Economic Study - Market Research for GEF ISLANDS Pacific Project

Final report

March 2023



Natural Capital Economics



Natural Capital Economics recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Melissa Barton. This piece was commissioned by Alluvium and tells our story of caring for Country, through different forms of waterbodies, from creeklines to coastlines. The artwork depicts people linked by journey lines, sharing stories, understanding and learning to care for country and the waterways within.

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GLOSSARY OF ABBREVIATED TERMS

ARFD	Advanced Recovery Fee and Deposit System
AUD	Australian Dollars
BAF	Biosecurity Authority of Fiji
BCR	Benefit Cost Ratio
CBA	Cost-Benefit Analysis
E-ELV	Equivalent End of Life Vehicle
ELV	End-of-Life Vehicle
EPI	Environmental Performance Index
FJD	Fiji Dollars
GDI	Gender Development Index
GEF	Global Environment Facility

GNI	Gross National Income
HDI	Human Development Index
MCA	Multi-Criteria Analysis
MOWE	Ministry of Waterways and Environment
NPB	Net Present Benefits
NPC	Net Present Costs
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
OH&S	Occupational Health and Safety
PICT	Pacific Island Countries and Territories
PNG	Papua New Guinea
POP	Persistent Organic Pollutant
SIDS	Small Islands Developing States
SPREP	Secretariat of the Pacific Regional Environment Programme
UNEP	United Nations Environment Programme
UNEP	United Nations Environment Programme
USD	United States Dollars
WGI	Worldwide Governance Indicators
WHO	World Health Organisation

Executive summary and recommendations

The problem and proposed solution

Unintentional Persistent Organic Pollutants (POPs) are toxic hazardous chemicals that have dangerous effects on the environment and our health through gradual exposure through food chains and other exposure. Health impacts include but are not limited to increased cancer risk, reproductive disorders, deterioration in the immune system, neurobehavioral impairment, and increased birth defects. These risks are exacerbated in Pacific Islands Country and Territories (PICTs) due to a lack of proper recycling of End-of-life-vehicles (ELVs) and other bulky waste due to inadequate infrastructure and capacity in any PICT, and because costs of ELV recycling are likely to exceed any revenues generated through the sale of recyclable materials through international scrap markets. One proposed solution is the establishment and operation of a regional ELV recycling facility, where ELVs and other bulky waste could be safely and comprehensively processed before export to world markets. In addition, smaller PICTs could depollute ELVs and export them to the regional facility for comprehensive processing before the re-export of materials to world scrap markets. This would reduce the need for the duplication of expensive capital equipment across multiple PICTs, reduce overall costs and maximise the environmental and financial sustainability of addressing the growing problem of ELVs across the South Pacific. This report assesses this option, primarily with the bulk of the processing occurring in a dedicated location (Fiji), but also with a scenario where more processing is undertaken in individual PICTs using a mobile crusher.

Preliminary assessment and findings from consultation

The preliminary analysis indicates that Fiji and Papua New Guinea are good early candidates for a regional recycling facility, but there will likely be additional funding support required to make them viable, particularly generating sufficient revenue from sales of recycled materials to be viable with only limited ongoing support. Based on a broad assessment against several criteria, it was concluded that Fiji was the preferred candidate site. Full details of this analysis are outlined in Appendix A and Appendix B.

A field visit was conducted in Fiji. The purpose of this visit was to gain a better understanding of the limitations and requirements of setting up a regional recycling facility in the region and to fill critical information gaps where information gathered in earlier phases of the project was insufficient. This included key representatives from government agencies, Suva City Council, industry, and the non-government sector. Key findings from this analysis were that there is significant interest and support for establishing an ELV recycling facility in Fiji. However, several gaps and impediments were identified that would need to be resolved to ensure the success of any facility. Full details are outlined in Appendix C.

Detailed findings (Fiji as the preferred location of the ELV recycling facility)

More in-depth research and analysis were undertaken to assess the viability of establishing a regional ELV recycling facility in Fiji. This considered the current situation in Fiji and the requirements to move the progression of a facility in Fiji forward. This considered institutional and legislative requirements, value chain analysis, labour and human capital requirements, and the economic and financial viability of the facility (all relevant revenues and costs). This analysis has found:

- **International agreements.** The Waigani Convention will assist in underpinning international obligations within the PICT. However, further work will be needed to be undertaken to ascertain whether Fiji's status under the Basel Convention restricts the ability to export materials to final international destinations for recycling. Further works will need to be undertaken to ascertain whether Fiji's status under the Basel Convention restricts the ability to export materials to final international destinations for recycling.
- **The Fijian regulatory environment.** Existing Fijian regulations would appear to be sufficient to provide the key legislative and regulatory environment for any ELV recycling facility utilizing appropriate sections of several regulations. Rather than new and bespoke regulations, this will require coordination across agencies and comprehensive guidance though the regulatory requirements for any potential operators.

  This should be confirmed through a specific study by regulatory specialists. Additional work will be required to research, identify, scope, and design an approach to meet the biosecurity risks of transboundary movement of partially recycled ELVs within the Pacific in a way to manage biosecurity risks to Fiji.
- **Depolluting ELVs.** The lack of proper and widespread management of liquid waste immediately after the decommissioning dumping of ELVs is a major risk to the environment and human health. The provision and use of common/shared services for liquid waste and battery management could significantly reduce the risks of dumping into the environment.
- **ELV wreckers and scrap metal dealers.** The ELV wrecking and scrap metal sector is relatively informal, and widespread and generally does not meet good environmental or OH&S practices.
- **Recycling facilities.** Research and consultation indicate that the recycling sector is still in its infancy in Fiji, with a lack of infrastructure, economies of scale, best practices, and processes to meet modern standards. The exception is the recycling and manufacture of lead-acid batteries.
- **Port and road freight infrastructure.** The Port of Suva has all the facilities required for the shipping of ELVs, including receiving ELVs from other PICT and the re-export of partially processed ELVs to international markets. There is not sufficient space at the Port to host the ELV recycling facility. However, there is suitable land available nearby. Available evidence suggests road transport or other transport-related logistics infrastructure and capacity are sufficient to underpin the operations of the ELV recycling facility. Given volumes of potential throughput, it may be prudent to consider establishing dedicated infrastructure (truck and operator) to reduce overall operating costs.
- **Labour and human capital.** Capacity building and training for the workforce is required along the value chain from ELV wreckers to recycling operators. It would be prudent to establish guidelines (noting SPREP is already implementing this initiative) and ultimately training for workers across the sector (including in the local language where appropriate). OH&S practices (including personal protective equipment) are lacking. A more formalised recognition of the waste sector is warranted, and the training of workers should be recognised in wages that reflect the acquisition of new skills.
- **Potential costs.** It is estimated that the establishment costs of the ELV facility (land, facilities, and capital costs) are around $60 million including a 25% contingency. There are multiple operational steps required to manage ELVs ranging from the initial collection of ELVs for processing to the ultimate export to global markets for recyclable scrap materials. It is estimated that the cost of processing an ELV in Fiji is approximately $226 (range of $222 to $234).

- **Revenues.** Revenues are derived from the ultimate sale of recyclable materials on world markets. Any ELV recycling initiative will be reliant on market prices to determine revenues. Current estimates are that saleable recyclable materials from an average ELV are $209 (range of $183 to $240)
- **Economic and financial viability.** The detailed economic and financial modelling using a cost-benefit analysis approach found that the ELV facility will almost certainly not be financially viable in the absence of ongoing financial assistance and/or some form of Advanced Recovery Fee & Deposit System. Key results from the analysis are shown below. Revenues from the sale of materials will not be sufficient to cover the cost of ELV recycling including all transport costs, and a potential estimated shortfall over the project life of $37 M is likely. Furthermore, where ELVs are imported to Fiji (before processing and re-export to global scrap markets), the incremental net cost per annum ranges from $1 K (Nauru) to $175 K (Fiji). The ARFD may be sufficient to cover the funding gap.
- **Entry points.** The key entry points to develop this project are to establish and prepare the facility and then follow up with a roving pickup of ELVs to begin drawing on the existing stockpiles of vehicles in Fiji. The gathering of vehicles can be done during the establishment of the facility.

Table ES1. Findings from the economic model

Finding	Scenario 1 – Value (low – high)	Scenario 2 – Value (low – high)
Net present costs	$156.87 M (139.96 M to 178.57 M)	$154.18 M (137.48 M to 175.81 M)
Net present benefits	$144.88 M (115.73 M to 183.14 M)	$144.96 M (115.15 M to 183.69 M)
Net present value	$-12.06 (-36.72 M to 16.91 M)	$-9.42 (-33.77 M to 20.37 M)
Benefit-cost ratio	0.92 (0.77 to 1.11)	0.94 (0.78 to 1.13)
Cars processed in the 30-year project life	694,000 (631,000 to 765,000)	
Additional funding is required per vehicle	$17.22 (55.04 to -23.45*) *There is a small profit of $23 per vehicle on the high end of estimates	$13.67 (50.14 to -28.03*) *There is a small profit of $28 per vehicle on the high end of estimates

Note: The low value is represented by the 10th percentile while the high value is presented as the 90th percentile of all results.

Key finding

The research, analysis, and consultation have found that an ELV recycling facility will almost certainly not be viable in the absence of ongoing financial assistance and/or some form of Advanced Recovery Fee & Deposit System. However, Where some form of sustainable finance could be secured, progressing the ELV recycling facility in Fiji is likely to be economically, financially, and operationally feasible.

The available data indicates that there is no significant difference between initial processing in PICTs compared to processing in Fiji.

Recommendations on the next steps

Based on all research, analysis, and consultation several key issues have been identified that each trigger recommendations for further in-depth analysis or actions to underpin the successful investment and operation of any regional ELV facility. These are outlined in the table below.

Table ES2. Recommendations on the next steps

#	Issue	Recommendation
Decision-making and governance		
1	Briefings	Conduct a series of briefings to key stakeholder organisations and potential investors.
2	Next phase of feasibility assessment	That the assessment of an ELV recycling facility located in Suva for the ultimate use as a regional facility is progressed to the next phase of decision-making and investment analysis.
3		Governance going forward Utilise existing arrangements (e.g., overall Programme Steering Committee) to oversee the governance of this project going forward. This should include representatives of SPREP, the Government of Fiji (Department of Environment and Biosecurity Authority particularly), Suva City Council, World Bank representatives, and industry (including Swire Shipping).

#	Issue	Recommendation
4	Issues/actions register	Establish and maintain and issues and actions register to manage and track progress.
5	Information and data	As the next phases of assessment progresses, periodically enhance and update economic and financial modelling (e.g., input data) to better inform financial investment decisions.
6	Secure investment	Secure investment for ELV facility through appropriate arrangements.
Issues for resolution in next phase of assessment (prior to establishment of ELV facility)		
7	International agreements	Further works will need to be undertaken to ascertain whether Fiji's status under the Basel Convention restricts the ability to export materials to final international destinations for recycling.
8	Biosecurity concerns	Additional work will be required to research, identify, scope, and design an approach to meet the biosecurity risks of transboundary movement of partially recycled ELVs within the Pacific in a way to manage biosecurity risks to Fiji.

9	Depolluting ELVs	The provision and use of common/shared services for liquid waste and battery management could significantly reduce the risks of dumping into the environment. This should be a priority feature of any future strategy. This could be rolled out across all participating PICTs in the short-term. Greater advancements should be made in exploring waste-to-energy endeavours to prevent the swift depletion of space at the Naboro landfill. This approach would offer a dual advantage by generating renewable energy while also eliminating the need for costly excavation and preparation of new pits to accommodate waste.
10	The capacity of ELV wreckers, scrap metal dealers and the recycling industry	Capacity building for ELV wreckers and scrap metal dealers should significantly reduce the environmental and health risks associated with the depolluting, dismantling, recycling, and appropriate disposal of residual components of ELVs. This should also improve efficiencies for any ELV recycling facility due to the quality and reliability of inputs stock made available.
11	Suitable site for ELV recycling facility	Because of space constraints at the Port of Suva, any ELV recycling facility will need to be located away from the Port. It would be prudent to undertake a detailed analysis of locations for the ELV recycling facility.
12	Human capital	Capacity building and training for the workforce is required along the value chain from ELV wreckers to recycling operators. It would be prudent to establish guidelines (noting SPREP is already implementing this initiative) and ultimately training for workers across the sector (including in local language where appropriate).
13	Monitoring, evaluation, reporting and improvement (MERI)	Establish and implement a monitoring, evaluation, reporting and improvement (MERI) plan for the ELV facility and broader initiative. This will be vital to informing decision-makers and investors (including for any expansion of the initiative in the future). This should include relevant regulatory, operational, OH&S and financial reporting.
14	Detailed design	Engage relevant experts to design the ELV facility including all access points, utilities, buildings, and specifications for capital equipment.
15	Secure approvals	Secure approvals and other regulatory requirements for the ELV facility and broader ELV recycling operations in Fiji.

#	Issue	Recommendation
On-ground establishment and implementation		
16	Deploying investment capital	Deploy investment capital in the establishment of the ELV facility and associated activities.
17	Operational procedures	Engage relevant experts to develop effective and efficient operating procedures for the ELV facility and associated activities. This should include capacity building.
18	Operational phase	Implement operational phase (all aspects of the ELV value chain).
19	Ongoing reporting	Periodically report against MERI plan.

1 Context, purpose, and approach

The Global Environment Facility (GEF), a global environmental fund, has provided funding to the Secretariat of the Pacific Regional Environment Programme (SPREP) to carry out the Islands Pacific Project, with the objective of "preventing the build-up of Persistent Organic Pollutants (POPs) and mercury materials and to manage and dispose of existing harmful chemicals and wastes across Pacific Small Island Developing States (SIDS)".[1] This also includes products such as End-of-Life vehicles (ELVs) and consumer white goods, which are major home appliances e.g., washing machines, refrigerators, air conditioning, etc.

As SIDS continue developing economically, adequate infrastructure will be required to properly dispose of and manage these waste products. It should be noted that the focus if this report is ELVs as that waste stream poses the greatest environmental and health risks. Furthermore, establishing infrastructure to manage ELVs will also ensure there is also infrastructure capacity to manage other bulky scrap metal items. Conversations with the Suva City Council and the Department of Environment underscored the urgency of developing an effective solution for the management of ELVs, and this will be the focus of this study.

Box 1. The importance of addressing Persistent Organic Pollutants (POPs) in the recycling of End of Life Vehicles (ELVs)

Unintentional Persistent Organic Pollutants (POPs) are toxic hazardous chemicals that have dangerous effects on the environment and our health through gradual exposure through food chains and other exposure. Health impacts include but are not limited to increased cancer risk, reproductive disorders, deterioration in the immune system, neurobehavioral impairment, and increased birth defects.

POPs are typically created as a by-product of industrial processes or unintentionally through combustion (e.g., as in combustion engines).

The Stockholm Convention on POPs is an international treaty to protect the environment and human health from harm attributable to POPs though a series of initiatives to restrict and/or eliminate their production, use, trade, release, and/or storage. Under the convention, as implemented by several countries, there are other initiatives to mitigate the likelihood of POPs entering the environment and creating risks to human health.

The risks of POPs to the environment and human health are exacerbated through poor waste management. The proper management and recycling of ELVs is one such initiative specifically designed to reduce this risk including proper management of waste oil, oil filters, other componentry that has been exposed to combustion processes, and materials that contain POPs (such as many plastics, foams and fire inhibitors that form part of a vehicle's componentry – particularly older vehicles).

This risk is elevated due to the high incidence of ELVs in waste management facilities across the Pacific that do not currently implement practices to mitigate the risk. Therefore, proper management and recycling of ELVs have been identified as a key initiative in the Pacific to reduce the risks of POPs. This will build on other initiatives such as the Moana Taka partnership between SPREP and Swire Shipping which is specifically designed to facilitate the removal of harmful waste products that would otherwise remain in the region to

[1] https://www.thegef.org/projects-operations/projects/10267

locations where they can be managed sustainably and safely and is consistent with relevant conventions.[2] In this project, POPs will be handled during the ELV depollution stage.

Sources: UNEP (2019) Stockholm Convention on persistent organic pollutants (POPs). WHO (2009) Persistent Organic Pollutants (POPs) Training modules. SPREP (2020a) Moana Taka Partnership. A Guide for Pacific Island Countries & Territories

Natural Capital Economics have been engaged by the SPREP to conduct market research to evaluate the economic feasibility of recycling end-of-life vehicles (ELVs).

1.1 Purpose

This project aims to identify a favourable entry point somewhere in Fiji, Samoa, and Papua New Guinea to establish a non-exclusive and regional recycling initiative for ELVs and consumer white goods. This will involve conducting an economic assessment of the waste management supply chain and include:

- Assessing the waste management value chain and identifying gaps for capacity building.
- Identifying the costs associated with establishing the initiative.
- Estimating investment required to sustainably support the initiative.
- Developing cost estimates for training delivery of POPs disposal.

The outputs generated from this project will support SPREP in meeting the objectives of the Pacific Child Project, to assist Pacific Island nations in developing sustainably and along safe chemical development pathways.

1.2 Key research questions

This study addresses several research questions, where several approaches have been used to address the research questions based on desktop research, consultation, and economic and financial modelling. The table below outlines the research questions and the relevant section(s) of this report that address the specific research questions.

Table 1: Key research questions

Key research question	Where is this question addressed?
The market for ELVs	
What is the current market for recycling ELVs in these countries? What is their current trade volume?	Sections 2.2 and 2.3
More viable location	

[2] The key regional convention is the Waigani Convention. This is modelled on the Basel Convention and constitutes the regional implementation of the international hazardous waste control regime (Basel, Rotterdam and Stockholm Conventions). Note that Fiji is not a signatory to the Basel Convention.

Of Fiji, Samoa, and Papua New Guinea, which country is the most ideal starting point for a regional recycling initiative for ELVs and white goods?	Sections 2.3 to 2.5
The current capacity of a more viable location	

Key research question	Where is this question addressed?
Who are the existing actors in the country across the grave-to-cradle value chain of ELVs and white goods?	Sections 3
What is currently missing in the value chain in the countries of the study?	Sections 3.1 to 3.3
What is the current capacity of the existing actors in the value chain? Are they compliant with all international environmental conventions regarding hazardous chemicals?	Section 3.2
What is required to scale up current enterprises to manage bulky waste regionally in an environmentally sound manner (that is in line with the Stockholm Convention requirements)?	Sections 4.1
Economic feasibility	
What are the in-country activities required to develop a regional initiative? What are the cost estimates for this (including equipment, extraction, logistics, and other procurement costs)?	Sections 4 and 5
Views on employing an Advance Recovery Fee and Deposit (ARFD) to recover the funding shortfall.	Sections 5.1
Capacity building	
An assessment of current needs and capacity-building requirements to scale up local actors to service the Pacific region in an environmentally sound manner that is in line with the Stockholm Convention requirements.	Sections 4.1
Next steps	
Recommendations on economically, environmentally, and socially sound next steps for the recycling initiative, organised by priority and estimated cost.	Section 6

1.3 Approach to study

The approach to the overall project is shown below (see Figure 1) achieved through four phases. Underpinning this approach is detailed research, consultation, and economic modelling and analysis to address the key research questions.



Figure 1. Stages of the project

Key phases of the approach were:

1. Firstly, an inception meeting was conducted (via teams) with representatives of SPREP. This focussed on ensuring the project was targeted at stakeholders' needs and addressing the research questions. A detailed economic assessment plan for the project was also developed and reviewed by SPREP before implementation (see Appendix A).
2. Data collection was undertaken remotely based on existing published data and data provided by SPREP and other stakeholder organisations. Information was reviewed relating to the volumes and capacities of the three candidate countries and some limited consultation was also undertaken (Papua New Guinea, Samoa, and Fiji) for the most ideal starting point for investment in the recycling of ELVs. A multi-criteria analysis (MCA) including a preliminary cost-benefit analysis (CBA) was undertaken to determine which country is more likely to be viable (recommended Fiji). This is summarised in the Preliminary report (see Appendix B).
3. A consultation process was then undertaken through several approaches including face-to-face consultation in Fiji, remote consultation (e.g., via teams), and a survey of knowledgeable stakeholders. This is summarised in the Consultation Report (Appendix C).
4. Based on the findings from phases 1 to 3, we then undertook detailed analysis and economic modelling of the feasibility, benefits, costs, and risks of implementing a regional ELV strategy based in Fiji, as the gaps and next steps to implement the recommendations. That is the focus of this report.

This report summarises the key information and recommendations from each of the four phases of the project, albeit with a major focus on Phase 4. Detail on the other phases is available in the relevant appendices.

2 Initial findings and selection of country for detailed analysis

This section briefly outlines the key information and analysis undertaken to determine which of the three shortlisted countries (Fiji, PNG, and Samoa) is potentially most suitable for a more detailed analysis. The contents of this chapter discuss the analysis conducted in Stage 2 of this project, and as such is based on rapid assessment of data from a rapid desktop analysis. Consequently, the economic model developed during this stage of the project has been built on assumptions that have been refined across the later stages of this project and as such, this early work should be considered a preliminary assessment.

The information from this chapter is a summarised version of the contents contained in Appendix A which houses the full preliminary report for Stage 2.

2.1 Current situation

This section briefly summarises the current situation across the three shortlisted countries for more detailed consideration – Fiji, PNG, and Samoa.

Regulatory and governance environment

Each of the shortlisted countries has some degree of regulations to manage hazardous waste. Key legislation and regulations in Fiji include:

- Fiji does not have dedicated legislation dealing with waste management. Rather, waste management is dealt with under general environmental and public health legislation.
- The key legislation is the Environment Management Act 2005. Under this legislation, environmental management and pollution control provisions extend to pollution caused by a variety of hazardous and other wastes. Part 5 specifically contains provisions relating to waste management and pollution control.
- The Environment Management Act 2005 establishes the Waste Management and Control Unit. That unit has specific responsibilities for waste management and pollution control in Fiji. This includes liquid and solid, hazardous and chemical wastes, and air pollution.
- There are also several other regulatory mechanisms and local bylaws that have a minor and indirect relevance to the management of hazardous waste and recycling of ELVs.

Key legislation and regulations in Samoa include:

- Samoa has a dedicated Waste Management Act 2010 administered by the Ministry for Natural Resources and the Environment (MNRE). This principal waste management legislation is complemented by other environmental and planning laws.
- The Land, Surveys, and Environment Act 1989 deals with Environment and Conservation. This includes the need for Environmental Impact Assessments for new projects that include pollution control and control and management of hazardous substances.

Key legislation and regulations in PNG include:

- PNG does not have specific waste management legislation. Rather, waste management provisions exist within a range of legislation and regulations.
- Permitting of some activities is required, including waste management facilities through the Environment (Prescribed Activities) (Amendment) Regulation 2011.

Key points

Samoa has the most advanced and specific regulatory environment relating to the management of waste, while Fiji and PNG rely on provisions within other legislation.

Each country has specific units within government agencies with direct and/or indirect responsibilities for the oversight of waste management.

In addition, each country is also a signatory to at least the Waigani convention. The table below shows the relevant international conventions relating to hazardous waste and the year that each country ratified the convention. While Samoa has ratified all conventions, the key convention for this analysis is the Waigani Convention. The Waigani Convention is to ban the importation of hazardous wastes and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific. Furthermore, most PICTs have signed or ratified the Waigani Convention which will facilitate any eventual regional ELV recycling solution that would require the movement of materials between the originating PICT and the location of the regional ELV recycling facility.

Table 2. International conventions and years ratified

Convention	Fiji	Samoa	Papua New Guinea
Waigani	1996	2001	1995
Stockholm	2004	2004	2004
Basel		2002	
Rotterdam		2004	

Source: https://www.sprep.org/convention-secretariat/waigani-convention

Key point

The objective of the Waigani Convention is to ban the importation of hazardous wastes and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific. All three focus countries have ratified that convention and that can provide the basis for moving forward with a recycling facility.

2.2 Current estimates of stockpiles of ELVs and drivers of growth

In this section, we primarily consider the existing stockpile in each of the three candidate countries to evaluate whether there is sufficient scrap material that can be obtained and sold. The size and growth of the stockpiles of ELVs currently in storage (formal and otherwise) provide some indication of the potential risks associated with a lack of management and recycling. Available data from the recent Scoping Study for Bulky Waste Recycling undertaken by Tonkin and Taylor estimated stockpiles of around 260,000 ELVs in Fiji, 250,000 ELVs in PNG, and around 10,000 in Samoa. Given the limitations in this information, a low range of estimates and a high range of estimates is also presented below.

