REVIEW OF REGIONAL E-WASTE RECYCLING

Including a

Model Product Stewardship Approach

for

Pacific Island Nations

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Executive Summary

This study considers the management of Ewaste in four the Pacific Island Countries (PICs) as of mid 2013. It determines the sources of Ewaste, the technical issues surrounding the collection, handling and recycling of waste electronic and electrical equipment, and presents a model system for addressing the problem of Ewaste in the Pacific Islands.

The key findings are as follows:

- **Ewaste generation** is driven by economic development, the nature of products and the rapid pace of technological change. The most significant generators of Ewaste in the four target nations are largely institutional; being both commercial and government. However, domestic generation is rapidly increasing.

- **Electronic equipment becomes Ewaste** through a variety of drivers, not simply through equipment failure, these being matters of obsolescence as well as partial failure of items. Pacific Island nations have, by 2013, a mostly well developed – and constantly improving – electrical repair sector. Repair of equipment, whilst being one measure to reduce waste flows, <u>is unlikely to make significant inroads into the problem</u>.

- **Electrical repair businesses** are frequently associated with electrical equipment supply retail business, and this commercial sector has a crucial roll to play as an initial collector of Ewaste, to determine in the first instance if repair can be effected, or if spare parts can be recovered to repair to other items. The secondary role of this sector could be to conduct manual breakdown of equipment, and identify components such that they are sorted into categories so as to increase the commercial value of the recyclable waste stream for export.

- **Pacific Island recycling businesses** can only participate in the Ewaste recycling sector to the level of manual disassembly, as subsequent stages require complex pyro- and hydro- metallurgical processes which cannot practicably be undertaken in PICs in any manner likely to be environmentally acceptable.

- **The quantities of materials available** in these small nations mitigate any further processing other than disassembly. However, it is important to create incentives such that crude processing – such as burning cables to remove insulation - are not undertaken, as these are exceptionally dangerous procedures resulting almost certainly in the release of toxic chemicals. The very real danger – which is already common – is the ‘cherry picking’ of higher value materials such as copper, whilst the remainder is dumped either informally or into local landfill.

- **The commercial economics** of recycling Ewaste from small PICs is such that it is unlikely to take place (apart from cherry picked materials) unless a sustainable method of financial support can be found to assist processing and export.

- **Export shipments of Ewaste** are likely to be in part container loads due to low volumes, and so likely to be mixed in with non-ferrous metals; but must be governed by Basel permitting processes, and the control of Basel permissions provides a pathway to ensure that recyclers are shipping all parts of the equipment processed if they are to access any financial support available.

- **There is a pressing need for capacity building** to PIC recycling businesses in order to help them learn how to safely and correctly dismantle items, and also identify componentry so as to increase value, as well as be aware of, and take action on, any potential Health and Safety or environmental hazards that they may encounter during this processing.

- **Where an Ewaste value chain can exist within a country** electrical repair shops have a potential incentive to do much of the breakdown and so provide a ‘high street’ option for the public to send in Ewaste for recycling. Also, as electrical suppliers are usually the main conduits of equipment supply to institutions, they are well placed to provide a institutional customers with a reverse logistical stream.

- **A Product Stewardship approach** could provide the formal structure to tie the various participants in the equipment use chain back to an export option, and provide the incentives required to ensure export of all Ewaste fractions that it is feasible to export.

- **A value chain could be set up through an Advance Recycling Fee** (ARF) which would be collected by Customs Officers at goods import, under suitable legislation, with the ARFs then directed back to the export of dismantled e-scrap through payment to accredited recycling businesses who operate under Basel rules.

- **An Advance Recycling Fee of around US$3 - $5** would appear to be a suitable level in the countries studied, being a flat rate collected off specified tariff lines. A flat rate is simple to implement, and needs to be low enough that it does not materially impact retail prices. Low value electrical equipment – for example memory cards – could be exempted through a minimum value provision.

- **Such a Product Stewardship system would require legislation** but in all the four countries studied there is potential to create relevant regulations under existing Acts of Parliament, but this does require more formal assessment.

- **Advance Recycling Fees** would be held in a special fund separate from normal government consolidated revenue accounts, but would be administered by national finance ministers. Ministries of Environment would typically provide oversight as the responsible Basel Convention authorities, and certify payments to recyclers - who must export under Basel rules - based on a cubic metre rate, with conditions of minimum density to avoid perverse incentives to ship un-dismantled equipment to increase export volumes.

- **Cathode Ray Tube devices are a special waste problem** that requires special provisions that may require local landfilling of CRT glass due to the current difficulties world-wide in dealing with CRT glass, and the high negative value of the material. This approach would have the side-effect of the development of dedicated low-level hazardous waste landfill areas in PIC landfills which could in turn deal with similar problematic - non-liquid - wastes that are currently not being adequately addressed.

The study provides detailed analysis to support these conclusions, both from an economic and technical approach. The study provides detailed information of dismantling and identification of component parts of typical Ewaste such that the materials can be sorted into classes acceptable to down-steam recyclers, and also indicative values that can assist in-country recyclers assess their commercial opportunities.

In addition, information is provided to give recyclers clear indications of any hazards they may encounter during their manual processing of Ewaste, along with advice on identifying and dealing with these issue effectively.

Brief comments are provided about accredited facilities that are available in Australia and New Zealand that would be the recipient of dismantled, sorted Ewaste shipments from Pacific island countries. These facilities comply with minimum environmental standards and also comply with international convention requirements when they on-ship Ewastes for processing and elemental recovery in Asia and Europe.

A detailed bibliography provides a resource for those who seek further detail on specific issues, and ensures easy access to the materials collected during the course of this study.

Project Overview

This study comprises a 2013 review of the management of Ewaste in four Pacific Island Countries (PICs), and presents a model system for addressing the problem of Ewaste in the Pacific Islands.

The assessment starts with the basic assumption that Ewaste is a problem that needs addressing regionally. The study is a component of a regional Strategic Action on International Chemical Management (SAICM) project being undertaken in the Pacific Islands region under the coordination of the Secretariat of the Pacific Regional Environment Programme (SPREP).

Whilst the term 'Ewaste' can cover a wide definition of any piece of equipment that has either an electrical cord or a battery, for the purposes of this study the term is restricted more specifically to electronic equipment, such as TVs, all computer related devices, telecommunications equipment, and audio equipment. Consumer white goods such as fridges, air conditioners and electric motor powered devices are largely a scrap metal issue with regard to recycling, and one that is already being addressed in large part in the target countries.

The four countries reviewed comprise three countries (Kiribati, Samoa and The Cook Islands) currently part of the regional SAICM project, and Tonga, as Tonga also has been proactive in work to deal with Waste Electronic and Electrical Equipment (WEEE).

The study was conducted to answer four questions:

1). Do the PICs have the capacity to repair electronic equipment that has a problem, and so reuse it, or do they need assistance in this area, so as to prevent equipment becoming Ewaste unnecessarily?

2). Which is the best option for recovery of Ewaste for recycling in PICs? Is this best achieved through occasional one-off 'eDays' some kind of Product Stewardship scheme, or some other approach?

3). Having determined through analysis which may be the better approach to dealing with Ewaste, how might such a system be structured and implemented?

4). What capacity gaps exist that hinder successful Ewaste processing for recycling in PICs?

The study provides detailed analysis and supporting information for the proposals offered, but in summary:

1). All the countries looked at already have a reasonable – if varying - capacity to repair electrical and electronic goods. Significantly, the reason that there are stockpiles of Ewaste in these countries is not related to a repair capacity.
However, one clear study conclusion is that electronic repair shops *do* have a significant role to play in the development of a viable logistical chain for Ewaste recovery in PICs.

2). The Cook Islands held an eDay in 2010 which was very well documented. New Zealand (NZ) has held eDays funded by the government regularly since 2007, but the last was in 2010 as the system in NZ has now moved to a more sustainable model. The Cook Islands eDay had a cost per item of $15.33 per piece of WEEE recovered. Items were shipped to New Zealand with no processing. This approach was compared to the approach being taken currently in Tonga where collected WEEE is manually broken down prior to shipment. This is the model being now largely followed in New Zealand. PICs typically have a very significant cost advantage in this approach as labour in most places (except the Cook Islands) is much cheaper than in New Zealand. In Tonga, work is conducted by a local recycling business with support from a local NGO which is funded by a small GEF grant.

The economics of the manual disassembly approach to Ewaste, rather than shipping whole with no breakdown is considerable better – although still not completely commercially viable - for two key reasons:

- Disassembly allows WEEE to be split up and sorted by commercial category, which adds significant commercial value to any shipment. WEEE packed on pallets and shipped un-dismantled typically has a negative value *before* any collection, shipping or handling costs are included.
- WEEE that is not dismantled contains a lot of air, container densities as a consequence are low, and shipping costs then become elevated, thus proving to be one of the key constraints to commercial recycling of Ewaste in PICs.

The analysis behind these first two answers comprises Part One of this study.

Part Two of the study then builds on the analysis of Part One to provide an answer to the third question as to how any generic model might be structured and operate.

3). Given that manual disassembly and sorting into commercial categories is found to be an essential step for any commercially sustainable Ewaste recycling system, but might not be commercially viable as it stands, how could such a system be put in place that would not require constant infusions of cash from donors or governments? Here the basic principals of Product Stewardship (PS) schemes are looked at, and any existing PS schemes that are used in PICs.

Part Two provides the generic details that would provide a system that would use an Advance Recycling Fee (ARF), collected at import of the product into the PIC. Such an approach would require some legislative support, and also is provided here such that it provides a simple and easily implemented system that does not require complex tracking of individual items over their useful lifetime. This generic approach proposed would act as follows:

- An ARF is collected at import on certain Harmonised System[1] of tariff lines, being either under Chapter 84 or 85 of the Tariff; the ARF is collected by Customs Officers at the time of a cargo's import clearance;
- The ARF would be a flat rate, expected to be or the order of US$3-$5 on any item falling under defined and relevant tariff lines.

[1] Harmonised System of international Tariff lines as used in all countries' customs tariffs.

- The ARF is placed in a fund controlled by the relevant statutory body; most likely the 'Ministry of Finance' or other government financial management ministry, but this fund is legislated as separate from 'General Revenue';
- This ARF fund can be used to provide a direct subsidy to those exporting Ewaste; the fund can also be the same fund that holds deposits for any beverage container recycling system or other PS scheme;
- A commercial recycler who wishes to access the ARF fund to support Ewaste shipment must have a contractual arrangement with the responsible regulatory agency; such a contract would require that any exports are only conducted under a Basel permitted process[2]. Typically, this contractual arrangement would be of the nature of a 'System Operator' format, and in the countries studied, would typically involve a single – or at most two – companies being designated System Operators;
- Only 'accredited' recyclers can access the ARF fund; they must conform with the rules, and will need to show chain of custody so that it is clear they are feeding an internationally recognised processor of Ewaste[3];
- The exporter receives a payment based on volumes shipped in cubic metres, but with a minimum density factor as a disincentive to ship fresh air and access funds without making significant exports; this factor would likely be in the order of a minimum of $250kg/m^3$;
- Payments can only be made on production of a Bill of Lading, indicating that shipment has been made.

Other details would be that Cathode Ray Tube (CRT) devices would receive special arrangements (see section 7) as they are both a difficult and a legacy waste problem. Also, the 'System Operator' may be required to take special local measures with some other potentially hazardous wastes, so bringing into formal control an existing problem in PICs where these wastes are being turned away from landfill – where intercepted – and as a result usually informally dumped at the expense of the environment.

Such a system would require legislative change in each of the four states visited, but existing legal frameworks could be potentially used in all four such that only regulations may need to be made, and no Act of Parliament is required. However, this may well not be true of *all* Pacific Island nations, and this assertion must be tested through formal discussion with respective governmental legal agencies in other nations.

Part Two also supplies supporting analysis of population and electrical equipment use rates, and some basic calculations of likely Advance Recycling Fee rates required to achieve the outcomes desired.

It should be clearly noted that this study holds that CRTs are a difficult waste and will require specific measures, and inclusion in a PS system described above – at least at the export end – will likely disrupt the economics of the entire scheme such that the initial ARF become larger and thus politically harder to agree. CRTs could usefully be the focus of any future project work in PICs on Ewaste to assist with the development of long-term sustainable solutions to the Ewaste problem. Donor funding under EDF10 is

[2] Basel Convention on Transboundary Movement of Hazardous wastes: all PICs in this study are signatories, and any shipment between parties requires specified documentation. www.basel.int

[3] Appendix 1 includes details of companies in the region who would meet requirements; the key point is to avoid providing support to exports that end up being processed in environmentally unsound ways in some countries.

currently available to potentially deal with this problem on a once-off basis for some PICTs.

It is also important to note that this system can create an effective local 'value stream' for WEEE independent of any value at the export end, depending on the size of the payment per m³ from the ARF fund. Where any recycler has a commercial incentive to buy WEEE, electronic repairers are very well placed to participate in the system. They can break down WEEE and sort into categories for on-sale to the exporting recycler as they can do this as part of their daily work, and as part of any spare parts recovery process. The technicians who repair equipment are actually best placed to identify and sort circuit boards to their different value categories, and this is a very important part of the recyclers' revenue stream. Mixed boards will attract the lowest category price, which can be up to ten times less than the highest value. Also, this approach also helps repair shops deal with the space problem caused by large quantities of old equipment lying around, and small repair operations may be one of the most significant informal dumpers of Ewaste. Another advantage of this approach is that repairs may be more accessible to the public than recyclers located in industrial areas. This point is also looked at in detail in Part Two.

Part Three of this report looks at the local situation in the four countries visited, with particular attention paid to local recycling businesses and the legal and regulatory situation in which they operate.

The final question this study seeks to address is the question of the knowledge capacity gaps that exist in the target PICs, both in the regulatory agencies and in the commercial recycling sector. Part Four deals with this in detail, along with detailed information in the Appendices.

4). The capacity gaps that are apparent are fairly straightforward to address at this stage, being those of a dearth of knowledge of the overall subject. Thus Part Four provides details of two key areas identified through the course of the country visits:

- Details of the categories of parts from disassembled WEEE that can feed directly into overseas e-scrap processors, how to identify and spit up equipment to these categories, and some indicative values of different categories to help recyclers maximise value of their breakdowns. This information will also help any electrical repairers break down equipment for on-sale to recyclers.

- Any Health & Safety issues that anyone disassembling WEEE – or being a regulator for such procedures – need to be aware of. There is often a lack of understanding as to what exactly are the hazards associated with dealing with Ewaste, and this is important to have a clear understanding of where any hazards might lie at the level of processing that any PIC might handle, and also procedures and activities that should *not* be undertaken by recyclers in PICs (such as burning cables to recover copper or shredding circuit boards to increase shipped densities). It is hoped that the information presented here, along with the detailed references provided, can provide some much needed clarity on these critical points.

List of Acronyms

ADB	Asian Development Bank
ARF	Advance Recycling Fee
BFR	Brominated Flame Retardant
CDL	Container Deposit Legislation
CFL	Compact Fluorescent Lamp
CPU	Central Processing Unit
CRT	Cathode Ray Tube
ECD	Environment and Conservation Division (of Kiribati)
EEE	Electronic and Electrical Equipment
EPF	Environment Protection Fund (Cook Islands)
EPR	Extended Producer Responsibility
FCL	Full Container Load
GEF	Global Environment Facility
GoK	Government of Kiribati
LCD	Liquid Crystal Display
H & S	Health and Safety
IMDG	International Maritime Dangerous Goods code
IT	Information Technology
MELAD	Ministry of Environment, Lands and Agricultural Development (Kiribati)
MfE	Ministry for Environment (NZ)
MNRE	Ministry of Natural Resources and Environment (Samoa)
MOIP	Ministry of Infrastructure and Planning (Cook Islands
MRF	Materials Recovery Facility
NES	National Environment Service (Cook Islands)
NGO	Non-Government Organisation
NZ	New Zealand
NZAID	New Zealand government overseas aid program
PCB	Printed Circuit Boards
PET	Polyethylene Terephthalate
PIC	Pacific Island Country
PS	Product Stewardship
PVC	Polyvinylchloride
RCI	Recycle Cook Islands Ltd.
SPREP	Secretariat for the Pacific Regional Environment Programme
SAICM	Strategic Action on International Chemical Management
SWM	Solid Waste Management
TCLP	Toxic Characteristic Leaching Procedure
TEU	Twenty Foot Equivalent Units (Shipping Container)
UNDP	United Nations Development Programme
WATSAN	Water and Sanitation
WEEE	Waste Electronic and Electrical Equipment

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Report Structure and Overview

Waste Electronic and Electrical Equipment (WEE) is a rapidly growing problem in Pacific Island Countries (PICs), as well as in most parts of the world today. The last twenty years, and the last decade in particular, have seen a rapid increase in the number of consumer electrical goods on the market in PICs. Pacific Islanders have embraced this electronic revolution, although the levels of disposable income being lower than OECD nations mean that ownership rates are lower. Much of this equipment has a limited lifespan, whether that results from failure of operation or obsolescence as technology moves forward. Whilst the technological capacity of equipment has increased rapidly, unit costs have typically fallen just as rapidly. The end result is that today, a large quantity of WEEE is heading for landfill after a relatively short period of use.

Much of this electrical and electronic equipment contains various chemical compounds and toxic heavy metal factions that are perfectly safe when the items are in normal use, but, when thrown into landfill (or worse, swamps, creeks and beaches) these items can degrade and slowly release these toxic compounds into the environment. A vast body of information exists on this subject, and thus this report starts from the assumption that WEEE (which will forthwith generally be referred to as Ewaste in this study) is problematic and needs to be dealt with in a better way than landfill where ever possible. Also, these items contain significant quantities of valuable materials, which, in a sustainable society, will be recovered and recycled for reuse. However, materials recovery that is conducted in an environmentally sound manner will not be conducted in PICs as the process is a complex industrial one. Thus Ewaste must be exported out of the region for processing to an acceptable standard.

The challenge that this report addresses, and seeks to provide a pathway forward to deal with this problem, is how to recover these materials in the Ewaste stream from PICs, get them to overseas industrial recycling plants, and create a system that is sustainable, which ideally will co-exist with existing waste streams of other materials sent from PICs overseas for recycling.

As the purpose of this study to assist Pacific Island countries (PICs) deal with their rapidly expanding Ewaste problem, the first step might then be - if we follow the global Three Rs system - can we ***<u>Reduce</u>*** the quantities of electronic materials in use? This is largely connected to the level of economic development and consumer behaviour in any specific country, and outside the purview of this study; as such, this issue is not dealt with here.

The next step then is: can we *Reuse* any items so that they do not become waste or scrap, so that their movement into the waste stream is delayed? This is a matter of capacity to repair electronic equipment locally, and an assessment of this capacity is a part of this study, being provided briefly for each target country, with an overall assessment at the beginning of this report as to whether improvement in capacity to repair electronic items is a viable way to significantly decrease flows of Ewaste.

Finally, how can we recycle WEEE such that it can be taken out of PICs and sent offshore to recycling facilities that can recover valuable materials, given the difficulties already faced with solid waste management (SWM) in PICs? This step is the main focus of this study, and involves several interlocking parts, namely, local legal structures, local recycling business capacity, technical requirements for any initial processing that may take place in PICs prior to export, including H & S (Health and Safety) issues, and then a look at the downstream processing system, such that all processing complies with existing conventions (such as the Basel Convention) and that final processing is occurring in facilities that act in an environmentally acceptable manner and to recognised international standards. The study of these issues, and recommendations resulting, comprise a very large part of the work laid out here.

This report is also mostly taking the view of Ewaste being electronic equipment, rather than the wider definition which would be any item that has a power cable attached and/or uses electricity at some point in its operation. This wider group includes items such as washing machines, fridges, cookers ('white ware'), power tools, air conditioners, and a whole range of electric motor power devices. With the increasing amounts of electronics in modern vehicles these will also become significant Ewaste generators in time. The processing of such items is largely a scrap metal operation, and it is not covered by any Basel Convention rules. As such, it is in large part already dealt with by existing recyclers, but there are synergies between the two such as where PCB (Printed Circuit Boards[4]) are components of white ware, and some instances of Brominated Flame Retardants (BFRs) being present in some plastics in these products. The Printed Circuit Board acronym used here must *not* be confused with PCB liquids[5], which have been used in electrical equipment in the past as cooling and insulating liquids. Where the term PCB is used here, it will refer to 'printed circuit board', as PCB is a widely used term in the e-scrap industry and the Ewaste literature. In turn, 'e-scrap' refers to items that have a potential commercial value as part of a recovery stream.

Cathode Ray Tubes (CRTs) are an exceptionally difficult waste, are in rapid decline and amounting to largely a 'legacy' waste problem, provide a special case and will be dealt with through specific recommendations throughout this report, most notably at the end of Part Two. Mostly, the reader should be alert to whether or not CRTs are included in specific recommendations around the model system design.

