health of an IRRC can also be supported by external sources such as through national government subsidies or grants, and international public or private climate financing.

If the IRRC is constructed and fully operated by the local government, then it is important to also include in the business plan, the figures for costs saved such as through reduced transport of waste to the dumpsite or landfill, and the reduced land required for the final disposal of the waste in the dumpsite or landfill. Sometimes the saved costs alone can financially justify the need to operate an IRRC. In short-term financial calculations, the capital costs of establishing an IRRC may not be justified solely by these saved costs (fuel and land), however when the costs of mitigating GHGs emissions, reducing disease vectors, and building social-ecological resilience and disaster risk reduction are included, the accounting can well justify both the capital and operational costs of an IRRC.

e. The sustainable development benefits of an IRRC increase when the IRRC implementation is integrated within local sustainable development plans and programmes.

The purpose of establishing an IRRC and its complementary urban waste management policies is ultimately to make a transformational change in the way urban societies manage and value waste as a resource. This purpose is integrated with the larger purpose of developing sustainable, resilient, inclusive, peaceful, innovative and cohesive societies. Therefore, it is essential to integrate the implementation of an IRRC with local multi-sectoral plans and programmes for achieving sustainable and resilient urban development. By doing so, the social, economic, and environmental benefits of an IRRC can be coherent with and possibly amplify the benefits accruing from other sectoral interventions for sustainable development, such as: wastewater and storm water management; faecal sludge management; water resources management, and groundwater recharge; management of urban riparian areas and green spaces; rehabilitating people living in informal urban settlements and providing improved water, sanitation and waste management; enhancing agricultural productivity and incomes in peri-urban and rural areas; building climate resilient and low carbon urban infrastructure; and enhancing social-ecological resilience and improving economic vibrancy of urban communities.

4. Other important dimensions of IRRC Implementation

a. Multi-stakeholder partnerships are locally embedded

Every city or town has different social, political, economic and environmental conditions, and a distinct capacity of its local government. These conditions and local capacities allow for unique partnership models to evolve in the procession of implementation of an IRRC. There is no perfect model of partnership. A successful partnership is one which ensures the financial sustainability of the IRRC, which, in turn, is built on sustained IRRC operational efficiency

and revenues, and on clearly negotiated and legally agreed terms of financial cooperation between the partnering entities.

b. Financial accounting and key performance indicators are essential for IRRC resilience

The IRRC should be run like a successful independent business entity, based on solid financial principles of diligent accounting, and by following key plant performance indicators. The IRRC staff must maintain diligent financial accounts on a monthly basis, to see trends and make necessary interventions. Similarly, the plant must be operated by measuring the key performance indicators as per the prescribed schedule, so that appropriate adjustments can be made to improve efficiency. It is important to note that an IRRC is mostly non-mechanized and thus depends on the observations and productivity enhancements of its managers or operators.

5. IRRC provides a range of sustainable development benefits

An IRRC is usually built on land owned or possessed by the local government, and provides waste management services and other benefits to its residential and commercial neighbours. This helps to maximize local sustainable development benefits. Some of the important benefits of an IRRC are:

- An IRRC creates socioeconomic opportunities by providing safe jobs to the urban poor and waste pickers, with better incomes and working conditions, and by facilitating the development of local market or value chains for waste-to-resource products. Door-to-door waste collection services and the operation of the simple and cost-effective technologies in an IRRC require manual labor where several workers can be employed. The IRRC also improves the working conditions of laborers, with good occupational health and safety through the regular use of gloves, boots, uniforms and masks, and provides them training to upgrade their skills.

- An IRRC mitigates environmental pollution by reducing GHG emissions. Every ton of waste converted into compost can save half a ton of carbon dioxide emissions. In addition, by improving the collection and treatment of biodegradable waste in a neighborhood, an IRRC can improve public health and sanitation conditions due to diminished disease vectors that breed in open waste. By diverting the organic and recoverable fractions from the municipal waste stream, an IRRC reduces the need for landfills and for transporting waste. In the long-term, this can help a local or national government to allocate the saved funds to further improve urban waste management and other integrated aspects of sustainable urban development.

- The participative process of implementing an IRRC is built on creating public awareness and facilitating the widespread adoption of 3R (reduce, reuse, recycle) practices. This is elementary in changing citizens' behaviors towards more waste-conscious, resource efficient, and sustainable lifestyles.

From 2009 - 2018, ESCAP, in partnership with Waste Concern, local governments and non-government stakeholders has implemented ten IRRCs, ranging from 2 tons to 5 tons per day, in nine cities in six countries (Figure 6):

- Kushtia City, Bangladesh
- Kampot City, Cambodia
- Jambi City and Malang Regency, Indonesia
- Islamabad City, Pakistan
- Matale City (two IRRCs) and Ratnapura City, Sri Lanka
- Kon Tum City and Quy Nhon City, Viet Nam

