Regional Recycling Network Scoping Study

PRE-FEASIBILITY STUDY – MAIN REPORT

Pacific Region Infrastructure Facility

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Content

Appendices (separate report)

Tables

Figures

Country Abbreviations

Country	Country Code
Cook Islands	COK
Fiji	FJI
Federated States of Micronesia	FSM
Kiribati	KIR
Marshall Islands	MHL
Nauru	NRU
Niue	NIU
Palau	PLW
Papua New Guinea	PNG
Samoa	WSM
Solomon Islands	SLB
Republic of the Marshall Islands	MHL
Tonga	TON
Tuvalu	TUV
Vanuatu	VUT

List of Acronyms

Acronym	Definition
3R	Reduce, Reuse, Recycle
ABS	Australian Bureau of Statistics
ADB	Asian Development Bank
APCO	Australian Packaging Covenant Organization
ARF	Advanced Recycling Fee
ASTM	American Society for Testing and Materials
AUD	Australian Dollar
CAPEX	Capital Expenditure
CH4	Methane
CO_2	Carbon Dioxide
DBO	Design Build Operate
DBFO	Design, Build, Finance, Operate
DFAT	(Australian) Department of Foreign Affairs and Trade
DRS	Deposit Refund System
DSRA	Debt Service Reserve Account
EBIT	Earnings Before Interest and Tax
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
EFS	Environmental and Social Framework
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
ESS	Environmental and Social Standards
FCL	Foot Container Load
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GDP_{ppp}	Gross Domestic Product based on Purchasing Power Parity
GHG	Greenhouse Gas
HDPE	High Density Polyethylene
IFI	International Financial Institutions
IEC	Information Education and Communication
IMA	Inter-Municipal Association
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
IWMS	Integrated Waste Management System
LDPE	Low-Density Polyethylene
LME	London Metal Exchange
MEA	Multilateral Environmental Agreements
NPV	Net Present Value
OHS	Occupational Health and Safety
OPEX	Operational Expenditure
PET	Polyethylene
PFS	Pre-Feasibility Study
PIC	Pacific Island Country
POP	Persistent Organic Pollutants
ppm	Parts Per Million
PPP	Public-Private Partnership
ppp	Purchasing Power Parity
PRIF	Pacific Region Infrastructure Facility
PRO	Producer Responsibility Organization
PSP	Professional Service Provider
PUR	Polyurethane

Acronym	Definition
PVC	Polyvinylchloride
RRC	Regional Recycling Center
RMI	Republic of Marshall Islands
rPET	Recycled Polyethylene Terephthalate
R&D	Research and Development
SPREP	South Pacific Regional Environment Program
SWM	Solid Waste Management
ToR	Terms of Reference
TEU	20-Foot Equivalent Units
ULAB	Used Lead Acid Batteries
UNS	Unified Numbering System
USD	United States Dollar
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital

Executive Summary

E.1 Background

Poor waste management is a major threat to sustainable development in Pacific Island countries (PICs), where the lack of proper management could lead to serious negative consequences, including on health, environmental quality, water resources, fisheries, agriculture, tourism, trade, and food security.

In several PICs, waste management is an acute problem as urban populations increase, economies develop, and waste volumes increase. Such problems are particularly evident in small atoll islands where scarce land availability means that land used for landfill waste disposal compromises potable groundwater.

There is a wide range of options to address waste management in PICs, and development partners are providing support in most countries through bilateral and regional initiatives. These initiatives include improving disposal sites, establishing new landfills, supporting recycling initiatives and waste collection.

One way to manage solid waste is to minimize disposal by recovering waste materials through recycling. The co-benefits of recycling include the reduction of energy usage, consumption of fresh raw materials, air pollution, water pollution (from landfilling), and greenhouse gas emissions. Recycling can also generate positive economic impacts through job creation and private business opportunities.

In 2017, the Pacific Region Infrastructure Facility (PRIF) and the South Pacific Regional Environment Program (SPREP) commenced joint work to assess the potential for a regional recycling network and assess the feasibility of establishing a sustainable resource circulation system.

PRIF initiated this work by conducting a study which identified and quantified the opportunities to improve the resource recovery of 15 common commodities present in the solid waste stream in 15 PICs[1]. The first phase of the study conducted a material flow analysis of imports and exports, estimated the available materials for recovery and quantified the expected increase in commodities based on various policy interventions. The results were published in *Pacific Region Solid Waste Management and Recycling - Pacific Country and Territory Profiles*.[2]

The key finding of the report is that, based on annual import and export data for the 15 recyclable materials, approximately 4.7 million tons were imported annually into the region with only 1 million tons exported.

The conclusion drawn from the report is that a large proportion of the imported materials remain onshore and should be available for recovery and recycling but material flows in individual countries were too small to be feasibly processed. Shipping to countries such as Australia was cost-

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[1] Cook Islands, Fiji, Federated States of Micronesia, Guam, Kiribati, New Caledonia, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Vanuatu

[2] https://www.theprif.org/sites/default/files/documents/prif_waste_book_web_0.pdf

prohibitive based on distance. Considering this, the report recommended that processing should occur at a regional level in the Pacific.

The report also identified that several PICs were adopting policy mechanisms that will stimulate the Reduce, Reuse, Recycle, Recover and Return philosophy that is key to developing the 'circular economy'. Mechanisms include extended producer responsibility, container deposit schemes, advance recycling fees, environmental taxes and levies, user-pays or pay- as-you-throw fees, product bans or a combination of measures. For example, Kiribati, Palau, RMI and FSM have made positive progress on container deposit schemes policy, while Tuvalu has launched the first advanced recycling fee for the Pacific with most other Pacific Island countries moving toward adoption. Another recommendation of the report is to establish a Pacific region wide container deposit schemes and extended producer responsibility programs under a regional framework.

The second phase of the work required a systematic and comprehensive waste audit program on representative samples to corroborate and validate the import and export data.

PRIF, in collaboration with PICs, SPREP, the Pacific waste management program (PACWASTE PLUS), the Global Environment Facility and the United Nations Environment Program, developed a standard methodology for waste audits in 2018 that was tested in Tuvalu in 2019. The methodology covers audits of household curbside waste, commercial premises, and landfills, and assesses current collection systems and infrastructure; collected data could be compared and aggregated to scope a regional recycling network.

Between 2019 and 2021, PRIF and partner agencies used the PRIF standard methodology to conduct waste audits in 15 Pacific Island Countries. Regular meetings were conducted to ensure synergies were maintained, particularly during the coronavirus disease (COVID-19) pandemic. With the waste data available for all countries, data on waste generation and stockpile materials became available for analysis. PRIF and partner agencies initiated the scoping of a regional recycling network in November 2021.

E.2 The Regional recycling network scoping study

The first step was to conduct a market assessment to identify the materials that would be viable for the development of sustainable business chains and to undertake a demand analysis of the potential markets. The market assessment identified 16 waste streams with a total volume of 1 million tons per annum in the region. Eight priority waste streams were identified following a multi-criteria assessment process.[3] From these, aluminum cans, used lead acid batteries (ULABs), and polyethylene terephthalate (PET) plastic were identified as potentially sustaining business cases under current regional and international conditions, with potential expansion to add value to the waste value chain.

Three potential recycling options solutions were considered, including (1) investment in best practice compaction and related improvements of the target waste streams in all 14 countries; (2) investment in value-adding technologies and related improvements of the target waste streams in a hub in Fiji and improved compaction and related improvements in eight node countries; and (3) investment in value-adding technologies and related improvements of the target waste streams in a

[3] The priority waste streams are aluminum cans, used lead acid batteries (ULABs), polyethylene terephthalate (PET) plastic, scrap steel, steel cans, paper and cardboard, glass bottles, and plastic bags, including plastic film.

hub in Fiji and Papua New Guinea (PNG), and improved compaction and related improvements in all 14 countries. Option 3 was selected for pre-feasibility assessment.

E.3 Regional recycling network pre-feasibility assessment

The option that was taken forward focuses on upgrading the facilities and networks in Fiji and PNG with value-adding processing for metals (excluding scrap steel), plastic, and paper/cardboard waste streams. At the same time, the option considered the upgrade required in other PICs through financial and technical investment to achieve best practice compaction and shipping. The anticipated outcome is that there is deliberate improvement to the percentage of the target waste streams that are collected, processed, and exported to international markets (except for glass).

The infographic illustrated below (Figure ES1) provides a summary of the key factors considered including level of investment required, internal rate of return, connectivity, economic and financial considerations, market access greenhouse gas, among others.

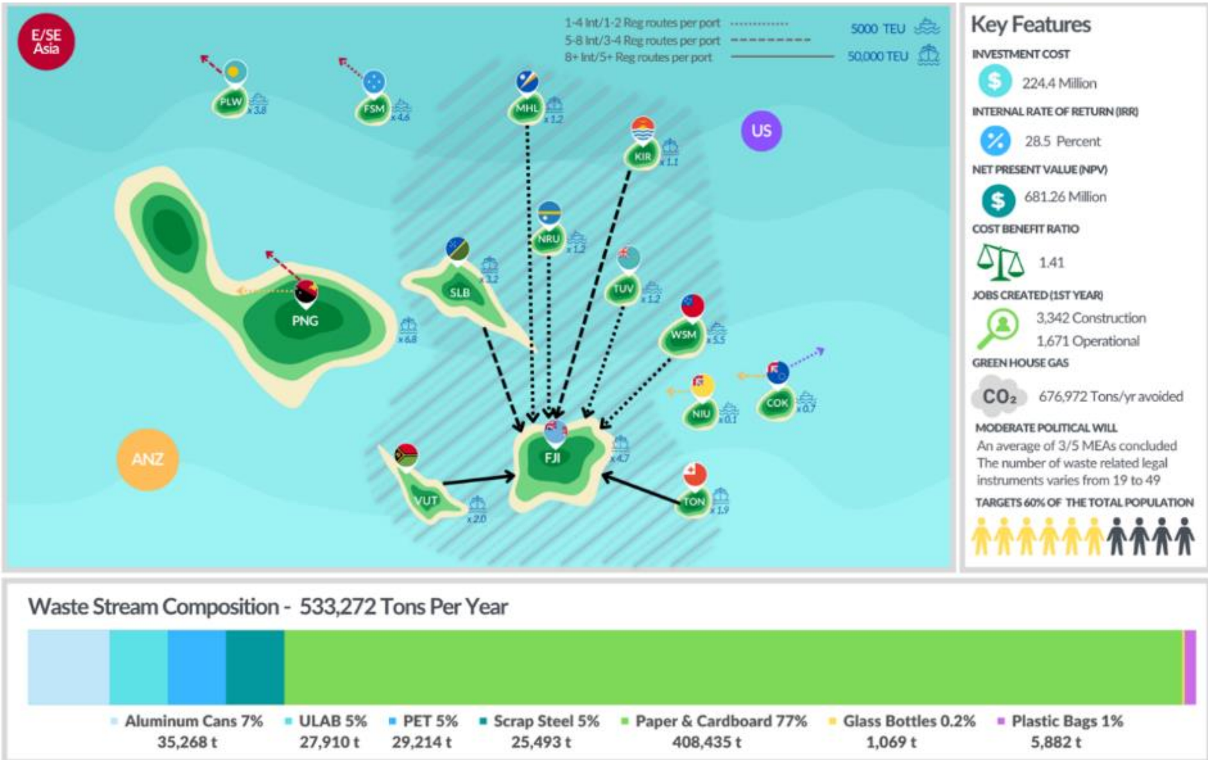

Figure ES1 Summary of Assessed Option

ANZ = Australia/New Zealand, COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MEA = multilateral environmental agreement, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TEU = 20-foot equivalent unit, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

E.3.1 Assessment of waste streams

It is estimated that 533,272 tons of waste, or approximately 55% of the 968,812 tons of waste generated annually, would be captured by the recycling facilities and recycled. The remaining 45% is not captured by the system and is disposed of in each of the islands' landfills, dumpsites, and other locations.

On a country-by-country basis, each waste stream was assessed by its ability to return a positive net revenue after considering updates to the following components: revenue streams (subsidy, gate fee, unit sale price) and maintenance and operational costs (facility operation and maintenance, transport to and from the facility, cost of depositing non-recycled wastes). Unprofitable materials were not considered any further.

The products of higher value will be generated in Fiji through regional compounding efforts and PNG through national compounding efforts. Input materials for Fiji would be segregated nationally and received regionally in pre-segregated and high-density forms from feed-in PICs. Input materials for PNG would be segregated nationally and then fed into domestic value-added systems. All high-value materials would be either processed into ingots (aluminum cans and ULABs), hot-washed flakes (PET and plastic film) or turned into Kraft cardboard and paper.

The products of lower value would be generated in all source countries through national collection and compaction efforts. All materials from non-hub PICs would enter directly into the global/international market without value-add activities, either compacted (aluminum cans, scrap steel), baled (PET, paper and cardboard, plastic film), crushed (glass), or palletized (ULABs). Scrap steel, as an entire waste stream, will also directly enter the international market at low value output. Similarly, glass is a low-value market, but domestically.

E.3.2 Technologies

Depending on the waste stream, the country, the product produced, and the final use, there are four categories of recommended technologies for recycling the eight priority waste streams. These include *Value Added*, *Improved Compaction*, *Pallet and Wrap*, and *Crushing*. Aluminum cans, for example, can be shredded, melted, and purified in a furnace, and cast into ingots for further sale. Other needed equipment, such as forklifts, pallet scales, collection bins, and vehicles, etc. have been considered.

This report has identified that, for all eight priority waste streams in all 14 countries' facilities and concentration centers would be required (where there is a viable business case) that will then transport materials either nationally, regionally (to the Fiji hub) or internationally. It is not envisaged that facilities where concentration centers operate will be any more complex than those that currently exist in the Pacific, although the volume of waste that would be collected and processed is expected to double.

There are two types of facilities that have been identified for the regional recycling center (RRC). The first type of RRC collects, concentrates, and transports waste streams to other facilities. The second type of RRC receives waste streams that have been concentrated and reprocesses these into new value-added intermediate or final products for the marketplace.

Siting of waste facilities is a complex and multi-dimensional process and approaches will differ from area to area and in accordance with the size and potential impacts of the waste activities to be conducted. A critical component in considering where a facility should be sited includes development of specific and relevant siting criteria, including a list of exclusionary siting factors based on relevant policy and legislation, as well as economic and environmental factors.

The capacity to move the expected tons of waste, however, does not significantly impact the current capacity of feed-in countries, nor does it impact the current capacity of non-hub countries to ship waste using existing published routes. Half of the PICs will continue to require less than 1% of the current 20-foot equivalent shipping containers.

E.3.3 Financial and economic aspects

Costs and benefits associated with the installation and operation of the recommended recycling option, as well as a calculation of the financial profitability and sustainability of the facilities (including an economic benefit-cost ratio of the project) have been identified through a two-step approach.

All costs have been identified for each of the 14 PICs through a full-fledged financial and economic analysis, as well as for all islands combined into one project. The recycling facilities and hubs gives an internal rate of return (IRR) of 28.5% and a net present value (NPV) of the cash flow of $681 million based on the individual islands' real discount rates. The minimum IRR is 11.1% and the largest IRR is 78.2%. Based on the assumptions outlined above, the profitability of the recycling facilities and hubs is good.

With the given assumptions, a recycling facility project is financially sustainable when there are positive cash flows every year, and the project sponsor can repay loans taken, as well as pay dividends on the provided equity. Given the size of the annual profit, the project sponsor can accumulate equity after having serviced the annual loan obligations.

A sensitivity analysis has revealed that a recycling project is very sensitive to changes in the unit sales prices of the recycled waste. Hence, if the unit sales prices fluctuate, it may be a severe risk to the profitability of the recycling project. On the other hand, if recycling prices are stable, as it appears today, the risk will not be significant. Waste amounts, on the other hand, do not severely influence the profitability of recycling projects. The IRR remains at a relatively high level with lower waste amounts.

If capital expenditures become 20% more expensive than the baseline estimate, recycling project profitability attains an IRR of 15%, and it becomes riskier. Operational and maintenance costs, on the other hand, can increase by 60% and the project is still profitable, with an IRR around 15%. This also holds for transportation costs, which do not severely endanger the profitability of the project, even if they turn out to be different from the baseline assumptions.

It has not been possible to outline a specific financing structure at this pre-feasibility study stage. However, given that many of the smaller islands' debt management strategies only allow external borrowing operations with a large grant element and a significant number of grace periods, the specific islands' recycling facilities will not be attractive as a standalone project financed by any international finance institution (IFI). Further, the size of most of the recycling projects is also not attractive for an IFI whose financing may only be attracted if several recycling facilities are bundled. Hence, only domestic grant and loan financing, as well as potential promotional financing, has been assumed for the recycling facilities on 12 of the islands. The size of the recycling hub investment on Fiji and PNG allows, however, for IFI financing.

E.3.4 Economic benefits and costs

Other economic costs to the society following implementation of the recycling center (which are less easy to quantify) have been identified as: (i) environmental impacts through recycled waste streams, in particular from inadequate recycling practices (including emissions); (ii) lost economic activity for pickers; and (iii) emissions through additional shipping and local transport activities.

Economic benefits have been calculated using different adjustments to the above cash flow to correct fiscal distortions. The following economic benefits have been identified and quantified: (i) resource savings as the recycling facility eliminates or reduces waste going to the landfill; (ii) reduced leachate generated due to reduced amount of waste deposited at the landfill; (iii) avoided cost of

CO_2 through recycling calculated by the amount used to produce 1 ton of the waste fraction multiplied by the total amount of the waste fraction recycled; (iv) additional employment generated in the recycling facility; and (v) reduction in greenhouse gas emissions due to the recycling facility.

The analyses have been conducted in line with the World Bank's Environmental and Social Framework and Standards to promote improved environmental and social performance in ways that recognize and enhance capacity.

As such, the establishment of an RCC has the potential to bring about a range of environmental and social benefits across the PICs, including, e.g., the conservation of natural resources through reuse of existing materials, increased lifespan of landfills through reduced amounts of waste being deposited, or the improvement of community health and well-being in general through improved waste management practices and job creation.

E.3.5 Institutional arrangements

Arrangements for waste management cover organizational structures and roles and responsibilities of related public and private sector institutions. These arrangements must meet good governance requirements to enable effective, efficient, and sustainable waste collection, recycling, and disposal services that are preserving environmental quality and protect public health. Good governance in waste management requires transparent, accountable, efficient, and effective institutions.

However, the PICs, like other small development states, have small, often scattered populations that must cover a variety of competencies like health, education, or environmental management, including waste management. With institutional fragmentation, along with few staff having the necessary education and skills and a high degree of turnover, sustainable waste management is challenging for governments. Common requirements for institutional arrangements must therefore first be implemented.

Regional integration through coordination, planning, and cooperation is crucial for the success of recycling systems in general and specific waste streams in particular. However, it is premature to specify an operational model at the pre-feasibility study stage given the many variables which currently exist. To do so would artificially constrain the future choices given the many unknown variables which will not be revealed until a detailed feasibility study is conducted.

E.3.6 Policy framework

To enable a sustainable RRC, behavioral change with respect to the priority waste streams will be necessary. To cultivate this change, the development, implementation, monitoring, and enforcement of an evidence-based, appropriate mix of regulatory, economic, and social policy instruments, coupled with investments in waste management systems and infrastructure, will be necessary.

The mix of policy measures and the investments should be guided by key waste management principles, such as "Polluter Pays". This mix should encourage material reuse as well as diversion of waste from disposal in landfills or dumping to recycling. Currently, the focus in waste is mostly on collection in the PICs.

The development of the integrated waste management system should be aligned with broader planning in a range of sectors that are generating waste and/or are affected by the lack of sustainable waste management, including tourism, fisheries, maritime transport, food and agriculture, and coastal development.

E.3.7 Risks

Apart from missing/inadequate institutional arrangements, other risks that could influence the success of the project have been identified for a variety of categories, from environmental to financial, institutional, operational, and social risks. Each risk has undergone a detailed analysis to identify the cause, its potential impact, and recommended mitigation measures. Major risks include: (i) mismanagement of residuals and associated risks to the environment and local population; (ii) price volatility in the recycling market, which could influence profitability and long-term sustainability of the RRC; (iii) lack of technical skill to implement and sustain the RRC; (iv) lack of waste management services and drop-off points, which can lead to environmental pollution and drain valuable resources from the system; and (v) shipping cost volatility, which will have a greater impact on small PICs, and can cause the regional recycling center to become uneconomical.

E.3.8 Road Map

The implementation of the RRC shall be conducted in consecutive steps over 5 years, starting with a preparation phase. This includes more in-depth discussions with interested off-takers of recyclables and obtaining letters of intention/interest from them, which will form the basis of the project and facilitate later discussions with interested IFIs. A kick-off meeting (as well as regular roundtable discussions thereafter) between all 14 PICs will set the stage for their future cooperation. Phase I will be concluded by a regional full feasibility study that will focus on optimizing collection/sorting of recyclables and determine infra-structure needs.

Phase II is dedicated to the implementation of the project and covers the following steps: (i) determining funding sources; (ii) design, tendering, and construction of required infrastructure/purchase of equipment; and (iii) negotiating framework contracts with interested off-takers/recyclers.

The entire project must be accompanied by public awareness measures (stakeholder inclusivity), which essentially means the effective involvement of all public and private stakeholders in the decision-making process and the effective participation of all stakeholders in the collection and recycling systems.

1 INTRODUCTION

In 2021, the Pacific Region Infrastructure Facility (PRIF) launched the consultancy entitled *Regional Recycling Center – Scoping Study* (PRIF Technical Assistance Project). The consultancy was awarded to COWI (Denmark) in cooperation with Marine Plastic Solutions (Australia).

The following reports were part of the consultancy:

- Inception Report: Detailed workplan; approach and methodology; initial waste audit data analysis; and comments on the Terms of Reference (ToR) - (*completed in January 2022*)
- Market Assessment Report: Analysis and findings of the regional recycling potential, market assessment of potential buyers vs volume to make it economically viable or level of subsidy required for viability (Activities 1 to 5) – (*completed in May 2022*)
- Options Report: Details of the options and the results of the options assessment for consideration by the working group (Activities 6 to 8) – *(completed in August 2022)*
- Draft Final Report: Draft PFS of the selected option for the recycling hub, including roadmap for the establishment of a Pacific Regional Recycling Network (Activities 9 to 11) - *(completed in November 2022)*
- Final Report: Revised PFS based on feedback and comments of the working group (Activities 12 and 13) – *(this report)*

The Draft Final Report was presented to the PRIF Urban Development Working Group[4] for review and feedback on 29 November 2022. Comments and suggestions have been incorporated in this Final Report.

1.1 Background

In Pacific Island Countries (PICs), inadequate waste management has the potential to negatively impact national development activities, including tourism and trade, food supplies, public health, and the environment. Recycling has largely been limited to non-ferrous metals as a staple, combined with episodic collection and export of ferrous metals and sometimes waste oil when global commodity prices make this a profitable activity.

Factors such as distance from viable markets, costs, reliability of shipping, low volumes of recyclable materials, lack of market use, and technical and human resources constraints lead to cardboard/paper, glass, plastics, and e-waste being stranded and adding to the general waste stream being burned, buried, and dumped in a polluting manner given the dearth of sanitary landfills.

[4] Members of the PRIF Urban Development Working Group include technical staff of Asian Development Bank, Australian Department of Foreign Affairs and Trade, European Union, European Investment Bank, Japan International Cooperation Agency, New Zealand Ministry for Foreign Affairs and Trade, United States Department of State, the World Bank Group, the South Pacific Regional Environment Program, PACWASTE PLUS and JPRISM programs.

Most materials entering the Pacific are stranded at the end of product value chains that are, in most cases, linear. The way forward involves purposeful programs to build new waste value chains such as the Department of Foreign Affairs and Trade (DFAT) Strongim Bisnis interventions and the International Union for Conservation of Nature IUCN Plastic Waste Free Islands pilots that mapped existing systems, identified barriers and benefits, and seek business approaches systematically.

The eight waste streams prioritized in the options report have been considered based on volumes, market value, viability of the business case and other considerations. In identifying suitable recycling network options, six conceptual models had been considered, compared, and scored, including a Fiji Hub with eight 'feed-in countries (nodes)', Minor Hubs, National Hubs, Combination Fiji Hub/National Hub, a Floating Hub, and a Virtual Hub. Based on this assessment, the Consultant recommended OPTION 3, i.e., the Combination Hub, as the most favorable option. This recommendation was endorsed by PRIF during a workshop held on 22 June 2022.

1.2 This Report

This report describes in further detail OPTION 3 presented in the previous report (Network Options), which was selected as the preferred option for the recycling network. The information provided includes the following elements taken from the overall Project Objectives from the terms of reference:

- Technical, environmental, social, financial and economic pre-feasibility
- Roadmap for the establishment of a Pacific Regional Recycling Network
- Recommendations on governance arrangements

It provides an overview of the existing situation (Chapter 3), and then proceeds to describe the preferred option as selected under the previous task of this Technical Assistance (Chapter 4).

Chapter 5 provides an overview of environmental impacts and benefits, as well as climate resilience issues.

Chapter 6 goes into details on financing and economics, covering a benefit-cost analysis, financial profitability, and sustainability, together with a sensitivity analysis.

Institutional arrangements, legal and regulatory frameworks, and public-private partnership (PPP) prerequisites are discussed as part of Chapter 7.

Chapter 8 provides a timeline and roadmap for implementation of the regional recycling center, together with recommended further studies and an overview of other donor activities currently taking place or being planned in the region.

Risks are covered under Chapter 8, showing both risks that result from the project and risks that influence the project's success. Mitigation strategies have been provided for each risk and they have been ranked according to their likelihood and severity.

Finally, Chapter 9 provides the overall conclusions of the study.

Several Appendices further elaborate certain aspects of the study, including a risk register, as well as a separate financial and economic analysis of each PIC.

1.3 Methodology

There is no pre-defined structure for a PFS, but the consultants have used the Asian Development Bank's (ADB), Cities Development Initiative for Asia (CDIA) Guidelines (2016) as overall guidance. The objective of the PFS is to determine the merit and feasibility of the previously selected investment opportunity (OPTION 3). Specifically, the PFS determines whether the proposed investment provides sufficient value to warrant the use of scarce resources (e.g., money, skills, time, etc.) and therefore whether it is worth proceeding to the next stage in the development process and conducting a full feasibility study.

The PFS builds on the Options Report that was previously prepared under this Technical Assistance and included a review of regional recycling options and priorities along with an initial scoping and costing and overall assessment of other relevant aspects. As such, this PFS provides a technical, financial, environmental, and social assessment at a level of detail sufficient to engage in a full feasibility study.

The report includes sections on limitations, economics, markets, shipping, technical, environmental and social sections as well as other components of the financial assessment, including greenhouse gas (GHG) assessments (waste and shipping), creation of jobs, Benefit-Cost and Sensitivity analysis.

It also includes the specific basis of estimate related to the development of input costs, including the range of different shipping costs per ton (based on country of origin, waste types, subsidy), different waste subsidies (government and private sector), different performance of waste facility equipment/value adding on waste/product weight.

Although a large part of the study is dedicated to the required infrastructural investments, it also addresses crosscutting subjects such as institutional, environmental and social issues in an integrated and holistic manner with related impacts clearly identified

.

2 Existing Situation

2.1 Solid Waste Management Baseline

2.1.1 Network Options Report estimate

In the Network Options Report, preceding this PFS Report, eight priority waste streams were reviewed based on their potential for value chain development. These waste streams included aluminum cans, used lead acid batteries (ULAB), polyethylene terephthalate (PET) plastic, scrap steel, steel cans, paper and cardboard, glass bottles, and plastic bags (inc. plastic film). The report estimated that these waste streams from municipal sources totaled 1,012,849 tons/year.

However, as noted in the previous report, information from a variety of sources identified that many of the eight target waste streams are not primarily generated from municipal waste sources. In Australia,[5] for example, it was identified that municipal solid waste made up only 16% of all solid waste, including only 20% of metal waste, 40% of paper and cardboard, and 50% of plastic wastes.

The report therefore cautioned that the volumes of target waste streams identified at that time should therefore be considered the minimum for the Pacific with larger quantities expected for many of the waste streams.

Table 1 Presence of Quantitative Data in Waste Audit Reports

Country	Aluminum Cans	Glass Bottles	Paper & Cardboard	PET	Plastic Bags	Scrap Steel	Steel Cans	ULAB	% Data points provided
COK	No	Yes	No	No	No	No	No	No	**13%**
FJI	No	Yes	Yes	Yes	Yes	No	No	No	**50%**
FSM	No	Yes	Yes	No	No	No	No	Yes	**38%**
KIR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**100%**
MHL	No	Yes	Yes	No	No	No	No	No	**25%**
NRU	No	Yes	Yes	No	No	No	No	Yes	**38%**
NIU	No	Yes	Yes	No	No	No	No	Yes	**38%**
PLW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**100%**
PNG	Yes	No	No	No	No	Yes	No	No	**25%**
WSM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**100%**

[5] Australian Bureau of Statistics, 2020.

SLB	Yes	No	No	No	Yes	No	No	No	**25%**
TON	Yes	No	No	Yes	Yes	Yes	Yes	Yes	**75%**
TUV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**100%**
VUT	No	No	No	No	No	No	No	No	**0%**
% Data points provided	**50%**	**71%**	**64%**	**46%**	**47%**	**40%**	**33%**	**53%**	

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The Options Report also identified that there was a notable lack of quantitative information across the countries, with a most scoring below 50%. Even where quantitative data were collected, the waste audits were spread across several different consultancies, each often having different teams in each country and results were therefore variable. Other report and data limitations, which are also valid for this PFS Report, are provided in 0 and 0.

2.1.2 Final Estimate for the Prefeasibility Report

To correct for a potential underestimation of the volumes of the eight waste priority waste streams and to present the best possible estimates for the prefeasibility study, further benchmarking has occurred to improve data estimates.

For those priority waste streams that are expected to include large volumes from sources other than just municipal wastes (industrial, construction, automotive, agricultural, utility), the most reliable source of benchmark information is available from the Australian Bureau of Statistics (ABS).

ABS uses industry and regulatory waste volume information that has been collected for a number of decades, and is used in this report as a benchmark to provide a total estimate of the volumes of used scrap steel, used lead acid batteries as well as paper and cardboard, which were not well quantified in Pacific Island waste audits that focused on municipal waste.

For aluminum cans and PET plastic bottles, information from Palau was used since this information is collected under the best-regulated and longest-run container deposit system in the Pacific and was considered to provide the best benchmark for other Pacific Islands with no or low-quality quantitative data.

In both cases, the benchmarked data from the Australian and Palau sources have then been adjusted following the World Bank approach of using gross domestic product (GDP) price parity per capita (GDPppp)[6] that was utilized in the global estimates of municipal waste in every country in the publications *What a Waste 1.0* and *What a Waste 2.0*.[7]

Table 2 below provides a comparison of different estimates for the eight priority waste streams, including estimates from the adjusted Pacific waste audit quantitative data (primarily from municipal

[6] Worldometer, 2020.

[7] Hoornweg & Bhada-Tata, 2015; Kaza et al., 2018.

sources), which is presented in previous reports, and the data now provided through benchmarking against Australian and Palauan data sources.

Table 2 Comparison of Waste Audit Volumes vs New Benchmarks

Priority Waste Stream	Waste Audits* T/Yr	Australia Benchmark T/Yr	Palau Benchmark T/Yr	Final Estimate used T/Yr	Difference T/Yr
Aluminum Cans	93,398	N/A	56,173	**56,173**	-37,225
ULAB	9,314	37,175	N/A	**37,175**	27,861
PET	66,247	N/A	55,683	**55,683**	-10,564
Scrap Steel (incl. Steel Cans)	485,689 (+56,674 Steel Cans)	1,354,732	N/A	**1,354,732**	869,043
Paper and Card-board	328,862	748,933	N/A	**748,933**	7,584.3
Glass Bottles#	57,182	N/A	N/A	**57,182**	N/A
Plastic Bags#	5,197	N/A	N/A	**5,197**	N/A

ULAB = used lead acid battery, PET = polyethylene.
**As presented in the Market Assessment and Network Options Reports. # No suitable benchmarks available.*
Note: Australian data for ULAB, steel and cardboard; Palau data for aluminum and PET.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The final adjusted estimates for used scrap steel (including steel cans), ULAB, paper and cardboard, aluminum cans and PET plastic bottles are considered to reflect actual volumes of these priority waste streams more accurately than the adjusted waste audit reports. For example, in Table 4, the estimated volume of ULAB generated in Fiji of 3,011 tons per annum (using the new benchmarked approach) now closely matches new industry estimates provided by Pacific Batteries[8] in Fiji of 3,200 tons per annum.

The new benchmarked volume of PET plastic bottles of 5,024 tons generated in Fiji per annum also matches Coca-Cola Fiji's[9] own estimates of 5,000 tons. This is a much better correlation than previous estimates.

The new generation baseline is shown in Table 4. The final captured fraction (Table 7) is achieved through a business case assessment where materials with no business case are eliminated (Table 5) and assessment and removal of recyclables not captured by the hub are shown in Table 6. Total volumes are summarized in Table 3 below.

[8] Pers com Mr Diwakar Dubey General Manager Pacific Batteries Fiji - Suva, Fiji, 2 November 2022

[9] Per coms with Mr Roger Hare General Manager Coca Cola Fiji - Suva, 1 November 2022

Table 3 Summary of Estimate for Captured Recyclable Volumes

Annual Metrics	Tons/Year	Reference Table
Estimated Total Generation Volume (t)	2,342,120	Table 4
Estimated of Total Generation for Recycling After Business Case Elimination (t)	968,812	Table 5
Estimate of Captured Wastes to be Recycled (t)	**533,272**	Table 7

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 4 Estimate of Total Generated Recyclables

Country	Aluminum Cans	ULAB	PET	Scrap Steel	Paper and Cardboard	Glass Bottles	Plastic Bags	Total
COK	154	71	174	2,603	1,439	68	119	4,629
FJI	4,901	3,011	5,024	109,733	60,659	6,453	3,422.11	193,203
FSM	580	376	581	13,699	7,573	273	396	23,478
KIR	538	376	519	13,720	7,584.3	332	353.39	23,423
MHL	308	195	311	7,124	3,938	280	212.11	12,369
NRU	76	40	83	1,459	806	197	56	2,717
NIU	26	8	25	204	170	29	17	479
PLW	146	71	163	2,583	1,428	318	111	4,820
PNG	43,089	28,800	42,518	1,049,582	580,194	35,680	28,961.71	1,808,824
WSM	1,029	654	1,039	23,852	13,185	1,725	707.87	42,193
SLB	3,209	2,190	3,135	79,807	44,116	2,572	2,135.64	137,165
TON	565	352	575	12,837	7,096	565	391.95	22,382
TUV	61	39	62	1,420	785	234	42	2,643
VUT	1,489	991	1,472	36,109	19,960	2,768	1,003	63,793
Grand Total	**56,173**	**37,175**	**55,683**	**1,354,732**	**748,933**	**51,495**	**37,929**	**2,342,120**

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 5 Estimate of Generated Recyclables After Business Case Eliminations

Country	Alumi-num Cans	ULAB		PET	Scrap Steel	Paper and Card-board	Glass Bottles	Plastic Bags	Total
COK	154	71		174			68	119	586
FJI	4,901	3,011		5,024		60,659		3,422	77,017
FSM	580	376		581	13,699		273		15,510
KIR	538	376		519	13,720	7,584.3	332	353.39	23,423
MHL	308	195		311	7,124	3,938	280	212.11	12,369
NRU	76	40		83			197	56	452
NIU	26	8		25			29	17	105
PLW	146	71		163	2,583	1,428	318		4,709
PNG	43,089	28,800		42,518		580,194		28,962	723,562
WSM	1,029	654		1,039		13,185		708	16,616
SLB	3,209	2,190		3,135		44,116	2,572	2,136	57,358
TON	565	352		575		7,096	565	392	9,545
TUV	61	39		62	1,420	785	234	42	2,643
VUT	1,489	991		1,472		19,960		1,003	24,916
Grand To-tal	**56,173**	**37,175**		**55,683**	**38,546**	**738,945**	**4,868**	**37,422**	**968,812**

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 6 Proportion of Recyclables not Captured by Hub

Country	Aluminum Cans	ULAB	PET	Scrap Steel	Paper & Cardboard	Glass Bottles	Plastic Bags
COK	30%	20%	50%	30%	50%	70%	70%
FJI	20%	10%	35%	15%	3%	65%	65%
FSM	40%	25%	50%	30%	50%	70%	70%
KIR	5%	5%	5%	45%	45%	65%	65%
MHL	50%	40%	50%	25%	45%	65%	50%
NRU	10%	10%	45%	65%	85%	85%	65%
NIU	20%	20%	50%	50%	50%	90%	70%
PLW	10%	20%	20%	30%	50%	40%	70%
PNG	40%	25%	50%	40%	50%	90%	90%
WSM	40%	10%	45%	35%	45%	85%	65%
SLB	30%	45%	45%	35%	30%	85%	65%
TON	40%	25%	45%	45%	45%	85%	65%
TUV	10%	10%	15%	15%	45%	75%	65%
VUT	40%	40%	45%	50%	50%	65%	65%

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 7 Captured Fraction of Recyclable Wastes

Country	Aluminum Cans	ULAB	PET	Scrap Steel	Paper and Cardboard	Glass Bottles	Plastic Bags	Total
COK	108	57	87		-	20	36	308
FJI	3,921	2,710	3,266	-	58,839	-	1,198	69,934
FSM	348	282	291	9,589	-	82	-	10,592
KIR	511	358	493	7,546	4,171.3	116	123.69	13,319
MHL	154	117	156	5,343	2,166	98	106.06	8,140

Country	Aluminum Cans	ULAB	PET	Scrap Steel	Paper and Cardboard	Glass Bottles	Plastic Bags	Total
NRU	69	36	46	-	-	29	20	199
NIU	21	6	12	-	-	3	5	47
PLW	131	57	130	1,808	714	191	-	3,031
PNG	25,853	21,600	21,259	-	290,097	-	2,896	361,705
WSM	618	589	572	-	7,252	-	248	9,278
SLB	2,247	1,204	1,724	-	30,881	386	747	37,190
TON	339	264	316	-	3,903	85	137	5,044
TUV	55	35	53	1,207	432	59	15	1,855
VUT	893	594	810	-	9,980	-	351	12,629
Grand Total	**35,268**	**27,910**	**29,214**	**25,493**	**408,435**	**1,069**	**5,882**	**533,272**

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

2.2 Waste Flows

On a country-by-country basis, each waste stream was assessed on its ability to return a positive net revenue after considering updates to the following components: revenue streams (subsidy, gate fee, unit sale price) and maintenance and operational costs (facility operation and maintenance, transport to and from the facility, cost of depositing non-recycled wastes). Unprofitable materials were not considered any further.

This results in the total volume of wastes targeted of 533,272 tons per year, of which 72,786 tons are processed twice by the hub system. That is, the first processing efforts are encountered in the feed-in nations (improved compaction and export) and the second through value-add processing activities in the Fiji hub. This equates to a processed volume of recyclables of 606,057 tons per year (Figure 1).