This report is provided in four parts:

Part One comprises a general situational analysis overview regarding Ewaste in PICs, the capacity for repair and reuse in the target nations (Cook Islands, Kiribati, Samoa and Tonga) and the problems faced by the commercial recycling sector in PICs. This section also provides analysis of the economics of the only successful eDay that has been run in the Pacific Islands, and also some details of the situation where two projects currently support Ewaste work in Tonga and Kiribati. This part also has a brief overview of the current state of the industry in New Zealand and Australia, indicating the state of the regional Ewaste recycling markets and government policy.

Part Two moves from the analysis of Part One to provide a model recycling system solution based on the principals of Product Stewardship (PS). The intention is that this system provides a clear guide for implementation of WEEE recycling in each country participating in the SAICM project under SPREP. This section finishes with special recommendations concerning CRTs as an especially difficult waste.

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[5] Poly Chlorinated Biphenyls

Part Three provides country status reports of the four countries visited during the course of developing the model system, with information and analysis relevant to the issues to do with starting, or improving, Ewaste recycling.

Part Four provides technical information that any recycling company or project, or any national regulating agency, will find useful regarding the level of WEEE reprocessing suitable for PICs, how to increase value of shipment through sorting and identifying any H&S (health and safety) hazard issues that are associated with this work.

The information in parts One, Three and Four has been instrumental in developing the model, but, for clarity, the model is provided prior to some of the analysis so that the details of the model are not lost amongst technical and country specific information.

PART ONE: Situational Analysis

This part of the study analyses how Ewaste comes about, how it might be minimised, how the commercial recycling sector in New Zealand[6] – as an example – operates, and an analysis of the economic lessons and insights resulting from the experience of eDays and other project work in the Pacific.

1. Repair of Electronic Equipment in PICs

For each of the four countries visited, a selection of electronic repair businesses was visited in order to gain some insight into local capacity for repair of electrical goods. The purpose being to see if it were the case that improvement in ability to repair electrical goods could make a significant impact on the Ewaste stream. The four countries visited, Kiribati, Samoa, Tonga and the Cook Islands provide a good sample of the various stages of economic development found across PICs. In all countries, a viable and vibrant commercial sector exists to supply and repair electronic equipment. Country specific details can be found in Part Three.

1.1 Existing Capacity to Repair Electronic Equipment

Those established businesses supplying electronics have found that they need to have some capacity for repair in order to gain credibility as suppliers. Indeed, those larger businesses who supply such items as computers from large global brands have to take on warranty responsibilities, and this brings them into a process of training by the global companies. Warranty claims for small problems that require an item such as a laptop is returned – by air mail – thousands of miles, are very costly for global suppliers, and so economic drivers push the system such that technicians are increasingly better trained[7]. The country where this process is least developed is Kiribati, but even there, there was no problem to find companies who can repair electrical goods, and the difference in this regard from as little as five years ago is significant[8].

It is also important in this regard to ask why items become Ewaste. Whilst there is the obvious case of outright failure of an item, in many cases there can be a partial failure, or intermittent problem. This is compounded by two ongoing pressures: the relentless development of electronic equipment with more features, and compatibility issues as the basic operational formats change (e.g. computer operating systems and media formats such as tape to disc). The cost of repair, and the ability to gain spare parts can be a significant constraint, which then means that even though something may be technically repairable, the cost of doing so is high compared to replacement with a new one, which in itself is 'better' and more compatible with current norms.. These various pressures mean that the simple technical fact of whether it is technically feasible to repair an item may not be the primarily driver as to whether it becoming waste. Also, in PICs, the normal ambient environment is one that is hot, humid with air that has a high salt content from winds blowing steadily off the surrounding sea. This has the typical effect of

[6] The Australian situation is essentially similar to that in NZ.
[7] Pers. Comm. Samoa Information Technology Society president June 2013.
[8] Consultant's personal observations having been a regular resident in Kiribati over the last decade.

shortening the life of many electrical items through internal corrosion, a problem that may be very difficult to deal with at the point of failure.

1.2 The New Zealand Ewaste Business Model and Repair

For most people in New Zealand, disposing of WEEE appropriately means paying someone to take it away. Where one takes the item oneself to certain businesses (typically only in the largest cities), some items may be dropped off for free (with the general exception of CRTs which typically cost around $20). The collection of CRTs and other Ewaste is currently occurring through a number of private, local authority or not-for-profit/community enterprise collection services. The RCN e-Cycle network has a national coverage. It is a partnership between a recycler, RCN, and the Community Recycling Network. The establishment of the e-Cycle collection network received funding support from the New Zealand government's Waste Minimisation Fund. This contestable fund spends money generated from a levy on waste to landfill.

Since September 2012, the New Zealand government has been running the TV TakeBack Programme (http://www.tvtakeback.govt.nz/content/minister-launches-tv-takeback). TV TakeBack is an initiative that involves the government of New Zealand partnering with a range of recyclers, retailers, producers and councils to help recycle more TVs. Through the programme, the New Zealand government will provide partners with subsidies to reduce the cost to New Zealanders for diverting televisions from landfill. The TV TakeBack programme coincides with New Zealand's switch from analogue to digital television (Going Digital). As a region gets closer to going digital, more drop off locations for recycling televisions will be opened. TV TakeBack is funded through the Waste Minimisation Fund. There are currently 3 recyclers involved in the programme: RCN, RemarkIT and Sims. The programme also has retail partners which has increased the number and type of collection options for end-of-life televisions. The recyclers, and other partners involved in TV TakeBack are investing in infrastructure at drop off sites and at recycling and dismantling centres to be able to continue to collect and recycle televisions beyond the duration of TV TakeBack where possible.

The programme is providing a subsidy for the recycling costs for TVs with a maximum charge to the public at drop off of $5 per TV. Most of the material so collected will be sent off-shore for eventual end-processing. Even so, significant quantities of CRTs are still making their way into landfills, and CRT glass is, at the time of writing, is a difficult waste stream to find a suitable end-use.

It is notable that the smaller Ewaste operations interviewed in New Zealand had a common business model that involved accepting Ewaste either for a small fee or for free, and first determining if it can be repaired, or parts recovered to repair other items. Items that can be repaired – or are still functional which is also common – are sold on through the second hand market. The waste materials generated from non-functional or non-repairable items become the Ewaste stream. It is significant that some businesses currently involved in Ewaste collection actually started as electronic repairers, but found that they generated significant quantities of Ewaste as a result of their operations, and have then adjusted their business models so that Ewaste becomes significant part of their business. These businesses break down materials that they either cannot repair or retain as parts, and sort and sell on to larger aggregators who are moving large quantities of Ewaste to off-shore processing plants; or even in at least one case become an exporter themselves.

The larger operations in the Ewaste stream, typically the accredited aggregating companies who accept Ewaste from the smaller operations, work to a different business model. Their primary market is larger companies and institutions such as government and schools, and the primary product they sell is data destruction and responsible removal of Ewaste. Electronic suppliers to large corporations typically remove old computers and IT equipment when new equipment is installed, and the customers want to be sure of two things: that any data on any equipment is destroyed, and also that their equipment is dealt with in an acceptable manner and that their corporate logos or other markings are not discovered on a riverbank in Asia with a six year old boy melting circuit boards over an open fire, or some such scenario. Business and other organisations pay money to ensure that these two functions are fulfilled, and this provides the basis for a compliant and controlled Ewaste recycling business.

For PIC Ewaste to be recycled to an environmentally and social acceptable standard, the waste must be channelled into the Ewaste stream described above. Companies that provide the end recycling processing services to any of several international recognised standards are identified in Appendix 1.

1.3 An Appropriate Logistical Chain for PIC Ewaste

The New Zealand small business model would work well in the Pacific, where electrical repair shops should be the ideal first stop for any item becoming potential Ewaste, as it can be seen that an outline of a suitable logistical chain is emerging from the analysis above. The technical people in these repair businesses are best placed to determine if an item can be:

a) Economically repaired, and if so repair it, either for re-sale or for a customer (or owner);

or

b) Retain any spare parts that they wish to hold in stock that may be useful to repair other items that come in;

c) Identify parts that have become Ewaste such that they are sorted correctly into categories in order to maximise recycling value.

In New Zealand, the excess Ewaste is passed downstream to another business who is exporting for recycling; in the Pacific Islands, the process currently stalls at this point. Every single electronic repair business interviewed during this study had excess stocks of Ewaste items that they wished to move on to someone else if they could, typical amounts being enough to fill a 20ft shipping container or so. All businesses interviewed highlighted this as a problem, and were enthusiastic about any system that could ease this problem. Storage costs money; indeed, this problem can be found further up the chain of ownership where government, larger companies and other organisations can all be found to have significant quantities of Ewaste stacked up in odd rooms taking up space which could otherwise find productive use[9].

In all countries, Ewaste can be found dumped informally; for example in Rarotonga, an island of only 14,000 people, even during the short visit of this study significant

[9] For example SPREP has an entire office room which is only used to store WEEE.

quantities of all types of WEEE were observed informally dumped[10], yet the main suppliers of electronics were doing their very best to retain their Ewaste as all reported large stocks and were eager to hear of any potential solution to their rising problem. This pattern is ubiquitous.

This study then draws several initial conclusions from the situation described above:

1) Ewaste generation is not caused largely by a lack of repair capacity in PICs; this repair capacity does exist and is improving, and driven by market forces;

2) The best ‘entry point’ for items to enter the Ewaste stream is through existing repair shops, who are best placed to either repair items – if economically and technically feasible – or recover any useful parts for spare parts stocks;

3) Electronic repairers are well placed to break down WEEE and sort into categories for on-sale to an exporting recycler as they can do this as part of their daily work (they typically already opened up an item to see if it is repairable), and as part of the spare parts recovery process; this approach also helps them deal with their space problem caused by large quantities of old equipment as items are broken down and moved out to any exporting recycler.

4) A downstream ‘value stream’ for Ewaste needs to be in place such that the electronic repairers can feed into this systems to remove WEEE from their premises. The Ewaste will then move to the local aggregator – the local recycling exporter – who ideally can afford to buy Ewaste from the repair shops, where they have input the labour required to break down the equipment and sort into suitable categories[11].

In outline: Ms. X takes her DVD player to company A and asks them to fix it. They open it up, and tell her it will cost $D but that she can buy a new one for $N. she decides to buy the new one. The company agrees that it can take the old item. It then pulls out the circuit boards, cuts out cables, removes the electric motor and puts the metal case in the scrap metal bin. All countries surveyed have scrap metal recyclers, and this immediately can get rid of much of the bulk. The disassembled parts are put in cardboard boxes – such as banana boxes – and every couple of weeks or so the items are sold to the local recycler by weight for each category. The business also gets the opportunity to save any parts for ongoing repairs, without the problems of bulk that are typically involved in storage.

This approach should result in a system where all valuable parts of the Ewaste stream are moving to the exporting recycler, rather than the current situation where some materials - especially copper windings – are removed from items such as CRTs and so devalue the entire waste stream[12]. It is essential that the more valuable parts of the Ewaste stream are not ‘cherry picked’ out as this will very likely result in the remainder having such a low value such that it cannot be exported, and so end up dumped into PIC landfills or informal dumps. This remainder material is largely where the toxic chemicals reside, and as such it is essential to avoid this situation (currently very apparent in Kiribati). A key driver of the model system presented here in Part Two is to avoid this

[10] See Appendix 3.
[11] Suitable categories can be found enumerated in Appendix 2.
[12] Most commonly seen in Kiribati where nearly all CRTs are found to be broken whilst the copper windings in the Yoke are removed for sale as scrap copper, devaluing an already low value item.

situation happening by creating a value stream for the entire Ewaste stream, a value which is to some extent independent of its recyclable value overseas by using a Product Stewardship approach.

The challenge is to create that value stream such that electronic repair shops are motivated to take old and broken equipment, and that recyclers can afford to pay the electronics shops for the sorted Ewaste. What sort of value is required, and what are the key constraints?

2. Recycling of Ewaste in PICs

Recycling in PICs is a difficult business and one which faces significant challenges. It is of note that very often owners of businesses who are involved in PIC recycling are people who are motivated on two counts, one for business, and another for environmental reasons. Without that second passion for their work, much current PIC recycling would not be taking place. This section looks at some of the challenges involved.

2.1 Constraints for Commercial PIC Ewaste Recyclers

All four countries covered (Cook Islands, Kiribati, Samoa and Tonga) have commercial recycling operators. However, the range of materials recycled is comparatively small, and none are successfully recycling Ewaste routinely or systematically, for the economics as things stand are not too good. The largest economic constraints for a commercial Pacific Island business involved in recycling in general are:

- High shipping costs to overseas markets;
- Low volumes of materials;
- Variable prices for recyclables and long lead times between collection and payment after shipment.

The main commercial advantage a PIC recycler enjoys over his overseas counterpart in NZ or Australia is low labour costs, but the shipping costs – and frequently the cost of fuel or electricity – do not fully compensate for this advantage.

Low volumes tend to have the result that shipping containers of some materials can take a long time to fill, and so cash flows between sales of materials can be a significant obstacle to an otherwise viable business activity. Similarly, variations in market prices can have the effect that when a material is first collected for subsequent export, prices might be good, but by the time sufficient quantities have been processed to fill a container, and that container received by the buyer, price movements can mean that the whole exercise operated at a loss, or minimal profit. Similarly, with the business typically reliant on single, large payments after export, often to a single buyer, revenue stream are not diverse enough to withstand quite small commercial disruptions. PIC recyclers are typically small businesses that are not highly capitalised, and so cash flow is a constant issue. This makes such businesses typically reluctant to become involved in a sector if the benefits are not clear. In the case of Ewaste, it is clear from interviews with recyclers that their knowledge of the business is at an elementary level in many cases, and so Part Four of this report – along with some information in the Appendices - seeks to provide useful information to help those in the recycling business better assess the risks and challenges.

Experience elsewhere has shown that where the recyclable materials can be bought in sufficient volumes to the recycling company at a low cost to that company, this can help overcome the very high shipping costs that recyclers typically face. Also, where revenue to an operation can be split between a locally generated 'Handling Fee' and income from shipments overseas, the business model can be much more robust[13], and may even allow a recycler to stockpile materials waiting for price improvements. All these points are generic to PIC recycling operations.

Where a recycler is operating at the mercy of market forces, they can only afford to go after the highest value parts of the waste stream. This 'cherry picking' has a significant adverse impact on the E-waste problem in PICs. Because most WEEE will contain copper in some quantity, by removing the copper fraction - the most accessible of the high value contents - the value of the entire E-waste stream is depressed. This results in it being even less likely that most WEEE is concomitantly recovered, and more likely that Ewaste is landfilled locally, or dumped informally.

The problem is in reality even more acute: removal of copper parts for non-ferrous metal shipment has two very common outcomes: Cathode Ray Tube (CRT) monitors and TVs are very commonly damaged in the process of copper removal, such that they then become an exceptionally difficult waste to handle, being both potentially toxic from the broken leaded glass content, and physically dangerous from jagged glass shards. Similarly, people trying to sell copper electrical cable to non-ferrous scrap dealers will often burn the insulation off the cables in open fires, so increasing the value of the material to the buyer by removing non copper parts, typically PVC insulation. This open burning process is excellent for producing highly toxic dioxins and furans which are known powerful carcinogens[14].

2.2 Key Parameters for Ewaste Recycling

The basic parameters of a solution that can involve the existing commercial sector in taking E-waste for a profit for shipment overseas can then be seen to be as follows:

- Avoidance of 'cherry picking' of WEEE so that only the high value parts are sent for recycling, leaving the bulk for landfill dumping in PICs;
- 'Level the playing field' for PIC Ewaste recyclers to that of their overseas counterparts; that essentially means finding some way to ameliorate the high shipping costs;
- Gain some leverage over the local recycling process to avoid the worst environmental excesses (such as open burning) being driven by commercial imperatives; and
- Encourage approaches that might bring the WEEE to the local recycling company's door at minimal cost to the recycler; this is likely to require creating a

[13] Both of these assertions in this paragraph are borne out by the operations of the CDL systems in place in Kiribati and FSM, where PET bottle in particular are exported only because the handling fees built into the system make this possible.
[14] Frazzoli, et al 2010: Diagnostic health risk assessment of electronic waste on the general population in developing countries' scenarios

value chain for WEEE in some manner, ideally through the electrical repair businesses.

So the question then becomes: what mechanism could be put in place that might encourage the commercial, sector to deal with these four main points, and mindful of the requirements identified for the electrical repair sector to ensure their participation?

2.3 Current Value of Ewaste in Australia & New Zealand

A key issue is value of Ewaste, and so a look at developed Ewaste markets in the region is appropriate. Current values of WEEE in Australia and New Zealand vary significantly depending on where one is in the chain. For households and organisations trying to disposer of unwanted WEEE, this typically comes at some sort of cost, even if it is the hidden one of taking it to a drop-off point at a processor. Collection is termed 'Stage 1' processing in the industry, and it is common that people pay someone to collect at Stage 1. 'Stage 2' is where WEEE is broken down manually to some extent, and it is at this point that some value starts to appear in the chain, but it does cost money to process at stage 2, primarily through labour and workspace expenses.

For householders and the general public, much WEEE can be dropped off at specific recyclers for free, but for people outside the large cities, charges usually apply[15] if taken to provincial recycling centres. The main exceptions are CRTs, printers and large photocopiers, which usually always have a fee. It is usual in New Zealand to pay $20 - $30 for a company to accept a CRT, and maybe up to $70 or more for a large photocopier. It is also usual in New Zealand and Australia that these items cannot be sent to landfill. As noted, most businesses in the Ewaste chain in NZ are also involved in some way in recovering usable items from the Ewaste stream, and re-selling them into the second hand market, along with the other main business of taking corporate IT equipment and ensuring that proprietary data is destroyed, generally on a fee-for service basis.

Once WEEE is manually dismantled and sorted by category, some value starts to emerge for bulk Ewaste. Values are very wide[16], and range from around $NZ80-90 per tonne (8¢/kg) for components such as keyboards and computer mice, up to NZ$6-7,000 per tonne for the highest grade PCB scrap. Low grade PCBs may only make $250/t, and computer power supplies $400/t. Overall, this study will use a 'Ballpark' figure of NZ$1,000/t ($1/kg) as something that might give an indication of the values that a recycler might achieve from manually splitting up WEEE. This figure is *before* the cost of dismantling, and shipping. It can be seen fairly clearly that it the business models enumerated above of either being paid to take the WEEE, or providing services such as data destruction, are likely essential in NZ and Australia if these businesses are to be viable. However, these models may not work well in the PICs under consideration here, due to the 'no cost' dumping options, the lack of large businesses interests who will pay for data destruction and similar economic constraints.

In PICs, whilst the drop-off for free model may be feasible for some people who have their own transport, and in small places with better economic conditions such as Rarotonga, it will not necessarily stop significant amounts of E-waste ending up being

[15] For example www.rcn.co.nz/Ewaste charges
[16] See Appendix 2 for some more indicative price detail

dumped locally. Where the items can be given a value, they may find a market locally. Indeed, a Tongan recycler of Ewaste is paying currently 5¢ per kg for Ewaste. Whilst this isn't much, it is better than nothing, and it has encouraged local repairers to bring Ewaste in to the recycler[17]. If the model common in NZ is used, that of receiving companies first looking at the potential to repair and on-sell, then the best place to start the E-waste value chain in PICs will be local electronic repair shops. These places already generate significant E-waste from their operations, but they also typically have non-functioning items 'dumped' on them by people who do not pay the repair bill or who do not want the item back once quoted the cost of repair.

2.4 PIC Recyclers and the Ewaste Value Stream

As noted, the only significant economic advantage that the PIC recycler has is labour cost. When it comes to some recycling, this may not be that significant, depending on the level of mechanisation, but with Ewaste, the first step to increasing the value of the materials collected is to manually disassemble items and sort the resulting sub-assemblies by category of different value[18]. This has the effect of increasing the value of any shipment over a mixed one. This being a labour intensive task, the PIC recycler can find themselves at an advantage over their New Zealand counterpart who has higher labour costs, but only if they know how to take things apart easily and safely, and what value categories to sort parts into. These issues are thus dealt with in Part Four of this report, with the intention of providing capacity support to those PIC recyclers identified as interested in working in this area.

Manual disassembly has the effect of not only increasing the value of those items collected, but also dramatically improves the shipped density of materials. Where weight of a Full Container Load (FCL) is not a limiting factor – and it is not with Ewaste - it is essential to get as much product as possible into each FCL. Thus the manual effort involved in disassembly has a double benefit, and volumes of E-waste can be reduced by at least a factor of six from the volume collected, and perhaps by as much as a factor of ten. Much of the materials discarded will be steel scrap from casings, but other bulky fractions may well be plastic housings, for example from the rear of CRTs, which can be baled in a vertical baler and then on-sold.

