REGIONAL E-WASTE MONITOR

EAST AND SOUTHEAST ASIA

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UNITED NATIONS UNIVERSITY
UNU-VIE SCYCLE
Sustainable Cycles Programme

環境省
Ministry of the Environment

Regional E-waste Monitor:
East and Southeast Asia

By Shunichi Honda, Deepali Sinha Khetriwal and Ruediger Kuehr

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Executive Summary

Electrical appliances and electronic gadgets are pervasive in our lives, and their number and use is still on the rise, impacting our professional and personal lives daily.

These devices, typically powered by a battery or a power supply, are used in all parts of the world and across all strata of society. In 2012, an estimated 56.56 million tonnes of Electrical and Electronic Equipment (EEE) were put on the global market.

Asia is both the world's largest manufacturer of and market for EEE, consuming 26.69 million tonnes in 2012 of what was put on the global market, or about half the global amount. In 2014, Asia generated 16 million tonnes of e-waste, which equals 3.7 kg per inhabitant compared to 15.6 kg per inhabitant in Europe. As Asian countries rapidly industrialise, and their citizens enjoy higher income and living standards, the consumption and disposal of EEE will continue to increase.

Properly handling end-of-life products is not only an environmental benefit, but it also protects the public's health, which is negatively impacted by improper recycling practices that emit hazardous substances. Proper handling also preserves limited resources essential for the production of high-tech products.

With a focus on the national jurisdictions of Vietnam, Thailand, Taiwan, Singapore, the Philippines, Malaysia, South Korea, Japan, Indonesia, Hong Kong, China and Cambodia, this Monitor covers nearly 30 per cent of the world's population across a wide range of socio-economic parameters.

This report uniquely presents a summary of the regional e-waste statuses, and it is arranged so as to allow direct comparisons where possible that can help further the development of e-waste management systems based on other countries' experiences.

Japan has been at the forefront of digital technology developments and is home to some of the largest EEE manufacturers on Earth. It has also been an early mover and global leader in implementing an Extended Producer Responsibility (EPR)-based system for e-waste, largely building on its strong existing framework for solid waste management.

As part of international commitments towards better environmental management of e-waste, Japan has been technically and financially supporting various kinds of e-waste activities through international programmes. It is under the aegis of this program that this report is developed as a compilation of knowledge and experience gathered over 10 years

through various MoEJ sponsored activities in the region through workshops, desk studies, pilot projects and a review and synthesis of relevant reports, studies and academic papers.

Successful and environmentally sound e-waste management needs a holistic approach to waste management, taking into account many factors, such as a country's socio-economic development, governance structures, geography, trade links, infrastructure, psychological considerations that reflect consumer attitudes, legal frameworks, collection mechanisms, recycling and recovery facilities, environmental awareness and health and safety standards. To simply these variables, four main pillars are identified, namely the legal framework, the collection mechanism, the processing infrastructure and the environmental health and safety standards, along with a country's e-waste management systems. For each pillar, three stages were identified, ranging from basic to advanced. We consider "prevention" as a common theme across all pillars, in line with prevention ranking higher up in the waste hierarchy.

This builds the E-waste System Matrix for this Monitor, which is comprised of four e-waste management types with Japan, Taiwan[1] and the Republic of Korea falling under Type 1 "Advanced", Singapore and Hong Kong falling under Type 2 "Voluntary Initiative", China, Malaysia, the Philippines and Vietnam falling under Type 3 "In transition" and Cambodia, Indonesia and Thailand under Type 4 "Informal Initiative".

Just as the supply chains of EEE are global in nature, so are the reverse chains at end-of-life, with large, and ever-growing, international trade in waste. The exponential growth and international controversies of these transboundary trades have led to the development of regulations at the national regional and international level. All focus countries of this Monitor plus Taiwan, Province of China, control e-waste either through the Basel Convention or their respective national legal framework (only for Taiwan). However, the measures to control imports and exports of second-hand electronics, and their effectiveness, are different. While some countries control and prohibit the export of e-waste, others control or outright prohibit the import of e-waste and second-hand products.

1 Throughout this publication and based on UN decisions, Taiwan always refers to the Province of China

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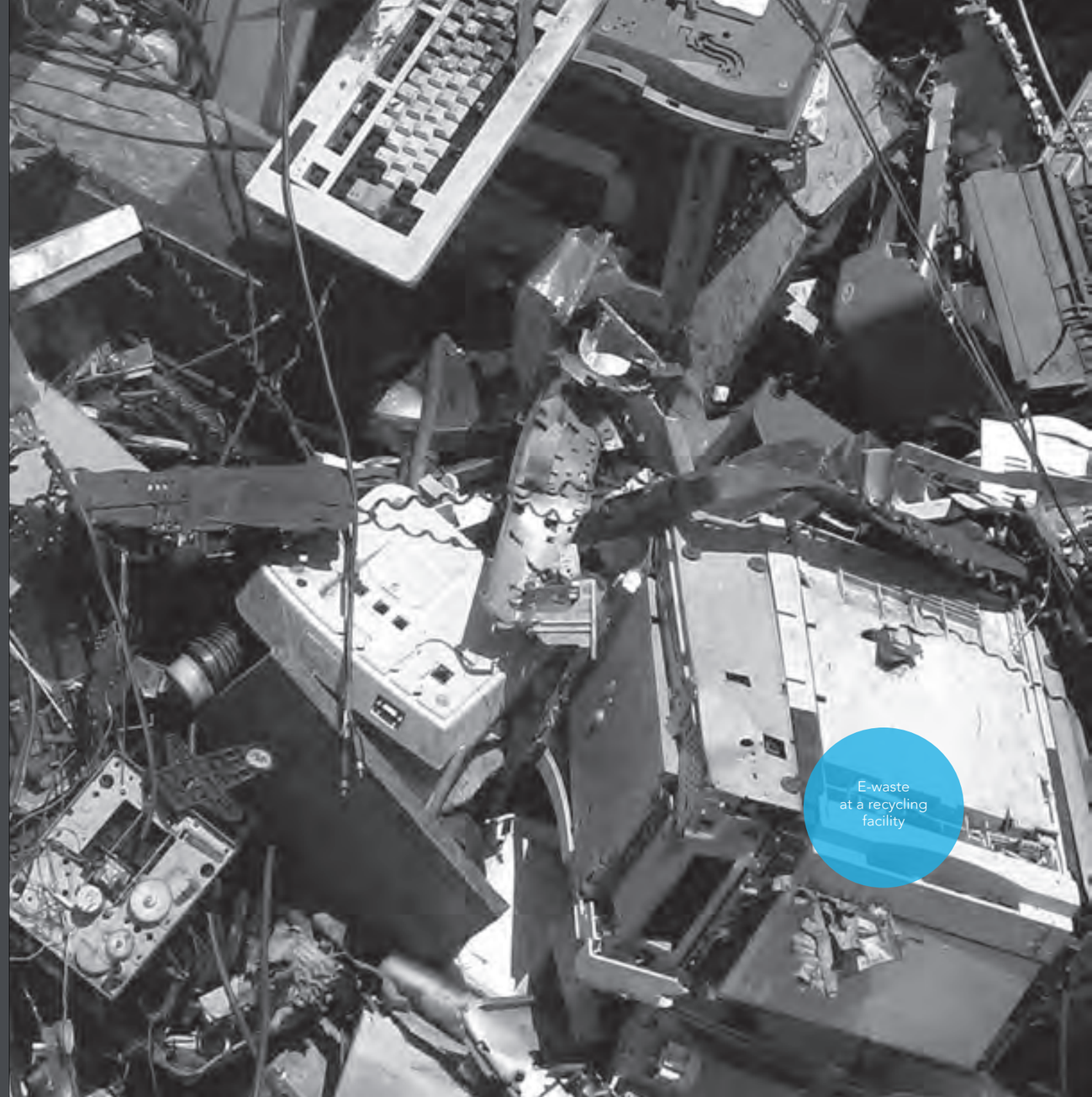

E-waste at a recycling facility

1. Introduction

» Information and communication technologies; consumer electronics including toys; large household equipment, such as dishwashers and washing machines; medical equipment; and electric tools have become central to our daily lives. «

We can expect further innovations for application of electronics in areas such as clothing, vehicles, logistics, etc. Greater access to electrical and electronic equipment (EEE) is seen as synonymous with economic development and therefore prosperity, and new products and promotions are put on the market constantly in response to the rapid technological progress and growing demand from consumers. Globally, sales of EEE have boomed in the last decades, and many Asian countries, as notable EEE manufacturers, have benefited from this boom. The total amount of EEE put on the market has increased from 51.33 million tonnes in 2007 to 56.56 million tonnes in 2012, as per United Nations University (UNU) estimates. Asia emerges as the largest consumer of EEE, accounting for nearly half of EEE put on the market, with 20.62 million tonnes in 2005, increasing to 26.69 million tonnes in 2012. The increase is particularly striking given the drop in EEE sales in Europe and the Americas in 2012 following the global financial crisis. Within Asia, Eastern Asian countries, including Japan, China, South Korea and Taiwan, account for the majority of EEE sales.