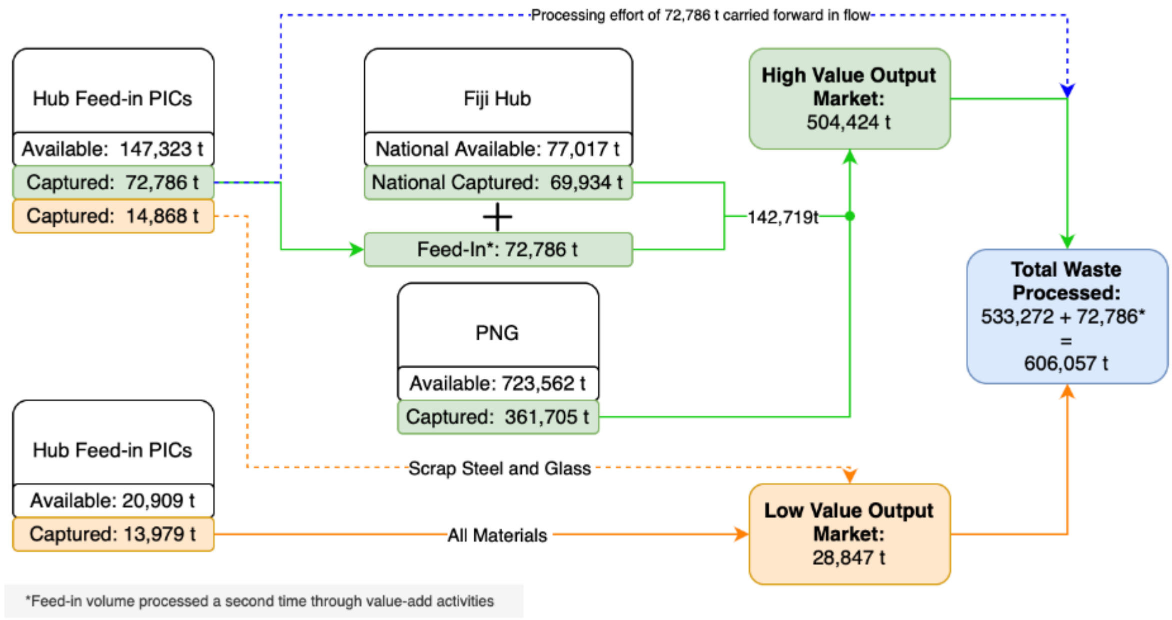

Figure 1 Flow of Recyclable Materials Through Processing Complexity Stages and End Markets

PIC – Pacific Island country, PNG = Papua New Guinea.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Figure 2 shows the flows and fates of recyclables from each PIC, whether they are expected to be captured by the system or not, and what the fate of the captured material is (to the hub or not). The Fiji hub, therefore, expects to process 142,720 tons of recyclables each year, with 390,552 tons managed outside the Fiji hub, dominated by PNG's waste contribution of 361,705 tons that will be processed to achieve similar output materials as Fiji.

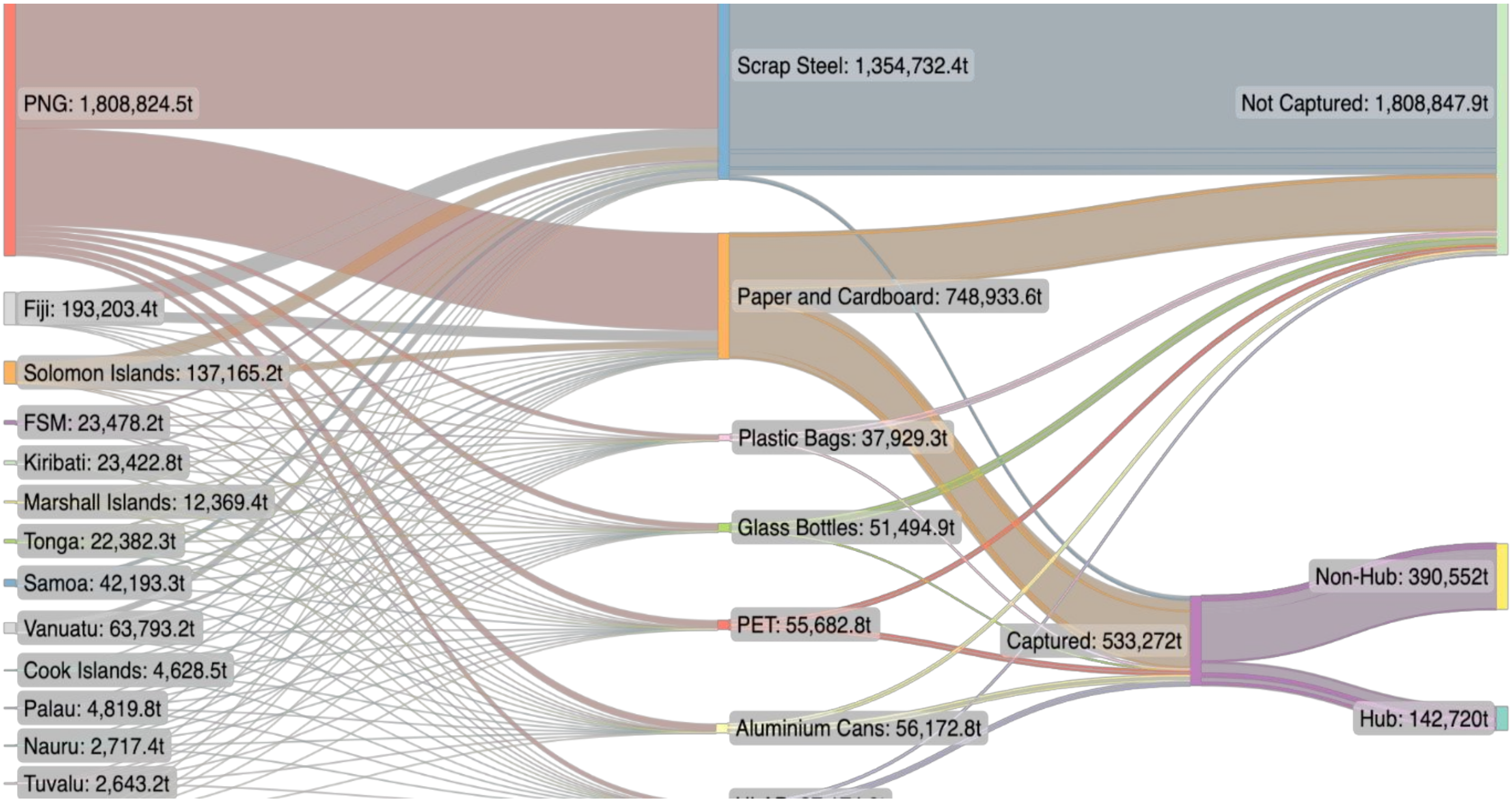

Figure 2 Flows of Recyclables to be Captured and Not Captured

FSM = Federated States of Micronesia, PNG = Papua New Guinea, PET = polyethylene.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3 Selected Option

3.1 General Description

In the selected option, it was assumed that the Fiji hub and PNG upgraded their national investment with value-adding processing for metals (excluding scrap steel), plastic, and paper/cardboard waste streams and that all remaining PICs upgraded through financial and technical investment to achieve best practice compaction and shipping. The anticipated outcome is that there is deliberate improvement to the percentage of the target waste streams that are collected, processed, and exported to international markets (with the exception of glass).

It is also assumed that the price paid for the value-added target waste streams would be discounted in feed-in PICs due to long-term purchase arrangements and/or establishment of in-country buying centers for the hub. It is also assumed higher prices can be paid in Fiji and PNG due to the development of a superior value chain for the target waste streams and that this generates greater participation in collected volumes.

Potentially harmful emissions and residues from value-adding processes would need to be managed, especially related to ULAB recycling. Such reprocessing already occurs in Fiji (Pacific Batteries).

Most of the economic and financial metrics are higher given the higher investment/higher return aspect in value-adding in both the regional hub and nationally in PNG (Table 8).

Table 8 Summary – Combination Hubs

Aspect	Description
Location	Fiji Hub/National Hub
Countries Included	Cook Islands, Fiji, FSM, Kiribati, RMI, Nauru, Niue, Palau, PNG, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
Type Waste Products Processed	Aluminum, Used Lead Acid Batteries, PET, Paper & Cardboard, Plastic Bags (Plastic Film)
Type Waste Products Produced	Metal ingots, hot washed plastic granules, intermediate paper cardboard product (Fiji hub/PNG) High Compaction Bales (all other countries)
Type of Waste Facility	Receival Location(s), storage/receival bays, equipment buildings, furnaces, battery reprocessing units, paper/cardboard pulpers, ingots castors, cardboard molds, comminution device, compactors, bailers, plasma cutters, forklifts, pallet scales, collection vehicles, collection bins (cardboard, plastic bags/film especially), equipment spares, power supplies, administrative equipment
Volume (t)	533,272

Aspect	Description
Value of the recyclables (mil. USD)	$328.95
Potential markets	Asia (lead ingots, aluminum ingots, PET plastic pellets, plastic film pellets) Australia (scrap steel, PET and low-density polyethylene (LDPE) pellets, cardboard/paper pulp) New Zealand (cardboard/paper pulp) Pacific Islands (lead for batteries, aluminum for input to extrusion products, cardboard/paper pulp for boxes, egg cartons, compostable plant pots, briquettes, glass for construction sand)
EBIT (mil. USD)	$83.7
Net Present Value - NPV (mil. USD)	$681.26
Internal Rate of Return - IRR	28.5%
Investment cost in total (mil. USD)	$224.4
Annual operating cost (mil. USD)	$234.44 (*includes transport)*
Transport cost (mil. USD)	$97.24
Expected NPV of Economic Benefits (mil. USD) 20 Years	$744.61
Benefit/Cost Ratio	1.41

EBIT = Earnings Before Interest and Tax, NPV = net present value, IRR = internal rate of return, PNG = Papua New Guinea, FSM = Federated States of Micronesia, RMI = Republic of Marshall Islands.
Note: NPV and IRR are calculated over a 20-year analysis period.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The Combination Hub infographic illustrated below (Figure 3) provides a summary of the key factors. It shows that it is economically feasible based on costs and benefits, jobs created, financial forecasting and in GHGs abated.

The infographic illustrates that connectivity and shipping for countries in the Fiji Regional Hub is good, which in turn has excellent access to multiple international markets and good access for most countries out of the hub, with some exceptions (Cook Islands, Nauru, Niue, and Tuvalu)

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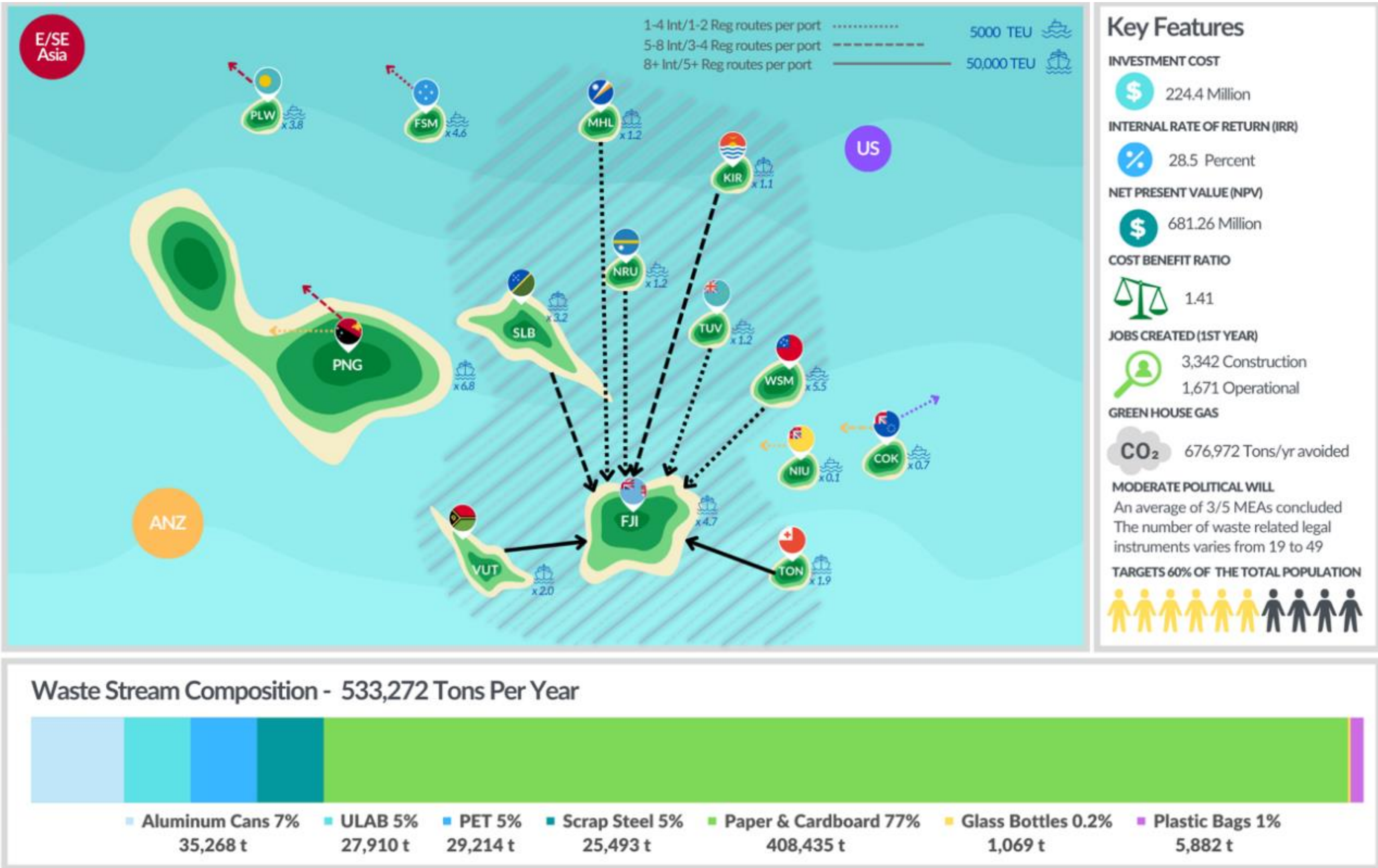

Figure 3 Summary of Assessed Option

ANZ = Australia/New Zealand, COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MEA = multilateral environmental agreement, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TEU = 20-foot equivalent unit, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

In this option, other countries participating in the scheme are upgraded to achieve best practice compaction and shipping connectedness, and that there is an improvement in the percentage of the target waste streams that are collected, processed and exported to international markets (with the exception of glass).

Around 55% of the available 968,812 tons per year will be captured (Table 9). Due to the impact of the volume of waste attributed to PNG (68% by weight), this option captures a significant number of recyclables.

The Fiji hub will contribute 13% of the total volume using materials generated from Fiji's national recyclable wastes but will process an additional 14% from feed-in nations for select materials (aluminum cans, ULAB, PET, paper and cardboard, plastic bags/film) by weight for value-add solutions.

The remaining wastes are accounted for by countries that do not feed into the Fiji hub and materials such as glass that are most suitably processed nationally. Overall, the materials with the most tons recycled will be paper and cardboard, aluminum cans, PET, ULAB, and scrap steel, while the least volumes are glass and plastic film.

Table 9 Recovered Waste Materials

Material	Recycled Tons/yr.	Available Tons/yr.	% of Available Material
Aluminum Cans	35,268	56,173	63%
ULAB	27,910	37,175	75%
PET	29,214	55,683	52%
Scrap Steel	25,493	33,546	66%
Paper & Cardboard	408,435	738,945	55%
Glass Bottles	1,069	4,868	22%
Plastic Bags (Plastic Film)	5,882	37,422	16%
Total	**533,272**	**968,812**	**55%**

PET = polyethylene, ULAB = used lead acid battery.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.2 Choice of Technology

There are four categories of technology choice for recycling the eight priority waste streams in Option 3. These include Value Added, Improved Compaction, Pallet and Wrap and Crushing. Table 10 below provides a summary of the choice of technology relating to the recycling outcome, country, waste stream, product, and final use of those products nationally, regionally, or if it is to be exported internationally.

Table 10 Technology Choice in Preferred Network Option

Recycling Outcome	Countries Included	Waste Stream	Recycling Technology	Product Produced	Final Uses
Value Added	Fiji (Regional Hub) Papua New Guinea	Aluminum Cans	Aluminum Furnace	Aluminum Ingots	Extruded Aluminum Products (Fiji hub & PNG) International Export
		ULAB	Battery Reprocessing Facility	Lead Ingots	Lead acid batteries and other products (Fiji hub & PNG) International Export
		PET	Granulation and wash plant	PET and film Flake	Recycled Polyethylene Terephthalate (rPET) Resin manufacture (Fiji hub & PNG) International Export
		Paper & Cardboard	Kraft Cardboard Recycling Plant	Cardboard and paper rolls	Cardboard Boxes and other paper/cardboard products (Fiji hub & PNG) International Export
Improved Compaction	All Countries	Aluminum Cans	High-strength compactor	Compacted Bales	Regional Export (Fiji hub) International Export
		PET	High-strength bailer	Compacted Bales	Regional Export (Fiji hub) International Export
		Paper & Cardboard	High-strength baler	Compacted Bales	Regional Export (Fiji hub)

Recycling Outcome	Countries Included	Waste Stream	Recycling Technology	Product Produced	Final Uses
					International Export
		Scrap Steel (including steel cans)	High-strength compactor	Compacted Bales	International Export
Pallet and Wrap	All Countries	ULAB	Wrapped Pallets	Pallets of ULAB	Regional Export (Fiji hub) International Export
Crushing	All Countries	Glass Bottles	Glass crusher	Crushed Glass	National Use Sand substitute for concrete, etc.

PNG = Papua New Guinea, PET = polyethylene, ULAB = used lead acid battery.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.3 Technology Description

3.3.1 Value-Added Technologies

This report has identified value-added technologies as having the greatest possibility to be implemented within the Fiji hub and PNG based on the viability of business cases, economics, and other factors for aluminum Cans, ULAB, PET and plastic film, and Paper/Cardboard.

The potential technologies for each of these waste streams is identified below.

(i) Aluminum Cans

For aluminum cans, the value-added technology involves processing into ingots, as shown in the simplified diagram in Figure 4.

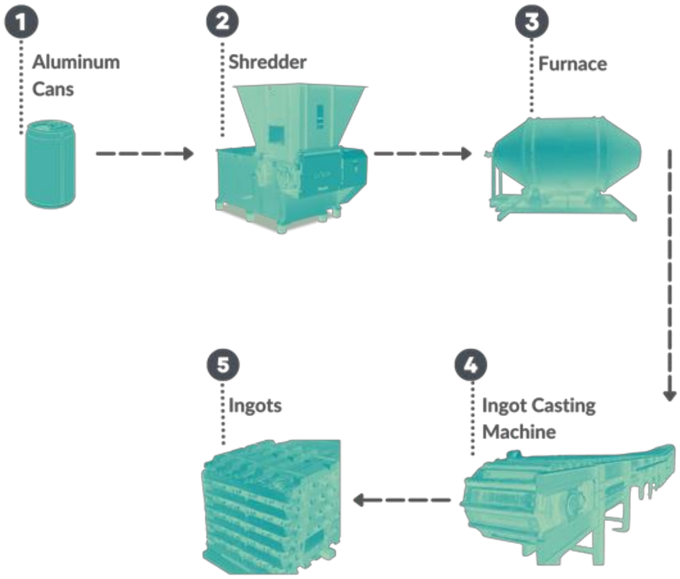

Figure 4 Value Adding Process for Aluminum Cans

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The figure above shows the initial processing in Stage 2 where the aluminum cans are shredded. The shredded cans are then transferred to the furnace in Stage 3 where they are melted at 700 degrees Celsius and mixed with additives to remove impurities. The molten aluminum then progresses to Stage 4 where it is transferred into the ingot casting machine with the final ingots being secured to pallets ready for market sale in Stage 5.

While the Pacific Islands do not currently have such value-adding facilities for aluminum, there are similar capabilities, for example, in Fiji with BlueScope Steel in using waste oil-fired furnaces to process imported steel billets into reinforced steel bars. There are small-scale versions of aluminum ingot manufacturing facilities in Australia, operating in similar economic circumstances.

Other equipment that will be needed includes receival points, storage/receival bays, equipment buildings, forklifts, pallet scales, collection vehicles, collection bins, equipment spares, power supplies, and administrative equipment.

(ii) Used Lead Acid Batteries

For ULABs, the value-added technology involves processing into lead ingots, as indicated in the simplified diagram in Figure 5 below.

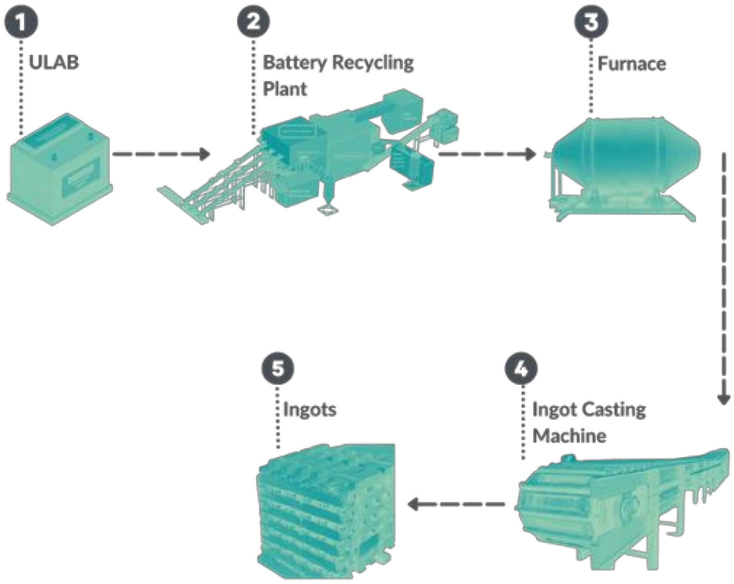

Figure 5 Value-Adding Process for Used Lead Acid Batteries

ULAB = used lead acid battery.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The figure above shows the initial processing in Stage 2 where the batteries are dismantled, the plastic fraction is removed, the acid is removed and treated, and the lead components are concentrated. This is followed by Stage 3 where the lead components are melted at 328 degrees Celsius and mixed with additives to remove impurities. The molten lead is then progressed to Stage 4 where it is transferred into the ingot casting machine with the final ingots being secured to pallets ready for market sale in Stage 5.

The Pacific Islands currently can process ULABs into lead ingots for use by Pacific Batteries to manufacture batteries (4,000 tons a year) for sale in Fiji, the Pacific (particularly PNG), and internationally. Pacific Batteries has an interest in doubling production. Lead ingots are also sold domestically in Fiji by Dominion Batteries.

Lead processing does cover environmental and human health risks, and assessments in 2019 of Pacific Batteries by the International Lead Association revealed several concerns with ventilation, staff management, and lead blood levels. Pacific Batteries, however, has undergone an upgrade of their system, which was endorsed by the International Lead Association and greatly reduced lead blood levels.

Other equipment that will be needed includes receival location(s), storage/receival bays, equipment buildings, forklifts, pallet scales, collection vehicles, collection bins, equipment spares, power supplies, and administrative equipment.

(iii) PET Plastic (Plastic Film)

For PET plastic bottles, the value-added technology required to produce hot washed PET flake involves processing into granulated PET in a size range of 3mm to 12mm and also washing and refining it to ensure purity. This follows several process stages, as indicated in the simplified diagram provided in Figure 6 below.

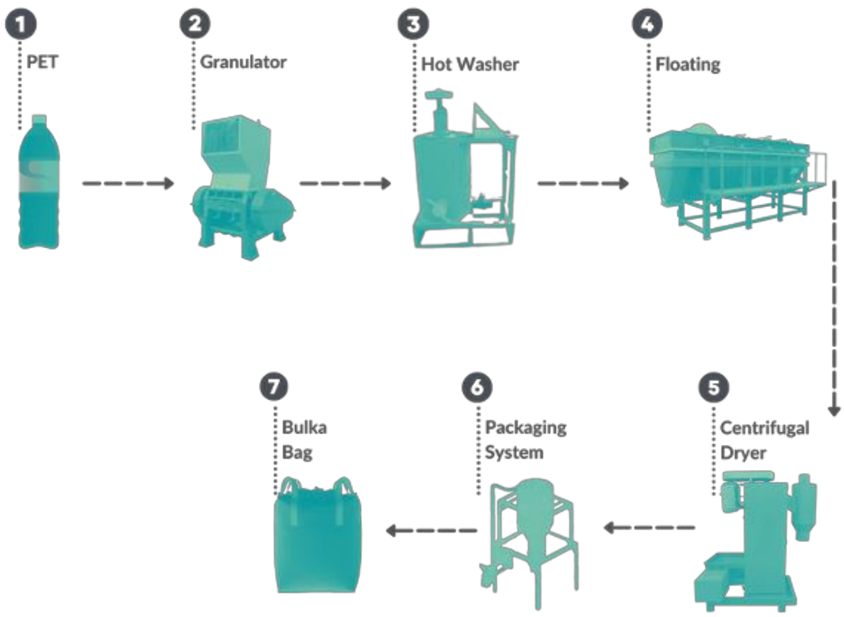

Figure 6 Value-Adding Process for PET Plastic Bottles

PET = polyethylene.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

This figure shows the initial processing in Stage 2 where the PET bottles are shredded into a uniform size and then transferred to a hot washer in Stage 3 which cleans the granulated PET to a high standard. The washed PET granules are then transferred to a floater in Stage 4 which removes other plastics. The purified PET granules are then transferred to a dryer in Stage 5, then packaged in Stage 6 where it is then loaded into bulk bags ready for market sale in Stage 7.

While the Pacific Islands do not currently have such value-adding facilities for PET and plastic film there is similar capabilities in the other recyclables targeted for value adding. There are small-scale versions of PET value-added manufacturing facilities operating in similar economic circumstances.

Other equipment that will be needed includes receival location(s), storage/receival bays, equipment buildings, forklifts, pallet scales, collection vehicles, collection bins, equipment spares, power supplies, and administrative equipment.

(iv) Paper and Cardboard

The value-added technology required to produce kraft paper and cardboard involves processing these waste streams first into cardboard/paper pulp and into rolls through several treatment and refining steps. This follows several process stages as indicated in the simplified diagram provided in Figure 7 below.

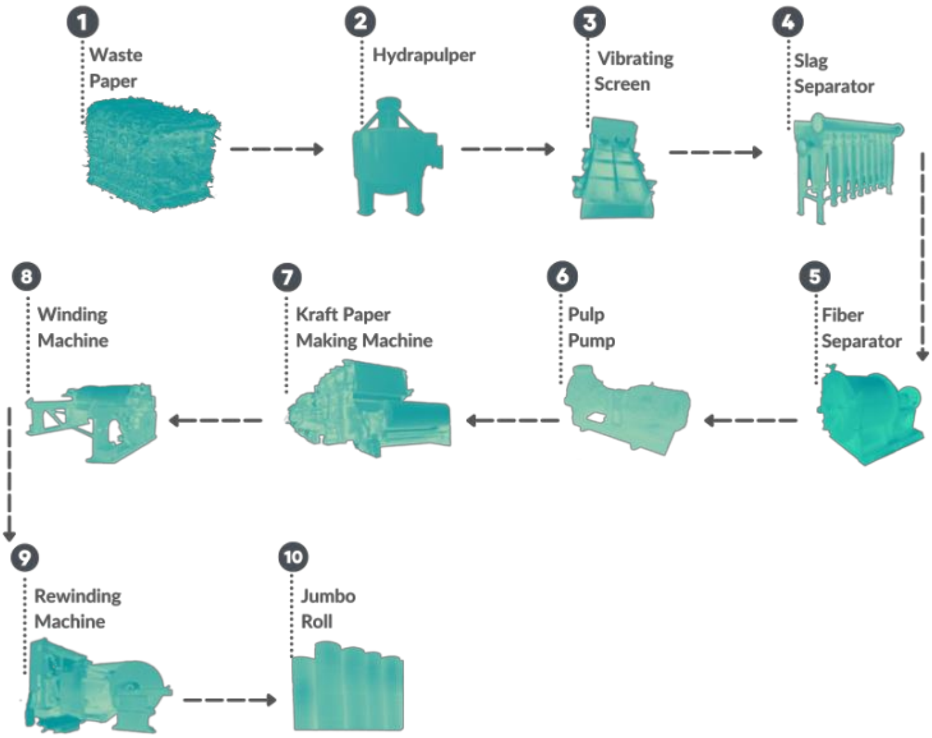

Figure 7 Value-Adding Process for Paper and Cardboard

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The figure above shows the initial processing in Stage 2 where the cardboard and paper is introduced into the hydra pulper which converts it into pulp. The pulp is then progressively processed through vibrating screens (Stage 3), grit and slag separators (Stage 4) and then fiber separators (Stage 5).

The refined and processed pulp is then transferred via the pulp pump (Stage 6) into the kraft paper/cardboard making machine (Stage 7) and then onto the winding machines (Stage 8 and 9) where it is prepared as Kraft paper/cardboard rolls ready for market sale in Stage 10.

The Pacific Islands currently have an ability to process used paper into commercial paper roles following a process very similar to that required for kraft cardboard production. South Pacific Waste Recyclers can annually process 8,000 tons of paper into toilet paper for sale in Fiji, where they have 60% of the market. South Pacific Waste Recyclers has an interest in expanding for both paper and cardboard.

Other equipment that will be needed includes receival location(s), storage/receival bays, equipment buildings, forklifts, pallet scales, collection vehicles, collection bins, equipment spares, power supplies and administrative equipment.

3.3.2 Improved Compaction Technologies

Improving compaction of collected aluminum cans, PET plastic bottles, paper and cardboard and scrap steel is essential to improving the value chain and in creating and maintaining viable business cases. Currently in the Pacific, there are only a few examples of improved compaction equipment present, with most recyclers using underpowered compactors and balers, which are producing 20-foot container loads of aluminum cans as low as eight to 12 tons, PET bales of four to six tons, and cardboard bales of only eight tons.

High-capacity metal compactors and plastic/cardboard balers can accommodate 18 and even 20 tons of aluminum cans and scrap steel and up to 14 tons of PET plastic bottles and cardboard. Though such equipment is typically more expensive, this can be recouped given high fixed costs including shipping where backloading is not provided and profit per shipment can be substantially increased. Examples of higher performance equipment are provided below.

(i) Aluminum Cans

Aluminum can compactors in the Pacific Islands typically have low levels of performance, with 20-foot container loads as low as seven tons reported from Tuvalu, average loads of only 12 tons from most of the recyclers in the Solomon Islands, and 15 to 17 tons in Kiribati and the Marshall Islands. However, better small machines suitable for the Pacific can be found, as shown in Figure 8 below.

Figure 8 High-Compression Aluminum Can Compactor

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Cost restrictions and the relatively low compaction in the small compactors suitable for the Pacific explains some of the poor outcomes, as does access to three-phase electricity (also limits use to lower power machines) or technical knowledge.

However, some small but powerful aluminum compactors have been identified and research is being conducted to further improve them.[10] The figure above shows an affordable lightweight (800

[10] University of Newcastle is piloting such work in collaboration with the private sector in the Solomon Islands.

kg) prototype of a compactor capable of 600–650 kg/m^3 of compaction. This is being piloted in the Pacific and could produce 20-foot container loads of 20 to 22 tons of aluminum cans of the shelf. This is also being piloted with a portable one-phase to three-phase invertors to avoid the need for fixed three-phase capability.

(ii) PET Plastic bottles, Paper and Cardboard and Plastic Film

For PET Plastic bottles, Paper and Cardboard and Plastic Film, Pacific performance has also been poor with very light loads, which has negatively impacted value chain development. PET bottle balers have produced poor results with 20 FCL loads reported as low as four tons and none of more than seven tons reported to date. More powerful small machines suitable for the Pacific for high-density loads are shown in Figure 9 below.

Figure 9 High Compression PET Bottle/Cardboard Baler

PET = polyethylene.

Source: LSM 2022.

The baler in the figure above is capable of baling PET Plastic bottles, Paper and Cardboard and Plastic Film to densities of 450–500 kg/m^3, which translates into 20 FCL weights of 14 to 16 tons, which is more than double what is currently being achieved. The same limiting factors occur for balers as with the compactors, with the Pacific default being cheap, small, and low-powered units due to cost restrictions, single-phase power limitations, and a lack of technical knowledge.

3.3.3 General Factors for Facilities

Siting of waste facilities is a complex and multi-dimensional process and approaches will differ from area to area and in accordance with the size and potential impacts of the waste activities to be conducted.[11]

The actual process would therefore have to be adjusted according to the national and regional circumstances and variations in accordance with the different jurisdiction's requirements and the benefits and impacts would have to be considered.

A critical component in considering where a facility should be sited includes development of specific and relevant siting criteria, including a list of exclusionary factors based on relevant policy and legislation, as well as economic and environmental factors. The established exclusionary factors would then be used as a starting point for defining unsuitable and suitable land areas.

Depending on the facility activities, typical exclusionary siting factors include current and anticipated incompatible land uses, local zoning restrictions, or lack of transportation access. A waste centroid analysis is also essential (to identify suitable sites in broad geographic terms), along with a cost/finance analysis to consider the feasibility and impacts on the business case.

Typical facility siting factors that would have to be considered are summarized in the Table 11 below.

Table 11 Major Factors in Facility Site Selection

Major Factor	Considerations
Environmental and human health risk	The potential for air and water quality pollution, groundwater pollution, contamination issues (lead processing) and the transport impacts, noise, and visual impact
Economic issues	The facility's effect on property values, its construction and operating costs, and its impact on local industry and the community (including job creation)
Regulatory	Land zoning and use, approval processes, permitting, licensing and other regulatory requirements would all need to be considered
Operational issues	Availability of water, sewer, and energy (gas, electricity, etc.) utility availability would need to be considered, transport (including shipping) and proximity to target waste streams, work force and markets, required use of fuel for the furnace, and access and storage of fuel
Social issues	Land use compatibility, equity in site choice, the effect on community image, aesthetics, and alternative and future land uses, perceived risks in the facility operations
Political issues	Impacts on elections, community groups' vested interests, site management responsibility and local control

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

A list of criteria for evaluating and ranking potential sites should be developed; those that meet the most criteria should receive the highest ranking. The level of complexity, effort, and time, as well as

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[11] US Environmental Protection Agency, National Environmental Justice Advisory Council. 2000. *A Regulatory Strategy for Siting and Operating Waste Transfer Stations*. https://www.epa.gov/sites/default/files/2015-02/documents/waste-trans-reg-strtgy.pdf.

formal process requirements, would be proportional to the size, complexity and potential impact of the facility. A summary of the process for site selection is provided in Figure 10 below.

Figure 10 Facility Site Selection Process

Source: King County, 2022.

This report has identified that, for all eight priority waste streams in all 14 countries, concentration centers will be required (where there is a viable business case) for further transport of materials either nationally, regionally (to the Fiji hub), or internationally. The report further identified that, for five of the priority waste streams, value added processes would be required in facilities for Fiji (acting as a regional hub) and Papua New Guinea facilities.

It is not envisaged that concentration centers will be any more complex than those that currently exist in the Pacific, though the volume of waste collected and processed is expected to double. This means either new facilities are developed, or existing ones improved and enlarged. For facilities established for value adding, it is expected that there would be a considerable increase in waste volumes processed, particularly in PNG.

While there would be a doubling of the waste processed in Fiji for ULAB and Paper, PET and Cardboard would require new facilities. How these facilities are configured is unknown as they could be distributed across several operators and geographic locations, or they could be centralized. It is beyond this report to identify this, but the expectation would be a larger number of disseminated collection points (transfer stations/waste banks, etc.) in geographic nodes within countries that feed into a lower number of concentration points, which in turn export or feed into value-adding facilities.

3.3.4 Types of Facilities

There are two types of facilities that have been identified in the preferred options for the RRC. The first type of recycling center collects, concentrates, and transports waste streams to other facilities. The second type receives waste streams that have been concentrated and reprocesses these into new value-added intermediate or final products for sale to the marketplace.

Table 12 below provides a summary of the types of facilities that are required geographically and for each waste stream.

Table 12 Facility Type for Value Adding and Concentration

Recycling Outcome	Countries Included	Waste Stream	Facility Type	Facility Technology	Area Required	Location
Value Added	Fiji (Regional Hub) Papua New Guinea (PNG)	Aluminum Cans	Value Adding	Aluminum can shredder Furnace Ingot Casting machine	10,000 sqm per 5,000 ton processed	Commercial land near port and urban areas identified through site selection process. Fiji Western Province is the preferred location.
			Concentration	General Compaction/Baling	2,500 sqm per 5,000 ton processed	Close to waste catchment areas identified through waste centroid analysis
		ULAB	Value Adding	Battery Recycling Plant Furnace Ingot Casting machine	10,000 sqm per 5,000 ton processed	Commercial land near port and urban areas identified through site selection process. Fiji Western Province is the preferred location.
			Concentration	Pelleting	2,500 sqm per 5,000 ton processed	Close to waste catchment areas identified through

Recycling Outcome	Countries Included	Waste Stream	Facility Type	Facility Technology	Area Required	Location
						waste centroid analysis
		PET (Plastic Film)	Value adding	PET hot wash processing plant	10,000 sqm per 5,000 ton processed	Commercial land near port and urban areas identified through site selection process. Fiji Western Province is the preferred location.
			Concentration	General Compaction/Baling	2,500 sqm per 5,000 ton processed	Close to waste catchment areas identified through waste centroid analysis.
		Paper & Cardboard	Value adding	Kraft Cardboard Recycling Plant	10,000 sqm per 5,000 ton processed	Commercial land near port and urban areas identified through site selection process. Fiji Western Province is the preferred location.
			Concentration	General Compaction/Baling	2,500 sqm per 5,000 ton processed	Close to waste catchment areas identified through waste centroid analysis.
Improved Compaction	All Countries	Aluminum Cans	Concentration	High compression compactor	2,500 sqm per 5,000 ton processed	Close to waste catchment (or port) areas identified through waste centroid analysis.

Recycling Outcome	Countries Included	Waste Stream	Facility Type	Facility Technology	Area Required	Location
		PET	Concentration	High strength bailer	2,500 sqm per 5,000 ton processed	Close to waste catchment (or port) areas identified through waste centroid analysis.
		Paper & Cardboard	Concentration	High strength bailer	2,500 sqm per 5,000 ton processed	Close to waste catchment (or port) areas identified through waste centroid analysis.
		Scrap Steel (Including Steel Cans)	Concentration	High compression compactor	2,500 sqm per 5,000 ton processed	Close to waste catchment (or port) areas identified through waste centroid analysis
Pallet and Wrap	All Countries	ULAB	Concentration	Pallet Wrapper Pallets	2,500 sqm per 5,000 ton processed	Close to waste catchment (or port) areas identified through waste centroid analysis
Crushing	All Countries	Glass Bottles	Concentration	Glass crusher	2,500 sqm per 5,000 ton processed	Close to waste catchment areas identified through waste centroid analysis

Source: personal communication with Pacific Batteries/South Pacific Waste Recyclers, 2022.

3.3.5 Other Needs for Facilities

It is not envisaged that the needs of the waste facilities for either the collection or value adding require any special or specific infrastructure beyond what has been procured for existing recycling activities. This study envisages at least a doubling in waste collected and a fourfold increase in value adding activities, but this can be built on existing practice and is not producing more advanced products than are currently produced in the Pacific (notably Fiji).

The same type of recyclables/products are already transported throughout the Pacific. No new requirements for customs are anticipated as increased loads for recyclables are insignificant as a percentage of total shipping. Existing infrastructure, systems, and capacity are considered sufficient.

Other needs that are specifically missing include finance, government support (which does exist in Fiji in the form of import tariffs and freedom from VAT), ongoing access to technical expertise, market knowledge and development, and equipment.

3.3.6 Shipping Logistics

Moving the expected tons of waste does not significantly impact the current capacity of feed-in countries, nor does it impact the current capacity of non-hub countries to ship waste using existing published routes. Half of the PICs will continue to require less than 1% of the current 20-foot equivalent shipping containers (TEUs).

TEUs handled annually (seven of 14 PICs), Kiribati, Solomon Islands, and Tuvalu will require less than 2% of the current TEUs handled annually, and Samoa and FSM will require less than 3% to move their recyclable wastes. Fiji will only require an additional 4% to the current management of TEU movement within the ports, and 6.9% for PNG (Table 13).