Key drivers of the growth in stockpiles are population growth and Gross Domestic Product (GDP) per capita (as a proxy for the affordability of new vehicles). Based on these key variables, Tonkin and Taylor estimated the growth in ELVs was around 3,300 in Fiji, 6,100 in PNG, and 100 in Samoa.

Table 3. Estimated stockpiles of ELVs and drivers of growth in stockpiles

Input	Unit	Low	Most likely	High
Real discount rate	%	4.00%	7.00%	10.00%
Population growth rate - Fiji	%	0.06%	0.45%	0.73%
Population growth rate - Samoa	%	0.39%	0.65%	0.87%
Population growth rate - PNG	%	1.90%	1.99%	2.10%
Stockpile volume - Fiji	No. E-ELVs	131,867	263,734	395,602
Stockpile volume - Samoa	No. E-ELVs	4,823	9,646	14,470
Stockpile volume - PNG	No. E-ELVs	124,166	248,332	372,498
Full dismantle - Fiji	$ per car per annum	$121	$242	$363
Full dismantle - Samoa	$ per E-ELV	$116	$232	$348
Full dismantle - PNG	$ per E-ELV	$60	$121	$181
Baler efficiency	ELVs per hour	11.4	14.3	17.1

Sources: Tonkin and Taylor (2022). Scoping Study for Bulky Waste Recycling. World Bank Group (2022). World Bank Open Data. Accessed at https://data.worldbank.org

It is the stockpiles of older ELVs that potentially create the greatest risks to the environment and human health. This is because the manufacturing techniques of those older vehicles are less likely to comply with the requirements of conventions relating to POPs in their manufacturing process (e.g. POPs embedded in plastics and foam).

Based on this simple analysis the greater risks are likely to be in Fiji and PNG, with little evidence from the data to differentiate the two countries. While the estimates of stockpiles do include a degree of uncertainty, even if

they are significant overestimates, the aggregate volumes are sufficient to justify an ELV recycling facility in either Fiji or PNG.

Key point

Based on this simple analysis the greater risks are likely to be in Fiji and PNG, with little evidence from the data to differentiate the two countries.

2.3 Selection of country for detailed analysis

Approach in brief

This section of the document outlines the approach taken to decide on the country that is most viable for further investigation of this economic analysis. We conduct a preliminary Multi-Criteria Analysis (MCA) based on currently available information from the desktop review. This is outlined in detail in Appendix A and Appendix B.

We identified 4 criteria for our assessment, weighted the criteria based on their relative importance to the decision-making process, evaluate and score each component, and summarised the results. The four criteria that were assessed were the existing recycling infrastructure, goods exporting capabilities, item collection, and CBA results.

The country with the highest score was selected as the candidate country for further analysis. The following section in this chapter discusses the initial findings of the preliminary CBA.

2.4 Results of initial Cost-Benefit Analysis (CBA)

A preliminary Cost-benefit Analysis (CBA) was undertaken to determine if any shortlisted The preliminary result indicates that there are no countries that are commercially viable without additional funding support, and losses over the 30-year assessment period will need to be covered by external funding in addition to the revenues from selling processed scrap metals. The findings of the preliminary analysis are uncertain, and the sensitivity analysis undertaken shows a wide range of possible outcomes.

Between the tree locations of Fiji, Samoa, and PNG, the locations with the best prospects based on the preliminary economic analysis are Fiji and PNG as they have the lowest external funding requirement.

The table below indicates that the losses for a recycling operation in Fiji are likely to be around $3.1 million over the next 30 years (but could be losses as great as $9.5 million or could even be profitable under more optimistic assumptions (profit of $2.7 million over 30 years)). Results for PNG are slightly better, but not sufficiently different to make a decision based on economic analysis alone. Other considerations are also relevant.

Table 4 below shows the range of the results. From this, we can conclude that Fiji and PNG are better candidates than Samoa, as they require the least amount of funding with higher BCRs and NPVs. The primary reason for this is that Samoa is significantly less viable due to both the volumes of available inputs (ELVs) and

processing costs. The conclusion drawn for Samoa is consistent with findings from previous work.[3] Detailed coverage of the initial CBA is provided in Appendix B.

Table 4. Range of NPVs and BCRs for the three candidate countries

Estimate	Fiji	Samoa	PNG
BCRs (Most likely) [Low – High]	0.81 [0.54 to 1.21]	0.24 [0.14 to 0.40]	0.89 [0.59 to 1.33]
NPVs (Most likely) [Low – High] $ M	-3.06 [-9.51 to 2.73]	-10.40 [-16.53 to -5.68]	-1.65 [-7.91 to 3.95]

Key point

The initial economic analysis of the potential economic viability of an ELV recycling facility found that Fiji and PNG were more likely to be viable as a location for major facilities. However, there was insufficient differentiation between Fiji and PNG to make a definite selection. This requires further consideration through the Multi-Criteria Analysis (MCA).

2.5 Results of initial Multi-Criteria Analysis (MCA)

Given the high level of uncertainty present in our estimates and the discussion outlined in 2.2, we pursue a Multi-Criteria Analysis MCA to decide between the two candidate countries of Fiji and PNG. This allows the inclusion of relative comparisons of each country against several very different criteria to determine which country is likely to be the most viable for the facility. The total adjusted scores are presented in the last row of the table below.

Table 5. MCA scores

Criteria - Weighting	Fiji	Samoa	Papua New Guinea
Existing recycling infrastructure - 20%	3 – There are significantly large disposal sites in the country with known balers.	3 – There are significantly large disposal sites in the country with known balers. There are balers at the Tafaigata landfill site. This provides a reasonable basis for a recycling industry to be developed	1 - Unknown capacity across 4 named recycling facilities. The materials seem to go to scrap dealers for them to process.

[3] World Bank Group (2021). Samoa waste characterisation and situation analysis report. Accessed at https://library.sprep.org/content/samoa-waste-characterization-and-situation-analysis-report-analysis-waste-generation-and

			Any recycling initiative will require the purchase of capital infrastructure as the number of balers is unknown.[4]
Goods exporting – 15%	3 – Fiji has established exporting capabilities.	1 – has very limited exporting capabilities for ELVs and no exporting capabilities for white goods, will need to establish capacity.	1 - PNG has very limited exporting capabilities for ELVs and no exporting capabilities for white goods, will need to establish capacity.
Item collection – 15%	3 - There are council-owned trucks and private contractors that are used to collect bulky waste.	3 - Samoa has a private collection of white goods. There is government collection of ELVs.	2 - PNG has no established private or government collection of white goods. There is private collection of ELVs
Economic analysis (based on CBA) – 30%	4 – BCR value range close to 1	1 – BCR value range very far from 1	4 – BCR value range close to 1
Total weighted score	**3.5/5**	1.7/5	2.65/5

Note: Each criterion is scored out of 5, with 5 being a perfect score and 1 being the worst score.

Additional considerations

We also consider other political, environmental, and social elements between the three countries that might affect the MCA results. Discussions of human development are multidimensional, and in Table 6 below we present several statistics which discuss how the three countries fare on their developmental track.

The Human Development Index (HDI) is a measure that provides a summary of how countries fare along the dimensions of lifespan, education levels, and income. The better the country fares along these dimensions the higher the HDI. Fiji has the highest HDI among the three countries, at a score of 0.730. Samoa falls slightly behind at 0.707 and PNG falters compared to the other two at 0.558. The marginally higher education attainment in Fiji could indicate a greater likelihood of an appropriate pool of labour to meet the needs of the facility.

The Gender Development Index (GDI) extends the HDI by measuring gender inequalities between men and women along the same three dimensions as the HDI. The closer the number is to 1, the greater the parity between men and women along those three dimensions. Fiji and PNG have the same GDI score at 0.931, and

[4] Tonkin & Taylor (2022) notes that the number of balers on PNG is unknown, and there is limited information available in the desktop review to identify how many balers there are. In the modelling process we have assumed that there are 0 balers in PNG and there will need to be a baler purchased. Even if we assume that there currently is a baler in PNG, the overall results do not change much as the range of BCRs remain roughly the same.

Samoa performs better compared to the other two countries. These results provide some indication that, with appropriate management, a facility should be able to be developed in any of the candidate countries and deliver gender equity across the workforce.

These indicators show that Fiji is more economically developed compared to Samoa and PNG. The higher income per capita levels also suggest that there is a greater capacity to purchase motor vehicles in Fiji compared to the other two countries as it is relatively more affordable. This implies a relatively stronger effective demand for motor vehicles in Fiji.

We also report the comparisons between regulatory quality and government effectiveness of the three countries. These measures are a part of the World Bank's Worldwide Governance Indicators (WGI), and they are reported in the form of a percentile rank, which ranks the country's performance among other countries in the world. The closer the score is to 100, the better the performance. Fiji scores better than Samoa and PNG on both measures, with PNG ranking the lowest. This implies that Fiji has a relatively more mature political and legislative system among the three countries, which may expedite any necessary legislation that is required to successfully deliver this project.

Yale University has developed an Environmental Performance Index (Wolf et al., 2022) which uses ranks countries based on "climate change performance, environmental health, and ecosystem vitality". This indicator provides a way to understand how countries compare in terms of achieving established environmental policy goals. The higher the score, the better the performance. Samoa ranks higher compared to Fiji and PNG, but its EPI has the greatest fall compared to the two countries. The data shows a declining trend for both Fiji and Samoa over the past 10 years, but a steeper fall for Samoa. However, the key issue is that Fiji currently outperforms PNG (as the next highest-ranking country in the MCA), potentially indicating the environmental risks of establishing the facility in Fiji may be lower.

Table 6. Human development and other relevant performance statistics for the candidate countries

Statistic	Fiji	Samoa	Papua New Guinea
Human Development Index (HDI)	0.730	0.707	0.558
Gender Development Index (GDI)	0.931	0.957	0.931
Regulatory quality (WGI)	70.67	67.31	16.83
Government effectiveness (WGI)	51.92	46.63	21.63
Environmental Performance Index (EPI)	31.30 Fiji ranks 147th worldwide	36.40 Samoa ranks 122nd worldwide	24.80 PNG ranks 175th worldwide
EPI 10-year change	-3.70	-7.40	+0.20

Source: World Bank (2023), UNDP (2023), Wolf et al. (2022)

Note: GNI per capita is reported in 2017 USD, adjusted for purchasing power parity.

These additional factors indicate that Fiji generally performs well against the other candidate countries, and therefore, the findings from the MCA are robust.

Key point

An MCA process was used to shortlist the preferred country for the ELV recycling facility. The analyses found that Fiji was the preferred location to be assessed in more detail in the remainder of this project. The initial analysis as outlined in Appendix B. The economic analysis conducted in this stage of the project was preliminary and based on available information at the time of the analysis. Further information for the candidate country can be obtained from the site visit and incorporated into the economic model.

Recommendation for a country for detailed analysis

Based on the preliminary analysis, Fiji was recommended as the candidate site to establish a regional recycling initiative.

3 Fiji – current situation

In this chapter, we examine the existing legislative requirement in Fiji, the value chain, existing infrastructure, availability of labour and human capital, and any potential intersectoral issues.

3.1 International agreements and legislative environment

This section briefly outlines the international agreement and legislative environment within which the ELV recycling facility and program would need to operate.

Compliance with international agreements and conventions

Fiji is a signatory to the Waigani Convention which is designed to ban the importation of hazardous wastes and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific. Furthermore, most PICTs have signed or ratified the Waigani Convention which will facilitate any eventual regional ELV recycling solution that would require the movement of materials between the originating PICT and the location of the regional ELV recycling facility.

Fiji is also a signatory to the Stockholm Convention. However, Fiji is not a signatory to the Basel Convention that:

- Seeks to restrict transboundary movements of hazardous wastes except where it is soundly managed.
- Establish a regulatory system applying to cases where transboundary movements are permissible.

It would be prudent that further research and consultation be conducted by an appropriate expert to identify the degree to which exports from Fiji of some components of ELVs may be restricted in the absence of Fiji's ratification of the Basel Convention. This analysis would need to be cognisant of the fact that the export of materials would need to meet several other domestic requirements (outlined below) that may constitute sound management under the Basel Convention.

Key point

The Waigani Convention will assist in underpinning international obligations within the PICT. However, further work will need to be undertaken to ascertain whether Fiji's status under the Basel Convention restricts the ability to export materials to final international destinations for recycling.

Domestic legislation and regulation

There are some key legislative and regulatory mechanisms relevant to the establishment of any ELV recycling system. Key legislations and regulations include:

- The overarching legislative provision is the Environmental Management Act 2005. Under this legislation, environmental management and pollution control provisions extend to pollution caused by a variety of hazardous and other wastes. Part 5 specifically contains provisions relating to waste management and pollution control. There is no obvious impediment to establishing an ELV recycling facility (including regional operations) under the Environmental Management Act 2005.

- The key regulation pertaining to the recycling and management of ELVs is the Environment Management (Waste Disposal And Recycling) Regulations 2007. These regulations outline the general requirements for any facility and the specific requirements for key elements of management and recycling of ELVs (e.g. permitting processes; the management of hazardous liquids; the handling, storing, processing, or controlling any hazardous substance, etc.). There are also specific permits required for recycling operations, the handling of batteries, and the transportation of waste. Permits will be required for all of these activities, with permit fees of approximately FJD 10,000 if individual applications are aggregated (although reductions in permit fees are possible when multiple permits are assessed concurrently). The regulations also include reporting requirements for regulated entities and penalties for breaches of the regulation.[5]
- Research and consultation with the Ministry of Waterways & Environment (MOWE) indicated that the project would be subject to an environmental impact assessment under the Environment Management (EIA Process) Regulations 2007. These regulations outline the process of application, requirements of EIA reports, site and site inspection requirements, and costs of lodgement to achieve development approval.
- Research and consultation with the Biosecurity Authority of Fiji (BAF) concludes that the export and importation of materials from ELVs will need to be compliant with the biosecurity requirements outlined in the Biosecurity Act 2008. This will include washing and fumigating materials being transported in containers and detailed processes for permits, reporting requirements, and inspections. Requirements on import procedures are outlined in sections 31-40, while exports are covered in sections 41-46. In addition to the Fiji biosecurity provisions, the requirements for export to markets will also need to meet and regulations from other PICTs will also be relevant (multinational issues within the Pacific should be manageable through the Waigani Convention). Consultation with BAF raised significant concerns regarding the importation of materials from other PICTs, particularly the degree to which they would be clear of contaminants and pests. Typically, this would require washdown and fumigation before shipment to Fiji.
- Consultation with the MOWE also indicated that any facility would also need to comply with occupational health and safety requirements for workers and these are covered under the Health and Safety at Work Act 1996. This legislation set out the general duties and requirements of both employers and employees in relation to the workplace. There are also Health and Safety at Work (Control of Hazardous Substances) Regulations 2006, which include requirements as wide-ranging as training and induction through to reporting of incidents.

Existing Fijian regulations would appear to be sufficient to provide the key legislative and regulatory environment for any ELV recycling facility utilising appropriate sections of several regulations. Rather than new and bespoke regulations, this will require coordination across agencies and comprehensive guidance though the regulatory requirements for any potential operators. This should be confirmed through a specific study by regulatory specialists.

Key points

There is a wide range of documents legislation and regulations that will apply to the development and operations of any ELV recycling facility and program.

Existing Fijian regulations would appear to be sufficient to provide the key legislative and regulatory environment for any ELV recycling facility utilising appropriate sections of several regulations. Rather than new

[5] Links to permits, fees and advice and the EIS check list are available at https://www.mowe.gov.fj/permits-licenses/

and bespoke regulations, this will require coordination across agencies and comprehensive guidance though the regulatory requirements for any potential operators. This should be confirmed through a specific study by regulatory specialists.

The capacity to enforce regulations is a significant challenge across all environmental regulations, and this is a broader issue that needs to be addressed through capacity building and resourcing.

Town planning requirements for facilities

Local government authorities also have responsibilities for land use planning and development applications (building permits) for any new development such as an ELV recycling plant. Consultation with Suva City Council indicated that where approvals from the Fiji Government were already secured and if the ELV recycling facility was to be located in an appropriate land use zone (i.e., industrial area), it is highly unlikely the facility would not be supported by Council.

The facility would then be subject to all relevant ongoing City Council fees and charges.

Key point

Where approvals from the Fiji Government were already secured, and if the ELV recycling facility was to be located in an appropriate land use zone (i.e., industrial area), it is highly unlikely the facility would not be supported by Council.

Gaps and deficiencies

Two key gaps and deficiencies have been identified concerning international agreements and domestic legislation and regulations, specifically:

- Further works will need to be undertaken to ascertain whether Fiji's status under the Basel Convention restricts the ability to export materials to final international destinations for recycling.
- Additional work will be required to research, identify, scope, and design an approach to meet the biosecurity risks of transboundary movement of partially recycled ELVs within the Pacific in a way to manage biosecurity risks to Fiji. This is a specific project that needs to be done to investigate the biosecurity risk and to establish proper guidance.

3.2 Value chain analysis

In this study, it is assumed hazardous waste materials such as POPs will need to be removed from ELVs, a process called depollution. Following this, high-value items are removed from the ELV. Finally, they are then crushed and placed in shipping containers for export overseas. In this report, we will refer to this ELV management system as Partial Stripping.

Managing hazardous fluids

Face-to-face consultation revealed that there is little evidence of proper management of hazardous wastes in the early stages of ELV management at sites such as wreckers, particularly concerning fluids (oil, brake fluids, transmission fluids, battery acid, etc.). Often the practice is likely to be the disposal of liquids (potentially illegally) through the existing drainage infrastructure. This is largely due to multiple reasons including a lack of

knowledge of best practices, a lack of infrastructure and equipment to collect and store waste liquids, a lack of downstream options to manage the waste, costs that cannot be recovered through sales of recycling materials, and the low likelihood of enforcement of existing requirements. (Deo. Pers comms.) In addition, permit fees under the Environment Management (Waste Disposal And Recycling) Regulations 2007 can be significant (e.g., a hazardous waste endorsement permit is FJD 2,000) and this provides a disincentive to seek permissions to manage hazardous fluids.

Consultation indicated that the management of hazardous liquid waste is not a widespread practice due to a lack of infrastructure, costs, and a low likelihood of prosecution due to a lack of resources for effective enforcement. Often the liquid waste is disposed of through the drainage system or the general burning of waste (Wilson, Ahmad, Phillips, Lal – all Pers comms.).

The is one relatively large waste management company in Nausori that manages liquid waste from collection to storage and approved disposal – Waste Clear Fiji PTE Limited. They have a range of portable tankers ranging from 4,000 litres to 12,000 litres, portable tanks (including for hire), and storage facilities. However, they do not currently undertake any activity for commercial customers managing liquid waste from ELVs.

Given the relative risks posed by liquid waste (dumped into the environment or burned) and the urgency for management immediately after an ELV is decommissioned, this issue potentially requires more urgent actions than the recycling of more environmentally benign components of ELVs.

Key point

The lack of proper and widespread management of liquid waste immediately after the decommissioning dumping of ELVs is a major risk to the environment and human health.

Management of POPs through depollution

The list of POPs that have been identified in the transport sector are listed in the list below. These POPs require treatment prior to disposal in landfills which require compliance with Basel Convention Technical Guidelines for ESM of POPs (UNEP, 2023a). Information and guidance documentation provided by UNEP through personnel communication (UNEP, Pers comms) provides the following list of POPs to consider under the Technical Guidelines:

- DecaBDE[6]
- c-PentaBDE[6]
- HBCD[7]
- SCCP and MCCPs[8]
- PFOA[9]
- PFOS[9]

To be compliant with the Guidelines, the landfilling of waste streams from the ELV recycling process will have to be directed to Specially Engineered Landfills. This is important because Specially Engineered Landfills are designed with adequate protective measures in mind to minimize and protect against potential environmental damage from POPs content. Naboro landfill is the best candidate to handle this waste stream, as it is specifically lined to prevent the contamination of leachate to the surrounding environment.

[6] UNEP (2021a)
[7] UNEP (2021b)
[8] UNEP (2019b)
[9] UNEP (2023b)

As the landfill is rapidly filling up,[10] expansion works may need to be considered to reduce the volume of waste that is occupied by recycling of ELVs. The Environment Ministry is exploring possibilities for waste-to-energy initiatives aimed at diminishing the landfill's capacity through incineration and the conversion of waste into renewable energy.[11] However, progress in this area has been relatively limited.

It is important to make progress in exploring waste-to-energy initiatives to mitigate the rapid filling of the Naboro landfill. This approach offers a dual advantage by generating renewable energy and avoiding the need for additional expenses related to excavating and preparing new landfill pits to accommodate waste. In this study, we have included a waste-to-energy initiative in the case of pyrolysis of ASR (see 5.1) into our primary results to illustrate the benefits of such an initiative.

The understanding of the proportion of POPs captured through depollution and the costs associated with specialized disposal and landfill sites in the South Pacific is limited. Therefore, it is necessary to conduct further analysis during the detailed design phase of an ELV recycling facility to address this uncertainty.

ELV wreckers and scrap metal dealers

There are several ELV wreckers across Fiji, with the majority clustered in industrial areas within major cities and towns. These operations vary in size and regulation of operations is relatively minimal. The focus of the work is harvesting resalable components (doors, windows, engine parts, etc.) and the breakdown of the remaining components for sale as scrap metal (where viable) or disposal of unusable materials. Where possible, the focus of operations will be on the harvesting and sale of parts for more popular brands of vehicles (e.g. Toyota and Honda hybrid vehicles), with older and less common models having a lower commercial appeal for scrap yards. Processes for the dismantling of ELVs are very manual (using basic tools), with very limited major capital equipment (crushers or shredders), and a low focus on occupational health and safety (OH&S) considerations.



Figure 2. Car wreckers and scrap yard. Laucala Beach Estate, Suva

Consultation indicated that there was also a widespread practice of 'back yard' and very small-scale ELV dismantling, where easily removed and valuable parts and scrap metal are sold to larger scrap metal dealers and wreckers, while other components (including hazardous components) are dumped (often on the side of the road where local councils are then required to remove and dispose of them). The consultation process also

[10] Boila, S. (2021). Waste exceeds Naboro landfill capacity. Accessed at https://www.fbcnews.com.fj/news/waste-exceeds-naboro-landfill-capacity/

[11] Vacala, K. (2020). Ministry continues to dig for new pits to accommodate waste. Accessed at https://www.fbcnews.com.fj/news/ministry-continues-to-dig-for-new-pits-to-accommodate-waste/

revealed that proof of ownership of metal being sold to some dealers is often not required, raising questions on the legitimacy of ownership.[12]

Coordination across the ELV wrecking and scrap metal sector is limited and significant capacity building. Practically, the provision and use of common/shared services for liquid waste and battery management could significantly reduce the risks of dumping into the environment.

Key points

The ELV wrecking and scrap metal sector is relatively informal, widespread, and generally does not meet good environmental or OH&S practices.

The provision and use of common/shared services for liquid waste and battery management could significantly reduce the risks of dumping into the environment.

Recycling facilities

In addition to landfill and waste management sites across Fiji, where are also a number of recycling operators, many of which are very small and informal operators.[13]

The table below provides the contact information that has come recommended to the project team during the site visit.

Table 7. Key recyclers in the greater Suva area

Organization name	Phone number and address	Email
Pacific Scrap Buyers	Phone: 336 4757/933 0575 (Lot 7 Lami St, Wailada, Lami)	pacific_scrap@yahoo.com
Waste Recyclers (Fiji) Ltd	Phone: 336 1055/992 1056 (Lot 26 Wailada Subdivision, Lami)	wasterec@connect.com.fj
Pacific batteries Pte Limited (Batteries only)	Phone: 336 2708 (Wailada Rd, Lami, Fiji)	info@pacificbatteries.com.fj
South Pacific Waste Recyclers (Wastepaper only)	Phone: 334 1115 (15 Bulei Rd, Laucala B Estate)	spwr@cjsgroup.com.fj
Waste Clear Fiji PTE Limited (Includes liquid waste)	Phone: 347 7725 (Lot 14 Rambissesor Road, Manoca Industrial, Nausori)	waste.clear@yahoo.com

[12] The common lack of proper management of depolluting vehicles and other potential areas of non-compliance make direct consultation with the industry challenging due to concerns of the sector about how the data will be used. Therefore, meaningful dialogue will take time to develop a level of trust and confidence between operators and the proponents of ELV recycling (Deo, Pers Comms).