E-waste worker in China [Empa]

Global EEE Put on Market [million tonnes] 2012

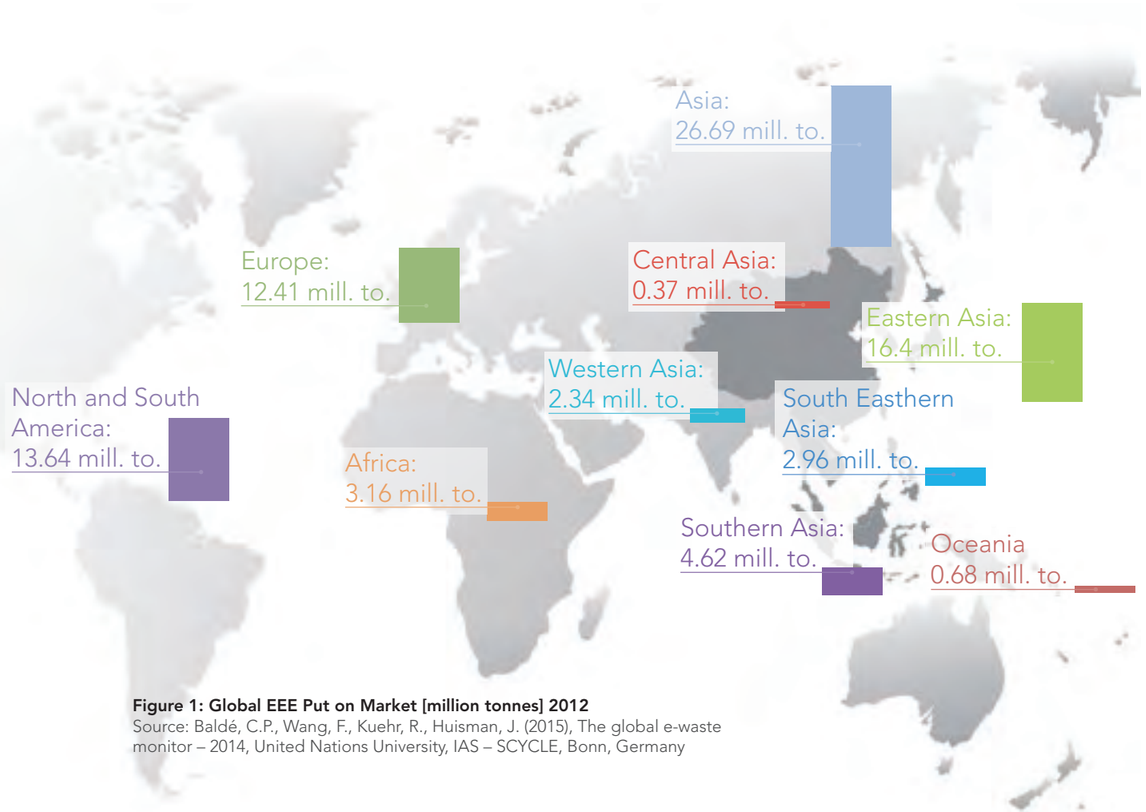

Figure 1: Global EEE Put on Market [million tonnes] 2012
Source: Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany

The downside to this production boom is the environmental costs that result from the production, usage and final disposal of EEE. Rapid technological developments and subsequent quick turn-around of products often contribute to the shortening of product lifetimes, as users

Global EEE Put on Market [per cent]

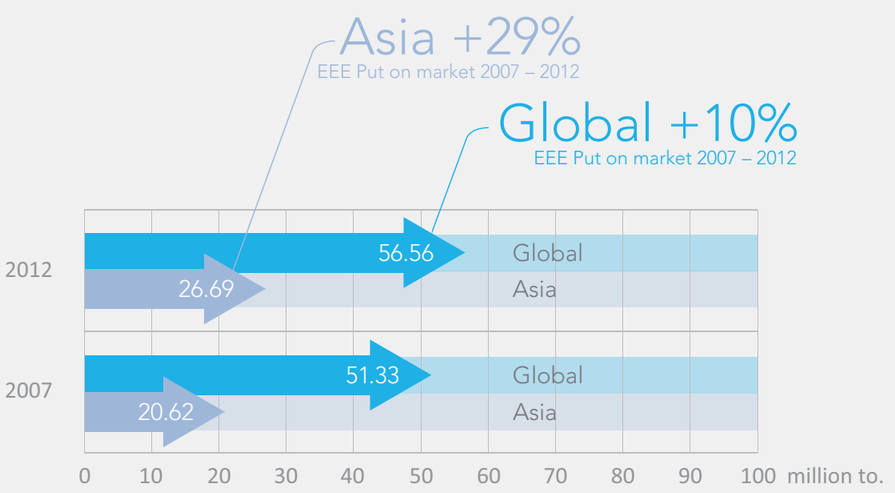

Figure 2: Global EEE Put on Market [per cent]

replace their gadgets more frequently. In addition, many products are designed for low-cost production, but not necessarily repair, refurbishment or easy recycling.

This results from producers' interests to increase their market share and consumers' demands for low-cost products. All in all, these circumstances are leading to increasing quantities of e-waste, but also increased consumption of resources for producing the equipment.

E-waste at a recycling facility [Shunichi Honda]

Printed Circuit Boards awaiting recycling stored in the open-space storage [Ruediger Kuehr]

Open-air storage of cables for recycling [Ruediger Kuehr]

1.1. What is E-waste?

» "E-waste is a term used to cover items of all types of electrical and electronic equipment (EEE) and its parts that have been discarded by the owner as waste without the intention of re-use." – Step Initiative[2] «

2 Solving the E-Waste Problem (Step) White Paper (2014): One Global Definition of E-waste, Bonn, p. 4-5. Access online: http://www.step-initiative.org/files/step/_documents/StEP_WP_One%20Global%20Definition%20of%20E-waste_20140603_amended.pdf

The Solving the e-waste problem (Step) Initiative emerged in 2004 as an independent, multi-stakeholder platform for designing strategies that address all dimensions of electronics in an increasingly digitized world. The Step mission is to apply an integrated, science-rooted approach to create salient solutions to global e-waste challenges along the entire electronics life cycle. http://www.step-initiative.org

There are different definitions of e-waste around the world, some more inclusive and others more specific. The debate often hinges on when a product should be considered "waste" and the associated legal obligations that characterization brings. In this report, we follow the Step Initiative's e-waste definition mentioned above, as it provides a comprehensive yet simple description of e-waste.

» How many products do you have that come with a plug or are battery operated?

» How quickly do you replace your EEE products?

» Have you thought of what happens to your discarded EEE?

E-waste stored in a typical Japanese home [Shunichi Honda]

E-waste in a Japanese home:

① Two “broken” digital cameras, ② two “functional but old-fashioned” mobile phones, ③ one “un-functional” mobile phone bought in another country that does not work in Japan, ④ one “old fashioned” laptop computer, ⑤ one “broken” recorder, ⑥ one “broken” radio and ⑦ two “unused” iPods made obsolete due to new smart phones.

Categorizing E-waste

E-waste may be categorized in different ways: by product type, product size or even treatment technology. Japan’s categorization is largely by size (e.g., “Large Household Appliances” and “Small Household Appliances”). The European Union’s WEEE directive previously had a product-oriented categorization, and in the recent recast, moved to a treatment-oriented categorization, with six main categories:

- **Temperature exchange equipment**, also commonly referred to as “cooling and freezing equipment”, comprised of refrigerators, freezers, air conditioners, etc.
- **Screens** including televisions, monitors, laptops, notebooks and tablets.
- **Small equipment**, typically comprised of vacuum cleaners, microwaves, fans, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments
- **Lamps**, which includes all types of straight fluorescent lamps, compact fluorescent lamps, fluorescent lamps, high intensity discharge lamps and LED lamps.
- **Small IT and telecommunication equipment**, which includes products such as mobile phones, GPS devices, pocket calculators, routers, printers, telephones, etc.
- **Large equipment**, which typically includes products such as washing machines, clothes dryers, dish washers, electric stoves, large printing machines, copying equipment and photovoltaic panels.

Global E-waste arising

As a continent, Asia generates the highest volume of e-waste, estimated at 16 million tonnes in 2014. However, on a per capita basis, this amounts to only to 3.7kgs per inhabitant, as compared to Europe and the Americas, which generate nearly four times as much per capita.