Both Fiji and PNG are well equipped to manage high container movement volumes and have highly regular and frequent shipping. Fiji receives 1,973 port calls annually (approximately 165 a month),[12] and PNG receives 2,863 calls annually (approximately 239 a month).[13]

Table 13 Estimated Proportion of TEUs to Currently Handled TEUs for Managing Waste

Country	Waste TEUs	TEUs Handled/Year	% Waste TEUs to TEUs Handled
COK	19	3,632	0.5%
FJI	9,327	234,064	4.0%
FSM	537	22,954	2.3%
KIR	752	52,712	1.4%
MHL	446	58,350	0.8%
NRU	11	6,157	0.2%
NIU	3	447	0.6%
PLW	160	18,823	0.8%
PNG	23,443	338,300	6.9%
WSM	611	27,444	2.2%
SLB	2,440	161,163	1.5%
TON	328	96,475	0.3%
TUV	99	5,946	1.7%
VUT	837	99,556	0.8%

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, VUT = Vanuatu, TEU = 20-foot equivalent shipping container.
Note: 3-year average (2017–2019 incl.) from World Bank data and Index Mundi 2020.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team & World Bank 2020.

The number of shipping agents within the Fiji hub network is typically three to four per country, except for Nauru which has one to two. The number of shipping routes connecting one PIC to another is high for Fiji (18+ routes)[14] and is strongly linked to hub-participating PICs. Major shipping lines are Kyowa, Mariana Line, Matson, NPDL, and Swire. Given the very low impact that even the increased volumes of waste envisaged to be collected in this study will have on total volumes, there is no

[12] UNCTAD 2020a.

[13] UNCTAD 2020b.

[14] Kokusai Kogyo Co., Ltd. & Yachiyo Engineering Co., Ltd. 2021

apparent need for specific shipping infrastructure to be provided beyond what is already commercially available and used.

3.4 Output Material

A summary of the intended level of processing and output markets for materials is presented in Figure 11.

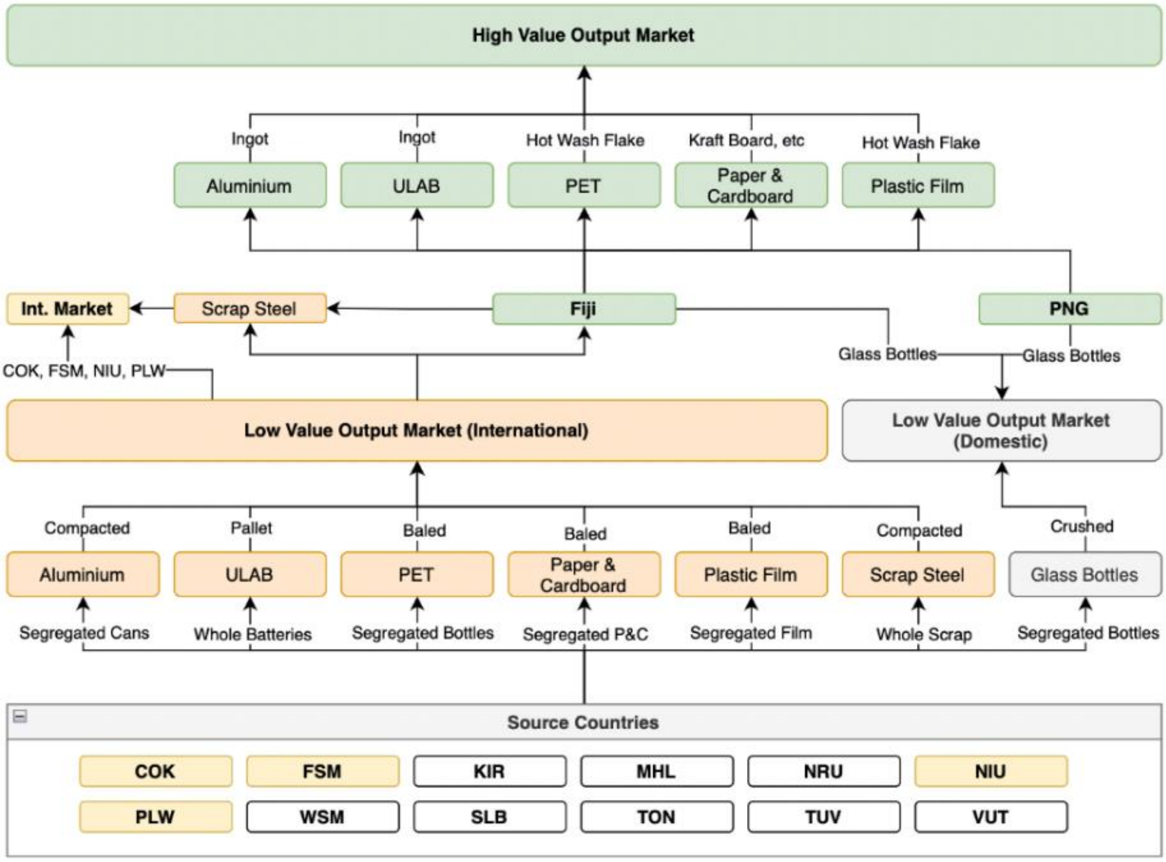

Figure 11 Intended Recyclable Output Flows for 14 PICs

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, VUT = Vanuatu, PET = polyethylene, ULAB = used lead acid battery.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.4.1 Lower-Value Recyclable Outputs

The products of lower value will be generated in all source countries (Figure 11) through national collection and compaction efforts. Seven recyclable materials are considered for improved compaction and export activities (summarized in Table 14). The select materials from the eight feed-in nations will be processed to the output quality described in this section. All materials from non-hub PICs will enter directly into the global/international market without value-add activities. Scrap steel, as an entire waste stream will also directly enter the international market at low value output. Similarly, glass enter a low-value market, but domestically.

Table 14 Lower Value Recyclable Outputs

Material	Input Material	Technology	Output
Aluminum cans	Segregated cans	Compactor	Compacted
ULAB	Whole batteries	Pallet wrapper	Pallets
PET	Segregated PET bottles	Baler	Baled
Scrap steel	Whole scrap	Compactor	Compacted
Paper & cardboard	Segregated paper and cardboard	Baler	Baled
Glass bottles	Segregated glass bottles	Glass crusher	Crushed (replacement sand)
Plastic film	Segregated film packaging	Baler	Baled

PET = polyethylene, ULAB = used lead acid battery.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Lower-Value Aluminum Cans Output

The low-value recyclable output for aluminum cans is improved compaction density (Figure 12) to the targeted 18 tons per TEU.

Figure 12 Example of Compacted Aluminum Cans (Gizo, Solomon Islands)

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Lower-Value ULAB Output

The low-value recyclable output for ULAB is palleted shipments for all PICs except Fiji and PNG. The output standard[15] for this waste stream will require ULAB to conform to the following parameters (Figure 13):

[15] ABRI, undated. PACKAGING STANDARD FOR USED LEAD ACID BATTERIES (ULAB). Australia. https://batteryrecycling.org.au/wp-content/uploads/2013/11/ULAB-packaging-standard-2013-final2.pdf

- For each layer of batteries, there must be a horizontal strap.
- Minimum of two vertical straps to secure the load to the pallet.
- Strapping 19 mm wide with a combined break strength of 1500 kg.
- Clear plastic stretch wrap to the full height of the pallet stack (must be transparent stretch wrap. Black not acceptable).
- A pallet in a good, sturdy condition.
- Conform to Basel Convention requirements.

The target density per TEU is 24 tons.[16]

Figure 13 Example of Good ULAB Packaging

ULAB = used lead acid battery.
Source: ABRI 2013.

Lower-Value PET Bottles Output

The low value recyclable output for PET bottles is to improve bale density to the targeted 11 tons per TEU. Only PET bottles that are clear or colored transparent blue will be acceptable under this option. Bottles will be accepted with lids and labels. Bales should aim for 98% PET purity.

Table 15 Target Impurity Rates for PET Bales

Impurity	Percentage/Description (Max %)
Glass	<1% by weight
Metal	Metallic and mineral impurities with an item weight of >100g and cartridges for sealants are not permitted. Other metal articles <0.5% by weight

[16] Maximum tonnage per TEU generally permitted by industry.

Impurity	Percentage/Description (Max %)
Paper/Cardboard	< 0.5% by weight if sending to compounders. < 1% by weight if sending to other sorters
polyvinylchloride	< 0.5% by weight if sending to compounders < 1% by weight if sending to other sorters
Plastic Films	<1% by weight
Transparent Colors	<5% light blue. No dark colors e.g., brown
Opaque Colors	<0.5% by weight or zero
Other Plastics	<8% (incl. High-Density Polyethylene [HDPE], Polypropylene [PP], Low-Density Polyethylene [LDPE] as lids or other packaging)
Moisture	<5% (residue food, liquids, soil, other)
Prohibited Impurities	Minerals, rubber, wood, sacks, hazardous waste, medical waste, glass, compostable, oxo, and bio- degradable material, food contamination, silicone, Polyethylene Terephthalate Glycol (PET- G), Crystalline Polyethylene Terephthalate (C-PET), Polystyrene, textiles

Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Storage infrastructure should ensure that PET bales are kept dry and on concrete hardstand to avoid contamination with gravel or other debris.

Figure 14 Example Baled PET (Majuro, Marshall Islands)

Source: Regional Recycling Centre Pre-Feasibility Study Report project team, Majuro, Marshall Islands.

Lower-Value Scrap Steel Output

The low-value recyclable output for scrap steel is to improve bale density to the targeted 20 tons per TEU.

Figure 15 Example of Scrap Steel Bale

Source: Bicanski, n.d.b.

Lower-Value Paper and Cardboard Output

The low-value recyclable output for paper and cardboard is to improve bale density to the tar-gated 15 tons per TEU. This targets both post-consumer and post-industrial materials. Paper and cardboard bales must be compliant with the following requirements Table 16).

Table 16 Unacceptable Paper and Cardboard Bale Contaminants

Contaminants	List/detail
Prohibited	Bottles, cans, glass, dirt/gravel, bags, plastics, metal
Unacceptable	Hazardous, contaminated, dangerous, medical, food, poisonous wastes
Moisture	Wet bales will incur weight and quality adjustments

Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Figure 16 Example Paper and Cardboard Bale

Source: Vulcan Wire 2016.

Lower-Value Glass Bottles Output

The low-value recyclable output for glass bottles is to reduce virgin use of sand in areas such as building and construction. All beverage glass bottles, regardless of color, are acceptable. Unacceptable contaminants are outlined in Table 17.

Table 17 Unacceptable Crushed Glass Contaminants

Contaminants	List
Unacceptable	Medical glass, chemical refuse, hazardous/toxic liquid containing bottles/jars, needles and syringes, coal, dust
Critical	Ceramics, Pyrex, inorganic materials (e.g., bricks, concrete, gravel), non-container glass (e.g., laboratory glass, tubes, bulbs
Hazards	Metals that are not magnetic (e.g., lead, aluminum), wire, wood, plastic, textile

Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Figure 17 Example of Crushed Glass

Source: Dropyourenergybill.com, n.d.

Lower-Value Plastic Film Output

The low-value recyclable output for plastic film is to improve bale density to the targeted 15 tons per TEU. Plastic film sources include stretch film (<20 µm), shrink film (<20 µm), pellet covers (20 µm< x < 90 µm), thin film (<90 µm), thick film (>90 µm) and dry food packaging. Intended impurities acceptance levels, following the Australia Packaging Covenant Organization draft guidelines, for baled plastic film are in Table 18.

Table 18 Target Impurity Rates for Plastic Film Bales

Impurities	Percentage/Description (Max %)
Metals	Metallic & mineral impurities with an item weight of >100 g are not permitted. Other metal articles <0.1% by weight
Paper and cardboard	< 1% by weight
Polyvinylchloride	< 1% by weight
Other plastics such as strings/ropes	< 2% by weight, incl polyethylene, polypropylene
Moisture sources	<5% (Residue food, liquids, soil, other)
Prohibited impurities	Hazardous waste, medical waste, glass, minerals, oxo- or degradable material, food contamination, silicone, expanded polystyrene and polyurethane
Total Impurities	**≤ 8% by weight**

Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Figure 18 Example of Plastic Film Bales

Source: Waste-Outlet 2022.

3.4.2 Higher-Value Recyclable Outputs

The products of higher value will be generated in Fiji through regional compounding efforts and PNG through national compounding efforts. Only five recyclable materials are considered for value-added activities (summarized in Table 19). Input materials for Fiji are segregated nationally and received regionally in pre-segregated and high-density forms from feed-in PICs. Input materials for PNG are segregated nationally and then fed into domestic value-added systems. All outputs are an extension of the materials collected under section 3.4.1.

Table 19 Higher Value Recyclable Outputs

Material	Input Material	Output
Aluminum cans	Baled cans	Ingot
ULAB	Palleted batteries	Ingot
PET	Baled	Hot washed flake
Paper and cardboard	Baled	Kraft cardboard (paper as per SPWR)
Plastic film	Baled	Hot washed flake

PET = polyethylene, ULAB = used lead acid battery.
SPWR = South Pacific Waste Recyclers.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Higher-Value Aluminum Cans Output

The higher-value recyclable output for aluminum cans is to produce ingots to a density of 24 tons per TEU for use either domestically or sale to an international market. Casting aluminum into ingots typically produces a product between 99.5% and 99.9% purity.[17]

[17] Xin Dongyu Metal Materials (Shandong) Group Co., Ltd. n.d

Table 20 Composition of Aluminum Ingots (Maximum Impurity)

Element	Composition, % Maximum
Silicone (Si)	0.10
Iron (Fe)	0.20
Zinc (Zn)	0.03
Gallium (Ga)	0.04
Vanadium (V)	0.03
Others Each	0.03
Others Total	0.10
Aluminum	Remainder (99.5%)

Source: The Aluminum Association 2007.

Table 20 shows the London Metal Exchange (LME) Special Contract Rules for High Grade Primary Aluminum and the maximum chemical impurity composition of aluminum ingots.[18] The LME also sites GB/T 1196-2008 Al99.70 specification, which is purposed for "Unalloyed Aluminum Ingots for Remelting" at a purity of 99.7% aluminum.

Figure 19 Example of Aluminum Ingot

Source: The Tehran Times 2022.

Higher-Value ULAB Output

The higher-value recyclable output for ULAB is to produce lead ingots to a density of 24 ton per TEU for use either domestically in battery manufacturing or sale to an international market. Casting lead into ingots typically produces a product between 99.97% and 99.995% purity.

[18] P1020A in the North American and International Registration Record entitled "International Designations and Chemical Composition Limits for Unalloyed Aluminium" (revised March 2007)

Table 21 Composition of Refined Lead Ingots (Maximum Impurity)

Element	Composition (Weight Percent)	
Lead (min) by difference	**99.97 UNS No. L50021**	**99.995 UNS No. L50006**
Grade	**Refined Pure Lead**	**Low Bismuth Low Silver Pure Lead**
Argentum (Ag)	0.0075 maximum	0.0010 maximum
Aluminum (Al)	0.0005 maximum	
Arsenic (As)	0.0005 maximum	0.0005 maximum
Bismuth (Bi)	0.025 maximum	0.0015 maximum
Cadmium (Cd)	0.0005 maximum	
Copper (Cu)	0.0010 maximum	0.0010 maximum
Iron (Fe)	0.001 maximum	0.0002 maximum
Nickel (Ni)	0.0002 maximum	0.0002 maximum
Sulfur (S)	0.001 maximum	
Antimony (Sb)	0.0005 maximum	0.0005 maximum
Selenium (Se)	0.0005 maximum	
Tin (Sn)	0.0005 maximum	0.0005 maximum
Tellurium (Te)	0.0002 maximum	0.0001 maximum
Zinc (Zn)	0.001 maximum	0.0005 maximum

Source: London Metal Exchange, n.d.

Table 21 shows the London Metal Exchange (LME) Special Contract Rules for Refined Lead and the maximum chemical impurity composition of lead ingots. The LME sites ASTM B29-03 (2014) – Standard Specification for Refined Lead in two grades: Refine Pure Lead (99.97%) and Low Bismuth, Low Silver, Pure Lead (99.995%).

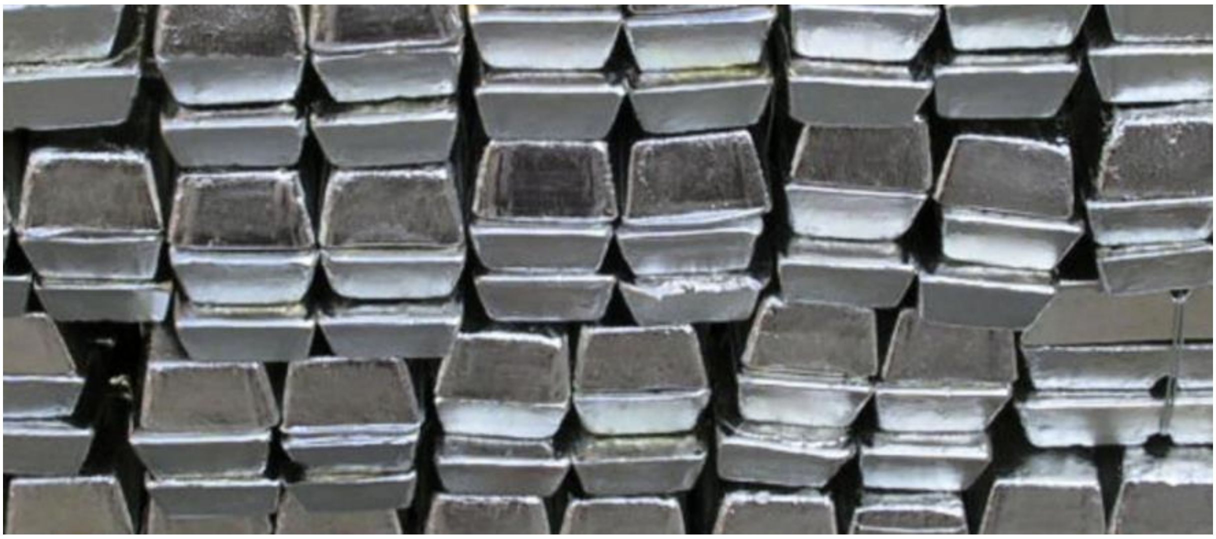

Figure 20 Example of Lead Ingots

Source: IndiaMART 2022c.

Higher-Value PET Output

This output is an extension of the materials collected under the section Lower-Value PET Bottles Output and targets PET bottles that are clear or blue colored (no opaques, darks, brown, green, black, or white). The Intended impurity acceptance levels for target output to be marketed into food grade and non-food grade packaging and applications, following the Australia Packaging Covenant Organization draft guidelines, are mentioned in the Lower-Value PET Bottles Output section.

The specific technical properties intended for hot washed and flaked PET are in Table 22 and acceptable impurity levels in Table 23.

Table 22 PET Flake Technical Properties

Technical Property	Specification
Bulk density	250-500 kg/m^3
Intrinsic Viscosity (IV)	0.73-0.84 dl/g
Melting Temperature Range	245-255 °C
Flake size	98% at 3-12mm
Flake distribution	<1mm = 0.5 wt% max; ≥ 12mm = 0.1 wt%
Fines	≤ 1.00 weight %
Moisture	≤ 1.00 % or lower i.e., ≤ 0.7 weight %

PET = polyethylene.
Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Table 23 PET Hot Wash and Flaked Impurities

Impurities	Percentage/Description (Max ppm)
Polyvinylchloride (PVC)	≤ 50 ppm
Polyolefins content (PE, PP)	≤ 25 ppm
Metal	≤ 20 ppm
Paper	0 ppm
Wood	0 ppm
Other contaminants	≤ 10 ppm
Total contamination	**≤ 80 ppm**

PET = polyethylene.
Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Hot washed and flaked PET is intended to be transported in polypropylene (PP) bulk bags labelled clearly with:

- Product code and name
- Batch number
- Date of manufacture
- Name of manufacturer and production factory
- Gross and tare weight
- Special handing requirements

Figure 21 Example of Hot Washed and Flaked PET

PET = polyethylene.
Source: IndiaMART 2022a [left] & Teka Scrap LTD 2022 [right].

Higher Value Paper and Cardboard Output

The higher value recyclable output for paper and cardboard is to produce recycled paper products for consumer use such as kraft paper, toilet paper, egg trays, remanufactured cardboard, etc.

Figure 22 Example of Paper and Cardboard Recycled Products

Source: Naturally Wrapt n.d. [left], Bicanski n.d.a [middle] & Coetzee 2013 [right]

Higher Value Plastic Film Output

This output is an extension of the materials collected under the section Lower-Value Plastic Film Output and targets plastic film that are either clear or colored to be washed and flaked to produce a mixed colored flake product. Input materials are polyethylene films (including LDPE, Linear Low-Density Polyethylene [LLDPE], HDPE). Following the Australia Packaging Covenant Organization draft guidelines, output products are not intended to be suitable for food contact applications. Acceptable impurity levels are identical to flaked PET in Table 23 and the technical properties expected from flaked plastic film are found in Table 24.

Table 24 Plastic Film to Flake Technical Properties

Technical Property	Specification
Bulk density	250-500 kg/m^3
Melting Temperature Range	160-170 °C
Flake size	98% at 8-12mm
Flake distribution	<1mm = 0.5 wt% max; ≥ 12mm = 0.1 wt%
Fines	≤ 1.00 weight %
Moisture	≤ 1.00 % or lower i.e., ≤ 0.7 weight %

Source: Australian Packaging Covenant & National Waste and Recycling Industry Council 2022.

Hot washed and flaked plastic film is intended to be transported in polypropylene bulk bags labelled clearly with:

- Product code and name
- Batch number
- Production date
- Source name and supply chain
- Gross and tare weight

Figure 23 Example of Hot Washed and Flaked Plastic Film

Source: IndiaMART, 2022b.

3.5 Selling Price of Output Material

The sale price for each material is summarized in Table 25 and discussed in detail in sections 3.5.1 to 3.5.7. Values presented in this section are gross market values (i.e., before costs). Further information on costs is discussed in detail in section 5 Financial and Economic Analysis.

Table 25 Summary of Selling Price of Outputs

Waste Fraction	Fiji/PNG Unit Sale Price (USD/tons)	Feed-in Unit Sale Price (USD/tons)	Non-Feed-In Unit Sale Price (USD/tons)
Aluminum Cans	2,000	1,275*	1,500
ULAB	1,800	680*	800
PET	1,050	552.50*	650
Scrap Steel (& cans)	167	167	167
Paper & Cardboard	300	106.25*	125
Glass Bottles	63	63	63
Plastic Bags (Plastic Film)	500	159.80*	188

ULAB= used lead acid battery, PET = polyethylene.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The rationalization for the feed-in unit sale price for the participating countries is that, in exchange for a guaranteed/secured marketplace within the Pacific, the materials directed into the Fiji hub are discounted by 15% (impacted fractions identified with "*" in row three of Table 25) to the international market Table 25). The intention is to incentivize feed-in PICs to participate with the hub with near-market prices while also incentivizing the hub itself to purchase waste materials from feed-in PICs at a market price advantage. Feed-in materials (as explained throughout this report) that are considered under discount are aluminum cans, ULAB, PET, paper and cardboard, and plastic bags/film.

The Sensitivity Analysis found in Section 5.8 includes several scenarios based on potential increases and decreases in output sale prices and how this impacts the business case.

3.5.1 Aluminum Selling Price

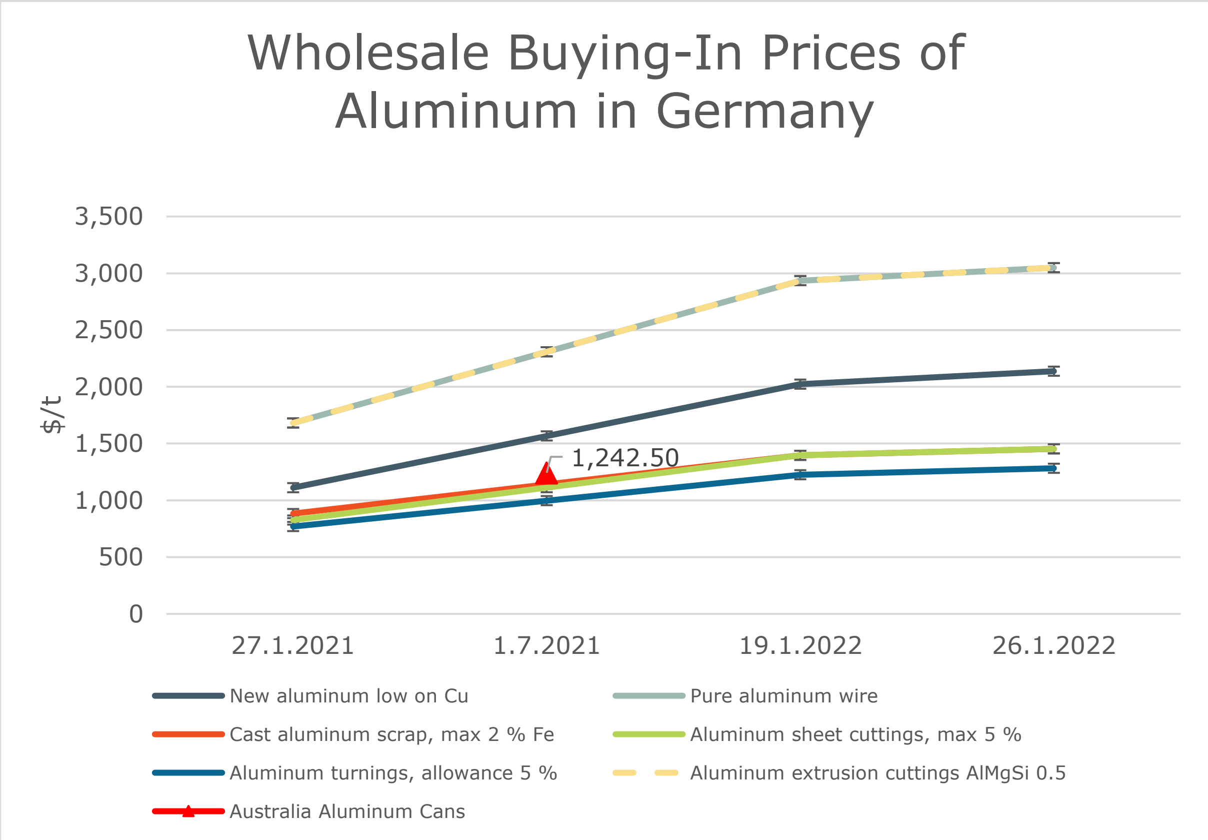

Figure 24 European and Australian Market Price of Post-Consumer Aluminum

Source: EUWID 2022a [European market] & Sustainability Victoria 2021 [Australian Market].

Aluminum is a major global commodity and all forms of aluminum scrap currently command high prices; as shown in Figure 24, these can fluctuate strongly in short periods of time. Presently for Aluminum Cans, there is a well-established international market currently offering buy prices of $1,500 per ton based on recent sales from Tuvalu to Busan in 2021. This is underpinned by global aluminum prices of $2,640 on the LME.[19] The reported price in Australia for Aluminum Cans in July 2021 was only A$1,242/ton as reported by the Recovered Resources Market Bulletin, Victoria, ed. 16[20]. The proposed value-added output of aluminum ingots is expected to add further value of approximately $500 per ton to the price of baled aluminum cans. For non-feed-in countries, the best and most reliable markets are international including Asia and the US. The best spot prices fluctuated geographically over time; however, attaining higher densities in compaction efforts, or by ingoting aluminum, will result in higher economic returns compared to the current rates achieved.

[19] OLME, LME Aluminium Alloy. 3-month closing price.

[20] Sustainability Victoria, 2021

Table 26 Summary of Aluminum Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Higher Value	$2,000	Fiji, Papua New Guinea
Lower Value	$1,275	Feed-in Pacific Island Countries
Lower Value	$1,500	Cook Islands, Federated States of Micronesia, Niue, Palau

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.5.2 Used Lead Acid Battery Selling Price

Figure 25 International Market Price of Lead in a 60-Month Period

Source: Trading Economics, 2022.

The above figure shows the relatively high values of lead over the last 5 years in the international markets, as well as the fluctuations that indicate demand over time, where 80% of modern lead usage is in the production of batteries.[21] For ULAB, there are no specific up-to-date trend data for the Pacific. ULABs are a hazardous waste and a dangerous good that are subject to the transboundary controls and the Basel Convention (Waigani Convention). However, they are also a valuable source of elemental lead. This means that ULAB has positive value as a commodity and negative value as a controlled waste stream.

Therefore, unprocessed ULAB does not receive the same prices as elemental lead. Despite this, recent international sales of ULAB from Kiribati and Tonga to Republic of Korea received $800 a ton, while sales from the Solomon Islands to Samoa (regional) received $600 a ton. The proposed value-

[21] Trading Economics – Lead. https://tradingeconomics.com/commodity/lead (22.12.2022)

added output of lead ingots is expected add a further value of approximately $1,000 per ton to the price of unprocessed ULAB.

For non-feed-in countries, shipment of unprocessed ULAB to international markets such as Asia is still the most suitable option. The best spot prices fluctuated geographically over time. Attaining higher densities for unprocessed ULAB is not possible, but through value-add, outputs like lead ingoting increase the marketability as an intermediate product for repurposing in other activities requiring lead.

Table 27 Summary of ULAB Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Higher Value (Ingot)	$1,800	Fiji, Papua New Guinea
Lower Value (Baled)	$680	Feed-in Pacific Island Countries
Lower Value (Baled)	$800	Cook Islands, Federated States of Micronesia, Niue, Palau

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

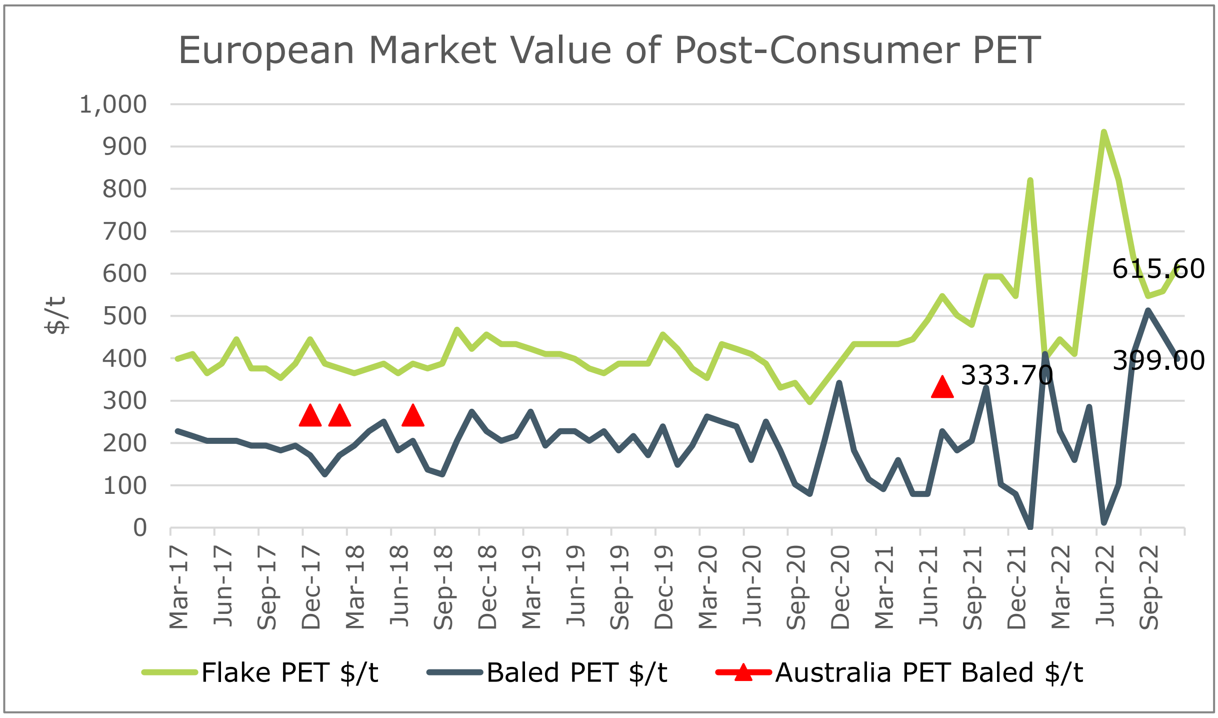

Figure 26 European and Australian Market Price of Post-Consumer PET

PET = polyethylene.
Source: Plasticker 2022 [European Market], APCO 2018 & Sustainability Victoria 2021 [Australian Market].

3.5.3 Polyethylene Selling Price

Figure 26 above shows both European trend data for baled PET Plastic Bottles and spot price date for Australia, which shows strong growth and fluctuations in recent months, achieving $300 to $400 a ton. In the past, the strong fluctuations have impacted viable business case development in the Pacific and globally. However, recent trends supported by mandatory recycled PET content in new packaging is strengthening prices in the region and globally. Figure 26 shows how the value of flaked PET (a value-added product) fluctuates, but it is typically $200 a ton higher in value than unprocessed (baled) PET. Recent values provided by Coca-Cola have indicated the demand in the Pacific region for value-added PET products such as hot washed flake is attaining prices of $1,050 per ton and $650 per ton for clean baled PET.[22] This information is consistent with information from research in other international markets (US, Europe, Asia).

Table 28 Summary of PET Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Higher Value	$1,050	Fiji, Papua New Guinea
Lower Value	$552.50	Feed-in Pacific Island Countries
Lower Value	$650	Cook Islands, Federated States of Micronesia, Niue, Palau

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.5.4 Scrap Steel Selling Price

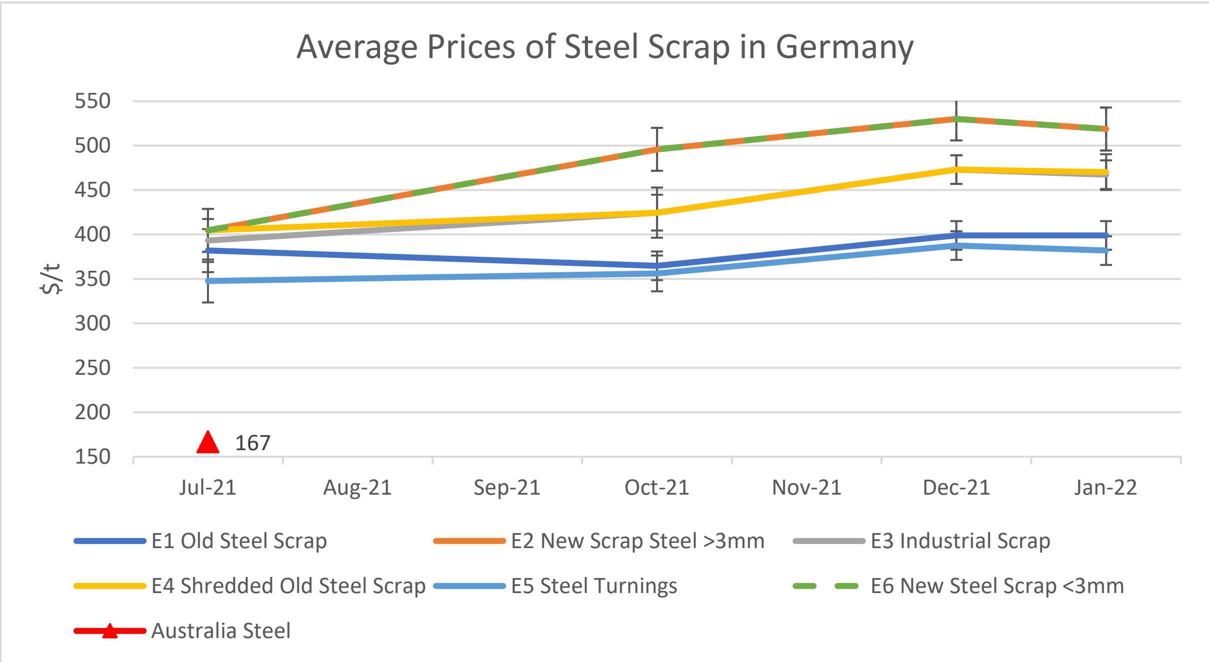

Figure 27 European and Australian Steel Scrap Market Prices in a 7-Month Period.

Error bars indicate upper and lower price ranges.
Source: EUWID 2022c [European market] & Sustainability Victoria 2021 [Australian Market].

Figure 27 shows recent trend data for different types of Scrap Steel in Germany. While such trend data were not available for the Pacific, recent imports to Australia were resulting in lower offers of A$180 per ton for light steel and A$235 a ton for heavy steel compared to European markets.[23] Asian markets are disrupted and made unpredictable by changes in the People's Republic of China's (PRC) demands and policies on a range of imports.

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[22] Discussions with Coca-Cola, November 2022.

[23] 2021, July Recovered Resources Market Bulletin, Victoria, ed. 17

Scrap steel is a very diverse market with a large range of subcomponents with varied values. Markets for related non-ferrous scrap derived from waste streams similar to those that make up scrap steel remain strong such as engines, compressors, copper windings, brass components, and axles.

Spot markets are typically varied but are concentrated on Australia now due to reliability, while Asian markets are in flux. The value output for scrap steel will be improved, with tighter quality control (sorting) and improved compaction. The international market to nearby markets such as Australia is currently considered the most suitable destination for all PICs. The Australian spot price of $167 (converted from Australian dollars) is the most realistic regional value point.

Table 29 Summary of Scrap Steel Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Lower Value	$167	All Pacific Island Countries

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.5.5 Paper and Carboard Selling Price

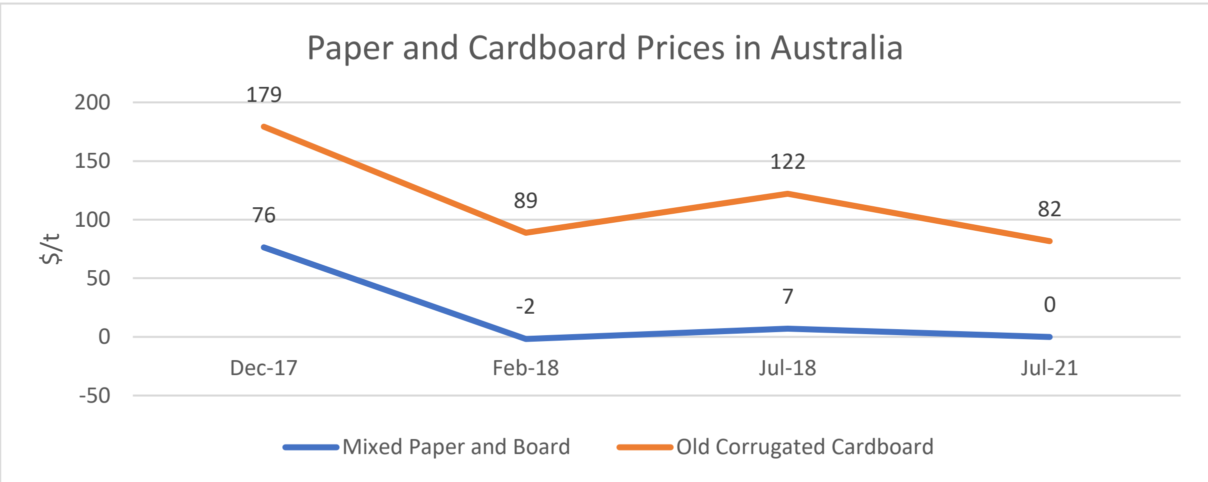

Figure 28 Australian Market Price of Paper and Cardboard for 2017, 2018, and 2021

Source: APCO 2018 & Sustainability Victoria 2021.