[13] Note: At the time of completion of this report, data on the number of registered recycling operators had not been received from the Department of Environment. However, the Ministry of Commerce, Trade and Tourism and Transport does maintain a database of some operators at https://site2.mcttt.gov.fj/wp-content/uploads/2022/07/Database-for-licensed-Scrap-Metal-Dealer.pdf

Waste Recyclers (Fiji) Ltd uses a manual approach to cutting ELVs using heavy machinery including saws for removing recyclable scrap metals. They also have a bailing machine capable of compressing low-gauge steel only.

Pacific Batteries in Lami (Wailada Rd, Lami) is a supplier and recycler of batteries since 2009. The company is ISO 9001:2008 QMS Certified. Pacific Batteries Ltd is the only company set-up in the South Pacific capable of manufacturing and recycling lead-acid batteries (including from other PICTs). The recycling process involves cutting open the batteries before neutralising the acid. The lead and terminals in the batteries are then melted at very high temperatures before re-manufacturing as new batteries. Currently, there is not technology or capacity to recycle batteries form EVs, and options for exporting these batteries for recycling internationally are being exported.[14]



Figure 3. Operations at Pacific Batteries and Waste Recyclers

Research and consultation indicate that the recycling sector is still in its infancy in Fiji, with a lack of infrastructure, economies of scale, best practices, and processes to meet modern standards. The exception is the recycling and manufacture of lead-acid batteries.

Key point

Research and consultation indicate that the recycling sector is still in its infancy in Fiji, with a lack of infrastructure, economies of scale, best practices, and processes to meet modern standards. The exception is the recycling and manufacture of lead-acid batteries.

Port facilities

There are two major ports on Viti Levu, where the bulk of the population resides and the stockpile of ELVs will be – the Port of Suva and the Port Of Lautoka. Consultation with Swire Shipping indicated a slight preference

[14] https://www.investinfiji.today/product/pacific-batteries-pte-ltd/

for the Port of Suva as the main port for the import and export of ELVs, and this is consistent with co-locating the facility where the bulk of the stockpile is more likely to be around greater Suva.

The Port of Suva has three wharves (Kings, Princess and Walu Bay) with a total of over 800 metres of dock length and a total area of 6.6 ha. The Port is serviced by mobile harbour cranes capable of moving and stacking containers and has a total storage capacity of 3,500 TEUs. The port also has all necessary facilities for the importation and export of ELVs including biosecurity and fumigation facilities, several stevedoring and freight forwarding companies, fuel and other logistical supplies, quick access to the major road network, and all necessary administrative support (Port of Suva, 2023).

There is currently limited space available at the depot to hold containerised ELVs. Swire Shipping has an agreement with the Port of Suva where they can store containers at a port storage location situated 10 minutes away from the port. They can use this location for up to 72 hours without additional charge from Suva Port. The port depot is used for container handling, and consignments bound for Fiji first go to the depot for treatment and disinfection.



Figure 4. Port of Suva

Because of the lack of available space at the port, any ELV recycling facility would need to be located away from the wharves, adding a degree of double handling for transport and logistics, particularly where operations are expanded to an import, process, and re-export of ELV from other PICTs.

Key points

The Port of Suva has all the facilities required for the shipping of ELVs, including receiving ELVs from other PICT and the re-export of partially processed ELVs to international markets.

There is insufficient space at the Port to host the ELV recycling facility. However, there is suitable land available nearby.

Land transport and logistics

Road transport networks will need to be capable of handling the movement of ELVs from the point of collection (or import from other PICTs) to the recycling facility, and then to return to the Port of Suva for export.

The majority of flat-bed vehicle transport trucks in Fiji are capable of carrying two complete vehicles at a time. It is most likely that this would be the most common form of transport to the ELV recycling facility from other locations.

The import and export of ELVs will be in 20ft containers with a maximum weight of around 22 tonnes.

There are currently two main roads in Fiji which are the connectors between Suva and Nadi. These roads are Queens Road and Kings Road. The current mass limit for trucks under the Land Transport Act 1998 is 32 tonnes, which means that a truck carrying a container weighing 18-22 tonnes or any flatbed truck carrying several ELVs will be compliant under the Act. However, it should be noted that while the design specifications of the arterial network can manage heavy loads, congestion is a problem on the roads around the Port of Suva, particularly during the current period when civil works are underway.

Some domestic road transport companies could service the land transport needs of the ELV facility. However, given the volume of ELVs to be transported, it may be prudent to consider establishing dedicated infrastructure (truck and operator).

Key points

Available evidence suggests road transport or other transport-related logistics infrastructure and capacity are sufficient to underpin the operations of the ELV recycling facility.

Given volumes of potential throughput, it may be prudent to consider establishing dedicated infrastructure (truck and operator) to reduce overall operating costs.

Gaps and deficiencies

Gaps and deficiencies have been identified concerning the ELV recycling value chain specifically:

- Infrastructure and practices to manage the depollution process for ELVs.
- The ELV wrecking and scrap metal sector is relatively informal, widespread, and generally does not meet good environmental or OH&S practices. Capacity building across the sector would be advisable.
- Because of space constraints at ports, any ELV recycling facility will need to be located away from the Port.
- To ensure sufficient road transport to underpin operations, establishing dedicated infrastructure (truck and operator) would be advisable to reduce overall operating costs.

3.3 Labour and human capital

The new recycling facility will require a sufficiently trained and well-equipped labour force to efficiently process ELVs. A competitive wage will have to be paid to attract workers to this job. There is an existing workforce across the ELV wrecking and scrap metal sector, much of it casualised or informal with limited formal training or skills recognition.

There is currently an informal waste-picking labour force that can be formalised and incorporated into a local ELV recycling industry; however, this will require significant coordination among advocacy groups, the government, and the informal waste-picking community. There are currently no clear estimates about the size of this community.

The informal waste-picking community consists of individuals who are often socio-economically disenfranchised, come from vulnerable backgrounds, and the bulk of this labour force consists of women and children. Some individuals consider this form of work as full-time employment where they work 40-hour weeks whereas other individuals work part-time.

A meeting with the Pacific Recycling Foundation (PRF) was held during the site visit to Fiji at their offices to better understand the steps that need to take place to incorporate the informal waste-picking community into a formal industry.[15] In the meeting, it was suggested that there are three key considerations involved that require investment. These are summarised in Table 8 below:

Table 8. Areas requiring investment to incorporate the informal waste community

Area	Comment
Occupational health and safety	This refers to having sufficient funds to purchase requisite equipment that fulfils occupational health and safety requirements. This includes items such as hardhats, safety goggles, protection gloves, steel-capped boots, earmuffs, high-visibility vests, long trousers, shirts, etc.
Leadership	This refers to ensuring that any effort to formalize the industry e.g., workshops and community engagement be targeted towards the members of the community who are most vocal and will be drivers of change from the ground up. They will need to be emboldened to be advocates within their community through a values-based approach. PRF finds that this type of messaging often resonates stronger with women than with men.
Community engagement	Any effort to disseminate information into local communities must be done in a localised manner and done informally e.g., no suit and tie. Further, this means that the lessons and workshops have to be done in local languages and involve local organisations that have ethics and visions that are aligned. Any sort of workshop should be accommodative and considerate of the socio-economic factors that drive individuals to pursue this line of work. It was recommended by PRF that Multi-day workshops should provide room and board to incentivise participation.

Additionally, it was recommended that there should be a salaried program attached to capacity building, acknowledging that while the minimum wage is FJD 4 per hour, it should be allowed to increase to FJD 6.50 with training to compensate them for additional skills acquired. It can then grow to FJD 7.50 – FJD 10.00 for skilled truck operators. These wage estimates should be considered indicative, as the general idea is that the workers should be fairly compensated for their work and best practice labour standards are followed. Additional work will need to be done to ensure that there is proper guidance that can be followed.

Key points

Capacity building and training for the workforce is required along the value chain from ELV wreckers to recycling operators. It would be prudent to establish guidelines (noting SPREP is already implementing this initiative) and ultimately training for workers across the sector (including in the local language where appropriate).

OH&S practices (including personal protective equipment) are lacking.

[15] Pacific Recycling Foundation is a human-rights driven organisation that seeks to advocate for the welfare for the informal waste picking community in Fiji and Pacific.

A more formalised recognition of the waste sector is warranted, and the training of workers should be recognised in wages that reflect the acquisition of new skills.

Equity and inclusion

As highlighted above, the informal waste-picking community consists of individuals from vulnerable social and economic conditions. This means that there can be a higher risk of worker exploitation. It is first important to acknowledge that members of this community are already providing a valuable service to society in the status quo through the segregation and recycling of waste (WIEGO, 2020; Dias, 2016).

Furthermore, the casualised nature of much of the work within the ELV wrecking and scrap metal sectors means that many workers do not benefit from initiatives available to permanent workers (e.g., regular contributions to the Fiji National Provident Fund (FNPF)). The establishment of any ELV recycling facility should aim to improve the security (tenure) of the workforce. This should also improve the continuity of the workforce, reduce turnover, provide opportunities for skills development, and ultimately enhance operational efficiencies.

Further, it is important to note that an expectation of a full 5-day work week may be considered too onerous for some workers within the community. This is especially the case for the women within the community who are often expected to also undertake significant tasks in the home (e.g. as a principal carer for children). There should be ample flexibility with consideration for workers' circumstances to ensure gender equity and inclusive workforce objectives can be met. As the cost model has accounted for full-time positions, the work hours could be shared between members of the community to access flexible working conditions. With women being the majority of waste pickers in developing countries, providing them with a reliable form of employment and income can help alleviate poverty.

There is also an important health dimension to consider as well. In a survey conducted by Wilson et al. (2022) on health outcomes for men and women waste pickers in South Africa, they find that both groups reported experiencing frequent cuts and lacerations as they go about waste picking with the poor condition of Personal Protective Equipment. Further, waste pickers are often exposed to respiratory risks due to the open burning of waste and mould, which can cause long-term adverse outcomes for chest and respiratory health. A proper recycling facility with high-quality equipment and proper ventilation can reduce this risk significantly as it will also have proper health and safety protocols in place.

Social stigma is commonly experienced by waste pickers who are perceived as 'filthy' or 'unclean' due to their work with waste, which may lead to verbal harassment and subsequent psychological distress (Aparcana, 2017). Integrating waste pickers into a formal recycling facility can provide some mitigation against the stigma experienced as it can boost the self-esteem and confidence of workers who may consider this a decent form of employment (Medina, 2008).

The development of such an initiative as part of the circular economy provides a great opportunity to improve social inclusion.

Key points

Capacity building of the workforce should be mindful of the needs of workforce participants from vulnerable groups and communities.

The establishment of any ELV recycling facility should aim to improve the security (tenure) of the workforce.

Gaps and deficiencies

Gaps and deficiencies have been identified concerning the ELV recycling workforce specifically:

- The capacity of the workforce across the ELV value chain is often limited.
- OH&S practices (including personal protective equipment) are lacking.

4 Fiji – requirements moving forward

This section identifies the key infrastructure and actions required to move forward to establish an ELV recycling facility and capacity in Fiji (including overcoming key gaps and deficiencies outlined in Section 3). These requirements are then costed and incorporated into the economic and commercial analysis presented in Section 5 of this report.

Currently, there are around 140,000 registered vehicles in Fiji, of which around 132,000 are cars or vans. New registrations of imported vehicles since Covid 19 have been relatively low (averaging around 7,500 per annum in 2020 and 2021), but before Covid new registrations were in the range of 12,500 to 15,000 per annum in the years preceding Covid.[16]

Box 2. A shifting risk profile of ELVs

Many of the hazardous materials (plastics and foams) that contain POPs have been reduced or eliminated in cars built over the past 10-15 years as manufacturing countries became signatories to the relevant international conventions. While this mitigates some of the environmental and health risks attributable to the stockpiles of ELVs across the Pacific, the POP risks attributable to other components and materials (e.g., fluids) remain, and the risk is significantly higher in the bulk of the stockpile that will comp roves older vehicles.

Many cars in Fiji are second-hand imports and many are from Japan. Currently, there are an estimated 15,000 hybrid cars in Fiji. These contain lithium-ion and nickel metal hydrate batteries that cannot be recycled in Fiji and create additional hazardous material for export and recycling. Therefore, any development of an ELV strategy will need to be cognizant of the changing nature of the risks associates with the future stockpile of ELVs.[17]

The development of the strategy for managing ELVs will need to be cognizant of the different levels of risks posed by the different ages of components of the stockpile and the changes in the composition of ELVs that will gradually include a higher proportion of hybrids and electric vehicles.

4.1 Value chain requirements

Capital requirements and indicative establishment costs

[16] https://mcttt.gov.fj/division/transport/transport-statistics/

[17] https://fijisun.com.fj/2021/01/09/shine-a-light-the-challenges-of-importing-hybrid-cars/

Land

Ideally, a site would be at around 5 hectares, with good access to the road network and be located in an area where land use conflicts were minimal, and the likelihood of flooding was low. Industrial land availability is relatively constrained in Lami. Land available for purchase is typically in the range of $275 per m^2 through to over $1,000 per m^2 with a large shed and office already established.

Suva City Council indicated an interest in potentially participating in the programme, as they have a major problem with ELVs and bulky electronics being illegally dumped and utilising significant landfill space. Suva City Council do own several parcels of land that could be utilised, including the old dump site on the seaward side of Queens Rd approximately 1km north of the Port of Suva, a site of approximately 2,000m^2 in an industrial estate on Carpenter Street, and a site between Fulaha Street and Lekeba Street of around 15,000m^2 that already has a large shed and holding area for ELVs (this site is also adjacent to existing car wreckers that would enhance logistics and reduce operational costs).

Facilities and capital equipment

Unless a site is acquired with appropriate facilities, a new facility will need to be built for this purpose. This is essentially a large shed (around 200m^2) with a concrete slab, an office, toilet and shower facilities, on-site storage tanks for liquid waste and diesel fuel, water and waste services connected, and connection to three-phase power. Indicative building costs per m^2, are around $1,200.

Some specific capital equipment items would be required for a fully functional ELV recycling facility. Key items include, but are not limited to:

- A baler of a sufficient scale to bale car bodies.
- A heavy-duty forklift.
- A tilt tow truck for retrieval and land transport of ELVs to the recycling facility.
- Incidental equipment (e.g., oxy torch for cutting steel, tanks for storage of liquids etc).
- A proper depollution station to safely remove liquids.
- Pyrolysis plant.





Figure 5. Depollution station (left-hand image) and car baler (right-hand image)

Indicative establishment budget for site and capital equipment

Based on research and consultation, an indicative establishment budget for the site and capital equipment has been established for one facility built. This is shown in the table below, with a range of estimates for each major item.[18]

The net present total fixed costs were calculated using a cash flow model to estimate how much it costs to establish a facility over 30 years. A Monte Carlo simulation was run to extract the 90th percentile estimates for the total fixed costs which reflects the limitation in the quality of the data available, and the scope of the equipment included in the estimates. The 25% premium is then calculated based on this 90th percentile estimate. The total establishment cost is the sum of the total fixed cost and the contingency cost.

Table 9. Indicative establishment budget

Item	Unit	Low	Most likely	High	Source and comment
Land	$ per m2	$275	$638	$1,000	Suva City Council and web search of commercial land/properties for sale. Note: low end of estimates based on a Suva City Council contribution of site.
Buildings/facility	$ per m2	$600	$1,200	$1,800	Consultation and web sources.
Baler cost	$ per unit	167,500	$335,000	$502,500	Consultation and response to direct costing requests from Australian-based suppliers.
Heavy duty forklift	$ per unit	$37,500	$75,000	$112,500	Consultation and web sources.
Tilt tow truck	$ per unit	$65,625	131,250	196,875	Consultation and web sources.
Incidental equipment	$ total	$15,000	$30,000	$45,000	Consultation and web sources.
Depollution Station	$ per unit	$20,000	$40,000	$60,000	Consultation and web sources.
Pyrolysis plant	$ total	$300,000	$300,000	$500,000	Consultation and web sources. This is assumed to be inclusive of a gas cleaning and char cleaning system along with the pyrolysis reactor.
Net present total fixed costs	$ total	$47,764,000	$48,125,000	$48,583,000	Discounted over 30 years. Reporting the most likely values. Rounded to the nearest 1,000.

[18] Note that costs estimates were obtained through various means including a review of commercial land available for purchase, indicative quotes provided by equipment suppliers, and consultation during the project mission to Suva.

Contingency (25%) on P90 probabilistic estimate of the total fixed costs.	$ total	$11,941,000	$12,031,000	$12,146,000	Discounted over 30 years. Reporting the most likely values. Rounded to the nearest 1,000.
Total Establishment Cost	$ total	$59,705,000	$60,156,000	$60,728,000	Discounted over 30 years. Reporting the most likely values. Rounded to the nearest 1,000.

Key point

We estimate that the budget for land and capital cost of establishing an ELV facility is in the range of $48 M to $49 M discounted over a 30-year project period. The estimated contingency cost of 25% on this figure is around $12 M. Therefore, the total establishment cost which is the sum of the two costs range from $60 M to $61 M.

Operational requirements

In this section, we discuss the operational requirements needed to run the recycling plant. There are three components that we have deemed necessary for further discussion in this report.

To compare between ELVs and bulky white waste of different sizes, we first adjust them to a common factor based on their weight. This allows us to simplify our analysis and compare the different stockpile volumes in a given year. The table below illustrates the conversion between different ELVs/white goods to a common factor. In this report, we refer to this equalised value as Equivalent ELVs (E-ELV). For example, A truck weighing 4 tons is estimated to be equal to 2.9 cars, so it has an E-ELV value of 2.9.

Table 10. ELV conversions

Item	ELV type	Weight (tons)	Equivalent ELV (E-ELV)
Truck Equivalent ELV	Large	4	2.9
Boat Equivalent ELV	Large	0.5	0.4
Motorbike Equivalent ELV	Small	0.18	0.1
Car ELV	Medium	1.4	1.0
Van Equivalent ELV	Large	2	1.4
Heavy Machinery Equivalent ELV	Large	4	2.9

Note: The weight of a car at 1.4 tons is assumed to be the base unit of comparison.

Existing stockpile of ELVs

While there are known stockpiles of ELVs at landfills (e.g., Naboro and Lami) where ELVs can be harvested for recycling, ELVs can also be found in other locations such as private land or backyards or dumped on public land. Suva City Council currently subcontracts the collection of ELVs to relocate them to dumpsites. This

currently costs the council approximately FJD 100 per car (USD 45). Based on this estimate, collecting just 1,000 cars will be a costly exercise. Moving forward, it may be more cost-effective to hire full-time workers for this purpose.

Operational steps

Each ELV will need to be processed through several sequential steps including:

1. Collection from the location where the ELV has been left, or ELV dropped off at the facility. This will include the operating costs of a flatbed truck and operator. At this point, administrative processes to deregister the ELV should also be undertaken (if not already undertaken).
2. Depolluting vehicle including removal of engine fluids, brake fluids, remaining fuels etc. This should be undertaken using a proper depollution station to avoid the discharge of POPs into the environment.
3. Removal of saleable parts (doors, wheels, batteries etc.). This provides an opportunity for wreckers to generate revenue and cover much of the cost of managing the ELV.
4. Separation and sorting of recyclable and marketable materials and materials for safe disposal.
5. Crushing or shredding of materials for recycling.
6. Treating Automotive Shredder Residue (ASR) with pyrolysis and refinement of pyrolysis oil
7. Preparation of materials for export to recycling centres. This includes categorisation, packing in 20ft containers, completing necessary paperwork etc.
8. Road transport of full containers to the Port of Suva.
9. Biosecurity requirements (e.g., fumigation).
10. International shipping to the final destination for recycling and sale of refined pyrolysis oil for use in the domestic market

Estimates of the costs of these activities have been prepared and are incorporated into the economic analysis (Section 5). It is worthwhile noting that these costs will need to be updated once final estimates of shipping and fumigation costs have been provided by Swire Shipping.

These steps will need to be documented in a more detailed manner as part of the next phase of this overall project including the Practitioner's Guideline For the Management Of End-Of-Life Vehicles.

Key point

There are multiple operational steps required to manage ELVs. These have been incorporated into the economic modelling (Section 5 of this report).

Labour force

Labour will be required for the operations and maintenance of the ELV facility and other relevant steps in the value chain. This will include manual labourers, machine operators and drivers, mechanics (to maintain equipment – potentially contractors) and administrative staff. These costs have been incorporated into the costings for the economic modelling outlined in Section 5.

Establishing formal guidelines and training for workers in the sector should be undertaken (noting SPREP is already progressing in the development of guidelines). This should include OH&S considerations and the needs of vulnerable workers. Investments in the human capital of the sector will improve operational efficiencies and reduce the environmental and health risks associated with POPs in ELVs. These costs also

include provisions for site managers and a designated training officer responsible for overseeing upskilling and training of staff for the first few years of the recycling facility as it is being established.

Key point

Investments in capacity building of the workforce will be necessary. The costs of that investment are not included in the economics for the ELV recycling project as the activities are broader than the specific establishment of an ELV recycling facility in Fiji.

4.2 Governance

A SWOT analysis conducted by Numfor et al. (2021) on the challenges and opportunities for ELV recycling in developing countries, found that some of the common challenges faced in these nations are the lack of ELV recycling infrastructure, a limited vehicle deregistration process, and a lack of an ELV regulatory framework,[19] which are also issues that feature prominently in PICTs.

A robust vehicle deregistration system will also be an important element of this process, as it enables authorities to keep track of the number of ELVs that are added to the stockpile each year. This information can then be used in forecasting the future generation of ELVs, which can then assist authorities in their planning process.

Furthermore, coordination across multiple agencies will also be required, particularly in the early stages of the establishment of the ELV facility. It would be prudent to establish and multi-agency steering committee to guide the establishment and early phases of the operations for the facility.

Key point

Actions will be required to enhance the underpinning governance for the ELV recycling sector.

[19] The countries considered in this study are India, Mexico, Malaysia, Nigeria, and South Africa.

5 Economic analysis

The preliminary economic analysis that was conducted during Stage 2 was refined with new information gathered during Stages 3 and 4 of this study, as we were able to learn more from site visits and meetings with key stakeholders. This implies the preliminary results outlined from the CBA in 2.4 and MCA in 2.5, as additional variables will need to be considered in our analysis.

Further, upon consultation with the SPREP project management team, we have also provided an additional spreadsheet-based economic model for the SPREP team to plan for different scenarios.

Like the preliminary analysis done in Stage 2, we estimate the economic viability of this potential regional recycling initiative through the use of Cost-Benefit Analysis (CBA). It involves comparing the expected costs of the project or decision to the expected benefits it will generate. The purpose of a CBA is to determine whether the benefits outweigh the costs or vice versa so that informed decisions can be made.

If the benefits outweigh the costs, then the project or decision is considered to be economically viable and worth pursuing. If the costs outweigh the benefits, then the project or decision may need to be revised or abandoned.

5.1 ELV facility in Fiji

The economic analysis assesses the long-term costs of establishing and implementing an ELF facility against the benefits (largely revenues received). It should be noted that this analysis focuses on the revenues from the sale of recycled materials as the benefits. This will result in underestimates of the benefits as it does not explicitly include the negative externalities (the costs to the environment and human health that would be avoided by mitigating the likelihood of POPs entering the environment. In this section, we summarise the findings from the CBA of the facility and its operations over 30 years. This is based on a model where all car

crushing occurs in Fiji. At the end of this section, we also present the results of an alternative scenario where a mobile car crusher is used.

A more detailed overview of the CBA approach can be found in Appendix A. The key inputs into the final economic model can be found in Appendix D.

Overview of costs

The costs of the facility include the costs of the establishment (see Table 8) and the fixed and variable operating and maintenance costs.