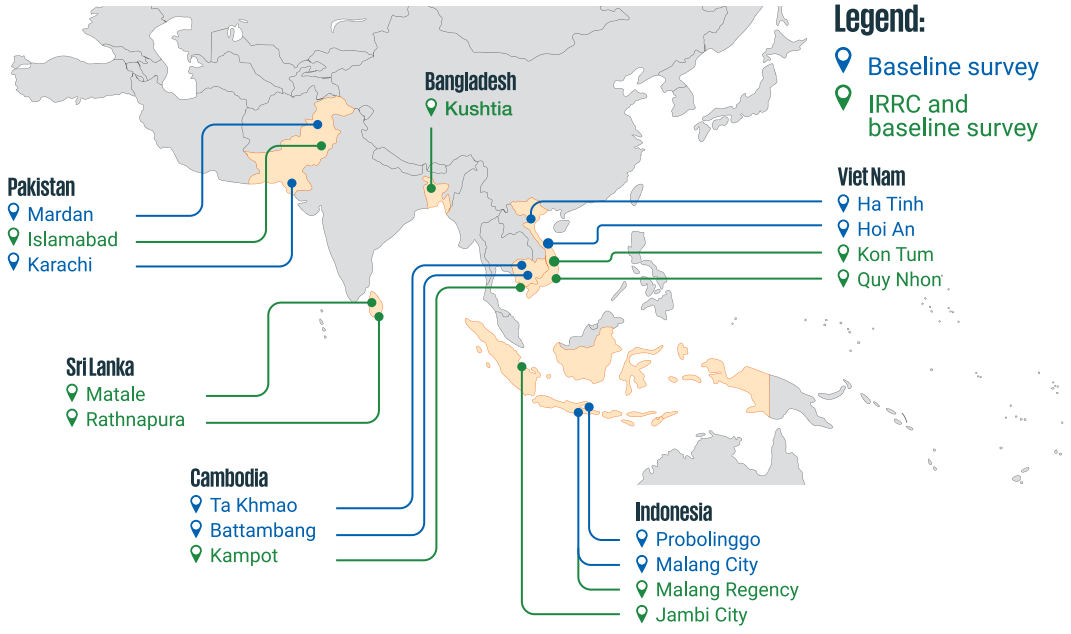
The successful implementation and operation of these IRRCs have led to several replications. In Sri Lanka, the three IRRCs that ESCAP constructed in partnership with the Sevanatha Urban Resource Center in Matale and Ratnapura cities were replicated with three similar IRRCs through funding provided to the local governments by the Central Environmental Authority of Sri Lanka.

In Pakistan, the IRRC model that ESCAP constructed in partnership with UN-Habitat and the Akhtar Hameed Khan Memorial Trust in Sector G-15 of Islamabad City in August 2015, is being replicated in three small towns (Manshara, Hasilpur, and Sakrand) in the states of Punjab and Sindh through local and national government support, and another IRRC is being planned in Sector F-17 of Islamabad City.

In Bangladesh, the project enhanced an existing IRRC in Kushtia City to improve faecal sludge co-composting, which has become an exemplary model for training on decentralized urban faecal sludge management. Six IRRCs have been constructed nationwide using the Climate Change Trust Fund of the Government of Bangladesh.

A more detailed analysis of the benefits of the IRRCs towards the implementation of actions for achieving sustainable development, as seen from IRRCs in secondary and small cities in six countries, is discussed in the following chapters.

Figure 6. IRRCs in Asia and the Pacific



III. The Contributions of IRRCs towards the Implementation of the Global Agendas for Sustainable Development

The ESCAP project on "Pro-poor and sustainable solid waste management in secondary cities and small towns in Asia-Pacific" is implemented by the Environment and Development Division (EDD) at ESCAP. The EDD is guided in its work by the global agendas for sustainable development, namely the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction, the Addis Ababa Action Agenda on Financing for Development, the Paris Agreement under the United Nations Framework Convention on Climate Change, and the New Urban Agenda (NUA) adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III); as well as by the Regional Road Map for the 2030 Agenda in Asia and the Pacific, and the Ministerial Declaration on Environment and Development in Asia and the Pacific. These frameworks inform the work of the EDD towards improving urban resource efficiency, sustainability and resilience, through the inclusive and integrated implementation of the sustainable development goals. The following sections discuss the contributions of the IRRC to the implementation of select global and regional agendas for sustainable development, namely:

- The 2030 Agenda for Sustainable Development, and the Regional Road Map for Implementing the 2030 Agenda in Asia and the Pacific
- New Urban Agenda
- Paris Agreement and its related Nationally Determined Contributions
- Ministerial Declaration on Environment and Development in Asia and the Pacific

1. The 2030 Agenda for Sustainable Development

In September 2015, in New York, the General Assembly of the United Nations (UN) adopted the 2030 Agenda for Sustainable Development as a global plan of action for people, planet, peace, and prosperity.[11] The 2030 Agenda contains 17 interrelated and indivisible Sustainable Development Goals (SDGs) with 169 targets and 244 indicators.[12]

On 19 May 2017, ESCAP's 73rd Commission Session adopted the Regional Road Map for implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific. The road map recognises national and regional realities, capacities and levels of development, and aims to facilitate cooperation at the regional level. It emphasises support for implementation of the 2030 Agenda by maintaining its universality and transformative nature, and promotes

11 http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E [Accessed: 14.11.2017]
12 https://unstats.un.org/sdgs/indicators/indicators-list/ [Accessed: 12 November 2017]

the balanced integration of social, economic and environmental dimensions of sustainable development through regional cooperation in priority areas.[13]

The implementation of IRRCs in secondary cities and small towns can contribute to multiple SDGs and their targets related to improving urban services and resource efficiency, building resilient infrastructure and mitigating environmental pollution, eradicating poverty and building awareness for sustainable lifestyles, ensuring gender sensitive and inclusive economic development, and facilitating innovation and multi-stakeholder partnerships (see Figure 7, and Tables 3, 4). The IRRC approach has a wide range of benefits related to each of the three integrated dimensions of the sustainable development: social, economic, and environmental (see Annex A for the detailed list of SDGs, targets and indicators where IRRCs have contributions).