In a successful PIC recycling stream, there are two main types of commercial operators who need to be competent in breaking down and sorting E-waste: they are the recycling companies themselves, and any electrical repair companies. This second group produces significant amounts of WEEE themselves[19], and as noted they are well placed to do breakdown as part of ongoing operations, and on-sell the sorted e-scrap. An additional advantage of having the electronic repair operations as part of the recovery stream is that they are typically located in places where the public can find easy access to them, rather than going to industrial areas or landfills where recyclers are usually found.

However, if it likely that even with the advantages of cheaper labour costs, the Ewaste value chain is still a constraint to commercial processing in PICs, how can this value chain be affected such that values can be increased for the PIC participants (and that

[17] Pers Comm. DataLine, Tonga May 2013.
[18] See Appendix 2.
[19] For example Taotin Trading in Tarawa reports having two FCL plus two warehouses full of old equipment that they do not really know what to do with it.

may even include the public at large) with a simple mechanism that can achieve the results sought, but ideally keep most of the value in the country? The model that may provide an answer is Product Stewardship in some form, and that model is the subject of Part Two of this study.

3. Economic Analysis

This final section of Part One looks at the current economics of the Ewaste stream (mindful that there are currently no unsupported commercially viable operations in the target countries), using information from the Cook Islands eDay and project support in Tonga and Kiribati.

3.1 eDay Model Analysis

As part of developing a model system that might be applied in several Island nations, (albeit with some individual characteristics to suit each nation), it is important to assess any existing approaches to collecting and exporting Ewaste in the region. One approach has been to hold a dedicated 'eDay' at which temporary Ewaste collection points are set up and people bring in Ewaste for drop off. These have required one-off funding and one-off event organising, but do collect a lot of equipment in one or two days. They are typically restricted to accepting certain classes of Ewaste, such as computer related equipment.

New Zealand has most experience with these events, having conducted eDays annually between 2007 and 2010 which were part funded by the New Zealand government through the Ministry for Environment (MfE), and these are well documented. These have now ceased as the New Zealand government wants a long-term solution for the management of e-waste that is available every day.

The only eDay known to have taken place in the PICs covered by this report was that in the Cook Islands in December 2010. The items accepted for drop-off were largely only those related to computers and peripherals, with some small number of digital cameras and mobile phones also accepted. A total of 5,154 items were counted, and these were placed in seven FCL twenty foot equivalent (TEU) shipping containers which were sent to New Zealand. Two hundred and thirty eight vehicles dropped off the Ewaste, an average of 21.6 items per vehicle. Seventy volunteers were involved in the process, requiring significant organisational support which was provided by the eDay Trust of New Zealand. The total dollar cost of the operation was $78,987, with the Ewaste shipped to NZ having to be paid for to be taken by a processor in NZ. Items were packed direct onto pallets and into containers with no dismantling, following NZ eDay practise. Significant local sponsorship was provided by local businesses and government, such as waiving of port charges and raffle prizes for those who bought items in for recycling, which is not reflected in the cost. The actual dollar cost per piece collected was $15.3321[20].

[20] Note that a mouse or a keyboard was also considered one separate piece

3.2 Economic Analysis of the Cook Islands eDay

The minimum wage in the Cook Islands is $5/hr. If the volunteer labour was costed out at a minimum wage, simply for one day (some people were involved for several days) and at 8 hours[21] for 70 people, that would be an additional $2,800. $1,540 was actually spent on volunteers' drinks and food.

Shipping / transport costs, including customs, insurance and all associated logistics costs, were $29,400, being $4,200 per FCL. The cost of recycling the items in New Zealand was $35,390, being $33,470 for 1101 monitors, at a cost of $30.40 each; and $1,920 for 543 printers, being a cost $5.53 each.

For the purpose of evaluating this model for use elsewhere, some assumption and rounding of the numbers is made, in order to develop an indicative cost per unit collected. These costs are in 2010 figures.

- Let it be assumed that:$80,000 dollars would collect 5,200 units of Ewaste, providing a raw cost of about $15.40 each;
- Let it be assumed that if an eDay was a regular annual event it would be easier to organise and so might cost slightly less, so a figure of NZ$15/unit collected will be used as an indicator[22].

One point of interest to note is that the average vehicle drop off rate was 21.6 items per vehicle. Whilst there were some categories that covered small items, such as computer mice, keyboards, speakers and printer cartridges, if these small items are amalgamated, they come to 1,397 items. If these are taken out of the equation, then 238 vehicles dropped off 3,757 items, being around 16 pieces each. This is a higher unit rate than might be expected if this was a largely household collection. The indications are that a significant quantity of this material had been stockpiled and also came in through commercial and institutional routes. Targeting these larger sources could generate a significant amount of Ewaste at a significantly lower cost per unit, especially as these sources will generally willingly transport the Ewaste to a local drop off point in order to get rid of it.

If the seven FCL had been broken down into component parts, the glass from the CRT monitors removed and not shipped (but the other parts of the CRT removed and recycled), and plastics and steel casings baled, it can be reasonably be expected to fit all the materials into a single FCL, which would cost an estimated $4,200. In addition, as the materials had been broken down, there would certainly have been no payment required when delivered to the downstream receiver in NZ. If this scenario is considered, it might be expected that $25,200 of shipping costs (six FCL) plus the $35,400 in payments to the recycler could be avoided. This would amount to $60,600 savings.

What would it cost to break down 5,200 items into component parts? If those items took one year to break down manually, assuming 240 working days per year, and 7 working hours per day, that would amount to three items per hour. If the person breaking them down was paid at the minimum wage[23], this would cost around $11,000/yr[24]. If the

[21] A nominal day's work.
[22] If a rate of 0.8:1 for conversion to USD is used, the cost per unit collected in an eDay might be US$12.
[23] Cook Islands minimum wage is $5/hr.
[24] Assuming 8 hours pay per day.

person breaking it down were paid twice the minimum wage, it would still only cost around one third of the cost of sending the items whole. Processing three items of Ewaste per hour, to split them up in a way as described in Part Four of this report, would be a very slow rate of disassembly, given that items such as phones, keyboards and mice can be processed in seconds rather than minutes, and a typical CPU from a desktop computer might take five to ten minutes to split it up at most. It might be reasonable to expect to split up that equipment in less than one year, say half a year and at a cost of $10,000[25] if wages were double the minimum wage.

In addition, the materials resulting from the breaking down process would have some value, as indicated in Part Four and Appendix 4. If it is assumed that[26] the value is $1/kg, and that 5 tonnes would constitute one FCL of Ewaste, then the value of an FCL might be $5,000. If it is assumed that it cost $10,000 to process it, then the full cost is $10,000 + $4,200 for shipping, minus the $5,000 received from the sale of materials, total cost being $9,200. If we assume that this applies to only 5,200 items, then that gives a cost of around $1.80 per item.

These figures are provided only as indicative, and obviously are somewhat ‘Ballpark’, but have been developed under a very conservative scenario (i.e. high cost); however, it can be clearly seen that the potential cost per item is significantly lower where a breakdown approach is followed rather than an eDay approach. The numbers are quite far enough apart that there is plenty of opportunity to increase costs of the ‘breakdown’ approach and still have this model significantly cheaper than the eDay model.

A big difference is generated by removal of the CRT glass from the shipped stream, and it is *very important to note that the analysis above assumes that CRT glass is removed* and not shipped, and that CRT monitors and TVs are not sent whole, or paid for to be recycled at the other end. There are two potential ways to deal with CRT glass without significantly impacting the costs outlined. One is to crush the glass locally and ship it with the Ewaste[27], the other is to dispose of the glass to landfill locally[28].

3.3 Economics of a Product Stewardship Approach Vis á Vis eDay

If it is assumed that a cost of $2 per item is a cost of processing and shipping where the items are broken down, then if a value in excess of $2/item could be found and then directed to the processing and export, it can be instrumental to look at the impact of that in order to create a commercially viable operation.

In 2009 the National Environment Service (NES) of the Cook Islands carried out a study of the Ewaste issue[29]. From the 2001 census, around 12,000 items of potential Ewaste - including mobile phones - were identified of general electronic equipment of the type we are concerned with here. Note that these numbers do not include things such as computer mice and keyboards, which were separately identified in the eDay collection numbers.

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[25] This can be expected to be a very conservative estimate.
[26] Pers Com Barry Exeter of TES-AMM, these conservative values are purely informed ‘guestimates’, but have some validity coming from someone in the business.
[27] Likely method being in steel drums with clamp on lids, and assumes that someone is prepared to accept it at the other end, but value will be most likely negative.
[28] This issue is dealt with in detail at section 7 as it is potentially controversial and not ideal.
[29] Teariki Rongo, 2009: Draft 3 Status Report Ewaste (Cook Islands).

The rate of increase between the 1996 census and the 2001 census of the electronic household items category was around 15%, over the five years. If we apply the same simple approach to these numbers, then it can be expected that in the ten years since 2001 there will be around 16,000 items by 2011. This is purely household electronics. The population of the Cook Islands at 2011 was 17,800, so it can be fairly said that, for purely household electronic items alone, there is around one item per person[30] by 2013. This does *not* include any business, government, school or commercial Ewaste.

If it is assumed that each item has an average lifetime of 3 years, then it can be expected that one third will become waste each year that is around 18,000 items in use today[31], or 6,000 items of Ewaste per year. This equates fairly well with the 5,200 items collected on the eDay. If 6,000 items per year arrive into a recycling system on a daily basis, five days per week, allowing for holidays, that is around 240 working days per year, which would be 25 items per working day. If the commercial and government sectors are added, let it be assumed that 30 items per day are processed, and that when broken down they fill two FCL TEU per year.

- The number of items processed per hour is 4.3:
- The cost of shipping two FCL is $8,400.
- The labour cost is $20,000 (double the minimum wage in the Cooks)
- The total cost is $28,400, let it be assumed $30,000.

If 7,200 items must provide $30,000 then each item needs to pay $4.20 at import in an Advance Recycling Fee to raise that much money. The value at which the recycler sells the materials shipped becomes profit, less additional running costs such as electricity, fuel. If, say, $4,000 is made from spending $30,000, then that is a Return on Investment ROI) of 13%, not huge.

3.4 Analysis of Other Current Ewaste Projects

There are two additional examples where Ewaste recycling is receiving some development project support. One is in Kiribati, where the current NZ AID project has spent around A$5,000 to put in place some basic infrastructure to start handling Ewaste. This system is still in its infancy, and no local recycler was handling Ewaste before. Indeed, local recyclers were buying scrap copper, and this has resulted in most discarded CRTs being physically damaged through having the CRT funnel glass snapped off to get the copper windings out of the yokes around the electron gun. This has created more of a problem than if they were left alone (see the Kiribati country report). At this stage, the Kiribati work is not generating any viable numbers in which to provide meaningful comparisons, but current expectations are that the aid money will assist with a clean-up of some existing waste, and kick off a system that can be sustained using a Product Stewardship system using the existing Container Deposit Legislation.

In Tonga, a GEF project has provided some storage space for Ewaste previously collected in a local eDay from 2010, but this material was never processed, not having significant financial support. This project is providing rent support to a local recycler to

[30] Especially if we count single items at the level of the eDay count.
[31] Assuming the 3% increase per year or so seen before, and also mindful that this is ONLY household items.

operate an Ewaste Stage 2 processing operation, and wage subsidies of two thirds of the cost of two workers who do the dismantling. The local operator is an experienced recycler who has operated many years, and they initial offered 10¢/kg for Ewaste dropped off, now decreased to 5¢/kg. Whilst they have done some numbers for their business, it is clear that if they felt there was more money in the operation, they would offer a higher rate, as there is no shortage of Ewaste in Tonga, and at 5¢/kg it is coming in only slowly (largely from repairers who want to clear their working areas). This indicates that without support, even competent commercial operations cannot exist to process and ship Ewaste from PICs. The final key point is that volumes of materials are likely to be low enough that Ewaste must become just another part of an existing recycling business' revenue stream, rather than a whole new, stand-alone business.

PART TWO: A Model Approach to Ewaste Recycling in Pacific Island Countries

Part Two of this study now builds on the analysis of Part One to the development of a model system, using the principals of Product Stewardship, which may provide sufficient incentive for commercial operation of Ewaste recycling in PICs. A sound and viable system will provide a way for consumers to feed into electronic repairers and recycling companies who are already operating. Any system must be simple to operate, easy to understand, and ideally be fiscally neutral with regard the part any PIC government might have to play in the process.

4. Product Stewardship

Product Stewardship (PS) involves a way of ensuring that consumer products that subsequently become waste are recycled using a mechanism that is connected to the production and initial purchase of the product[32]. Extended Producer Responsibility (EPR)[33] is a very similar concept but more specific in that it ties the producer directly to the product through the product's life. Where there are large local industries, this approach can work well. In PICs, with diverse suppliers of a wide range of items, any stewardship approach will be a broader Product Stewardship scheme.

4.1 The Essentials of Product Stewardship

The common manifestation of the Product Stewardship approach in PICs is the Container Deposit Legislation which operates in Kiribati[34], the FSM and Hawaii, and is slated for introduction in Fiji. A more specific example of EPR is where drink companies – such as brewers – place a deposit on the bottle, built into the product pricing, so that refunds are paid to get the bottle back to the original brewer for refilling, as found in Samoa and Fiji. Thus PICs are no stranger to PS schemes in one form or another.

PS is relatively straightforward where the product is easily defined, such as an aluminium drink can. However, when the diverse product range that comprises WEEE is considered, it would be difficult, and potentially very complicated, to place a direct deposit payment requirement on individual products, and pay a directly associated refund on the same item when it became waste possible some years later. However, by looking carefully at the logistical stream that will handle WEEE, it can be seen that there are points of intervention that could be identified and administered on a simple basis. For

[32] For example, from the NZ Ministry for Environment: "Product stewardship schemes are initiatives that help reduce the environmental impact of manufactured products. When a product stewardship scheme is introduced anyone involved in the product life cycle such as producers, brand owners, importers, retailers and consumers accept responsibility for its environmental effects."

[33] See also SPREP paper: AFD Stewardship background paper, Oct. 2012:
"Extended Producer Responsibility (EPR) is a concept where manufacturers (producers) and importers of products bear a significant degree of responsibility for the environmental impacts of their products throughout the product's life-cycle, including upstream impacts inherent in the selection of materials for the products, impacts from the production process, and downstream impacts from the use and disposal of the products. EPR is based on the principle that producers (usually brand owners) have the greatest control over product design and marketing, and thus the greatest ability and responsibility to reduce toxicity and waste."

[34] See Section 8.5 Part Three for a description of how the Kiribati CDL system works and is legislated.

example a broad, flat rate levy, called an Advance Recycling Fee[35], might be raised on a range of products at import, and this could then be returned to the recycling process at some point in the logistical chain. If done well, this approach might have the impact of raising the value of the entire E-waste stream within a particular PIC, without making any significant impact on the value of the goods imported, and be independent of the value of the e-scrap sold overseas. The obvious point to raise an Advance Recycling Fee (ARF) on electronic equipment would be through customs at the point of import, in a similar manner to the current CDL recycling systems.

The bigger challenge is to identify the point and manner whereby any ARF collected could be returned to the commercial logistical recycling stream, and thus achieve the outcomes sought. But first, the mechanics of an ARF must be looked at in the PIC context.

5. How a Product Stewardship Scheme Might Operate in PICs

In small PICs of less than 200,000 people, the country type concerned with in this report, there will be no local industry producing electronic equipment; thus the issue becomes one entirely of imports. This makes designing and operating the collection side of any ARF system reasonably straightforward, in that the ARF needs to be raised solely at the point of entry of the item into the country. The harder part is feeding the fees collected back into the recycling logistics so as to create incentives for the recycling of Ewastes.

5.1 Initial Identification of Items Subject to an Advance Recycling Fee

Identification of any items that should be subject to an ARF is done using the international Harmonised System (HS) of tariff codes. The HS tariffs use a code of six digits that are harmonised internationally, and an additional seventh and eighth digit that represent additions and extensions at the national level. Whilst individual tariff lines may be slightly different in different countries, the relevant chapters of any countries Customs Tariff will be the same, namely, for the case in question here, Chapters 84 and 85.

However, given that electronic equipment that will become E-waste can be diverse, to keep the system reasonably simple and as an aid to implementation, targeting certain tariff lines using the first four digits will actually likely be sufficient to identify the main target items in a PIC context. For example, 8471.XXXX covers ‘automatic data processing machines’, which will cover all types of computer and the parts connected to a typical computer set-up[36]. As the proposed system is not intending to create a direct link between a deposit and a refund for any specific, individual, item of equipment that may end up as E-waste at some point in the future, it is sufficient to target broad categories, such as computers, TV, DVD players and mobile phones, so that most items are covered. The aim is to create a sufficient base of funding with which to deal with the problem. As will be seen below, as the recycling end of the system is a collection of broken up WEEE, exact matching of numbers is not an issue[37].

[35] As used in Switzerland for example
[36] HS 8471.60XX “Input or output units, whether or not containing storage units in the same housing”
[37] This also addresses the issue where people come in on flights with things like laptops that get around the customs.

5.2 Advance Recycling Fee Payment into a Product Stewardship Fund

Actual revenue collection is done by the national Customs Service at the time that an Import Entry is filed in order to import something into the country. The Import Entry form - these days almost always filled out in electronic format by importers and agents – would have an electronic field such that when certain tariff lines are entered into the form, the ARF field then becomes 'live' and in order to produce a completed Entry, the ARF to be paid is shown up alongside any duties payable[38]. The money so collected by customs at the pointing of clearing any shipment for import needs to be set aside into a separate ARF fund, and this fund is something that needs legislating under suitable regulations[39]. It will also be much easier to have a small, standard dollar amount as an ARF, irrespective of the value of the import, but based on a unit item quantity[40], and this will always make collection and administration easier. A simple, easy to understand system is important for all those involved in collecting the ARF – importers, Customs Officers, Customs Agents – and this is more likely to achieve the outcome of a small fee applied widely generating sufficient funds to deal with the problem at the 'back end'.

Any money collected as an Advance Recycling Fee is placed by Customs into a separate account; almost certainly this account will be operated by the Ministry of Finance / Treasury or similar government body. Placing the money with 'Finance' is likely to be a simple process, as Customs Service collections normally all go to 'Finance'; if the system is set up so that Customs collects money and actually diverts this to an entity other than the 'Ministry of Finance', this may well be found to be legally and administratively difficult. It will almost always be preferable to use existing systems, and add and/or adjust them to suit the aims of the program, rather than set up some completely new system that follows un-tried pathways. It may well be that the Ministry of Environment – or equivalent body – is nominally administering the ARF fund, but the actual accounting, account management and transactions will almost certainly remain under the purview and control of the Ministry of Finance. Trying to set up another entity to control and manage the ARF funds is likely to be more politically involved than simply using normal 'Finance' processes.

The actual details of each system will need to be country specific; however, very clear examples of a similar PS system – but for beverage containers and lead-acid batteries - exist in both Kiribati and FSM that can provide guidance to anyone developing the practicalities of such systems.

5.3 Access to the Advance Recycling Fee Fund

Having collected money in the form of a small ARF on certain tariff lines, this money must now become available to assist the export of these items when they become waste. As noted, WEEE can comprise a wide variety of items, and a system that tracked individual items and associated ARF across years would likely be complex and administratively difficult. The aim of collecting the ARF is to level the playing field for PIC recyclers so that WEEE is subsequently exported wherever possible, in order to remove a potential pollution hazard from the Islands. So, in simple terms, where the ARF

[38] Where an import is zero rated for duty it will still have to make an import entry and so this is not an impediment to this procedure.
[39] The legal status and the potential for setting up the ARF funds in each country are looked at in the individual country reports in Part Three.
[40] HS Chapters 84 & 85 use 'number' as the quantity for recording purposes (other chapters may use kg or litres for example).

payments from the fund are targeted at exports, this should ensure that the aim of the ARF is achieved. The next question is how to achieve this: how can ARF funds be paid out for exports and to ensure that exports are made?

5.4 Accreditation to the Advance Recycling Fee Fund

At this point the regulating agency – likely to be a Ministry of Environment or similar – needs to be involved. If someone is to gain access to the ARF fund, on what basis should they be paid? How can payments from the fund be sure to achieve the aims of the PS scheme? To address these issues, there needs to a be a process whereby any recycling business wishing to access the funds so as to assist them with export of e-scrap can in some way be accredited, such that the administrator of the fund is confident that the money is going to the right aim. That accreditation can be fairly straightforward, but one signal requirement should be that e-scrap is exported with a Basel Permit, as all the PICs involved here are signatories to the Basel and Waigani Conventions. Thus a simple requirement can be that any business wanting to access the ARF fund holds a Basel Permit arrangement with an overseas buyer[41]. This in itself requires that the business in question has contact with the relevant Ministry[42], as they need the clearance of the Ministry in order to fulfil the permit requirements issued to the importer overseas who will receive the e-scrap. Being accredited to access the ARF fund should also assist these businesses with arranging their Basel clearances from the relevant Ministry. (Something broadly similar occurs in New Zealand, but the specifics are different[43].)