Fixed costs

Fixed costs are the costs of the ELV facility and its operation that do not change with the level of throughput (i.e., the number of vehicles processed). The fixed costs included in the economic model are:

- Land and facilities: A recycling plant requires sufficient land for the storage of vehicles and the dismantling and processing of parts. A facility with adequate space, such as a warehouse or manufacturing plant, may need to be constructed or leased.
- Equipment: To operate a recycling plant, several pieces of equipment are required, such as depolluting stations, hydraulic shears, forklifts, balers, crushers, shredders, and pyrolysis. These machines can be costly to purchase or lease, but they are essential to process and recycling ELVs efficiently.
- Permits and licenses: Obtaining the necessary permits and licenses from the local and state governments is crucial to operating a recycling plant legally. These costs may include environmental permits, waste disposal permits etc.

Key point

Fixed costs will be significant and because they don't materially change with the level of throughput from the ELV facility, it will be imperative to ensure asset utilisation is as high as possible to minimise the processing cost per ELV. These costs can be found in Table 9.

Variable costs

Variable costs are the costs of the ELV facility and its operation that do change with the level of throughput (i.e., the number of vehicles processed). The variable costs in the economic model are:

- Raw materials: The cost of raw materials such as metals required for the recycling process will vary based on market conditions and availability. In the analysis this is considered as the cost of ELV collection.
- Labour costs: A recycling plant requires a team of employees to operate, including engineers, technicians, and administrative staff. Salaries for these individuals are a fixed cost that will be incurred monthly/annually. In addition to fixed salaries, a recycling plant will also incur variable labour costs based on the volume of ELVs processed. This may include overtime pay or temporary staffing during peak periods. Labour cost data was drawn from correspondence with local stakeholders as well as an online search for salaries.

- Utilities: Energy costs such as electricity are variable costs that depend on the amount of processing required and the location of the recycling plant. Energy cost information was gathered from Energy Fiji Limited tariff rates.
- Maintenance and repairs: Equipment used in the recycling process may require repairs or maintenance, which will incur variable costs depending on the frequency and severity of repairs required. Estimates for maintenance and repairs were provided through personnel correspondence with equipment retailers.
- Transportation: ELVs may need to be transported to the recycling plant, and processed materials may need to be transported to the port for shipping. These costs will depend on the distance and volume of materials being transported.

The proportion of these costs are presented in the table below.

Recyclable material	%	Most likely (low to high)
Car collection cost	17%	24.41 (22.15 to 26.85)
Labour cost	52%	73.27 (66.47 to 80.60)
Energy cost	1%	1.20 (1.09 to 1.32)
Operations and maintenance	16%	22.95 (20.82 to 25.25)
Pyrolysis disposal	2%	2.33 (2.11 to 2.56)

Recyclable material	%	Most likely (low to high)
Importation and export cost (shipping)	11%	15.83 (14.36 to 17.42)
Total	100%	140.00 (127.00 to 154.00)

Key point

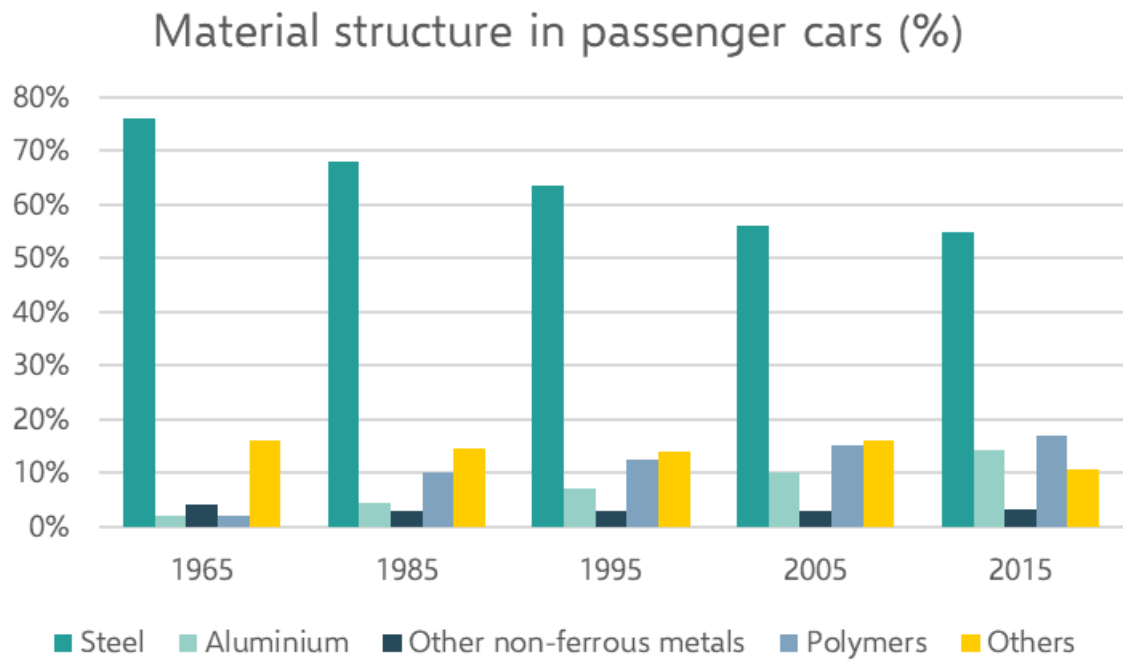
Variable costs are approximately $140 per ELV, ranging from $127 to $154. Salaries and wages constitute a significant portion of the variable costs. This is partly driven by the need for skilled factory managers and training officers to oversee the operations of the factory.

Potential revenues

The potential revenues from operating the facility come from the proceeds from the sale of exported scrap metals that can be harvested from the ELV. Ferrous metals will generate the most economic return as they constitute the greatest proportion of the ELV. This value can vary significantly and is estimated at 36-70% of the vehicle mass in Europe and 50-55% in Japan. For this study, we will assume that the recoverable scrap steel from ELVs in the Pacific will follow the estimate for Japanese cars, as second-hand Japanese cars are popular in Fiji and form the bulk of the second-hand car market.

Given the variability in the age of the cars, the amount of recoverable material will vary as well. Merkisz-Guranowska (2018) profiles the change in material structure in passenger cars from 1965 to 2015 and finds a decreasing share of steel as the proportion of vehicle weight, and a rising share of polymers. This information is presented in Figure 6. Since scrap steel prices and volumes will be the main driver for the revenues, the revenues from recycling ELVs will likely decline over the next few decades.

Figure 6. Material structure in passenger cars



Source: Adapted from Merkisz-Guranowska (2018)

This is followed by the non-ferrous metals of aluminium and copper. The proportion of aluminium in a car is estimated to vary from 6.9% (Yue, 2012) to 14.3% (Merkisz-Guranowska, 2018). Copper is estimated to take up approximately 1.9% (Yue, 2012).

The automotive shredder residue (ASR) generated during the recycling of end-of-life vehicles is a complex and challenging waste stream to manage. ASR is composed of various materials such as plastics, rubber, glass, and metals, which make it difficult to recycle or dispose of safely (Harder, 2007).

Pyrolysis, a thermal degradation process that breaks down the organic fraction of the ASR into simpler molecules, can convert the ASR into useful products such as gas, oil, and solid char. This technology can reduce the volume and toxicity of ASR, making it easier to handle and dispose of while also recovering valuable resources that would otherwise go to waste.

Pyrolysis can also effectively handle POPs present in the ASR by breaking down the complex organic compounds into simpler molecules.[20] The high temperatures in the pyrolysis process promote the thermal degradation of POPs, reducing their concentration in the final products. Pyrolysis is also effective in the management of foam and plastics for energy recovery (Lucas et al., 2018). However, it's important to note that the efficiency of POP removal depends on the specific conditions of the pyrolysis process, such as temperature, residence time, and the composition of ASR.

The ASR is estimated to be between 20-25% of the total ELV weight (Cossu and Lai, 2015). From this, Pyrolysis treatment at around 500°C will maximise liquid yield (Basu, 2018). Following this, the liquid yield is then

further refined to enable additional energy recovery from the ASR. Haydary et al. (2016) estimates that the liquid yield from this remainder ranges from 7-28% of the ASR weight, with the solid residue ranging from 30-34% of the ASR weight, and the solid residue will end up discarded at the landfill. The pyrolysis oil undergoing further refinement is converted assuming a density of 0.7-0.75 kg per litre (Speight, 2011). Refinement into fuel oil will yield an estimated price of $1.17 per litre. Diesel prices are used as a proxy value to estimate the market value for this liquid.

Market prices from ELV recycling

The economic model will account for the potential revenues from exporting these 3 salvageable materials. We will also include the value of second-hand batteries that can be salvaged from ELVs for resale.

Table 11. Market prices received for key recyclables

Recyclable material	Market price
Steel	$0.45 per kg (0.25 - 0.47)
Aluminium	$0.24 per kg (0.15 – 0.30)
Copper	$7 per kg (3 - 11)
Hybrid car battery[21]	$968 per battery (810 - 1,125)
Pyrolysis oil	$1.17 per litre (0.82 – 1.26)

Note: Market prices for recyclable metals were obtained from financial news information websites such as Investing.com and TradingEconomics.com. Market prices for batteries were identified through a study by the Consumer Council of Fiji (Consumer Council of Fiji, 2018) and adjusted to USD. Diesel prices were used as a proxy for the market price for refined Pyrolysis oil. Sourced from World Bank data and prices reported by local Fiji news sources.

[20] The main means by which POPs are removed will be through vehicle depollution.

[21] It is assumed that the 5% of the existing ELV stockpile are hybrid vehicles, with a linear increase over time to 100% fleet of ELVs

These prices are used to drive the benefit estimation in the economic model.

Findings and recommendations

The key finding estimated from the full economic model arrives at the same conclusion as the preliminary economic analysis (see section 2.4), that there will be a funding shortfall. However, the funding gap estimated by the final economic model is $12 M, with a high of $37 M and a potential profit of $17 M. The high costs primarily driven by the significant investments required during the establishment phase of the project.

The results of the economic model are summarised in the table below.

Table 12. Findings from the economic model

Finding	Value USD (low – high)

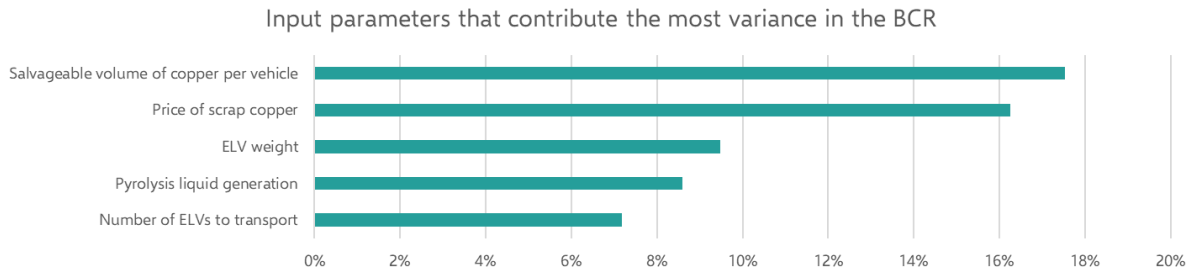
Net present costs	$156.87 M (139.96 M to 178.57 M)
Net present benefits	$144.88 M (115.73 M to 183.14 M)
Net present value	$-12.06 (-36.72 M to 16.91 M)
Benefit-cost ratio	0.92 (0.77 to 1.11)
Cars processed in the 30-year project life	694,000 (631,000 to 765,000)
Additional funding is required per vehicle	$17.22 (-23.45* to 55.04)

Note: The low value is represented by the 10th percentile while the high value is presented as the 90th percentile of all results. * There is a small profit of $23 per vehicle.

Sensitivity analysis

The variables that have the greatest impact on the variation of BCR are presented in Figure 7 below. From this, we can observe that the 5 inputs that contribute most to the variance in the BCR are the salvageable volume of copper per vehicle, the price of scrap copper, ELV weight, pyrolysis liquid generated per vehicle, and the number of ELVs to transport between PICTs. These 3 variables alone contribute to around 60% of the total variation of the BCR. It is also notable that the salvageable volume of steel and copper contributes to 10% of the Variance in the BCR, as these inputs affect the potential return from the recycling of ELVs.

Figure 7. Tornado chart for BCR



The funding requirement across the value chain as well as the revenue generated are presented in Figure 8 in present value terms. Costs associated with developing infrastructure capacity constitute the smallest component of the overall costs, as they are primarily driven by the operational requirements of running the facility and processing the ELVs.

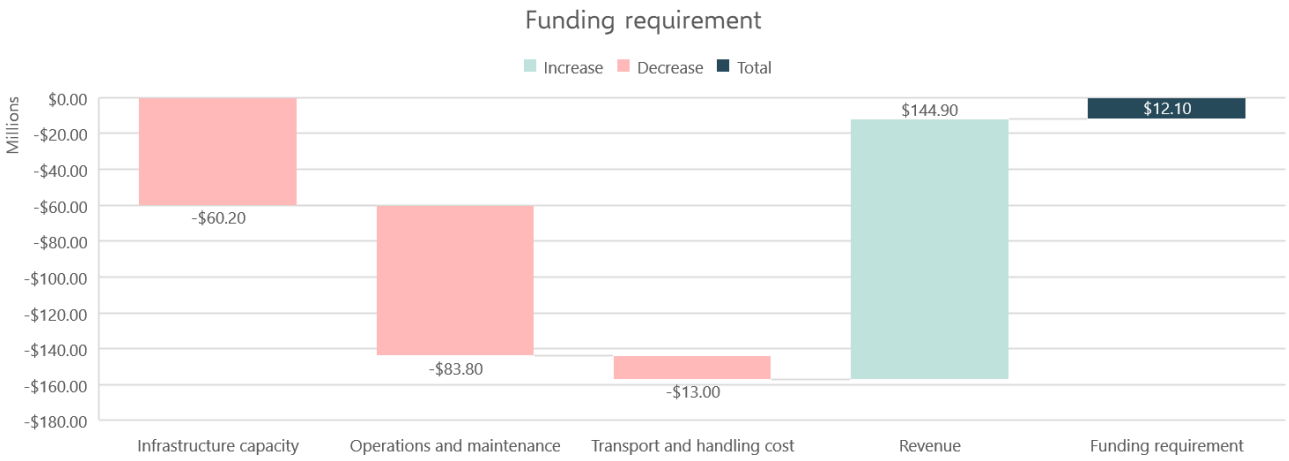


Figure 8. Funding requirements and revenues across the value chain

Note: Values presented are for the most likely costs and revenues generated.

5.2 Regional ELV processing

To manage investment and operational risks, the focus should be on the collection and processing of ELVs in Fiji. As the facility reaches high levels of efficiency it would be prudent to then increase capacity and accept and process ELVs from other PICTs. Revenues from the sale of recycled materials will be the same irrespective of the original location of the WLV (e.g., Solomon Islands, Tuvalu etc.). However, the value chain and associated collection, processing (including within Fiji) and transportation costs for ELVs from other PICTs will be higher for the other PICTs. Specifically:

- Depollution should ideally occur in each PICT before transport to Fiji for further processing. This would require the establishment of depolluting stations in each PICT. In addition, labour costs would be incurred within the PICT for depolluting (but would be avoided in Fiji). It is assumed that there will be depollution and fumigation in each PICT prior to further processing in Fiji. This is calculated based on previous work by Tonkin and Taylor (2022) and assumptions around the number of ELVs per container.
- Biosecurity management costs would be incurred (e.g., fumigation) to ensure ELVs could be safely received within Fiji for further processing. Cost for this was obtained from the Biosecurity Authority of Fiji.
- Additional shipping costs would be incurred from the PICT to the Port of Suva. This data was repurposed from SWIRE Shipping estimates.

It is estimated that these three items above constitute $390 per ELV, ranging from $371 to $409. Of this, depollution costs and fumigation costs are 39% of this amount, and shipping costs are estimated at approximately 62%.

- Additional road transport costs would be incurred in Fiji, specifically the costs of moving containerised unprocessed ELVs from the Port of Suva. The fixed costs for the vehicles are estimated based on retail truck costs, and this cost was estimated using information provided by SWIRE shipping.
- Additional documentation and administrative costs would be incurred (export documentation from the PICT and import documentation at the Port of Suva). A simplifying assumption has that a wide-scaled development of this initiative will expedite the documentation and administrative process for ELV recycling and the overall impact that this has on the cost model is insubstantial.

The economic model used for Fiji was extended to include ELVs from other PICTs and the associated costs outlined above; The results of this modelling are shown in Figure 9 below, where the net costs (revenues from the sale of recyclable materials less all costs) for each PICT are shown by the columns while the net costs for Fiji are shown by the horizontal line. The net costs are higher for Fiji as there is a comparative advantage of processing more cars in Fiji as they can be more easily transported to the recycling facility. The values presented in the figure reflect the total cost for processing ELVs in PICTs over the project study period of 30 years.

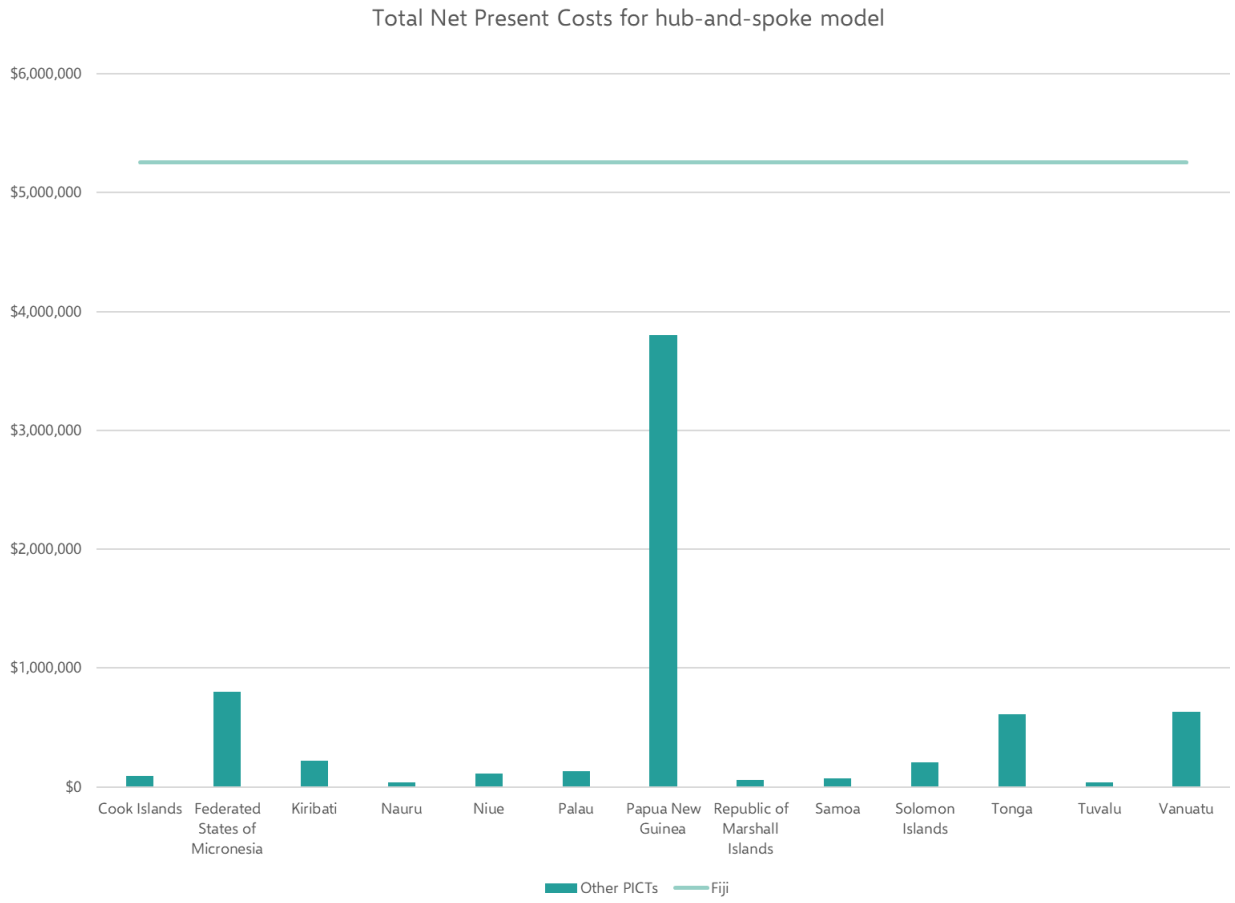


Figure 9. Total net costs for PICTs

Note: Figure reports total Net Present Costs for each country serviced.

The estimates for each PICT and Fiji are shown in Table 13 below. The first column presents the total estimated number of ELVs processed in each PICT over 30 years. In the second column, the net costs for servicing each PICT are presented, which is calculated as the processing cost per ELV multiplied by the number of ELVs processed in each PICT.[20] A negative number in the third column means that there is the potential for a slight profit from recycling ELVs. The fourth column presents the annual costs for servicing each PICT.

[20] The costs here consider the costs for fumigation, depollution, shipping to Fiji, shredding, pyrolysis, and then shipping to other destinations. The revenues considered are from the key recyclables of steel, aluminium, copper, hybrid car batteries, and pyrolysis oil.

Table 13. Net cost estimates for servicing PICTs in a hub-and-spoke model

Country	ELVs processed over 30-year period per annum (low - high)	Net costs for servicing each PICT over 30 years (low to high) ($ M) *	Annual cost for servicing each PICT ($ K)
Cook Islands	3,250 (2,600 to 3,900)	$0.09 M (-0.13 M to 0.28 M)	$3.09 K (-3.94 K to 10.35 K)
Federated States of Micronesia	27,950 (26,000 to 29,900)	$0.80 M (-1.12 M to 2.43 M)	$26.57 K (-33.85 K to 89.03 K)
Fiji	455,876 (353,974 to 557,778)	$5.25 M (-7.37 M to 16.00 M)	$175.08 K (-223.04 K to 586.66 K)
Kiribati	7,800 (6,500 to 9,100)	$0.22 M (-0.31 M to 0.68 M)	$7.42 K (-9.45 K to 24.85 K)
Nauru	1,300 (1,300 to 1,300)	$0.04 M (-0.05 M to 0.11 M)	$1.24 K (-1.57 K to 4.14 K)
Niue	3,900 (2,600 to 5,200)	$0.11 M (-0.16 M to 0.34 M)	$3.71 K (-4.72 K to 12.42 K)
Palau	4,550 (3,900 to 5,200)	$0.13 M (-0.18 M to 0.40 M)	$4.33 K (-5.51 K to 14.49 K)
Papua New Guinea	133,250 (79,300 to 187,200)	$3.80 M (-5.33 M to 11.58 M)	$126.68 K (-161.37 K to 424.46 K)
Republic of Marshall Islands	1,950 (1,300 to 2,600)	$0.06 M (-0.08 M to 0.17 M)	$1.85 K (-2.36 K to 6.21 K)
Samoa	2,600 (1,300 to 3,900)	$0.07 M (-0.10 M to 0.23 M)	$2.47 K (-3.15 K to 8.28 K)
Solomon Islands	7,150 (6,500 to 7,800)	$0.20 M (-0.29 M to 0.62 M)	$6.80 K (-8.66 K to 22.78 K)
Tonga	21,450 (11,700 to 31,200)	$0.61 M (-0.86 M to 1.86 M)	$20.39 K (-25.98 K to 68.33 K)
Tuvalu	1,300 (1,300 to 1,300)	$0.04 M (-0.05 M to 0.11 M)	$1.24 K (-1.57 K to 4.14 K)
Vanuatu	22,100 (15,600 to 28,600)	$0.63 M (-0.88 M to 1.92 M)	$21.01 K (-26.76 K to 70.40 K)
Total	694,000 (631,000 to 765,000)	$12.06 M (-16.91 M to 36.72 M)	$401.87 K (-511.94 K to 1,346.55 K)

Note: Net costs = Costs – Revenue. * A negative number means that there is a slight profit. It is assumed that the processing cost per ELV is the same for each PICT, as the in-country processing costs for PICTs ex Fiji involve the same startup components e.g., fumigation, depollution, labour, shipping to Fiji, shredding, and shipping to final destinations)

Key points

The aggregate net costs over 30 years (revenues from the sale of recyclable materials less all costs) for each PICT are estimated at $12.06 M (a low of -$16.91 M to a high of $36.72 M). The smallest contributor to this is Nauru ($0.04 M) and the largest contributor is Fiji ($5.25 M). While the costs associated with ELVs from other PICTs are higher than for those originating and processing in Fiji, the additional costs are likely to be significantly lower than replicating ELV recycling facilities across all PICTs. Particularly for smaller PICTs where expensive equipment is unlikely to be fully utilised.