Global E-waste Generation in 2014 [million tonnes]

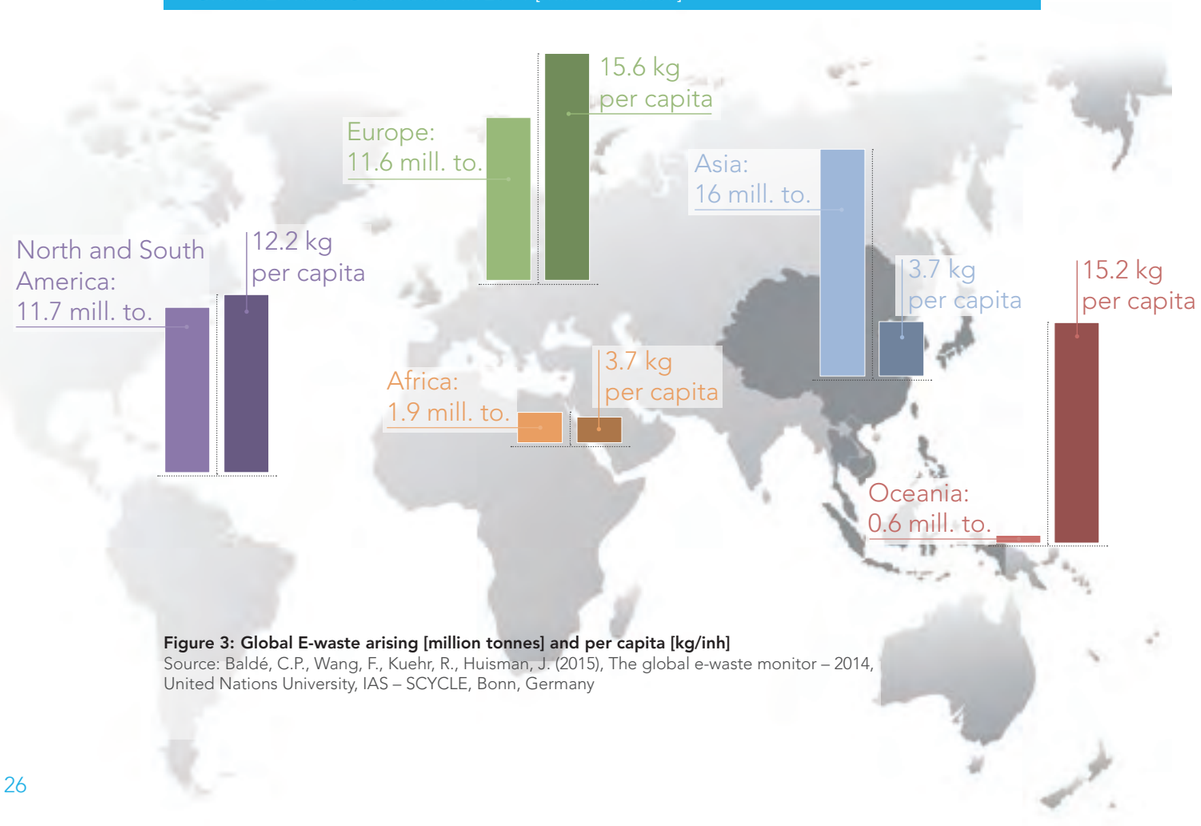

Figure 3: Global E-waste arising [million tonnes] and per capita [kg/inh]
Source: Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany

Disposal Routes for E-waste

Once a product is discarded by its last owner, whether after a single use or multiple uses, it should be treated in an environmentally-sound way without any adverse effects to human health and the environment. When collected, treated and recycled properly, e-waste is a rich "urban mine" – a source of valuable and precious resources that can reduce the need for primary resource production. When disposed of improperly, valuable materials are lost, and they may also be hazardous to the entire ecosystem, leaching toxins into soil, water and air.

The original function, weight, size, material composition and collection and treatment require-ments for each category differ, as do consumers' attitudes regarding their disposal of their unwanted EEE products. E-waste from consumers is destined for one of the following:

- Into **direct reuse** reuse often through donations and consumer-to-consumer sales (e.g., eBay and Amazon), second-hand EEE provides large sections of the population the opportunity to enjoy the benefits of modern gadgets and appliances at more affordable prices. Products may be reused domestically, or exported, often to lower-income countries.
- For **function recovery** as source for reusable parts, often through asset recovery programs. Repaired and refurbished gadgets are also in demand, both in the developed and developing world, because of their price competitiveness. In addition, prolonging the lifetime of many products also reduces their ecological footprint by preventing resource-intense production.
- Into recycling for **material and energy recovery,** following collection either through formal take-back or informal collection systems to reclaim various raw materials and energy. In several countries around the world, including in Asia, formal take-back systems have been set up to channel e-waste towards industrialized material and energy recovery facilities. However, of the estimated 48.1 million tonnes e-waste generated

globally, only 6.5 million tonnes are collected by official take-back systems[3]

- Disposed into **landfill**, either following earlier processing or together with municipal solid waste.

1.2. E-waste – An International Issue

The export of e-waste emerged as an international issue in the early 2000s, particularly following the publication of the widely reported documentary by the Basel Action Network (BAN) "Exporting Harm – The High Tech Trashing of Asia"[4], which highlighted the concerns of primitive e-waste recycling practices and large-scale transboundary shipments from industrialized countries to industrializing countries. As a complex and relatively recent waste stream, countries all over the world have been introducing specific legislation to enforce sound environmental treatment of e-waste. As yet, only the minority of states around the globe have national and regional e-waste legislation in force.

However, e-waste remains a global challenge, not only because of its increasing generation worldwide, but also because its proper treatment and prevention require the active engagement of a diverse set of actors, often spanning national borders. The international community has been working on e-waste issues for several years, particularly within the framework of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, under which transboundary movements of e-waste containing are controlled.

3 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

4 Basel Action Network, 2002. Access online: http://ban.org/E-waste/technotrashfinalcomp.pdf

The five key e-waste issues in which the international community has been engaged are:

- **Assessing e-waste volumes**, particularly through inventorisation and assessment studies,
- **Providing policy support** to develop relevant and effective e-waste legislation,
- **Building capacity** of various actors in the e-waste chain, including policy makers, regulators, customs and enforcement agencies, recyclers, etc.,
- **Assisting in technology transfer** to improve recycling practices towards more sound techniques, technologies, systems and processes, and
- **Assessing the impacts of transboundary movements** of e-waste from an environmental, economic and social perspective.

Cathode Ray Tubes from monitors on a recycling line in China [Bejamin Hale]

1.3. Framework conditions in East and Southeast Asia

Asian countries, home to more than half of the world's population, have wide disparities in socioeconomic indicators, such as Gross Development Product (GDP) per capita, economic growth and access to technology. This Monitor focuses on Vietnam, Thailand, Taiwan, Singapore, the Philippines, Malaysia, South Korea, Japan, Indonesia, Hong Kong, China and Cambodia. The 11 national jurisdictions on which this report focuses comprise nearly 30 per cent of the world's population.

East and Southeast Asian Countries on which this monitor focuses

* Province of China

Population – Southeast Asia 2015 [million]

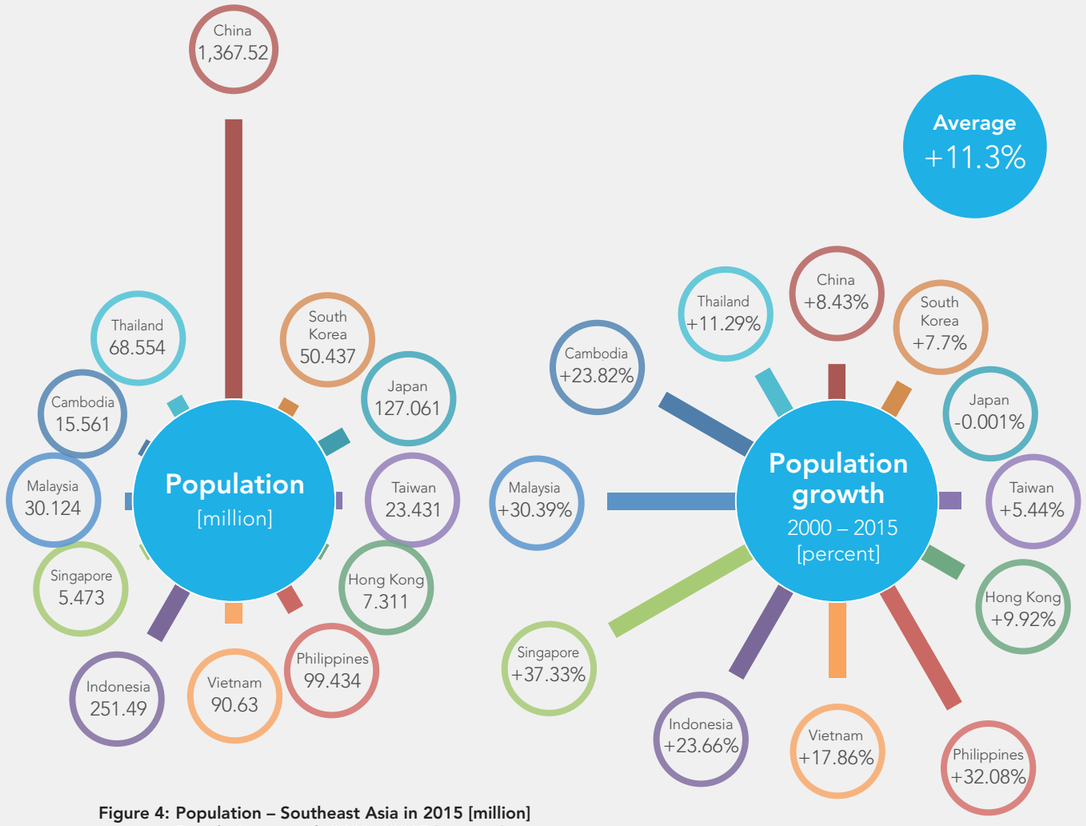

Figure 4: Population – Southeast Asia in 2015 [million]
Population growth 2000 – 2015 [percent]