It will be possible through this process to also ensure that accredited recyclers are sending Ewaste to overseas processors who are dealing with the wastes in an acceptable way, being themselves companies certified under some process whereby it can be clear that the e-scrap is not ending up – for example being burnt in the open to extract precious metals. Certification processes such as ISO 14001, R2, e-stewards and compliance with Australian/NZ relevant standards are all relevant to where the e-scrap is being sent to the 'downstream processor'. Any certification or standard in an OECD country will be, today, very concerned that e-scrap is being moved downstream to acceptable and reputable operations that will not result in pollution and worker exploitation; this is a basic and fundamental principal of any certification today. Details of companies who are certified under different schemes, or hold Basel permits for export of e-scrap from Australia and New Zealand are provided at Appendix 1.

5.5 Payments from the Advance Recycling Fee Fund

In what form should payments take? Should they be $x per computer, TV, etc? If this path were followed, it could effectively remove a very important part of the Ewaste value chain, as the accredited recycler would want to source whole items, and this would tend to cut out the electronic repair shops, especially where they already break items down to recover spare parts. Where the recycler can take items already manually disassembled, the electronics repair shops have a place in the value chain, as they are constantly taking things to pieces anyway, as noted in Part One, and they potentially have a very

[41] Where the e-scrap is going into an OECD country it will be the reliving country business that actually needs to hold the permit.

[42] or other designated government Basel Focal Point

[43] http://www.mfe.govt.nz/issues/waste/product-stewardship/index.html

important role to play as 'High Street' collectors from consumers with WEEE, as well as ensuring that repairable items are going back out, or useful spare parts are recovered.

With disassembly, volume reduction, and shipment density maximisation being essential steps to take to improve the economics of e-scrap shipments, then the ARF payments should target activities that contribute to this process. There needs to be incentives to ship improved density over non-dismantled Ewaste, and so, if the ARF payments were based on around these parameters, this should encourage this approach. Therefore, payments from the levy fund should be paid out to accredited recyclers on the basis of cubic metres shipped, as volume is the key shipping cost with e-scrap. However, to avoid an incentive to ship items that are not broken down (such that the ARF payments may not be able to cover the volumes that need shipping in an un-dismantled state) the cubic metre measure would need to be tempered with a minimum weight per cubic metre (m^3) - in the same manner as a 'revenue tonne'[44]. This should avoid a perverse incentive to ship largely fresh air, should that – by chance – have a possibility under the economic conditions occurring at any point. Given the different value of different fractions of the e-scrap, a flat rate per m^3 should be applied. This again adds simplicity. That flat rate might be applied such that container density must be greater than 250kg/m^3 [45] in order to be able to claim against the ARF fund. Average FCL weight in the Cook Islands eDay was 6 tonnes/FCL, but the materials shipped had a cost when shipped at this density; the driver for the recycler is to get value at the other end of the shipment, as well as access the ARF to assist in making the whole operation profitable. This figure could be usefully tested in a 'real-life' situation, and this is a particular example of where the project supported work in Kiribati and Tonga should ensure that this type of data is collected in order to help the development of any ARF system.

It would also be advisable to allow a process whereby the recycler claiming the ARF can have the materials physically inspected in order to confirm the export is of e-scrap. Such provisions need not be written into any Regulations; these are the sort of conditions that should be included in any contractual arrangements between the regulating agency and any recycler who wishes to be a 'System Operator'[46].

Thus, the accredited recycler would need to provide evidence of a Basel process attached to his/her shipment, along with m^3 and weight details. The details of where the shipment is going must be already apparent in order to complete any Basel connected paperwork that would permit export.

Payments from the ARF fund must be on a basis such that only once shipment has occurred can a payment be made. A claim can be lodged prior to a shipment actually leaving the country, but such that once a Bill of Lading has been issued, only then can a payment be made. With all and any conditions and paper work completed, the regulating body, such as a Ministry of Environment, can then issue a payment voucher of some form, which the recycler then takes to the Ministry of Finance and receives payment from the ARF fund.

[44] One cubic metre or one tonne, whichever is the larger, a very widely used shipping measure.
[45] This would give around 6 tonnes per TEU FCL (allowing for air space).
[46] To use the Kiribati CDL terminology and model, which is easily applicable in such a circumstance as this.

6. Economic Impacts of an Advance Recycling Fee System

There are several economic impacts to raising an ARF and directing it at exports of e-scrap. Some of these can be either directly measured - or at least some 'ballpark' estimates can be made in dollar terms. These may be listed as follows:

- Increase in retail prices through increased importation costs;
- Increased value of WEEE where it arises in the commercial waste stream;
- Savings in landfill space, and hence costs;
- Job creation through stimulation to the commercial recycling sector;
- Export income to the nation.

An additional impact in avoided costs of pollution is very hard to quantify in dollar terms, but there is a saving. The imposition of an ARF in the manner described above will in effect internalise some economic costs that are currently externalised. For Example many organisations are storing WEEE awaiting a solution for disposal, and as such are actual paying a significant hidden cost by housing items for which they have no use. The actual cost could be said to be twice the value of the area actually taken up, because not only are they paying the cost of that area and getting no value from it, but they are actually loosing any productivity from the same amount of space that they could be using if the WEEE was not being stored.

6.1 Retail Price Increases

The immediate one is that it would add to the price of electrical items. To address this, the ARF needs to be as low as possible in order to effect the impact sought. Where a flat-rate ARF is used, this economic impact will be greatest on lower value items, as it will be a higher percentage of the retail price. If the case of a simple mobile phone is looked at, assuming a retail cost of $60, an ARF of $3 would be 5% of the retail value. For a laptop computer costing $700 retail, the same ARF would be less than 0.5%. It might be fairer to have two levy rates perhaps, say items under $100 c.i.f. at import being charged $1, and items over that price being $3[47]. At whatever rate the ARF might be set, a small dollar amount will not be expected to significantly impact sales of such items, for the simple reason that electronic goods have a wide range of prices for similar items across stores, and the ARF values suggested here can confidently be expected to get lost in the 'price noise' of varying prices, stores and products. By way of comparison, work in Fiji to look at the impact of a 10¢ deposit on beverage containers found that a 10¢ deposit was typically significantly less than the range of prices commonly found for exactly the same product in different stores[48].

As the ARF is raised at import, it simply becomes just another cost to get a product onto a store's shelves. There is no requirement to involve retailers and retail customers in the ARF payment process (unless they are importers) as the ARF is just like a cost of shipping, carriage or any other of the costs that go to make up the retail price of a product. One salient point is that electrical equipment changes so fast these days that an item sold one month may well have changed the next, being slightly different – some new feature/colour/compatibility factor or whatever. This dynamic environment of the

[47] Most target items have c.i.f. costs greater than $100 in PICs, so this is not likely to impact revenues to the ARF fund significantly; also, items under $100 tend to be small and cheap to export, and require minimal processing, e.g. A phone would simply have its battery removed.
[48] Introduction of Container Deposit Legislation in Fiji, UNDP 2009

electrical goods marketplace, with its constantly changing prices, will add to the effect that any small ARF will get lost in 'price noise'.

6.2 Increased Local Commercial Value of WEEE

By providing support to shipping of e-scrap, the value of the e-scrap can be increased locally, i.e. *inside* the target country. The value of e-scrap is typically the price received through sale overseas, minus the cost of collection, processing and shipment to the overseas buyer. A very significant part of this equation is the shipping cost. Where that shipping cost is decreased, the local value of the shipment is increased, independent of the price paid by the overseas buyer. The impact of locally increasing the value of a shipment is that any local purchase price between local participants in the recovery chain can be improved.

For example, currently in Tonga a recycling company is paying 5¢/kg for WEEE; this low value means that it is very hard for anyone else to get involved in the commercial value chain. However, electrical repair shops are known to have significant quantities of WEEE as a result of their activities, thus if the recycler is able to pay more for e-scrap – especially when sorted - the repair shops could find it worth their while to actively breakdown WEEE so as to increase the value of what they sell to the recycler. This approach has the advantage that repairers are already very familiar with how to disassemble WEEE, and easily able to differentiate the component parts recovered. They may also be situated in places easy for the public to reach, and so result in better recovery rates of WEEE from the public.

Similarly, where larger electrical retailers are supplying government, corporate and institutional clients with new equipment, they may find themselves better placed to take back old equipment, disassemble it, and on-sell to the local recycler. This business model is indeed very common in Australia and New Zealand, as noted in Part One. Companies working with larger clients usually supply data destruction services, something that an electrical repair shop can also likely do better than a recycler.

6.3 Savings in Landfill Costs

Associated savings in landfill costs will be fairly easy to quantify. For example, where the cost of building landfill space is $X per m³, and where the volume reduction of disassembling WEEE is, say 8:1, then, in the case of Kiribati, where landfill was A$25/m³ to build, and a 20ft shipping container of e-scrap is shipped out of the country, the resulting saving is of the order of 30m³ x 8 x $25 = $6,000 of landfill space if it were dumped without dismantling. This calculation is necessarily crude – but based on real figures – but does illustrate the economic impact on this point. Whilst WEEE deposited to landfill can be expected to undergo some compaction through being run over by heavy equipment, the rate will be nowhere as high as that achieved through disassembly, and WEEE can be exactly the sort of items that can give landfill operators mechanical problems, with cables getting wrapped around prop-shafts and steel cases puncturing tyres and the like.

6.4 Job Creation and Export Income

The number of direct jobs likely to be created by Ewaste recycling is realistically likely to be small, but might be of the order of two to five in the small PICs looked at in this study. For example, one Tonga recycling company had two full-time staff working on only disassembly of WEE recently. Dismantling of WEEE is a useful training ground for budding technicians, and whilst these effects may be small, they are nevertheless real and positive, especially given the level of proposed ARF.

Export income may be small in dollar terms, but in small PICs with very few exports, recycled materials can in fact comprise significant parts of the export income. Where generally money is flowing out of the country, this is a small step to counter that flow.

6.5 No Overall Local Economic Loss through an ARF

One crucial point to bear in mind with an ARF system such as this: where the levy increases retail costs to consumers, this value will not be lost to the local economy because the benefits of the ARF remain local, as the ARF is independent of the price of the e-scrap overseas, and is fed back into the local economy. This is an important point: the money does not flow out of the country – unless the recycler is an expatriate business and exports its profits.

6.6 Estimating Suitable Advance Recycling Fee Rates

Identifying suitable Advance Recycling Fees for individual nations is beyond the scope of this study, but it is important to have some idea of how much any ARF might be. Part One section 3.3 of this study has looked at that briefly in the case of the Cook Islands, and suggests that a $5 ARF would be sufficient to create the desired economic environment in the Cooks. This section makes some attempt to look at this in a less economically developed nation, such as Samoa or Kiribati. Whilst data on ownership of electronic equipment is sparse, several studies and databases have produced numbers (see Bibliography). If it is assumed that electrical equipment is owned at the rate of one piece per household, and that a typical shipping cost from Samoa to Singapore is used[49], the following analysis is offered.

Assume a country of 100,000 people. Assume an ownership rate of any electronic equipment as one piece per household, and assume seven people per household. Assume that the life of typical electronic item is three years, and assume that items that fail are replaced, and that there is no growth in household rates of ownership. No accounting is made for institutional WEEE producers. CRT devices are excluded from this scenario for specific reasons, including their high negative value (see below).These are fairly conservative estimates.

In this scenario, 14,300 households with 14,300 pieces of equipment would produce 4,800 WEEE items per year, and buy 4,800 items per year as replacements. If each item had paid a $2 ARF at import, that would raise $9,600 per annum.

[49] FCL TEU only, variety of sources agree on a current price of around US$2,500.

4,800 items could be expected to fill perhaps one 20ft FCL, if we look at the Cook Is. eDay experience, assuming that these items are broken down and sorted by category[50]. But let us assume that they fill two FCL TEU; that would be around 60m³ of space shipped[51]. If the $9,600 had to provide an incentive to ship those 60m³, that would provide a rate of around $160/m³ paid to an accredited recycler, which may well give him an incentive to go looking for WEEE to ship, and encourage him to buy WEEE.

It is thus held that the level of Advance Recycling Fee, whilst needing to be different for different countries, will likely fall into the $2-$5 range for the countries in consideration.

Ideally, project support would assist PICs introduce any ARF system, and during this phase sufficient local study can be made, taking account of local costs and conditions, to develop an ARF that achieves the outcome desired whilst minimising the economic impact on all upstream parties. During this introductory phase it should be possible to tune the ARF in the light of experience, especially if project funding is used to in initially capitalise any ARF fund.

7. Devices Containing Cathode Ray Tubes

The model provided above has specifically excluded CRTs, as CRTs are a difficult, 'legacy' waste, with a high negative value, and one that should be rapidly decreasing in the waste stream. This section explains why CRTs are a problem, and the potential ways of dealing with them without upsetting an otherwise viable PS model.

7.1 CRT Physical Properties

Cathode Ray Tubes (CRT) are a 'sunset' technology that was previously ubiquitous in the construction of TVs and computer monitors. Over the last ten years this function has been almost entirely replaced by 'flat screen' TVs and monitors, of Plasma, LCD or LED type. CRTs comprise a glass funnel attached to a glass face panel; the entire device is sealed up and a very powerful vacuum is maintained inside the glass enclosure. The glass parts contain lead included in the glass manufacture; this lead is in different amounts depending on several factors: location in the glass enclosure, manufacture type, or whether the device is colour on monochrome. The subject is a technical one[52], but CRTs have generally been denied access to non-toxic waste landfill in recent years as tests to determine their toxicity[53] have indicated that lead will generally be found to leach out of CRTs if landfilled. The issue has recently become of greater interest in many OECD countries as a switch in TV systems to digital has resulted in a large flow of old CRT devices to landfill. Some states in the US do allow CRTs from domestic sources to be landfilled[54], and of course many have entered landfills in PICs as well as New Zealand and Australia. The part of the CRT that contains by far the most lead is the 'Frit Seal' that joins the panel glass to the funnel[55]. Many CRTs that become waste in PICs

[50] CRT glass elements are not included in this scenario, as the theses is that these are largely legacy and special wastes that need different treatment.
[51] Unfilled airspace will actually be likely more significant that this for e-scrap (one TEU = 32m³)
[52] For further information check papers on this subject cited in the Bibliography
[53] The Toxic Characteristic Leaching Procedure TCLP test a standard created by the US EPA.
[54] Florida Center For Solid And Hazardous Waste Management, State University System Of Florida, Report #99-5, Characterization Of Lead Leachability From Cathode Ray Tubes Using The Toxicity Characteristic Leaching Procedure
[55] ibid

are found to have the neck broken off as the electron gun is surrounded by a copper 'yoke' that has a significant amount of copper windings, enough to make recovery and sale by scavengers worth while. This creates an additional problem in that whilst the CRT glass is whole it is not a leachate problem[56], but once it is broken it becomes a Health & Safety (H&S) problem having sharp glass protruding. In addition, attempts to break off the neck frequently result in the collapse of much of the funnel as the strong vacuum causes an implosion.

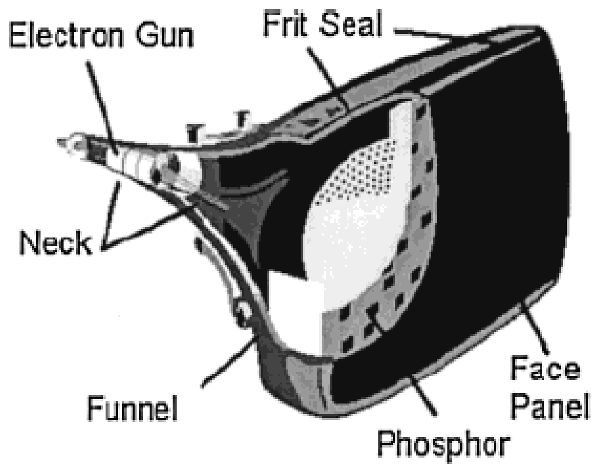

Figure 1: components of a typical CRT[57]

This also exposes the phosphor dust from inside the face panel. Whilst in previous decades this phosphor – a generic name for a variety of mixtures depending on the commercial producer – contained Cadmium in large enough quantities to be of concern, since around 2000 with the implementation of the EU RoHS directives[58] and other measures in the US, cadmium has been eliminated from the phosphors[59] used. As electrical equipment in PICs has such a comparatively short lifespan due to the typically harsh environment, the equipment typically coming in to PIC Ewaste sections is likely to be newer, but items containing Cadmium can still be expected to appear on occasion. Issues around handling CRTs are further explored in Part Four of this report.

7.2 Commercial Value of CRTs

Complete CRTs do have some parts that have value at break down, but as a whole the units are fundamentally of negative value. The Yokes contain copper windings of fine clean wire; the degaussing wire is thick copper wire; both have good value. However, the circuit boards are usually the lowest value, and the plastic housings – where older – may well contain Brominated Flame Retardants (BFRs) which can make on-sale problematic. Very old units may come in wooden cabinets. CRTs are heavy and awkward to handle, and difficult to stack onto pallets if shipped whole.

[56] ibid
[57] Sourced from the paper cited above.
[58] Restrictions on Hazardous Substances: Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment
[59] For example Material Safety Data Sheet for 'CRT Luminophore 2111' made by Nichia North America Ltd. contains 99wt% ZNS; 0.5wt%Ag; 0.5wt%Cl. Sept. 2003.

Prices are poor and almost certainly negative for complete units. For example, in New Zealand the current TV Takeback programme charges the public a maximum of $5 for a CRT TV and the government then provides a per collected TV subsidy to the recycler that takes in the item. Globally, there is a growing problem of how and where to safely recycle CRT glass. The CRT to CRT end-use market has virtually ceased and the few processing plants able to recover the lead from the CRT glass are at maximum capacity and do not want to accept more leaded glass. This is an issue shared by all countries and recyclers. The consultant was advised by a participant in the industry that a typical value to ship CRT glass to Australia previously was a negative $500 per tonne. A figure quoted to the Kiribati SWM project for an Australian company to take CRT TVs and Monitors (complete, un-dismantled) was a price of A$1.24 per kg delivered to the door, with a typical unit weight being of the order of 15kg, that is a typical cost of around $18 per unit *before* shipping and packing costs. It is notable that a US spot price for CRT glass obtained in May 201363 was US$160/t for loads greater than Truck Load – being minimum 20,000lbs and in reality probably significantly larger - and delivered to the processing plant door. These current commercial realities make any commercial handling of CRTs out of PICs difficult.

7.3 Potential Options for CRTs outside of the Advance Recycling Fee Model

It can easily been seen from these figures above that CRT glass is a significant constraint to developing a viable Ewaste PS system, if it has full participation in any system. Given that CRTs are a sunset technology, and can be characterised as a 'legacy' problem as the quantities are expected to drop dramatically over the next few years, this model developed above has effectively set them aside from other, ongoing, Ewastes. However, something must be done: to simply turn these items away at landfill or recycling centre will result in them going into pits, scrubland, streams and sea in PICs. Thus this study proposes two solutions, neither ideal, but may be acceptable.

The first is considerably simpler than the second: that is that PIC regulators accept that CRT glass is acceptable in local landfill. This should go with caveats that it is placed in parts of landfill that are identified as the most suitable area. CRTs could be broken into small pieces manually[60], and placed into landfill. Experience in Kiribati[61] indicates that where the landfill area is lined with calcium carbonate sands (typical coral island sands) that the alkaline environment will help significantly to immobilise any lead that leaches out, primarily due to positive metal ions interacting with the alkaline surrounds. It should also be noted in this context that some US states do allow the landfilling of domestic CRTs, which is essentially the situation we are dealing with PICs.

This approach may have the benefit of developing areas of PIC landfills that are set aside for low-level hazardous and problematic solid wastes, for example asbestos, old fire extinguishers, marine paints, materials used to clean up oil spills and similar difficult wastes that are currently largely not being addressed, and as a result, often suffer from informal dumping in the absence of any other options.

[60] Which is how they are processed in New Zealand: after splitting off the panel from the funnel, the gun is removed and the glass broken by hammer into drums by a worker wearing protective clothing.
[61] This is complex subject but the author is able to supply detailed supporting information for this contention.

The second option of dealing with CRTs is to stockpile them and search for project support to export them in one-off exports country by country, rather in the manner that the regional POPs project addressed some legacy liquid wastes in the previous decade. The danger of this approach, if no program is clearly in place, is that stockpiled CRTs become targeted for stripping out the valuable copper fractions, and so a difficult packing problem compounds an even greater reluctance on the part of any accepting agent overseas to deal with them. Broken but largely whole CRTs –where the glass is not actively broken into small (i.e. less than 10cm) parts - may possibly also attract onerous Dangerous Goods packing requirements, and will inevitable have very low shipping densities, increasing any project costs very significantly. This should be a high priority for the parallel EDF10 Ewaste project that will be carried out in the Pacific through SPREP between 2013-2017.