Figure 28 shows Australian prices for two grades of Paper & Cardboard as well as fluctuations, with the lower-grade paper mostly being without value. However, corrugated cardboard maintains a value of approximately $80 per ton. International Paper & Cardboard markets were heavily disrupted by PRC policies on recyclables and have not recovered.

However, manufacturing of products from recycled Paper & Cardboard does occur in PNG and Fiji and where the potential, based on the very large volumes of cardboard waste present in the Pacific Islands, is most favorable. Through discussions with local Fijian wastepaper recyclers and product manufacturers, a high-value output product price is approximately $300 per ton. Visy in Australia has exhibited a recent interest in Pacific cardboard and several container loads have been shipped from Fiji under the Moana Taka scheme and therefore is a potential market candidate for lower-value outputs (baled) from non-feed-in PICs.

Table 30 Summary of Paper and Cardboard Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Higher Value	$300	Fiji, Papua New Guinea
Lower Value	$106.25	Feed-in Pacific Island Countries
Lower Value	$125	Cook Islands, Federated States of Micronesia, Niue, Palau

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.5.6 Glass Selling Price

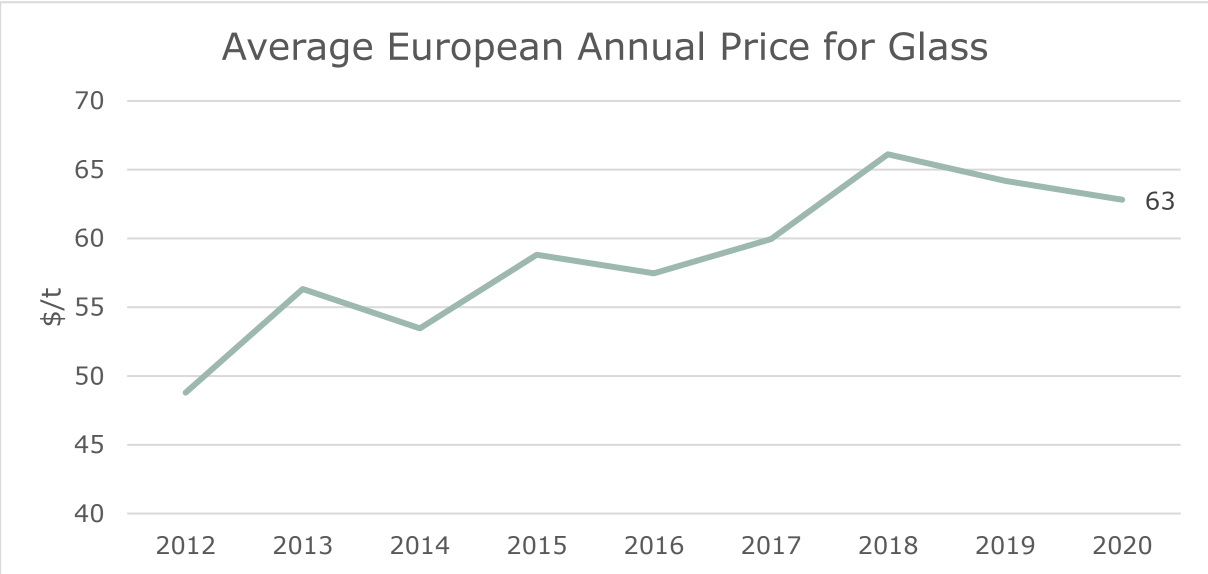

Figure 29 European Yearly Average for Glass Market Prices (2012 to 2020)

Source: EUWID 2022b [European Market].

Glass as a recycled commodity has a relatively low value and requires several steps to sort, grade, and process for specific purposes outside of a subsidized system. Export is not considered a suitable option but there are national applications as sand substitute materials at the lower-value end.

Several breweries in the Pacific do have well-developed bottle return systems that have high levels of return. Globally, an unsubsidized glass business case does not really exist. In many PICs without subsidy, glass recycling is not currently thought to be economic. In PICs with a positive business case, the low-value output is $63 per ton.

Table 31 Summary of Glass Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Lower Value	$63	All Pacific Island Countries

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

3.5.7 Plastic Bags Selling Price

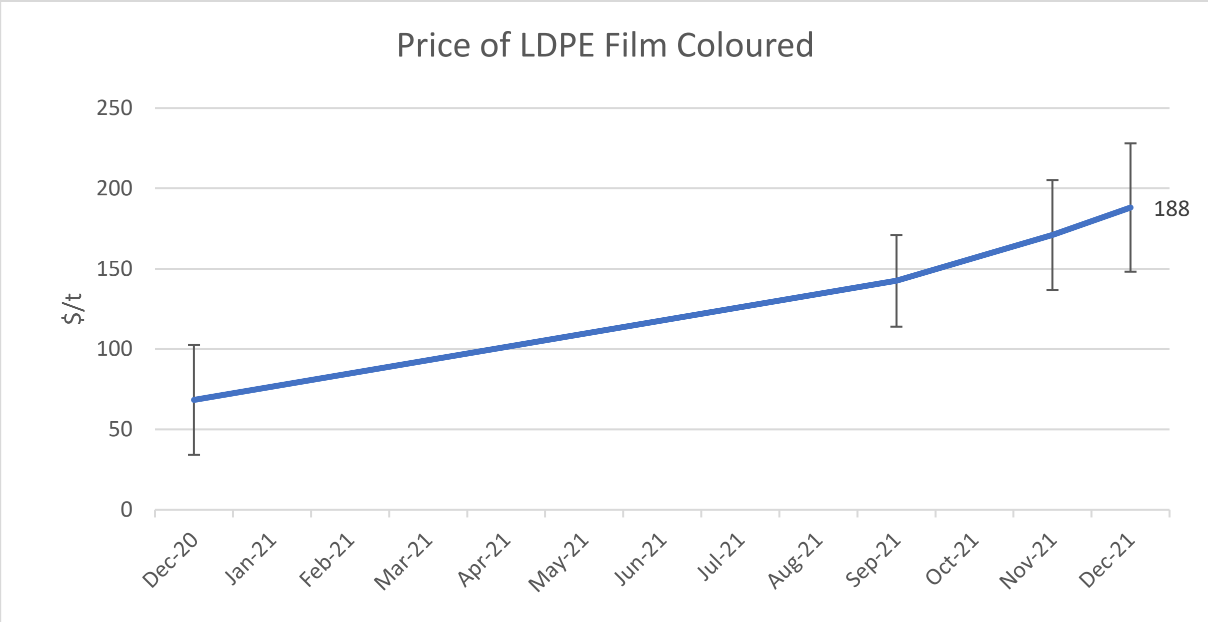

Figure 30 European Market Price of Post-Consumer LDPE (PE-LD) Colored Film

Source: Plasticker 2022 [European Market].

No recycling of colored film is currently taking place.

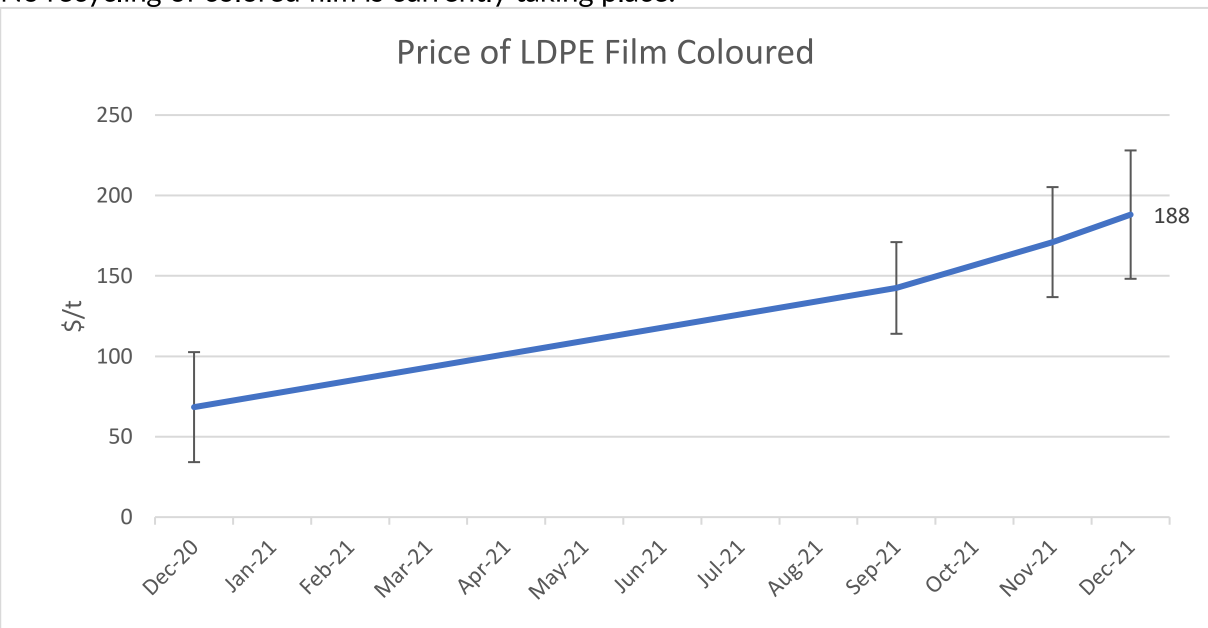

Figure 30 above shows both European trend data for baled LDPE Film Colored showing market demand for recycled plastic grow over 2020-21. This is corroborated in the Australian mixed plastic market (Resin Identification number 1-7), which is receiving A$115 per ton.[24] The sale price for lower value outputs is $188.

24 2021, July Recovered Resources Market Bulletin, Victoria, ed. 17

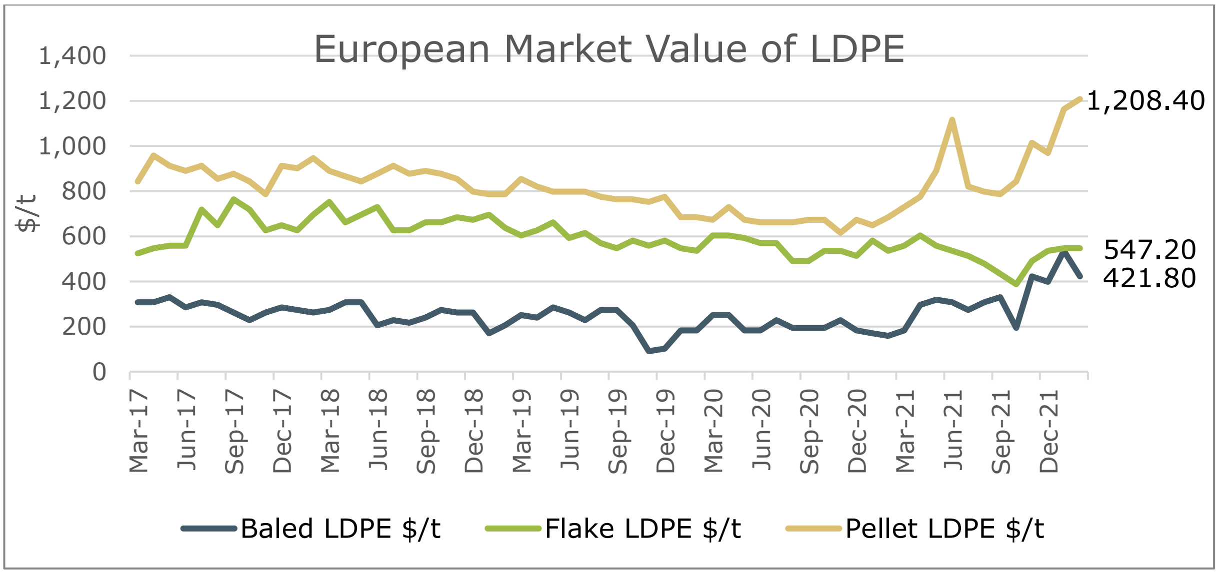

Figure 31 European Market Price of Post-Consumer LDPE (PE-LD) Colored Film

Source: Plasticker 2022 [European Market].

Figure 31 shows the potential that LDPE can have through value adding in producing LDPE flake. There is increasing focus on plastic film to follow PET as the major waste plastic type to target for recovery and recycling. Due to high volumes, a value-add plastic film value chain is foreseen in Fiji and PNG to produce flaked plastic films.

A new chemical recycling plant is being developed in Australia by Nestlé in partnership with IQ Renew with a target to greatly increase LDPE recycling. Similar large-scale plants are being established in Southeast Asia and there are proposed trial collections to collect and carry to Australia from the Pacific. Figure 31 shows that the value-added output of plastic film flake achieves approximately $500 per ton.

Table 32 Summary of Plastic Film Selling Prices

Output	Value (USD per Ton)	Benefitting Pacific Island Countries
Higher Value	$500	Fiji, Papua New Guinea
Lower Value	$159.80	Feed-in Pacific Island Countries
Lower Value	$188	Cook Islands, Federated States of Micronesia, Niue, Palau

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

4 Environmental Impact and Climate Resilience

This section reviews the environmental and social impacts and benefits connected with the project. A more detailed analysis will be presented as part of the risk assessment under Chapter 8 and 0.

4.1 Environmental Impacts and Benefits

The establishment of an RRC has the potential to bring about a range of environmental and social benefits across the PICs. Information gathered from recent waste audit reports (which have been used to establish a baseline for the implementation of corrective actions) and expert opinion have been used to create the following analysis on predicted and possible environmental and social benefits and opportunities in connection to different recyclable waste streams.

This analysis has been conducted in line with the World Bank's Environmental and Social Framework and Standards to promote improved environmental and social performance in ways that recognize and enhance capacity. Benefits are given in Table 33:

Table 33 Environmental Benefits

Benefit	Description
Clearing of Stockpiles and Bulky Waste	Across several Pacific Island Countries (PICs), large stockpiles and bulky wastes have resulted in overcrowded storage facilities and illegal dump sites that now pose a variety of Occupational Health and Safety (OHS) risks, including fires. COVID-19 and changes to the People's Republic of China recyclables market have exacerbated challenges around stockpiles through the loss of markets for certain waste streams. Clearing these stockpiles and bulky wastes would ease the spatial burden currently facing atolls and small islands that in some cases have over 10 years' worth of collected materials.
Conservation of Natural Resources	Natural resources are conserved through the reuse of existing materials. This is especially the case for organic materials, which can contribute significantly to low carbon levels that are common in the Pacific and can replace expensive imported soil ameliorants. In some PICs, there is already some recovery of recyclables.
Increasing Landfill Lifespans	At current disposal rates, several landfill sites across the Pacific are estimated to reach capacity within the next 3–10 years. Land is a precious commodity across most PICs and recyclable waste materials consume precious space, negatively impacting human and environmental health. Disposal of these waste types at landfills and dumpsites is less than ideal, and recovery of these waste streams would not only divert waste from landfills, but also reduce hazardous emissions to air, soil and water.
Avoidance of Leakage into the Terrestrial and Marine Environments	Commonly mismanaged waste streams can be extremely harmful to the terrestrial and marine environments, posing serious negative consequences to major national revenue streams across the PICs including fishing, farming, and agriculture. These waste streams also negatively impact human health through air, soil, and marine pollution, as well as disease, and even kill coral through transferring harmful microorganisms via wastes such as plastics.
Promoting Sustainable Tourist Waste Behaviors	For all PICs, tourism is a source of national revenue. However, tourism also generates additional waste at a rate far higher than average residents. Prioritizing the recovery and management of tourist generated recyclables would help to minimize the negative impacts of this important revenue stream.

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

4.1.1 Availability of Renewable Energy

Through the application of electricity production generated using renewables (2018 or most recent year[25]) and the expected waste generation volumes, the percentage of renewable energy available for commercial use for this option was calculated as 57.8% when averaged across the 14 countries.

Energy consumption under the Fiji hub component of this option is effectively double handled. The slight improvement in the percentage of renewable energy for this option is due to Fiji's superior renewable energy ratio to the feed-in countries it obtains the recyclable wastes from.

Potentially harmful emissions and residues from value-adding processes would need to be managed, especially related to ULAB recycling. Noting that such reprocessing already occurs in Fiji (Pacific Batteries).

4.2 Social Impacts

4.2.1 Political Will

For this option, results indicate moderate levels of political will. When averaged, the total number of waste-related legal instruments from the six hub nations (one regional hub and five national hubs) is 28.6, which falls into the 80th percentile range and is fairly high in comparison to the regional average of 24 (which falls into the 40th–59th percentile range).

Individually, Fiji and PNG demonstrate the highest levels of political will across the 14 PICs, while Cook Islands, FSM, and Palau also demonstrate relatively high levels of political will when compared with the remaining 11 PICs. Niue is among the bottom four (falling into the 20th–39th percentile range); however, its small size and support from New Zealand means that extensive waste-related legal instruments may not be necessary in its context.

Thus, Niue's ability to operate as a national hub is unlikely to be impacted by this factor. Moreover, although Niue has not yet ratified the Basel Convention, its ability to function as a national hub is unlikely to be affected due to its low volumes for the target waste streams, and its connection to New Zealand.

Table 34 Option 3 – Political Will

	Legislation	Regulations	Orders/By-Laws	Policies	Total
COK	7	6	0	10	23
FJI	10	12	21	6	49
FSM	11.25	4.75	0	10	26
NIU	6	2	0	11	19

[25] SPREP, 2020.

	Legislation	Regulations	Orders/By-Laws	Policies	Total
PLW	9	11	0	5	**25**
PNG	6	14	0	10	**30**

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, NIU = Niue, PLW = Palau, PNG = Papua New Guinea.
Source: Kokusai Kogyo Co., Ltd. & Yachiyo Engineering Co., Ltd. 2022, Peel, J., Godden, L., Palmer, A. & Markey-Towler, R. 2020 & National Waste Audit Reports for the 14 PICs.

Results from the status on Multilateral Environmental Agreements (MEAs) found that four of the six hub nations have concluded three or more of the five conventions. All countries have signed or concluded the Waigani and Stockholm Conventions, and four of the six countries have also concluded the Basel Convention. However, only FSM has specific implementing legislation in place. Palau is the sole country to have concluded the Minamata Convention, and only Cook Islands has concluded the Rotterdam Convention. Further, neither of these countries has implemented specific legislation.

Fiji's score as a part of this measure was not impacted by their ratification status on the Basel, Minamata, and Rotterdam Conventions. This is due to the lack of relevance these MEAs have on Fiji's ability to function as a regional hub which receives recyclables from node countries (covered under Waigani), and on its ability to export processed product (made from recyclables) to other markets. Moreover, for this option Marshall Islands would need to ratify the Waigani Convention in order to ship its recyclables to Fiji. However, this does not pose any real barrier as the process is administratively simple and can be carried out on an as needs basis (Table 35).

Table 35 MEAs Status

Country	Waigani Convention	Basel Convention	Stockholm Convention	Minamata Convention	Rotterdam Convention
COK	Concluded 2001	Concluded 2004	Concluded 2004		Concluded 2004
FJI	Concluded 2001		Concluded 2004		
FSM	Concluded 2001	Concluded 1995	Concluded 2005		
KIR	Concluded 2001	Concluded 2000	Concluded 2004	Concluded 2017	
MHL		Concluded 2003	Concluded 2004	Concluded 2019	Concluded 2004
NRU	Signed 1995	Concluded 2002	Concluded 2004		
NIU	Concluded 2003		Concluded 2005		
PLW	Signed 1995	Concluded 2011	Concluded 2011	Concluded 2017	
PNG	Concluded 2001	Concluded 1995	Concluded 2004		

Country	Waigani Convention	Basel Convention	Stockholm Convention	Minamata Convention	Rotterdam Convention
WSM	Concluded 2001	Concluded 2002	Concluded 2004	Concluded 2017	Concluded 2004
SLB	Concluded 2001		Concluded 2004		
TON	Concluded 2003	Concluded 2010	Concluded 2004	Concluded 2019	Concluded 2010
TUV	Concluded 2001	Concluded 2020	Concluded 2004	Concluded 2019	
VUT	Concluded 2008	Concluded 2019	Concluded 2005	Concluded 2019	Concluded 2019

Key	
	Not Party
	Signature
	Concluded
	Concluded with specific implementing legislation

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, VUT = Vanuatu. Source: Kokusai Kogyo Co., Ltd. & Yachiyo Engineering Co., Ltd. 2022, Peel, J., Godden, L., Palmer, A. & Markey-Towler, R. 2020 & National Waste Audit Reports for the 14 PICs.

4.2.2 Improving Community Health and Wellbeing

Improving recycling practices and amenities such as regularly serviced bins/collection points and properly managed landfill/recycling facilities could lead communities away from unsanitary and harmful waste practices such as burning, burying, and dumping. As a result, communities could be better protected from soil, air, and water pollution as well as vermin and disease.

4.2.3 Expansion/Up-Scaling of Recycling Initiatives

Lack of staff and/or skilled staff is a frequently cited challenge to effective waste management across the PICs. Moreover, although several recycling organizations (government, community-based, and private) and initiatives exist, their ability to remain operational let alone expand has proved difficult due to lack of markets for certain waste types, COVID-19, and changes to the PRC market. However, expansion and up-scaling of recycling activities and initiatives presents opportunities for job creation, up-skilling, work-readiness, entrepreneurship, and higher incomes across value chains through improved quality, quantity, and access to higher-value markets and increased production driving inclusive economic growth.

4.2.4 Formalization of Informal Waste Workers

In most developing countries, resource recovery relies heavily on the informal waste sector. Waste pickers, who live nearby and make their living off dumpsites and landfills, collect, sort and recycle approximately 15%–20% of generated waste. Some waste pickers work alone; however, most are families and microenterprises comprised of women, children, and elderly relatives, meaning that children also live and work in these strenuous and dangerous conditions, and are unlikely to have access to education. Improving effective recovery of recyclables and improving the livelihoods of waste pickers is inextricably linked. Informal waste workers could be better recognized for their integral role in the waste value chain by being fully integrated within the waste management system and supported by government, waste associations, and the community.

4.2.5 Increased Education and Awareness

The establishment of a regional recycling hub and an increase of recycling activities could benefit from increased education and awareness around all 16 recyclable waste types, as well as source separation and the 3Rs (Reduce, Reuse, Recycle). Several PICs including Fiji, Samoa, Nauru, and Tuvalu cite lack of education and awareness around waste, as well as harmful normative waste behaviors (littering, dumping, burning, and burying) as key challenges to improved national waste management. Through coherent formal education and awareness-raising initiatives and programs using theory and evidence-based behavior change frameworks (e.g., Community-Based Social Marketing, the COM-B Model), communities and waste sector workers can be taught and encouraged to take up positive waste behaviors and to contribute to the health and wellbeing of their environments.

Targeted Population Percentage

This option expects to target approximately 60% of the total population across the 14 PICs as shown in Table 36. This measurement is based on 100% of the urban populations and 50% of the rural populations of the six hub nations (one regional hub and five national hubs) and the eight node countries.

The decision to target only 50% of rural populations is due to most waste and most people being concentrated in urban centers, and that there is often a high level of difficulty associated with reaching some outer-island and rural areas.

Table 36 Expected Impacted Population

Country	Urban (100%)	Rural (50%)
Cook Islands	13,223	2,171
Fiji	513,187	191,629
Federated States of Micronesia	26,378	44,322
Kiribati	66,405	26,521
Republic of Marshall Islands	46,049	6,573
Nauru	10,834	0
Niue	1,626	0

Country	Urban (100%)	Rural (50%)
Palau	14,652	1,720
Papua New Guinea	1,193,981	3,876,523
Samoa	35,494	81,458
Solomon Islands	169,453	258,713
Tonga	24,415	40,641
Tuvalu	7,549	2,122
Vanuatu	78,400	114,375
Totals	**2,201,646**	**4,646,765**
Grand Total	**6,848,411**	**60%**

Source: Regional Recycling Centre Pre-Feasibility Study Report project team & World Bank 2022.

4.2.6 New Waste Jobs

For this option, it was calculated that for the first year **6,733 direct waste jobs (4,489 construction and 2,244 operational**) would be created. Indirect jobs would also be created along the value chain, including for people that benefit from a larger and better-remunerated value chain for the input wastes, and for the services sector, which will provide services to all direct jobs created.

As discussed in the other options, Australian references on this subject indicate that, for the waste sector, this could have a multiplier effect of 1.84 and it has also been estimated that direct Full Time Equivalent (FTE) employment per 10,000 tons of waste is 9.2 for recycling and 2.8 for landfill disposal.[26] This shows that recycling creates over 3 times as many jobs per ton of waste compared to disposal. This will lead to approximately **4,129 indirect jobs generated** (based on operational jobs as they are ongoing). This increase in waste-related work opportunities will extend to vulnerable communities and those who are often underrepresented, including women and waste pickers (informal waste workers).

4.3 Climate Sensitivity Screening

Inadequate waste management already poses a risk to the environment. On top of that, small island nations are especially vulnerable to the impacts of climate change. Effects could be, e.g., increased frequency and strengths of storms (hurricanes), floods, extreme or reduced rainfall, landslides, tsunamis, and rising sea levels.

One of the major contributors to climate change is the production of GHGs from inadequate landfilling of waste and the production of methane, which is more than 25 times as potent as CO_2 at trapping heat in the atmosphere. Two main factors for reducing GHGs in the waste sector are

[26] Access Economics, 2009.

reducing methane emissions from inadequate landfilling and avoiding emissions altogether through recycling and thus diverting waste (resources) from being landfilled in the first place.

In this option, the net tons of CO_2 avoided each year is equal to approximately 676,972 tons per year as shown in Table 37. The tons on CO_2 from shipping are calculated based on the distance (in nautical miles) from each node country to the Fiji hub and the non-participating countries to the international market (5.8g CO_2 per ton-nm travelled by ship). Shipping and port data is provided in 0.

This takes into consideration the tons of CO_2 avoided through recycling materials compared to production of material and subtracts the CO_2 produced per ton-km of recyclable waste shipped to achieve a net value avoided. The tons of CO_2 from shipping are calculated based on the distance (in nautical miles) from each node country to the Fiji hub and the non-participating countries to the international market (5.8g CO_2 per ton-nm travelled by ship).[27]

Table 37 Net Tons of CO2 Reduced Through Recycling

Material	Tons CO_2 Reduction/Ton Recycled	Total materials recycled (tons)	Avoided CO_2 (tons)	CO_2 Produced by Shipping	Net tons CO_2e Avoided
Aluminum Cans	10.6	35,268	373,840	970	372,870
ULAB	0.725	27,910	20,235	741	19,493
PET	2.34	29,214	68,362	354	68,008
Scrap Steel	2.1	25,493	53,536	378	53,158
Paper & Cardboard	0.4	408,435	163,374	4,979	158,395
Glass Bottles	0.4	1,069	428	-	428
Plastic Bags (Plastic Film)	0.8	5,882	4,706	85	4,621
Total					**676,972**

ULAB = used lead acid battery, PET = polyethylene.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team; Hillman, 2015.

Additional environmental benefits due to the avoidance of landfilling recyclables have been calculated. Production of leachate that would otherwise have been generated in a landfill has been estimated to be 58,659.87 m^3 per year. This is based on an average leachate production rate of 0.11 m^3 per ton of waste entering landfills throughout the Pacific (Table 38).

Table 38 Reduced Leachate Generation

	Conversion Factor	Units
Total waste reduced to the landfill	533,272	Tons
Leachate production rate	0.11	m^3/ton
Leachate production	58,659.87	m^3 leachate

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

[27] International Maritime Organisation (IMO), 2009

5 Financial and Economic Analysis

The financial and economic assessment of the recycling facilities is done in a two-step approach. First, the financial profitability and sustainability of the recycling facilities is calculated. Financial profitability is assessed using net present value and the internal rate of interest of the cash flow, whereas sustainability is assessed using the annual cash flow in the financial statements. Second, the identified economic costs and benefits are outlined along with the adjustments made to the financial calculations to arrive at the Benefit-Cost Ratio, which determines the viability of the recycling project.

All costs and benefits are identified for each of the 14 islands included in this preferred recycling option. Hence, a full-fledged financial and economic analysis is done for each island as well as for all islands combined. The focus in this chapter is on the combined projects seen as one project. All assumptions made and the resulting financial and economic results for the different islands are presented in a separate Appendix for each island (Appendices B–O). Financial assumptions, such as CAPEX, cost of waste, subsidies, etc. are provided under 0.

5.1 Financial Profitability and Sustainability of the Recycling Facility

The financial and economic profitability of the recycling facilities and hubs is calculated based on the standard methodology. The analysis period has been assumed to be 20 years. All calculations are done in US dollars. The analysis is done in fixed 2022 prices.

5.1.1 Investment Costs of the Recycling Facility

Capital expenditures are the total investment costs required to procure the recycling facilities and hubs, the land, the buildings, the equipment, and the machinery. The investment costs of the recycling facility are assessed based on similar facilities implemented elsewhere.

It is assumed that it will take 2 years to plan, construct, and implement the recycling facilities on the 12 smaller islands, i.e., in 2023 and 2024, and commercial operations will commence in 2025. For the larger Fiji and PNG hubs, it is assumed that it will take 3 years to implement the projects and that commercial operations will commence in 2026. The investment costs on the different islands are shown in Table 39 below.

Table 39 Investment Costs in the Recycling Facilities/Hubs (USD)

Cook Islands	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue
200,000	57,337,442	1,715,905	3,723,857	1,303,772	200,000	60,000
Palau	**PNG Hub**	**Samoa**	**Solomon Islands**	**Tonga**	**Tuvalu**	**Vanuatu**
506,783	147,717,640	1,677,577	6,517,474	914,388	660,569	1,894,358

FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The total investment costs on the Islands are estimated to be $224.4 million.

The investment costs are divided into civil works, mechanical, and electrical parts, with different economic lifetimes. These assumptions are shown in Table 40 below.

Table 40 Investments in the Recycling Facilities and the Economic Lifetime of the Assets

Investment cost component	% Structure	Lifetime of asset in years
Civil works	50%	30
Mechanical parts	17%	15
Electrical parts	20%	10
Legal	5%	
Planning	8%	
Total investments	100%	

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

In addition to the above physical investments in civil works, and mechanical and electrical equipment, it has been assumed that legal and planning costs constitute 13% of the total investment costs. These costs are assumed amortized over a 5-year period.

To continue recycling the waste requires that the capital equipment of the recycling facilities is up-to-date and properly maintained and rehabilitated. Hence, whenever an asset such as the electrical equipment reaches the end of its economic lifetime, it is assumed replaced. For example, if the life expectancy of electrical equipment is 10 years, the calculation assumes that after 10 years the electrical equipment is worn out and replaced by similar new electrical equipment. These rehabilitation costs are assumed financed from the revenues generated from the operations of the recycling facility.

The information on the economic lifetime of the assets in the above Table is also used to calculate their annual depreciation and the required rehabilitation/reinvestments over the 20-year analysis period. Each asset is depreciated in line with its life expectancy. A straight-line depreciation is assumed. At the end of the analysis period, the scrap value of the assets has been included in the cash flow calculations. The scrap value is calculated based on the investment costs minus the accumulated depreciation.

5.2 Waste Streams

The annual amount of waste has previously been assessed in Chapter 3 of this report. The different waste fractions and streams going to the recycling facilities on the different islands and hubs are summarized in Table 41 below. Not all waste is recycled, and the amount of waste not recycled from the different islands is shown in Table 42, while the amount of waste recycled is shown in Table 43.

In total, 968,812 tons of waste generated annually has been identified. It is estimated that 533,272 tons of waste or approximately 55% will be captured by the recycling facilities and hubs and recycled (Section 4.1). The difference of 45% of the waste is not captured by the system and is deposited in each of the islands' landfills. As discussed in Section 3.2, under this hub, several materials will be initially processed nationally followed by a secondary processing (value add) in Fiji's hub. Therefore, when accounting for in-system multi-handling, waste processed in the hub will amount to 606,057 tons per year. The financial assessment has included consideration of value increases for materials that undergo this two-step process

Table 41 Annual Amounts of Waste Fractions Sent to the Recycling Facilities/Hubs (Tons)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solo-mon	Tonga	Tuvalu	Vanu-atu	Total
Aluminum Cans	154	9,787	580	538	308	76	26	146	43,089	1,029	3,209	565	61	1,489	61,058
ULAB	71	6,209	376	376	195	40	8	71	28,800	654	2,190	352	39	991	40,373
PET	174	9,193	581	519	311	83	25	163	42,518	1,039	3,135	575	62	1,472	59,852
Scrap Steel	-	-	13,699	13,720	7,124	-	-	2,583	-	-	-	-	1,420	-	38,546
Steel Cans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper & Cardboard	-	119,444	-	7,584	3,938	-	-	1,428	580,194	13,185	44,116	7,096	785	19,960	797,730
Glass Bottles	68	-	273	332	280	197	29	318	-	-	2,572	565	234	-	4,868
Plastic Bags	119	5,170	-	353	212	56	17	-	28,962	708	2,136	392	42	1,003	39,170
Total waste	**586**	**149,803**	**15,510**	**23,423**	**12,369**	**452**	**105**	**4,709**	**723,562**	**16,616**	**57,358**	**9,545**	**2,643**	**24,916**	**1,041,597**

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 42 Annual Amount of Waste not Recycled (Tons)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solo-mon	Tonga	Tuvalu	Vanu-atu	Total
Aluminum Cans	46	980	232	27	154	8	5	15	17,235	412	963	226	6	596	20,905
ULAB	14	301	94	19	78	4	2	14	7,200	65	985	88	4	396	9,265
PET	87	1,758	291	26	156	37	12	33	21,259	468	1,411	259	9	663	26,468
Scrap Steel	-	-	4,110	6,174	1,781	-	-	775	-	-	-	-	213	-	13,053
Steel Cans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper & Cardboard	-	1,820	-	3,413	1,772	-	-	714	290,097	5,933	13,235	3,193	353	9,980	330,510
Glass Bottles	48	-	191	216	182	167	26	127	-	-	2,186	480	176	-	3,799
Plastic Bags	83	2,224	-	230	106	37	12	-	26,066	460	1,388	255	27	652	31,540
Total waste	278	7,084	4,918	10,104	4,229	253	57	1,677	361,857	7,338	20,168	4,501	788	12,287	435,540

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 43 Annual Amount of Waste Recycled (Tons)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solo-mon	Tonga	Tuvalu	Vanu-atu	Total
Aluminum Cans	108	8,807	348	511	154	69	21	131	25,853	618	2,247	339	55	893	40,153
ULAB	57	5,908	282	358	117	36	6	57	21,600	589	1,204	264	35	594	31,108
PET	87	7,435	291	493	156	46	12	130	21,259	572	1,724	316	53	810	33,384
Scrap Steel	-	-	9,589	7,546	5,343	-	-	1,808	-	-	-	-	1,207	-	25,493
Steel Cans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper & Cardboard	-	117,624	-	4,171	2,166	-	-	714	290,097	7,252	30,881	3,903	432	9,980	467,220
Glass Bottles	20	-	82	116	98	29	3	191	-	-	386	85	59	-	1,069
Plastic Bags	36	2,946	-	124	106	20	5	-	2,896	248	747	137	15	351	7,630
Total waste	308	142,719	10,592	13,319	8,140	199	47	3,031	361,705	9,278	37,190	5,044	1,855	12,629	606,057

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.3 Cost of Waste Handling

5.3.1 Transportation Cost

The transportation cost of the waste streams to the recycling facilities has been assessed based on the amount of waste and the unit transportation cost to the recycling facilities. The unit transportation costs (USD/ton) to the recycling facilities/hubs are presented in Table 45 and the total transportation costs to the recycling facilities are presented in Table 46. These are estimated based on the round-trip distances (km) from the center of the nearest city to the main landfill, as presented in Table 44.

Table 44 Round Trip Journey from the Nearest City and the Main Landfill

Country	Landfill Name	Nearest City	Return Journey (km)
Cook Islands	Rarotonga Landfill	Avarua	14
Fiji	Naboro Landfill	Suva	44
FSM - Pohnpei	Dekehtik Landfill (Pohnpei)	Palikir	22
Kiribati	Nanikaai Landfill	Bairiki	4
Kiribati	Betio Landfill	Betio	0.6
Marshall Islands	Majuro Landfill	Uliga	12
Nauru	Nauru Waste Facility (“Topside”)	Denigomodu	8
Niue	Makato Dumpsite	Alofi (city)	12
Palau	New landfill Aimeliik State	Koror	31.4
PNG	Baruni Landfill	Port Moresby	42
Samoa	Tafaigata Landfill	Apia	22
Solomon Island	Ranadi Landfill	Honiara	14
Tonga	Tapuhia Landfill	Nuku'alofa	22
Tuvalu	Funafuti Landfill	Funafuti	16
Vanuatu	Bouffa Landfill	Port Vila	20

FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 45 Unit Transportation Costs to the Recycling Facilities (USD/Ton)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solo-mon	Tonga	Tuvalu	Vanu-atu
Aluminum Cans	19	59	30	5	16	11	16	42	57	30	19	30	22	27
ULAB	19	59	30	5	16	11	16	42	57	30	19	30	22	27
PET	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Scrap Steel	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Steel Cans	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Paper & Cardboard	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Glass Bottles	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Plastic Bags	19	59	30	5	16	11	16	42	57	30	19	30	22	27
Total waste	**19**	**59**	**30**	**5**	**16**	**11**	**16**	**42**	**57**	**30**	**19**	**30**	**22**	**27**

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 46 Transportation Costs to the Recycling Facilities/Hubs (USD)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Na-uru	Niue	Palau	PNG Hub	Samoa	Solomon	Tonga	Tuvalu	Vanu-atu	Total
Aluminum Cans	2,925	577,423	17,408	2,690	4,930	838	417	6,132	2,456,054	30,876	60,979	16,949	1,351	40,204	3,219,176
ULAB	1,357	366,338	11,277	1,882	3,128	440	121	2,977	1,641,587	19,634	41,607	10,567	857	26,752	2,128,525
PET	3,309	542,399	17,431	2,594	4,982	912	397	6,844	2,423,540	31,176	59,571	17,262	1,366	39,757	3,151,542
Scrap Steel	-	-	410,976	68,600	113,987	-	-	108,486	-	-	-	-	31,230	-	733,280
Steel Cans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper & Cardboard	-	7,047,196	-	37,921	63,010	-	-	59,970	33,071,050	395,551	838,206	212,882	17,264	538,932	42,281,982
Glass Bot-tles	1,293	-	8,200	1,659	4,478	2,163	468	13,355	-	-	48,870	16,943	5,150	-	102,580
Plastic Bags	2,254	305,023	-	1,767	3,394	621	271	-	1,650,817	21,236	40,577	11,758	930	27,081	2,065,730
Total waste	**11,139**	**8,838,379**	**465,293**	**117,114**	**197,909**	**4,974**	**1,675**	**197,764**	**41,243,050**	**498,474**	**1,089,809**	**286,362**	**58,148**	**672,726**	**53,682,816**

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.3.2 Transportation Cost from the Recycling Facilities

The transportation cost of the recycled waste from the recycling facilities to the potential off-takers has been assessed based on the amount of waste and the unit transportation cost between the recycling facilities and the potential off-takers. These unit transportation cost figures are presented in Table 47 below together with the total transportation cost from the recycling facilities in Table 48.