Mobile crushing scenario

The CBA presented above is based on a regional processing facility where all ELVs are crushed in a single location (Suva). This section briefly outlines the findings of a scenario where a mobile crusher and depollution facility is used to circulate PICTs, undertaking initial processing within the PICTs before the partially processed bails are exported to Fiji for further processing before re-export to the final recycling destination. Under this scenario, there would be additional transportation costs associated with moving a mobile facility around PICTs, offset by lower transport costs to move ELVs to Fiji for further processing.

While additional capital equipment would be required, operational savings could be achieved in some areas (particularly the transport of ELVs to Fiji). The differences in viability indicated by the BCRs in Table 14 are relatively negligible. Where the range of estimates is considered, there is a significant cross-over between the primary option is considered, and the mobile crushing scenario. This indicates that, based on the existing level of information, there is no statistical difference from the analysis.

Table 14. BCR comparison between Scenario 1 and 2

Finding	Scenario 1 – No mobile crushing (low – high)	Scenario 2 – Mobile crushing (low – high)
Benefit-cost ratio	0.92 (0.77 to 1.11)	0.94 (0.78 to 1.13)

It should be noted that this scenario is not mutually exclusive from the main scenario assessed in this CBA. As operations mature and processing efficiencies are enhanced, a hybrid approach could be adopted that includes both crushing in Fiji and the use of a mobile crusher.

5.3 Alternative funding options

Additional funding support will be required to make up for the shortfall estimated in Section 5. In this section, we discuss a variety of alternative funding options to fill the gap in the analysis. We consider Advanced Recovery Fee & Deposit Systems (ARFDs).

Advanced Recovery Fee & Deposit System (ARFD)

Overview

ARFDs are tools to facilitate sustainable financing of waste and recycling management systems. There are 4 types of ARFDs currently running in the Pacific: Container Deposits, Beverage Deposits, Advanced Disposal Fees, and Waste Levies.

ARFDs work by charging a small fee for the import or manufacture of a product. These fees are then passed onto the consumer when they purchase the product. When the consumer returns the product for recycling, the fee (or a proportion of it) is returned to the consumer. Fees that are unclaimed by the consumer or the leftover amount after the return are then used to finance the recovery, recycling, and management of the exporting of recycled products.

In the context of this project, ARFDs can be understood as financial instruments with both deterrent and incentive functions. It is a tax on the consumer for importing second-hand cars, and this amount is then directed towards subsidising the collection and recycling management of the vehicle at the end of its life.

Practically, this can be administered/disseminated through the Land Transport Authority as people report their vehicles for deregistration.

ARFDs in PICTs

Table 15 shows PICTs with ARFDs currently established. ARFDs are already implemented in some PICTs for a variety of different products but most commonly for Aluminium cans and glass/ whiteware. Notably, Tuvalu has ARFDs for heavy equipment, Vehicles, Motorbikes, and lead-acid batteries. A prospective ARFD system in Fiji can follow the design set out in Tuvalu.

Table 15. ARFDs in Pacific Islands

Country	Items included ($)
Federated States of Micronesia (Yap, Kosrae and Pohnpei respectively)	Aluminium cans/ polyethylene terephthalate [21] (PET) (beverage and oil)/glass (USD 6c) Aluminium cans/PET (beverage and oil)/glass (USD 6c), lead-acid battery (USD $4) Aluminium cans (USD 6c)
Kiribati	Aluminium cans/PET (AUD 4c)/car batteries (AUD $5)
Palau	All beverage containers (USD 10c)
Republic of the Marshall Islands	Aluminium cans/PET/glass (USD 6c)
Tuvalu	Aluminium cans/PET/glass (AUD 10c), lube oil (AUD 40c/L), nappy (AUD 5c), whiteware (AUD $100/$60/$30), heavy equipment (AUD $2,000/$1,000/$ 500), vehicle (AUD$ 300), motorbike (AUD $200), lead-acid battery (AUD $60/$30/$10)

[21] PETs are materials used in the manufacture of a wide range of different products such as food and drink containers, the manufacturing of electronics, and fibres (SpecialChem, 2023).

Source: SPREP (2020b).

SPREP has produced guidance material that steps out of the process of designing and implementing an ARFD. This is broken down into 5 documents for the 5 stages involved in the process. The documents can be found in the SPREP Virtual Library. These documents are:

Step 1 Implementing an ARFD: Guidance on the 21-step Pathway – Decisions and Actions Needed
Step 2 Step 2 Determining Scheme Partners: Roles and Responsibilities
Step 3 Step 3 Build it Yourself Designing and ARFD Scheme: Key Questions Decision
Step 4 Step 4 Example table of Contents: For ARFD Policy and Drafting Instructions
Step 5 Step 5 Build yourself: Guidance to Drafting ARFD Policy

Estimating funding generation for an ARFD in Fiji

Our estimates are deliberately designed to incentivise ELV vehicle owners to undertake actions that both reduce the environmental and health risks of inappropriate disposal and reduce the costs of the ELV recycling strategy and increase the likelihood that it could be commercially viable in the long run. We estimate the funding amount that could be generated from the establishment of an ARFD in Fiji, at a high level. In this scenario, a fee of FJD 200 would be charged to vehicle owners purchasing a new car (second-hand or otherwise). Of this figure, FJD 150 would be returned to the vehicle owner upon successful deregistration of the ELV. This is constituted of:

- FJD 100 ($45) will be returned to the vehicle owner if they bring their car in for deregistration. This would represent the cost avoided by the relevant authorities to recover the car if it is abandoned. This incentivises the ELV owner to transport the vehicle to an appropriate facility. This will reduce costs for the ELV recycling facility.
- An additional FJD 50 ($22.5) will be returned to the vehicle owner if the hazardous liquids are still contained in the vehicle. This means that the liquids were not discarded inappropriately. If the hazardous liquids were not contained in the vehicle, or there is evidence of some liquids removed from the vehicle, the FJD 50 will be forfeited. This provides an economic disincentive for discharging fluids etc. in a manner that creates environmental and health risks.
- The remaining FJD 50 ($22.5) will be retained to recuperate the actual cost for properly depolluting the vehicle at the ELV facility. The table below presents at a high level, the figures that constitute the initial fee.

Table 16. ARFD return value

Item	FJD	USD
Delivery of vehicle	100	45
Vehicle contains liquids	44 (rounded to 50)	20 (22.5 after rounding)
Processing for liquids	44 (rounded to 50)	20 (22.5 after rounding)
Total	200	85 (90 after rounding)

This amount will be sufficient to cover the funding shortfall of $17 per vehicle as estimated in Table 12. Other financing options should be considered in tandem with ARFDs.

Opportunities

In a study by Linderhof et al. (2019) who assess the effectiveness of deposit-refund systems for household waste in the Netherlands, they find that deposit-refund schemes like ARFDs are more likely to encourage recycling for products that have low current recycling rates. This suggests that ARFDs are likely to significantly boost ELV recycling in Fiji, as there is a low rate of ELV recycling. This also means that vehicle deregistration will increase as well, as drivers who wish to recuperate their funding amount will be required to deregister their vehicles before being able to claim the funds.

AFRDs should not be considered in isolation, and they can be paired with other sources of funding such as a grant from the World Bank / Fijian Government. Modelling by Chen et al. (2015) finds that employing a suite of policy instruments such as a value-added tax, government subsidies, and an ARFD would lead to greater ELV recycling rates as opposed to any one independent strategy alone.

Non-revenue benefits

While the key driver for revenues is scrap metal prices, there are wider economic benefits that can be taken into consideration. These externalities benefits are often non-market and are not reflected in the process of goods and services. This includes benefits such as the avoided impacts of pollution on local communities from the reduced stockpile of ELVs, cost savings from landfill site expansion as ELVs are cleared which also increases the lifespan of existing landfills, and improvements in water quality from a reduced number of pollutants discarded near waterways.

There is currently very limited information on the value of the externalities available in the PICT context to incorporate them into the CBA. This is because the causal links relevant to our study region are not readily understood in the context of this project, and previous studies have not been undertaken to explicitly value the externalities. If these additional benefits were to be included, this will have the impact of increasing the BCR estimate. The reason why these estimates have not been included in the calculation of the BCR is that we want to illustrate what the results suggest purely on a financial basis as a test of its commercial viability.

However, in Box 3 we consider the potential value of one of the wider economic benefits, specifically avoiding landfill consumption.

Box 3. Case study of estimated avoided landfill costs

Under a business as usual (BAU) scenario, we assume that ELVs will be collected from around the country, valuable parts dismantled, and the remainder then dumped in a landfill site. To estimate the avoided landfill cost, we find the reduced tonnage of waste that will be directed to landfill sites under this initiative due to recycling.

Under this BAU scenario where there is the dismantling of ELVs where the components of a 1.4-tonne vehicle which have economic value are removed, this will reduce the weight of an ELV by 25%, which leaves the post-dismantled ELV weight at 1.05 tonnes.

In contrast to this recycling initiative where the ELV components are shredded, and the remaining automotive shredder residue is treated with pyrolysis, this leaves the remaining solid residue of 0.11 tonnes. This means that there will be a marginal reduction in waste to landfill of 0.94 tonnes per ELV. Under an assumption of $25

per tonne for waste going to the landfill (ADB, 2014), this translates to a nominal avoided cost (or benefit) of approximately $16 M over 30 years, or $23 per vehicle.

While the occurrence of these benefits does not necessarily result in an inflow of cash, this will have a positive impact on improving the welfare of local communities.

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Appendix A – Economic Assessment Plan

Report

Economic Study - Market Research for GEF ISLANDS Pacific Project

Economic Assessment Plan

February 2023



NCECONOMICS

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1 Economic Assessment Plan / Methodology

The purpose of this document is to outline our assessment plan for this project and our method for undertaking the economic analysis.

In this document, we begin by outlining our overall approach. This is then followed by a more detailed breakdown of our value chain analysis, and we conclude with a brief discussion regarding the inputs and assumptions incorporated into our analysis. The full table of inputs and assumptions can be found in the Appendix of the 'Desktop Study' companion report.

1.1 Method overview – cost benefit analysis of value chain

Plainly, the economic viability of a regional recycling initiative is evaluated by comparing the costs from waste along the scrap metal value chain, against the revenues generated from the harvest and export of scrap metals.

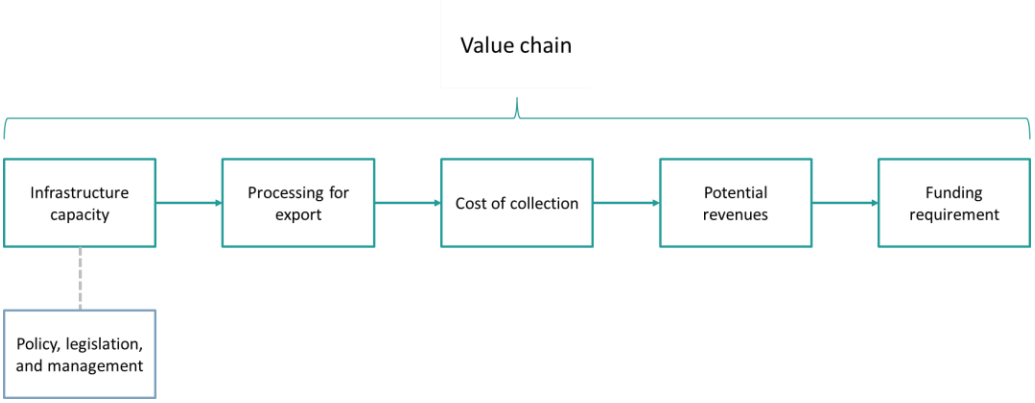


Figure 1. Value chain for ELV and consumer white goods

If long-term revenues are greater than costs, then the recycling initiative will be economically viable without additional funding support. If costs are greater than revenues, then additional funding support will be needed to ensure that the initiative can remain operational.

We then compare the funding required between the three candidate countries and propose the one that requires the lowest funding requirement to establish this initiative.

Our economic assessment takes the form of a cost-benefit analysis (CBA), where we will present the net present value (NPV) and benefit-cost ratio (BCR) of the three countries, assuming a project life of 30 years. Our approach follows the guidance of Infrastructure Australia's guide to economic appraisal.[22] The primary

[22] Infrastructure Australia (2021). Guide to economic appraisal. Accessed at https://www.infrastructureaustralia.gov.au/guide-economic-appraisal

purpose of adopting a CBA approach in this assessment is that it enables us to rank and compare between the three candidate countries.

Box 1. What is a Cost-Benefit Analysis?

Cost-benefit analysis (CBA) is one of the most commonly used economic and assessment techniques for assessing and the pros and cons of a particular project, or to compare project options – in this case locations of a recycling facility. It does this by identifying and valuing key benefits and costs over the life of the project and then assessing them in a CBA model.

In the case of this initial assessment, benefits are the revenues that could be derived through the sale of recycled materials (steel, copper etc.) from recycled goods. The costs are the capital and operating costs of the recycling project.

All costs and benefits are assessed over the long-term (in this case 30 years). All values over the assessment period are then 'discounted' (converted to 'resent value' terms – their equivalent value today)[23] to enable the assessment of long-term options that may have different project lives. The discounted benefits are then compared to the discounted costs to assess if the project provides net benefits (i.e. benefits are greater than costs). Where the benefits exceed the costs, the project is viable.

CBA primarily uses two decision rules to assess and compare projects.

Net present value (NPV) – This metric is the sum of discounted benefits over the project's life less the discounted costs. The higher the NPV, the higher the net benefits. For a project to be viable, the NPV should be > 1.

Benefit-cost ratio (BCR) – This metric is the sum of discounted benefits divided by the sum of discounted costs. A BCR >1 indicates a project is viable. When comparing different projects, the project with the greatest BCR is generally considered superior.

Where there is variability or uncertainty in the inputs used in a CBA model, sensitivity analysis is employed to see how the NPV or BCR change when input data or assumptions are changed. This has also been undertaken for the analysis of each option. Given the variability in the input data along with the limited availability of information, we have employed a range of +-50% around the central estimate where we believe that there is significant uncertainty in the data. A simulation of the model is run over 10,000 iterations to establish the range for our results.

Value chain analysis to inform the CBA

Here, we explain our evaluation of the scrap metal recycling value chain in further detail. Figure 2 illustrates at a high level, how we estimate the costs and revenues along the supply chain. Further detail is provided below.

[23] In this case a central discount rate of 7% is used.

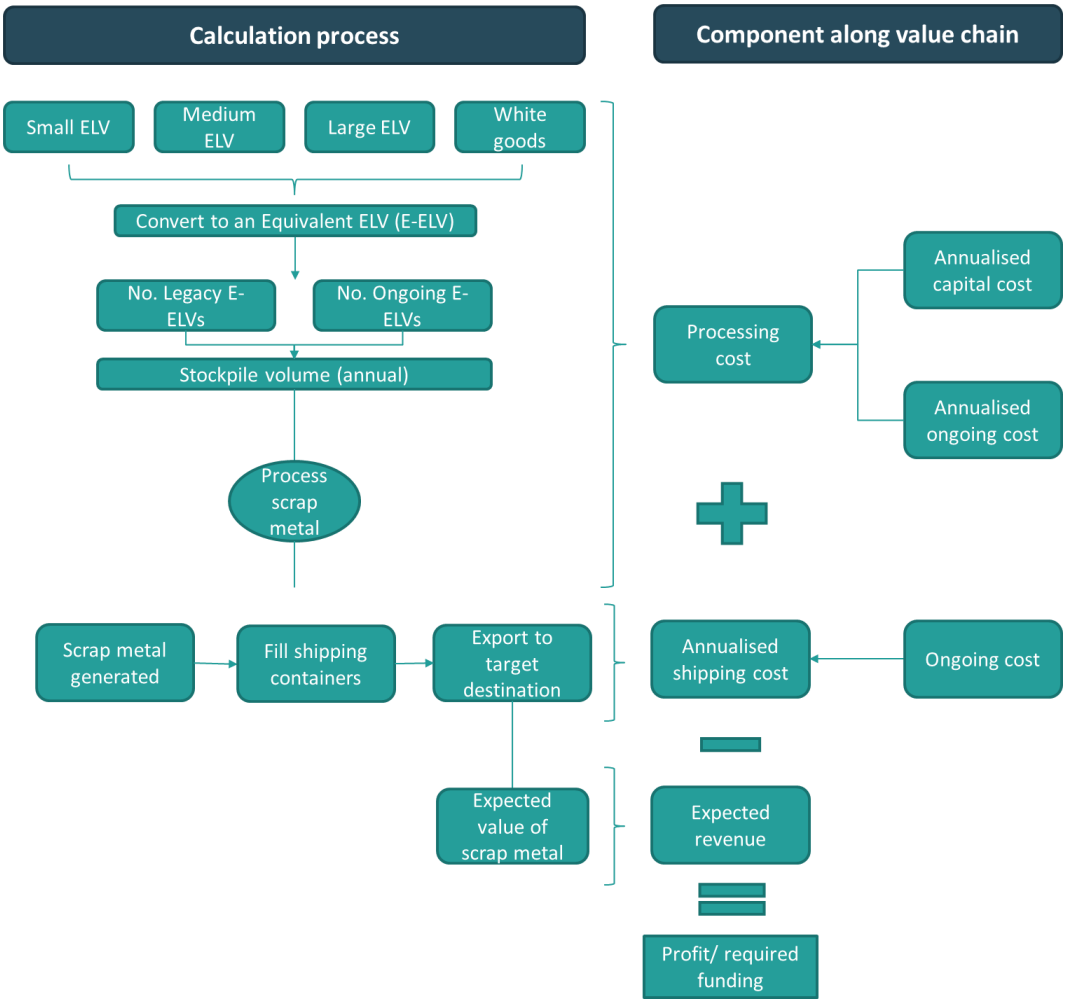


Figure 2. Overview of supply chain valuation

Estimating processing costs

Capital and ongoing costs

Processing costs are defined as capital and ongoing costs of processing ELVs and consumer white goods. Capital costs are defined as the costs of purchasing balers, forklift, tow trucks, and other incidental equipment required for the processing facility to be operational. Processing costs are defined as the costs associated with depolluting bulky items and the removal and non-metal items. With the remaining high value items and metals exported. This procedure is implemented in Fiji, Samoa, and PNG.[24]

Treatment costs

A desktop review of existing processing costs of other waste products such as foam, plastics, rubber etc generated from ELVs have yielded limited information on this front. Based on current information, we believe that this is the case for hazardous liquid waste e.g., oil, lubricants, battery acid, gasoline or diesel. We expect that there is currently limited or no processing of hazardous liquid waste that is currently done in a safe and

[24] Tonkin and Taylor (2022). Scoping Study for Bulky Waste Recycling.

environmentally sound manner. This will be confirmed during the site visit after engaging with local stakeholders. In the event that there is a system currently in place for management of these waste streams, we will adopt their cost structure as the basis for our model and identify what enhancements and upgrades might be needed to further develop the treatment of these products. Alternatively, if there is an inadequate system that is currently in place, we will assume in the cost model that there will be a need to establish it. In lieu of this information at this stage of the project, we have omitted it in the cost-benefit analysis. We will revisit this aspect of the cost model after the consultation process.

Equivalent ELVs

In order to compare between ELVs and bulky white waste of different sizes, we first adjust them to a common factor based on their weight. This allows us to simplify our analysis and compare between the different stockpile volumes in a given year. Table 1 below illustrates the conversion between different ELVs/white goods to a common factor. In this report we refer to this equalised value as Equivalent ELVs (E-ELV). For example, A truck weighing 4 tons is estimated to be equal to 2.9 cars, so it has an E-ELV value of 2.9.

Table 1. ELV conversions

Item	ELV type	Weight (tons)	Equivalent ELV (E-ELV)
Truck Equivalent ELV	Large	4	2.9
Boat Equivalent ELV	Large	0.5	0.4
Motorbike Equivalent ELV	Small	0.18	0.1
Car ELV	Medium	1.4	1.0
Van Equivalent ELV	Large	2	1.4
Heavy Machinery Equivalent ELV	Large	4	2.9
White good Equivalent ELV	Small	0.15	0.11

Note: The weight of a car at 1.4 tons is assumed to be the base unit of comparison.

The table below is an example of we would estimate the total E-ELVs in a given country given this calculation method.

Following this, we proceed to assess the total stockpile of both legacy and ongoing generation of E-ELVs. This is based on legacy volumes estimated by Tonkin & Taylor (2022). The table below shows how we have worked with the data provided in that report to generate estimates for our model. We take the average of the upper and lower estimates to form a central estimate for our assumptions, adjust the white goods to E-ELV terms, take the sum of the two and then apply a range of +-50%.

Table 2. Mid-point calculation of E-ELVs from Tonkin & Taylor (2022)

ELV	White goods

Item	Upper	Lower	Mid-point estimate	Upper	Lower	Mid-point estimate	E-ELV (1 white is 0.11 ELV)
Fiji	18,000	73,600	45,800	513,800	3,554,300	2,035,055	217,934
Samoa	600	3,200	1,900	6,700	137,900	72,300	7,746

Item	ELV			White goods			
	Upper	Lower	Mid-point estimate	Upper	Lower	Mid-point estimate	E-ELV (1 white is 0.11 ELV)
Papua New Guinea	76,700	218,900	147,800	171,200	1,705,400	938,300	100,532

Estimates for each country in terms of E-ELVs are presented in Table 3. We estimate that the ongoing volume of E-ELVs will be increasing at the same rate as the population in each country. We have estimated the population growth rate using the long-term historical average (past 10 years) based on World Bank data.[25] We believe that this is a reasonable estimate to make as the purchase and use of cars and white goods can be expected to increase with rising incomes and population. For now we have used the population growth rate as the sole driver of growth in the model, but will consider other factors in the development of the final.

We recognise that there are many factors which may drive the growth of the car market for PICTs, and fluctuation in the annual growth rate is captured by the range as a part of the assumption. The final version of the model will be developed with these different growth scenarios in mind.

Table 3. Stockpile volume (E-ELVs) in the three candidate countries

	Fiji	Samoa	PNG
E-ELV legacy volume at Year 0	263,734	9,646	248,332
E-ELV ongoing volume at Year 0	3,300	100	6,100
E-ELV growth rate (annual %)	0.45%	0.65%	1.99%

Assessing processing capacity

Processing capacity is a function of the infrastructure established and the operational and human ability to utilise all inputs efficiently. It is assumed that there will a slight lag effect associated with getting this new recycling initiative up to full capacity and will ramp up over time to 100% efficiency. This lag effect might be due to several factors, including but not limited to:

- Developing sufficient internal capacity such us upskilling and hiring sufficient labour.
- Developing standard operating procedures on handling the processed goods.

[25] World Bank Group (2022). World Bank Open Data. Accessed at https://data.worldbank.org

- Improving and streamlining the on-site processing strategy.

Given the lack of current information, it is assumed this process will take several years (allowed to vary between 3.5-10.5 years in the model). Currently, we assume that the time taken to ramp up processing will be the same between the three countries due to limited information. This is expected to be varied after Stage 3 for the final model in Stage 4 with better data.

After this, we make estimates around the baler uptime, which will enable us to calculate the number of E-ELVs that can be dismantled each year. Here we assume that the baler will be operated 40 hours per week for 46 weeks per year which allows for periods of maintenance and public holidays, with an efficiency of 11 – 17 E-ELVs per hour.[26]

We note that this is a more conservative estimate but given the preliminary nature of this stage of the project, this estimate can be refined through the consultation process in Stage 3 and a more accurate range can be reached on in the final economic modelling process.