Both options could remain open in the medium term by allowing the processing of CRTs such that the glass is manually broken – given appropriate H & S measures – and placed in drums with clamp on lids. This allows a stockpiling to take place in controlled conditions, minimise space taken by stockpiles, will allow extraction initially of valuable components, and a later decision can be made. Where CRT glass was placed in industrial plastic drums with screw-on lids, these could even be landfilled as they are. It is likely however, given that such drums are not typically available in the PICs targeted here, that some external support may be required to import the drums[62].

[62] For example the Kiribati project imports drums suitable for shipping small cell batteries.

PART THREE: COUNTRY STATUS REPORTS

Part Three of this study looks at the situation in each of the four countries visited, looking at any local recyclers, the administrative frameworks involved in waste management, and the existing legal frameworks that might possibly provide a basis upon which to create a regulation to introduce an Advance Recycling Fee for WEEE.

8. Kiribati

8.1 Kiribati Overview

Kiribati[63] has recently started on active efforts to collect and export Ewaste for recycling. A previous attempt was made in 2005 as part of the Kaoki Mange recycling project, but no specific funding was available, and the 15m³ or so of materials collected at that time ended up being landfilled.

The Environment and Conservation Division (ECD) commenced planning to collect E-waste in 2011, and New Zealand Aid provided funding and technical assistance to this work as part of the larger SWM Initiative which is also working on landfill improvements, a pre-paid garbage bag collection system, and collecting scrap metal and End-of-Life (EOL) vehicles. This assistance has created an Ewaste collection, storage and processing area inside the existing Betio Materials Recovery Facility (MRF), but as yet, no Ewaste has been exported.

Kiribati has a product stewardship legislative framework which currently covers aluminium, PET drink bottles, and lead-acid batteries. The system has been operating commercially for eight years, and it is potentially fairly easy to extend this system to cover Ewaste.

Significant numbers of CRTs have already gone to landfill in Tarawa (where half the population of the country live), and most were broken before being dumped in order to remove the copper components. A significant quantity of Ewaste, particularly old CRTs, is held by GoK offices, due to the difficulty of writing-off equipment from the Government of Kiribati (GoK) Stock Verifier schedule[64]. These items are typically stored in unused rooms, under stairs or any other odd corners. Also, the largest electronic equipment retailer and repairer in Kiribati, along with other repair shops, report a large amount of stored WEEE.

8.2 NZAID SWM Initiative Ewaste Project Activities

The NZAID SWM Initiative commenced its work in mid 2011, but it was not until mid 2012 that a Project Officer was hired to specifically deal with Ewaste. The bulk of the NZ-funded project activity is directed at improving household waste collections, and the Ewaste work is a fairly small component, at around $50,000 of funding, part of a total of A$3 million for SWM improvements over three years. The NZAID project also provides a

[63] These notes are drawn largely from the consultant's visit to Kiribati of March and April 2013.
[64] Electrical and Electronic Waste Baseline Study, p 14, ECD, 2008,

Technical Assistance (TA) position on a contract basis to support all parts of the SWM Initiative[65]. The TA is typically is on island for two to three months, and then away a month or so. This pattern has changed in 2013 such that the TA visits become shorter, with longer periods in between, as the NZAID project activities mature.

The first Project Officer (PO) left after three months on obtaining a permanent job in another government department. The second lasted six months before leaving for the same reason. The PO contracts and funding were for only one year. A third PO has commenced work in early May, and has commenced work picking up from his predecessors. The first PO's primary achievement was to work with the GoK National Audit Office in order to develop a clear protocol to allow GoK Ministries and other agencies to write off EOL equipment from their stocks, so allowing the items to be removed from the respective buildings. This was an important initial first step, as the GoK collectively provides the largest single source of WEEE in the country.

The second PO oversaw local contracts to source, install and paint three shipping containers, which have been placed on permanent foundations in the Betio MRF. These three containers have also had a single roof built over all three, and working benches have also been made so that Ewaste dismantling can take place at the site, in the open air but under the roof, between the containers. Materials for dismantling are placed inside two of the containers, in sorted piles, and the third container holds items that have been broken down and sorted into categories for shipment. The MRF also houses a large scrap metal pile (which will be shipped out sometime during the next year) and the *Kaoki Mange* aluminium can, PET bottle and lead-acid battery recycling operation. This recycling operation has a large vertical baler, which can be used to bale plastic housings from Ewaste if necessary.

8.3 Current Recycling Activities

Processing of WEEE in Kiribati is at an early stage, but having dedicated facilities and a paid position to oversee operations, should result in ongoing improvement to the situation. As of late April 2013, only a very few items had actually been broken down into parts for sorting and shipping, and this work had been undertaken by the TA for demonstration purposes only.

Three small stand-alone collection points have been made by the NZAID project and placed in the three South Tarawa landfills. These collection points are simple wooden structures, reasonably portable, of about 2m³, with a sloping tin roof and a single door. The process is that where the landfill gate-keeper / watchman identifies Ewaste coming in to the landfill, it is placed in the collection point. Once a week, the Ewaste PO comes by with a pick-up truck and removes any items in the collection point, and takes then to the MRF. The landfills all have prominent notice boards indicating to the public what is and is not allowed to go into the landfill, Ewaste being a prohibited item.

The PO also goes to selected Ministries and arranges for them to write off any items, and then make a collection once all the paperwork is in order. This steady approach is trying to avoid the situation where a large quantity of un-processed WEEE is collected, and the subsequent problems of keeping it housed and dry prior to dismantling. Even so, the public do regularly bring items into the MRF, and drop them outside the Ewaste

[65] The author of this report has been the intermittent TA from mid 2011 until the time of writing.

containers; the variety of items dumped – and some of it is very old and dirty – and the quantity does make keeping the area around the containers clean a challenge.

The project has also entered into an MOU with a local electronic repair shop for that business to dismantle Ewaste for free in return for access to spares, but this process is only just now beginning.

However, the efforts undertaken so far have proved very instructive on several counts, which have an important bearing on future development of this work. The key points are:

- About two thirds of CRTs (around 80 units currently in the MRF), have been damaged by removal of the copper choke from the rear of the unit. This almost invariably results in breaking the glass of the CRT, which in turn results in an item extremely difficult to handle, and an immediate H&S risk as very sharp – and leaded – glass is sticking out ready to cut hands very easily. Also, in this condition these items cannot be stacked in any meaningful or safe way.
- Much of the items that come from the public sources have already been partially dismantled, and clearly often spent periods of time lying around outside.
- Air conditioners were commonly collected, but these need dealing with by a scrap metal recovery method as they have few electronic components, but significant non-ferrous metal content. Ideally, these should fall under the ODS (Ozone Depleting Substances) project purview, and have the gas removed prior to dismantling, but no gas recovery equipment exists in Kiribati at this time.
- Laser printer cartridges were present, but nearly all had the old cartridge placed into the packing from which the new one came, which is excellent for shipping these items, as this will meet IMO DG regulations if they are shipped.
- Various large and difficult items were found in the collected Ewaste, such as cooking stoves, medical autoclaves, microwave cookers, and a radar antenna. Much of this type of material has little in the way of circuit boards or similar items, but does usually have copper windings, but needs effort – and some skill - to dismantle, and needs to be going into a scrap metal recycling business stream.

In general, items often come to the collection points in a dirty or dusty condition, and this appears to have the tendency for the PO to become less engaged, the job being essentially a dirty one when items are coming in like that, a problem compounded when theses items are dumped outside the E-waste containers in the MRF.

The wide variety of things that can be nominally classed as Ewaste also places constraints on adequately processing those items that can be processed. Having the Ewaste containers in the MRF, and usually unattended, results in a large number of items being dumped around the area. In addition to anything that had a electrical cord, the site also had old bottles of medicines, engine coolant and spent fire extinguishers dumped there, being something of a Hazardous Waste collection point in many peoples' minds. This has a detrimental impact on the operations of what can be dealt with.

The TA has opened discussions with ECD around agreeing that all damaged CRTS can be placed into a designated pit at Nanikai Landfill and buried so as to take them out of circulation. Whilst this is not ideal, and there are significant numbers of CRTs in Nanikai already, and this must be preferable to having them lying in the open and breaking up further and potentially releasing lead directly to the surround environment.

8.4 MELAD/ ECD

The Environment and Conservation Division of the Ministry of Environment, Lands and Agricultural Development (MELAD) is the lead agency on dealing with Ewaste. ECD has hired a SAICM position as of July 2013, which will run for one year, and is charged with developing the policy environment to deal with this problem. In addition, the Ewaste PO under the NZAID program is based in ECD, with the overall NZAID project management based in the Project Planning Unit at MELAD, in the same office compound.

The Ewaste Baseline Study conducted by ECD in 2008 estimates imports of items which will become Ewaste in 2010-2011 as of the order of 50 – 60 tonnes. If it is taken as a rule of thumb that equipment might last three to five years, this material will be entering the waste stream from now onwards. Existing flows to landfill are comparatively low, due to low imports at the turn of the century; by comparison, the Cook Islands e-Day which collected materials in Rarotonga in December 2010 realised 42 tonnes of Ewaste for around 5,000 items, being an average weight of 8.5 kg. At the same factor, using the data from the 2008 report, Kiribati might be expected to have around 6,000 items of Ewaste coming in per year for disassembly.

ECD also conducted some planning in 2011 around developing an Ewaste recycling system, and this was incorporated into the overall project planning for the NZ-funded SWM work. ECD thus has a longer-term interest in this area of work, and some in-house capacity is developing, although much of the actual Ewaste related work is done by short term hires. This can have the effect that institutional knowledge does not build as fast as it might, as people come and go and take valuable knowledge and experience with them.

8.5 Legislative Framework

Kiribati does not have a Waste Management Act - or similar legislation - as found in some other nations under this study. Solid waste management is the responsibility of urban councils in both South Tarawa and Kiritimati Is. the two urban areas in the country, and where the vast majority of Ewaste will be generated. MELAD is responsible for developing waste strategy, but a national Solid Waste Management Strategy, developed initially in 2007, is still in a draft form, having never formally been endorsed by the Government at Cabinet level. This document now needs significant reviewing, as the work conducted over the last two years under the NZAID –funded program has improved the situation significantly.

The piece of legislation that may very likely provide a useful framework to deal with this issue is the Special Fund (Waste Materials Recovery) Act 2004. This is the legislation under which the existing Kiribati recycling system operates. This is *de facto* a form of Container Deposit Legislation (CDL) which itself is a type of Product Stewardship. The Act sets up a Special Fund, being a separate fund from any GoK Consolidated Revenue or General Account, and provides that the funds deposited therein can only be used for special purposes. The detail of the legislation is in regulations under the Act. These currently provide for a deposit of 5¢ to be taken at import on aluminium drink cans, PET bottles containing beverages or cooking oil, and a refund of 4¢ each to be paid to the public on returning these items to the designated ‘System Operator’ who is the recycling business who has a contract with GoK to operate the system. Refunds are in minimum of lots of 5, thus the minimum payout is 20¢. In addition, $5 is taken as deposit off each lead-acid battery imported (and vehicles are all charged at import as assumed to have one battery each).

The ‘System Operator has the contractual responsibility to operate the system, collect materials and pay out the refunds, which are then claimed from the Special Fund; whereas the System Operator pays out 4¢ on beverage containers, he claims back the full 5¢ deposit from the fund, the 1¢ difference providing the ‘Handling Fee’. In addition, the System Operator gains ownership of the materials collected, but *must* export them at their own cost. Batteries have no handling fee associated with them. The contracted System Operator also has the right to use half of the MRF area rent free to process the materials for export, and use the equipment originally supplied to GoK by donors when the program was set up. Ownership of all the equipment remains with GoK.

This legislation could probably be fairly easily adapted to include an ARF so that a small ARF was taken on certain tariff lines at import, and the current System Operator (or perhaps a separate one) could claim a refund based on WEEE shipped. The funds are managed by the Ministry of Finance, and claims by the System Operator against the Fund are made on a weekly basis using a prescribed certificate process. It may be that the existing regulations can be changed effectively to effect Ewaste recycling, or that a separate regulation dealing with only this issue is developed. The new SAICM hire in ECD, along with support from the NZAID–funded project, is expected to be looking into this issue over the next few months.

MELAD provides the regulatory oversight, and Regulations under the Act are made by the Minister of Environment. The body in MELAD responsible for operation of the system is the Project Planning Unit, the same body that is the project management unit for the current SWM work.

8.6 Conclusions

Kiribati has a solid foundation for a good Ewaste management system, with some processing infrastructure in place in a Materials Recovery Facility. A legal framework that is potentially adaptable exists. Shipping costs from Kiribati are very high, but shipping lines going direct to Asia do exist, and it may be that a direct shipment into Singapore, for example, is possible. The greatest constraint on that may be the effort required to process sufficient WEEE to make up a full shipment. However, there is a well funded Ewaste project in place, and the potential to leverage the existing work through the SAICM project is great.

The Kiribati project work should be closely monitored to provide useful data to input into development of ARF systems used elsewhere, such as breakdown ratios, container densities and value of shipment fractions. This information would be very useful to other countries in the region, and can help with development of suitable AFR rates.

9. Tonga

9.1 Tonga Overview

The details provided here are drawn from a study visit to Tonga that took place in late May 2013. The focal point for the consultant in Tonga was Ms. Mafile'o Masi, of the Tonga Department of Environment. The consultant was based in the Department of Environment EIA unit during the visit.

A key aim of the visit was to determine the current state of Tonga's efforts to collect and export for recycling materials collected under the local Ewaste project funded by GEF[66]. Reports had reached SPREP that a successful shipment of Ewaste had taken place, and the SAICM project was keen to see what had occurred, and learn any potential lessons that might be applicable to other countries in the region and their efforts to tackle the Ewaste problem. It was found that, whilst a significant amount of Ewaste items have been collected, and perhaps one third to one half of what has been collected has been broken down in preparation for export, that, as of May 2013, no export had taken place. The amount of material collected of actual Ewaste, and prepared for potential export (i.e. parts of collected Ewaste but not including steel cases) was approximately enough for about one quarter to one third of 20 ft full container load.

The consultant also met with the Ewaste project chairman twice, which project is run by a volunteer NGO specifically set up to start Ewaste recycling in Tonga. The current state of activity and funding of the NGO is described below. In addition, the consultant looked at the current legislative framework, with the intention of determining if any current legislation could be used to put in place any form of Extended Producer Responsibility or Product Stewardship program to assist processing and export from Tonga of Ewaste for recycling off-shore.

9.2 E-waste Tonga

E-Waste Tonga was born out of the United States Peace Corps ICT Committee, which conducted an informal Ewaste collection campaign under partnership with local recycler, GIO Recycling, in late 2009. This initial work was funded through $3,000 raised locally, and one of the key drivers initially was the attempt by a well meaning donor from the US to send a container load of old desktop computers to Tonga for re-use in schools; this was realised to be actually a potential waste problem, and this kicked off a wider interest in the issue. The information provided here is in very large part from that provided by E-waste Tonga Chair Mr. Sam Fonua, during meetings with the consultant and via email[67].

The ICT Committee had delivered information about the hazards of Ewaste and the procedures for its safe removal to 22 schools on the main island of Tongatapu with the offer of free Ewaste removal. This initiative relied heavily on word-of-mouth marketing, yet was highly successful with the schools, many of which worked independently or with their village youth groups to clear their institutions of Ewaste and deliver it to the recycling facility.

[66] Global Environment Fund Small Grant programme, administered by UNDP

[67] Much of the background information to E-waste Tonga provided here is also taken from the GEF project document.

Before E-Waste Tonga was launched as an NGO, the committee applied for and received a GEF planning grant that was initiated by Tupou Tertiary Institute and the Peace Corps ICT committee, to establish an Ewaste removal program for Tonga. The initial organizational meeting in April 2010 was a success with many stakeholders attending, including GIO Recycling, the only licensed exporter of hazardous waste in Tonga. Subsequently, E-waste Tonga was formed as a fully registered NGO with a constitution and bank account, and received US$50,000 from GEF as part of funding for a project estimated at US$85,000 in total. E-waste Tonga is a fully voluntary organisation with regard to its administration, and has no dedicated office space. The NGO receives its funds from GEF via the Tupou Tertiary Institute in Nuku'alofa. A copy of the GEF funding application was supplied to the consultant.

The project has promoted E-Waste Tonga through advertisements on radio, television, and newspapers. E-Waste Tonga has also established relationships with government ministries, schools, and businesses, and has partnered with youth groups as part of the Ewaste removal. Several businesses also supported E-Waste Tonga by giving discounts and donations of goods and services, many of which went towards promotional activities: Digi TV has run adverts for free; TCC (the national telecoms company) also provided assistance in the beginning.

The project is currently assisting GIO Recycling through rent support for an industrial unit in the Small Business Centre in Nuku'alofa. This support comprises $500/mth for rent of premises where Ewaste is dropped off, and broken down into categories for export. In addition, the project supports two workers at GIO through paying a subsidy of $800/mth, which does not cover the full cost of workers, as these are paid $150/week. (all costs are Tongan Pa'anga). This subsidy started in February and will go to August this year on current planning, but it may be that the subsidy could go to the end of the year if sufficient funding is available from the GEF funds[68]. E-waste Tonga also paid for a roof to be constructed over five old shipping containers at GIO which are full of Ewaste, and were in a very poor condition, being containers that had been removed from elsewhere by GIO for scrapping. These have been painted red, and the roof is in place, protecting the Ewaste stockpile.

The project provides some funding for two interns from a the Ministry of Works, who go around Tongatapu and pick up Ewaste - wherever it can be found, or when people notify requests for pick-up. This collection effort is expected to extend to outer islands, as Tongatapu is reported to have been largely covered[69]. The project has also printed two different posters, at a local cost of TOP$7 each, which cost was a significant discount on the normal price of $14 each. This printing is done by a company supplying office equipment and services, who is supporting the project. The posters had just been printed at the time of the visit. The design of the posters used artwork from High School Students.

Mr. Fonua reports that around US$14,000 remains to be drawn down from the GEF grant, based on acquittal of the last draw-down. Mr. Fonua said that electrical repair shops had not been actively supportive of the initiative; however the consultant did visit two such repair shops, and whilst one – a small and perhaps new place that was also an internet café - seemed to know little about the project, the other, a much larger

[68] Pers. Comm. Sam Fonua, May 24th 2013.
[69] Ibid.

operation, activity sent its old equipment to GIO for recycling and was very supportive of the initiative.

9.3 Gio Recycling

The consultant met with GIO recycling staff three times, and had a comprehensive tour of their operations during the visit. The tour of their operations was led by Villiame Tu'ikolovatu, son of the owners Mr. Filimone and Mrs. O'fa Tu'ikolovatu; Villiame has a degree in ICT from UH, and is in charge of the Ewaste operations for GIO. GIO has been in the recycling business for over ten years, and recycles scrap metals – both ferrous and non-ferrous - used lead-acid batteries (ULAB) and some plastics. Vehicle wrecks are stripped out and crushed in one facility in a car crusher on hire from New Zealand. Aluminium scrap, including aluminium cans (bought for 50¢/kg), and tin cans (5¢/kg) are baled in a horizontal scrap baler at their main office, and they also have a large vertical baler which can bale paper, cardboard and plastics. Ewaste is dealt with at separate premises in the small business centre, supported by E-waste Tonga. Most of the Ewaste coming in is delivered to this small industrial unit facility. Some Ewaste is bought in to their main office, and this is purchased at 5¢/kg. Previously, they have paid 10¢/kg, but after recent calculations feel that 5¢'kg is all they can offer; this price includes CRTs that are bought in.

At the Ewaste processing area in the industrial unit, items are broken down into categories for export. Items are split up by two grades of Printed Circuit Boards (PCBs) based on colour (brown or green), CPU mother boards, power supplies, mother board chips, hard drives, CD drives, copper coils such as CRT yokes, ribbon cables, electric motors and other cables. Plastic housings are baled in the large vertical baler at the main office; plastic car parts from the stripped bodies and some PET bottles are also baled in this baler. Metal cases are diverted into their scrap metal baling stream. At the time of the visit, one labourer was working in the Ewaste facility, dismantling items. A second worker had only just been terminated, after being unable to develop the manual skills required to break down and sort items with sufficient efficiency. Some indicative pictures are supplied at Appendix 3.

Much of the materials bought in by the E-waste Tonga pick-up were in very poor condition, having clearly been lying around outside for some time. These items bought in also included old fridges and washing machines. The consultant estimated – from what was observed and information supplied - that 2-3 truck light loads a week were coming in, perhaps 6 – 8m^3 loose in volume. In addition, five TEU shipping containers full of Ewaste were seen at the GIO owners' personal property, a residual from the original collections in 2009. The flow of Ewaste materials coming in to GIO are such that they have been unable to process this stockpile as yet, but the consultant saw evidence that originally the small industrial unit was full of E-waste, as well as another shed housing the vertical baler at GIO, and these are being emptied and processed to a degree that shows that inroads are slowly being made into the backlog.

The consultant asked about mercury lamps found in scanners, and these are set aside at the back of the shed, but Villiame was not especially aware of any potential hazards associated with these items or also what can be done with these lamps. This provides an example of the sort of capacity building required for PIC recyclers; some attempt to address this issue is provided by Part Four of this study.