GDP per capita – Southeast Asia

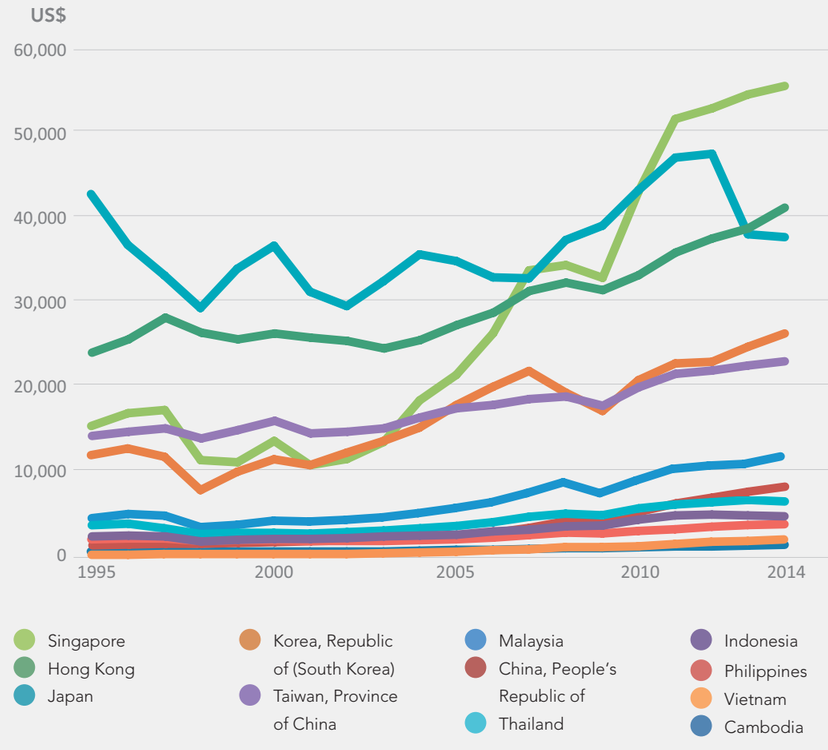

Figure 5: GDP per capita – Southeast Asia 1995 – 2014 [in US$]

While some countries in Asia enjoy high per capita incomes, others have large swathes of the population living in extreme poverty of less than US$ 1.25 per day. Emerging economies that have witnessed rapid economic growth tend to have a larger gap in income levels among their population. As these countries have grown rapidly, more and more people are able to afford the latest electronic gadgets, such as laptop computers and mobile phones. However, for large parts of the population in Southeast Asia, new electronic gadgets are simply unaffordable, and the only possibility to bridge the digital divide is to acquire a used personal computer (PC) or mobile phone bought on the second-hand market. What is clear, however, is that the quantity of e-waste generated domestically in East and Southeast Asian countries is rapidly rising.

East and Southeast Asia has also become a hub for the manufacture of electronics, not only for consumption within Asian markets, but globally. EEE supply chains are global, often with components and parts sourced from East and Southeast Asia for products assembled in other regions of the world, if at all.

As both consumption and production of EEE in East and Southeast Asia is rising, so is the problem of managing e-waste. Of the 11 national jurisdictions covered in this report, only five have passed e-waste specific legislation. However, there is a growing need for e-waste specific legislation and policies, and more and more countries are adapting current waste management rules to apply to e-waste, publishing guidelines or drafting specific policies and legislation on e-waste.

TThe rising volumes of e-waste have also resulted in a rapidly-growing recycling industry, both formal and informal. Given the large demand for second-hand products, collection, repair and refurbishment shops, mostly in the informal sector, are also commonly found in several countries.

1.4. Main Actors

The production, consumption and disposal of EEE engages a number of actors along the forward and reverse supply chain. These actors are also at least partially responsible for the functioning of developed e-waste management systems. Though most enacted e-waste legislation emphasizes the responsibilities of the producers, there is agreement that governments, municipalities, consumers, retailers, etc. must also make their important contributions to support a successful model.

Although countries in East and Southeast Asia have similar actors, in different countries, different actors are dominant, as reflected in their level of influence and engagement.

Governments:

The main role of the government is to provide the policy and regulatory framework for the management of e-waste. In some countries, governments play a strong role, not only framing the legislation but also being involved in implementation (e.g., China), while in other countries they only play a minor role, eschewing legislation in favour of voluntary mechanisms (e.g., Singapore).

Municipalities:

Operating at the local level, municipalities across all countries have the responsibility for waste management. In some countries, they make special arrangements to collect e-waste separately, while in other countries, they are hardly involved as e-waste rarely enters the municipal waste stream, often already collected and sorted by an informal network of collectors and waste pickers.

Producers and Trade Associations:

With most e-waste legislation based on the principle of Extended Producer Responsibility (EPR), producers have a major responsibility to organize, finance and operate an e-waste take-back system, either individually or collectively, through Producer Responsibility Organisation (PROS) (also called Producer Compliance Organisations – PCOs). In some countries, while producers accept the responsibilities mandatorily or voluntarily, they are often criticized for not showing the same responsibility in other countries that lack specific EPR legislation around e-waste.

Retailers:

As the consumer touch-point for producers, retailers often also act as collection centres or take-back points. However, this varies by country and product–where they might offer take-back for some products, but not others.

Consumers:

Household and business consumers are the often considered the weakest link in the chain, and their behaviour determines the fate and route of e-waste. Consumer behaviour and attitudes, though difficult to quantify objectively, can be gauged subjectively through levels of environmental awareness, which differs greatly from country to country.

Industrial Recyclers:

Small and large industrial recyclers, some specializing in e-waste, have come up in all countries across the region, particularly in the last decade. Industrial recyclers, more often than not, are capital intensive, operating mechanized shredding and sorting facilities or large-scale material recovery facilities. The number and capacity of such industrial recycling facilities varies greatly by country, linked not only to the volume of e-waste generated, but also the legislative landscape and the presence of an active or inactive informal recycling sector.

Informal Recyclers:

The informal sector is also a key actor in e-waste management. This involves players in the collection, pre-processing and first material recycling. A small fraction of the informal sector contributes to the adverse effect in human health and the environment due to unsound treatment practices through, for example, open burning of disposed machines or acid-baths to recover valuables such as gold, silver and copper.

Civil Society Organizations:

Non-governmental organizations, both international and local, have played an important role in brining awareness about the e-waste issue.

Increasingly, there is acknowledgement that individual solutions through legislation or setting up an individual take-back program are insufficient to solve the overall e-waste problem. Therefore, in many countries, there have been, and continue to be, initiatives to bring the various key stakeholders, particularly governments, regulators, producers and recyclers, to set up wider take-back and collection systems. Standing in the way of a more harmonized solution, some common complaints across the region are:

a) at the governmental level, there is often a lack of technical expertise, but more importantly, there is a lack of sufficient resources for implementation and regulation;
b) at the producer level, there is a lack of concerted effort between producers, and scalability remains a problem;
c) between all stakeholder, there is a lack of knowledge about how best to prevent e-waste generation and how to design appropriate e-waste management systems; and
d) at the consumer level, there is a low level of consumer awareness of environmentally-sound disposal of e-waste.

1.5. Background to the Report

Though the e-waste issue in East Asia and Southeast Asia has been discussed for more than a decade and a patchwork of activities in a various countries has taken place, a comprehensive overview and analysis of the e-waste situation in the region is still lacking. Therefore, this report aims to fill this gap, presenting the past and current situations in 11 countries including Taiwan, compiling information about on-the-ground activities and pilots sponsored and supported by international organizations, such as UN Environment and UNU, and governments like Japan's.

This report uniquely presents not only a summary of regional e-waste status, but it is arranged so as to allow direct comparisons where possible to and help to draw conclusions for furthering the development of e-waste management systems based on other countries' experiences.