Figure 7. Linkages of the IRRCs with the Sustainable Development Goals

13 Regional Road Map for Implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific (http://www.unescap.org/sites/default/files/publications/Final%20SDG%20Roadmap_Updated%20Logo.pdf)

Table 3. The potential co-benefits of recycling one ton of organic waste in an IRRC (decentralized and pro-poor manner)

	Problems	Potential co-benefits per ton of recycled waste	Comments	Sector impacted and type of co-benefits
1	Lack of formal job opportunities for the urban poor in cities in developing countries	Create 2 jobs for the urban poor including waste pickers	Provides better and more stable income and safer working conditions to waste pickers	Social/Economic- Public and Private
2	Unmanaged organic waste full of nutrients remains unutilized and creates pollution	Produce 0.20-0.25 tons of decent quality compost	High-quality compost can replenish organic matter in the soil	Economic/ Environmental- Public
3	Unmanaged organic waste generates methane under anaerobic conditions	Reduce 0.5 tons of GHG emissions	Aerobic treatment of waste avoids methane generation	Economic/ Environmental -Public
4	Slow degrading organic waste (fish waste, meat waste, leachate water, cow dung etc.) is difficult to treat	Produce 40-80 cubic meters of biogas (clean energy which can be used for cooking purpose or electricity generation)	Anaerobic digestion of organic matter can produce biogas.	Economic/ Environmental Public and Private
5	Land for landfill sites is becoming scarce in most developing countries due to increase in land prices and opposition to landfills	Save 1.1 cubic meter of landfill area	City authorities can save considerable resources by diverting waste away from landfill	Economic - Public
6	Lack of regular waste collection from the communities creates pollution and health hazards for the citizen.	Provide benefits to 2,000-3,000 citizens from improved waste collection	Decentralized waste treatment can help extend waste collection to underserved communities, especially low-income ones	Social/Environmental- Public and Private
7	Mixed municipal waste discharges toxic leachate water which can pollute both surface and ground water.	Avoid production of 0.2-0.3 cubic meters of polluting waste water.	Waste water from source separated organic waste has high nutrient value which be used during composting process to control moisture.	Economic/ Environmental Public
8	Unmanaged waste can create more than 40 diseases	Reduce the risk of diseases directly or indirectly linked with unmanaged municipal solid waste;	Waste-borne disease can be responsible for high incidence of absence from work.	Social/Economic- Public and Private
9	Due to heavy use of chemical fertilizer, lack of crop rotation, high cropping intensity and drought, the soil is losing its fertility thus causing threat to food security.	Increase crop production between 25-30% and reduce use of chemical fertilizer by 35-40% by the use of compost	By using compost, farmers can manage their production in a more sustainable manner, reduce costs and increase revenues	Economic/ Environmental Public and Private

Source: Waste Concern, 2017

Table 4. Economic value of benefits from IRRCs (with only composting) in Bangladesh, Sri Lanka and Viet Nam for every ton of prevented CO_2eq emissions

Benefit	Type	Value (USD)		
		Bangladesh	Sri Lanka	Viet Nam
Job creation: additional income for waste-pickers employed	Social/ Economic	7.53	6.00	N/A
Cost savings for the municipality for avoided landfilling of waste	Economic	22.36	57.50	69.70
Savings in chemical fertilizer use (25% reduction)	Economic	9.71	2.26	21.09
Savings in subsidy to chemical fertilizers	Economic	4.13	5.58	N/A
Increase in crop yields	Economic	49.09	43.05	93.42
	TOTAL	**93.82**	**114.29**	**184.21**

Source: ESCAP and Waste Concern[14]

2. New Urban Agenda

The New Urban Agenda (NUA) was adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) in October 2016 in Quito, Ecuador, and endorsed by the UN General Assembly in November 2016. The NUA shares a vision for a sustainable future and reaffirms the global commitment to sustainable urban development. It calls for the concerted efforts of a wide range of actors – governments, urban entities, donors, UN programmes and agencies and civil society organisations – in implementing the 2030 Agenda for Sustainable Development in an integrated manner, at the global, regional, national, sub-national, and local levels, with a focus on Goal 11 of making cities and human settlements inclusive, safe, resilient and sustainable.[15]

To fully harness the potential of sustainable urban development, the NUA lists transformative commitments through an urban paradigm shift grounded in the integrated and indivisible dimensions of sustainable development: (i) sustainable urban development for social inclusion and ending poverty, (ii) sustainable and inclusive urban prosperity and opportunities for all, and (iii) environmentally sustainable and resilient urban development.

Among the transformative commitments listed in the NUA, the IRRC approach has direct linkages to commitments which address the following (see Annex B for a detailed list):

- Promoting equitable and affordable access to sanitation and waste disposal services, with a focus on reaching the services to underserved, poor, and vulnerable urban communities (para 34)

14 For details of the calculation, please see "Valuing the sustainable development co-benefits of climate change mitigation actions: The case of the waste sector and recommendations for the design of Nationally Appropriate Mitigation Actions (NAMAs).

15 http://habitat3.org/wp-content/uploads/N1639668-English.pdf

- Strengthening sustainable natural resources management, with a focus on the environmentally sound management and the minimization of waste and GHG emissions, in ways that consider urban-rural linkages and strive to transition to a circular economy the facilitates ecosystem conservation, regeneration, and resilience (para 71)

- Promoting environmentally sound waste management to substantially reduce waste generation by reducing, reusing and recycling waste, minimizing landfills and converting waste to energy when waste cannot be recycled; and reducing marine pollution through improved waste and wastewater management in coastal areas (para 74)

- Establishing safe material recovery and recycling facilities (para 76)

Similarly, the IRRCs have clear linkages with the following means of effective implementation (see Annex B for a detailed list):

- Promoting adequate investments in protective, accessible and sustainable infrastructure and service provision systems for water, sanitation and hygiene, sewage, solid waste management, urban drainage, reduction of air pollution and storm water management, in order to improve safety in the event of water-related disasters, improve health, ensure universal and equitable access to safe and affordable drinking water for all, as well as access to adequate and equitable sanitation and hygiene for all and end open defecation, with special attention to the needs and safety of women and girls and those in vulnerable situations (para 119)

- Supporting decentralized decision-making on waste disposal to promote universal access to sustainable waste management systems; and promotion of extended producer responsibility schemes that include waste generators and producers in the financing of urban waste management systems. (para 122)

- Promoting coordination of food security and agricultural policies with that of energy, water, health, transport and waste policies, to minimize waste and reuse food waste (para 123)

Cities have become the centres of innovation, social interaction, political activity that drive technological development, economic growth, and social transformation. At the same time cities are also the centres for the accumulation of natural and human capital, consumption of resources and generation of waste and pollutions, and the concentration of social and economic inequalities. Among its important calls for commitment towards integrated and inclusive approaches for sustainable development, the NUA recognizes and promotes decentralized sectoral approaches that engage the most vulnerable populations and localize the processes, impacts, and benefits of sustainable development.