Table 47 Unit Transportation Costs from the Recycling Facilities (USD/Ton)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solo-mon	Tonga	Tuvalu	Vanu-atu
Aluminum Cans	278	104	139	139	139	278	278	139	52	139	139	139	278	139
ULAB	208	104	104	104	104	208	208	104	52	104	104	104	208	104
PET	455	91	227	91	91	455	455	227	91	91	91	91	455	91
Scrap Steel	250	125	125	125	125	250	250	125	63	125	125	125	250	125
Steel Cans	250	125	125	125	125	250	250	125	63	125	125	125	250	125
Paper & Cardboard	333	67	167	67	67	333	333	167	67	67	67	67	333	67
Glass Bottles	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastic Bags	333	67	167	67	67	333	333	167	67	67	67	67	333	67
Total waste	**278**	**104**	**139**	**139**	**139**	**278**	**278**	**139**	**52**	**139**	**139**	**139**	**278**	**139**

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 48 Transportation Costs from the Recycling Facilities/Hubs (USD)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solomon	Tonga	Tuvalu	Vanuatu	Total
Aluminum Cans	29,937	917,349	48,356	70,973	21,395	19,046	5,795	18,250	1,346,521	85,767	312,027	47,079	15,355	124,088	3,061,937
ULAB	11,905	615,419	29,367	37,255	12,218	7,505	1,265	5,906	1,124,991	61,358	125,460	27,518	7,303	61,925	2,129,396
PET	39,586	675,893	66,027	44,806	14,155	20,720	5,644	29,628	1,932,648	51,960	156,765	28,771	23,990	73,624	3,164,216
Scrap Steel	-	-	1,198,681	943,256	667,893	-	-	226,013	-	-	-	-	301,655	-	3,337,498
Steel Cans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper & Cardboard	-	7,841,615	-	278,090	144,399	-	-	118,988	19,339,796	483,451	2,058,751	260,189	143,863	665,348	31,334,490
Glass Bottles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastic Bags	11,864	196,367	-	8,246	7,070	6,586	1,692	-	193,078	16,517	49,832	9,145	4,934	23,403	528,735
Total waste	**93,292**	**10,246,643**	**1,342,430**	**1,382,625**	**867,130**	**53,858**	**14,395**	**398,786**	**23,937,034**	**699,053**	**2,702,834**	**372,703**	**497,100**	**948,389**	**43,556,271**

ULAB = used lead acid battery, PET = polyethylene, FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.3.3 Operational and Maintance Costs

This section present various operational and maintenance costs that have been used in the financial and economic analysis.

The unit cost of $50/ton has been used where non-recycled waste fractions are disposed of to landfill. For operational and maintenance costs the annual costs at recycling facilities, based on experience from similar facilities in the area, constitute 20% of the investment.

The annual operational and maintenance costs detailed in the sections and tables above to operate the recycling facilities are summarized in Table 49 below.

Table 49 Annual Operational and Maintenance Costs at the Recycling Facilities/Hubs (in US dollars)

Waste fraction	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solomon	Tonga	Tuvalu	Vanuatu	Total
Cost of waste	77,009	22,130,293	-	-	58,645	-	-	21,263	44,436,778	470,372	2,487,802	233,888	-	623,254	70,539,303
Maintenance costs of the facility	12,000	3,440,247	102,954	223,431	78,226	12,000	3,600	30,407	8,863,058	100,655	391,048	54,863	39,634	113,661	13,465,786
Transportation costs to the facil-ity	11,139	8,838,379	465,293	117,114	197,909	4,974	1,675	197,764	41,243,050	498,474	1,089,809	286,362	58,148	672,726	53,682,816
Operational costs of the facility	28,000	8,027,242	240,227	521,340	182,528	28,000	8,400	70,950	20,680,470	234,861	912,446	128,014	92,480	265,210	31,420,167
Transportation costs from the fa-cility	93,292	10,246,643	1,342,430	1,382,625	867,130	53,858	14,395	398,786	23,937,034	699,053	2,702,834	372,703	497,100	948,389	43,556,271
Cost of depositing non-recycled waste fractions	13,913	354,195	245,885	505,200	211,457	12,636	2,867	83,869	18,092,851	366,908	1,008,421	225,052	39,423	614,337	21,777,014
Total operational and maintenance costs	235,353	53,036,998	2,396,789	2,749,710	1,595,896	111,467	30,937	803,038	157,253,240	2,370,321	8,592,361	1,300,883	726,785	3,237,578	234,441,357

FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The total annual operation and maintenance costs amount to $256,925,845 for all recycling facilities and hubs.

5.4 Revenues

The revenues to the recycling facilities and hubs are either due to a subsidy for receiving the waste fraction, or from facility gate fees, or from sales of recycled waste fractions. The revenues to the recycling facilities and hubs from the two sources are outlined in Table 50 below.

Table 50 Revenues to the Recycling Facilities and Hubs (USD)

Revenue source	Cook	Fiji Hub	FSM	Kiribati	RMI	Nauru	Niue	Palau	PNG Hub	Samoa	Solomon	Tonga	Tuvalu	Vanuatu	Total
Gate fees or subsidies	-	5,062,061	-	279,480	410,488	-	-	-	19,436,495	485,869	2,069,044	261,490	-	668,675	28,673,602
Expected revenues from sales of waste fractions	271,959	72,814,119	2,543,220	2,897,519	1,507,752	142,121	45,359	730,411	201,385,357	2,313,761	8,061,033	1,228,618	376,891	3,107,320	297,425,440
Total revenue	271,959	77,876,180	2,803,987	4,015,468	1,918,240	142,121	45,359	1,298,753	220,821,852	2,799,630	10,130,078	1,490,109	1,565,253	3,775,995	328,954,982

FSM = Federated States of Micronesia, PNG = Papua New Guinea, RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team

Annual revenues amount to $329 million. Most of this revenue is due to sales of the recycled waste fractions, whereas 10% of the revenues are from gate fees or subsidies received for handling the waste. This annual revenue is based on the following unit sales prices outlined in Table 51 below of the different waste fractions.

However, it has been assumed that the above estimated annual revenues and costs will gradually reach the annual steady state costs and revenues in year 5 after commissioning of the recycling facility. It has been assumed that a gradual ramp-up of revenues and costs is going from 80% in the first year of operation to 100% in the fifth year of operation. It has not been possible to present different scenarios where fuel costs increase in real terms compared to other costs or other valid changes to future waste generation compared to today's quantities has been estimated. However, waste generation will develop corresponding to population growth and consumption pattern changes, which are hard to predict. Hence, a steady state cost and revenue scenario has been chosen as the base case realized after the fifth operational year.

Table 51 Unit Sales Price

Waste fraction	Fiji/PNG Unit Sale Price (USD/tons)	Feed-in Unit Sale Price (USD/tons)	Non-Feed-In Unit Sale Price (USD/tons)
Waste fraction 1 - Cans	2,000	1,275	1,500
Waste fraction 2 – ULAB	1,800	680	800
Waste fraction 3 – PET	1,050	552.50	650
Waste fraction 4 - Scrap Steel	167	167	167
Waste fraction 5 - Steel Cans	167	167	167
Waste fraction 6 - Paper & Cardboard	300	106.25	125
Waste fraction 7 - Glass Bottles	63	63	63
Waste fraction 8 - Plastic Bags (Plastic Film)	500	159.80	188

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.5 Financing Structure, Assumptions and the WACC

It has not been possible to outline a specific financing structure at this pre-feasibility stage. But given that many of the smaller islands' debt management strategies only allow external borrowing operations with large grant elements and significant grace periods, the specific islands' recycling facility will not be attractive as a stand-alone project financed by any international financing institution (IFI). Further, the size of most of the recycling projects is also not attractive for an IFI. IFI financing may only be attracted if several recycling facilities are bundled. Hence, only domestic grant and loan financing, as well as potential promotional financing, has been assumed for the recycling facilities on 12 of the islands. The size of the recycling Hub investment on Fiji and PNG, however, allows for international financing.

The promotional loans are assumed to be for 8 years with a 4% real interest rate and a 1-year grace period, whereas the domestic or commercial loans are assumed to have a 10-year repayment period and carry a 6% real interest rate. The international loans are assumed to be 15 years with a 4% real interest rate and a 1-year grace period. For the time being, no additional fees such as commitment fees, upfront fees, or agency fees are assumed on the loans. The required real return on the equity from the Project Sponsor has been assumed to be 8%. The Project Sponsor or equity provider is assumed to receive dividends if there is a positive annual net result and there is a positive cash balance in the previous years. The financing structure and assumptions for the recycling facilities on the 12 smaller islands are outlined in Table 52 whereas the financing structure and assumptions for the Fiji and PNG recycling hubs are summarized in Table 53

Table 52 Assumed Financing Structure for the Recycling Facilities on the 12 Smaller Islands

Financing for implementation	Financing structure	Interest rate	Repayment period in years
Domestic government grants	20%		
Domestic government or commercial loans	40%	6%	10.0
International grants	0%		
International loans	0%	4%	15.0
Equity from owners	20%		
Promotional loans	20%	4%	8.0

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 53 Financing Structure and Assumptions for the Fiji and PNG Recycling Hubs

Financing for implementation	Financing structure	Interest rate	Repayment period in years
Domestic government grants	20%		
Domestic government or commercial loans	10%	6%	10.0
International grants	0%		
International loans	40%	4%	15.0
Equity from owners	20%		
Promotional loans	10%	4%	8.0

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

All the different revenue and cost items are summarized in the annual cash flow, which comprises the initial investments, the reinvestments/rehabilitation, the fixed and variable operation and maintenance cost, and the scrap value at the end of the analysis period. This cash flow is discounted to a Net Present value (NPV) with the weighted average cost of capital (WACC). The WACC is calculated as the weighted average of the above financing structure and attains a real value of 6% on the smaller islands and 5.3% on Fiji and PNG. The combined real WACC is 5.75%.

This discounted cash flow generates the NPV of the specific recycling facility. The same cash flow is used to calculate the IRR of the recycling facilities and hubs.

5.6 Financial Profitability Analysis

The recycling facilities and hubs give an IRR of 28.5% and an NPV of the cash flow of $681 million based on the individual islands' real discount rates (combined profitability on all 14 islands). The minimum IRR is 11.1% and the largest IRR is 78.2%. Hence, based on the assumptions outlined above, the profitability of the recycling facilities and hubs is good.

5.7 Economic Benefit-Cost Analysis

To calculate the economic benefits and costs of the recycling facilities and hubs, different corrections to the above cash flow must be made. The below criteria are used to correct fiscal distortions:

- Prices for input and output are considered net of Value Added Tax (VAT)
- Prices for input are considered net of direct and indirect taxes
- Prices (e.g., tariffs) used as a proxy for the value of outputs are considered net of any subsidies and other transfer granted by a public entity.

The following adjustment (fiscal corrections) have been made in the economic benefit-cost analysis:

- Taxes and subsidies are transfer payments and do not represent any real economic costs or benefits for the islands as they involve merely a transfer of certain resources from one group on the island to another group and are thus excluded in the economic analysis.
- VAT payments on construction costs and selling prices are excluded in the economic analysis. Subsidies granted are equally excluded in the calculation of the economic cash flow.

5.7.1 Economic Benefits

The following economic benefits have been identified and quantified:

1. Resource savings
In the economic analysis, there are resource savings as the recycling facility eliminates or reduces waste going to the landfill. It has been assumed that the existing depositing charge at the landfill is equivalent to the cost of landfilling, although the existing gate fee may be underestimated (covering only the operational costs) as compared to the total costs of disposal (including capital costs).

2. Avoided cost of CO_2 through recycling
The avoided cost of CO_2 through recycling is calculated by the amount of CO_2 used to produce 1 ton of the waste fraction times the total amount of the waste fraction recycled. This amount of avoided CO_2 is reduced by the estimated amount produced by transporting the waste fraction to the islands. To assess the cost of emissions, the avoided CO_2 is monetized based on an assumed unit cost of $21; this has further been assumed to increase by 3% annually.

3. Reduction in GHG emissions
GHG emissions, primarily methane (CH_4), are reduced when waste is recycled instead of deposited at landfill. To evaluate the cost of CH_4 emissions, the tons 4 emitted are converted into CO_2-equivalents and then monetized based on a unit cost. A CO_2 unit cost of $21 has been assumed with a 3% annual increase.

4. Reduced leachate generated due to reduced amount of waste deposited at the landfill. For every ton of waste at a landfill, 0.11 m^3 leachate is generated, depending upon the precipitation and the height of the waste at the landfill. The cost of leachate constitutes the cost of cleaning 1 m^3 to an environmentally acceptable level. An average wastewater treatment cost equivalent to $5/$m^3$ leachate has been applied. This is equivalent to an annualized cost of building a new wastewater treatment plant of an appropriate size.

5. Employment effects
In addition, the additional employment generated in the recycling facility has been assessed both during the construction phase as well as during the operational phase. It has been assumed that any new additional employees at the recycling facilities were unemployed before and received unemployment benefits. Hence, only the new wage impact (new wage less unemployment benefits) is included, net of taxes of each additional job created. In addition, an indirect job creation factor of 1.8428 has been applied.

The recycling facility's annual economic benefits are summarized in Table 54.

Table 54 Economic Benefits Quantified

NPV of economic benefit	2023 (USD)	Annualized economic benefits
NPV of resource savings	290,954,545	24,854,355
NPV of avoided cost of CO_2 through recycling	199,426,986	17,035,751
NPV of avoided CO_2 at the landfill	75,962,743	6,489,003
NPV of reduced leachate production	3,167,976	270,620
NPV of additional wages	175,093,225	14,957,076
Total NPV of economic benefits	744,605,475	63,606,805

NPV = net present value.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

The total economic benefits are calculated to be $745 million during the 20-year analysis period of the recycling facilities and hubs. The annualized economic benefits are calculated to be $63 million, based on a real discount rate of 5.75%.

Human health co-benefits due to improved management of wastes and formalization of the workforce, although not quantifiable here, are expected to reduce the negative impacts of infections transmission, physical bodily injury, non-communicable diseases, and psychological effects (e.g., personal hygiene and social stigma).[29] It has not been possible to monetize negative externalities such as noise and odors following continuous use of the landfill. In addition, health and environmental hazards (variation in contamination of air) have likewise not been possible to monetize. However, if quantified, it would have benefitted the project to a larger extent. Only contamination of non-potable water and soil has been quantified.

5.7.2 Economic Costs

There are very few economic costs to the society following implementation of the waste recycling projects. The following economic costs have been identified:

1. Environmental impacts (Pb, Fl to air and land, water usage and treatment, etc.)
Recycling waste streams causes impacts to the environment. This could be lead (Pb) to air and land, water usage in connection with cleaning the waste and the subsequent treatment of the wastewater. However, with proper handling of the waste, the environmental costs are reduced.

[28] Employment in the Waste Management Sector: Access Economics, 2009.

[29] Ziraba, A.K., Haregu, T.N. & Mberu, B, 2016

2. Lost economic activity for pickers
It is a source of income for poor residents who rummage through the rubbish in search of anything of value. Pickers will experience less material for potential reuse since the waste resources are redirected to the recycling facilities. On average, it is estimated that 58% of the waste is recycled while the rest is still going to the landfill. However, the number of poor pickers on the Pacific Islands is insignificant and is thus not estimated as an economic cost.

3. Emissions - additional shipping activity, local transport
There will be additional local shipping activities to transport the waste from the source to the recycling facility instead of to the landfill. Obviously, this will create additional emissions. However, this effect has already been considered when assessing the avoided tons CO_2 through recycling the waste stream. Hence this economic cost of CO_2 emissions has been monetized, because net CO_2 emissions are used in the economic benefit calculations.

These are highly unlikely to be material compared to the benefits but are noted here for completeness.

5.7.3 Economic Results

Correcting for the transfers in the cash flow provides the basis for calculating the total benefit of the recycling project. This economic cash flow is discounted to an economic NPV. Dividing the economic NPV of the financial and economic benefits with that of the costs gives the Benefit-Cost Ratio of the recycling project. A ratio above 1 indicates that the benefits are higher than the costs, and vice versa. However, when the NPV of the recycling facility is positive, the Benefit-Cost Ratio is above 1 before adding the economic effects. When adding the economic benefits to the adjusted financial cash flow, the Benefit-Cost Ratio attains a value of 1.42. The individual islands' Benefit-Cost ratios are presented in the appendices.

5.7.4 Effect of Subsidy

One feature of this analysis is the presence of subsidies on certain waste stream in certain countries and the effect this has on the cost benefit ratio. Table 55 shows the details of this with Micronesia and Kiribati having certain subsidized waste streams through container deposit legislation (CDL) and in Tuvalu through an Advanced Recycling Fee (ARF).

Table 55 Ranked Benefit-Cost Ratio and Material Subsidies

PIC	BCR	Aluminum Cans	ULAB	PET	Scrap Steel	Steel Cans	Paper & Cardboard	Glass Bottles	Plastic Film
NIU	1.62	No	No	No	No	No	No	No	No
NRU	1.60	No	No	No	No	No	No	No	No
MHL	1.48	Yes	No	Yes	No	No	No	Yes	No
FSM	1.46	Yes	Yes	No	No	No	No	Yes	No
FJI	1.43	No	No	No	No	No	No	No	No

PIC	BCR	Aluminum Cans	ULAB	PET	Scrap Steel	Steel Cans	Paper & Cardboard	Glass Bottles	Plastic Film
KIR	1.43	Yes	Yes	Yes	No	No	No	No	No
PNG	1.42	No	No	No	No	No	No	No	No
COK	1.36	No	No	No	No	No	No	No	No
PLW	1.35	Yes	No	Yes	No	Yes	No	Yes	No
VUT	1.32	No	No	No	No	No	No	No	No
WSM	1.28	No	No	No	No	No	No	No	No
SLB	1.28	No	No	No	No	No	No	No	No
TON	1.23	No	No	No	No	No	No	No	No
TUV	0.78	Yes	Yes	Yes	Yes	No	No	No	No

COK = Cook Islands, FJI = Fiji, FSM = Federated States of Micronesia, KIR = Kiribati, MHL = Republic of the Marshall Islands, NRU = Nauru, NIU = Niue, PET = polyethylene, PLW = Palau, PNG = Papua New Guinea, WSM = Western Samoa, SLB = Solomon Islands, TON = Tonga, TUV = Tuvalu, ULAB = used lead acid battery, VUT = Vanuatu.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 55 shows that there is no discernible effect on subsidizing waste costs on CBR values in 13 of the countries (i.e., they all remain greater than 1) where the subsidies relate to beverage containers and sometimes batteries. However, for Tuvalu there is a profound impact with the CBR falling below 1 to 0.78 as a result of also subsidizing scrap steel.

Table 56 Tons of Target Recyclable Wastes with a Subsidy

Country	Total Waste (Ton/year)	Total Subsidized Waste (Ton/year)	% of Subsidized of Total Waste
Cook Islands	308	-	0%
Fiji	69,934	-	0%
FSM	10,592	712	7%
Kiribati	13,319	1,362	10%
Marshall Islands	8,140	408	5%
Nauru	199	-	0%

Country	Total Waste (Ton/year)	Total Subsidized Waste (Ton/year)	% of Subsidized of Total Waste
Niue	47	-	0%
Palau	3,031	453	15%
PNG	361,705	-	0%
Samoa	9,278	-	0%
Solomon Islands	37,190	-	0%
Tonga	5,044	-	0%
Tuvalu	1,855	1,350	73%
Vanuatu	12,629	-	0%
Total	**533,272**	**4,284**	**1%**

PNG = Papua New Guinea, FSM = Federated States of Micronesia.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

This difference is explained in Table 56, which shows that Tuvalu, by including scrap steel, ends up subsidizing 73% of the total waste targeted for collection. Whereas for other countries subsidies limited to beverage containers and sometimes batteries result in only 5% to 15% of the waste being subsidized.

This shows care needs to be taken that, although high levels of subsidy will improve IRR and waste value chain, this could nonetheless impact the overall economic benefits realized.

5.7.5 Financial Forecast

The financial statements are summarized for all recycling projects on the 14 islands as if it were implemented by one Project Sponsor of the recycling facility until 2030.

With the given assumptions, the recycling facility project is financially sustainable as there are positive cash flows every year, and the Project Sponsor can repay loans, as well as pay dividends. Given the size of the annual profit, the Project Sponsor will accumulate equity after having serviced the annual loan obligations.

Profit and loss statement All islands

	Unit	2023	2024	2025	2026	2027	2028	2029	2030
Expected revenues from sales of waste fra	USD		0	18,580,771	239,101,650	253,972,922	268,844,194	283,715,466	297,425,440
Gate fees or subsidies	USD		0	5,624,789	25,575,183	27,151,660	28,728,137	30,304,614	31,529,542
Total revenues	USD		0	24,205,560	264,676,833	281,124,582	297,572,331	314,020,080	328,954,982
Operational and maintenance costs									
Cost of waste	USD		0	3,177,786	56,630,054	60,157,019	63,683,984	67,210,949	70,539,303
Maintenance costs of the facility	USD		0	929,985	10,830,753	11,504,042	12,177,331	12,850,621	13,465,786
Transportation costs to the facility	USD		0	2,881,110	43,126,322	45,810,463	48,494,604	51,178,745	53,682,816
Operational costs of the facility	USD		0	2,169,965	25,271,756	26,842,765	28,413,773	29,984,781	31,420,167
Transportation costs from the facility	USD		0	7,498,076	35,313,647	37,491,461	39,669,274	41,847,088	43,556,271
Cost of depositing non-recycled waste fractions			0	2,663,974	17,588,109	18,676,960	19,765,811	20,854,661	21,777,014
Total operational and maintenance costs			0	19,320,895	188,760,641	200,482,709	212,204,777	223,926,845	234,441,357
EBITDA	USD		0	4,884,665	75,916,191	80,641,873	85,367,554	90,093,235	94,513,625
Depreciation and amortization	USD		0	1,431,993	16,606,069	16,606,069	16,606,069	16,606,069	16,102,327
EBIT	USD		0	3,452,672	59,310,122	64,035,803	68,761,485	73,487,166	78,411,297
Interest payment	USD		0	619,990	8,773,604	8,707,730	8,272,465	7,837,200	7,401,936
Profit or loss - before tax	USD		0	2,832,682	50,536,518	55,328,073	60,489,019	65,649,965	71,009,361
Tax	USD		0	566,536	10,107,304	11,065,615	12,097,804	13,129,993	14,201,872
Profit or loss - after tax	USD		0	2,266,145	40,429,215	44,262,459	48,391,216	52,519,972	56,807,489
Dividend payments	USD		0	0	377,681	7,259,263	11,203,297	15,162,110	19,147,218
Profit or loss after dividends	USD	0	0	2,266,145	40,051,533	37,003,196	37,187,918	37,357,863	37,660,271

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Balance sheet	All islands								
ASSETS	**Unit**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Short term assets									
Cash	USD	0	0	1,590,650	36,929,735	78,639,556	124,431,217	170,392,823	216,246,063
Inventory	USD	-	0	2,017,130	22,056,403	23,427,048	24,797,694	26,168,340	27,412,915
DSRA	USD		0	619,990	9,548,591	13,010,444	12,575,180	12,139,915	11,704,650
Total short term assets	USD	0	0	4,227,770	68,534,729	115,077,049	161,804,091	208,701,078	255,363,629
Long term assets									
Tangible long term assets	USD	67,893,961	135,787,922	194,325,644	183,554,748	172,783,853	162,012,958	151,242,062	140,471,167
Intangible assets amortization	USD	10,145,075	20,290,149	28,672,128	22,836,954	17,001,780	11,166,606	5,331,432	0
Other long term assets	USD	0	0	0	0	0	0	0	0
Total long term assets	USD	78,039,035	156,078,071	222,997,772	206,391,702	189,785,633	173,179,564	156,573,494	140,471,167
TOTAL ASSETS (I + II)	USD	78,039,035	156,078,071	227,225,541	274,926,431	304,862,682	334,983,655	365,274,572	395,834,796
LIABILITIES AND EQUITY	**Unit**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Short Term Liabilities									
Short term liability	USD	0	0	529,631	9,438,342	10,026,170	10,613,997	11,201,825	11,756,550
Total short term liabilities	USD	0	0	529,631	9,438,342	10,026,170	10,613,997	11,201,825	11,756,550
Long Term Liabilities									
Domestic government or commercial loan:	USD	15,634,027	31,268,055	43,027,145	42,252,158	37,949,444	33,646,729	29,344,014	25,041,300
International loans	USD	32,264,599	64,529,198	96,793,797	96,793,797	94,642,823	92,491,850	90,340,877	88,189,904
Promotional loans	USD	3,848,716	7,697,433	9,608,681	9,124,314	7,923,229	6,722,144	5,521,058	4,319,973
Total long term loans	USD	51,747,343	103,494,685	149,429,623	148,170,268	140,515,495	132,860,723	125,205,950	117,551,177
TOTAL LIABILITIES (I+II)	USD	51,747,343	103,494,685	149,959,254	157,608,611	150,541,665	143,474,720	136,407,775	129,307,727
EQUITY									
Equity	USD	26,291,693	52,583,386	75,000,142	75,000,142	75,000,142	75,000,142	75,000,142	75,000,142
Retained earning	USD	0	0	0	2,266,145	42,317,679	79,320,875	116,508,793	153,866,656
Profit (Loss) for the current financial perioc	USD	0	0	2,266,145	40,051,533	37,003,196	37,187,918	37,357,863	37,660,271
Total Equity	USD	26,291,693	52,583,386	77,266,287	117,317,821	154,321,017	191,508,935	228,866,798	266,527,069
TOTAL LIABILITIES AND EQUITY (I+II+II	USD	78,039,035	156,078,071	227,225,541	274,926,431	304,862,682	334,983,655	365,274,572	395,834,796

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Cash flow statement	All islands								
Operating activities	**Unit**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Operating profits	USD	0	0	2,266,145	40,051,533	37,003,196	37,187,918	37,357,863	37,660,271
Depreciations	USD	0	0	1,431,993	16,606,069	16,606,069	16,606,069	16,606,069	16,102,327
Operating profit before working capital cha	USD	0	0	3,698,139	56,657,602	53,609,265	53,793,988	53,963,932	53,762,598
Investing activities									
Investments	USD	78,039,035	78,039,035	68,351,694	0	0	0	0	0
Net cash flow used for investing activities	USD	78,039,035	78,039,035	68,351,694	0	0	0	0	0
Financing activities									
Domestic government grants	USD	10,683,886	10,683,886	8,746,417	0	0	0	0	0
Domestic government or commercial loan:	USD	15,634,027	15,634,027	11,759,091	-774,987	-4,302,715	-4,302,715	-4,302,715	-4,302,715
International grants	USD	0	0	0	0	0	0	0	0
International loans	USD	32,264,599	32,264,599	32,264,599	0	-2,150,973	-2,150,973	-2,150,973	-2,150,973
Equity from owners	USD	15,607,807	15,607,807	13,670,339	0	0	0	0	0
Promotional loans	USD	3,848,716	3,848,716	1,911,248	-484,367	-1,201,085	-1,201,085	-1,201,085	-1,201,085
Net cash generated from financing activitie	USD	78,039,035	78,039,035	68,351,694	-1,259,354	-7,654,773	-7,654,773	-7,654,773	-7,654,773
Changes in working capital	USD		0	-1,487,499	-11,130,561	-782,818	-782,818	-782,818	-689,850
Net annual increase in Cash and Cash Equi	USD	0	0	2,210,640	44,267,687	45,171,674	45,356,396	45,526,341	45,417,976
Cash and Cash equivalents (Start of year)	USD		0	0	2,210,640	46,478,326	91,650,000	137,006,397	182,532,738
Cash and Cash Equivalents (End of year)	USD	0	0	2,210,640	46,478,326	91,650,000	137,006,397	182,532,738	227,950,714

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Key performance indicators	All islands	2023	2024	2025	2026	2027	2028	2029	2030
Financial indicators									
- Gross margin	%			20%	29%	29%	29%	29%	29%
- EBITDA	USD			4,884,665	75,916,191	80,641,873	85,367,554	90,093,235	94,513,625
- EBITDA margin	%			20%	29%	29%	29%	29%	29%
- Debt-equity ratio	%			193%	126%	91%	69%	55%	44%
- DSCR	%			37%	508%	360%	393%	428%	464%
- Solvency ratio	%			2%	36%	40%	45%	51%	56%
Profitability									
- Return on total assets	%			1%	15%	15%	14%	14%	14%
- Return on equity	%			3%	34%	29%	25%	23%	21%
- Gross profit margin	%			20%	29%	29%	29%	29%	29%
- Net profit margin	%			9%	15%	16%	16%	17%	17%
- Return on investment	%			25%	40%	40%	40%	40%	40%
Asset management									
- Asset turnover	%			11%	96%	92%	89%	86%	83%
Financial solvency									
- Debt to equity ratio	%			193%	126%	91%	69%	55%	44%
- Total long term debt to total asset ratio	%			66%	54%	46%	40%	34%	30%
Liquidity ratios									
- Current ratios				8.0	7.3	11.5	15.2	18.6	21.7
- Acid ratio				4.2	4.9	9.1	12.9	16.3	19.4
- Cash coverage ratio	%			466%	561%	608%	685%	770%	867%
- Working capital	USD			3,698,139	59,096,387	105,050,879	151,190,094	197,499,253	243,607,078

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.8 Sensitivity Analysis

A sensitivity analysis has been carried out to assess the profitability of the overall recycling project in case important parameters change from the central values. The following parameters have been analyzed between plus and minus 60%, 40%, and 20% from the central values.

- Investment costs
- Waste amounts
- Operational and maintenance costs
- Transportation costs to and from the recycling facilities
- Unit sales prices

5.8.1 Investment Costs

The consequences of the recycling projects profitability on changing the investment costs are shown in the Table below and illustrated on the following figure by the annual EBIT and IRR.

Table 57 Sensitivity of Changes in Investment Costs

	60%	40%	20%	Baseline	-20%	-40	-60%
EBIT (mil. USD)	67.58	76.56	85.54	94.51	103.49	112.47	121.45
IRR	13.3%	17.5%	22.4%	28.5%	36.5%	47.9%	66.3%
NPV (mil. USD)	293.98	423.19	552.40	681.61	810.83	940.04	1,069.25
Benefit/Cost ratio	1.26	1.31	1.36	1.42	1.48	1.55	1.63

EBIT = Earnings before interest and tax, NPV = net present value, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

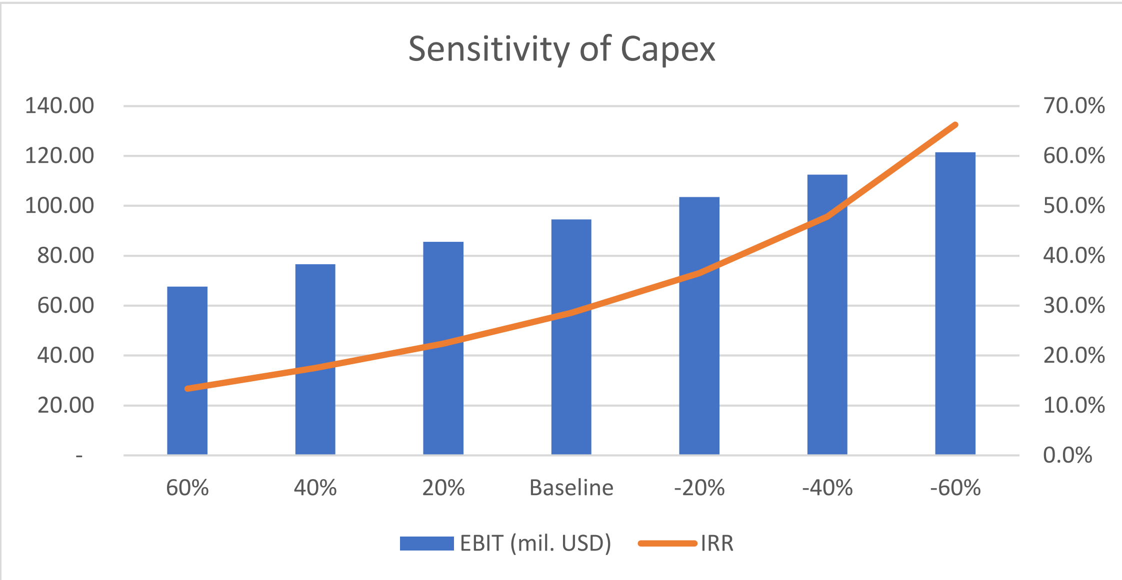

Figure 32 Sensitivity of CAPEX

EBIT = Earnings before interest and tax, IRR = internal rate of return
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

If the CAPEX increases by 105% compared to the baseline case, the overall projects will attain an IRR equal to the WACC and thus generate an NPV of zero.

5.8.2 Waste Amounts

The consequences of the recycling projects profitability on changing the waste amounts are shown in Table 58 and illustrated in the following figure by the annual EBIT and IRR.

Table 58 Sensitivity of Changes in Waste Amounts

	60%	40%	20%	Baseline	-20%	-40	-60%
EBIT (mil. USD)	178.15	150.27	122.39	94.51	66.63	38.75	10.87
IRR	46.2%	40.8%	35.0%	28.5%	21.1%	12.1%	-0.1%
NPV (mil. USD)	1,478.22	1,212.68	947.15	681.61	416.08	150.54	(114.99)
Benefit/Cost ratio	1.55	1.52	1.47	1.42	1.34	1.23	1.07

EBIT = Earnings before interest and tax, NPV = net present value, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

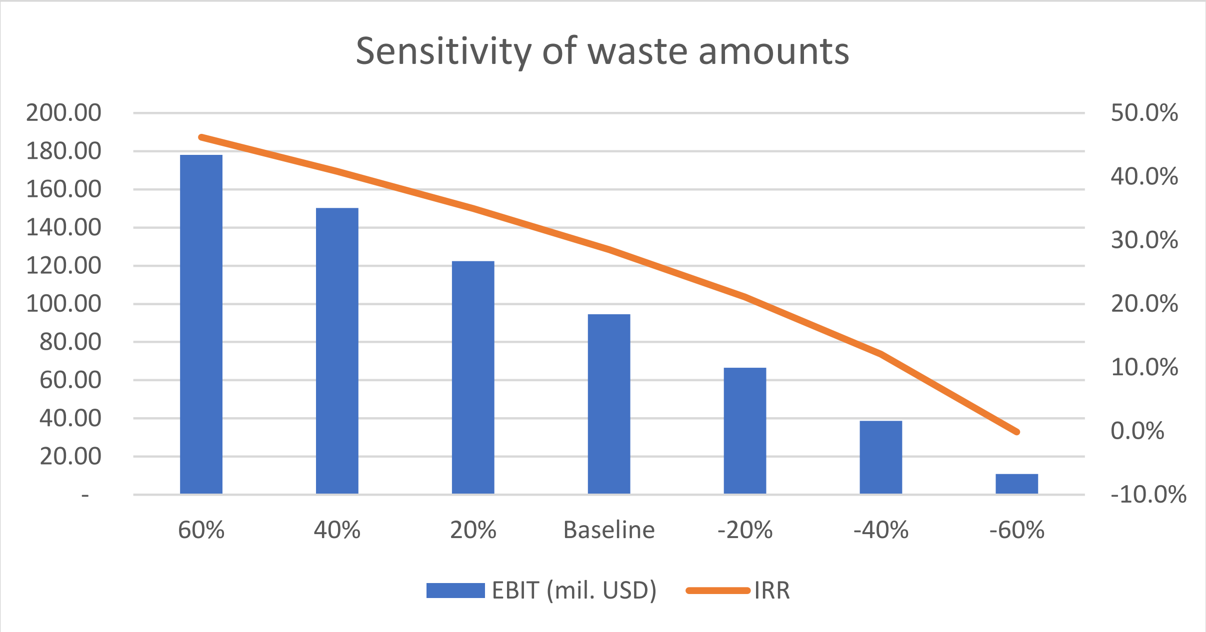

Figure 33 Sensitivity of Waste Amounts

EBIT = Earnings before interest and tax, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

If the waste amounts fall by -51% compared to the baseline case, the overall projects will attain an IRR equal to the WACC and thus generate an NPV of zero.

5.8.3 Operational and Maintenance Costs

The consequences of the recycling projects' profitability on changing the operational and maintenance costs are shown in Table 59 and illustrated in Figure 34 by the annual EBIT and IRR.

Table 59 Sensitivity of Changes in Operational and Maintenance Costs

	60%	40%	20%	Baseline	-20%	-40	-60%
EBIT (mil. USD)	67.58	76.56	85.54	94.51	103.49	112.47	121.45
IRR	21.3%	23.9%	26.2%	28.5%	30.7%	32.8%	34.8%
NPV (mil. USD)	424.77	510.38	596.00	681.61	767.23	852.85	938.46
Benefit/Cost ratio	1.28	1.32	1.37	1.42	1.47	1.52	1.58

EBIT = Earnings before interest and tax, NPV = net present value, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

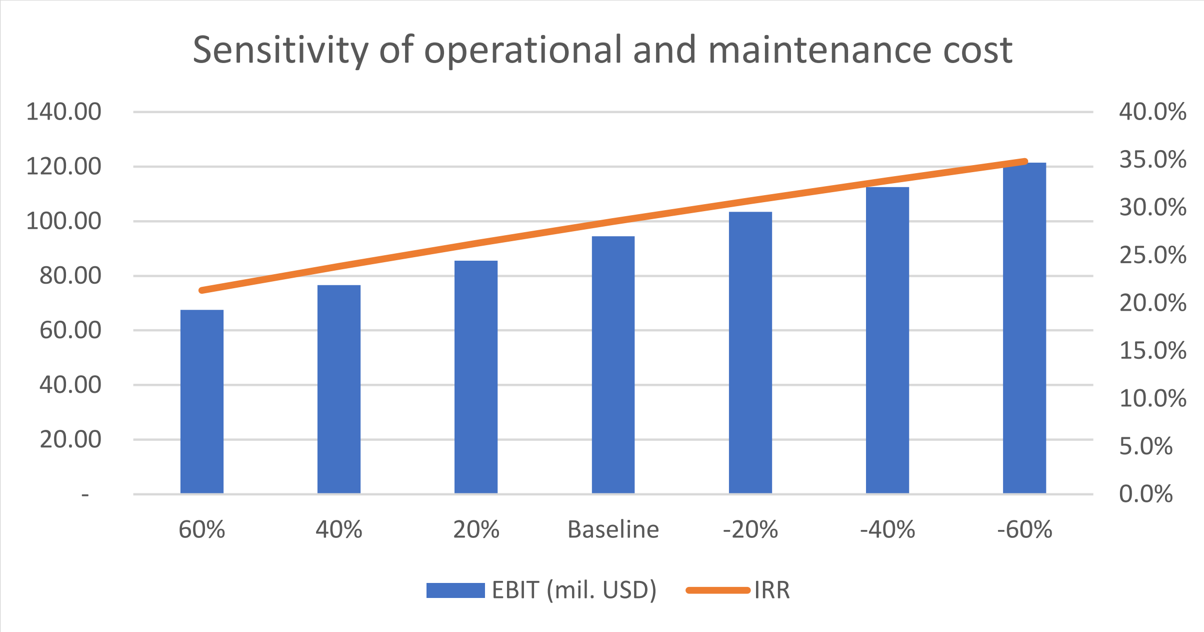

Figure 34 Sensitivity of Operational and Maintenance Cost

EBIT = Earnings before interest and tax, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

5.8.4 Transportation Costs to and from the Recycling Facilities

The consequences of the recycling projects' profitability on changing the transportation costs to and from the recycling facilities are shown in Table 60 and illustrated in Figure 35 by the annual EBIT and IRR.