CRTs are fully dismantled, including removal of steel safety band. The remaining glass is taken to the landfill. Cost of landfilling is $15/mth as they have an industrial licence and they report sending about two truckloads of waste each week from all their operations. Significant landfill waste would also come from stripping out the car bodies prior to crushing. The worker doing the Ewaste dismantling uses a small battery drill with screwdriver tips to assist dismantling. They have tried using compressed air tools but the electricity bill went up significantly, and so they find that battery drill is much cheaper and easier. Several bales of plastic computer and CRT cases were observed to have been made in their vertical baler; bales are fairly large, being around a cubic metre or so, and weights of perhaps 200kg – 400kg.

Villiame estimated a rough ballpark 6:1 reduction in volumes is achieved across the E-waste stream. The consultant would estimate that there is one quarter to one third of a shipment of Ewaste that has been split up and in 'one tonne' bags. The consultant would expect – as a very rough estimate – that once all the stockpiled materials have been processed, and given the rate it is coming in, that a FCL might take until the end of the year. No shipment has been made as yet. They do have a buyer lined up for Singapore but as yet nothing has actually been shipped. They have been quoted a shipping rate of $2,600 for a TEU to ship into Asia / Singapore.

GIO have taken a risk here as they do not appear to have detailed knowledge of the Ewaste business, not surprising given that they are new to it, and also the poor state of development of the business in New Zealand where they send scrap materials currently. But they are a highly motivated company and appear to be very well organised, and have clearly made a success of scrap metal and other recycling, even with the lower prices of the past couple of years. There is a real danger that if the support for their Ewaste work is pulled before a shipment can be got together, that they back out of it simply because they cannot afford to subsidize this operation, as it takes a while to get sufficient quantities together.

9.4 Waste Management Authority

A meeting was held with Ms. Talita Helu, information Officer of the Waste Management Authority (WMA), the government agency responsible for waste management on Tongatapu. The WMA operates two compactor waste collection trucks, a wheel loader with compacting wheels for landfill operations, and the municipal landfill at Tapuhia? The meeting was the same meeting at which E-waste Tonga were first interviewed.

The WMA has collected some Ewaste at its landfill site at the recycling drop area at the site, but none was there when the consultant visited the landfill, with the allotted area empty and materials had been removed. Traces did indicate that this is where E-waste had been collected. The landfill appears well managed, with good internal roading, and the waste obviously compacted very frequently with the compacting wheel loader. No Ewaste was obvious, but it was noted that private trucks did come in to dump without being inspected at the gatehouse, so Ewaste can no doubt easily make its way into the landfill. The first cell is still being filled, and room exists for three more cells. An area has been set aside for Hazardous waste in this landfill, but the area was overgrown and access was not available. This area could be used for placing CRT glass in the landfill.

The WMA was reported as having submitted a regulation to Cabinet regarding a levy to control plastic bags. However, any detail as to how the levy might actual operate, such as who pays, how much, for what, where and to whom, and what might happen to the money, were not available, either from Ms. Helu or from the Dept. of Environment. The consultant was directed to the law firm TMP by the Solicitor General's Office, but three visits to their offices by the consultant were unable to obtain a meeting with the relevant lawyer Mr. Aisea Taumoepeau. This may be of interest from the point of view of developing any Ewaste regulation.

9.5 Relevant Legislation

There are potentially three pieces of legislation that might affect this issue: the Environment Management Act 2010; the Waste Management Act 2005; and the Hazardous Wastes and Chemicals Act 2010. The consultant studied all three pieces of legislation, and determined that the most potentially useful one is the Waste Management Act 2005. This Act's main content is to create the Waste Management Authority for Tongatapu, and provide for the Ministry of Health to be the prescribed waste management authority in other islands.

The Waste Management Act contains both the power to make regulations (a power of the Minster of Environment) and also the power for the WMA to levy, at section 27 (e): *special levies on particular goods the disposal of which is likely to have adverse effects on the environment*. The Act charges the WMA with various functions, including: section 21 Recycling of Wastes**:** (1) *An approved Authority* [the WMA] *shall promote the recycling of wastes;* and also at section 13 Fees and Charges**:** (1) *An approved Authority may levy and vary the following fees —* [for the collection and disposal of] (d) *disposal of hazardous wastes*.

These various provisions, taken along with some of the provisions of sections 6 and 8 on the Functions and Powers of the WMA, could be seen as potentially creating an existing legal framework to develop a Advance Recycling Fee system as described in Part Two.

Of course the actual mechanics of any system for Tonga would need some researching and preparation, but it may well be that the Customs Service could be engaged to be the ARF collector under section 16 Collection of Fees and Charges**:** (3) *An approved Authority may, subject to any directions given by the Board, enter into arrangements for the collection of fees and charges by persons or organisations approved by the Board to be collection agents on behalf of the approved Authority.*

9.6 Conclusions and Recommendations

Things are moving in the right direction on this issue of Ewaste processing in Tonga. A significant amount of material has been collected, a campaign is up and running, albeit without any full-time support, and the key ingredient of a commercial recycling operation as partner is in place. It may be that there is also a legal framework that can be used to develop a regulation and associated mechanisms that will allow some financial support to the WEEE recycler to be carried out. However, right now, no one is charged with developing the legal framework (although E-waste Tonga clearly envisioned doing this at the outset) and the support to the recycler may well cease before all the materials collected have been processed for export. Given that the value of any shipment of Ewaste is very unclear at this time, especially after processing and shipping costs have been deducted, there is a potential danger that the processing may cease before any shipment is made. This may result in much of the collected material ending up in the landfill at a later date if it cannot be shipped.

SPREP / SAICM should keep a close contact with E-waste Tonga and GIO Recycling to ensure if possible that support can be maintained until at least the backlog of collected materials is processed. This amounts to about US$800 per month, and if the current support ceased in August, and support went for another six months, would require around US$5000 of support. If additional financing was required, and possibly this could be sourced through SPREP, this could be delivered via E-waste Tonga. In return, GIO could supply SPREP with detailed information as to the quantities and types of materials shipped, breakdown reduction factors and the prices these materials have been sold for, along with any associated costs, such as shipping, handling, and labour to process. This information could be extremely useful in developing some of the finer points of a system, as described in Part Two, such as suitable ARFs and rates of payment out of the fund per cubic metre shipped.

10. Samoa

10.1 Overview

The details provided here are drawn from the study visit to Samoa that took place in late May and early June 2013. The focal point for the consultant in Samoa was Ms. Fuatino Matatumua-Leota of the Samoa Ministry of Natural Resources and Environment. (MNRE) The consultant was based in SPREP at the Waste Management and Pollution Control Division during the visit.

Whilst Ewaste is recognised as a significant problem in Samoa, there has been little concerted activity to deal with the issue, largely because the way ahead is unclear. There is a lack of technical knowledge at the recyclers that needs addressing, but there is clearly the capacity in the commercial recycling operators to deal with the problem if they have the right information and the right policy environment.

The Waste Management Act (which is similar to the Tongan legislation) clearly contains provisions that would allow a product stewardship process to be put in place. There are initial moves to implement Container Deposit Legislation and a used oil advanced recycling fee, and this would be done via regulations under the existing Act, which is how any PS system for Ewaste would also operate.

10.2 Ewaste Collection Efforts to Date

There has been only one organised effort to collect Ewaste in Samoa, and that was an effort by the local newspaper to push the issue in recognition that something needed to be done. The Samoa Observer newspaper urged their readers to bring in Ewaste. Details are uncertain, except that the result of the collection was not large, and they passed the items on to the Westend recycling company, who is now uncertain what to do with the stockpile of what remains - after probably picking the copper out of it.

Ewaste that arrives at the landfill, if it is intercepted at the gatehouse, is diverted to Pacific Recycling who has a recycling operation immediately adjacent to the landfill gateway. Some Ewaste was observed on the landfill during a visit, and this appears to be stripped of copper – in particular – by the waste pickers on the landfill: broken CRTs were observed, with the copper yoke smashed off the back. The materials so collected will no doubt be going for sale to Pacific Recycling next door to the landfill.

10.3 Recycling Companies in Samoa

Three recycling companies were identified, all based in Apia, which is where the main port is located. Two showed interest in WEEE recycling, and one has actually shipped a very small quantity of circuit board waste in with a container of non-ferrous metal scrap. But none had the knowledge they need to really sort out and so get real value from their e-scrap, or have had any support to identify any hazards they should be aware of in disassembling E-waste.

a) Pacific Recycling

This recycler operates on government land immediately adjacent to the landfill entrance, and recyclable materials that are diverted from landfill at the gate are directed to Pacific Recycle, run by Mr. John Sio. The business operates closely with the landfill operation to ensure that coordination between the recycler and landfill works well, as seen when the owner of Pacific Recycling attended a meeting between the consultant and the MNRE landfill operators to discuss the issue of how to implement a product stewardship system. The operation appears to be well run, with materials clearly moving through the business steadily such that large stockpiles of recyclables are not lying around, always a good sign. Pacific Recycle collects, bales and exports steel scrap, non-ferrous metals, including aluminium cans, and PET bottles, although it finds it difficult to export PET and make it commercially viable. The company operates a series of recycling collection points, being 2m³ steel cages which are placed around Apia, for the public or institutions to drop of aluminium and tin cans, and PET bottles. It is clear that PET is not commercially viable without some sort of support, ideally from a CDL type of system. This is largely due to the problems of getting shipping container densities high enough for the shipment to reach more than break-even value.

Currently, scrap shipment go to both Australia and New Zealand. The company has a scrap metal baling press that requires larges crap to be cut up for baling. It also has a grinder that could be used to grind up plastics into granules, which would get shipped densities up[70]. His Australian buyer has advised him that he would buy e-waste, but he does not know enough about the subject in order to sort materials sufficiently to get values up. He specifically asked for assistance regarding the following[71], which is reproduced here as these represent typical questions from all the recyclers met during this study:

1. Segregation of Boards (identifying which one[s] with high value to lowest);
2. Any Hazardous aspects of e-waste (toxic, etc.);
3. Do [we] need special storages?;
4. Packing for export (is there any packing requirements)?;
5. Is there any place in NZ where a training of dismantling of e-waste can be done?

[70] Though use of the grinder for plastics containing BFRs would not be advisable – see Part Four.
[71] Email from John Sio June 5th 2013 detailing his capacity gaps and where support is required.

A typical example of how a bit of technical support could go a long way was observed when the consultant saw one of Pacific Recycling workers trying to remove PCBs from an aluminium server rack. The boards were high value boards, being covered with chips; however, the worker was trying to pull out the boards with pliers – and having difficulty - as he was unaware of the clips holding the boards in place. When these were pulled to one side, the boards can be slid out, just as they are originally assembled easily. The boards then extracted were thrown in with all other PCBs, and so the whole box would be only receiving a low rate for it, perhaps as low as $0.5/kg in small lots rather than $5 per kg that the higher value server boards might make in small lots.

b) Westend Waste Management
Westend is both a recycler and contactor to MNRE as a household waste collector, operating two compactor trucks. The company also sells car parts, in fact started many years ago as a mechanic repair shop, expanded into car parts, and then scrap recycling as the amount of broken parts stacked up. This is a fairly common trajectory for the current PIC recycling companies. It handles mainly non-ferrous scrap, but also steel. The manager is Ms. Marina Keil. Their main focus in recycling is on non-ferrous scrap, and they clearly have a good understanding of grading different non-ferrous scraps such as copper. This approach would mean the company will probably easily expand into E-waste as this is largely about good sorting allowing better value to be obtained from a varied waste stream.

They used to ship scrap to Singapore, but the greatest difficulty seemed to be that of their company representation at the receiving end. Currently they export scrap for recycling to New Zealand. The company is interested in Ewaste recycling, but has little knowledge of how to handle, sort and pack materials, but would welcome technical support on these points[72].

c) Demolition Recyclers
Demolition is located close to Westend, but concentrates largely on scrap steel. The manager the consultant talked to had very little knowledge of Ewaste, and when his yard area was visited, old circuit boards and pieces of Ewaste could be seen in the scrap metal pile heading to the crusher. It was not clear if the materials headed to the crusher are carefully sorted (items of non-ferrous metal could be seen in baled scrap steel) and it may well be that some Ewaste is making its way into the steel scrap bales.

10.4 Local Electronics Supply and Repair industry

Samoa has significant commercial activity supplying electronics and IT equipment, along with a significant local electronics repair sector. As Samoa has – alongside a sizable government sector - several large regional institutions, such as SPREP and UN agencies, as well as some sizable businesses such as Computer Services Limited (CSL) and Blue Sky, there is a significant corporate IT equipment supply business. Associated with this is a strong cohort of technicians who work in these sectors who manage the organisational IT requirements. A typical situation was observed at the SPREP IT department, where an entire room of about 20m³ was given over entirely to storing disused IT equipment. The IT professionals are also often repairing equipment from their organisations, and as such, they could be breaking items down where they were no longer likely to be useful, and moving these on to recycling companies, possibly for

[72] Pers. Comm. Marina Keil, June 2013.

payment if there was sufficient value in the waste stream, as the proposed model would create.

The local repair industry members the consultant interviewed indeed reported problems of having stocks of WEEE, and this was dealt with in two ways: one was to no longer allow people to leave broken and non-repairable items with the repairer; the other was to send it to landfill. In addition, the development of the IT supply sector is perversely likely to increase the problem, in that whereas before the local supply company technicians could not repair items returned under warranty, and so these were exported back to the originating company, now, as they are skilled to a sufficiently recognised level, the overseas companies will allow local repair under warranty. This means that items that are designated as beyond repair may enter the waste stream in Samoa rather than overseas, when this decision can now be made locally[73].

SPREP IT manager offered to use the SPREP WEEE currently stored as materials for use in a workshop to local IT and recyclers to help determine how to break WEEE down so that they fit recycling categories and can be fed direct into the waste stream. This would be an excellent idea and was welcomed by other IT specialists talked to who are facing the same problems as SPREP, as well as clearly being an advantage for capacity building the recycling sector in Samoa.

10.5 Ministry of Natural Resources and Environment.

MNRE is the 'approved waste management operator' as described under the Waste Management Act, and as such is responsible for operation of the Tafaigata landfill, as well as contracts with the various companies who operate the waste collection trucks. Currently, the entire operation is free of charge, but there are plans to introduce charges in the future, but these plans are still at early stages of development it seemed.

The Ministry is charged, under the Act, with promoting recycling and various other functions to do with difficult wastes that clearly give it the responsibility to push the development of ways to adequately address the Ewaste problem. The part of MNRE that is responsible for landfill management is based at an office at Tafaigata landfill entrance.

10.6 Relevant Legislation

The Waste Management Act 2010 provides the legal framework for SWM in Samoa. The consultant met with the MNRE legal advisor and discussed issue regarding the ability of the existing legislation to create a PS system that could be used in Samoa to address the Ewaste problem. The consultant provided a list of questions for MNRE concerning the general ability for MNRE to administer a system whereby Customs could raise an Advance Recycling Fee which can then be used to support the recycling and export of the materials from the country. No answer has been received at the time of writing.

It is clear that the legislation does provide a quite sufficient framework to develop such a system, as outlined in Part Two of this report. Currently, there are no regulations under the Act, and as there are some moves to develop CDL for beverages, it would clearly make sense that any effort to develop a regulation to suit Ewaste would also be involved

[73] Interview with Samoa IT Society reps, June 4 2013.

in drafting the beverage regulations – or even any regulations concerning waste oil under the current AFD project at SPREP. As all of these constitute PS systems they should ideally be drafted at the same time.

The Waste Management Act in Samoa is very similar to the Waste Management Act in Tonga, and some useful efficiencies could perhaps be made by using any work on developing Regulations under one country's Act to help the other deal with this problem.

10.7 Conclusions and Recommendations

Samoa does have an existing legislative environment in which to develop a product stewardship system to deal with Ewaste. It has a competent local recycling sector that could successfully commercially recycle WEEE where the policy framework and suitable financial support can be put in place.

Clearly, the greatest constraint right now is the lack of knowledge on the part of recyclers as to how to deal with any E-waste that they may receive. Part Four of this report specifically aims to address these issues, with regard to splitting up WEEE into categories such that shipping densities are increased, whilst value of sorted materials is also increased, as well as any H & S issues of which any recycling business should be cognizant.

In addition, two other recommendations stand out:

- The SPREP stock of E-waste could be used as a basis for a simple one or two day workshop for WEEE dismantling and safe handling, using the materials at Part Four of this report as part of source materials, along with someone skilled in the e-scrap business from New Zealand or Australia. This workshop could be run by the SPREP IT manager, and delivered to local recyclers, electronic repairs and IT staff and equipment suppliers.
- Any drafting of regulations under the Waste Management Act for any CDL beverage container recycling system, Ewaste, or waste oil Product Stewardship scheme, should all be done in a single effort so that the cost of developing regulations, and the time taken to do so, is minimised, and the administrative and political efforts required to get regulations passed has the greatest chance of success in a reasonable timeframe.

11. The Cook Islands

11.1 Overview

The details provided here are drawn from the study visit to The Cook Islands that took place in June 2013. The focal point for the consultant in the Cook Islands was Mr. Vavia Tangatataia of the Cook Islands National Environment Service (NES). The consultant was based at NES during the visit.

The issue of Ewaste is one that the Cook Islands has been active on, with a detailed study by NES in 2009[74] leading to an eDay Ewaste collection event in December 2010.

[74] Status Report on Ewaste in the Cook Islands, Teariki Rongo, NES 2009

Ewaste is also specifically mentioned in the Cook Islands Solid Waste Management Strategy of 2013. The intention has been for NES to organise another eDay, but as yet no funding has been sourced for this.

Significant quantities of Ewaste are clearly waiting for some pathway to be developed in order to process them in some form. Currently, anyone asking how they should deal with their E-waste is told by NES to store it until such time as another eDay or some other system is put in place. The 2010 eDay largely targeted computer related Ewaste, and an analysis of the costs involved are provided in Part One of this report.

The current legislative framework does not include any Waste Management Act, and statutory responsibility for waste is fractured. There is strong support to introduce CDL for drink cans and bottles, and if this intention is followed through, there are obvious synergies to include an Ewaste ARF in any system. A potentially useful legislative framework was identified by the consultant through the use of the Environment Protection Fund, under the Environment Act 2003, which could be used to operate a product stewardship system to process and export Ewaste. This approach simply requires a regulation to be promulgated, along with some support work to various stakeholders to put the system in place in practical terms. Whilst the nation has the smallest population of those covered by this report, it is potentially the most advanced, with a very competent local recycling operation, and could put in place the legal framework and physical processing and export operation to deal with Ewaste without much effort if the political will is present.

11.2 Ewaste Collection Efforts to Date

The Cook Islands has held a single eDay for collecting Ewaste on December 8th 2010. The eDay concentrated on computer equipment, but included phones and digital cameras. Televisions were not accepted, nor white-ware or other types of non-electronic waste that can be considered parts of a broad definition of Ewaste. A total of 238 vehicles dropped off 5,154 recorded items that were placed into seven TEU, all exported to New Zealand. Packing was completed onto pallets and into containers within two days of collection. 70 volunteers participated in the day, which was on a Wednesday. The total cost of the operation at completion after all shipping and paying for the acceptance of the materials in New Zealand was NZ$78,987 which gave a total cost per unit collected of NZ$15.33 each piece. 90% of the funding, $71,308 was provided by eDay NZ Trust, which received funding from the New Zealand government for the purpose. A detailed economic analysis of the Cook Islands eDay is provided in Part One of this report and this is the only extant example of an eDay in a PIC that is comprehensibly documented. It has been intended to conduct another eDay, but as yet no funding has been secured, or even applied for formally.

11.3 Recycling in the Cook Islands

There is only one recycling company, Recycle Cook Islands Ltd (RCI) that exports any recyclables. This company collects all types of scrap metals and exports them to New Zealand. The company director is Mr. John Wichman, who is also the current chair of the Waste Management Committee, which was responsible for developing the SWM Strategy. In addition, the Ministry of Infrastructure and Planning (MOIP) operates a recycling facility at the Rarotonga Landfill, which is baling aluminium cans and PET bottles for export, and crushing some glass bottles for local use. The last export of this recyclable waste was done in partnership with RCI. RCI is a longstanding business that has also been exporting paper and cardboard to New Zealand since 2004 for recycling, and has extensive understanding of the logistics of shipping materials both into and out of the Cook islands. All shipped recyclable materials from the Cooks must go to NZ given the existing logistical structure, and no direct shipping to Asia is currently an option; this is the only nation of the four studied where no direct shipping link to Asia exists.