From this, we estimate the annual processing volume of E-ELVs, and how many containers can be filled in a given year. At an assumed value of 22 tons of maximum cargo weight per container,[27] the estimated number of scrap E-ELVs that can be fit into a container is estimated at approximately 16 E-ELVs per container.[28]

Estimating shipping costs

The shipping costs for candidate country will be different, reflecting the different destination locations that are most convenient given their locality. The most likely shipping costs for the three countries are presented in Table 4. We note that PNG has relatively lower costs compared to Fiji and Samoa, reflecting proximity to the Asian markets and thus lower transport costs. In the next phase of the project, additional work will be undertake to determine the most likely destination for the export of recycled materials to international markets.

Table 4. Shipping costs for the three candidate countries

	Fiji	Samoa	PNG
Shipping cost	$304 per container	$304 per container	$152 per container

The current destination countries for the candidate countries are:[29]

- Fiji – Australia, Thailand, China, India.
- Samoa – Australia, South Korea, New Zealand.
- PNG – Australia, South Korea, Singapore, Malaysia, Pakistan.

[26] Assumptions around optimal baler implementation to increase transport efficiency follows SPREP (2021a).

[27] Cargo Network International Pty Ltd (2022). Container weight limitations. Accessed at https://www.cargonetwork.com.au/container-weight-limitations/

[28] This value is estimated based on the number of scrapped E-ELVs that can be fit into a container.

[29] World Trade Organisation [WTO] (2022). World Integrated Trade Solution [WITS]. Accessed at https://wits.worldbank.org/Default.aspx?lang=en

Estimating revenues

It is assumed that the scrap value is $94 per E-ELV, with a range from $47 to $140. For this assumption, we assume that the three candidate countries are price takers, as they do not handle and process sufficient volumes to be able to influence the scrap prices received. The wide range in the estimate used reflects the variability in world prices. The values used here are based on the recommendation provided in Tonkin & Taylor (2022) and are adjusted to dollars per E-ELV as described above.[30]

Sensitivity testing

During the process of our preliminary economic analysis, assumptions have to be made in cases where the data is of low quality or is limited. To account for this uncertainty, we perform sensitivity analysis to understand the extent to which such assumptions affect the overall results.

The key inputs and assumptions used in this preliminary economic analysis can be found in the Appendix of the Desktop Study document.

1.2 Multi Criteria Analysis

MCA is a decision support tool that was developed as part of a field of study called 'operations research', where decision makers attempt to assess multiple options across a range of decision factors (reasons or considerations) that may have different and inconsistent assessment measures, including non-monetary valuation. MCA has been adopted for environmental management as it is a valuable tool for assessing unique elements of a project that do not include financial components. Put simply, it is valuable as a technique for 'comparing apples and oranges'.

Weightings are commonly applied to each of the categories of objectives to reflect their relative importance to decision-makers. Under each objective, there are typically several relevant criteria against which each project is assessed. These criteria are also typically weighted within the objective to reflect their relative importance.

MCA is most effective when there is a very clear basis for scoring project options against criteria and where this evaluation framework is agreed and documented before the analysis has commenced. However, MCA ultimately involves some subjective and non-testable judgements on values. In addition, it does not tell the decision-maker whether individual proposals are of net social benefit (i.e. whether anything at all should be chosen), or the optimal scale of any particular proposal.

Criteria and their weightings

Criteria form the focus and content of an MCA analysis, representing the diverse values and ways to evaluate a project option (that is, the different decision considerations or factors). These criteria are assessed individually, for each project option, and given a corresponding score. The criteria used to assess the options considered in this project, their definitions and the weightings are shown in Table 5.

Table 5. MCA criteria and weightings

[30] See Appendix A. The values recommended are conservative estimates based on global commodity prices. Based on our observation of global scrap futures for steel and other commodity prices, we believe that it is appropriate to lean towards a more conservative range for prices at this stage of the project as it can be corrected in Stage 4.

Criteria	Weighting
Existing recycling infrastructure: The existing infrastructure setup in each country based on existing capacity and capital requirements.	20%
Goods exporting: The level of exporting capabilities within each country	15%
Item collection: The current accessibility of transport (both public and private) of ELVs and consumer white goods	15%
Economic: Outcomes from the CBA	50%
Total	**100%**

The assessment varies for each criterion and provides the data required to implement the MCA. Some of the assessments are quantitative, such as calculating a benefit-cost ratio, and others are qualitative using a five-point Likert scale (where higher is better). All scores are standardised to a range of one to five to ensure compatibility across the criteria when weighted scores are aggregated. The scores are applied based on a review of

Weighted scores for each option for each criterion are then aggregated to establish an overall score. This allows for relative comparisons of the options and prioritisation based on scoring.

This preliminary MCA will be updated in the final report and it will include additional criteria that will be developed after the conclusion of the site visit and reweighted accordingly. We expect to develop these additional criteria from the result of our stakeholder consultation. This comes about from the

1.3 Assessing other considerations

The establishment of a regional recycling initiative needs to go beyond a consideration of economic viability. Making a decision on this metric alone might lead to tunnel vision, omitting concerns such as environmental impacts, community expectations, and impacts on the livelihoods of local businesses and vulnerable populations.[31]

Following this stage of the project, a more in-depth understanding of these other factors will be informed with issue of the online survey and especially with the in-country consultation as we believe that we can garner important information on how to smoothly incorporate this initiative to the local context and community.

These issues and more will be considered in the final report, quantified in a MCA where appropriate or described qualitatively where relevant.

We will also consider which of the 17 United Nations Sustainable Development Goals might be able to be achieved[32] through this initiative (i.e., Goal 8 – Decent work and economic growth, Goal 10 – reduced

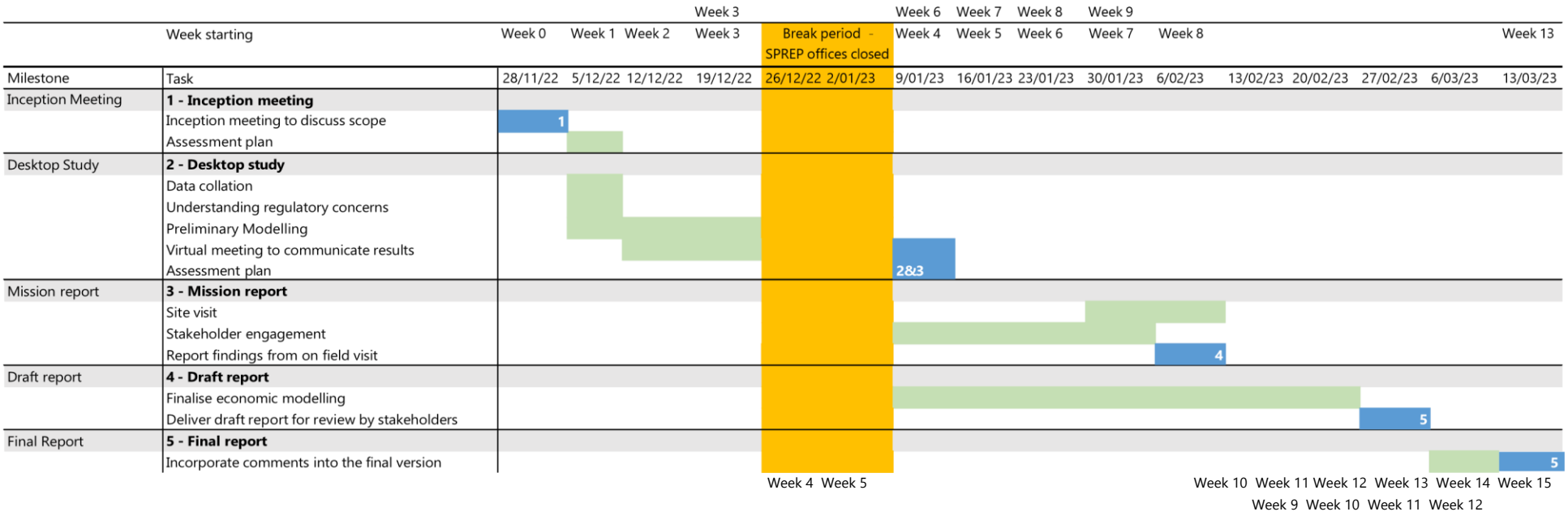
[31] These includes risks such as the release of particulate matter into the air due to cutting and shredding of scrap metals and fire hazard. EPA Victoria (2020).

[32] United Nations (2022). Sustainable Development Goals. Accessed at https://sdgs.un.org/goals

inequality) and suggest potential funding strategies in the case where external funding requirement is necessary.[33]

[33] An example of this would be a Container Deposit Scheme that has been proposed to help incentivise the local community to assist in transporting drink containers (cans and bottles) to a recycling collection point in exchange for a return on a deposit initially paid in the purchase of the drink. J-PRISM II (2022).

1.4 Timetable for delivery





Project **egend**

Deliverab ne due

Holiday reak period

Code	Delivery item
1	Inception meeting
2	Desktop Study & Economic Assessment Plan
3	Desktop Study & Economic Assessment Plan
4	Field Visit
5	Final report

Appendix B – Interim Desktop Study

Report

Economic Study - Market Research for GEF ISLANDS Pacific Project

Desktop Study

February 2023



NCECONOMICS

Document history

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Disclaimer

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Executive Summary

Based on a research plan for this preliminary analysis that can be found in a companion document, the preliminary analysis indicates that Fiji is a better early candidate to establish a regional recycling initiative relative to Papua New Guinea and Samoa. Further analysis is needed to fully develop the economic analysis and provide additional insights to identifying capacity building requirements for the initiative.

Headline findings

Using a cost-benefit analysis (CBA) which is a very common approach used for business cases and investment decision-making as it is an easy way of presenting the economic costs and benefits of a project over a time span, the most likely values of the benefit-cost ratios (BCR – the ratio of benefits to costs over the 30-year assessment period) for the three candidate countries are presented in Table 1 below, with high and low estimates in brackets. The BCR for any option should be greater than 1 to demonstrate that the project is viable without additional external funding.

Table 1. BCR results for the three candidate countries

	Fiji	Samoa	Papua New Guinea
Benefit-Cost Ratio (BCR)	**0.81 [0.54 - 1.21]**	0.24 [0.14 - 0.40]	**0.89 [0.59 - 1.33]**

The BCRs suggest that in the most likely scenario for all three countries, some additional funding support is required to ensure that a regional recycling initiative can be successfully established.

If we were to consider an optimistic scenario (high BCR estimate), we see that Fiji and PNG have BCRs greater than 1, indicating that no additional funding support may be needed, particularly if market prices for recycled materials are higher than long-term average prices. Given these estimates, we conclude at this point that based on the economic analysis alone, Fiji and PNG are more viable candidates compared to Samoa.

In addition, a high-level Multi Criteria Analysis (MCA) to act as a 'tie-breaker' between Fiji and PNG was undertaken. The purpose of this MCA is to examine how the three countries compare with each other with regards to four dimensions of existing infrastructure, goods exporting capabilities, item collection, and economic viability (based on the BCRs), with a total possible score of 5.

Table 2. Simplified MCA results for the three candidate countries

	Fiji	Samoa	Papua New Guinea
MCA Score	**3.5/5**	1.7/5	2.65/5

From this, we conclude that Fiji will be the best candidate for a regional recycling initiative.

1 Introduction

The Global Environment Facility (GEF), a global environmental fund, has provided funding to the Secretariat of the Pacific Regional Environment Programme (SPREP) to carry out the Islands Pacific Project, with the objective of "preventing the build-up of persistent organic pollutants (POPs) and mercury materials and to manage and dispose of existing harmful chemicals and wastes across Pacific SIDS".[34] This also includes products such as End-of-Life vehicles (ELVs) and consumer white goods, which are major home appliances e.g., dishwashers, refrigerators, air conditions etc. As SIDS continue developing economically, adequate infrastructure will be required to properly dispose of and manage these waste products.

Natural Capital Economics have been engaged by the SPREP to conduct market research to evaluate the economic feasibility of recycling end-of-life vehicles (ELVs) and consumer white goods.

The aim for this preliminary economic assessment is to identify a favourable entry point somewhere in Fiji, Samoa, and Papua New Guinea to establish a non-exclusive and regional recycling initiative for ELVs and consumer white goods. This will involve conducting an economic assessment of the waste management supply chain, and include:

- Assessing the waste management value chain and identifying gaps for capacity building.
- Identifying the costs associated with establishing the initiative.
- Estimating investment required to sustainably support the initiative.
- Developing cost estimates for training delivery of POPs disposal.

The outputs generated from this project will support SPREP in meeting the objectives of the Pacific Child Project, with the goal of assisting Pacific Island nations in developing sustainably and along safe chemical development pathways.

In this desktop study, a rapid review of the literature is conducted to collate data that is relevant to the project. With the available data, we will conduct a preliminary economic assessment to determine the value chain of ELVs and consumer white goods in the three candidate countries of Fiji, Samoa, and Papua New Guinea. With the findings of this economic model, we will propose a candidate country where further research will be done through a site visit and consultation with local stakeholders, to identify crucial capacity building opportunities and limitations of establishing a regional recycling initiative.

This report represents Stage 2 of the overall project (see Figure 1). In this document, we will primarily focus on the results of the economic analysis, with the Economic Assessment Plan / Methodology documented presented in a separate companion document and a more in-depth explanation of the results in Chapter 0. It is recommended that the Economic Assessment Plan be read as a companion chapter to the description of the results, as it provides additional context to the preliminary assessment that has been undertaken to date.

[34] https://www.thegef.org/projects-operations/projects/10267



Figure 1. Stages of the project

2 Findings

Prior to delving into the results, it is recommended that the Economic Assessment Plan / Methodology is read along this as a companion document, as it provides additional context to the findings discussed here.

2.1 Results of the CBA

The preliminary result indicate that there are no countries that are commercially viable without additional funding support, and losses over the 30-year assessment period will need to be covered by external funding in addition to the revenues from selling processed scrap metals. The findings of the preliminary analysis are uncertain, and the sensitivity analysis undertaken shows a wide range of possible outcomes.

Between the tree locations of Fiji, Samoa, and PNG, the locations with the best prospects based on the preliminary economic analysis are Fiji and PNG as they have the lowest external funding requirement.

The table below indicates that the losses for a recycling operation in Fiji are likely to be around $3.1 million over the next 30 years (but could be losses as great as $9.5 million or could even be profitable under more optimistic assumptions (profit of $2.7 million over 30 years)). Results for PNG are slightly better, but not sufficiently different to make a decision based on economic analysis alone. Other considerations are also relevant.

Table 3 below shows range of the results. From this, we can conclude that Fiji and PNG are better candidates than Samoa, as they require the least amount of funding with higher BCRs and NPVs. The primary reason for this is that Samoa is significantly less viable due to both the volumes of available inputs (ELVs) and processing costs. The conclusion drawn for Samoa is consistent with findings from previous work done.[35]

Table 3. Range of NPVs and BCRs for the three candidate countries[3]

Estimate	Fiji	Samoa	PNG
BCRs (Most likely) [Low – High]	0.81 [0.54 to 1.21]	0.24 [0.14 to 0.40]	0.89 [0.59 to 1.33]
NPVs (Most likely) [Low – High] $ M	-3.06 [-9.51 to 2.73]	-10.40 [-16.53 to -5.68]	-1.65 [-7.91 to 3.95]

Figure 2 illustrates the BCRs from the table in graphical detail, including the findings from the sensitivity analysis shown by the black error bars. The error bars here are designed to illustrate the variation from the results (10th and 90th percentiles). As mentioned in the Economic Assessment Plan, we simulate the model 10,000 times to establish a range for the results. The 10th percentile is considered the 'low' value on the range and the 90th percentile is considered the 'high' value on the range of estimates. In this context for Fiji, the 10th percentile BCR means that 10 percent of all BCR estimates for Fiji are below 0.54, and the 90th percentile BCR means that 90 percent of all BCR estimates for Fiji are below 1.21.

[35] World Bank Group (2021). Samoa waste characterisation and situation analysis report. Accessed at https://library.sprep.org/content/samoa-waste-characterization-and-situation-analysis-report-analysis-waste-generation-and [3] See Economic Assessment Plan companion document for a description of BCRs and NPVs.

Here, we can see that there is significant overlap between the estimates of BCRs Fiji and PNG. This suggests that relatively minor changes in the assumptions or input data used in the economic model may change the conclusions.

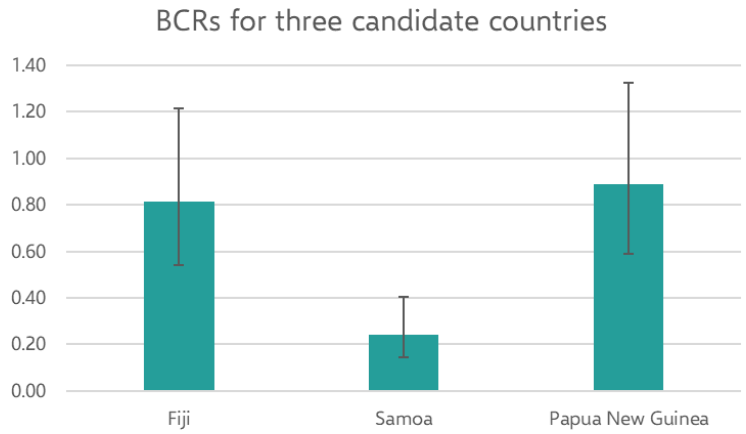


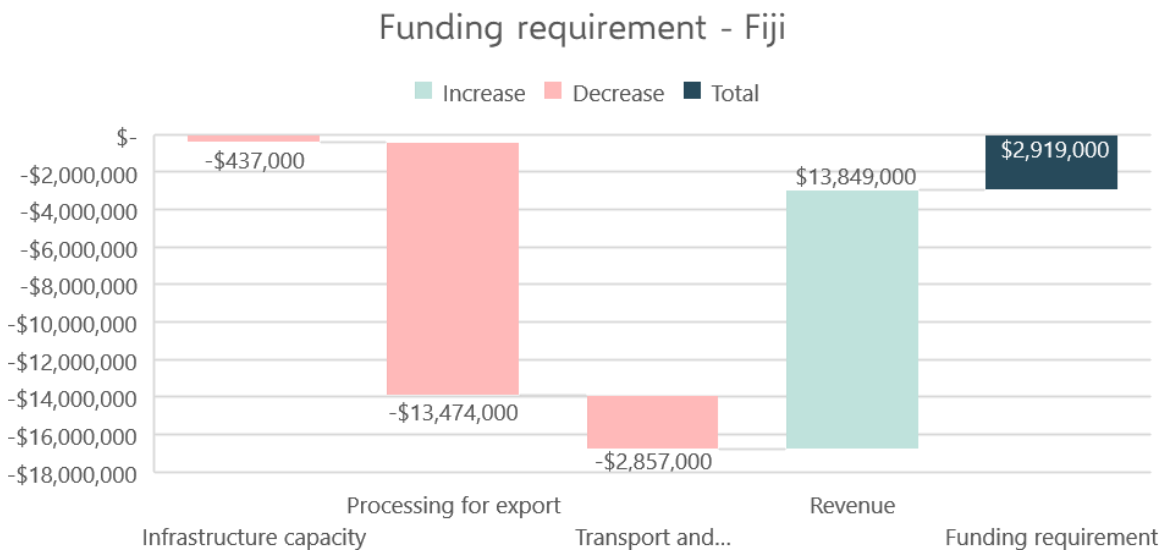
Figure 2. BCRs for the three candidate countries with P10 and P90 estimates in error bars

Breakdown along the supply chain

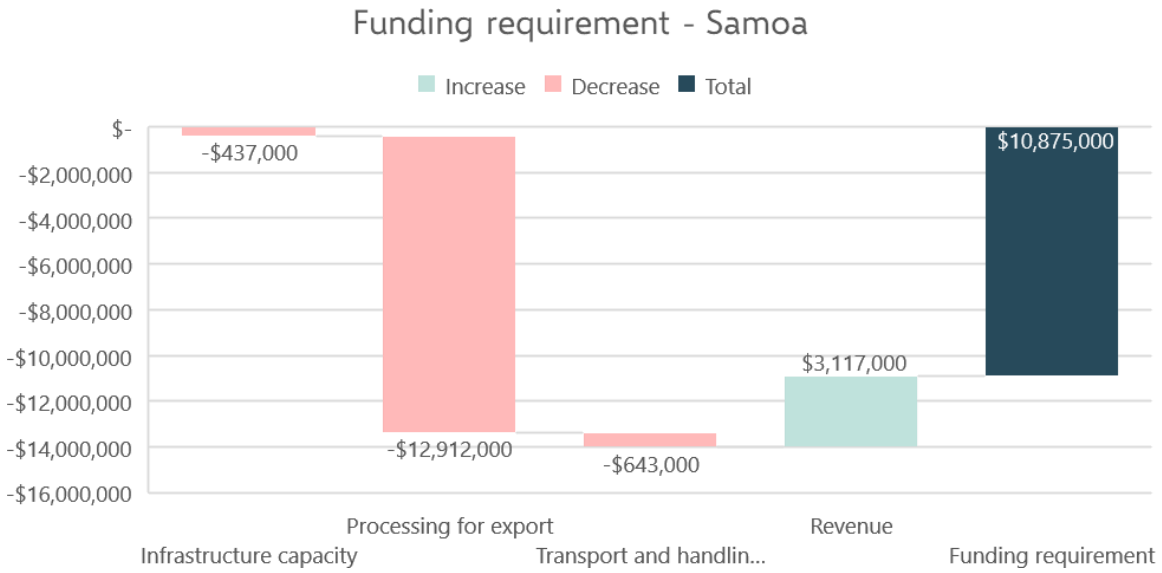
The costs along the value chain are illustrated in Figure 3. An estimated funding support of $11 M is required in Samoa, with considerably less funding needed in Fiji where $3 M is required and PNG where $2 M is required. The charts show the results for the mod-point of all estimates of benefits and costs. In each chart, the pink bars show the costs (infrastructure capacity capital costs, the operations and maintenance costs over 30 years, and shipping costs over 30 years). The light green bar shows the estimated revenues from scrap metal sales over the 30 years. Finally, the dark green bar shows the potential shortfalls over the 30 years that would require additional funding.

The closeness for these two estimates for Fiji and PNG reflect similarly large stockpile and legacy numbers, which mean that there is a significant amount that needs processing. The purpose of this section is to highlight the costs and revenues along different aspects of the supply chain. Following the site visit and stakeholder engagement, we will identify partnership opportunities with local businesses and organisations.

Fiji results over 30 years (present values)



Samoa results over 30 years (present values)



PNG results over 30 years (present values)

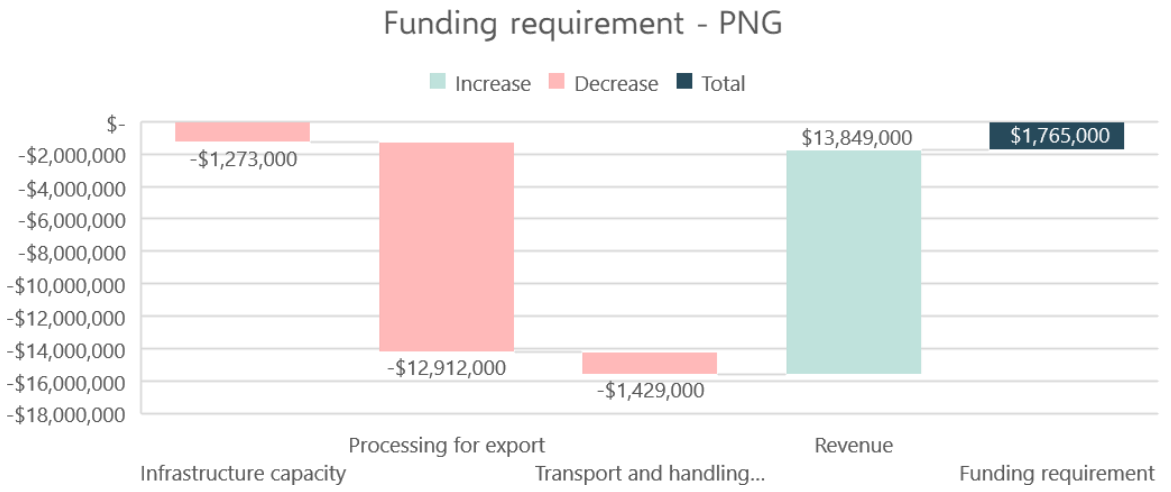


Figure 3. Estimates of costs and revenues along the supply chain for the three candidate countries

Potential subsidy requirement

Following the discussion above, another way for us to conceptualise these estimates is to break them down to a required subsidy per E-ELV. This breakdown is presented in Table 4.