Japan has been at the forefront of digital technology developments and is home to some of the largest global EEE manufacturers. It has also been an early mover and global leader in implementing an Extended Producer Responsibility (EPR) system for e-waste management, largely building on its strong framework for solid waste management. As a result, there is a strong legal framework backed up by an advanced collection and take-back system and processing infrastructure.

As part of international commitments towards better environmental management, Japan has been technically and financially supporting various kinds of e-waste initiatives through international programmes, such as the Basel Convention Partnership on the Environmentally Sound Management of E-waste for Asia-Pacific Region (Asia E-waste Project)[5]. This report has been developed under the aegis of this programme as a compilation of knowledge and experience. This report's information was gathered over 10 years through various Ministry of the Environment, Japan (MoEJ)-sponsored activities and others in the region through workshops, desk studies, pilot projects (listed in Table 1 and Figure 6) as well as a review and synthesis of relevant reports, studies and academic papers.

This report is intended to be used by all stakeholders, including policy makers, regulators, academic researchers, industry and business representatives, entrepreneurs, local community waste managers, campaigners and non-governmental organizations. However, please note that the report provides only a static snapshot of a complex and dynamic issue.

5 For more information, access online: http://www.basel.int/Portals/4/Basel%20Convention/docs/pub/leaflets/leaflet01012011-1.pdf

Past projects on E-waste in the East and Southeast Asian

Project	Strategic Objectives	Participating Countries and organizations
MoEJ-Funded Programmes		
Basel Convention Partnership on the Environmentally Sound Management of E-waste for Asia-Pacific Region **(Asia E-waste Project)** 2005 - 2013	1) Assess current situation on e-waste; 2) Prevent and minimize e-waste generation; 3) Introduce environmentally-sound e-waste management; and 4) Develop capacity through training, and promote awareness for all sectors.	Thailand, Malaysia, Cambodia, Indonesia, Sri Lanka, India, Vietnam, the Basel Convention Regional Centre for the Asia and Pacific Region in China (BCRC China), the Basel Convention Regional Centre for South-East Asia (BCRC-SEA)
Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes (Asian NT) 2004 onwards	1) Share common understanding on the status of illegal Transboundary Movements (TBMs) of hazardous wastes; 2) Exchange relevant information, including good practices, national legal frameworks, statistical data, illegal cases, etc.; and 3) Enhance communications among the participating countries at the annual workshops.	Brunei Darussalam, Cambodia, China (People's Republic of), Hong Kong (Special Administrative Region of the People's Republic of China), , Indonesia, Japan, Korea (Republic of), Malaysia, Philippines, Singapore, Thailand and Vietnam
Desk Study on the environmentally sound management of hazardous wastes including E-waste in Asia	1) Assess current status on ground implementation of waste management; and 2) Understand how environmentally-sound management is in interpreted into national mechanisms.	
Others Sources		
UN Environment-IETC programme on E-waste (2010-onwards)	1) Develop technical capacity development to manage e-waste in an environmentally-sound way; 2) Develop policy around e-waste management in cooperation among multi-stakeholders; and 3) Develop a management system for e-waste, including identification of technologies for recovery of useful materials.	Global
the United States Environmental Protection Agency (USEPA) and Taiwan Environmental Protection Administration (EPAT) International E-waste Management Network (IEMN) – 2011 onwards	1) Share best-practice with other countries, in particular developing countries. 2) Launch a network on e-waste management as an initiative by both USEPA and EPAT. 3) Serve as a resource for policymakers around the world who are working to improve E-waste management.	Argentina, Brazil, Canada, Colombia, El Salvador, Costa Rica, Egypt, Ghana, India, Indonesia, Japan, the Philippines, Malaysia, Mexico, Nigeria, Taiwan, Thailand, Trinidad and Tobago, the United States of America and Vietnam
The NIES (National Institute for Environmental Studies, Japan) Workshop on E-waste (2008-2013)	Annual workshop on E-waste since 2004, focusing on academic approach to tackle E-waste issues by sharing research.	

Table 1: Past projects on E-waste in the East and Southeast Asian region

Figure 6: Countries participating in the Asia E-waste project and Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes

Objectives

- Asessment of E-waste situation
- Prevention and minimization of E-waste
- Development of ESM for E-waste
- Capacity building and awareness-raising
- Promotion of information and training
- Share of common understanding on the status of illegal TBM of hazardous wates
- Exchange of national legal framework, statistical data, illegal cases, etc.
- Annual workshop for CA/FP to the Basel Convention

Update on Legal Framework

2004	Tokyo	Tor of the Asian Network
2005	Tokyo	Trends of trading
2007	Beijing	Definition of waste/non-waste
2008	Tokyo	Criteria for new/2ndhand/waste
2009	Kuala Lumpur	Asian situation in TBM of HW
2010	Yokohama	Frontline enforcement activities
2010	Siem Reap	Takeback issues/ESM standard
2011	Shenzhen	COP10 decisions/ESM
2012	Cebu	Takeback/Collaboration
2013	Bangkok	Collaboration/Border control
2014	Okayama	ESM/Border control
2015	Singapore	COP12 decisions/Border control

1.6. Quantification and Assessment Methodologies

The report relies on data from several studies and reports that use different methodologies to arrive at assessments of e-waste quantities. For some countries, more than one source is available, which often shows wide disparities in estimates. This is likely because official state sources are often not fully updated, or do not clearly define scope or methodology. Data availability and compatibility on e-waste flows are issues faced not only in countries without formal e-waste management systems, but also in countries with long established collection and take-back systems. At the international level under the Basel Convention as well there are challenges of collecting, harmonising and summarizing the data. Further complicating comparison-making is that the data includes different definitions of e-waste; for example, sometimes data is limited to only one or two product categories, while for others, it may include a much broader product scope. This section provides a broad outline of the methodologies used and briefly mentions the assumptions, gaps and drawbacks in each approach.

1.6.1. Methodologies for Assessment of National E-waste Inventories

Method 1: Country Assessments under the Asia E-waste Project

As part of the Japanese Ministry of Environment Asia E-waste project, several national assessments were performed using a standardized methodology to: 1 quantify the stocks and flows of e-waste within the country, 2 identify the main actors and assess the impact, for the purpose of identifying gaps and 3 recommend next steps towards sound environmental management of e-waste.

In each country, six products, namely, TVs, PCs, refrigerators, air-conditioners, washing machines and mobile phones were selected for assessment, not only because they represent a large share per weight of the total e-waste stream, but also because they carry a heavy environmental impact, as they are most often recycled inappropriately.

Field surveys and interviews with actors across the EEE chain, including importers, retailers, consumers, collectors, dismantlers, repair shops and recyclers, were conducted with the aim of establishing and quantifying e-waste flows, purchasing patterns and mapping recycling and disposal practices in the country. The sample sizes for the studies varied from 1,000 households and businesses in Cambodia to 1,200 households and businesses in Malaysia and Vietnam, and were spread around the country to ensure a geographically- representative sample.

The field research was supplemented by desk research and available statistical data on imports, exports, production volumes, etc. The estimates for e-waste generation were made using the simple delay model, whereby estimates for e-waste generated are based on the product sales in a specific historical year shifted in time by either a simple "average lifespan" of the product (e.g., in Cambodia) or a distributed lifespan where data was available (e.g., in Malaysia). For instance, using the simple delay model, if washing machines have an estimated average lifespan of 15 years, then the number of waste washing machines in the current year equals the number of washing machines sold 15 years ago. With a distributed lifespan, the model estimates e-waste generated in a particular year based on product sales over all historical years with the obsolescence rates expressed typically as a Weibull distribution.

Some countries reported inventory in units and mass, while others reported only in units or only mass. For the purposes this report, comparison is based on mass. Where only data in number of units disposed are available, they are converted to mass using the average mass derived from the table below.

For some products, such as washing machines, there is a large variation in average product mass from different sources. Therefore, for the purpose of this report, the average mass per product is taken as an average of the available averages.