The IRRC approach has also shown its effectiveness in improving coordination among national and local governments to implement integrated sectoral policies and creating an enabling environment, strengthening urban-rural linkages through the use of compost for supporting agricultural productivity and ecosystem regeneration, meeting local and national priorities for mitigating GHG emissions and pollutions, and facilitating the transition to a resource efficient, and circular economy that is within the sustainable biophysical limits.

Owing to its linkages with South-South cooperation and its successful demonstration of localized solutions for building capacities and improving urban services and sustainability, the IRRC approach has the potential to facilitate national and regional cooperation for sharing best practices in localizing sustainable development, and to develop a locally embedded model of climate change mitigation and sustainable development that can invite private investment and international climate financing for supporting replication and scaling-up of decentralized SUWM solutions.

3. Paris Climate Agreement and Nationally Determined Contributions

The Paris Climate Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was negotiated by representatives of 197 Parties to the Convention at the 21st session of the Conference of the Parties to the UNFCCC in Paris and adopted on 12 December 2015. As of November 2017, 195 UNFCCC Parties have signed the agreement, and 175 have become Party to it as of 20 March 2018. The Parties to the Paris Agreement have agreed to take national actions to mitigate global warming and limit the global temperature rise in this century (until 2100) to well below 2 degrees Celsius above pre-industrial levels, and to further pursue efforts to limit the temperature increase to 1.5 degrees Celsius. Each Party to the Paris Agreement has submitted its Nationally Determined Contributions (NDCs), which are short-term and long-term actions to mitigate global warming by reducing GHG emissions. The NDCs are submitted and registered with the UNFCC every five years, and each submission should reflect the Party's highest possible ambition on its previous version.

An assessment of the NDCs registered with the UNFCCC, shows that 25 Parties to the UNFCCC from the Asia-Pacific region have included waste minimization, SWM, waste-to-energy conversion, or waste-to-resource recovery as national commitments for mitigating GHG emissions and building low carbon climate resilient societies (see Annex C). The IRRC approach can be effectively used to help meet these waste-sector related national commitments, such as the following:

a. Reduce methane production in landfills by improving the waste segregation and recycling system through adopting new techniques such as pre-sorting of waste.

   Countries: China, India, Marshall Islands, and Sri Lanka.

b. Improve solid waste management through transforming solid waste into organic fertilizer to support the agricultural system; and providing market development assistance for compost.

   Countries: Afghanistan, Bangladesh, Bhutan, China, India, Indonesia, Japan, Kiribati, Lao PDR, Myanmar, Nepal, Pakistan, Sri Lanka, and Viet Nam.

c. Intensify the recovery and utilization of methane from landfills, and minimizes GHG emissions through application of zero waste concepts and sustainable waste management practices such as 3R principles.

   Countries: Afghanistan, Armenia, Bangladesh, Bhutan, China, Fiji, Indonesia, Japan, Kiribati, Maldives, Marshall Islands, Myanmar, Nepal, Palau, Sri Lanka, Thailand, and Viet Nam.

d. Reduce GHGs from waste and its transport, which can account for 20-50% of annual municipal budget.

   Countries: Marshall Islands, Palau, Kiribati, Mongolia, Nepal, Sri Lanka, and Viet Nam.

The NDCs of least developed countries (Afghanistan, Bhutan, Bangladesh, Cambodia, Kiribati, Lao PDR, Myanmar, Nepal) and small island developing States (Fiji, Kiribati, Palau, Maldives, Marshall Islands) also mention GHGs emissions reduction from waste sector. Domestic and international climate financing can help meet their waste-related NDCs. Nationally Appropriate Mitigation Actions (NAMAs) can include decentralized SUWM solutions for climate change mitigation and sustainable development, and it can attract domestic and international climate financing. The NAMAs can also provide opportunities for carbon trading which can financially support the implementation and operations of decentralized SUWM solutions.

Based on NAMA database maintained by Ecofys,[16] as of 11 April 2017, two countries in the Asia-Pacific region – China and Kazakhstan – are implementing waste-related NAMAs, and five more – Indonesia, Malaysia, Pakistan, Philippines and Viet Nam – are developing NAMAs that include components of waste-to-energy conversion and waste-to-resource recovery to help mitigate GHGs emissions and achieve sustainable development.

The IRRC approach can be developed as a NAMA to reduce GHGs emissions from waste and its transport by (i) generating clean and low-cost energy through anaerobic biodigestion, and (ii) improving urban and rural ecosystem health through the use of compost. For example, the Institute of Meteorology, Hydrology and the Environment (IMHEN) of Viet Nam, with support from ESCAP and the Overseas Environmental Cooperation Center of Japan (OECC) has designed a NAMA programme on the waste sector to promote 3R principles, reduce GHGs emissions from waste management, and enhance waste-to-resource recovery through the implementation of IRRCs and other decentralized SUWM solutions in cities and towns in Viet Nam.[17]

A key aspect of NDCs and related NAMAs is their monitoring, reporting and verification (MRV) to ensure real climate change mitigation and sustainable development benefits. Due to the nature of IRRC operations, with regular performance monitoring and financial book keeping, IRRCs are a good example of effective, decentralized, and low-cost monitoring and reporting that can be independently verified to substantiate social, economic, and environmental benefits of NDCs and NAMAs.