Recycle Cook Islands has already had discussions with RCN Ltd. in New Zealand as a local partner to collect and feed Ewaste to RCN in New Zealand. RCN is the focus of a network of regional recycling centres in NZ which collects and processes Ewaste in partnership with an MfE Product Stewardship programme. The model at this time is expected to be that anyone dropping off Ewaste at RCI would pay a disposal fee based on the charge rate that RCN network uses[75], with an additional component to cover cost of shipping: items would be shipped whole. However, as a result of discussion with the consultant RCI may be looking into modifying this model to one of a Stage II processing approach, i.e. local dismantling of much of the Ewaste stream, as described in Part Four. RCI has approached Telecom Cook Is. and they are now breaking down old equipment, including disused telephones, and then RCI is taking it away for recycling. No export has been made as yet.

There was previously a recycling operation that existed with some government support and operated a Materials Recovery Facility in Turangi, at the east side of Rarotonga. This recycling area is now abandoned and overgrown, but there is some dumping of Ewaste occurring there. It appears that this is coming from small electronics repairers, as quantities are comparatively small, but much of the equipment has had some dismantling taken place. Also, a Mr. Anderson operated an Ewaste collection around 2009-2010, but he has left the Cooks now and it is understood that much of what he collected went out with the 2010 eDay. This model was that of pay to recycle, as common in NZ.

In addition, there is at least one recycling operation on an outer island, being at Aitutaki, and currently gaining some support from overseas development funding. Significant quantities of Ewaste were observed by the consultant to be dumped around the island in gardens and empty plots. There is a light bulb crushing machine that is operated by the Foodland store in Avarua (also where cardboard is baled for export through RCI) provided under an ADB project, and this machine[76] could be used to process mercury lamps from photocopiers and scanners.

11.4 Local Electronics Supply and Repair Industry

There are four main local electronics supply and repair companies, and getting equipment repaired is not a problem it would seem; there are other smaller repairers operating too. All those interviewed report having large stocks of Ewaste, for example two report that they each have a container full of Ewaste that they need some guidance about what to do with it, and third showed the consultant about half a container full in the back of their shop. These companies were supportive of the Cook Is. eDay, and several

[75] www.rcn.co.nz/ewaste Ewaste charges
[76] See www.aircycle.com for details of the machine

provided sponsorship and material support. Given the size of the population, the sector is well serviced with electrical repair technicians, given that there are at least ten competent technicians on island who could deal with electronic repairs, which probably gives a similar ratio to doctors per head of population. With strong links between local businesses and the NZ economy, access to spare parts for electronics is not an issue, as virtually all electronic devices have come through NZ.

One electronic repair/supplier reports that they take back printer cartridges in exchange for new ones, but currently have no method of disposal and these are only stored with other Ewaste at the moment.

11.5 National Environment Service

The NES is governed by the Environment Act 2003, and is an independent government agency which reports to the Office of the Prime Minister, who is also Minister of the Environment. NES is largely a regulator when it comes to pollution and waste, actual SWM operations being the responsibility of MOIP (see below). In order to avoid the problem of an operator of a system also being responsible for regulating any potential impacts (a common problem in PICs) it is not appropriate for NES to be operating any Ewaste PS system.

NES is shortly to hire a SAICM officer to work on E-waste. It would perhaps make sense if this position were transferred to MOIP, physically if not administratively, as efforts to tackle the Ewaste issue should be coordinated with other waste management efforts, particularly if the intention to introduce CDL is followed up on.

11.6 Ministry of Infrastructure and Planning

The Ministry has a WATSAN (water and sanitation) project which is largely concerned with improving water and sanitation (sewage) infrastructure. This unit office is also responsible for waste collection and landfill management, including the relationship with the contracted waste collection operator T & M Heather Ltd, which provides household waste collections for the government across Rarotonga, at no charge to residents. Commercial operations – such as shops and hotels – typically either take their own waste to the landfill and pay a tipping fee, or else engage a commercial operator to collect from their premises, a service provide by General Transport Ltd., who must also pay the tipping fee.

MOIP WATSAN office is also responsible for development of SWM policy, and the operations of the Recycling Centre that operates at the entrance to the landfill site. Non-recyclable wastes are baled into 1m^3 bales in a large baler at the recycle centre yard, and carried to landfill by a forklift. All these operations are currently under MOIP and the WATSAN office.

There is a Waste Management Committee that has been set up, and it has drafted a SWM Strategy which was submitted to Cabinet in early June 2013. Cabinet has endorsed the Strategy, one key plank of which is to set up container deposit legislation. The consultant met with the WMC twice during the visit, and provided briefings on Ewaste and CDL, and the synergies of the legal and operational approaches that exist.

The committee is very proactive and most likely to provide the main mover for any efforts to tackle Ewaste problems; it also involves a range of stakeholders from the community.

11.7 Relevant Legislation

The current legislation covering SWM in the Cook Is. is fractured and requires work, as is clearly understood by the SWM Strategy. No Waste Management Act exists, but it is envisaged that one will be drafted and submitted to Parliament. The only current piece of legislation that might prove relevant to the Ewaste issue is the Environment Act 2003.

The Environment Act has provision[77] to operate an Environment Protection Fund (EPF), which could be used as a separate account to hold deposits and/or ARFs and pay out funds for recycling as part of any PS scheme. The Act also provides for powers to regulate the EPF[78]; a regulation could be made for the EPF to collect and hold any ARF, to be used to assist the shipping of Ewaste out of the Cook Islands. The regulation would define who pays the ARF, for what, when and how much, and then how money is disbursed from the Fund.

Details regarding how the designated 'Recycling System Operator' – who would be the business actually processing and exporting the Ewaste - interacts with the Fund, and the rules under which he/she operates, such as refund rates associated with density measures - would be largely contained in the contract between government and the System Operator.

Whilst there is an existing regulation covering operation of the EPF[79], the EPF itself is currently moribund and not operational, and the existing regulation does not provide for a PS system as described above in Part Two. If the existing regulation were repealed, and a new regulation promulgated with some simple rules about EPF operation as outlined above, a legal framework could be easily put in place to operate a deposit/refund recycling system. Once the EPF is re-configured to operate in this manner, other recyclable materials such as aluminium cans, PET bottles and old lead-acid batteries, can be bought into the same system using exactly the same fund of money.

Given that there is already a recycling centre set up at the landfill, the 'System Operator' would be expected to take over operations of all recycling at the landfill (but not the landfill operations, as this is essentially a separate operation). This would relieve the government of the current cost of operating the recycling part of the landfill operations, a situation likely to result, along with the increased diversion of waste from landfill, in a very positive economic outcome for the government.

11.8 Conclusions and Recommendations

It would appear to be reasonably simple to put in place an ARF using the legislation described above, by repealing the existing EPF regulation and creating a new one that will create a Product Stewardship system that can also be used for cans and bottles.

[77] **61. Environment Protection Fund** - (1) The monies held in the Environment Protection Fund shall be expended on the….protection from pollution of (and removal of pollution from) land, sea and air, ….
[78] **70. Regulations** (n) regulating the operation of the Environment Protection Fund;
(s) prohibiting or regulating the importation or disposal of recyclable or non-recyclable products;
[79] Environment Act (Environmental Protection Fund) Regulations 2005

A recycling operation exists that can easily accommodate an Ewaste stream as one part of a daily recycled materials stream. The cost of any ERF is likely to be about NZ$5 per item levied, from calculations based on the eDay information and also the 2009 report on Ewaste in the Cook Islands.

12. Australia and New Zealand

The consultant has visited WEEE recyclers in both Australia and New Zealand as part of the development of this study. Much of how the industry operates is already described in Part One, and names of companies who may be useful actors in the processing stream are provided at Appendix 1.

Any e-scrap that goes to New Zealand will almost certainly be exported again, and this is very likely to be the situation with Australia too. PIC recyclers should be looking to ship to Singapore where that is possible, as this is where suitable facilities can be found that operate in an acceptable manner.

This study draws extensively from interviews and visit to commercial operators in New Zealand and Australia, primarily those who are holding Basel Permits to export e-scraps of various types. Some information is provided in commercial confidence, but this has nevertheless allowed that this study provides a responsible representation of the current state of affairs in the commercial sector in the region. Details can be found in the Appendices.

PART FOUR: Technical Processes Required to Dismantle WEEE and Hazards that may be Associated with Manual Dismantling

13. Recycling Processes Appropriate for PICs

Recycling of WEEE to recover useful materials is typically a three stage process:

- Stage I is the collection of WEEE for the purposes of recycling;
- Stage II is the manual breakdown of WEEE into various categories of parts, sorted so as to increase the commercial value and assist end processing;
- Stage III is where materials are subject to shredding and pyro- and hydro-metallurgical processes in order to extract useful materials.

In the context of PIC recyclers, the only realistic processing will be disassembly of items, and sorting out the resulting parts into different categories suitable for on-sale overseas. This process should result in increasing the value of the e-scrap resulting, while also increasing the density of the shipped materials, both essential steps if any commercial operations are to survive in this business.

This section provides information to assist potential PIC WEEE recyclers process Ewaste through Stages I and II so that it can be exported for Stage III processing. Different commercial categories of e-scrap are provided in Appendix 2, along with indicative photographs.

13.1 Cases and Housings

Disassembly will remove a significant low value but bulky part of any item, being usually a steel casing or plastic housing. Steel casings are good quality panel steel and easily baled along with other steel items in a scrap metal press, which most PIC recyclers will already have in place. A ready market for steel exists overseas, and steel recycling is a typical core business for many PIC recyclers. Plastic housings are best baled in a large vertical baling press, which allows large bales to be made with high density and which can be held together with steel tie wires. Vertical presses are usually large enough such that plastic covers usually need no initial breaking in order to fit them into the press for baling. Bales can be handled with a forklift.

13.2 Printed Circuit Boards

Printed circuit boards (PCB) have different values, depending on what they contain. PCBs are not generally disassembled any more than to be removed from their housing, except to remove any larger heat sink items, any removable CPU chips, cell batteries on the boards, and any connecting wiring. PCBs should remain 'populated' that meaning that all the electronic components remain on the boards; this approach means that no de-soldering is required, which means no heat needs to be applied to them, and consequently no heat degradation or fume production can be expected to occur. This approach means that workers will not be exposed to potentially toxic chemicals bound up in the PCBs. PCBs should not be shredded, intentionally broken or otherwise processed to avoid possible toxic releases.

Boards have different values, and need to be sorted with that in mind, or else mixed value boards will result in the whole set having the low value rate. Samples of different PCBs of different value are provided at Appendix 2, along with an indication of the level of value of each.

In simple terms, TVs and computer monitor boards are usually low grade, along with miscellaneous boards taken out of odd pieces of equipment such as printers and air conditioners. These low value boards may also be brown in colour, but this is not necessarily an indication of value. Boards from modern audio equipment are usually medium value boards. Computers and computer related peripherals – routers, telecoms gear, and servers - have higher value boards, usually seen as they have many chips and also gold-plated contacts may be seen.

The value of different e-scrap PCBs can vary significantly and it is important for the recycler to sort the boards correctly. IT technicians can sort boards by grade much better as they have knowledge of what they are looking at, and this can be an advantage to the recycler where an electrical repair operation is breaking down WEEE and feeding sorted boards into the recycler, as indicated as a viable model in Part Two.

Any small batteries that may be found on PCBs – commonly button cells – must be removed from PCBs during the sorting process.

13.3 CPU Chips

Many computer boards may have a removable Central Processing Unit (CPU) chip that clips in place. These can be removed and kept as a separate group, and as such have a very good value, but it will lower the value of the boards they came out of. Where a recycler has a low volume of materials coming through, they must make a commercial decision about whether it is worth to remove these chips from boards, as if their volumes are low it may not be the best strategy.

13.4 Flat Screen TVs and Monitors

Flat screens should only have the stands removed from them, and then packed as they are. Further attempts at dismantling may result in breakage of mercury backlights and subsequent exposure of workers to toxic mercury vapour. In New Zealand for example most recyclers would not dismantle flat screens. However, it is important to note that good undamaged screens can have a good value - where they are unscratched for example – as they can be used for refurbishment processes. Damaged screens may well have a negative value, especially after shipping, so it is important to take care and assess screens as they come in, and ensure that physically undamaged screens are not treated roughly so as to damage them, and that they are well packed for shipment. Cardboard collected for recycling can be very useful as a packing medium to protect these items.

13.5 Cathode Ray Tubes

After removal of the plastic casing, CRTs will be found to contain a two-piece glass assembly, comprising a back part called the Funnel and a front part called a Face Panel. A large copper yoke is found at the rear around the electron gun, which is at the end of the funnel. This yoke should be carefully removed such that the glass is not broken. Any PCBs should be removed and sorted appropriately, and the copper degaussing wires that are laced around the funnel can be removed and placed with other copper wires. The steel safety band should be left in place as a precautionary measure if the glass is not to be broken. See section 7 for more details on dealing with CRTs and some indications of the negative commercial value, and 14.1 regarding H & S hazards. Where CRTs are to be broken, this normally involves a CRT 'splitter' which heats the Frit Seal between the funnel and panel glass, and allows the panel to be removed from the funnel, the phosphor to be vacuumed out, and the separate types of glass put aside. This also allows the removal of the shadow mask, which should be split into two parts, with the steel back part separated from the front grid which is a nickel iron and has a higher value – if a market can be found.

CRTs contain a vacuum, and need to be handled carefully. The vacuum can be released by removing the high voltage cable which enters the glass at the point on the funnel with a large rubber grommet - usually red – and poking a screwdriver or similar sharp rod into that hole to release the vacuum. Anyone doing this should be wearing safety equipment including eye protection. Care does need to be taken when dealing with CRTs generally, in particular mindful of potential for sharp and flying glass, and avoid inhalation of the phosphor (see below). The phosphor is unlikely to have a local use, and will likely be landfilled, with the bags from any vacuum cleaner used for this purpose placed inside strong sealable bags prior to landfilling. Only a small amount of phosphor is found in each CRT, so it will take some larger number of units to fill a typical vacuum cleaner bag.

13.6 Lithium and Other Small Cell Batteries

A typical PIC e-recycler is likely to find they have small quantities of a variety of batteries such as button cells of various types, batteries from a variety of 'cordless devices' such as power tools and toys, as well as Lithium ion batteries from laptops and cell phones.

These need to be placed into plastic, or plastic lined, drums, so that the risk of short circuits are minimised in case any residual charge exists. Best practise is to put a piece of strong sticky tape – such as duct tape or PVC insulating tape - over at least one terminal before placing the battery in the storage container, and this will prevent potential short circuits and provide peace of mind where small batteries are stored; batteries being stored should be treated with similar precautions as one might store liquid fuels such as petrol or diesel.

Lithium containing batteries are best kept separate from other types. Because quantities will be small, they may have to be sold as mixed category items, and be expected to have a negative value. Note Section 14.4 below regarding the potential for lithium battery fires. Dry cell alkaline batteries should not be included as part of the e-scrap and will need to be landfilled in PICs.

13.7 Power Supplies

Computer power supplies, such as found in desktop computers and a range of laptop and other device power supplies and chargers, can be placed in a single grouping for power supplies. Desktop power supplies can be sent with their steel casings, as with laptop and other chargers these can be sent simply with their associated cables cut off.

13.8 Printers, Scanner, Photocopiers

Small printers and 4-in-1 type multifunction devices are bulky but are often largely plastic parts. However, they should be dismantled to recover any circuit boards, and remove the mercury lamps (see Section 14.2 below). They typically contain some nicely made stainless steel rods which may find a local use or go for metal recycling. Breaking down the items will reduce bulk considerably. Large photocopiers from big offices are largely mechanical devices that contain many steel parts. Also, care must be taken with these bigger units - and laser printers too - that the toner cartridges are carefully removed so that the toner dose not spread around – see section 14.3.

13.9 Other Items

Significant other categories to be sorted out are:

- Hard drives from computers;
- CD drives from computers and DVD players;
- Fans, e.g. from inside computers and inverters
- Laptops can be sent complete;
- Any cables can be cut off appliances and packed together, and their plugs cut off which go into a separate category;
- Ribbon connectors connecting PCBs;
- All types of cell battery;
- Sealed lead batteries;
- Aluminium parts such as heat sinks and housings;
- Copper heat sinks;
- Small electric motors;
- Computer keyboards and mice can be sent as part of a general category of 'smalls' or can be opened up to remove any PCBs and contacts to reduce bulk, but this is only if the plastic can be baled and exported.

Toner Cartridges should be handled with care, and if no local take-back program exists, these can be put inside heavy-duty sealable plastic bags – such as zip-lock bags – and placed in the same part of the landfill that CRTs are placed, where is this allowed. Cartridges may come in to the recycler in original packing after exchange with a new one, and it may be possible to ship these in these boxes with any Ewaste shipment if a 'buyer' can be found, but it can be expected that these will have a negative value.

Appendix 2 provides a set of indicative photographs and categories to sort item into, and should be referred to alongside this section to help category identification.

14. Technical Hazards for Recyclers of E-waste in Pacific Islands

Recycling of Ewaste in Pacific Islands will be a disassembly process only, as no end-processing of materials should take place. End processing of Ewaste to recover useful materials usually involves some crushing, shredding or similar process before moving to two processes, either hydrometallurgy, processing using liquids such as acids to extract precious metals; and/or pyrometallurgy, which uses heat to extract valuable materials. No Pacific Island location covered by this report will be in any position to have environmentally sound facilities to conduct any of these extractive processes, and so these will not be considered here, and any attempt by any recycler to try and conduct such processes should not be undertaken in any form. Facilities to undertake such activity are even unusual in Australia or New Zealand, and any attempt to conduct either pyrometallurgy or hydrometallurgical processes in the islands in question is almost certain to result in activities that would contravene local environmental laws. Thus this section will take it as a core assumption that manual disassembly will be the only processing undertaken in Pacific Islands prior to any shipping of materials off-shore.

Manual disassembly of WEEE is a process very similar to that involved in repairing electrical equipment, without the ongoing exposure to solder fumes of which electrical repair shops must be careful. However, there are certain aspects of disassembly of WEEE that may have potential hazards that any recycler should be aware of, and take steps to address. The key hazards are these:

- Leaded glass and phosphor dust in CRTs;
- Mercury containing items, such as lamps in scanners, photocopiers and flat screen TVs and monitors;
- All types of batteries, large and small;
- Printer cartridges;
- Potential exposure to brominated flame retardants (BFRs) from some plastic cases.

This section will deal with each in turn, to provide a guide on how to identify the hazards, and what action to take. Whilst WEEE typically contains a large number of other potentially hazardous chemicals, these are bound up in materials that are set aside as separate components for the purposes of recycling, for example on printed circuit boards. These items will not release any toxic materials if kept clean, dry, stored out of the weather, and not heated or left in liquids. These potentially toxic materials become a concern during the process of materials extraction, where measures must be taken to deal with them.

Note that printed circuit boards, a very common component of WEEE, can also be referred to as PCBs - and are through this study - but this must not be confused with PCB liquids, which are Poly Chlorinated Biphenyls, and which have been used in electrical equipment in the past as cooling and insulating liquids. These Polychlorinated Biphenyls are highly toxic, and must be treated with extreme care; however, manufacture and use of polychlorinated biphenyls ceased about thirty years ago, and it is unlikely that any PIC recycler will come across such materials, unless they attempt to recycle very old – and large – transformers from a grid-based electrical distribution system.

This section draws strongly from relevant standards, such as the recent AS/NZS 5377 standard, but should in no way be taken to be any form of comprehensive reference material, and is provided for general information purposes only. More authoritive material is available from the sources cited in the Bibliography and elsewhere from sources with expertise in this subject.

14.1 Cathode Ray Tubes (CRT)

CRTs prove to be the most problematic of the common WEEE that any PIC recycler will come across. They are heavy, easy to break, and low value. The two chemical hazards associated with CRTs are that the glass contains lead at a sufficient concentration that these items can constitute a hazardous waste[80] in some jurisdictions. That is also why CRTs tend to be so heavy, a combination of glass and lead making up most of the weight. The second hazard is that the front Face Panel glass is coated on the inside with a dust called a ‘phosphor’. ‘Phosphor’ is a generic term that covers a variety of materials, but they have the similar property of being luminescent[81]. The potential substance of concern in the type of phosphor found in some CRTs is cadmium, and the toxic pathway is that of inhalation.

Whilst in previous decades this phosphor contained cadmium in large enough quantities to be of concern, since around 2000 with the implementation of the EU RoHS directives[82] and other measures in the US, cadmium has been eliminated from the phosphors[83] used. As electrical equipment in PICs has such a comparatively short lifespan due to the typically harsh environment, the equipment typically coming in to PIC Ewaste sections is likely to be newer, but items containing cadmium can still be expected to appear on occasion. Whilst exposure to a single event may not cause illness, repeated exposure may well do so, thus the dust should be carefully avoided as to inhalation or allowing it to blow around uncontained. See also Section 2.7 for further information and references.