Table 60 Sensitivity of Changes in Transportation Costs to and from the Recycling Facilities

	60%	40%	20%	Baseline	-20%	-40	-60%
EBIT (mil. USD)	36.17	55.62	75.07	94.51	113.96	133.41	152.86
IRR	11.0%	17.6%	23.4%	28.5%	33.2%	37.6%	41.6%
NPV (mil. USD)	122.80	309.07	495.34	681.61	867.89	1,054.16	1,240.43
Benefit/Cost ratio	1.15	1.23	1.32	1.42	1.53	1.67	1.83

EBIT = Earnings before interest and tax, NPV = net present value, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

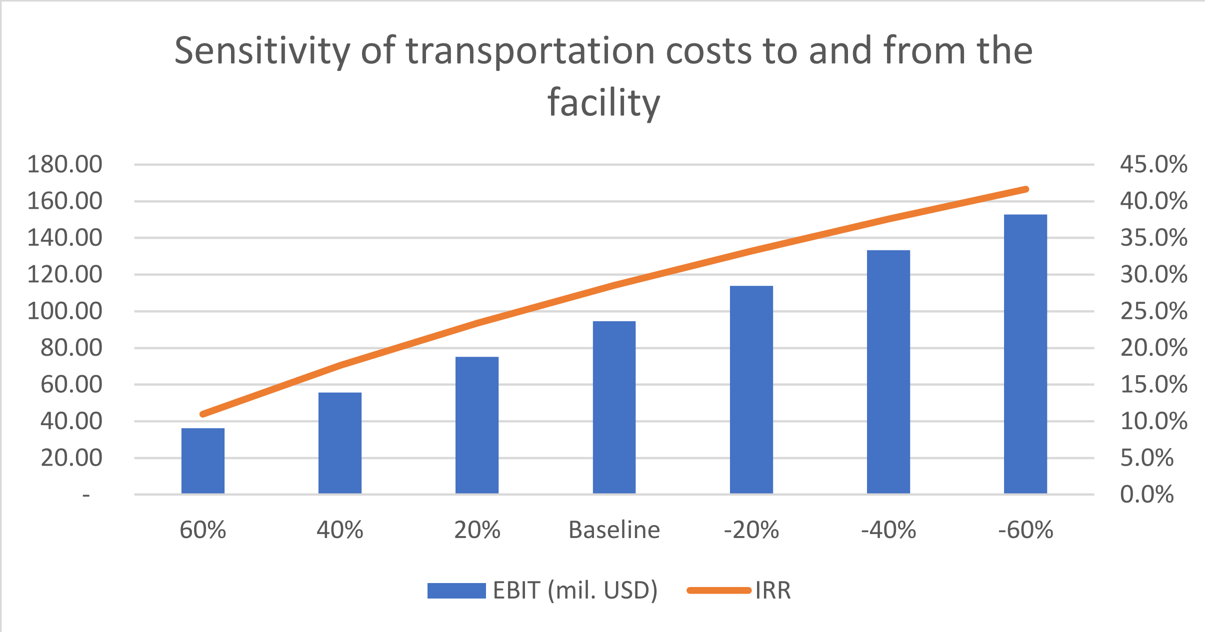

Figure 35 Sensitivity of Transportation Costs to and from the Facility

EBIT = Earnings before interest and tax, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

If the transportation costs to and from the recycling facilities increase by 73% compared to the baseline case, the overall projects will attain an IRR equal to the WACC and thus generate an NPV of zero.

5.8.5 Unit Sales Prices

The consequences of the recycling projects' profitability on changing the unit sales prices are shown in Table 61 and illustrated in the following figure by the annual EBIT and IRR.

Table 61 Sensitivity of Changes in Unit Sales Prices

	60%	40%	20%	Baseline	-20%
EBIT (mil. USD)	272.97	213.48	154.00	94.51	35.03
IRR	61.9%	52.5%	41.6%	28.5%	10.7%
NPV (mil. USD)	2,382.27	1,815.38	1,248.50	681.61	114.73
Benefit/Cost ratio	2.11	1.88	1.65	1.42	1.18

EBIT = Earnings before interest and tax, NPV = net present value, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

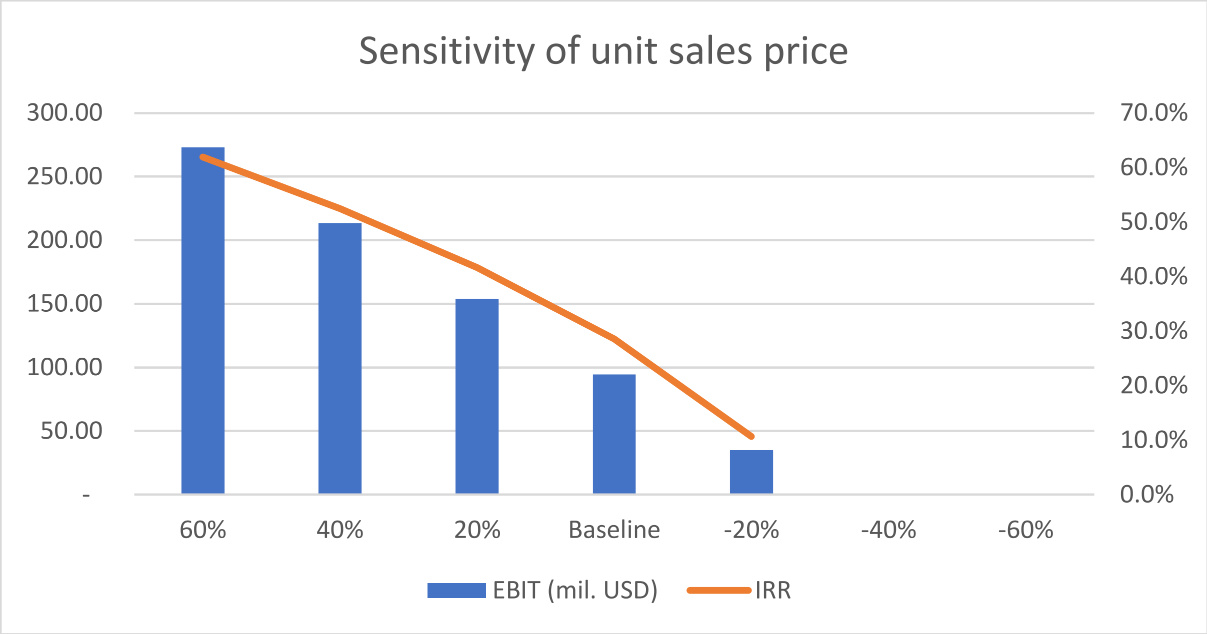

Figure 36 Sensitivity of Unit Sales Price

EBIT = Earnings before interest and tax, IRR = internal rate of return.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

If the unit sales prices fall by −24% compared to the baseline case, the overall projects will attain an IRR equal to the WACC and thus generate an NPV of zero.

5.8.6 Summary on the Sensitivity Analysis

The recycling project is very sensitive to changes in the unit sales prices of the recycled waste. Hence, if the unit sales prices fluctuate, it may be a severe risk to the profitability of the recycling project. On the other hand, if recycling prices are stable, as it appears today, the risk will not be significant.

If waste amounts are not properly assessed or it becomes more difficult to collect and deliver the different waste fractions to the recycling facilities, it is not important for the profitability of the recycling project. The IRR remains at a relatively high level with lower waste amounts.

If capital expenditures become 20% more expensive than the baseline estimate, the profitability of the recycling projects attain an IRR of 15%, and it becomes riskier.

The operational and maintenance costs are not very important for the profitability of the project. They can increase by 60% and still the project is profitable, with an IRR around 15%.

The profitability of the project is not severely in danger if transportation cost to and from the recycling facilities turns out to be different from the baseline assumptions.

6 Institutional Arrangements

6.1 General

Environmentally sound waste management is essential for sustainable development in PICs. Inadequate waste management impacts negatively on public health, atmospheric, terrestrial, aquatic (freshwater, coastal, and marine) environments, and economic sectors such as tourism, fishing, and agriculture. Environmentally sound waste management requires the development of an integrated waste management system (IWMS) in the individual PICs.

The development of an RRC can be an integral and crucial element of an IWMS.

"Integrated" refers to the strategic approach to sustainable waste management, covering all sources and all operations (generation, separation, collection, transfer, concentration/sorting, processing, recycling, and disposal) in an integrated manner, involving all stakeholders and incorporating various interlinked components. A policy, for example, needs an enabling institutional environment for its formulation and implementation. The legislation provides the regulatory and economic instruments needed to achieve the stated objectives. The institutions provide the human and technical capacities needed to implement the policy.

All operations must be covered. The existence of dumping sites for example where recyclable wastes are accepted, would undercut any recycling effort and the functioning of an RRC.

To enable a sustainable RRC, behavioral change with respect to priority waste streams will be necessary. To provoke the necessary change, the development, implementation, monitoring, and enforcement of an evidence-based, appropriate mix of regulatory, economic, and information-based (or social) policy instruments, coupled with the necessary investments in waste management systems and infrastructure, will be necessary.

The mix of policy measures and the investments should be guided by key waste management principles, such as the Polluter Pays Principle. They should encourage material reuse, as well as diversion of waste from disposal in landfills or dumping to recycling. Currently, the focus in waste is mostly on collection in the PICs.

The development of the IWMS should be aligned with broader planning in sectors that are generating waste and/or that are affected by the lack of sustainable waste management, including tourism, fisheries, maritime transport, food and agriculture, and coastal development.

6.2 Components of an Integrated Waste Management System

IWMSs can be grouped into two categories, with several key components that must be developed in the individual PICs:

A. Good Governance (refers to how public institutions conduct public affairs and manage public resources and guarantee the citizens a clean environment).

B. Operations and Infrastructure.

6.2.1 Good Governance

Good governance has the following components:

1. Institutional framework, with government institutions, that can create an enabling environment for the management of waste.
2. Policy framework, guided by waste management principles, and comprising a National Waste Strategy and a National Action Plan, aligned with both local strategies and action plans and national policy.
3. Legal framework, with enabling legislation.
4. A financing system: Providing good waste management services, while also ensuring financial sustainability of the system, is a major challenge.
5. Stakeholder awareness and inclusivity: IWMS's require extensive coordination and cooperation among, and participation from, all levels of government, private sector, community groups, and other stakeholders.
6. Data and knowledge: Solutions must be tailored to the local situation, which requires collection of data and knowledge. This requires the development of an information system to construct reliable waste statistics that can support policy and investment decisions.

6.2.2 Operations and Infrastructure

All waste must be collected and treated in an environmentally sound manner, in compliance with the framework. Individual PICs have one or more of the following options, depending on the waste stream:

1. Collection (all PICs):

- All households must have access to a reliable collection service and all types of waste must be collected. A 100% collection coverage should thus be the target, as well as avoiding open air burning, illegal dumping and disposal in public spaces, waterways, and coastal waters.
- The following waste streams must be collected separately at source:
    - Recyclable waste, in particular dry recyclables, including paper/cardboard; plastic packaging and metal cans.
    - Hazardous waste.
    - Any other waste stream covered by the RRC.

It is important to divert organic waste from kitchen and gardens from dumpsites and landfills to organic recycling. Moreover, it is important that all waste that is collected for recycling is clean and dry. Therefore, it should be avoided to mix recyclable waste with organic waste. Separate organic waste collection is, however, not recommended in the PICs to avoid the associated economic and environmental burdens. Instead, home and community composting, i.e., by households or in small community composting facilities, could be promoted. One other advantage of this practice is that it can generate "buy-in" from households who are otherwise less likely to separate organic waste, thus significantly decreasing residual waste volumes and increasing overall recycling rates.

- Separate collection to divert recyclable material from waste streams is a precondition for re-use and high-quality recycling, for example, to avoid plastic film contaminating bales and damaging equipment. Without source separate collection, most waste will continue to go into final disposal and recycling rates will remain low. Also, the quality of the secondary raw materials (the outputs of the waste processing) will remain low.

- The collection of recyclable waste at the curb (i.e., door-to-door) can in principle support higher rates of separate collection and of recycling that systems that solely rely on voluntary deposits at communal containers on streets, drop-off points (at shops, schools, events, etc.) and civic amenity sites. However, as there is no curbside collection yet in any PIC and as its introduction would involve economic costs and environmental burdens, it is not recommended in the context of the PICs. It is rather recommended to strengthen the existing collection systems.

2. Concentration (all PICs): sorting and baling or compacting (to ship at high density, reducing transportation costs).
3. Processing (adding value): Production of secondary materials, in existing facilities or in facilities to be developed, mainly in Fiji, the regional hub, and PNG.
4. Recycling: All separately collected waste streams must go to (mechanical) recycling facilities, either directly or after processing. The RRC must ensure this diversion for the waste streams that it covers. The facilities can be in the region, mainly in Fiji and PNG, or abroad. Whatever their location, they should all be licensed and of an adequate standard of technology and pollution control.
5. Safe disposal, i.e., landfilling (all PICs for inert waste) and incineration with energy recovery.

6.3 Institutional Framework

6.3.1 Good Governance Requirements

Institutional arrangements for waste management are understood to cover organizational structures and roles and responsibilities of institutions involved in various aspects of waste management and private sector involvement (which is covered in a separate section of this chapter).

These arrangements must meet good governance requirements to enable effective, efficient, and sustainable waste collection, recycling, and disposal services that preserve environmental quality and protect public health.

Institutional arrangements for waste management in the PICs vary, stemming from differences in their local conditions, such as geography, population, economic and social development, history and political structure, capacity, and available public financial resources.

There are, however, common challenges and requirements.

The PICs, like other small development states, have small, often scattered populations that must cover a variety of competencies like health, education, or environmental management, including waste management. With institutional fragmentation (see below), few staff with the necessary education and skills, and a high degree of staff turnover, sustainable waste management is challenging for governments.

There are also common requirements for institutional arrangements to work well, including the following:

- Clearly defined roles and responsibilities of each institution involved in waste management to avoid gaps and/or overlapping roles and thus potential for conflicts.

- The establishment of an effective mechanism for policy coordination and coherence in each of the PICs, such as a permanent national platform for dialogue on the waste management sector with key stakeholders, could help addressing this challenge. In turn, such national platforms could then coordinate and cooperate through a regional platform to be established to achieve greater regional coordination and cooperation.

- Adequate human and financial resources within responsible organizations to effectively carry out sustainable waste management in general, in and relation to the waste streams that are covered by the RRC in particular.

- Both human and financial resources are linked, as organizations should have the ability to secure the necessary budgetary transfers or revenues from user fees to cover costs. Adequate human resources involve enough staff, with the necessary awareness, knowledge and skills.

- Effective public participation and cooperation in waste management.

6.3.2 National Government

The main roles and responsibilities of different institutions in the context of waste management are defined in the following Table. Most of the roles and responsibilities are fulfilled by national government institutions.

It should be defined for each individual PIC which institution will fulfill which role in relation to the development of the RRC.

Some institutions may fulfill more than one role, but it is advisable to separate at least the regulatory and operational functions.

In addition, stakeholder engagement and communication are considered cross-cutting functions that require involvement from all roles.

Most of these roles and functions are shared among several institutions and across different levels of government. This requires adequate capacity at all levels.

Whatever the arrangements are, it is recommended that the responsibility of the "producers'" (i.e., companies that put packaging and packaged products on the market) be extended to the waste stage of their products, requiring them to organize and/or to pay for their collection, sorting, and recycling.

Without extended producer responsibility (EPR), the collection and recycling of packaging waste and other waste streams are unlikely to be meaningfully scaled. The necessity of EPR in the PICs is discussed in more detail further in this chapter.

In each individual PIC, a line ministry must be assigned to develop policies, draft legislation, and oversee waste management. It is recommended to establish a waste management section within the line ministry, staffed with professionals and empowered to initiate and carry out the measures and activities needed to make the RRC work.

6.3.3 Local Governments

Roles and Responsibilities

In most PICs, local governments are responsible for waste collection and treatment. Coordination is therefore needed to ensure a common national approach. In PICs where a local government does not exist (such as in the Cook Islands), the national government institutions oversee most aspects of waste management.

Where local governments exist, they should be incentivized to act and to improve local waste management and be adequately supported by the national government.

This national government support should at least aim to build local capacity, possibly also to co-finance waste management operations. From a sustainable financing perspective, municipal councils should have the authority to levy taxes on services provided to households. However, providing services to households with limited ability to pay for these services and ensuring that the services go beyond collection and aim for recycling is challenging and may require transfers from the national government.

Different Operational Models

The arrangements for the collection and transport of municipal waste often vary between municipalities in a country, with most countries displaying a mix of approaches. These arrangements can usually be categorized into one of the two main approaches:

- In-house service delivery. Municipal governments may directly deliver waste management services. In this case, municipal waste collection and treatment is predominantly carried out by the municipal waste management department or delegated to a municipality-owned company, or a company jointly owned by several municipalities through an exclusive contract.

- Competitive tendering of private sector services: In this case, waste collection and transport services for one (or more) municipal areas may be contracted out to commercial providers following competitive tendering.

A third approach is direct contracting between individual waste generators and private waste collectors, with varying degrees of oversight by local governments. This is common for businesses that generate waste, but it is not recommended for individual households. If the latter would be responsible for arranging the collection and transport of their waste, it may result in side-by-side collection, whereby multiple companies are operating side-by-side in the same municipality. This approach is seldom applied and is not recommended. It implies a weak role of the municipalities, resulting in illegal dumping, poor service coverage, and lack of separate collection of waste.

Outsourcing certain waste management service delivery functions to the private sector can possibly secure the necessary skills to improve service delivery and efficiency. Also, private-sector participation can increase effectiveness through performance-based contracts. However, the effectiveness of public-private partnerships will depend on the capacity of responsible organizations to design and manage contracts with operators to ensure that key targets are achieved. This is discussed in more detail in a separate section of this chapter.

Intermunicipal Cooperation

It is recommended that municipalities collaborate, primarily to achieve economies of scale within the individual PICs and within the region, but also for the following reasons:

- Increasing capacity: Small municipalities with low capacity require a lot of support and guidance to improve their systems, which can be done in a more effective and efficient manner if they collaborate.
- Increasing efficiency: Municipal budgets are often strained and therefore the coordination of services and the pooling of resources are all the more important.
- Increasing policy effectiveness: Many problems that relate to increasing recycling rates cannot be solved within municipal boundaries.
- Increasing policy coherence: Decisions made by one municipality can have adverse or positive impacts on other municipalities and the environment.

Generally, an intermunicipal approach can maintain local input and decision-making while addressing the shortcomings of having individual municipalities with low capacities.

Despite the potential benefits for participating local authorities, it is not easy to establish intermunicipal cooperation. Ironically, where intermunicipal cooperation can help to address capacity issues, opportunities are often missed due to administrative capacity issues.

Measures should therefore be taken at a national level to facilitate and to encourage such cooperation, through a variety of guidance tools and incentives. It could also be promoted by an association of municipalities. Where such an association does not yet exist, its establishment could be encouraged.

The objectives, scope, and forms of intermunicipal cooperation can vary considerably. In practice, intermunicipal cooperation will be successful only if it benefits all participating authorities. The main forms of intermunicipal cooperation are:

- Common procurement of services, which is the simplest form of intermunicipal cooperation. This may involve, for example, joint contracting of waste collection and transport services to achieve economies of scale.

- A cooperation agreement between a lead municipality and smaller local authorities, whereby the lead local authority takes responsibility for delivering services and/or establishing waste management facilities, which are then shared by the smaller local authorities according to the cooperation agreement.

- An intermunicipal association (IMA), which is an advanced form of cooperation between several local authorities based on agreement. There are two forms of IMA:

    - IMA as a consultative, supervisory, and coordinating authority
    - IMA with delegated responsibilities, in which case it has much broader functions as local authorities transfer partially or entirely their responsibilities. The IMA in this case could be responsible for organizing and contracting waste management services, and in some cases implementation of investment projects of common interest, including financing and ownership of treatment and disposal infrastructure.

- An intermunicipal company, which implements and operates common waste management services and facilities.

6.3.4 Regional Integration

Waste management must be improved in the individual PICs, at the national and local levels. However, regional integration through coordination, planning, and cooperation is crucial for the success of recycling systems. The related challenges are too large or complex for any one PIC to address.

The development of the RRC is one means to realize the benefits and opportunities of regional coordination.

Another means is the development of a regional platform, which creates the needed venue and framework for coordinating the national policies and goals among all PICs. The regional platform can gather representatives of the national platforms that may be established to achieve greater policy coordination and coherence in the individual PICs.

Regional integration presents the opportunity to, among others:

- Pool efforts
- Increase economies of scale
- Enhance capacities for development of harmonized policies and legislative standards
- Enhance capacities to generate and share data
- Facilitate partnerships between governments, businesses, and civil society organizations
- Share information and best practices
- Transfer skills and technology
- Increase the available investment capital through consolidation

- Accelerate private-sector investment, as companies realize the potential to scale up

It is premature to specify an operational model at the prefeasibility stage given the many variables that currently exist. To do so would artificially constrain the future choices given the many unknown variables which will not be revealed until a detailed feasibility study is conducted.

Questions include what is the modality? Is it government led, private sector led or are regional organizations responsible? Will something new and unique be proposed? How will funding sources shape this? These are questions that need to be answered via future stakeholder engagement.

6.4 Policy Framework

6.4.1 Strategy and Planning

The individual PICs need an agreed, long-term, and stable policy framework for guiding and coordinating efforts in the waste management sector and for monitoring and measuring progress in improving waste management, within which the RRC can be planned and the necessary waste collection, recycling, and disposal infrastructure can be provided.

Such a framework may include several documents that can be referred to as a National Waste Strategy, with the vision, goals, and overall objectives that guide decisions, and a National Waste Management Plan.

This national policy framework can be developed in line with the Pacific Regional Waste and Pollution Management Strategy 2016–2025, which provides strategic direction to all PICs, based on their common challenges and priorities.

Several PICs have developed a national policy framework, but implementation remains challenging, often due to the lack of political will and/or inadequate technical capacity and financial resources.

Typically, a National Waste Management Plan does the following:

- Describes the current waste management situation, for each of the waste streams that have been identified as priority waste streams

- Sets out specific policy objectives for each of the priority waste streams, which should in any case include those that are targeted by the RRC

- Set targets (usually quantitative) in line with the policy objectives; these targets should at least relate to collection and recycling within the context of the RRC

- Identifies the necessary mix of policy measures and actions that will be taken to meet the objectives and targets, including diversion of the priority waste streams to recycling facilities in the context of the RRC

- Specifies the required human, financial, and technical resources and where to spend them

- Outlines a process for monitoring implementation of the plan, often setting out the indicators that will be used to assess implementation

Where relevant, depending on local conditions, and in particular on size, population, political, and administrative structure and capacity, the National Waste Management Plan could be complemented with local action plans, aligned with the national policy and plan. These local action plans should be prepared by municipal authorities and outline how waste will be managed within their jurisdiction. Local action plans may be mandatory, as required under legislation, or voluntary, in which case financial and other incentives may be given by the national government to prepare them.

If a municipal planning process is not in place, the National Waste Strategy and Management Plan should also set out goals, objectives, and actions for local governments.

6.4.2 Policy Direction

Before a policy framework can be defined, including an appropriate mix of policy measures for addressing specific waste management issues and streams, it should be clear what the policy direction is. Policy direction is being determined by:

- the nature of the waste management problems to be addressed;
- the overall and specific policy objectives;
- the existing barriers to achieving the policy objectives, and thus to improving waste management, and in particular to increasing collection and recycling; and
- the underpinning Waste Management Principles.

Policy Objectives

The importance of objectives cannot be overestimated by policy makers. Objectives create guidance and are directing the activities of policy makers, and other stakeholders, including from the private sector, toward achieving the objectives.

All stakeholders must know the policy objectives and should subscribe to them. They should thus be made aware of them in the course of a stakeholder involvement process. All policy measures taken should contribute to achieving the objectives.

To enable the RRC, the following objectives with respect to the waste streams that it targets, are key:

- minimizing the generation of the waste streams that are targeted by the RRC
- increasing the separate collection of these waste streams
- increasing the processing and recycling of the separately collected waste streams, either in-country or abroad
- ensuring sustainable financing of the integrated waste management system, including of collection, processing, and recycling

Barriers to Increased Recycling

Recycling opportunities in PICs are inherently limited, due to relatively low volumes of recyclable materials generated and the even lower volumes that are collected separately; and the related lack of economies of scale.

Other factors hampering the expansion of recycling in the PICs include the following:

- Lack of sufficient political will: Governments of PICs should have strong political will to support recycling. However, there are varying levels of political will across the PICs for developing recycling.
- No enabling business environment: lack of adequate policies and regulations.
- Rising imports of products that, once they become waste, cannot be recycled in-country or in the region, and that lead to significant human health and environmental risks.
- Lack of access to technologies to recycle the increasing waste quantities and diversity.
- Capital requirements: Very high levels of capital are required to establish, maintain, and sustain recycling facilities.
- Human resources constraints: for example, limited access to technical knowledge (expertise will have to be imported) and lack of qualified staff for maintenance and operation.
- Unstable and unreliable markets for some recyclates due to occasional poor international demand (for PET bottles, paper and cardboard).
- Lack of market development and knowledge.
- Distance from viable markets and shipping constraints:
    - High marine transportation costs, accounting for as much as 30% of the cost of preparing and shipping recyclable commodities from PICs and territories to the Far East. The cost to ship recovered materials for recycling to markets compares negatively to the market price at the destination.
    - Low reliability (shipping routes fluctuate and costs increase).

Energy in the PICs is an important consideration to recycling both in relation to costs for waste facility management and processing of recyclables, as well as the GHG emissions which are produced by these activities.

Waste Management Principles

The Waste Management Principles that underpin the waste management policy should be defined. They should provide a common framework for action, within which policy measures must be developed and within which all stakeholders must act. They can thus also constitute a national standard, against which the conduct of stakeholders can be assessed.

The principles do not constitute a legal instrument, though some may be incorporated in legislation for effective implementation and enforcement.

In Table 62, a set of Waste Management Principles, often derived from international agreements and also included in the Pacific Regional Waste and Pollution Management Strategy 2016–2025, are listed and briefly described.

Table 62 Waste Management Principles

Principle	Description
Regionalism	Regional cooperation and collaboration must be undertaken where appropriate to complement national efforts, overcome common problems, share and pool resources, and harness shared strengths.
Precautionary Principle	Where evidence of environmental or human health risk exists, appropriate precautionary action should be taken, even in the absence of certain scientific evidence and conclusive proof of causes.
Prevention principle	▪ This principle requires preventive measures be taken to anticipate and avoid environmental damage before it occurs. ▪ In the context of waste management, it means preventing the generation of waste; where this is avoidable, minimize the amount of waste generated and reducing the hazardous content of that waste, where this is practicable, by changing the current production and consumption patterns. ▪ It requires the development of systems that place a greater emphasis on consumption reduction, and that encourage the use of durable products and the re-use of products (such as refillable packaging).
Waste "Hierarchy"	▪ The five-step Waste Hierarchy defines a preferred order of waste management options according to best practice. Implementing the best option for specific waste streams may require departing from the hierarchy where this is justified by lifecycle thinking on the overall impacts of the generation and management of such waste. Implementation may also be subject to technical feasibility, affordability, and financial sustainability constraints. ▪ The hierarchy was first adopted by the European Union, followed by several countries in other regions. Some have adopted the 3R principle, i.e., Reduce, Reuse, Recycle, which is a partial application of the hierarchy. ▪ It gives top priority to preventing waste in the first place. When waste cannot be avoided, it gives priority to preparing it for re-use, then to (mechanical and organic) recycling, then to other forms of recovery (such as incineration with energy

Principle	Description
	recovery, which is often not the most efficient way of managing used materials, particularly those that are difficult to burn or which release chemicals at high temperatures), and last of all disposal (which includes landfilling and incineration without energy recovery). ▪ Implementing the hierarchy requires, among other things, source-separated collection and post-collection sorting to allow for subsequent recycling domestically when technically and economically feasible. If not feasible, the waste should be diverted to appropriate recycling facilities in other countries.
"Polluter Pays" Principle	▪ Waste producers (i.e., consumers) and polluters should pay the cost of managing their waste or cleaning up the pollution and remediating associated environmental damage. The cost should thus not be borne by society at large. ▪ This principle plays a significant role in environmental management, acting as a deterrent and directing accountability for damage. ▪ In the context of municipal waste management, it means that those responsible for the generation of waste should cover the cost of managing their waste and remediating associated environmental damage. The spending for waste management should thus be recovered from them.
Extended Producer Responsibility (EPR)	▪ EPR means the application of the "Polluter Pays" principle to those that place products on the market that result in waste once they have come to the end of their useful life. They are being made responsible for the end-of-life management of their products. ▪ Without EPR, the collection and recycling of packaging waste and other waste streams that are targeted by the RRC are unlikely to be meaningfully scaled and large quantities of this waste will continue to end up in the environment.
Affordability	Waste management service costs should be affordable to users. This policy principle can conflict with the "Polluter (and user) Pays" principle.
Financial sustainability	▪ The waste management system must be financially sustainable. This means that the organizations providing the services must have a positive cumulative cash flow in every year. There is thus a minimum revenue needed annually to cover the service costs and to sustain the services. ▪ Effective cost recovery mechanisms, complemented with other sources of financing, are necessary to ensure the long-term financial sustainability of the system.

Principle	Description
	▪ The affordability and financial sustainability principles influence the design, scale, scope, targets, and implementation scheduling of the waste management system.
Private sector involvement	The private sector can bring on investment finance and provide the operational experience needed to implement efficient waste management services.
Proximity principle/ self-sufficiency principle	▪ The treatment and disposal of waste should take place as close to its source, in order to minimize the risks involved in its transport. ▪ The proximity principle is related to the principle of self-sufficiency, according to which a country should develop an integrated and adequate network of waste facilities to enable it to move toward self-sufficiency in waste recovery and disposal. ▪ The application of these principles is subject to technical feasibility, affordability, and financial sustainability constraints. ▪ These principles can conflict with cost-effectiveness criteria and the economies of scale often associated with larger, centralized, treatment facilities. Not all countries, and particularly not small island development states, can be expected to develop facilities for all types of waste streams and treatment operations. Indeed, for most PICs, investment in treatment will mean investing in export systems and infrastructure for shipping waste for recycling to Fiji, another PIC, or, in most cases, to Asia, New Zealand, or Australia.
Selection of appropriate and affordable technology	All waste management technologies selected must allow for the environmentally sound management of waste, in compliance with local legislation and international treaties, and must be affordable and consider the prevailing socio-economic conditions and capacity of PICs.

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

6.4.3 Policy Measures

General

The National Waste Management Strategy and Plan must be put into effect via policy measures (sometimes also referred to as "instruments"). They are the means of government intervention in markets or, in broader perspective, society. Policy measures aim to change activities in society toward achieving the policy objectives, by encouraging behavioral change of a defined set of actors (businesses and consumers).

Effective policy measures require supporting legislation and administrative capacity (human, technical, and financial resources), also to enforce compliance. Furthermore, the design of policy measures is at least as important as the choice of the measure for the effectiveness of policies.

Different modes of intervention (or triggers) are being used by policy measures: regulation, economic incentives, and persuasion. Accordingly, the following typology of policy measures can be distinguished:

1. Regulatory measures: mandate change through regulation, accompanied by credible enforcement.

2. Economic (or market-based) instruments provide a financial incentive to change behavior.

3. Information-based instruments (or social instruments) educate stakeholders to allow them to change their behavior.

In addition to policy measures, voluntary approaches can be distinguished whereby firms or industries make commitments to improve their environmental performance beyond what the law demands.

Common examples of voluntary approaches include agreements and unilateral commitments. Public-private collaborations and partnerships are common in relation to plastics, in particular plastic packaging. These can be formalized by voluntary agreements between a government authority and one or more private parties, following a process of negotiation. Businesses can also make unilateral commitments to improve their performance beyond legal obligations.

Policy makers should recognize that a single policy measure can rarely achieve a stated policy objective. Consumer behavior, for example, is shaped by the regulatory framework, the range and prices of products and their alternatives, and received information. Changing consumer behavior, including waste generating and management practices, therefore requires an ambitious combination of regulatory, economic, and information-based measures, appropriate to the policy challenges, complemented with investments in supporting systems and infrastructure.

The policy framework should update the mix of instruments. The mix must provide a coherent set of incentives for improved waste management (and broader, for greater resource efficiency), throughout a product's lifecycle. These should ensure that each of the main stages of a product's lifecycle is addressed: material extraction, transport, production, consumption, recycling, and final disposal.

Currently, policies of the PICs are more focused on the post-consumption stages, i.e., on the waste stage, rather than on upstream activities. This is partly due to the tendency of countries to focus on the life-cycle stages occurring within their territories rather than those that take place beyond their boundaries. Policy mixes should therefore be rebalanced to provide more focus upstream in the production and consumption phases. In particular, waste prevention is not being fully exploited in existing policy mixes.

The following sections review the main types of policy measures and identify the policy measures for each type that can contribute to achieving the specific objectives to which the RRC is also expected to contribute.

Regulatory Instruments

There is a wide range of regulatory instruments that the individual PIC can apply to improve waste management.

Table 63 provides a brief overview of these instruments, and they are categorized according to their main objectives, recognizing that some instruments can contribute to achieve more than one objective.

The following objectives are being distinguished:

- To improve the environmental performance of waste generators.
- To improve the environmental performance of products.
- To promote separate collection and recycling, either in-country or abroad.

From this overview, a selection of instruments could be made that should be included in an effective and efficient mix of policy instruments to support the development and functioning of the RRC.

Table 63 Regulatory Instruments

Regulatory Policy instruments	
Instrument	**Description**
To improve the environmental performance of waste generators	
Fines and penalties	▪ Criminal or administrative fines (monetary penalties) must help ensuring compliance with the regulation. ▪ In order to be an effective enforcement instrument and to deter future non-compliance, they must be designed following several key principles, such as the following: o They must eliminate any financial gain or benefit from non-compliance. o They must be proportionate to the nature of the offence and the harm caused.
Authorizations	▪ Registration or licensing (permitting) of companies that conduct waste operations. ▪ Licensing applications should be followed up by a visit to the facility or premises and licenses should only be issued if the operation complies with all environmental standards.
Standards:	
Environmental standards	Environmental standards leave the choice of the technology required to the regulated. The main types are: ▪ Ambient standards (i.e., goals for the quality of the ambient environment). ▪ Emission standards that limit the amount or rate of particular pollutants that a facility can release to the air or water bodies in a given period of time.
Technology standards	▪ Technological standards specify that the waste treatment must include certain technologies or processes. ▪ Technology standards are easy for officials to inspect compliance.
Practice standards.	▪ Best practice standards require or prohibit certain work practices that have significant environmental impacts. For example, a standard might prescribe that certain waste streams must be stored in containers or on concrete floors that meet certain requirements. ▪ Best practice standards are easy for officials to inspect, but it is difficult to ensure ongoing compliance.
Waste management plans	▪ Waste management plans can be made mandatory for companies that generate and/or manage certain waste streams, above a certain threshold. Such plans should document the types and quantities of waste produced and/or managed, and how each waste type will be properly managed on-site, collected, recycled or disposed of, if it can be demonstrated in the plan that recycling is not an option. ▪ Drivers for mandatory waste management plans are cost reductions generated from resource efficiency, reduction of environmental impacts, development of a (local) recycling industry and assisting companies in becoming good corporate citizens.
Waste reduction plans	Mandatory waste reduction plans for businesses for selected waste streams, for example plastic packaging.
Producer accountability:	
Public performance disclosure	▪ The regulator could require that waste treatment facilities publicly disclose information about their environmental performance, including emissions to air, waste effluent discharges, waste, and compliance with standards in a manner that is clear to a wide group of stakeholders. ▪ This would provide an incentive for performance improvement.

Regulatory Policy instruments	
Instrument	**Description**
Environmental liability assignment	▪ Liability for environmental damage, which provides incentives to actual or potential polluters to protect the environment by making them liable for any damage they cause. ▪ Based on such liability arrangements, economic instruments such as mandatory insurance can be developed.
Environmental reporting	▪ Companies that generate and/or manage certain waste streams (above a certain threshold) should report on a regular basis to the government, at least on the amounts of waste collected and on how they are managed. ▪ This information can underpin the waste policy and will also encourage companies to improve their environmental performance.
Product take back obligations	▪ Under Extended Producer Responsibility schemes, producers/importers are required to take back their products from the consumer once they have come to the end of their useful life. This type of requirement is often achieved by establishing collection and recycling targets for a product. ▪ Commonly, consumers can return any products, for example, electronics products, they own to retailers, even if they were not purchased at the store. ▪ Another approach is to establish a deposit-refund system.
Basel Convention legislation	▪ Controlled export of (hazardous) waste requires legislation that facilitates compliance with the Basel Convention. ▪ Adoption of the Basel Convention Technical Guidelines on the management of a range of different waste streams, may help to improve existing management practices. For several of the waste streams targeted by the RRC, Technical Guidelines have been developed, including on: o The identification and environmentally sound management of plastic wastes and for their disposal (Plastics). o The environmentally sound recycling/reclamation of metals and metal compounds (R4). o The Environmentally Sound Management of Waste Lead-acid Batteries (currently under revision).
To improve the environmental performance of products	
Product bans	▪ A prohibition to import and/or to place on the market certain products with adverse impacts on the environment, such as products: o Containing non-biodegradable and/or hazardous substances; o With a short product life (for example, countering premature obsolescence or single-use plastic products); and o That are not reusable, repairable or recyclable. ▪ It can also be that not all products of a certain product category are banned, but only those that do not meet certain product standards (provided that these are developed).
Product standards:	▪ Product standards can be developed that specify the level of expected performance of a product. ▪ A government can then ban the marketing of products that do not meet the standards and allow only the marketing of products that are certified as meeting the standards. ▪ Through certification, users will know that the products are acceptable for the use and will meet a certain performance level.
Eco-design requirements	▪ Eco-design or environmental performance requirements. Eco-design means designing a product or service so as to minimize its impacts on the environment. Eco-design applies at every

Regulatory Policy instruments	
Instrument	**Description**
	stage in a product's life: raw material extraction, production, packaging, distribution, use, recovery, recycling, and incineration. ▪ Eco-design should result among other in products that are durable (last longer) and that are easier to reuse, to repair (i.e., easier to dis- and re-assemble) and to recycle. ▪ Eco-design legislation can also prescribe material restrictions, i.e., the reduction or elimination of hazardous substances in products.
Quality requirements	▪ Low-quality products on the market contribute disproportionally to the amount of waste generated, due their relatively short product life. Banning products that do not meet certain quality standards can reduce the number of low-quality products on the market. ▪ On the positive side, quality standards for recycled products, such as sorted plastic waste and recycled plastic, can enhance consumer confidence in these products and thus help increasing their market acceptance and share.
Minimum recycled content standards	▪ Standards can specify a minimum amount of recycled material that must be incorporated into products. ▪ Such standards would require recycled content certification by independent certification companies to allow a producer to demonstrate that his products meet the standards, and customer specifications.
Legal guarantee	▪ A legal guarantee must ensure a minimum product lifetime of durable products, such as electric and electronic products or accumulators. In cases where the guarantee is relatively short, for example, below 1 or 2 years, it may be appropriate to extend the legal guarantee to 2 years or beyond, depending on the product, with the burden of proof on manufacturers. ▪ Mandatory display of the warranty period on a related labelling scheme may stimulate further competition and market differentiation for the products concerned.
To promote re-use and recycling	
Mandatory separate collection	Mandatory waste segregation at source and separate collection of products, in particular recyclable products.
Landfill bans	A ban on the landfilling of certain waste streams: ▪ for which landfilling is not an appropriate form of disposal (such as tires, hazardous waste such as batteries) due to the related risks. ▪ or from which resources such as materials and energy can be recovered, including biodegradable waste, recyclable material streams or combustible waste (provided that incineration with energy recovery is a feasible option).
Targets:	Setting targets is a policy instrument that is driving behavioral change by requiring the regulated community to act on specific topics of waste management, but that leaves it open to those regulated how they will reach the targets.
Design targets	They can, for example, relate to minimum recycled content.
Consumption targets	Consumption reduction targets set legally binding reductions in consumption from a base year.
Collection targets	Legislation may explicitly set collection target rates for specific waste streams, to be reached within a certain timeframe.
Re-use, recycling and recovery targets	Legislation may explicitly set (minimum) target reuse, recycling and recovery rates for specific waste streams, to be reached within a certain timeframe. The benefits of such targets include among others:

Regulatory Policy instruments	
Instrument	**Description**
	▪ A clear signal is sent to all stakeholders (including local authorities and the public) that recycling and recovery is a priority policy objective. ▪ Legal certainty is provided, which is required for future private sector planning and investments in recycling and recovery.
Landfill diversion targets	Instead of outright landfill bans, a legislator may prescribe landfill diversion targets for specific waste streams (such as biodegradable waste), which specify the percentages of waste to be processed in a way different from landfill.
Mandatory treatment	A legal requirement to have specific waste streams treated with a specific treatment method.
Mandatory contracts	The legislator can prescribe mandatory contracts between: ▪ Generators and licensed waste collection companies, for the collection of all waste generated at a facility or for specific waste streams. ▪ Product users and their suppliers, providing that the suppliers will take back all products once they come to the end of their useful life, and ensure the collection and recycling of these products. ▪ Waste collection and processing or recycling companies.
Export ban.	A legal ban on the export of certain waste streams (such as used lead-acid batteries), to support the domestic recycling industry and/or to avoid the export to countries where the waste may be recycled in facilities of which the environmental performance cannot be ascertained
Support for the repair of durable products	▪ Mandatory requirement for importers of designated products (e.g., electric and electrical equipment) to provide after-sales repair services for all imported products. ▪ Right-to-repair legislation which requires original equipment manufacturers to provide consumers and independent repair businesses equal access to repair documentation, diagnostics, tools, service parts and firmware as their direct or authorized repair providers.