4. Ministerial Declaration on Environment and Development in Asia and the Pacific

The seventh Ministerial Conference on Environment and Development (MCED7) in Asia and the Pacific, organized by ESCAP on 7-8 September 2017 in Bangkok, adopted the Ministerial Declaration on Environment and Development in Asia and the Pacific, wherein the Ministerial Conference recognized the need to: assess the use of technologies for development; take informed policy designs for improving economic prosperity, environmental sustainability, and

16 http://www.nama-database.org/nama-db-pipeline.xls [Accessed: 21.07.2017]
17 http://www.unescap.org/sites/default/files/NAMAs%20Workshop_Report_Final.pdf

social well-being; and rely on greater regional cooperation to promote a resource efficient and pollution free Asia-Pacific region.[18] The Ministerial Conference also emphasized the importance of enhancing public awareness, participation and partnerships towards resource efficient and environmentally sustainable practices such as the 3R principles to mitigate the negative social and ecological impacts of urbanization and economic growth, as well as to make cities environmentally sustainable. The implementation of IRRCs, which is integrally based on the 3R principles, builds public awareness and adoption of resource efficient practices and mitigates pollutions, directly contributes towards achieving the Ministerial Declaration's objectives of making the Asia-Pacific region pollution free and resource efficient.

18 Ministerial Declaration on Environment and Development for Asia and the Pacific, 2017 (E/ESCAP/MCED(7)/5)

IV. Policy recommendations to implement decentralized solid waste solutions

The efficacy of decentralized approaches for SUWM in contributing to sustainable urban development depends on the synergy of beneficial social, economic, and political factors, such as inclusive planning and implementation, multi-stakeholder partnerships, targeted financial incentives, and environmental and waste management regulations that promote 3R practices and locally appropriate SUWM solutions. Policies are tools that governments can use to create an enabling environment where the interplay of the beneficial social, economic and political factors is conducive to the participatory design and implementation of pro-poor SUWM solutions such as IRRCs. Below are some policy recommendations, for improving MSWM and its benefits for sustainable urban development. A list of key national, sub-national, and local actors is shown in Figure 8.

Figure 8. Key actors and activities for supporting the implementation of IRRCs

	Actors/Stakeholders	Activities/Instruments
Policies/Regulations/ Strategies	• Ministry of Agriculture • Ministry of Local Government • Ministry of Urban Development • Ministry of Environment • Ministry of Energy • Ministry of Forests • Other relevant Ministries • Municipalities	• Promotion of compost/ biogas/ appropriate technologies, RDF • Standardization of products • Feed in tariff/Support to compost • Tipping fee/waste collection fee • Land for the Facility • Public-Private Partnership Rules and Guidelines
Fiscal Incentives	• Ministry of Finance • Central Bank • Tax Department • Local Banks	• Low interest rate financing • Less/reduced tax for private sector operator • No VAT
Capacity Building/ Awareness Raising	• International Agencies • Government, Research Institutions (local & international), • Educational Institutions • International NGOs • Local NGOs and CBOs • Private Sector	• Operation & Maintenance of IRRCs • Public Private Partnership Agreement • Technology selection • Monitoring of emissions reductior • Key Performance Indicators development for IRRCs

Source: Waste Concern, 2017

1. Integrate decentralized urban waste management solutions into local, sub-national and national policies

Well-structured SUWM strategies, policies, and programmes at the national and local levels are based on 3R principles, people's participation, and multi-stakeholder partnerships, and are aligned with the implementation of the global and national agendas for sustainable development, urban housing and climate change.

Using a systems approach, policy-makers can integrate decentralized approaches for SUWM within multi-sectoral policies and programmes for sustainable urban development, and climate change mitigation and adaptation. The systems approach helps to identify key stakeholders and their interrelationships, resource stocks and flows, leverage points and feedback loops, and the interplay of subsystems; this can lead to the preparation of strategic national and local actions plans aligned with the implementation of SDGs to:

a. Leverage and efficiently use resources and capacities among sectors, especially when municipal budgets for providing basic urban services, such as waste management and sanitation, are limited.

b. Create mutually beneficial feedbacks among sectors and sectoral stakeholders, such as through strategically integrating the sectors of urban wastewater, faecal sludge, and solid waste management with those of water resources management, public health and sanitation, management of urban green spaces, climate change mitigation, ecosystem-based adaptation for enhancing social-ecological resilience, and improving public awareness and adoption of 3R practices.

c. Identify areas where economically-oriented policy interventions may be further needed, such as through the provision of fees, rebates, tax-breaks, subsidies, grants, and preferential loans for enhancing MSWM.

d. Generate opportunities for social and economic development based on resource efficient, innovative, inclusive, and environmentally sustainable approaches, such as by (1) promoting the development of small scale enterprises and creating forward and backward value chains for maximizing the economic value addition from recovered waste products (compost, recycled plastics, biogas, etc.); (2) improving working conditions of informal waste workers and urban poor; and (3) enhancing public engagement in local government programmes for sustainable development.

e. Provide impulses for paradigmatic change in society, towards attaining more resource efficient, sustainable and resilient processes.

The integration of policies needs to be done both ***horizontally*** among sectoral policies at the local government level, and ***vertically*** among sectoral policies between national and local governments. The combined vertical and horizontal integration of policies ensures that programmatic planning and implementation is done using a comprehensive systems approach that maximizes the sustainable development benefits across cities and towns. Learning from decentralized waste management sectors can contribute to design national level plans for reducing waste, mitigating climate change impacts, and improving economic productivity through urban resource efficiency. Similarly, national policies aimed at enhancing

rural agricultural productivity, and developing urban green spaces for climate change mitigation and adaptation, provide guidance for local policies for maximizing the recycling of urban organic waste into compost which can be a feedstock for ecosystem enhancement.