	Air Conditioners [kgs]	Mobile Phones [kgs]	Personal Computers [kgs]	Refrigerators [kgs]	Televisions [kgs]	Washing Machines [kgs]
UNU	35.8	0.3	31.5	46.5	28.3**	72.4
Oguchi Product Flow Analysis 2007	46.00	0.11	9.79*	61	29.58	39
Perunding Good Earth	60.00	0.1	30	70	35	50
Robinson Brett	55.00	0.1	25	35	30	65
Step China [Ref. No. 13-14]	51.00		15	45	30	25
Average mass [kgs]	**50.1**	**0.1**	**22.5**	**48.8**	**30.5**	**52.2**

Table 2: Average product mass – average of averages – from different sources

* only Desktop PCs, excluding monitor ** only CRT TVs

Method 2: National E-waste Inventories under UNU Projects

The UNU's estimates of e-waste generated is based on a sophisticated model using UN Comtrade statistics of 260 HS codes from 1995 to 2012 as a basis, which is then analysed to eliminate outliers and blanks using statistical routines to arrive at a harmonized dataset of products sales of a country. As trade statistics are often only expressed in units, an average weight data per product category for each of the "54 UNU Keys" categories is calculated. Having arrived at the "sales per year" in each country, the "Sales-Lifespan distribution" method is used to estimate e-waste outflows from the system. In doing so, the lifetime, mathematically, takes the form of a Weibull function, with parameters of scale and shape where the scale parameter, which is associated to the average life of EEE, is fitted to real data in EU in order to get as close to real life characteristics. The average age of household EEE stocks and the average age of discarded e-waste has been used to construct the lifetime profiles for each product. These profiles also include the dormant time of electronic equipment in storage. A more detailed description of the methodology can be found in the UNU's 1st Global E-waste Monitor[6].

Method 3: National E-waste Inventories under Other Projects

Other sources of data, where available, include: country registers and collection and take-back scheme data (e.g., in Japan); data from published academic papers; data from so-called "grey" literature presented by government officials; and other research reports and market studies. A drawback of these sources is that often their methodologies are not explicitly detailed, which renders comparing data from the different sources difficult. However, these sources do add valuable reference points to the data, and they have therefore been included.

6 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

The Devil in the Detail: Case study – Japan PC Waste and TV estimates.

Three data sources on waste PCs provide three very different numbers, with significant differences between them. On the face of it, it may seem that either one or more of the numbers are inaccurate or suffer from a calculation error. However, closer inspection of the methodologies suggests that the differences can be explained due to:

- Differences in the definition of a waste PC both temporally and spatially – whether at end-of-use of the first consumer, at point of disposal or point of recovery. For example, used electronics exported from Japan are can be either considered as waste PCs or as PCs for reuse.

- Disposal routes being included in estimate: Collection and recycling directly by waste management facilities who collect PC wastes as a waste, in particular, waste generated by business sectors are not counted in data reported by PC3R, though they are by other authors such as Oguchi (2008)[7].

7 Oguchi, M., Kameya, T., Yagi, S., & Urano, K. (2008). Product flow analysis of various consumer durables in Japan. Resources, Conservation and Recycling, 52(3), 463-480.

- Export as mixed metals after dismantling PC wastes and collecting metal portions (but not much) at waste recyclers outside the voluntary programme.

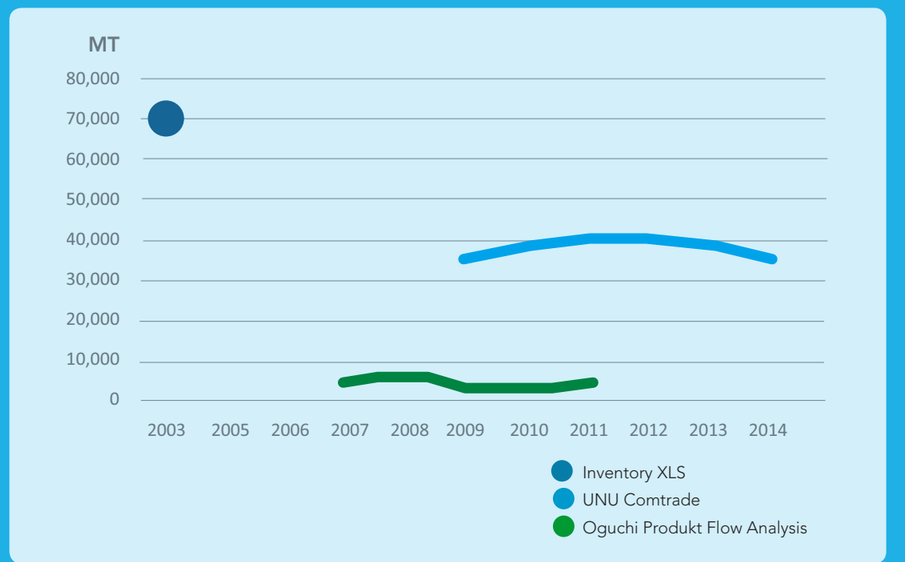

Figure 7: Estimates for PC waste in Japan (in metric tonnes)

1.6.2. Methodology for Assessment of Transboundary Shipments

Illegal transboundary movement of e-waste and second-hand electronics, including near-end-of-life electronics, is one of the most important and challenging issues in Asia, which is home to many countries on the receiving end of this flow. Although there are previous studies on transboundary e-waste flows by the MoEJ[8], Secretariat of the Basel Convention[9], and a recent study by the Massachusetts Institute of Technology (MIT) under the aegis of the Step Initiative[10], there are no accurate and comparable figures regarding the routes and volumes in the absence of an internationally agreed-upon methodology for generating the data and robust data sets. As in the national inventories, the challenge in quantifying illegal e-waste shipments is also associated with the diversity of e-waste definitions around the world. Additionally, other challenges exist related to different shipment practices, including administrative requirements and lack of enforcement due to limited capacity and corruption, at ports of exit and entry.

To overcome some of the challenges facing assessing transboundary flows, past desk studies (namely the studies by the MoEJ, 2010 and the SBC, 2010) summed data from a few years into one data set in order to surface transboundary movement of various kinds of hazardous wastes. These studies concluded that there was no time-series trend for transboundary movement of hazardous wastes.

8 MoEJ: Analysis of Transboundary Movements of Hazardous Wastes and Other Wastes in Asia, 2010, MoEJ, http://archive.basel.int/convention/cli/wildhaus-meeting/TBM%20Analysis%20in%20Asia.pdf

9 Secretariat of the Basel Convention: Waste without frontiers, 2010, the Secretariat of the Basel Convention, , http://www.basel.int/Portals/4/Basel%20Convention/docs/pub/ww-frontiers26Jan2010.pdf

10 H. Duan, Miller, R., Gregory, J., Kirchain, R. 2013. Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics. Access online: http://www.step-initiative.org/files/step/_documents/MIT-NCER%20US%20Used%20Electronics%20Flows%20Report%20-%20December%202013.pdf

Article 13-3 of the Basel Convention stipulates that the Parties submit a report on the previous calendar year before the end of each calendar year, containing the following information;

- The amount of hazardous wastes and other wastes exported, their category, characteristics, destination, any transit country and disposal method as stated on the response to notification; and
- The amount of hazardous wastes and other wastes imported their category, characteristics, origin and disposal methods.

In this study, the Basel Convention national reporting data is used as the primary source of data. The transboundary movement (TBM) of e-waste and other hazardous wastes is analysed separately. Only export data is considered, because not only is there better data description available under Article 13-3 (b), but also because of consistency between the period of shipment and the period of reporting. This data was then re-categorized into six common categories as per definitions and terminologies in the national reports: 1 E-waste[11]; 2 waste fluorescent lamps; 3 glass cullet; 4 waste office equipment, ink and tonner; 5 nickel-cadmium (Ni-Cd) batteries; and 6 waste lead-acid batteries. Transboundary flows data for

11 As per the definition of the Basel Convention

every three years from 1998 to 2009 were then combined, because not all the Parties annually submit their data on TBM despite their mandate of the convention, available data does not represent actual TBM flow. Finally three routes of transboundary flows were analysed: flows within the selected Asian countries; export flows from the selected Asian countries to other regions and import flows from other regions to the selected Asian countries.

Although the national reporting data from the Parties to the Basel Convention mandated under Article 13 provides some information to analyse flows and amounts of transboundary movement of e-waste, this data is insufficient for a comprehensive analysis for the following reasons:

- **Incomplete reporting:** Many Parties do not submit a national report, with less than 40 per cent submitting their reports for 2013;
- **Ambiguous definitions:** Interpretations of definitions are different among the Parties resulting in irregularities in aggregating and analysing data;
- **Incorrect categorization:** A type or category of hazardous waste is different among the Parties despite Annexes I, VIII and IX of the Basel Convention, which provide the categories of wastes to be controlled, the list of hazardous wastes to be controlled and the list of non-hazardous wastes;
- **Discrepancies in reporting:** The amount of transboundary movement of hazardous wastes in the national reports maybe imprecise, because the amounts described in a notification and a movement document are usually different (amount described in a notification is a maximum amount of expected transboundary movement of hazardous wastes); and
- **Data inaccuracies:** Often, the same transboundary shipment is reported to have different amounts of a hazardous waste, as described by the importing country and by the exporting country.

CHAPTER TWO

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2. Overview of e-waste management in East & Southeast Asia

East & Southeast Asia plays a key role in the product life cycle of electronics and electrical equipment (EEE). Not only is the region home to some of the largest and most technologically advanced manufacturers, it is also a hub for both formal and informal end-of-life (EoL) recycling and disposal. Increasingly, the region is a dominant consumer of EEE due to the rapidly expanding middle class. East & Southeast Asia is also a large market for second-hand EEE, because a sizeable segment of the population can only afford used EEE.