The average PIC recycler will, however, likely receive a large number of CRTs with broken funnel glass. This is usually caused by someone breaking the tip off the end of the funnel – with a hammer or even a rock – in order to recover the copper windings in the ‘yoke’. This copper will no doubt be offered to the recycler as copper, a much better price per kg than a CRT. Broken CRTs present a physical handling hazard – with sharp glass easy to cut hands - to a recycler’s staff, as well as a potential inhalation hazard. A CRT may well come in that has had the yoke removed brutally (it can be removed

[80] When tested by a Toxic Characteristic Leaching Procedure (TCLP) test, see also: Characterization of Lead Leachability from Cathode Ray Tubes Using the Toxicity Characteristic Leaching Procedure in the Bibliography.

[81] A **phosphor,** most generally, is a substance that exhibits the phenomenon of **luminescence.** Somewhat confusingly, this includes both phosphorescent materials, which show a slow decay in brightness (>1ms), and fluorescent materials, where the emission decay takes place over tens of nanoseconds. Phosphorescent materials are known for their use in radar screens and glow-in-the-dark toys, whereas fluorescent materials are common in CRT and plasma video display screens, sensors, and white LEDs. http://en.wikipedia.org/wiki/Phosphor accessed 1/6/13

[82] Restrictions on Hazardous Substances: Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

[83] For example Material Safety Data Sheet for ‘CRT Luminophore 2111’ made by Nichia North America Ltd. contains 99wt% ZNS; 0.5wt%Ag; 0.5wt%Cl. Sept. 2003.

without breaking the glass if a little knowledge and technique is applied), but still has a significant quantity of materials inside of interest to the recycler. There is plenty of copper wire, as well as at least one PCB inside, and these are all easy to recover. Broken CRTs should be placed away from any working areas, and damping down with a little water will prevent the phosphor dust getting mobile[84]. It is highly likely that these cannot be shipped overseas for recycling, and where local authorities permit, these should be landfilled as soon as possible, and covered, in a landfill – or part thereof – set aside specifically for low level toxic wastes.

The lead content, being vitrified in the glass, is a long-term heavy metal leachate hazard rather than an immediate one, except where breaking of the CRT produces dust and fines that may be easily mobile. CRTs can also be a potential hazard as they contain a vacuum, and whilst generally have a tendency to implode, it is possible for them to explode too. To prevent this, a steel safety band is placed around the front of the tube - at its fattest point usually – and this should be left in place if stripped tubes are stored or shipped overseas whole.

14.2 Mercury in WEEE

The next most common issue that recyclers need to take care around is the presence of mercury in lamps in scanners and photocopiers[85]. These lamps can also be found in flat screen monitors and TVs, but flat screens should not be dismantled to try and remove the lamps as they are easy to break in those devices. However, typical printers, scanners and photocopiers may be broken down to reduce the considerable volume these items usually occupy due to having a large number of mechanical parts. The lamps in scanners and photocopiers – and found in multifunction printers – are easy to remove, and are reasonably more robust, or certainly usually more so than a typical florescent tube lamp, which has the same toxic hazard problem. The lamp is a small thin glass item, usually part of a sub-assembly that is moved on a carriage under the glass of the scanning device. This sub-assembly *should not* be dissembled in order to extract the glass lamp alone. The entire sub-assembly can be set aside in a container with other mercury lamps; that container should have a lid or some closure such that the container is kept normally closed and airtight, and only opened in order to place lamps inside. This same container, where conforming to IMDG packing regulations can also be used as the container for exporting these lamps once it is full. The best option is to have a lamp crushing device at hand such as that described in the Cook Islands[86], where lamps can be crushed and contained in the sealed drum underneath, along with strip neon and CFL lamps.

These lamps also exist inside flat screens, but flat screens should only be dismantled to the extent of removing the heavy stand, in order to make packing easier, and the screen requires no further dismantling.

Where the recycler also receives any compact florescent lamps, or strip fluorescent lamps, these should be treated in the same way as mercury lamps, as these items also contain mercury. Mercury is a highly toxic material and the mercury in the lamps, whilst

[84] http://e-stewards.org/standard-appendixes/appendix-c/clean-up-procedures/ accessed 29/5/13
[85] Chemical hazards associated with treatment of waste electrical and electronic equipment, Tsydenova et al, 2011
[86] See also www.aircycle.com

in very small quantities, could be expected to cause serious illness if repeated exposure occurs[87].

14.3 Ink and Toner Cartridges

The problem from these items is largely the inhalation hazard from the inhalation of the very fine powders that are found in toner cartridges. These items need to be kept inside sealed bags – heavy duty Ziploc bags will suffice – and also placed inside containers, such as drums, with sealable lids, and kept away from normal working area. In some places a system exists for the supplier to take back toner cartridges, but where this does not occur, these items will likely need to be landfilled where this is permissible by local authorities, in a suitable low level hazardous waste landfill area.

14.4 Batteries

Apart from wet lead-acid batteries, which have an acid spill hazard, but are currently being recovered by PIC recyclers in all places covered by this study, the main hazard with old batteries is the potential for remaining charge in batteries to be short circuited and so cause sparks and possible fire. The key additional issue is where Lithium Ion batteries might be physically damaged through impact, which can cause them to explode and burn out. All batteries should be removed as a first step from and WEEE, and stored and packed separate from other items.

The number one rule with batteries is to be careful with them, and ideally at least one terminal should be taped with insulation tape or duct tape so as to avoid the potential for short circuit. Batteries packed for shipping must conform to IMO DG rules under Class 9 and typically packing group II[88]. Large quantities of batteries should not be kept in the same pile or container, and where put on pallets or similarly stacked, layers of non-conducting materials, such as thick plastic sheets or cardboard, should placed between the layers. Any pallets should be well wrapped with pallet wrap to stop the load moving about during transport or handing.

It must be noted that fires caused by burning lithium batteries can be very difficult to fight and very dangerous. Powdered copper is recommended as suitable for fighting lithium fires[89], but of course most facilities will not have this on hand unless they are prepared. Lithium batteries should be kept separate and not commingled with other types, and stored such that they are protected from heat, humidity, sunlight, water and physical damage[90].

14.5 Plastic Containing Brominated Frame Retardants

Some electronic equipment has plastic covers that have been treated with BFRs. Whilst production of this chemical is now significantly reduced, and is being phased out under the Stockholm Convention and recent EU RoHS rules, it may still be present in some

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87 Aucott,M.,McLinden,M.,Winka,M., 2003. Release ofmercury from broken fluorescent bulbs. Journal of the Air and Waste Management Association 53 (2), 143–151.

88 Refer Chapter 4.1 – 'Use of Packings' in the International Maritime Dangerous Goods Code 2008 edition.

89 As/NZS 5377: 2013 Collection, Storage, Transport and Treatment of End-of-life Electrical and Electronic Equipment, B 4.

90 Ibid

plastic housings that recyclers may remove, particularly from CRTs. These chemicals are known toxins, and are found in several different compounds and combinations. Studies have found that recycling workers can be exposed to excess levels of these chemicals where the plastic is shredded or ground up and workers have continual exposure[91]. It can be difficult to determine and identify if plastic covers contain BFRs, some are marked such that this is so, but not always. Appendix 4 provides some guidance on this issue.

Thus PIC recyclers should not process plastic Ewaste through machines such as grinders or shredders so as to reduce density for shipping. Studies indicate that large particle size is the key factor to lowering exposure, and as such, baling in a vertical baler should not be expected to create any significant hazard. However, it is as well to make sure that any baling of E-waste plastic housings is done in a very well ventilated area; quantities of materials expected in the target countries of this report should mean that baling of plastics in a vertical baler is an irregular process. Where possible, plastic housing awaiting baling should be kept dry and out of the sun.

Circuit boards may also contain BFRs, and as such, PCBs should not be shredded – or otherwise intentionally broken up by PIC recyclers before shipping. These items should be stored prior to shipping such as to avoid physical damage through impacts, excessive heat, sunlight, rain, immersion in water or other liquids. Appendix 4 provides some information about which items may contain BRFs and how to decide what to do with them.

Plastics containing BFRs are not allowed to be recycled - under the Stockholm convention rules – as the aim is to remove BFRs from the product streams. Burning of plastics containing BFRs – especially at low temperatures such as open fires – will almost certainly result in the generation of extremely toxic dioxins, and must not be done under any circumstances. Dioxins are one of the most potent carcinogenic substances known. BFRs can be present in a wide variety of plastics used in electrical products, and as such it is extremely important that materials derived from WEEE are not burnt. It is essential that anyone found burning electrical equipment in order to extract non-ferrous metals – for example burning cables to remove a plastic component - should be subject to significant sanction and local publicity such that communities become aware of what a dangerous practise this is, especially for their children's' development.

Plastics containing BFRs will not be allowed to be exported from New Zealand for recycling and most likely Australia[92] too. Plastics containing BFRs in New Zealand are only allowed to be landfilled in Class A landfills[93].

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[91] Chemical hazards associated with treatment of waste electrical and electronic equipment, Tsydenova et al, 2011

[92] http://www.mfe.govt.nz/publications/waste/bromide-flame-retardant-waste/index.html

[93] Class A landfills meet, or are consistent with, the site selection and design standards outlined in the Centre for Advanced Engineering's *Landfill Guidelines (2000).* These landfills are sited in areas that reduce
The potential for adverse environmental effects, have engineered systems designed to provide a degree of redundancy for leachate containment, and collect landfill leachate and landfill gas.

Appendix 1: List of Ewaste Businesses in the Pacific Region Complying with Internationally Recognised Standards

The following comprise companies that have some form of accreditation to either International Standards Organisation recognised level (such as ISO 9001 or 14001), accreditation to a recognised international Ewaste recycling standard, or hold a Basel Permit to export materials considered as Ewaste from either Australia or New Zealand. Australia and New Zealand also have a recent standard for processing Ewaste: ASNZS 5377-2013, but this is not a certification or regulatory standard at this time.

There are two international accreditation schemes for Ewaste, but they are US based:
1) The USA e-stewards standard, as found at www.e-stewards.org , not available outside US at this time;
2) The USA R2 standard www.r2solutions.org ;
Only Sims Recycling Solutions and TES-AMM have R2 certification in the region covered by this study.

Company Name	Address	Contact person	website	Notes
New Zealand				
Computer Recycling Ltd	3 Southdown Lane Penrose Auckland	graeme@dumanys.co.nz	http://computerrecycling.co.nz	Basel permits in place for Ewaste.
Sims Recycling Solutions	5/113 Pavilion Drive Airport Oaks Auckland		www.apac.simsrecycling.com	ISO 9001/14001 Basel permit for transit.
TES-AMM New Zealand Ltd	89 Lansford Crescent Avondale Auckland	barry.exeter@tes-amm.com	http://www.tes-amm.com	R2 certified ISO 9001, ISO 14001 & OHSAS 18001, Basel Permit
RCN Group	2 Piermark Drive Albany Auckland	Shannon@e-cycle.co.nz	http://www.rcn.co.nz	NZ Basel permit.
Interwaste	Auckland Airport	info@interwaste.co.nz	http://www.interwaste.co.nz	Only Mercury containing lamps.
Australia				
MRI	5 Bently st. Wetheral Pk NSW 2164	bjackson@mri.com.au	www.mri.com.au	EPA licensed
Sims Recycling Solutions	82 Marple Ave. Villawood NSW 2163	graham.muir@simsmm.com.au	www.apac.simsrecycling.com	R2 certified ISO 9001/14001

TES-AMM Australia Pty Ltd	1 Marple Avenue Villawood NSW 2163	Info.au@tes-amm.com	www.tes-amm.com	R2 certified ISO 9001, ISO 14001 & OHSAS 18001, Basel Permit
PMG Refiners	7 Mills Rd Dandenong Victoria,	office@pgmrefiners.com	http://www.pgmrefiners.com	ISO 9001 & 14001 certified
Singapore				
TES-AMM	No. 9 Benoi Sector Singapore 629844	info@tes-amm.com	http://www.tes-amm.com	R2 certified ISO 9001, ISO 14001 & OHSAS 18001, Basel Permit
Cimelia Global	No 3 Tuas Avenue 2 Singapore 639443	info@cimeliaglobal.com	www.cimeliaglobal.com	Basel permit to import

Appendix 2: Commercial Classes of Ewaste Applicable to PIC Recyclers

The information below is of the most common classes of e-scrap that PIC recyclers may use; this is provided for indicative purposes only. The prices provided are only to provide a relative indication of value, as of early 2013. Any actual prices must be negotiated between buyer and seller at the time of sale.

ID	Ewaste Scrap Categories	Price Per Tonne NZD, indicative only	Basel Permit Reqd?	Packing type
1	Whole Computers, inc. laptops	500	y	pallet
2	Hard dives	1800	y	bag
3	Keyboards, mouse, speakers	90	y	bag
4	Populated Circuit Boards from Computers / Server and Networking	4000	y	bag
5	Populated Circuit Boards from Audio / small router, modem devices or printers	3000	y	bag
6	High Grade Circuit Board Scrap, Ram, SIM, IC	7000	y	bag
7	High Grade Circuit Board, CPU chip only	15000	y	bag
8	Transformers & Transformer Windings	600	n	bag
9	CRT Yokes	1500	n	bag
10	CRT degaussing coils	4000	n	bag
11	TV/Monitor circuit boards, low grade	250	y	bag
12	Power supplies, computer, laptop and other	450	y	bag
13	LCD Monitors Whole and Clean, no marks or scratches	1000	n	pallet bin
14	LCD monitors broken and scratched screens	negative	y	pallet
15	Fans	300	n	bag
16	Copper Heat Sink	6500	n	bag
17	Copper / Alum / Stainless Heat Sink	1000	n	bag
18	Alum Heatsinks	1000	n	bag
19	Steel Chassis	170	n	pallets
20	CD Rom/ floppy drives	250	y	bag
21	cables / plugs cut off,	2000	n	bag
22	Magnetic Tape Media Waste	150	n	bag
23	CD/ DVD Scrap Media	90	n	bag
24	small Printers / scanners	90	y	pallet
25	large printers, photocopiers	120	y	pallet
26	Mixed small batteries (see note 1)	negative	y	Drum
27	CRT glass(TV and computer monitors)	-500	y	Drum

Notes:

1. Mixed Small Batteries

This class will be a mixture of several types of batteries for the PIC dealt with in this study, due to low volumes. It will likely include the following:

Mixed Button Battery Scrap: assorted common round button style batteries commonly used in hearing aids & wrist watches, may include nickel and lithium button batteries;

Lithium Content Batteries: assorted batteries that contain lithium or lithium alloys or lithium ion batteries;

Mercury/Silver Oxide Batteries: may contain a variety of batteries that contain mercury and silver oxide.

Nickel Content Batteries: assorted sizes of common household Nickel/Cadmium Batteries and Nickel/Metal Hydride, sorted to be free of common alkaline batteries. May include spent rechargeable or non-rechargeable batteries.

Sample Photos of commercial categories of e-scrap. The numbers are referenced to the classes in the table above.

1. Whole computer

2. Hard drives all types

3. Keyboard, mouse, small speakers

4. PC motherboard

4. Server card

4. Server motherboard


5. Router PCB

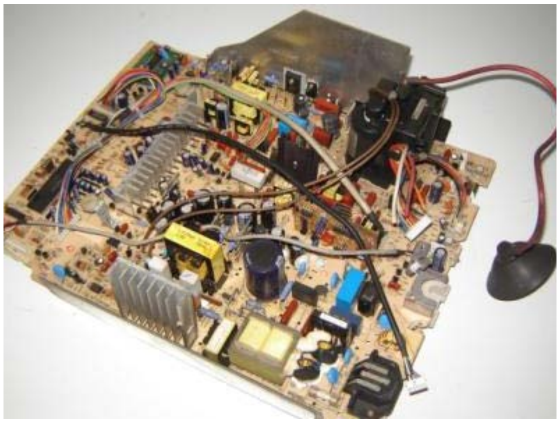

5. Large switch PCB


6. Ram Cards (High Value)


7. CPU (High Value)


8. Mixed Transformers


9 & 10 CRT Yoke (centre) & Degaussing coils


11. CRT PCB


12. Laptop Power supply


12. Mixed computer internal power supply


15. Fans


17. Mixed metal CPU heatsink


17. Mixed metal heatsink


18.Anodised Aluminium heat sink


20. CD Rom drive


21. Mixed wires, plugs and connectors removed


26. Mixed small batteries


26. Mixed small button cell batteries


27. Broken CRT glass


Other: mixed clipped connectors


Other: Mixed plugs

Other indicative photos:


Ewaste disassembly workspace


Palletised CRT monitors

Appendix 3: Photos of Current E-waste Situation in the Target Countries

Kiribati

Betio MRF E-waste processing area

Damaged CRTs dropped off

Sorted E-waste

Processing area for dismantling

Items awaiting dismantling

Tonga

GIO E-waste processing area

Hard drives

High grade circuit boards

CPU chips

Power supplies

Samoa

The results of the Observer E-day

PCB mixed in with scrap steel for baling

WEEE awaiting dismantling

various PCBs packed together

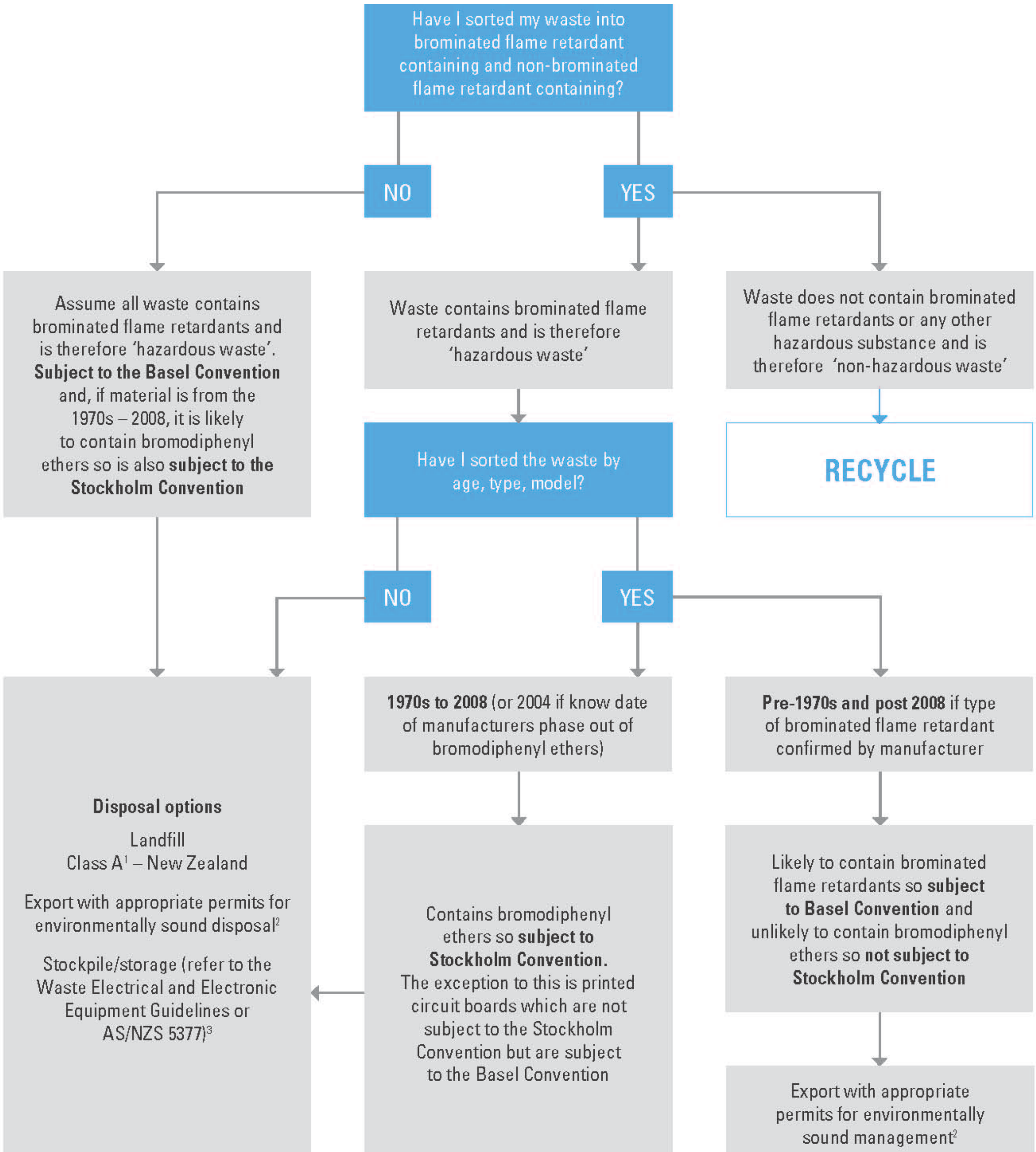
Cook Islands

Recycling Centre at Rarotonga Landfill

Ewaste dumped in wasteland by the old Turangi recycle centre

Appendix 4: Brominated Flame Retardants: Identification and Management Decision Tree

This decision tree is extracted from an NZ government Ministry for Environment document[94] in order to assist recyclers identify steps to take for materials on this issue.



[94] http://www.mfe.govt.nz/publications/waste/bromide-flame-retardant-waste/managing-waste-that-may-contain-brominated-flame-retardants.pdf

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