The initial estimates show that for Fiji and PNG, external funding required per vehicle could be less than $10. Of course, this is subject to a better understanding of costs and revenues for recycled materials that will be developed in later phases of this project.[36]

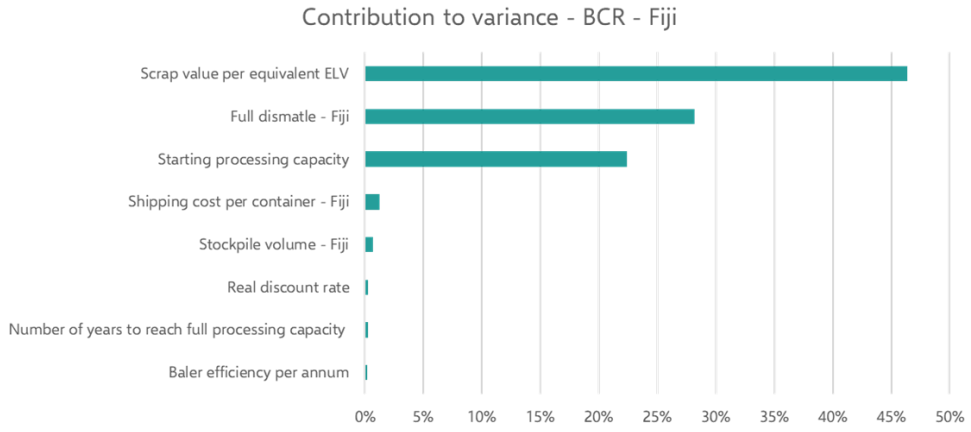
Table 4. Subsidy required per E-ELV

Criteria	Fiji	Samoa	PNG
Estimated number of equivalent ELVs that can be processed over 30 years	363,000	41,000	363,000
External funding (subsidy) required per vehicle $ per E-ELV	$ 8	$ 266	$ 5

Sensitivity analysis

Sensitivity chart (Figure 4) below shows the contribution of each variable to the overall variation in the potential results. We report an indicative chart for Fiji, as the overall structure of the assumptions made are the same for all three locations.

Scrap value, full dismantle costs, and starting processing capacities have the biggest impact on the overall variation in the results, when combined, contributing to approximately 90% of the total variation in the BCR.



[36] These resourcing concerns have been outlined in previous research (see SPREP (2021b)).

Figure 4. Contribution to the variance of BCR estimate - Fiji

While the economic analysis is sufficient to show that Samoa is not the preferred site, the results of the analysis for Fiji and PNG are not statistically different. Therefore additional analysis is required to reach a recommendation in a preferred location. This is outlined in the MCA (Section 4).

3 Multi Criteria Analysis (MCA)

Given the high level of uncertainty present in our estimates and the discussion outlined in 0, we pursue an MCA to decide between the two candidate countries of Fiji and PNG. The total adjusted scores are presented in the last row of the table below.

Table 5. MCA scores

Criteria - Weighting	Fiji	Samoa	Papua New Guinea
Existing recycling infrastructure - 20%	3 – There are significantly large disposal sites in the country with known balers.	3 – There are significantly large disposal sites in the country with known balers. There are balers at Tafaigata landfill site. This provides a reasonable basis for a recycling industry to be developed	1 - Unknown capacity across 4 named recycling facilities. The materials seem to go to scrap dealers for them to process. Any recycling initiative will require the purchase of capital infrastructure as the number of balers are unknown.[37]
Goods exporting – 15%	3 – Fiji has established exporting capabilities.	1 – has very limited exporting capabilities for ELVs and no exporting capabilities of white goods, will need to establish capacity.	1 - PNG has very limited exporting capabilities for ELVs and no exporting capabilities of white goods, will need to establish capacity.

Criteria - Weighting	Fiji	Samoa	Papua New Guinea
Item collection – 15%	3 - There are council owned trucks and private contractors that are used to collect bulky waste.	3 - Samoa has private collection of white goods. There is government collection of ELVs.	2 - PNG has no established collection from Private or Government of white goods. There is private collection of ELVs

[37] Tonkin & Taylor (2022) notes that the number of balers on PNG is unknown, and there is limited information available in the desktop review to identify how many balers there are. In the modelling process we have assumed that there are 0 balers in PNG and there will need to be a baler purchased. Even if we assume that there currently is a baler in PNG, the overall results do not change much as the range of BCRs remain roughly the same.

Economic analysis (based on CBA) – 50%	4 – BCR value range close to 1	1 – BCR value range very far from 1	4 – BCR value range close to 1
Total weighted score	**3.5/5**	1.7/5	2.65/5

Note: Each criterion is scored out of 5, with 5 being a perfect score and 1 being the worst score.

As discussed in the Economic Assessment Plan, this MCA is considered preliminary and is based on available information. This MCA will be updated in the final report. Given that we will only visit one candidate site, there will be more context provided for Fiji relative to the other two countries. This MCA will be expanded with additional categories after the site visit, based around additional issues that have been discussed and where there is new information for us to base our decision on.

For example, we will meet with Amitesh Deo, an owner-operator for Waste Recyclers Fiji and founder of Pacific Recycling Foundation, an organisation that looks to raise awareness on human rights issues around the recycling industry in Fiji. We believe that speaking to him will enhance our understanding of the human impacts of recycling and, what the current gaps are, and how a proposed initiative like this can be designed in an inclusive manner. In the following section, we discuss the regulatory and governance environment in each of the three countries.

Regulatory and governance environment

Each of the shortlisted countries has some degree of regulations to manage for hazardous waste. Key legislation and regulations in Fiji include:

- Fiji does not have dedicated legislation dealing with waste management. Rather, waste management is dealt with under general environmental and public health legislation.
- The key legislation is the Environment Management Act 2005. Under this legislation, environmental management and pollution control provisions extend to pollution caused by a variety of hazardous and other wastes. Part 5 specifically contains provisions relating to waste management and pollution control.
- The Environment Management Act 2005 establishes the Waste Management and Control Unit. That unit has specific responsibilities for waste management and pollution control in Fiji. This includes liquid and solid, hazardous, and chemical wastes and air pollution.
- There are also a number of other regulatory mechanisms and local bylaws that have a minor and indirect relevance to the management of hazardous waste and recycling of ELVs.

Key legislation and regulations in Samoa include:

- Samoa has a dedicated Waste Management Act 2010 administered by the Ministry for Natural Resources and the Environment (MNRE). This principal waste management legislation is complemented by other environmental and planning laws.
- The Land, Surveys and Environment Act 1989 deals with Environment and Conservation. This includes the need for Environmental Impact Assessments for new projects that include pollution control and control and management of hazardous substances.

Key legislation and regulations in PNG include:

- PNG does not have specific waste management legislation. Rather, waste management provisions exist within a range of legislation and regulations.
- Permitting of some activities is required, including waste management facilities through the Environment (Prescribed Activities) (Amendment) Regulation 2011.

Key points

Samoa has the most advanced and specific regulatory environment relating to the management of waste, while Fiji and PNG rely on provisions within other legislation.

Each country has specific units within government agencies with direct and/or indirect responsibilities for the oversight of waste management.

In addition, each country is also a signatory to at least the Waigani convention (SPREP, 2001). The table below shows the relevant international conventions relating to hazardous waste and the year thet each country ratified the convention. While Samoa has ratified all conventions, the key convention for the purposes of this analysis is the Waigani Convention. The Waigani Convention is to ban the importation of hazardous wastes and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific. Furthermore, most PICTs have signed or ratified the Waigani Convention which will facilitate any eventual regional ELV recycling solution that would require movement of materials between the originating PICT and the location of the regional ELV recycling facility. This section of the report will be appended into a segment for the MCA in the final report.

4 Conclusion and next steps

4.1 Conclusion and recommendation

Based on the economic analysis and MCA, we recommend Fiji as the candidate site to establish a regional recycling initiative.

4.2 In-person site visits and consultation

In the next stage of the project we will proceed with conducting site visits and in-person consultation with relevant stakeholders such as local experts and community leaders and representatives within the proposed candidate country of Fiji.

The purpose of the visit is to get a better understanding of the current ELV and bulky white waste processing capabilities in the country, along with other variables that will contribute to the successful implementation of this regional recycling initiative. This will enable us to input data that is more accurate into our model, which will improve our estimates of the economic modelling.

4.3 Improving inputs, assumptions and analytical outputs

The input data used in our preliminary analysis is quite high-level, and in the coming stages of the project we will focus on drawing on higher quality and more in-depth information that can improve the reliability of the economic model. The input data used in the model thus far has been mostly conservative, with wide ranges for the low and high estimates to account for the quality of the information. We expect that with better data, we

can be less conservative with some input variables and we can narrow the ranges applied, making our estimates more precise.

These improvements in the outputs from the analytical component of the project will reduce future investor risks and uncertainty.

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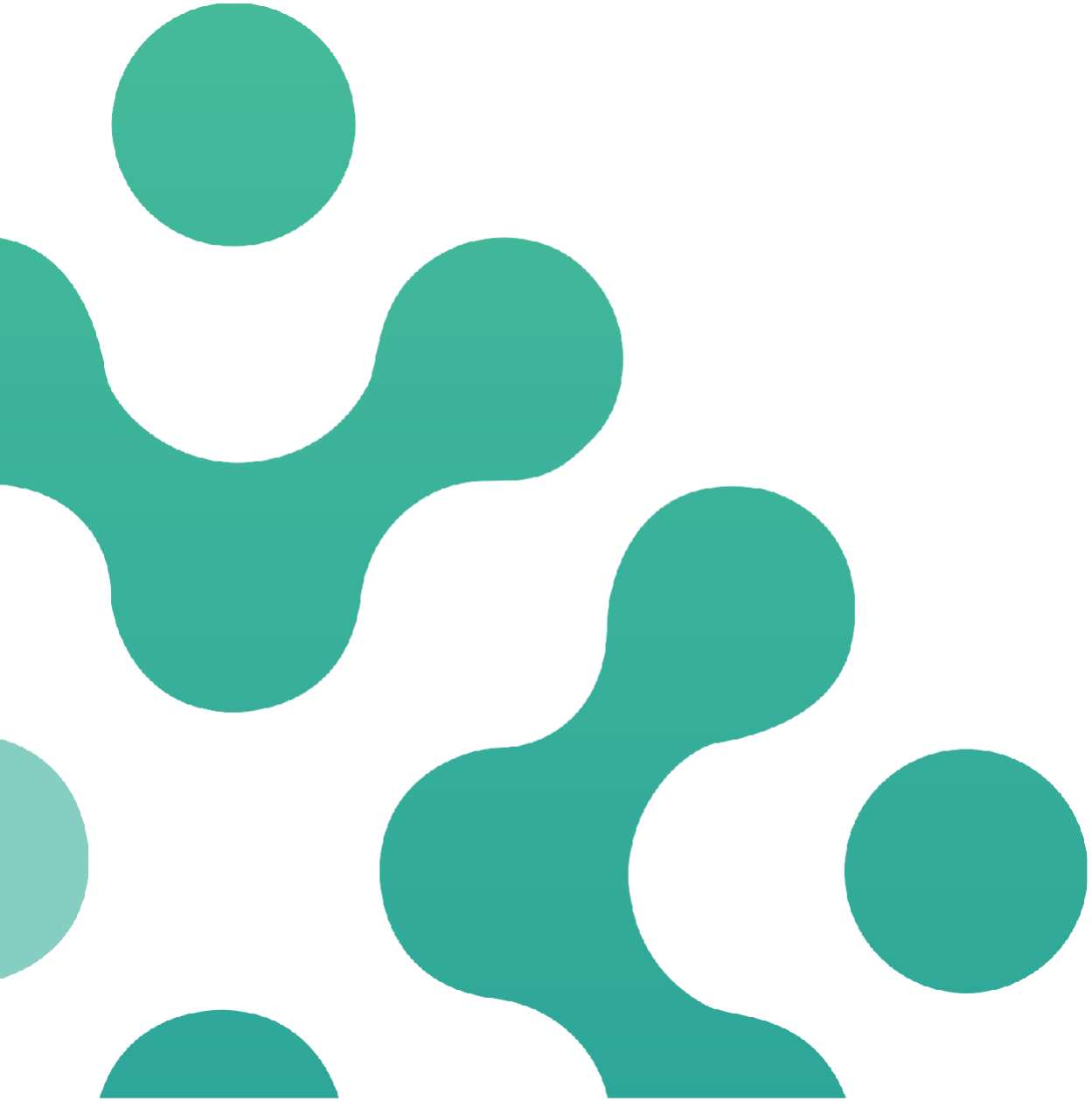
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Appendices

A

Inputs and assumptions

Appendix Subtitle



Inputs and assumptions

The table below contains a list of the input data that has been used in the desktop study. We report the range of low, most likely, and high values.

Table 6: Modelling input data

Input	Unit	Low	Most likely	High	Source
Real discount rate	%	4.00%	7.00%	10.00%	Infrastructure Australia (2021)
Population growth rate - Fiji	%	0.06%	0.45%	0.73%	World Bank Group (2022)
Population growth rate - Samoa	%	0.39%	0.65%	0.87%	World Bank Group (2022)
Population growth rate - PNG	%	1.90%	1.99%	2.10%	World Bank Group (2022)
Stockpile volume - Fiji	No. E-ELVs	131,867	263,734	395,602	Tonkin and Taylor (2022)
Stockpile volume - Samoa	No. E-ELVs	4,823	9,646	14,470	Tonkin and Taylor (2022)
Stockpile volume - PNG	No. E-ELVs	124,166	248,332	372,498	Tonkin and Taylor (2022)
Starting processing capacity	%	15.00%	30.00%	45.00%	NCE Assumptions
Number of years to reach full processing capacity	Years	3.5	7	10.5	NCE Assumption
Baler cost	$ once off	$300,000	$600,000	$900,000	NCE Assumption
Heavy duty forklift	$ once off	$37,500	$75,000	$112,500	NCE Assumption
Tilt tow truck	$ once off	$65,625	$131,250	$196,875	NCE Assumption
Incidental equipment	$ once off	$15,000	$30,000	$45,000	NCE Assumption
Full dismantle - Fiji	$ per car per annum	$121	$242	$363	Tonkin and Taylor (2022)
Full dismantle - Samoa	$ per E-ELV	$116	$232	$348	Tonkin and Taylor (2022)
Full dismantle - PNG	$ per E-ELV	$60	$121	$181	Tonkin and Taylor (2022)
Baler efficiency	ELVs per hour	11.4	14.3	17.1	NCE Assumption
Average ELV weight	ELVs per annum	8,400.0	10,500.0	12,600.0	NCE Assumption
Baler efficiency	No. E-ELVs	23	46	69	NCE Assumption
Baler efficiency per annum	No. E-ELVs	0.8	1.6	2.5	NCE Assumption
Scrap value per equivalent ELV	ELVs per annum	8,400.0	10,500.0	12,600.0	NCE Assumption

Appendix C – Consultation

Economic Study - Market Research for GEF ISLANDS Pacific Project

Site Visit Mission Report

10 February 2023

Natural Capital Economics



Natural Capital Economics recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Commissioned Artwork by Melissa Barton. This piece tells our story of caring for Country, through different forms of waterbodies, from creeklines to coastlines. The artwork depicts people linked by journey lines, sharing stories, understanding and learning to care for country and the waterways within.

Document history

Revision

Revision no.	01
Author/s	Boris Lam Jim Binney
Checked	Tim Fisher
Approved	Tim Fisher

Disclaimer

This report was prepared at the request of the Secretariat of the Pacific Regional Environment Programme [SPREP] ('the client') by Natural Capital Economics Pty Ltd ('NCEconomics'). The intended user of this report is the client. No other third party shall have any right to use or rely upon the report for any purpose.

This report may only be used for the purpose for which it was prepared, and its use is restricted to consideration of its entire contents. The conclusions presented are subject to the assumptions and limiting conditions noted within.

Natural Capital Economics

Citation

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1 Objective of the Mission Report

A field visit was conducted in Stage 3 of the overall project from the 30th January – 3rd February 2023. The purpose of this visit is to gain a better understanding of the limitations and requirements of setting up a regional recycling facility in the region and to fill critical information gaps where information gathered in earlier phases of the project was insufficient. Information gathered from the site visit will build on the desktop study conducted in the earlier stages of this project by refining the data used in the preliminary economic analysis and provide additional dimensions to be discussed e.g., capacity building requirements, regulatory concerns, and socio-economic factors.

The key outputs that can be found in this mission report include a detailed list of the stakeholders engaged along with the minutes of the items discussed during the meetings. The information provided in this stage of the project will inform the development of the full economic model and the final report.

As outlined in the memo, the engagement process follows a semi-structured interview style. The use of a semi-structured interview style was used to enable in-depth exploration of participants and stakeholders' experiences and perspectives. We have the flexibility to ask follow-up questions and probe for more information, leading to a deeper understanding of the participants' perspectives. Consequently, the themes originally outlined in the memo preceding this document were modified on an interview-by-interview basis, as we focused on issues that were more pertinent to the conversation.

With this in mind, the full notes of the meeting are grouped into themes with notes on the relevant issues explored. Most interviews were between 90 and 120 minutes in duration.

Following this, we present the table of contacted stakeholders as part of the site visits. Then, we go through the minutes of the meeting, and conclude with the next steps for the meeting.

2 Table of contacts

The table below shows a list of people who were directly engaged as a part of the site visits. It contains their names, organisation, contact details, and date of engagement.

Name	Role	Organisation	Contact details	Date engaged
Amitesh Deo	Founder & Director Operations	Pacific Recycling Foundation & Waste Recyclers Fiji	+ 679 992 1067 amitesh@recyclingfoundation.org	31st February
John Wilson	Project Manager	Pacific Recycling Foundation	+ 679 992 1046 john@recyclingfoundation.org	31st February
Kevin Chan	Assistant Commercial Manager	SWIRE Shipping	+679 9998 596 Kevin.chan@swireshipping.comn	1st February
Shyam Reddy	Regional Operations Manager	SWIRE Shipping	+ 679 9907 889 Kevin.chan@swireshipping.com	1st February

Virashna Singh	Sustainable Development Management Associate – Pacific Island Countries and Territories.	SWIRE Shipping	+ 679 9993 847 Virashna.singh@swireshipping.com	1st February
Khalid Ahmad	Floor manager – Lami Recycling Facility	Waste Recyclers Fiji	Via John Wilson	1st February
Aaron Phillips	Director Services	Suva City Council	+679 3313 433 aaron.phillips@scc.org.fj	1st February
Nitesh Datt	Acting Chief Plant Protection Officer	Biosecurity Authority of Fiji	+679 3312 512 ndatt@baf.com.fj	2nd February
Kavnil Lal	Principal Environment Officer	Waste Management & Pollution Control Unit, Department of Environment	kavnil.lal@govnet.gov.fj	3rd February
Vira Harieta Atalifo	Land transport division	World Bank	vatalifo@worldbank.org	3rd February

3 Key insights from meetings

The meetings provided several key insights for the project, including opportunities, gaps in information and impediments to any establishment of a recycling facility in Fiji. These are separated into broad themes consistent with the structure of the Final report being developed.

Policy and legislative environment

Current situation

Waste

Fiji does not have dedicated legislation dealing with waste management. Rather, waste management is dealt with under general environmental and public health legislation. The key legislation is the Environment Management Act 2005. Under this legislation, environmental management and pollution control provisions extend to pollution caused by a variety of hazardous and other wastes. Additional legislation is not likely to be required.

The Waste Management and Control Unit has specific responsibilities for waste management and pollution control in Fiji. This includes liquid and solid, hazardous, and chemical wastes and air pollution where businesses must have a permit and report against that permit. Because the management of ELVs is so fragmented (including potentially hundreds of small and informal businesses), anecdotal evidence suggest that only a small portion of operators are licensed, and compliance with the management of hazardous wastes (e.g. from depolluting ELVs) is likely to be low.

International shipments between Pacific countries would be possible under the Waigani Convention. However, additional arrangements may be required for export to final destination requirements to ensure broadly consistent with the Basil Convention.

Biosecurity

Biosecurity provisions should not be a concern for the recycling and export of ELVs from Fiji. However, Biosecurity Fiji has major concerns regarding the ability of smaller PICTs to meet good biosecurity practice (washing to remove soils etc. and fumigation to kills pests) prior to exporting ELVs to Fiji. While fumigation requirements could be managed at the point of entry into Fiji (there are facilities at Port of Suva), washdown facilities are harder to establish, particularly in PICTs with significant constraints on water supply.

OH&S

Occupational health and safety provisions are outlined in the Health And Safety At Work Act 1996. No specific or additional legislative requirements were identified during the interviews. However, observations during site visits did reveal practices that were short of best-practice (e.g. lack of personalised protective equipment - PPE).

Town and land use planning

Where approvals from the Fiji Government were already secured and if the ELV recycling facility was to be located in an appropriate land use zone (i.e. industrial area), it is highly unlikely the facility would not be approved.

Suva City Council also have a number of suitable sites for any recycling facility and may be able to participate in the project through the provision of a site.

Requirements to move forward

There are a number of potential requirements to move forward. These include:

- Encouraging businesses in the ELV value chain to seek permits to operate.
- To mitigate the risks of a fragmented and (often) informal sector, it may be prudent to consider a centralised service to ensure proper disposal and recycling of depollution materials (e.g. liquids and gasses). This will overcome the significant capital and regulatory hurdles faced by small operators and significantly mitigate environmental and health risks from ELVs.
- A specific detailed analysis and design of potential biosecurity measures is required to ensure that ELVs can be safely imported into Fiji for processing from other PICTs.
- Ensure that the implementation of any ELV initiative is underpinned by a programme of proper training (operational and OH&S) and that PPE is provided.
- Ensure that Suva City Council are included in detailed consideration of future sites.

Supply and value chain

Current situation

There is no certain estimate of the number of ELVs in Fiji (or any other PICT) as historical storage and disposal approaches are relatively informal. However, all interviews indicated that the number of vehicles was significant, with many simply being 'abandoned' on the side of the read once salvageable parts and materials had been removed and the vehicle de-identified (removal of registration plates and Vehicle Identification Number etc).

Suva City Council advise that the cost of collecting each abandoned vehicle in the greater Suva region is FJD80-120.

The management of ELVs once collected generally follows a few general steps.

1. Depollution. The lack of proper and widespread management of liquid waste and other depollution activities immediately after the decommissioning dumping of ELVs is a major risk to the environment and human health. Anecdotal evidence is that fluids are generally illegally dumped or added to waste fires – both creating significant and immediate environmental and health risks. There is no realistic financial gain from proper depollution practices, and this is generally considered a straight cost. Alternatively, depollution is not undertaken at all, and materials are left in-situ in ELVs at their location of abandonment/disposal.
2. Stripping locally marketable parts. Salvageable parts with a local resale value (e.g. doors, windscreens, batteries, wheels etc.) are typically stripped at formal and informal wrecking yards. These are then sold locally for cash at market rates. There are several licenced and unlicenced car wreckers across Fiji, with potentially hundreds of 'back yard' operators.
3. Scrap for sales for recycling. ELVs are then further dismantled to remove any materials with a value from salvage and recycling. This includes high value metals (e.g. copper wire), and lower-value larger metals (particularly steel). This is undertaken at multiple sites (wreckers yards, backyards, and dedicated recycling facilities). Materials are then typically aggregated and catalogued before export for sale in global recycling markets. There are a small number of buyers of scrap metal and other recyclable materials that are exposed to the financial carrying costs of often significant delays between buying materials from locals and being paid by international scrap merchants. Note that only a small volume of potential material is recycled (SWIRE Shipping will be providing estimates).
4. Disposal/abandonment. Once steps 1 to 3 have been undertaken, vehicles are generally disposed of acre a range of legal/formal and illegal/informal sites. It is clear that depolluting (step 1) is often not undertaken resulting in chronic environmental and health risks (a cost to society), while opportunities to recover and sell components and scrap metal products are often missed due to the location of disposal/abandonment.