Awareness has grown around e-waste issues among various stakeholders in the region over the past few decades. However, only a few countries have established the necessary legal framework, enforcement capacity and physical infrastructure for e-waste management, with other countries in the region in various stages of developing their own systems.

This chapter provides estimates of e-waste arising in the region; reviews the region's existing legislation and collection and treatment systems; and discusses some of the region's common challenges related to e-waste management.

2.1. E-waste arising

One of the first, and perhaps most important, steps a country must complete to establish an environmentally sound e-waste management system is to develop a national inventory that tracks the quantities and types of e-waste within its borders. This elucidates the dynamics and interdependencies of EoL product and material flows. Policy and legal frameworks based on robust data are more tailored and better regulated.

Total e-waste arising in East & Southeast Asia

Of the national jurisdictions studied for this report, only Japan, Taiwan and Hong Kong collect data on e-waste arising and maintain national inventories. Several countries have made previous attempts, often supported by international development agencies, to establish baseline inventories of e-waste. However, for many countries in the region, national inventories are still lacking, are incomplete or have poor data quality, due to one or more of the following reasons:

- **Lack of information and awareness** on the part of some or all stakeholders regarding the need for an e-waste inventory;
- **Inadequate reporting mechanisms** to collect data on product flows, particularly in the absence of reporting requirements for stakeholders like manufacturers, importers, distributers, retailers, recyclers and those who treat e-waste;
- **Insufficient capacity to capture and analyse statistical data** due to lack of investment in systems and processes to collect as well as human capacity to analyse the data;
- **Unclear definition** of e-waste that may result in double-counting or under-estimation, which can occur in the absence of a clear scope of e-waste that specifies types of products and the point at which they become waste.

E-waste arising in East & Southeast Asia 2015 [kilo tonnes]

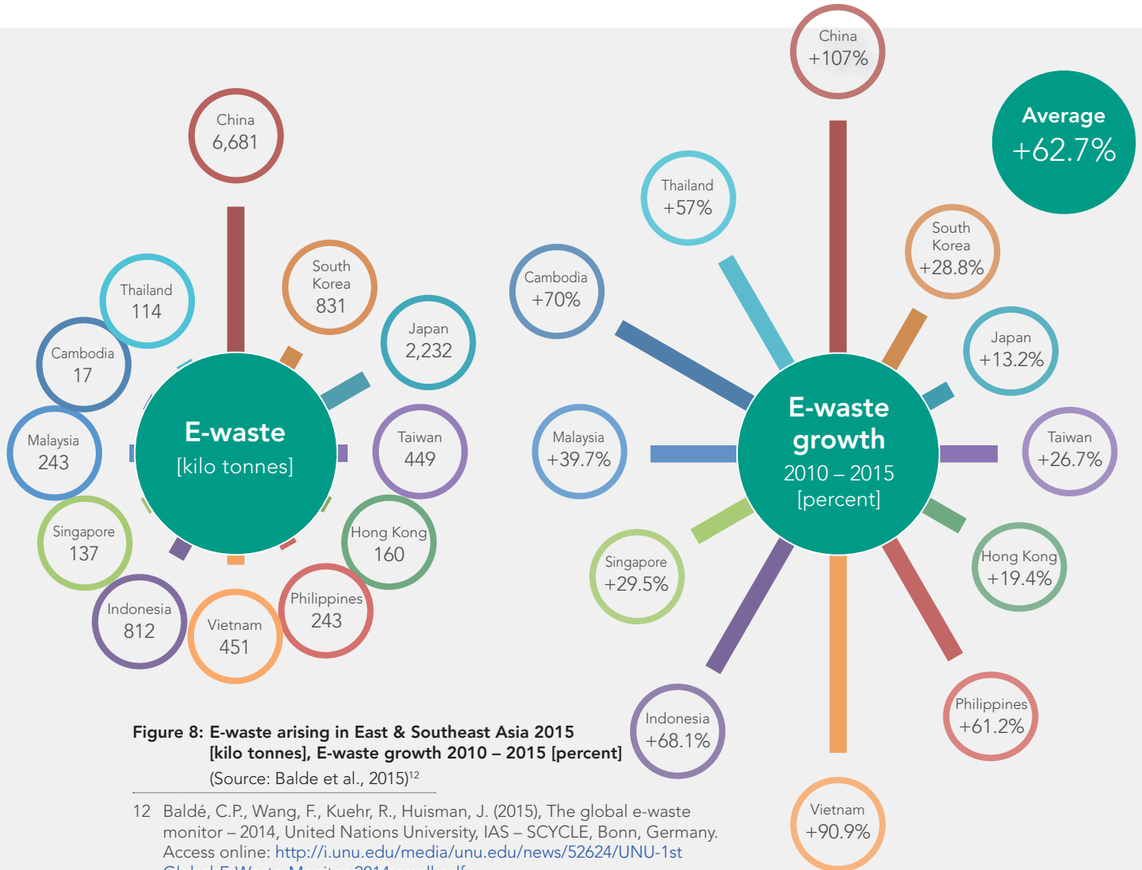

Figure 8: E-waste arising in East & Southeast Asia 2015 [kilo tonnes], E-waste growth 2010 – 2015 [percent]
(Source: Balde et al., 2015)[12]

12 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1st Global-E-Waste-Monitor-2014-small.pdf

In response to the need for statistically validated and robust data on e-waste arising, the UNU has published the first Global E-waste Monitor. Using the UNU estimation methodology, a first-of-its-kind estimation has been made of the total e-waste arising in East & Southeast Asia This figure includes e-waste arising across all of the 54 UNU Keys, the most comprehensive product classification worldwide that can also be easily linked to other categorisations, such as those of the EU WEEE Directive.

Across all countries in the region, there is an overall trend in rising e-waste quantities that is outpacing population growth. This indicates an increasing number of products being disposed of, with the fastest growth in newly industrialising countries. The largest contributor is unsurprisingly China, given its large and increasingly affluent population that demands the latest gadgets and appliances.

Per capita, e-waste arising in the national jurisdictions studied is also increasing overall, with the highest per capita e-waste arising found in Hong Kong of 21.7 kg/capita in 2015, followed by Singapore (19.95 kg/capita) and Taiwan, Province of China (19.13 kg/capita). Of the countries studied for this report, Cambodia (1.10 kg/capita), Vietnam (1.34 kg/capita) and the Philippines (1.35 kg/capita) had the lowest e-waste arising per capita in 2015.

The average e-waste generation rate for the region is approximately 10 kg/capita, but the national jurisdictions fall into two camps – one that is well over this, including Singapore, Hong Kong, Japan, Korea and Taiwan, and the rest, which fall well below this rate, as observed in Figure 9 below.

E-waste arising per capita in East & Southeast Asia

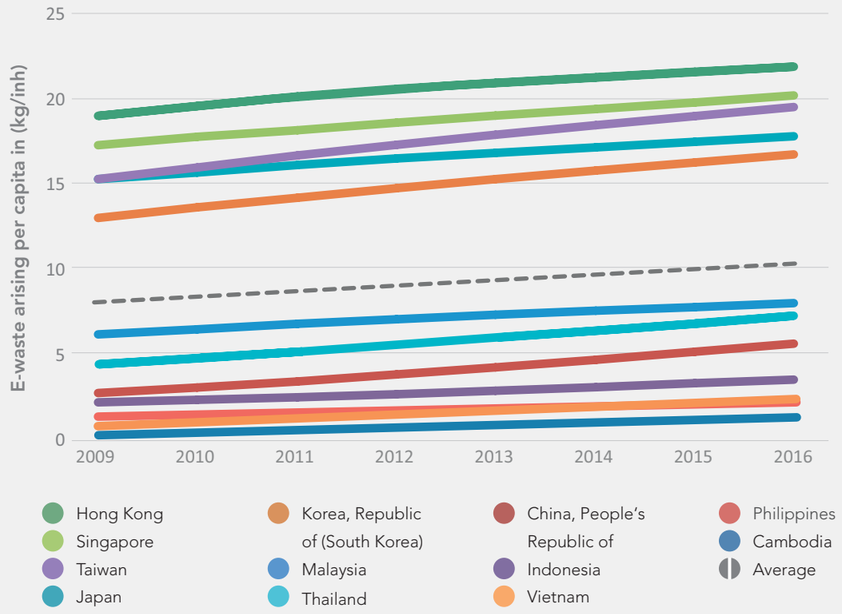

Figure 9: E-waste arising per capita (Source: Balde et al., 2015)[13]

13 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

E-waste arising per capita in East & Southeast Asia – the highest and the lowest [2015]