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Economic Instruments

Many countries increasingly favor economic or market-based instruments (MBIs) for pollution control and natural resource management. The term "market-based instruments" refers to all the instruments that act through the market mechanism.

Economic instruments change prices to either reward desired behavior (e.g., subsidies for a recycling operation or investment or a reduced or zero-rated VAT on second-hand goods and repair services) or to penalize undesired behavior (e.g., a tax on landfill for increases the price of this option, thereby promoting waste recycling and reducing the amounts of waste ending up in landfills).

Economic instruments pursue primarily motivational objectives. However, they can also provide government with a source of revenue, which ideally should be used to support waste management programs.

In order to qualify as an economic instrument, the rates must be determined, and the revenue collected by a public authority or a publicly mandated body.

Several economic instruments for environmental management are based on the Polluter Pays Principle. They only function properly in the formal sector because informal operators do not register or pay any taxes on their waste purchases, sales, or profits. In essence, this means that any economic instrument based on Polluter Pays Principle. must be backed up by integration of the informal sector, by environmental laws that are strictly enforced, and by the closure of waste management facilities that fail to meet the legal standards. If this is the case, and they are properly planned and implemented, they can have a range of benefits and result in environmental improvements.

Most of the economic instruments applied for waste management are designed to intervene where wastes have no value to the generator and where their disposal represents a cost. However, they can also be required to improve the management of waste with a value, in particular when that value may fluctuate and change with external factors, i.e., international market supply and demand. In any case, when planning economic instruments, the market realities, should be carefully considered. ULABs, for example, have a value that is strongly dependent on the international lead price. Their value has not yet led to the environmentally sound management of all ULAB in all PICs. Government intervention through policy instruments therefore remains needed.

The range of economic instruments includes the following categories:

- *Revenue-raising instruments:* These include:
    - Environmental taxes, which increase the cost of polluting, including wasteful, products or activities.
    - Service fees and charges, used to recover the costs of providing waste management services.

- *Revenue-providing instruments*: The Government may use subsidies to encourage better waste management, waste reduction, and investments in improved waste management (e.g., to switch to alternative products or to invest in improved collection and recycling of a given waste stream). These may take the form of direct subsidies or tax measures. Fiscal policy is a key instrument for promoting improved waste management (and broader, for the transition to a circular economy).

- *Non-revenue instruments*: These do not generate revenue, but can be crucial in supporting behavioral change, such as Deposit-refund systems.

There is a wide range of economic instruments that the individual PIC can apply to improve waste management. Table 64 provides a brief overview of these instruments. Unlike the regulatory instruments in this Chapter, they are not categorized according to their main objectives, but according to the above listed categories. They can be applied to pursue similar objectives though, e.g., improving the environmental performance of waste generators, improving the environmental performance of products, and promoting separate collection and recycling, either in-country or abroad.

From this overview, a selection of instruments could be made that should be included in the mix of policy instruments to support the development and functioning of the RRC.

Table 64 Policy Instruments

Economic policy instruments	
Instrument	**Description**
Revenue-raising instruments	
Environmental taxes	
Waste management taxes	▪ Waste management taxes are used to internalize the environmental costs of waste treatment and disposal, making more environmentally harmful treatment methods (such as landfilling and incineration) more costly and creating incentives to use alternative treatment methods (such as recycling). ▪ Waste management taxes include both landfill and incineration taxes. They aim to promote recycling and reduce the amounts of waste ending up in landfills or incinerators. In most systems, waste taxes are paid by the owner of the landfill of incinerator, who passes on the cost through fees charged for the reception of waste.
Product taxes	▪ Taxes are applied to individual products, such as beverage containers, lead-acid batteries, tires, or lubricants. ▪ The taxes may be levied on the production, processing, marketing, import and or export of products. ▪ Examples are: ○ A virgin plastic tax on the manufacture or use of virgin polymers. ○ A tax on putting products on the market, for example, hard-to-repair or -recycle products. ○ A consumption levy (for example, on single-use plastics), which is charged downstream, increasing the cost of products, thus ensuring that they are not provided free of charge at the point of sale to the final consumer. ○ Import levies (see below). ▪ The objectives of product taxes include primarily; ○ To increase the price of the products, such that they become less attractive for consumers. ○ To generate revenues that can be used to finance the collection and recycling of the end-of-life products. ▪ There are also taxes on producers of waste, such as the tourism sector, to finance waste management.
Fees and charges	Fees and charges are used to recover the costs of providing goods or services. Unlike taxes, fees and charges are a requited payment, meaning that the person paying gets something in return in proportion to the payment, whereas taxes are unrequited payments.
Waste collection charges	Waste collection charges (user charges) require the waste generator to pay a rate to the municipal waste collection service providers.
Gate fees	A "gate fee" is the payment treatment facilities, such as landfills, charge waste disposers to accept their waste.
Advanced recycling fee (ARF)	ARFs are introduced to defray recycling costs. ARFs are front-end financing systems that charge consumers a fee at the point of sale, which is then used to finance collection and recycling programs.

Economic policy instruments	
Instrument	**Description**
Revenue-providing instruments	
Direct subsidies	Direct subsidies are often part of de-risking and blended-finance mechanisms to lower (capital) costs of providing public services or that achieve a societal objective, such as a reduced environmental impact from waste management, and that stimulate the economy.
Reuse and Recycling credits	Reuse and recycling credits are paid in some countries to third parties that remove items from the municipal waste stream and reuse or recycle them.
Shipping subsidy	A subsidy to finance the transfer of waste, often from remote areas, such as islands, to environmentally sound waste management facilities.
Grants	Direct payments, to support projects (e.g., the development of recycling facilities or of alternatives for harmful products, such as single-use plastic products).
Credit support	Soft loans are publicly supported loans offered by government agencies or banks, at low interest rates, often with longer grace periods and longer repayment periods.
In-kind transfers	Examples include the land on which a recycling facility will be built.
Relocation incentives	Direct payments to waste treatment facilities to relocate from a residential area to an industrial zone.
Removal of subsidies	Removal of subsidies for environmentally harmful products and activities. The effects of subsidy removal on producers' and consumers' decisions depend on the overall policy setting of the subsidy (including environmental policy measures) and on the availability of alternatives.
Incentives given in direct taxation	On income or property.
Tax deductions	Tax deductions reduce taxable income. Their value therefore depends on the taxpayer's marginal tax rate, which rises with income. Tax deductions cut taxes in broad categories like mortgage interest or charitable contributions.
Tax credits	Tax credits reduce taxes directly and do not depend on rates. Income tax credits can be granted for example for the purchase of recycling machinery, for green job creation or for R&D.
Incentives given in indirect taxation, i.e., differentiations in or exemptions from:	Incentives given in indirect taxation on commodities.
Value Added Tax (VAT)	▪ VAT is a tax, assessed on the value added to goods and services. It is charged as a percentage of the price, which means that the actual tax burden is visible at each stage in the production and distribution chain. It is a consumption tax, not a tax on business, as it is ultimately borne by the final consumer. ▪ Differentiated VAT rates, i.e., reduced or zero rates, could for example be applied to the collection of second-hand goods, the sale of recycled material or material to be recycled or products with a high recycled content.
Import levies	▪ Taxing of imported goods to make them less attractive (such as non-reusable or non-repairable products) and/or to improve the competitive position of domestic manufacturers. ▪ Or exempting goods from import levies, such as recycling equipment and machinery.

Non-revenue instruments	
Deposit-refund system	▪ A deposit-refund system places a surcharge on the price of a product likely to pollute the environment. The surcharge is a monetary deposit, paid at the time a product is sold, that is eventually refunded when the product is returned to an approved collection point, mostly a point of sale.
Green Public Procurement	A Government can promote and support development of sustainable production through their own purchasing practices. A Green Public Procurement policy is a preferential procurement policy under which a government favors products that pose relatively low environmental risks.

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Social Instruments

Social instruments, often also referred to as information-based instruments, rely on communication, awareness raising, and interaction between the government institutions and the public and other stakeholders.

Education and awareness are essential to changing people's traditional views about waste, influencing lifestyle choices and encouraging their participation in source separated collection and recycling systems.

Most of the social instruments are based on the idea that information might encourage companies and individuals to change their behaviors, habits, and practices on a voluntary basis. Information is provided, in particular, on the environmental impacts, both positive and negative, of existing practices, but also on alternative, better practices.

However, it takes more than information to change behaviors, habits, and practices. Encouraging people, engaging with communities, and leading by example are equally important.

Social instruments are relatively easy to implement, although they also require monitoring and enforcement, for example, to verify the environmental information that providers of products and services give to consumers.

The development, implementation and coordination of information and awareness raising measures for waste streams that are subjected to EPR, is often done through the EPR schemes.

The most relevant social instruments for waste management are listed in Table 65. From this overview, a selection of instruments could be made that should be included in the mix of policy instruments to support the development and functioning of the RRC.

Table 65 Social Instruments for Waste Management

Social (i.e., information-based) policy instruments	
Instrument	**Description**
Public information, education and communication (IEC) campaigns	Sustained education and awareness-raising campaigns are essential for encouraging individuals and business to adopt sound prevention and management practices.
Product labelling and marking.	Labels on products provide information to the consumer on the environmental aspects of his purchase or on appropriate behavior (e.g., "do not litter" or "do not flush"). Recycling symbols, for example, can help consumers to identify how products (e.g., different types of packaging) can be recycled.
Quality protocols	Waste quality protocols set out requirements that industry can volunteer to follow, for example, requirements for recycled materials or for when certain wastes can become non-waste once they have been fully recycled and can therefore be used without waste regulation controls. Public certification of products against such quality protocols could enhance their market acceptance.
Public recognition	Good performance of companies with a proven track record of working efficiently, effectively, and in compliance with all relevant standards, can be encouraged by recognizing them publicly, for example, through award competitions.
Technical assistance	▪ Technical assistance provided by the government, e.g., to develop the capacity of businesses in relation to relevant topics, or to help them comply with policy and legislation. Relevant topics include for example: o Environmentally sound waste management. o Waste prevention (e.g., plastic-free tourism operations). o Repair and reuse products. o Recycling technologies. o Trans-frontier shipment of waste, with implementation of the Basel Convention (including for certain types of plastic waste, which, as of 1 January 2021, came under the Prior Informed Consent procedure). ▪ Technical assistance may be provided through: o Guidance manuals. o Expertise and information exchange networks. o Research and studies. o Pilot projects. o Advisory services.
Excess materials exchange platform	▪ The government can establish jointly with the private sector a system that supports the exchange of excess digital materials, both waste and non-waste, between companies for reuse in high-value applications. Such a system can create a new revenue stream, while increasing recycling rates and resource efficiency. ▪ To support effective matchmaking, such a system will require several components, including a material passport, in a standardized format, giving an overview of the key features of each material (such as composition or origin), an assessment of its high-value reuse options, and an identification system (through identifiers like barcodes or QR codes) to match materials with their digital twin. ▪ It will thus not be sufficient to merely design the platform, but it should also be managed, i.e., be given substance (through the various components) and maintained. Managing the platform is a business activity, and it should thus best be done by a commercial organization.

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

6.5 Legal Framework

The individual PICs must adopt a comprehensive legal framework for their waste management policy.

A legal framework wherein a single regulation is preferred over a large number of regulations will help ensure that waste legislation is coherent and consistent and that no gaps exist. Indeed, numerous pieces of legislation may create gaps or inconsistencies.

The framework law must set out the general principles, procedures, and requirements in the field of waste management. Other legal acts, including the supporting regulation(s), must conform to the general requirements of the framework law.

The main elements of a framework law are:

- Common definitions and waste classifications distinguishing between hazardous and non-hazardous waste.
- Basic requirements for waste management operations and practices, including for waste prevention, separate collection, preparation for reuse, processing, recycling, and disposal.
- Bans and restrictions (e.g., on uncontrolled dumping of waste and landfilling to support recycling).
- Requirements in the case of waste imports and exports for recycling.
- Legal objectives and targets.
- Responsibilities of all stakeholders, including government institutions, waste generators and holders, including documentation and reporting requirements.
- Requirements for obtaining permits or licenses for waste treatment and disposal activities and operations.
- Allocation and financing of waste management costs.
- Control and enforcement provisions, including giving appropriate officials the authority to implement and enforce the laws and penalties (for example for illegal dumping) that are sufficiently high to be effective.

The implementing, supporting regulation(s) should define legal requirements for waste management facilities (including on the siting of new facilities, discharge and emission standards, and minimum performance criteria) and for waste streams requiring particular attention (including among other collection and recycling targets). These waste streams may include municipal waste, construction and demolition waste, packaging waste, certain categories of plastics, waste electric and electronic equipment, batteries and accumulators, sewage sludge, end-of-life vehicles, used tires, waste oils and textiles, and any waste stream that is targeted by the RRC.

If governments lack sufficient resources to invest in new facilities or to upgrade existing dumpsites and/or if waste management legislation is not enforced, dumpsites that do not meet any environmental quality standards and/or that are not licensed continue to operate and undercut efforts to increase separate collection and recycling.

6.6 Stakeholder Awareness and Inclusivity

Municipal waste management is a public service that is especially dependent on stakeholder awareness and inclusivity for success.

Stakeholder inclusivity means the effective involvement of all public and private stakeholders in the decision-making process and their effective participation in the collection and recycling systems.

Stakeholders, such as the tourism industries, businesses, retailers, civil society organizations and consumers, are key groups driving the process to prevent waste and to properly collect, process, and recycle.

All the relevant stakeholders must be fully and effectively engaged in the identification, development, implementation and monitoring of waste management policies and systems, via inclusive decision-making processes. They should be given the opportunity to provide informed input, which should be duly taken account of by the decision-makers, and they should also be informed of the results of the consultation process.

Such stakeholder engagement should result in a comprehensive approach to waste management.

All stakeholders should also actively contribute to making waste management sustainable in a responsive and accountable manner. They must therefore all change their behavior, habits, and practices to:

- reduce their consumption of wasteful products;
- avoid illegal dumping and burning of wastes; and
- participate in source-separate collection and recycling programs.

To incentivize their participation, an appropriate mix of policy instruments that encourages behavior change, must be applied. The mix should also include information-based instruments that make stakeholders aware of:

- The waste they generate and/or manage.
- The associated impacts and management costs.
- What they can do to minimize these impacts and costs, including also how they can effectively participate in the collection and recycling systems.
- The benefits of improved waste management.

Increased awareness should also increase the public willingness to pay for sound collection and recycling service. It is also critical to ensure that the public can hold responsible agencies accountable for the quality of waste management services.

6.7 A Financing System

6.7.1 General

Waste management is a net cost activity which has ultimately to be paid for, in one form or another, by those that are responsible for the generation of the waste.

Investment in waste collection systems and equipment and infrastructure, adjusted to the specific waste composition, is necessary for ensuring that the waste is being collected and diverted from sub-standard dumpsites to appropriate waste management facilities, and in particular recycling facilities, either in-country or abroad.

The economics of recycling will be undermined if sub-standard disposal facilities are allowed (and not upgraded or closed and remediated) and if the cost of disposal is relatively low (because of gate fees not existing, or where they exist, not covering the full cost).

Providing good waste management services while also ensuring financial sustainability is a major challenge. In a financially sustainable system, the necessary investments can be made provided that recurrent costs can be paid and any capital that has been borrowed can be repaid.

A sound financial basis is all the more important, given that waste management costs will increase, when done in an environmentally sound manner, and when waste is diverted from sub-standard dumpsites to recycling facilities.

For the system to become financially sustainable, it must be revenue based (i.e., financed by revenue generated by operations), which requires the application of the Polluter Pays Principle through economic instruments.

The main economic instruments to ensure the application of the Polluter Pays Principle are EPR, user fees for waste management services and product taxes. Fee setting should be based on the key principles of Affordability, Full cost recovery and Economic efficiency.

But implementation of the Polluter Pays Principle is a precondition for improving waste management.

Other sources of (co-)financing that can be considered include:

- Transfers from municipal budgets, fed by local taxes (e.g., on property), if waste management costs are not fully recovered through user charges.
- National government:
    - Transfers (i.e., grant finance) from the national government to local governments (awaiting full cost recovery). This may be necessary to initiate the implementation of the waste management as well as to help keep tariffs within affordability limits.
    - Grants, loans, tax exemptions and other economic instruments as part of the policy mix to improve waste management. The application of these instruments should in principle leverage additional financing by the private sector.

- Private sector:
    - Public-private partnerships.
    - Investment by private sector waste management firms (retained earnings, equity finance) with potential access to loans from commercial banks. However, they will expect to make commercial returns commensurate with the risk associated with the investment. Guarantees and counter-guarantees on investments are typically required especially in higher risk environments.
- International:
    - Grants from international donors (national and inter-governmental organizations).
    - International financial institutions (IFI) funding via long-term loans.

Several key policy decisions must be taken at the national and municipal levels when defining and preparing the financing strategy, including the following:

- The most effective and efficient mix of financing and investment mechanisms.
- Provision of the services directly by the municipality or delegation to private sector operators, and how the related service costs will be financed and charged to households and legal entities.
- Provision of waste services by local authorities to legal entities or not. Local authorities may leave commercial waste collection entirely to the private sector or may offer services, often competing with private firms. By operating over a compact area with short distances between collection points, municipal operators have opportunities to offer services at lower rates than those provided by private companies focused solely on commercial waste. Integrating the management of commercial waste into municipal waste management can contribute towards a municipality's fixed costs, thereby reducing its average costs. Businesses should in any case be charged the full cost of the services provided.
- The modalities of the introduction of EPR.
- The extent to which the Polluter Pays principle will be applied for households. This can cover a wide range of aspects, including full or partial cost recovery from users; affordability and support given to low-income and vulnerable households; striking a balance between achieving cost recovery (and revenue stability) and waste management objectives.
- The charging mechanism that will be applied (i.e., flat-rate charges, per household or variable-rate charges that may be related to the service level or not). The decision made has a direct implication on the design of the waste collection system and its associated charging regime.

6.7.2 Waste Collection Fees

Waste collection fees are user charges that require the waste generator to pay a rate to the municipal waste collection service providers, operating curbside collection systems, (which are not recommended in the PICs) or drop-off facilities (such as civic amenity sites).

The level of the charges can be based on different assessment units:

- Flat-rate charges, per household, regardless of how much waste the household generates.
- Variable-rate charges (or pricing):
  - Not related to the service level, but, for example, based on the size of the building or estate, on the household income or on the number of people living in a household).
  - Service-related charges, related to the service level.

Service-related charges (also known as unit pricing) are introduced under "Pay-as-You-Throw" programs. Users are charged a rate based on how much waste (by volume or weight) they present for collection and on the level of sorting at source.

To prevent service-related charges leading to an increase in open air burning or illegal dumping, complementary measures must be taken to reduce some of the disincentives caused by specific, direct waste charges to offer waste for collection.

The simplest way to apply service-related charges is a volume fee, e.g., for each bag or can of waste residents generate. Other systems allow billing residents based on the weight of their waste. Either way, a "Pay-as-You-Throw" program is fair, as the less waste individuals offer for collection, the less they pay.

A national government could set maximum charges for various collection methods to protect households against excessive charges.

6.7.3 Extended Producer Responsibility

EPR schemes can play an important role in the financing of separate waste collection, sorting, recycling and treatment of special waste streams. Without EPR, the collection and recycling of packaging waste and other waste streams that are targeted by the RRC are unlikely to be meaningfully scaled and large quantities of this waste will continue to end up in the environment.

The producers have a primary responsibility under EPR but sharing responsibilities across the product chain is an inherent part of EPR. All actors in the product value chain, and in particular retailers, and in society, such as consumers that must participate in the collection systems, must participate in order to optimize its effects.

An EPR policy is characterized by the shifting of responsibility—financial and/or physical—upstream toward the producer (and ultimately to the consumer) and away from municipalities (and the general taxpayer). Producers are made responsible for the prevention and the environmentally sound management of post-consumer products, i.e., for the end-of-life management of the products that they have placed on the market.

The extension of the responsibility of producers is justified, among other because of the following:

- The producer can be regarded as the polluter. EPR is an application of the Polluter Pays Principle.

- The producer enjoys the financial gains of placing the product on the market, part of which can be used for the environmentally sound management of the product once it has come to the end of its useful life.

- The producer has the decision power and also the technical and managerial know-how to reduce this environmental impact. The producer can, for example, reduce the environmental impact of his product at the end of its useful life by taking into account environmental considerations when designing the product (eco-design) or importing the product (e.g., avoiding the import of low-quality products with a short lifetime). Regarding collection, he can for example reverse the flow of waste materials in the distribution channels through the introduction of Deposit-Refund Systems (DRS).

The leadership role that producers should take is thus fundamental in increasing collection and recycling rates

To ensure that EPR supports decreased landfilling of waste and increased recycling, schemes should include statutory collection and recycling targets.

If the responsibility of the "producers" is purely financial, they pay fees to municipalities which remain responsible for waste management. In the case of organizational responsibility, producers both finance and organize waste management operations and contract directly with waste operators (including recyclers), which may include municipal operators.

Initial investments in separate collection containers are typically covered directly by the "producers", with the collection vehicles and sorting infrastructure being provided by the companies contracted to undertake the respective service.

The principle of EPR is focused on internalizing some of the end-of-life costs of products, included waste management costs and environmental impacts. Assigning such responsibility could therefore in principle provide incentives to prevent wastes at the source, promote product design for the environment and support the achievement of public materials management and recycling goals.

EPR represents a mandatory approach. A related approach, Product Stewardship, is of a less regulatory nature and places a shared responsibility for end-of-life product management on producers and all other entities involved in the product chain. The Product Stewardship approach preceded in some countries the EPR approach, which has now become the dominant approach, for reasons of effectiveness and efficiency.

EPR schemes are commonly developed to capture the following recyclables:

- Packaging waste
- Electric and electronic waste
- End-of-life vehicles
- Portable batteries
- Accumulators

- Tires
- Waste oils

The above listed goods are particularly relevant for the RRC. Without the introduction of an EPR scheme, their collection and recycling are unlikely to improve significantly and to be meaningfully scaled.

Increasingly, ERP schemes are being developed for the following waste streams:

- Fishing gear
- Textiles, to include clothing and commercial textiles
- Bulky waste, to include mattresses, furniture, and carpets
- Construction and demolition materials

Typically, EPR schemes are established by legislation that makes producers responsible for the collection, recycling, and final treatment of end-of-life. The EPR approach must be effectively implemented through an appropriate mix of regulatory, economic and information-based instruments, such as product take-back requirements, collection and recycling targets or mandatory recycled content requirements.

The regulated producers can be given two options to meet their obligations under an EPR scheme: to act individually or to act collectively, with all or several companies from a given industry sector. The producers that decide to act individually must collect and recycle the end-of-life products through their own private schemes. In practice, producers often work together to meet EPR requirements and exert the responsibility collectively. They can take up collective responsibility by creating or joining a third-party producer responsibility organization (PRO), to which they transfer their obligations for managing their end-of-life products. A PRO is usually a board-led, not-for-profit organization established by industry, owned by the obligated companies and open to all producers and importers of a given product. All companies that adhere to the PRO will have to pay a membership fee, based on sales volumes, so major brands pay more, ideally differentiated according to the environmental characteristics of the product (e.g., recyclability, hazardous substance content). Commonly, the financial contributions are also used by the PROs to cover the costs of providing adequate information to waste holders and the costs of data gathering and reporting to the government.

At their core, EPR schemes rely on producer fees to be paid to PROs, as well as penalties in cases of non-compliance.

At the municipal level, PROs must establish and maintain the infrastructure needed for the collection (or take-back) and sorting of the waste. Citizens should have ready access to this infrastructure so that they can separate their waste daily and effective municipal waste collection services can be delivered.

Some waste streams, such as packaging waste, at the industrial and commercial levels, are commonly collected directly by waste collectors. A minimum requirement for PROs must be that they establish systems both for monitoring quantities that have been put on the market and collected and quantities that have been recycled.

There may be some challenges in applying EPR policies in the PICs, including the following:

- The absence of well-established integrated waste management systems, with open dumps as a cheap, sub-standard management option for recyclable waste subjected to EPR, and with a lack of recycling facilities.

- Lack of stable institutions, with sufficient authority and capacity to regulate and monitor EPR systems.

- Limited role (or even absence) and capacities of stakeholders such as manufacturers, sector trade associations, municipalities, and recyclers that have potentially significant roles in EPRs.

- Presence of a large informal sector that may compete for valuable products that are subjected to EPR.

However, at the same time, EPR systems can also address these challenges and provide more opportunities for stakeholders, including informal recyclers, when they address market failures, including:

- Increasing quantities of hazardous waste streams (e.g., e-waste resulting from low-quality appliances).

- Low-value materials that are not being picked up by the formal or informal sector.

- Recyclables that are difficult to dismantle and/or hazardous to effectively recycle (e.g., E-waste)

- Recycling in areas where there are few value chain buyers within a reasonable transport distance, such as in the PICs.

Though challenging, it is nonetheless important to ensure that the informal sector is considered in the design of EPR systems. The informal sector plays a key role in delivering waste management services and in increasing collection and recycling rates. Despite their being small-scale solutions that are inefficient and difficult to regulate, the development of an IWMS that integrates the sector is necessary. Also, if waste management systems are being improved, including through the introduction of EPR, the informal sector can collide with both the public and private sectors, i.e., the responsible "producers" and the formal waste management operators. Failure to integrate informal workers into formal waste management systems can seriously undermine EPR systems.

It is possible to have well-functioning EPR systems in PICs without full scale legislation or strong government leadership. Greater use may have to be made of economic instruments and regulatory requirements may be less important.

Commitment and leadership of the producers will nonetheless be of utmost importance. In this respect, it can be noted though that several of the products subjected to EPR are manufactured and/or imported in the PICs by multinational Fast-Moving Consumer Goods companies that operate in the global market. In many cases, they are already subjected to EPR in Europe or in other regions, and they could also be required to assume their EPR in the PICs. Coca-Cola, for example, is already partly assuming its responsibility on a voluntary basis in some PICs, through its limited program for the buyback of its own branded aluminum cans and PET bottles in Fiji and Samoa.

The companies that operate region-wide could also be encouraged to develop equivalent EPR systems.

Deposit-refund schemes

As mentioned above, the EPR approach must be implemented through an appropriate mix of regulatory, economic, and information-based policy instruments. One of the possible instruments are deposit-refund schemes (DRSs).

In a DRS, a payment (the deposit) is made when a product is purchased and is fully or partially refunded when the product (or its empty packaging or residual) is returned to selected collection points, mostly in the retail network.

A DRS is a market-based instrument, which can work more effectively than voluntary return systems, as they provide a strong financial incentive for returning products to a point of sale.

If the product or its residual is not returned, the deposit can be used for measures that improve the waste management of products. The deposit can be collected by anybody finding and returning the product.

DRSs can be either voluntary or mandated by government legislation, possibly under an EPR scheme. Indeed, a DRS is shifting the burden of waste recycling back to the manufacturers of products by ensuring that retailers, and then wholesalers, take back materials.

DRSs allow for high collection rates and high quality of collected material, which enables high-quality recycling (i.e., the use of recycled instead of new material).

DRSs are a popular instrument because extensive monitoring by authorities is usually not required. DRSs are less popular with industry, at least for one-way beverage packaging, due to their implementation and recycling cost.

DRSs can comprise different sub-schemes, e.g., according to the object they are addressing. This is the case of deposit-refund systems for reusable or one-way packaging of beverages, which include glass and plastic bottles, as well as aluminum cans.

DRSs are useful to increase the collection rate for products likely to pollute the environment and/or for products that can be reused or recycled.

Most DRSs have been set up for increasing the separate collection of beverage containers. However, DRSs can go beyond collection and recycling and can be used within reuse systems for consumption "on-the-go" and for food delivery services. Products other than beverage containers have also been subjected to DRS in some countries, including ULABs, end-of-life vehicles, tires, or used lubricating oil.

DRS involve collaboration with wholesalers, retailers, and consumers. Administrative arrangements between the producers and retailers need to be made at the onset of the DRS. Cooperation of as many retailers as possible is needed to allow the consumer to return the product to any point of sale rather than going to the specific retail location where the product was purchased.

Refunds need to be high enough as to minimize “leakage” to informal waste operators that may not manage the product in an environmentally sound manner. If these informal waste operators would pay more for the used product, consumers would rather turn to them with their used products.

A similar system could be operated by retailers, who could give a discount against the purchase price of a new product (e.g., a lead-acid battery), if the customer returns a similar end-of-life product (e.g., a ULAB, which has a scrap value). Such a system can help increase collection rates. If such a scheme would be operated on a voluntary basis, it would not be labeled as a policy instrument. Whether such a system increases environmentally sound recycling depends on the choices made by the retailers. If they sell to scrap dealers that can offer higher prices because they in turn sell them to (unregistered) smelters that do not pay taxes and do not operate in an environmentally sound manner, the environmental gains are limited or non-existent. Only when the system brings the ULAB into the formal recycling market will the environmental benefits be clear.

6.7.4 Product Taxes

Product taxes are applied to individual products and may be levied on the production, processing, marketing, import and/or export of products.

Examples are:

- A virgin plastic tax on the manufacture or use of virgin polymers.
- A tax on putting products on the market, for example, hard-to-repair or recycle products.
- A consumption levy (for example on single-use plastics) that is charged downstream, increasing the cost of products, ensuring that the products are not provided free of charge at the point of sale to the final consumer.
- Import levies or exempting goods from import levies, such as sustainable alternatives or recycling equipment and machinery.

The objective of the taxes can at least be threefold:

- To increase the price of the products (such as non-reusable, non-repairable or short-lived products), such that they become less attractive for consumers.
- To generate revenues that can be used to finance the collection and recycling of the end-of-life products.
- To encourage environmentally sound recycling through a partial or complete refund when the producer provides proof of such recycling.

There are also taxes on producers of waste, such as the tourism sector, to finance waste management.

Product taxes are commonly distinguished from ARFs, which are front-end financing systems that charge consumers a fee at the point of sale which is then used to finance collection and recycling programs.

Arrangements under which governments collect fees from producers through a product tax and disburse these fees to waste management service providers for the collection and recycling of the concerned end-of-life products, are a conventional manner of government taxation and funding of societal activities. This Producers-pay-Government-distributes approach more directly involves governments in both the managerial and oversight dimensions of end-of-life management than they would be involved in EPR systems.

Such government-run systems should not be labelled as EPR; only systems in which producers have a decision-making or managerial role should be thusly labelled.

To avoid having the fees collected in a government-run system being diverted to uses other than end-of-life management, they could be channeled to an environmental fund. Funds are typically governmental, or quasi-governmental, institutions, capitalized by a variety of earmarked public revenue sources, including environmental charges and fines. They are typically created as a comprehensive and flexible financial instrument for implementing state environmental policy. They provide financing usually in the form of grants or soft loans, to a wide range of environmental protection activities for both the public and private sectors.

A Producers-pay-Government-distributes approach is sometimes considered by governments that wish to keep greater control than they would have with an EPR approach and/or believe that the responsible industry sectors in their country may not be mature enough to organize and manage an EPR system.

However, the public sector may be in no better position than industry to collect and disburse funds. Indeed, it should be noted that a government-run system requires a strong capacity to effectively collect and disburse the funds, which may in some countries also have to be strengthened. In any case, a government-run system does not have the same advantages as a well-designed EPR system, which encourages producers to realize cost savings through efficient processing, eco-design of products, and/or the import of sustainable products.

6.7.5 Public-Private Partnerships

Definition of PPPs

- PPPs are a mechanism for government to procure and implement infrastructure so that risks are borne by the party best able to manage them at least cost. PPPs are a means to harness the comparative and competitive advantages of the private sector.

Six generic forms of a Professional Service Provider (PSP) arrangement that reflect rising levels of responsibility, risk transfer and expectations of financial return can be distinguished:

1. Outsourcing (management or service contracts, franchise)
2. Lease Arrangements
3. Design, build, and operate (DBO) contracts
4. Private finance and transfer contracts
5. Concession
6. Private ownership

The three most used contract types are service contracts, DBO contracts, and DBFO contracts.

What the most appropriate contract model to use in procuring services depends on the scope of these services.

Residual waste collection, separate waste collection, and recyclable material sorting are typically procured through service contracts. Waste treatment and disposal infrastructure consisting of long-lived assets is typically procured via DBO or DBFO-type contracts.

There are no legal or universally accepted definitions for these contract categories and types. Names (and acronyms) can differ between jurisdictions, even though the type of contract is fundamentally the same.

Pre-Conditions for Successful PPPs

Certain pre-conditions must be met for successful and sustainable private sector involvement:

- A supportive legal, institutional, financial and tax framework, including a procurement framework that specifically provides for competition.

- Government agencies have a critical role to play. They must have the capacity to prepare, procure, manage, and monitor private sector participation contracts efficiently. Contracting with the private sector requires fundamental change in municipal organizational arrangements and in the roles, responsibilities, and attitudes of municipal staff. Public institutions increasingly shift their focus from service provision to regulation, service planning, contract management, and performance monitoring. For the successful and cost-effective involvement of the private sector, public institutions need the regulatory and administrative capacity (powers, resources, and expertise) to manage these. PPPs are thus not a substitute for strong, accountable, and effective governance.

- While PPPs can be implemented in the short and medium term, a dedicated strategy on improving capacity to manage PPP contracts is recommended.

- National and local waste management strategies and plans should be sufficiently well developed and integrated to enable potentially viable PPP projects to be clearly identified and defined.

- A proven tariff-setting mechanism and operational charging system, based on the full recovery of service costs.

PPP Opportunities

The participation of the private sector could be considered when:

- The infrastructure and/or services take up significant proportions of municipal investment and operations budgets.

- The service cannot be provided with the resources or expertise of the public sector alone or when the services are provided less efficiently by the public sector.

- The infrastructure and/or services need new technologies, such as for the recycling of specific waste streams.

- The involvement of the private sector is likely to increase the quality or level of service or enable it to be implemented sooner.
- The outputs of the service can be defined, measured, and priced easily.
- Costs of the service can be defined in full and recovered largely or fully through user fees.

PPP opportunities in the PICs exist for the following infrastructure and/or services:

- Collection:
  - The improvement of waste management system, including increasing the recycling rates, starts with securing affordable waste collection and transportation services for all.
  - A system of separation at source must be developed in all PICs for organic waste, dry recyclables (paper/cardboard, plastics, metals/cans, and glass) and possibly other priority waste streams like electrical and electronic waste.
- Concentration: sorting and baling or compacting to ship at low density, thereby reducing transportation costs. All PICs must develop and invest in concentration facilities.
- Processing: Development and investment in processing facilities must be promoted in Fiji, which acts as the regional hub for the RRC. Investments in processing facilities in PICs other than Fiji and PNG are not likely to be feasible.
- Recycling: Use of the secondary materials in a production process (in existing manufacturing facilities, e.g., plastic converters for plastic granules or in manufacturing facilities to be developed). Investments in recycling facilities in PICs other than Fiji and PNG are not likely to be feasible.

However, the scope for PSP is also limited, due to the significant challenges that must be addressed, as identified in this chapter, to increase the recycling rates and due to the inherent financial risks of waste management operations.

Financial risks are usually of primary importance for the private partner. A prerequisite for involving the private sector is to guarantee that private companies can recover all legitimate costs (including profit) incurred in financing, constructing, and operating the services.

This depends on establishing the full costs of service provision, setting tariffs on a full cost recovery basis, ensuring that the resulting charges are affordable to users and collecting the charges in a performant manner. Otherwise, the private sector will not enter the market or will withdraw. From the commercial or financial perspective, it is challenging to increase private sector participation, particularly in the waste management sector. Environmentally sound waste management is expensive, while cost recovery from households in the form of fees paid for waste collection is generally very poor. User fees for waste collection are usually kept artificially low. Industrial waste collection can be more profitable, but seldom covers the full cost.

In addition to these risks related to cost recovery, recycling operations and facilities face market risks associated with the quality and quantities of separately collected or sorted materials, the availability and long-term consistency of markets, or the volatility of market prices.

In short, sufficient commercial potential to attract private companies is necessary.

7 Roadmap for Implementation

7.1 Timeline and Actions

Table 66 presents a preliminary schedule for implementing the objectives. Note that some of the below tasks can be conducted in parallel. Subject to funding, improving concentration in feed-in countries, and reprocessing/value adding in the Fiji hub/PNG can be achieved in a relatively short period.