2. Improve waste segregation collection, recovery, and final disposal using 3R principles

The economic efficiency and the social and environmental benefits of decentralized urban waste urban management approaches are closely linked to reliable waste segregation and collection. National and local governments can implement policies and complementary regulations to ensure high quality of waste segregation and collection, as well as implement programmes to improve public awareness and adoption of 3R practices. Decentralized urban waste management solutions can maximize the recovery of economic value from waste resources, efficiently distribute the economic benefits locally through jobs and improved occupational health and safety conditions for the urban poor, and effectively mitigate environmental pollutions.

3. Ensure inclusive planning and implementation, and participatory assessment of the social, economic, and environmental impacts, of SUWM solutions

Before SUWM solutions are implemented, they should undergo a robust process of assessment for their expected social, economic and environmental impacts – both positive and negative impacts. This, in turn, should be based on a comprehensive assessment of the "baseline" conditions: local waste generation status and trends; social, environmental, and geographic conditions; local and non-local stakeholders; market conditions and existing waste-related value chains; and local and national policies and programmes.

Inclusive planning for SUWM and the participatory assessment of the impacts ensure that the solutions are locally appropriate – that is, socially acceptable, economically affordable, inclusively accessible, and environmentally sustainable. In addition, this informed participation can help achieve four important social objectives:

a. Build the knowledge and capacity of citizens for SUWM and its related benefits.

b. Encourage citizens to engage, articulate, and contribute in a process of transformative social change that is driven by improved social and environmental consciousness and economic productivity, using SUWM as a medium.

c. Ensure multi-stakeholder partnerships – government, non-government, and private actors – to implement SUWM solutions.

d. Inspire innovative forward and backward linkages (value chains) and enhance economically beneficial activity in relation to the SUWM solutions, thereby improving local economic health and societal resilience.

National and local governments can, thus, implement policies and programmes and enforce regulations to ensure inclusive, gender sensitive, public participation in planning and implementation, and participatory and multidimensional assessments of SUWM solutions.

4. Decentralize national level funds and facilitate local governments to build technical capacities and resources for SUWM

Local governments in developing countries often have low financial resources and technical capacities to deal with their increasing MSW volumes, and follow costly end-of-pipe solutions for MWSM that involve inefficient waste collection, cumbersome transporting and unsanitary disposal in dumpsites or unmanaged landfills. In addition, they have low revenues from municipal tax collections that can support improvements in local MSWM capacities and processes. In this scenario, it is necessary for national governments to decentralize funds and authority for enabling local governments to build their technical capacities, and to create enabling policy and regulatory environments for private and non-governmental stakeholders to participate in improving MSWM.

National governments can design and implement effective policies for fiscal and administrative decentralization, in conjunction with policies and regulations that empower local governments to implement cost-effective decentralized SUWM solutions. Local governments can achieve several outcomes by:

a. Creating a conducive environment for the financial sustainability of decentralized SUWM solutions, such as through: providing gate fees or tipping fees to IRRC operators; loaning waste collection trucks and workers; providing grants to civil society organizations for conducting public awareness programmes for waste segregation and adoption of 3R practices; and assisting the IRRC operators in marketing the compost and other recovered waste products.

b. Building of multi-stakeholder partnerships.

c. Conducting trainings of IRRC operators and managers, and refresher trainings where necessary during changes of staff in the IRRC.

d. Improving waste collection services and attracting private financing, and international climate financing such as through NAMAs.

e. Gradually scaling-up or replicating IRRCs to enhance the recovery of waste resources.

f. Creating intra-city and inter-city networks for sharing good practices and locally appropriate solutions for decentralized and inclusive SUWM.

g. Collecting data on waste and urban resource efficiency, preparing and implementing an integrated local action plan for sustainable development goals, with SUWM as an entry point.

h. Ensure monitoring, reporting, verification, and documentation of social, economic, and environmental benefits of SUWM activities.

5. Establish programmes, and guidelines for monitoring, reporting, verification, and documentation of SUWM programmes and projects

To document the financial health, operational efficiency, and sustainable development impacts of decentralized SUWM solutions, it is important to regularly monitor, report, and verify (MRV) the progress of SUWM operations. Understanding and documenting the failures and success of SUWM programmes and projects, and their related co-benefits, can allow governments to effectively build on the learnings and enhance the efficacy of SUWM activities and the implementation of sustainable development goals. In addition, MRV is one of the requirements associated with the implementation of NDCs, as well as for international climate financing such as through NAMAs and the Green Climate Fund.

Good MRV can help in the following:

a. Document and help to improve social, economic, and environmental benefits of SUWM solutions, through specific interventions.

b. Verify data on waste production, collection and treatment, and GHG emissions, and relate it to demographic and socio-economic trends.

c. Provide useful information for scaling-up, and replicating SUWM activities.

d. Make SUWM solutions more relevant for NDCs and facilitating a transition to low carbon and climate-resilient societies.

To support this, national and local governments can implement policies, guidelines, programmes, and resources for improving MRV and documentation of SUWM programmes and projects.