Requirements to move forward

There are a number of potential requirements to move forward. These include:

- Capacity building is required to ensure on-ground dismantling and recycling is undertaken in a proper and safe way.
- Reducing the risks of depollution processes. There is no obvious financial gain to be had from proper depollution processes, and the capital and operational costs could be significant. It would be prudent to assess the viability of a 'mobile depollution service' where properly trained workers with the correct equipment depollute ELVs prior to any further processing and ensure materials are properly disposed of. The provision of a proper depollution services could also overcome a significant impediment to the formalisation (i.e. certification) of many of the smaller operators along the value chain.
- Establish a more formalised Fiji market for scrap metal and other valuable recyclables. This would include market coordination (buyers and sellers and their locations), scheduled logistics services and coordination of exports to market.
- Overcome capital equipment and associated service constraints (see Section 3.3).
- Enhance labour force capabilities and safety (see Section 3.4).

Infrastructure and associated services

Current situation

The industry in Fiji (and all PICTs) is characterised by a primarily manual approach to depollution, wrecking and disposal of ELVs. A number of larger wreckers and recycling facilities have capital equipment including forklifts and oxy-fuel torches for cutting steel, there is insufficient large capital equipment (crusher, bailers, shredders) to make a material contribution of recycling ELVs. Furthermore, most facilities are very size-constrained, indicating a purpose-build facility will be required to enable operations that the scale necessary.

Port and other transport and logistics facilities are adequate, with the Port of Suva being the more viable point of import/export due to the potential co-locations with the bulk of Fiji's legacy stockpile. There is insufficient land available within the port facilities to host a recycling facility, therefore the facility will need to be located off-site. This will result in a degree of double handling for road transport of any containers imported and subsequently re-exported once their contents are partially processed in Fiji.

International shipping covers most PICTs with opportunities to re-export to key markets for recycled materials (e.g. China, South Korea, Australia and New Zealand).

Private transport operators with the capability of moving cards and 20-foot containers operate across Fiji. However, the use of their services for ELVs is relatively limited due to market conditions (i.e. nobody prepared to pay as it is difficult to recover the costs of transport).

While there are some operators that collect hazardous liquid waste, this is primarily from large multi-national resorts and businesses. Anecdotal evidence suggested that collection and proper disposal of hazardous liquid wastes from ELVs was extremely rare.

Note: Detailed costs data for the economic modelling is still being sourced from Swire shipping on the shipping and associated logistics costs. The research team are also in consultation with suppliers of capital equipment to establish costs and budgets for ownership and operation. Operators and government agency representatives were able to outline labour rates. Land costs were sourced from current industrial land on the market in Suva.

Requirements to move forward

There are a number of potential requirements to move forward. These include:

- Assessment and potential establishment of a mobile depollution service including all necessary infrastructure to mitigate environmental and health risks.
- The establishment of a dedicated recycling facility at an appropriate scale. This would include land, sheds, plant (crusher, shredder, forklifts, wash-down facilities, liquid waste tanks etc.), a dedicated workforce, and all necessary regulatory approvals in place.
- Formalised agreements with shippers and access to international recycling markets.

Labour and human capital

Current situation

The current ELV management industry is a mix of formal and informal businesses and activities. There are no formal estimates of the number of participants in the industry. Anecdotal evidence suggests tasks range from informal 'waste pickers' through to small-scale formalised recycling operations. The workforce is primarily casualised, with limited opportunities for training and capacity building.

OH&S practices are typical of less developed countries, but significantly below those necessary to keep the workforce safe. If not addressed, this will also create a 'reputational' risk for any future international donors or investors in the sector.

Requirements to move forward

There are a number of potential requirements to move forward. These include:

- Formal and informal training in the management and handling of ELVs and other bulky waste. This will include the development of appropriate training materials.
- The provision of proper PPE and other safeguards for the workforce.
- Gradual recognition of waste and recycling workers as a legitimate workforce. This would enable workers to move to and beyond minimal wages (currently FJD4/hour) and receive other entitlements.

4 Next steps

Following the delivery of the mission report, we will begin work on including these findings in the final report. This is accompanied by the development of the full economic model which will contain additional data gathered from the in-person consultations. The highlights of the next steps from these meetings are:

- Follow up with the additional contacts provided from the stakeholders engaged. This will provide additional insight with respect to some elements of the value chain in Fiji.
- Obtain cost information from SWIRE Shipping for their operations and logistics costs that are relevant to this project. This will enable the finalisation of the cost components of the economic model.
- To escalate the issues raised during the meeting with the Department of Environment to the Permanent Secretary of this project. This is so we can obtain approval from the Department for a formal data request regarding licensed operators in Fiji. Note that that information is not critical to the economic feasibility of any facility established in Fiji.
- Look to include Kavnil and his team from the Department in the Environment, Vira from the World Bank, and Aaron from Suva City Council during the presentation of the final report, prior to delivery to the steering committee.
- Further investigate the opportunities for collaboration and identify opportunities with the World Bank through keeping in contact with Vira. This will be vital as the World Bank does have funding available for technical studies to underpin overall feasibility assessments and ultimately a business case to finance a facility.

The additional information and insight from these next steps will then be incorporated into the Final Report (already being written).

Appendices

A

Findings from stakeholder engagement

Pacific Recycling Foundation & Waste Recyclers Fiji

Date 31 January 2023

Attendees Amitesh Deo

John Wilson

Topic	Findings
Purpose of the organization	The Pacific Recycling Foundation endeavours to minimize the stockpile of rubbish that ends up in landfill. The foundation sees itself as a rights-based organization that was registered in 2022 with the aim or remedying the lack of activism in the waste management space. PRF aims at assisting informal waste pickers and intends on providing support to them in a myriad of different ways. They have previously conducted workshops on gender and human rights.
Profile of informal waste pickers	Informal waste pickers are individuals who travel from site to site, and they are socio-economically disenfranchised. The bulk of the informal waste picking labour force are made up of women and children. Some individuals consider this form of work as full-time employment where they work 40-hour weeks whereas other individuals work part time. Informal waste pickers are currently paid around 4-6 FJD per hour, with a premium given for processing and dismantling of materials, recognition of additional waste PRF are currently registering people with banks, as financial literacy is very low among this demographic. As there is a low prevalence of smartphones, PRF's goal is to make things as simple as possible. It was emphasized by Amitesh that compensation should be issued in a manner to encourage the use of bank accounts e.g., direct deposit.
Steps to formalize informal waste pickers	It was noted that formalizing this type of work will be a challenging prospect, as not everybody will be willing to participate in the transition process. An example of this that were given were sex workers who were resistant to participate. The key features of any formalization process involve having adequate, targeted, and guided financing. Adequate: This refers to having sufficient funds to purchase requisite equipment that fulfils occupational health and safety requirements. This includes items such as hardhats, safety goggles, protection gloves, steel capped boots, earmuffs, high-visibility vests, long trousers and shirts etc. Targeted: This refers to ensuring that any effort to formalize the industry e.g., workshops and community engagement be targeted towards the members of the community who are most vocal and will be drivers of change from the ground up. They will need to be emboldened to be advocates within their community through a values-based approach. PRF finds that this type of messaging often resonates stronger with women than with men. Guided: Any effort to disseminate information into local communities have to be done in a localized manner e.g., no suit and tie, informal. This means that the lessons and workshops have to be done in local languages, involve local organisations that have ethics and visions that are aligned. Any sort of workshop should be accommodative and considerate of the socio-economic factors that drive individuals to pursue this line of work. Multi-day workshops should provide room and board to incentivize participation. This helps to build a strong sense of ownership and create change that is sustainable.

Capacity building and political will	PRF are currently lobbying for changes with the government as advocates in the community. PRF have also interacted with other similar organisations in other PICTs and noted that there is stronger political will in Fiji, and considers Fiji as having great potential to lead the way in this space for other Pacific Islands. They believe that the current political atmosphere in Fiji is amenable to driving change. There should be a salaried program attached to capacity building, acknowledging that while the minimum wage is $4 per hour, it should be allowed to grow to $6.50 with training to compensate them for additional skills acquired. It can then grow to $7.50 - $8 for skilled truck operators.
Limitations to collaboration	There were ethical concerns raised around working and collaborating with certain scrap metal dealers, as there are historical issues around infrastructure and materials theft which have then be taken up by the dealers.
Management of waste	There is currently a problem where liquid waste is not properly disposed of by car scrappers. It was anecdotally mentioned that liquids are often poured down the drain or waterways and otherwise discarded inappropriately.
Participation in the project going forward	WRF and PRF would welcome the opportunity to take on a leadership role as they have the experience to do so, but they would rather work within a more decentralized system through pursuing a collaborative based approach.

SWIRE Shipping

Date 1st February 2023

Attendees Kevin Chan
Shyam Reddy

Topic	Findings
Depot Space	SWIRE currently has access to shared space at the Suva depot, where 70% of their containers currently occupy space in the depot. Their depot is currently used for handling of containers and whatever that is bound to Fiji will first go to the depot for treatment. Currently, SWIRE is able to occupy container space at the port for 3 days free, and there will be additional costs incurred after. It was mentioned that if extra time was necessary, SWIRE may be able to get access to a special rate to hold the containers. If external space is required (non-port storage location), then SWIRE currently has an area available at a 10 minutes' drive from the port.
SWIRE Transport schedule	In terms of the ideal location, it was highlighted that there is a preference between Lautoka and Suva. There is little difference between the two as it is not a major factor in SWIRE's decision making since there is only a day's difference for transport between the two. Other considerations that were brought up under this theme is that there is cheaper industrial land space in Lautoka and is relatively less space constrained in Suva. SWIRE's schedule on their company website is up-to-date for the next 6 months and it can be used as an indicator of frequency of travel between locations. Their service currently goes to Japan, Korea, China. There is the potential of using SWIRE slots on a non-SWIRE vessel bound to New Zealand.
Biosecurity protocols	SWIRE's biosecurity teams are primarily concerned with pesticides. Vehicles will have to be cleaned prior to SWIRE team handling. To move forward, SWIRE would like to receive some additional information from the department of environment regarding the sprays that are recommended. It is key that the vehicles are washed out before coming into Suva. If these vehicles are not cleaned, they will be considered hazardous waste. If the ELVs are to be processed in Fiji, whatever that is not done by Suva will need to be done in Lautoka.
Road access to port and limitations on travel	SWIRE believes that there are currently no issues for an 18-ton truck, and they can double check and make arrangements with the port to ensure that processing can happen within 72 hours of arrival.
Insurance	This was raised by the sustainability team as a new issue worth considering. It is currently hard to get insurance from other PICTs with regards to handling of hazardous waste streams. The sustainability team suggested that this could have been driven by insurance companies being reluctant to be involved in a relatively low value product. They also suggested that SPREP programme might need to set up protocols to manage risk and raised the possibility of organising a joint insurance product.
Moana Taka partnership	For Moana Taka, SWIRE requires the consignment to find their own export destination and SPREP proceeds with the background checking. SWIRE will be able to provide a factsheet overview to NCE along with other data needs.

Waste Recyclers Fiji

Date 1st February 2023

Attendees Khalid Ahmad

Topic	Findings
Overview	NCE team were able to visit the Waste Recyclers Fiji site in Lami right after meeting with SWIRE Shipping who were able to help us organise this conversation and site visit. We were also able to acquire some pictures of the site that we are hoping to include in the final report but we will first need to obtain approval from the site operator to get their sign off. As we were only there for a short while, we were still able to discuss and observe a few things of note with the site manager Khalid. The total site is approximately 1,000m^2 with a shed covering around half of the site. Multiple recyclable materials are sorted and separated from both ELVs and other bulky scrape metal items. Items are then partially cleaned and scrubbed before export in 20 foot containers (where market process are received for a total load up to 24 tonnes). It takes 80-120 manhours to fill a container.
Labour and workload	The waste dismantling workers at this particular site get paid above the minimum rate to compensate them for the added difficulties for this job. The site manager says that they work and operate 5 days a week at an 8 hour work shift. The workers are sorted into different streams e.g., removing wires, picking apart of larger metal objects, loading and transport. This

	shows that there is a skilled workforce that can be incorporated into a wider regional recycling centre.
Equipment (observation)	Mechanical equipment on site is largely restricted to a forklift and an oxy-fuel torch for cutting metal. Most dismantling and separation of recyclable waste is undertaken using manual processes by hand using simple tools (pliers, hatchets, spanners etc). The NCE team believes that part of the development of a regional recycling initiative should be accompanied with the provision of adequate personal protective equipment to the workforce to ensure that they are working in sufficiently safe environment. This includes steel cap boots, safe work wear, hearing protectors, helmets, etc. While the workers at this particular site were wearing the minimum required equipment, we believe that a regional recycling facility will require further upgrades.
Opportunity to scale-up and future participation	The site us very constrained by the creek at the rear of the site, adjacent commercial premises, and a narrow vehicle entry and is essentially running close to full capacity. However, the processes being used and the general business model are consistent with what would be required for any major ELV recycling facility. However, this would require significant improvements in OH&S

	and additional capital equipment.

Suva City Council

Date 1st February 2023

Attendees Aaron Phillips

Topic	Findings
Overview	Upon meeting Aaron, he envisions that this will be a significant problem for his council in the next 5-10 years. He expects that 1st and 2nd generation Prius Hybrids to be a big part of the future ELV stockpile, as he believes that most of them have a shorter than expected useful life.
Improper disposal of waste streams	A key issue that Aaron highlighted was the disposal of old batteries. He outlined that it is common practice for people to dispose of hazardous waste in an improper manner e.g., dumping in drainage / waterways. This is a problem that can be mitigated with a regional recycling initiative. He suggested that NCE team should chase up with the Ministry of Environment to identify whether individuals are currently disposing of waste streams properly.
Partnership opportunities	Aaron expressed his support to come on board the regional recycling initiative as a partner. There were a few sites recommended by Aaron which can be used to establish a recycling centre. These include: • Samabula Depot • The Old Suva Rubbish Dump

	• Korovao – Pacific Harbour • Industrial land at the end of Carpenter Street – Aaron that this was the best location among the four options and it is estimated to have an area of 2000 m^2.
Costs	Labour costs for Suva City Council are quite prohibitive, and Aaron expects that the collection of ELVs around the municipality to also be costly. He suggested that a levy system would be effective. It costs council $100 per car to hire contractors to tow trucks to bring cars to a disposal site.
Other relevant parties	Aaron believes that the Land Transport Authority needs to be involved in the process to fine individuals who desert their cars inappropriately. This includes looking up the Chassis and Engine numbers of vehicles to find out who was the owner of the vehicle. The costs of administration can be levied against the car owner. Aaron understands that enforcement of these rules may be difficult but will require buy in from the authorities.

Biosecurity Authority of Fiji

Date 2nd February 2023

Attendees Nitesh Datt

Topic	Findings
Overall	The meeting with the Nitesh confirmed most of our early understanding of the biosecurity requirements in Fiji and so we were able to conclude this meeting quickly. Nitesh directed us to look at Fiji's Biosecurity Act – Line 31, for information on Fiji's biosecurity requirements. He believes that at this stage it will be challenging to implement an import system due to a lack of readiness from other PICTs.

Summary of biosecurity process for incoming and outgoing vehicles	A biosecurity officer at the biosecurity point of entry can assess whether incoming articles include contents that are regulated. An importer that does not make the articles ready for inspection at the biosecurity point of entry by an officer will have been deemed to have committed an offense and the articles reconsigned or destroyed. If the biosecurity officer is satisfied after assessing the incoming article or consignment that there are no regulated articles, then it may be released from the biosecurity point of entry upon payment of a presecribed fee, if required. There are no real issues for exporting as it is just scrap metals.
Cooperation and participation	BAF is happy to facilitate but is concerned the management of the biosecurity risk. They look forward to any existing proposals or projects in this space where they can collaborate. When containers come from other PICTs, BAF has to clean and fumigate them. This risk is only pertinent for loaded containers and there is minor risk with empty container. BAF is happy to be involved with operating the system but believes that collaboration with other organisations and authorities will be essential to the development of this initiative.

Department of Environment

Date 3rd[t] February 2023

Attendees Kavnil Lal

Topic	Findings
Overview	Kavnil briefed us on the permit procurement process for a recycling initiative. A waste management service will first require a screening process. After this screening process there will be an EIA or a smaller scaled assessment, depending on the results of the screening process. After this stage, there will be a Terms of Reference released for a formal EIA and there will be a need to engage consultants for this purpose. All consultants are registered with the Ministry of Environment. There are two categories of permits, a waste disposal permit (Category A), and waste recycling permits (Category B). There will be a short screening time for EIAs (10 days). Approval of EIAs come with conditions that require compliance. The Ministry of Environment will be involved in ensuring that developers/operators are compliant.

	Kavnil would also like to be invited to the presentation of the final report to SPREP before it goes to the steering committee to ensure that the Ministry is informed and kept up-to-date
Innovative solutions to encourage handling of waste streams	The Ministry of Environment is supportive of an idea raised by the NCE team whereby a mobile liquid collector run by the Ministry roams around to the various processing facilities to collect waste liquids, this will incentivise producers to be compliant as the costs for management is subsidised by the Ministry.
Data request	The Ministry of Environment will entertain a data request as long as a formal letter is sent for this purpose. This data request will be for the number of waste facilities that currently are on the island, their locations, sizes, and volume of waste generated/ stockpiles. This can also be done for recycling businesses on the island.

World Bank

Date 3rd February 2023

Attendees Vira Harieta Atalifo

Topic	Findings
Understanding World Bank's interest in this space	Vira advised that the Bank's interest in ELVs is relatively recent, and it is primarily driven by their transport unit that has environmental concerns as a secondary

	consideration. Their waste unit is also new to working in the Pacific, but their current primarily focus is marine plastics entering the environment.
The Bank's work in this space	Vira is currently working on a report on Fiji's vehicle import policy which is currently in interim stage. It is looking at what kind of policy instruments are needed. Vira will require clearance prior to sharing the document with the NCE team. This report will identify possible policy mechanisms ranging from import regulations through to financial incentives, but will not analyse the effective or efficiency of individual policies. In effect, it is simply a literature review of the range of options.
Available funding	The World Bank manages a suite of investments in research, feasibility, infrastructure and services. Of direct relevant to this SPREP-funded project are Advisory Services and Analytics (ASAs). These are grants that can be applied to within the Bank to work on analytics and research work for topics of interest to the bank. These funds are typically applied to cover the costs of research, feasibility studies, business cases and consultation (all pre-cursors to investment in actual on-ground projects or programmes). Vira advised that there is currently a small amount of money available for ASA work looking into town planning procedures and ELV work. The current funding is stretched but Vira believes that there may be more ASAs in the future, particularly to full current information gaps.

Other reports to consider	Vira suggested that NCE Team have a look at Kiribati legacy clean-up.
Future work	It would be advisable to include World Bank representatives in future consultation for this project. Where this project identifies material gaps in information (e.g. multilateral biosecurity arrangements needing finalisation), the ASAs could be a potential contributor.

Appendix D – Input parameters

Variable	Unit	Low	Most Likely	High	Source and comment
Real discount rate	%	4.00%	7.00%	10.00%	Infrastructure Australia (2021)
Starting processing capacity	%	15.00%	30.00%	45.00%	NCE Assumption
Existing stockpile of ELVs	ELVs	18,000	45,800	73,600	Tonkin and Taylor (2022)
Ongoing generation of ELVs	ELVs per annum	12,500	13,750	15,000	Tonkin and Taylor (2022), Ministry of Trade, Co-operatives, Small and Medium Enterprises.
Number of years to reach full capacity	Years	1	4	7	NCE Assumption
Land unit cost	$ per m2	275	638	1,000	Estimated from Property.com/Fj listed land prices to obtain a range for land cost.
Land size	m2		2,000		Consultation with Ministry of Waterways & Environment, Suva City Council, Waste Recyclers Fiji, Pacific Recycling Foundation.
Building unit cost	$ per m2	600	1,200	1,800	NCE Assumption
Building and concrete slabs	m2	100	200	300	NCE Assumption
Cost for permit	$ per permit	6,000	8,000	10,000	Permit for planning approvals, obtained from the Ministry of Environment.
Baler efficiency	Tons per hour	16	20	24	Metquip Rentals (2011). Baling production of 16-24 t/hr for the Lefort 500. This are the high and low values for the model. The most likely value is the average of the two estimates.
Baler cost	$ per unit	167,500	335,000	502,500	Quoted from Machinery Specialist Australia. Adjusted cost to USD.
Heavy duty forklift	$ per unit	37,500	75,000	112,500	MainStream Economics and Policy (2017)
Tilt tow truck	$ per unit	65,625	131,250	196,875	MainStream Economics and Policy (2017)
Incidental equipment	$ once off	15,000	30,000	45,000	MainStream Economics and Policy (2017)
Depollution station	$ per station	20,000	40,000	60,000	Quoted from Machinery Specialist Australia. Adjusted cost to USD.
Depollution cost	$ per ELV	20	60	120	Tonkin and Taylor (2022) and NCE Assumption

Pyrolysis plant	$ per system	300,000	400,000	500,000	Estimated from online heavy machinery suppliers and communication with MetalCo.
Refinery plant for pyrolysis	$ per plant	213,750	427,500	641,250	Swire Shipping. Pers Comms.
Fumigation cost	Shipping cost		86		Biosecurity Authority of Fiji (2023). Adjusted to USD.

Variable	Unit	Low	Most Likely	High	Source and comment
Maintenance cost as a % of capital	% per annum	2%	3%	4%	Quoted from Machinery Specialist Australia. Adjusted cost to USD.
Salvageable volume of steel per vehicle	% per ELV weight	36%	50%	55%	Merkisz-Guranowska (2018)
Salvageable volume of aluminium per vehicle	% per ELV weight	3%	7%	10%	Merkisz-Guranowska (2018), Yue (2012)
Salvageable volume of copper per vehicle	% per ELV weight	1%	2%	3%	Merkisz-Guranowska (2018), Yue (2012)
The proportion of car batteries that can be salvaged	%	20%	35%	50%	NCE assumption as there is limited information in the literature around the proportion of an ELV battery that can be salvaged
ASR volume per ELV	%	20%	22.5%	23%	Cossu and Lai (2015)
Liquid volume from ASR	%	7%	18%	28%	Haydary et al. (2016)
Pyrolysis disposal cost	$ per tonne	26	53	79	Adapted from Swire Shipping. Pers Comms., MetalCo. NCE assumption that this cost is inclusive of POPs waste disposal.
Battery price	$ per battery	810	968	1,125	Consumer Council of Fiji (2018) adjusted to USD
Price of scrap steel	$ per kg	0.25	0.45	0.47	Investing.com (2023) scrap futures
Price of scrap aluminium	$ per kg	3.09	7.05	10.58	Trading Economics (2023) scrap futures
Price of scrap copper	$ per kg	0.15	0.24	0.30	Trading Economics (2023) scrap futures
Diesel price	$ per litre	0.82	1.17	1.26	World Bank (2023). Pump price for diesel fuel (US$ per litre), FijiVillage (2023)

Car collection cost	$ per ELV	100	115	131	Meeting with Suva City Council. Cost adjusted to USD and estimated for collecting cars around the island.
Recycling facility worker wage	$ per annum	5,400	7,200	9,000	Adjusted based on a 8 hour work day for 250 days in a year. Adjusted to USD.
Number of workers required	No. Employees	4	6	8	NCE Assumption
Managers required	No. Employees	1	1	2	NCE Assumption
Recycling facility manager wage	$ per annum	27,702	43,146	57,780	SalaryExplorer (2023). Adjusted to USD.
Energy use per worker per annum	kwh per annum	2,080	8,320	10,400	Ferrao, P., & Amaral, J. (2006).
Energy cost	$ per kwh	0.17	0.34	0.51	Energy Fiji Limited tariff rates

Variable	Unit	Low	Most Likely	High	Source and comment
Cost of importing ELVs from PICT for processing in Suva	$ per ELV	371	390	409	Compiled from multiple sources. Swire Shipping Pers Comm, Biosecurity Authority of Fiji (2023), Tonkin and Taylor (2022) and estimated by NCE.
Cost of shipping recyclable materials from Fiji to target destinations	$ per container	3,055	3,147	3,262	The costs here are for 3 destination locations, Busan (low), Yokohama (most likely), Shanghai (high). Data provided by Swire Shipping.