Table 66 Timeline and Actions

	Action	Description	Key Players	Timeline
1	More in-depth discussions with interested off-takers for recyclables.	A more in-depth discussion with companies interested in recycling/processing is needed to determine their appetite for doing business and their overall capacity. Pre-agreements (letter of intention/interest) can be drafted at this stage to put their commitment in writing.	PRIF Recycling companies	3 months
2	Round table discussions of 14 Pacific Island Countries (PICs) to introduce and launch project	A round table conference, or series of conferences, shall have to be set up between all 14 PICs to launch the project and determine their interest in participating.	PRIF Project Management Units (PMUs) of 14 PICs	3 months
3	Create technical guidelines for recycling hub	The hub requires technical guidelines detailing the cooperation between the PICs and the recyclers/processing companies.	PRIF PMUs of 14 PICs	4 months
4	Draft/revise legal framework in participating countries to align legislation	Based on the institutional assessment, gaps in legislations of each island nation shall have to be determined to align them in all 14 PICs. Note that the MEAs required for the proposed option are already ratified, so MEAs are not a barrier for the target waste streams.	PRIF PMUs of 14 PICs Relevant Ministries (Ministry of Environment, Ministry of Trade, etc.)	9 months
5	Setting up shipping connections (e.g., through backloading initiatives)	Discussions with shipping companies shall have to commence to set up freight contracts, negotiate space on cargo ships and determine possibilities for backloading initiatives.	PRIF PMUs of 14 PICs Shipping companies	3 months
6	Regional full feasibility study on optimizing collection/sorting of recyclables and determination of infrastructure needs.	A regional feasibility study is needed to optimize collection and sorting on each island nation. This could be combined with additional waste audits (see Chapter 8.2 on further recommended studies). This feasibility study shall include a list of infrastructure and equipment needs on each island together with detailed financial calculations.	PRIF PMUs of 14 PICs Consultant engaged to conduct feasibility study	8 months

	Action	Description	Key Players	Timeline
7	Determining funding sources for infrastructure needs	The feasibility study shall support the hub in seeking funding from IFIs to finance infrastructure/equipment needs. This can be done in parallel to preparing the feasibility study. Determining the general appetite of IFIs in providing funding for an RRC can already be done at an early stage. Possibilities of engaging the private sector shall also be explored (e.g., PPP arrangements).	PRIF PMUs of 14 PICs Consultant engaged to conduct feasibility study Interested IFIs	9 months
8	Design of required infrastructure and preparation of tender documents for infrastructure and equipment	The required infrastructure (sorting plant, storage areas, etc.) shall have to be designed and tender documents prepared, to include equipment (vehicles, balers, etc.). Value-add technologies shall be identical/similar to those which already exist in Fiji (i.e., mostly off the shelf).	PRIF PMUs of 14 PICs Consultant engaged to conduct feasibility study Suppliers/Construction companies	7 months
9	Negotiate framework contracts with interested off-takers/recyclers	Letters of intention sought from potential off-takers at the beginning of the project shall now have to be turned into framework contracts.	PRIF PMUs of 14 PICs Recycling companies	6 months
10	Tendering and construction of required infrastructure	Tendering of equipment/infrastructure will take place over approx. 4 months, with subsequent purchase/construction and 1-year defects notification period. Equipment determined as part of the full feasibility study can be tendered before the infrastructure.	PRIF PMUs of 14 PICs Potentially Consultant engaged to conduct feasibility study to support with tendering process	2.5 years
11	Accompanying public awareness program	A public awareness program shall support the project from start to finish. It is designed to, among others, implement separate collection at the household level and raise the general level of awareness of the population for proper waste management.	PRIF PMUs of 14 PICs (Accompanying measures Consultant)	Throughout

MEA = multilateral environmental agreement, PRIF = Pacific Regional Infrastructure Facility, PMU = project management unit.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Table 67 Timeline for Project Implementation

	2023				2024				2025				2026				2027			
Action	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
I. Preparation Phase																				
More in-depth discussions with interested off-takers for recyclables.	■																			
Round table discussions of 14 PICs to introduce and launch project		■																		
Create technical guidelines for recycling hub		■	■																	
Draft/revise legal framework in participating countries to align legislation			■	■	■	■	■	■												
Setting up shipping connections (e.g., through backloading initiatives)				■	■	■														
Regional feasibility study on optimizing collection/sorting of recyclables and determination of infrastructure needs.					■	■	■	■												
II. Implementation Phase																				
Determining funding sources for infrastructure needs								■	■											
Design of required infrastructure and preparation of tender documents for infrastructure and equipment									■	■										
Negotiate framework contracts with interested off-takers/ recyclers										■	■									
Tendering of equipment and tendering/ construction of required infrastructure											■	■	■	■	■	■				
Defects notification period																	■	■	■	■
III. Accompanying Measures Phase																				
Accompanying public awareness program					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Regular conferences/meetings of all members of the Hub	■			■			■			■			■			■			■	

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

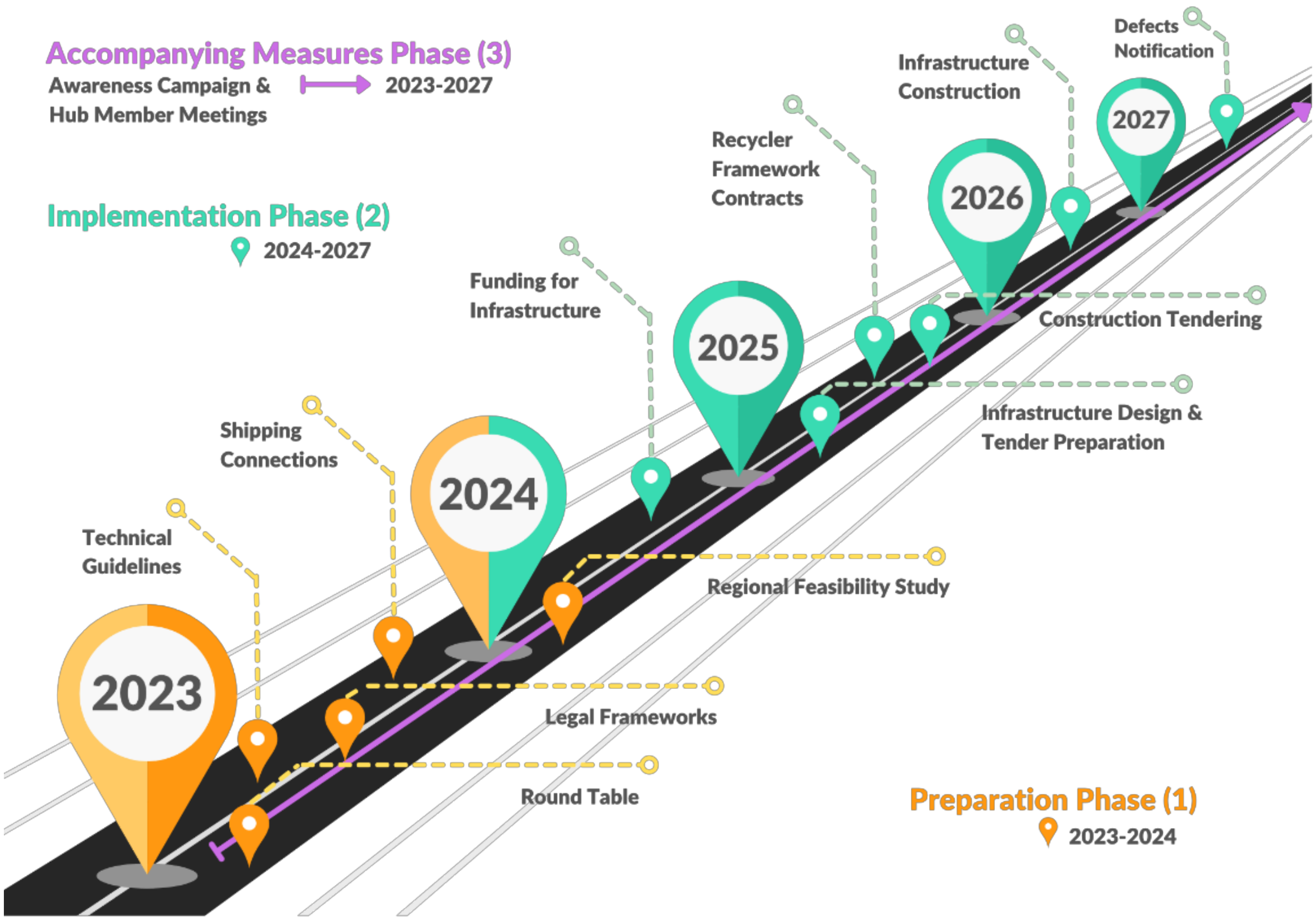

Figure 37 Roadmap

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

7.2 Further Studies

As mentioned in the Options report, a review of the waste audits found discrepancies in data quality, completeness, and approach despite the three separate teams of consultants[30] all having followed the same in-house household waste survey tool ("a common approach" – a household waste methodology promoted by Asia Pacific Waste Consultants).

A common approach focused predominantly on the collection of information on municipal solid waste, mostly from household waste surveys, through qualitative, semi-quantitative, and quantitative (visual) methods. While accredited international American Society for Testing and Materials methods were available (such as for landfill waste surveys), these were not used and little consideration was given to quantifying commercial, industrial, utility, and agricultural waste.

This was found to have resulted in an underestimation of the volumes of wastes in total and for specific waste streams when only municipal solid waste has been quantified after benchmarking was done to correct this using total waste estimates from other sources (Australian Bureau of Statistics, World Bank).

As part of the next step in the project, it is recommended that a high-fidelity waste audit targeting all waste sources (including municipal, commercial, industrial, utility and agricultural) be conducted using accredited methods by a qualified and experienced team. This will likely show much larger quantities of the target waste streams and have a positive effect on project finances. Methodology should be purposefully selected based on international best practices.

It is recommended that discussion with identified recycling partners be expanded to better inform the planned feasibility study with the capacities of these existing businesses to be used as a platform to better develop an RRC, with the inherent increase in total volumes of recyclables processed and the economic benefits that can be realized from this.

A study focused in this area can also better match national and regional market opportunities that are currently covered by imports and should also be conducted for each of the target waste streams. Discussions with the private sector in Fiji identified downstream products for aluminum, plastic resins, paper and cardboard, which may be supplied from regional hub materials.

The role of government frameworks needs to be more systematically studied and recommendations to further support an RRC were identified for each of the materials, noting that freedom of import duty, customs charges nationally and VAT regionally already play a role. There are already many discretionary financial tools that PICs can use to either support small enterprise or attract larger-scale recycling that could be better used strategically.

Given the ability of container deposit and advanced recycling fees to enhance or even create waste value chains, a study on the role of subsidies and other financial instruments will be important. This study has conducted some analysis on this area and has shown IRR and even CBR does appear to be improved when this is applied to beverage containers made from aluminum and PET.

But this study report also found that when a subsidy was applied to a low-value, high-volume waste stream with expensive shipping that CBR fell well below 1, indicating the total benefit to society

[30] Waste audits used in the PRIF study following a common method were conducted by APWC, Tonkin + Taylor and Total Waste Management.

was not equal to the cost. Further study on the pros and cons of financial instruments that maps out the right mix of government and private sector support, consumer chargers and impacts/roles, would be valuable for sustained and appropriate support to waste value chains.

7.3 Planned and Ongoing Development Partner Activities

There are several planned and ongoing donor activities in the Pacific region. Table 68 shows an overview of projects from various IFIs in the recycling/waste management sector that the Consultant is aware of.

Table 68 Development Partner Activities

No.	Source	Program name/description	Country
		PRIF	
1	Cook Islands National Infrastructure Investment Plan 2021–2030	Due to population density and most pressing needs, solid waste projects are limited to the island of Rarotonga, and cover a waste management strategy, waste center upgrade, waste handling facilities, a recycling transfer facility, a waste incinerator, and a composting facility	Cook Islands
2	Nauru Integrated Infrastructure Strategic Plan, 2019	Only two projects in the solid waste sector are planned. Relocating the medical waste incinerator to the landfill and replacing heavy duty equipment for solid waste management.	Nauru
3	Palau National Infrastructure Investment Plan 2021–2030	The Investment Plan mentions a row of infrastructure projects in Palau: • Operation and maintenance of M-Dock Landfill. • Waste tire shredding project to reduce the large number of stockpiled tires. • Scrap metal project: A contractor collects all scrap from M-Dock for recycling. The contract includes buying and redeeming of beverage containers for recycling. • Redemption centers collect recyclables, which are then exported. • Awareness programs on waste segregation, 3R, and best waste management practices.	Palau
4	Solomon Islands Priority Infrastructure Investment Pipeline	Sanitary landfills are part of the prioritized infrastructure investment pipeline. The landfill in Honiara shall include a preliminary assessment, construction, fencing, road access, drainage, leachate system, cell construction, leachate pond, treatment facility, site office, gate, billboards, wash bay, facilities and utilities construction, machinery and equipment, and tools. Landfills in provinces shall include in Stage 1: feasibility studies, land identification, preliminary assessment, and landfill design developed. Environment and social safeguards. Stage 2: Construction, capacity development. Stage 3: Infrastructure support for operations, e.g., excavator.	Solomon Islands
5	Tonga National Infrastructure Investment Plan	Projects in Tonga include the conversion of dump sites into new structured landfill, Ha'apai (Foa) and 'Eua (Angaha); Closing (Kalaka) and establishing a new landfill Vava'u (Leimatu'a and/or Toula)	Tonga
6	Tuvalu Priority Infrastructure Investment Plan 2020–2025	The 2016 investment plan noted improvements to solid waste management on all islands: landfills, equipment (including that required for pumping out septic tanks). These projects are said to be ongoing. The current plan proposes a general upgrade of the waste management system of Funafuti and all outlying islands, to include equipment, additional bins, promoting home composting, and reducing littering and open burning. It was set for completion in 2022.	Tuvalu
7	Vanuatu Infrastructure Strategic Investment Plan 2015–2024	Three Solid Waste Management (SWM) projects have been identified in the Plan, including waste collection trucks for Port Vial, improved waste management in Luganville and the improvement of Lenakel town dumpsite.	Vanuatu
		Asian Development Bank (ADB)	
8	Solomon Islands: Preparing the Honiara	The project includes conducting feasibility studies, assessments, and consultations to develop the Honiara SWM Service Improvement Plan. The plan will be aligned with the SWM Roadmap and include prioritized	Solomon Islands

No.	Source	Program name/description	Country
	Sustainable Solid Waste Management Project.	physical (e.g., waste management facilities and landfills) and nonphysical interventions (e.g., community awareness, expansion of waste collection, institutional strengthening) to be supported under the ensuing ADB-financed project.	
9	Pacific Approach, 2021–2025	The Pacific Approach, 2021–2025 provides strategic guidance ADB's operations across the 12 small Pacific Island countries (PIC-12). It includes quality and affordability of water supply and sanitation services, and solid waste management improvement.	Cook Islands, FSM, Kiribati, RMI, Nauru, Niue, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Niue
10	Marshall Islands. Preparing Urban Service Improvement Projects	Projects on delivering sustainable and affordable urban services, public awareness and community outreach campaigns focusing among others on solid waste issues. Develop an integrated SWM investment plan for Majuro.	RMI
	Preparing the Nauru Sustainable Urban Development Project	The Nauru Sustainable Urban Development Project covers the urban services of water supply, sanitation, and solid waste. Projects will be planned and executed under these sectors.	Nauru
		World Bank	
11	Community Access and Urban Services Enhancement Project	The Community Access and Urban Services Enhancement (CAUSE) project aims to improve basic infrastructure and services for vulnerable, urban population in the country, with skills training, short-term job opportunities, and income generation being prioritized to develop self-sustaining communities. The development objective is to improve basic infrastructure and services for vulnerable urban populations in targeted urban centers of the recipient. The project comprises of four components, of which one and four include SWM. 1) Urban works and services, including providing waste management and cleaning services. It encompasses community-based waste management services. 4) Project management support, including safeguards oversight, monitoring and evaluation, audits, communications, and media support (for the project overall, and specifically around the waste management services to increase awareness), short-term technical help, training, financial management, procurement, and provision of goods and operating costs.	Solomon Islands
		SPREP	
12	Niue Legacy E-Waste Stockpile Clearance and E-Waste Dismantling/Processing Training	South Pacific Regional Environment Program (SPREP) has launched a tender for qualified and experienced contractors who can offer their services to identify and design an electronic waste management (dismantling/processing) operation for Niue.	Niue
13	Asbestos Contaminated Materials (ACM) Removal and Disposal in Tonga	SPREP has launched a tender for qualified and experienced contractors who can offer their services to undertake removal and disposal in Tapuhia landfill of ACM from high-risk building locations on Tongatapu and the development of a strategic action plan for eventual removal/abatement of ACM in Tonga.	Tonga

No.	Source	Program name/description	Country
14	Federated States of Micronesia organic processing program development	SPREP has launched a tender for qualified and experienced contractors who can offer their services to develop the organic waste processing program for six villages in Colonia, Yap State of Federated States of Micronesia.	FSM
		European Union and European Commission	
15	PacWaste Plus	The PacWastePlus program will generate improved economic, social, health, and environmental benefits by enhancing existing activities and building capacity and sustainability into waste management practices for all participating countries. PacWastePlus is investing in country and regional projects that support and improve waste management and positive environmental outcomes for businesses, community groups, and social enterprises.	Timor-Leste Cook Islands Fiji Micronesia Kiribati RMI Nauru Niue Papua New Guinea Palau Solomon Islands Tonga Tuvalu Vanuatu Samoa
		Global Environment Facility	
16	Implementing Sustainable Low and Non-Chemical Development in Small Islands Developing States (SIDSs)	This program aims to build a sustainable model for the sound management of chemicals and wastes in order for SIDSs to continue to sustainably develop without a build-up of toxic and hazardous substances in their territories. This will be achieved through creating the enabling environment to allow for sustainability which will require, among other things, harmonizing procurement practices, standards and labelling and capacity building which can only be accomplished at the global/regional level in the context of SIDSs.	Cook Islands, Fiji, Kiribati, RMI, Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu
17	Development of A Minamata Initial Assessment in Marshall Islands	Early implementation of the Minamata Convention contributes to the protection of human health and the environment from the risks posed by unintentional and intentional emissions and releases as well as unsound use and management of mercury. This includes mercury from unsustainable waste management practices.	RMI
18	Continuing Regional Support for the POPs Global Monitoring Plan under the Stockholm Convention in the Pacific Region	To strengthen the capacity for implementation of the updated Persistent Organic Pollutants (POPs) Global Monitoring Plan and to create the conditions for sustainable monitoring of POPs in the Pacific Islands Region.	Fiji, Kiribati, RMI, Niue, Palau, Samoa, Solomon Islands, Tuvalu, Vanuatu

RMI = Republic of Marshall Islands.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

8 Risks

Possible project risks have been identified for each of the following categories:

- Environmental
- Financial
- Institutional
- Operational
- Social

Each risk has undergone a detailed impact analysis and, where applicable, existing controls have been listed. Risks which result from the project and risks which influence the project's success have both been taken into consideration.

Once the likelihood or probability of a certain risk has been ascertained, the consequence or impact of this risk on the project has been determined. Multiplied with each other, these two factors then equate the overall risk rating. The higher a risk ranks, the bigger the threat to the project.

The top-left corner of Table 69 is where the likelihood and impact of a risk occurring are very low. On the opposite side, in the bottom-right corner, the likelihood and the impact are the greatest.

Table 69 Risk Rating

Likelihood (L)		Consequence				
		Insignificant	Minor	Moderate	Major	Extreme
May occur but in exception circumstances	**Remote**	LOW 1	LOW 2	LOW 3	MEDIUM 4	MEDIUM 5
Could occur at some time	**Unlikely**	LOW 2	LOW 2	MEDIUM 6	HIGH 8	HIGH 10
Might occur at some time	**Possible**	LOW 3	MEDIUM 6	HIGH 9	HIGH 12	EXTREME 15
Will probably occur in most circumstances	**Likely**	MEDIUM 4	HIGH 8	HIGH 12	EXTREME 16	EXTREME 20
Expected to occur in most circumstances	**Almost certain**	MEDIUM 5	HIGH 10	EXTREME 15	EXTREME 20	EXTREME 25

Source: TMS. 2019. How to use the risk assessment matrix to organize your project better. https://tms-outsource.com/blog/posts/risk-assessment-matrix

The consequence of each risk on the above-mentioned five categories is described in more detail in the below Table:

Table 70 Consequence Matrix

Consequence Value		Impact to				
Rating	**Value**	**Operation**	**Institutional**	**Environmental**	**Social**	**Financial**
Insignificant	1	Negligible operational impact	Disparities are discrete but manageable and flexible	Negligible environmental impact	Negligible impact on society	Negligible financial impact which will not impact operation
Minor	2	Short term disruption to import/export activities and geographically limited	Inconsistencies/disputes in national and Regional Recycling Project systems are minor and rectifiable in the short term	Minor environmental damage. Can be rectified within available budget	Short term negative impacts that limit engagement of some communities	Minor financial impact which can be compensated by available budget
Moderate	3	Restricted operational capacity on some Pacific Island Countries or waste streams for the medium term	Inconsistencies/disputes in national and Regional Recycling Project systems restrict part or whole participation of some Pacific Island Countries	Some environmental damage requiring the allocation of some additional resources to rectify	Restricted on whole or parts of communities, negatively impacts on livelihood and ability to participate for medium term	Moderate financial impact which can only be compensated by using a large portion of the available budget
Major	4	Long term disruption to whole waste streams or whole countries participating in the Regional Recycling Center	Inconsistencies/disputes in national and Regional Recycling Project systems disrupt whole participation of many Pacific Island Countries	Extensive environmental damage requiring significant resources to rectify	Long term negative impacts on livelihood and/or ability to participate for whole communities	Extensive financial impact which can only be compensated by using available budget

Consequence Value		Impact to				
Extreme	5	Shut down of Regional Recycling Center	Inconsistencies/disputes result in no political will to support Regional Recycling Project	Catastrophic environmental damage leading to fines, significant resources to rectify, or permanent damage	Widespread loss of livelihood of informal workers and private recyclers. Threat to health and well-being of people.	Severe financial impact which leads to negative balance

Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

Appropriate mitigation strategies have then been identified and assigned to each risk. The detailed risk register can be found under 0.

The risks with the highest ratings are highlighted in Table 71.

Table 71 Highest Rated Risks

Risk Identification				Risk Analysis & Evaluation				Risk Mitigation
ID	Risk Description	Cause	Risk Category	Potential Impact	L	C	Risk Rating	Mitigation Action Plan
14	Mismanagement of residuals	One set of environmental impacts from waste are transferred to polluting industry practices (e.g., hazardous waste, air emissions, liquid pollutants, etc.)	Environmental	Clean technologies are required to ensure harmful wastes and emissions are not produced. This may mean that recyclers must make an investment for which they lack the funds.	4	4	16	Measures need to be taken to ensure that cost-effective clean technologies are selected and support for financing is available to reduce the likelihood of reversion to unsanitary practices
17	Price volatility in the recycling market	Price fluctuations have important consequences for profitability and long-term sustainability of the Regional Recycling Center	Financial	An unstable market for recyclables, lack of recyclate and competitive virgin prices can all have a negative impact on the long-term financial sustainability of the Regional Recycling Center.	4	4	16	Maximizing competitive engagement with incentivization models (such as with organizations committed to The Australia, New Zealand and Pacific Islands Plastics Pact (ANZPAC) recycling targets) to ensure competitive prices are obtained.
19	Lack of technical skill	Pacific countries are smaller, imported expertise would be required	Operational	Technical capability may not be achieved. Maintenance is insufficient due to lack of funding and/or lack of technical capability.	4	4	16	Provide technical expertise and ongoing operational training to workers as part of the start-up process and/or encourage immigration of

Risk Identification				Risk Analysis & Evaluation				Risk Mitigation
ID	Risk Description	Cause	Risk Category	Potential Impact	L	C	Risk Rating	Mitigation Action Plan
								skilled workers, which will ensure a transfer of knowledge and the creation of a new job sector.
10	Lack of waste management services	Lack of waste collection services and drop-off points for rural and outer island communities are a major concern regarding waste disposal practices.	Environmental	Without formal systems, valuable recyclables that could feed into the Regional Recycling Center are lost to and pollute the local environment. Without segregation practices such as source separation, comingled waste entering landfills is shortening valuable landfill lifespan and creating an environmental burden, especially in PICs where land is already a precious commodity.	5	3	15	To prevent any further missed opportunity, the recovery of recyclables from these more isolated communities needs to be planned for through formal channels like national and provincial waste management plans. Source segregation recyclable waste recovery chain will maximize recovery of valuable feedstock while also extending landfill lifespans for waste that currently lacks other management options in PICs.
16	Shipping cost volatility	When compared to the global situation, shipping of recyclables from each PIC will be on relatively small scale. Fluctuations in shipping costs	Financial	Shipping rates are highly volatile and depend on a wide variety of factors, from global supply and demand to unexpected alterations to shipping routes, to the price of	5	3	15	Maximize the benefits of shipping schemes like Moana Taka and consider extension/development of future schemes to take

Risk Identification				Risk Analysis & Evaluation				Risk Mitigation
ID	Risk Description	Cause	Risk Category	Potential Impact	L	C	Risk Rating	Mitigation Action Plan
		will therefore have a greater impact.		fuel. The ongoing COVID-19 pandemic has caused additional disruptions in recent times. These fluctuations are often difficult to predict, and may, in connections with price fluctuations for recyclables, cause shipping to the Regional Recycling Center to become uneconomical.				advantage of backloading activities.

PIC = Pacific Island Country.
Source: Regional Recycling Centre Pre-Feasibility Study Report project team.

9 Conclusions

Through the RRC, high-value recyclables (aluminum cans, ULAB, PET, paper/cardboard and plastics) will be generated in Fiji and PNG through national compounding efforts, while lower- value recyclables (such as ULABs, scrap steel and glass bottles) will be generated in all source countries through national collection and compaction efforts. The select materials from the eight feed-in nations will be processed to a certain output quality. Input materials for Fiji are received in pre-segregated and high-density forms from feed-in PICs. Input materials for PNG are segregated nationally and then fed into domestic value-added systems. All materials from non-hub PICs will enter directly into the global/international market without value-add activities.

The overall profitability of the recycling project has been assessed as part of a sensitivity analysis, which concentrates on investment costs, waste amounts, operation and maintenance costs, transportation costs to and from the recycling facilities, as well as unit sales prices. The recycling project is very sensitive to changes in the unit sales prices of the recycled waste. Hence, if the unit sales prices fluctuate, it may be a severe risk to the profitability of the recycling project. Waste amounts, on the other hand, do not severely influence the profitability of the recycling project. The IRR remains at a relatively high level with lower waste amounts.

If capital expenditures become 20% more expensive than the baseline estimate, the profitability of the recycling projects attains an IRR of 15%, and it becomes riskier. Operational and maintenance costs, on the other hand, can increase by 60% and still the project is profitable with an IRR around 15%. This also applies to transportation costs, which do not severely endanger the profitability of the project, even if they turn out to be different from the baseline assumptions.

The establishment of an RRC has the potential to bring about a range of environmental and social benefits across the PICs. Major environmental benefits include increasing landfill lifetimes by waste diversion, reuse, and recycling. Natural resources are conserved through the reuse of existing materials, especially in the case where organic materials, which can contribute significantly to low carbon levels which are common in the Pacific, replace expensive imported soil ameliorants. Several social benefits, from improving community health and wellbeing to job creation, accompany the implementation of this RRC.

One of the major contributors to climate change is the production of GHGs from inadequate landfilling of waste and the production of methane. Two main factors for reducing GHG emissions in the waste sector are reducing methane emissions and avoiding emissions altogether through recycling and thus diverting waste (resources) from being landfilled in the first place.

The implementation of the RRC will be conducted in consecutive steps over 5 years. Starting with a preparation phase, which includes more in-depth discussions with interested off-takers of recyclables and obtaining letters of intention/interest from them, which will form the basis of the project and help facilitate later discussions with interested IFIs. A kick-off meeting (as well as regular roundtable discussions thereafter) between all 14 PICs will set the stage for their future cooperation. Phase I will be concluded by a regional full Feasibility Study that will focus on optimizing collection/sorting of recyclables and determine future infrastructure needs.

Phase II is dedicated to the implementation of the project, and covers the following steps:

- Determining funding sources
- Design, tendering and construction of required infrastructure/purchase of equipment
- Negotiating framework contracts with interested off-takers/recyclers

The entire project will be accompanied by public awareness measures (stakeholder inclusivity), which essentially means the effective involvement of all public and private stakeholders in the decision-making process and the effective participation of all stakeholders in the collection and recycling systems. Stakeholders can be the tourism industries, businesses, retailers, civil society organizations and consumers. They are key groups driving the process to prevent waste and to properly collect, process, and recycle the waste which cannot be avoided. It should be noted that increased awareness also increases public willingness to pay for sound collection and recycling services, another prerequisite for a successful RRC.

10 References

AACE. 2020. International Recommended Practice No. 17R-97. Cost Estimation Classification System. Morgantown, West Virginia, USA.

Australian Bureau of Statistics. 2020. *Waste Account, Australia, Experimental Estimates, Australia*. Canberra. https://www.abs.gov.au/statistics/environment/environmental-management/waste-account-australia-experimental-estimates/latest-release (viewed 15 July 2022).

Department of Environment, Water, Heritage and the Arts. 2009. *Employment in the Waste Management Sector: Access Economics 2009, Employment in Waste Management and Recycling*. Canberra: Australian Government.

Hoornweg, D. and Bhada-Tata, P. 2012. What a Waste: A Global Review of Solid Waste Management. *Urban Development Series*, no. 15. Washington, DC: World Bank.

International Maritime Organisation (IMO). 2009. *Second IMO GHG Study, United Kingdom*. London: IMO. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/SecondIMOGHGStudy2009.pdf (viewed 24 March 2022).

Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series, The World Bank, Washington, DC.

LME.com. 2022. OLME, LME Aluminum Alloy. 3-month closing price. https://www.lme.com/Metals/Non-ferrous/LME-Aluminium-Alloy#Trading+day+summary (viewed 7 November 2022).

Worldometer. 2020. GDP per Capita. https://www.worldometers.info/gdp/gdp-per-capita (viewed 30 January 2022).

Xin Dongyu Metal Materials (Shandong) Group Co., Ltd. 2022. Aluminum Ingot. https://aluminumproducers.com/aluminum-ingot (viewed 20 October 2022).

Ziraba, A.K., Haregu, T.N. and Mberu, B. 2016. A Review and Framework for Understanding the Potential Impact of Poor Solid Waste Management on Health in Developing Countries. *Archives of Public Health* vol. 74, no. 5. pp. 1-11.

Figure References

ABRI. 2013. Packaging Standard for Used Lead Acid Batteries (ULAB). https://batteryrecycling.org.au/wp-content/uploads/2013/11/ULAB-packaging-standard-2013-final2.pdf (viewed 5 September 2022).

APCO. 2018. Market Impact Assessment Report (Dec 2017-July 2018). Sydney: APCO. https://documents.packagingcovenant.org.au/public-documents/Market%20Impact%20Assessment%20Report%20Chinese%20Import%20Restrictions%20For%20Packaging%20in%20Australia (viewed 28 February 2022).

Bicanski. n.d.a. Cardboard, Carton, Close-Up, Egg Box, Package, Product, Yellowish Brown, Retro, Empty, Old. https://pixnio.com/media/cardboard-carton-close-up-egg-box-package (viewed 10 November 2022).

Bicanski. n.d.b. Pressed, Metal, Bales, Waste, Material. https://pixnio.com/textures-and-patterns/metal-texture/pressed-metal-bales-of-waste-material (viewed 20 October 2022).

Coetzee, C. 2013. Roll of Toilet Paper with One Sheet Folded Down in Front. https://c1.staticflickr.com/9/8085/8486352769_6ca83e8aa1_b.jpg (viewed 20 October 2022).

Dropyourenergybill.com. n.d., Recycled Glass. https://dropyourenergybill.com/recycled-glass/ (viewed 10 November 2022).

EUWID. 2022a, Price Watch Aluminum Cans , EUWID Recycling and Waste Management database. https://www.euwid-recycling.com/markets/nf-scrap-metals-germany/ (viewed 26 January 2022).

EUWID. 2022b, Price Watch Glass Germany, EUWID Recycling and Waste Management database. https://www.euwid.de/en/industry-news-service/verpackung/ (viewed 09 February 2022).

EUWID. 2022c, Price Watch Steel Scrap Germany, EUWID Recycling and Waste Management database. https://www.euwid-recycling.com/markets/steel-scrap-germany/ (viewed 26 January 2022).

IndiaMART. 2022a. Clear Hot Washed PET Flakes, Packaging Type: PP Bag, Pack Size: 30 Kg. https://www.indiamart.com/proddetail/hot-washed-pet-flakes-13286012562.html (viewed 20 October 2022).

IndiaMART. 2022b. Multicolor Grinded Multicolour Waste Plastic Bt Road. https://www.indiamart.com/proddetail/multicolour-waste-plastic-bt-road-23328586055.html (viewed 20 October 2022).

IndiaMART. 2022c. Remelted Zinc Ingots. https://www.indiamart.com/proddetail/remelted-zinc-ingots-12402532012.html (viewed 20 October 2022).

King County. 2022. Northeast Recycling & Transfer Station project. https://kingcounty.gov/depts/dnrp/solid-waste/facilities/northeast.aspx (viewed 10 November 2022).

LSM. 2022. Cardboard Balers for Rent. https://www.lsm-balers.co.uk (viewed 10 November 2022).

Naturally Wrapt. n.d. Natural Recycled Kraft Wrapping Paper Rolls 50cm x 6m 50gsm. https://naturallywrapt.co.uk/Natural-Recycled-Kraft-Wrapping-Paper-Rolls-50cm-x-6m-50gsm-p291843626 (viewed 10 November 2022).

Plasticker. 2022. The Home of Plastics. https://plasticker.de (viewed 10 November 2022).

Sustainability Victoria. 2021. July 2021 Recovered Resources Market Bulletin. *Victorian Market Intelligence Project*, ed. 18. Victoria: Sustainability Victoria.

Teka Scrap LTD. 2022. PET Flakes. https://tekascrapltd.com/product/pet-flakes/ (viewed 20 November 2022).

The Tehran Times. 2022. Aluminum Ingot Production Exceeds 275,000 Tons. https://www.tehrantimes.com/news/446940/Aluminum-ingot-production-exceeds-275-000-tons (viewed 28 October 2022).

Trading Economics. 2022. Lead. https://tradingeconomics.com/commodity/lead (viewed 28 October 2022).

Vulcan Wire. 2016. How to Make a Cardboard Bale. https://www.vulcanwire.com/how-to-make-a-cardboard-bale/ (viewed 20 October 2022).

Waste-Outlet. 2022. LDPE Plastic Foil. https://www.waste-outlet.com/wp-content/uploads/2018/10/20180926_083830_resized.jpg (viewed 10 November 2022).

Table References

Australian Packaging Covenant & National Waste and Recycling Industry Council. 2022. Voluntary Recovered Material Specifications (Draft). Canberra: APCO & NWRIC.

Hillman, K., et al. 2015. Climate Benefits of Material Recycling: Inventory of Average Greenhouse Gas Emissions for Denmark, Norway and Sweden. Copenhagen: TemaNord, Nordic Council of Ministers.

Kokusai Kogyo Co., Ltd. & Yachiyo Engineering Co., Ltd. 2021. Data Collection Survey on Promotion of Recycling Plastics and Other Materials in Pacific Island Countries (Final Report). Japan: JICA.

London Metal Exchange. n.d. Special Contract Rules for Lead. London: LME.

Mil-tek. 2021. Mil-tek New Zealand - Recycling Balers & Compactors. https://www.miltek.co.nz (viewed 6 July 2022).

Ministry of Commerce, Tourism, Trade & Transport, Fiji. 2021, Database for Valid Scrap Metal Dealers. https://www.mcttt.gov.fj/wp-content/uploads/2021/06/Scrap-Metal-Database.pdf (viewed 20 February 2022).

Peel, J., Godden, L., Palmer, A. & Markey-Towler, R. 2020. Stocktake of Existing and Pipeline Legislation in the 15 PacWastePlus Participating Countries. Samoa: Secretariat of the Pacific Regional Environmental Programme.

Pragmatic Metal Group. 2022, About Pragmatic Metal Group. https://www.pragmaticmetalgroup.com.au/about/ (viewed 20 July 2022).

PWC. 2022. World Tax Summaries. https://taxsummaries.pwc.com (viewed 28 February 2022).

Secretariat of the Pacific Regional Environment Programme (SPREP). 2020. *Built environment - Renewable energy (Pacific Region Factsheet).* Samoa: SPREP.

Secretariat of the Pacific Regional Environment Programme (SPREP). n.d., Pacific Recyclers List. https://www.sprep.org/attachments/j-prism-2/PIC_Detailed_List_of_Recyclers_and_Recyclable_Materials_List.pdf (viewed 24 May 2022).

Telford Smith. 2022. Granulators, Shredders & Recycling Systems. https://www.telfordsmith.com.au/machines/Brand/ZERMA/Granulators-Shredders-and-Recycling-Systems/?gclid=Cj0KCQjwof6WBhD4ARIsAOi65aijaYJ7a5N51p6ONPEitaTgZR0CotWwUiZe0Z9ZG17TyW7JWTybTgaAqvsEALw_wcB (viewed 10 July 2022).

The Aluminum Association. 2007, *International Designations and Chemical Composition Limits for Unalloyed Aluminum*. Arlington. Virginia: The Aluminum Association.

Upshall, E. 2021. EcoBlue Invests $25m in Bottle-To-Bottle Recycling Facility in Thailand. https://www.foodbev.com/news/ecoblue-invests-25m-in-bottle-to-bottle-recycling-facility-in-thailand/ (viewed 3 March 2022).

Utilities Regulatory Authority (URA). 2017. *Comparative Report: Pacific Region Electricity Bills*, Vanuatu: Utilities Regulatory Authority.

Van, T. 2020. HSBC Vietnam Rolls Out First Green Financing Package for Duy Tan Plastics Recycling. https://vir.com.vn/hsbc-vietnam-rolls-out-first-green-financing-package-for-duy-tan-plastics-recycling-77652.html (viewed 3 March 2022).

World Bank. 2022. Population, total - Fiji, Kiribati, Palau, Micronesia, Fed. Sts., Nauru, Samoa, Tonga, Vanuatu, Solomon Islands, Papua New Guinea, Tuvalu, Marshall Islands. https://data.worldbank.org/indicator/SP.POP.TOTL?end=2020&locations=FJ-KI-PW-FM-NR-WS-TO-VU-SB-PG-TV-MH&start=2020 (viewed 9 June 2022).

World Bank. 2020. World Development Indicators, UNData. https://data.un.org/Data.aspx?d=WDI&f=Indicator_Code%3AIS.SHP.GOOD.TU (viewed 15 March 2022).

World Food Programme (WFP). 2022. Country Port Profiles, Logistics Capacity Assessments (LCAs). https://dlca.logcluster.org (viewed 16 January 2022).

Xin Dongyu Metal Materials (Shandong) Group Co., Ltd. n.d. Aluminum Ingot. https://aluminumproducers.com/aluminum-ingot (viewed 20 October 2022).

National Waste Audit Reports:

Asia Pacific Waste Consultants. 2021. *Kiribati Waste Characterization and Situation Analysis Report (Draft)*. The World Bank Group.

Asia Pacific Waste Consultants. 2020. *Palau Waste Audit Report*. UN Environment.

Asia Pacific Waste Consultants. 2021. *Plastic Waste Free Islands Project: Plastic Waste National Level Quantification and Sectorial Material Flow Analysis in Fiji (Draft)*. International Union for the Conservation of Nature (IUCN).

Asia Pacific Waste Consultants. 2019. *Port Reception Waste Facilities Review – Vanuatu*. Centre for Environment Fisheries & Aquaculture Science (CEFAS), UK.

Asia Pacific Waste Consultants. 2021. *Samoa Waste Audit Report*. The World Bank Group.

Asia Pacific Waste Consultants. 2019. *Solomon Islands – Best Practice Waste Management Report (Draft)*. Centre for Environment Fisheries & Aquaculture Science (CEFAS), UK.

Asia Pacific Waste Consultants. 2019. *Solomon Islands – Waste Data Report*. Centre for Environment Fisheries & Aquaculture Science (CEFAS), UK.

Asia Pacific Waste Consultants. 2021. *Tonga Waste Audit and Situation Analysis Report (Draft)*, The World Bank Group.

Asia Pacific Waste Consultants. 2019. *Vanuatu – Waste Data Report*, Centre for Environment Fisheries & Aquaculture Science (CEFAS), UK.

Prince, A. & Mackeen, D. 2018. *Pacific Region Solid Waste Management and Recycling*. Sydney: Pacific Region Infrastructure Facility.

Tonkin & Taylor International. 2021. *Waste Audit Report Cook Islands Consultants' Final Report*. Sydney: Pacific Region Infrastructure Facility.

Tonkin & Taylor International. 2021. *Waste Audit Report Fiji Consultants' Final Report*. Sydney: Pacific Region Infrastructure Facility.

Tonkin & Taylor International. 2021. *Waste Audit Report Federated States of Micronesia (Draft).* Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Tonkin & Taylor International. 2021. *Waste Audit Report Nauru*. Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Tonkin & Taylor International. 2021. *Waste Audit Report Niue (Draft).* Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Total Waste Management Group PNG Limited. 2021. *PacWaste Plus Waste Audit Program Timor-Leste.* Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Total Waste Management Group PNG Limited. 2021. *Waste Audit Report Papua New Guinea*. Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Tonkin & Taylor. International 2021. *Waste Audit Report Republic of the Marshall Islands (Draft).* Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Wander, A., Sagapolutele, F., Prince, A. & Thompson, G. 2021. *Waste Audit Report Tuvalu Consultants' Final Report*. Sydney: Pacific Region Infrastructure Facility.

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