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Annexes

A. SDGs, targets and indications where IRRCs have directly or indirectly related benefits

Goals	Relevant Targets	Relevant Indicators
Goal 1: **End poverty in all its forms everywhere**	**1.1** By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day **1.2** By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions. **1.3** By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	**1.1.1** Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural) **1.2.1** Proportion of population living below the national poverty line, by sex and age **1.2.2** Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions **1.4.1** Proportion of population living in households with access to basic services
Goal 2: **End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment **2.4** By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	**2.3.1** Volume of production per labour unit by classes of farming/ pastoral/forestry enterprise size **2.3.2** Average income of small-scale food producers, by sex and indigenous status **2.4.1** Proportion of agricultural area under productive and sustainable agriculture

Goal 3: **Ensure healthy lives and promote well-being for all at all ages**	**3.9** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	**3.9.1** Mortality rate attributed to household and ambient air pollution **3.9.2** Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)
Goal 6: **Ensure availability and sustainable management of water and sanitation for all**	**6.3** By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally **6.a** By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies **6.b** Support and strengthen the participation of local communities in improving water and sanitation management	**6.3.1** Proportion of wastewater safely treated **6.3.2** Proportion of bodies of water with good ambient water quality **6.a.1** Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan **6.b.1** Proportion of local administrative units with established and operational policies and procedures
Goal 7: **Ensure access to affordable, reliable, sustainable and modern energy for all**	**7.1** By 2030, ensure universal access to affordable, reliable and modern energy services **7.2** By 2030, increase substantially the share of renewable energy in the global energy mix	**7.1.1** Proportion of population with access to electricity **7.1.2** Proportion of population with primary reliance on clean fuels and technology **7.2.1** Renewable energy share in the total final energy consumption

Goal 8: **Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**	**8.2** Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors	**8.2.1** Annual growth rate of real GDP per employed person
	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	**8.3.1** Proportion of informal employment in non-agriculture employment, by sex
	8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	**8.4.1** Material footprint, material footprint per capita, and material footprint per GDP **8.4.2** Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	**8.5.1** Average hourly earnings of female and male employees, by occupation, age and persons with disabilities **8.5.2** Unemployment rate, by sex, age and persons with disabilities
	8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	**8.8.1** Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status **8.8.2** Level of national compliance with labour rights (freedom of association and collective bargaining) based on International Labour Organization (ILO) textual sources and national legislation, by sex and migrant status

Goal 9: **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**	**9.4**	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	**9.4.1**	CO_2 emission per unit of value added
	9.a	Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States	**9.a.1**	Total official international support (official development assistance plus other official flows) to infrastructure
	9.b	Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities	**9.b.1**	Proportion of medium and high-tech industry value added in total value added
Goal 10: **Reduce inequality within and among countries**	**10.1**	By 2030, progressively achieve and sustain income growth of the bottom 40percent of the population at a rate higher than the national average	**10.1.1**	Growth rates of household expenditure or income per capita among the bottom 40 percent of the population and the total population
	10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status	**10.2.1**	Proportion of people living below 50 percent of median income, by sex, age and persons with disabilities
	10.3	Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard	**10.3.1**	Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law
Goal 11: **Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**	**11.6**	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	**11.6.1**	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities

Goal 12: **Ensure sustainable consumption and production patterns**	**12.2** By 2030, achieve the sustainable management and efficient use of natural resources **12.4** By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment **12.5** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse **12.8** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	**12.2.1** Material footprint, material footprint per capita, and material footprint per GDP **12.2.2** Domestic material consumption, domestic material consumption per capita and domestic material consumption per GDP **12.4.1** Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement **12.4.2** Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment **12.5.1** National recycling rate, tons of material recycled **12.8.1** Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
Goal 13: **Take urgent action to combat climate change and its impact**	**13.1** Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries **13.2** Integrate climate change measures into national policies, strategies and planning **13.3** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	**13.1.1** Number of countries with national and local disaster risk reduction strategies **13.2.1** Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other) **13.3.2** Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions

Goal 14: **Conserve and sustainably use the oceans, seas and marine resources for sustainable development**	**14.1**	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	**14.1.1**	Index of coastal eutrophication and floating plastic debris density
Goal 15: **Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss**	**15.3**	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	**15.3.1**	Proportion of land that is degraded over total land area

Goal 17: **Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development**	**17.6**	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	**17.6.1**	Number of science and/or technology cooperation agreements and programmes between countries, by type of cooperation
	17.7	Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed	**17.7.1**	Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies
	17.9	Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North-South, South-South and triangular cooperation	**17.9.1**	Dollar value of financial and technical assistance (including through North-South, South-South and triangular cooperation) committed to developing countries
	17.14	Enhance policy coherence for sustainable development	**17.14.1**	Number of countries with mechanisms in place to enhance policy coherence of sustainable development
	17.16	Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries	**17.16.1**	Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the sustainable development goals
	17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships	**17.17.1**	Amount of United States dollars committed to public-private and civil society partnerships

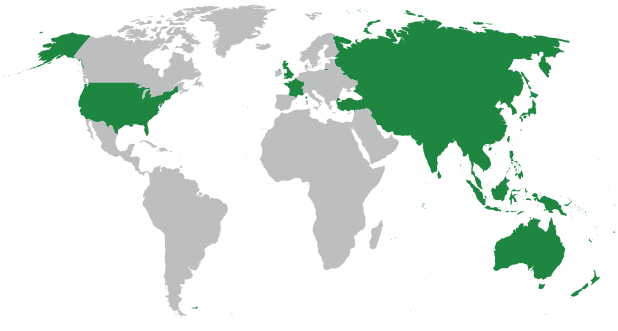
B. Transformative commitments and means of effective implementation of the New Urban Agenda where IRRCs have direct or indirect contributions

NUA transformative commitments	IRRC Contributions
34. We commit ourselves to promoting equitable and affordable access to sustainable basic physical and social infrastructure for all, without discrimination, including affordable serviced land, housing, modern and renewable energy, safe drinking water and sanitation, safe, nutritious and adequate food, waste disposal, sustainable mobility, health care and family planning, education, culture, and information and communications technologies. We further commit ourselves to ensuring that these services are responsive to the rights and needs of women, children and youth, older persons and persons with disabilities, migrants, indigenous peoples and local communities, as appropriate, and to those of others in vulnerable situations. In this regard, we encourage the elimination of legal, institutional, socioeconomic and physical barriers.	Direct
71. We commit ourselves to strengthening the sustainable management of resources, including land, water (oceans, seas and freshwater), energy, materials, forests and food, with particular attention to the environmentally sound management and minimization of all waste, hazardous chemicals, including air and short-lived climate pollutants, greenhouse gases and noise, and in a way that considers urban-rural linkages, functional supply and value chains vis-à-vis environmental impact and sustainability and that strives to transition to a circular economy while facilitating ecosystem conservation, regeneration, restoration and resilience in the face of new and emerging challenges.	Direct
74. We commit ourselves to promoting environmentally sound waste management and to substantially reducing waste generation by reducing, reusing and recycling waste, minimizing landfills and converting waste to energy when waste cannot be recycled or when this choice delivers the best environmental outcome. We further commit ourselves to reducing marine pollution through improved waste and wastewater management in coastal areas.	Direct
76. We commit ourselves to making sustainable use of natural resources and focusing on the resource efficiency of raw and construction materials such as concrete, metals, wood, minerals and land. We commit ourselves to establishing safe material recovery and recycling facilities, promoting the development of sustainable and resilient buildings and prioritizing the use of local, non-toxic and recycled materials and lead-additive-free paints and coatings.	Direct
NUA effective implementation	**Linkage**
119. We will promote adequate investments in protective, accessible and sustainable infrastructure and service provision systems for water, sanitation and hygiene, sewage, solid waste management, urban drainage, reduction of air pollution and storm water management, in order to improve safety in the event of water-related disasters, improve health, ensure universal and equitable access to safe and affordable drinking water for all, as well as access to adequate and equitable sanitation and hygiene for all and end open defecation, with special attention to the needs and safety of women and girls and those in vulnerable situations. We will seek to ensure that this infrastructure is climate resilient and forms part of integrated urban and territorial development plans, including housing and mobility, among other things, and is implemented in a participatory manner, considering innovative, resource-efficient, accessible, context-specific and culturally sensitive sustainable solutions.	Direct

122. We will support decentralized decision-making on waste disposal to promote universal access to sustainable waste management systems. We will support the promotion of extended producer responsibility schemes, including waste generators and producers in the financing of urban waste management systems and 17 reducing the hazards and social economic impacts of waste streams and increasing recycling rates through better product design.	Direct
123. We will promote the integration of food security and the nutritional needs of urban residents, particularly the urban poor, in urban and territorial planning, in order to end hunger and malnutrition. We will promote coordination of sustainable food security and agriculture policies across urban, peri-urban and rural areas to facilitate the production, storage, transport and marketing of food to consumers in adequate and affordable ways in order to reduce food losses and prevent and reuse food waste. We will further promote the coordination of food policies with energy, water, health, transport and waste policies, maintain the genetic diversity of seeds, reduce the use of hazardous chemicals and implement other policies in urban areas to maximize efficiencies and minimize waste.	Direct
NUA effective implementation	**Linkage**
126. We recognize that the implementation of the New Urban Agenda requires an enabling environment and a wide range of means of implementation including access to science, technology, and innovation and enhanced knowledge sharing on mutually agreed terms, capacity development, and mobilization of financial resources, taking into account the commitment of developed countries and developing countries, tapping into all available traditional and innovative sources at the global, regional, national, sub-national, and local levels as well as enhanced international cooperation and partnerships among governments at all levels, the private sector, civil society, the United Nations system, and other actors, based on the principles of equality, non-discrimination, accountability, respect for human rights, and solidarity, especially with those who are the poorest and most vulnerable.	Indirect
127. We reaffirm the commitments on means of implementation included in the 2030 Agenda for Sustainable Development and the Addis Ababa Action Agenda on Financing for Development.	Indirect

C. Possible contributions of IRRCs towards the implementation of Paris Agreement (Nationally Determined Contributions)

Improving solid waste management systems:
1. Improve solid waste management through transforming solid waste into organic fertilizer to support the agricultural system; and providing market development assistance for compost. Countries: Afghanistan, Bangladesh, Bhutan, China, India, Indonesia, Japan, Kiribati, Laos PDR, Myanmar, Nepal, Pakistan, Sri Lanka, Viet Nam. 2. Intensify the recovery and utilization of methane from landfills, and minimizes GHG emissions through application of zero waste concepts and sustainable waste management practices such as 3R principles. Countries: Afghanistan, Armenia, Bangladesh, Bhutan, China, Fiji, Indonesia, Japan, Kiribati, Maldives, Marshall Islands, Myanmar, Nepal, Palau, Sri Lanka, Thailand, Viet Nam. 3. Make GHGs reductions from waste and its transport, which can account for 20-50% of annual municipal budget. Countries: Marshall Islands, Palau, Kiribati, Mongolia, Nepal, Sri Lanka, Viet Nam. 4. Conduct international forums and conferences for the sharing of experiences in urban waste and management. Countries: Singapore
Improving energy efficiency through waste-to-energy solutions:
1. Promote environment-friendly power generation, and reduce pollution from non-recyclable waste through introducing new technologies that can transform waste into different types of energy source such as electricity. Countries: Afghanistan, Bangladesh, Cambodia, China, Fiji, India, Japan, Kiribati, Laos PDR, Myanmar, Nepal, Pakistan, Palau, Sri Lanka, Viet Nam. 2. Promote comprehensive reutilization of agricultural and forestry wastes and animal waste. Countries: China, Indonesia, Myanmar, Mongolia, Nepal Pakistan.
Improving waste segregation:
1. Reduce methane production in landfills by improving the waste segregation and recycling system through adopting new techniques such as pre-sorting of waste. Countries: China, India, Marshall Islands, Sri Lanka.



The green areas of the map represent the members and associate members of ESCAP

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