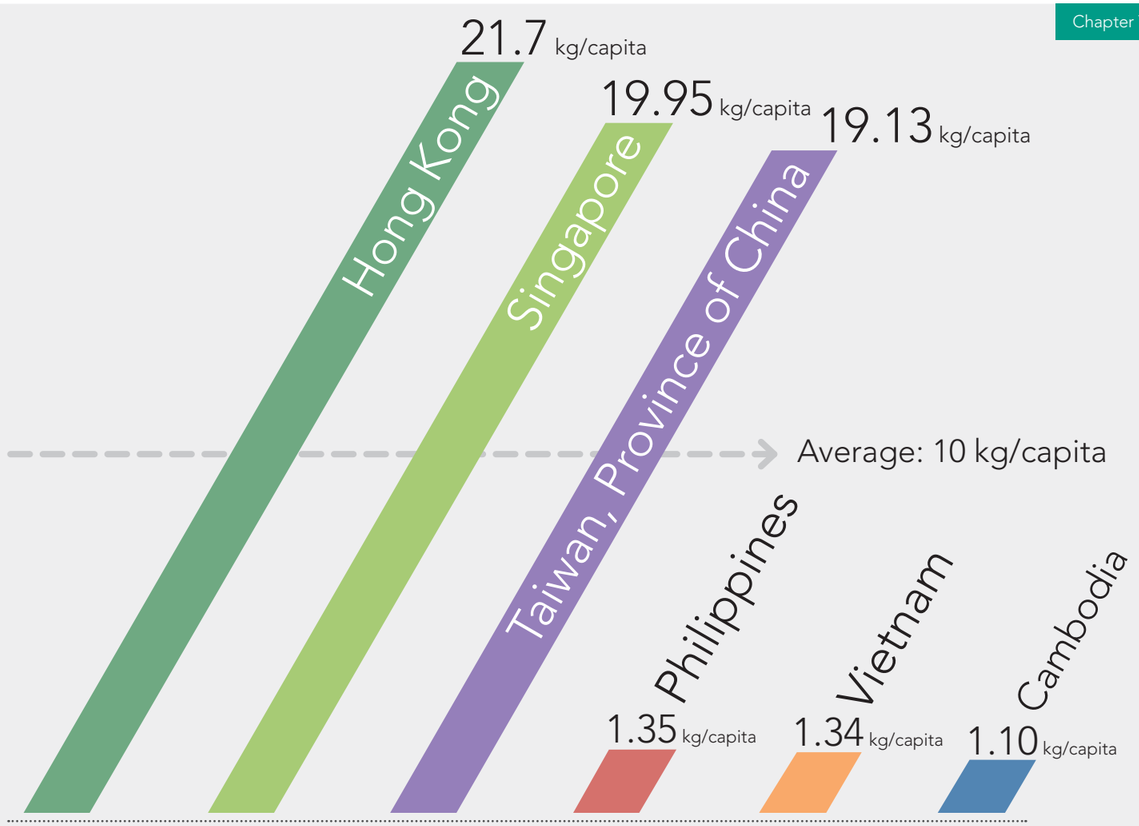

Figure 10: E-waste arising per capita in East & Southeast Asia – the highest and the lowest [2015]

2.2. E-waste legislation

E-waste legislation is often essential for better and more systematic management. Japan and Taiwan have had e-waste-specific legislation since the late 1990s, with preparation for the legislation beginning in the early 1990s. Both pieces of legislation are based on the principle of Extended Producer Responsibility (EPR). In the past decade, more and more countries around the world and in East & Southeast Asia have enacted EPR-based e-waste legislation, and many other countries have draft laws under discussion.

2.3. E-waste collection, treatment and recycling

E-waste collection is often considered the weakest link in the reverse supply chain. The ability to collect and concentrate e-waste from widely dispersed households and offices is essential in order to route it for proper treatment and recycling. The countries in the study show different collection systems – from government-organised collection, to voluntary collection schemes, to privately organized collection in the formal and informal sector. Each of these systems has its own benefits, challenges and associated costs. By and large, while post-industrialised countries rely on existing waste management infrastructure from municipal authorities and strong logistic networks, developing countries rely on door-to-door collection by informal sector collectors.

Post-consumer e-waste is a valuable waste stream, and its proper treatment and recycling yields precious and critical raw materials that can be returned to EEE production. As e-waste volumes have increased and legislation targeting proper collection has proliferated, it has also spurred the development of e-waste treatment standards and recycling technologies. E-waste management can be largely divided into to four main stages:

1. **Collection** of EoL equipment, either through consumers returning their products to retailers, collection points in municipalities, or by informal collectors going from door-to-door collecting equipment
2. **Dismantling and depollution**, generally a manual process that is essential to remove hazardous components in e-waste, such as batteries and capacitors
3. **Sorting and separation** by manual or mechanical means, such as shredding, density separation, eddy currents and optical sensors to sort out ferrous and non-ferrous fractions, e.g., aluminium and copper, plastic and glass mainly
4. **Material and energy recovery** to extract raw material through smelting and hydro-metallurgical processes and energy recovery, mainly from the plastic fractions

The treatment and recycling of e-waste currently takes place in large industrial facilities, small- and medium-scale enterprises or micro enterprises, which are often located in and around residential areas in developing countries. Treatment technologies have developed significantly over the past years, with research efforts focusing on separating fractions better and more effectively for greater recovery of materials and to retain value in different fractions from the waste stream. This has been particularly the case for plastics, which form a large fraction of the overall material in e-waste, and had to be either incinerated or landfilled in the past. With the development of technology, it is possible that they can be recycled back as reprocessed polymers.

However, especially in developing countries, the barriers for innovative and sustainable e-waste treatment and recycling technologies can be difficult to overcome. Toxic and hazardous elements are also present in e-waste, which is one reason to support sound collection and treatment processes.

2.4. Common issues and challenges

All countries in East & Southeast Asia, irrespective of their level of their economic development, face challenges related to e-waste. Many face the same issues and share similar concerns, but each country also has its own unique context and constraints. These challenges may be in parts or all through the post-consumer e-waste chain, the so-called reverse supply chain, from consumer awareness to recycling technologies and techniques, to enforcement and regulation. And even though the countries face similar challenges, they may differ in their importance from country to country. For example, the collection of e-waste can be considered a common challenge for all countries; however, it is significantly different for (post-) industrialised countries compared to developing and newly industrialising countries; while developed countries face the challenge of increasing the rate of separately collected e-waste, some developing countries show impressive collection rates through door-to-door collectors. For these countries, however, the collection is enacted by the informal sector, and it is therefore difficult to follow the fate of the collected e-waste. On the other hand, there are some challenges unique to developing countries, such as primitive material recycling techniques and landfilling, while developed countries face the challenge of increasing product lifetime through reuse.

2.4.1. Increasing volumes

A common challenge faced by all countries is increasing volumes of e-waste, which is particularly acute in the rapidly growing economies of the region. For many countries that already lack infrastructure for environmentally sound e-waste management, the increasing volumes are a cause for concern, as they increase the burden on existing waste collection and treatment systems, which results in flows towards environmentally unsound recycling and disposal. The main trends responsible for increasing volumes are:

- **More gadgets:** Innovation in technology is driving the introduction of new products, particularly in the portable electronics category, such as tablets and wearables like smart watches, etc.;
- **More consumers:** In the East & Southeast Asian region, there are industrialising countries with growing populations, but also rapidly expanding middle classes that are able to afford more gadgets;
- **Decreasing usage time:** The usage time of gadgets has decreased; this is not only due to rapidly advancing technology that make older products obsolete due to hardware incompatibility (e.g., flash drives replacing floppy disks) and software requirements (e.g., minimum requirements for PCs to run operating software and various other applications) but also soft factors such as product fashion. As more devices are replaced more rapidly, e-waste arising grows; and
- **Imports:** Import of EEE provides greater availability of products, both new and second-hand, which also increases e-waste arising as they reach their EoL.

Thus, with more EEE put on market to meet the growing demand, there is also a greater and continuously increasing quantity of domestically generated e-waste due to an ever-increasing throughput rate of EEE consumption combined with decreasing usage time for most EEE.

2.4.2. Improper & illegal dumping

Improper and illegal e-waste dumping is prevalent in most countries in East & Southeast Asia, irrespective of whether or not national e-waste legislation exists. Consumers, dismantlers and recyclers are often guilty of illegal dumping, particularly of "open dumping", where non-functional parts and residues from dismantling and treatment operations are released into

the environment. Based on studies conducted in the region, the main reasons for this are:

- **Lack of awareness:** End users do not know that they should dispose of their obsolete EEE separately or how or where to dispose of their e-waste. Additionally, informal e-waste recyclers often lack the knowledge about the hazards of unsound practices;
- **Lack of incentives:** Users choose to ignore collection and/or recycling systems if they need to pay for them;
- **Lack of convenience:** Even if disposal through existing systems does not incur a fee, users may choose not to dispose of their e-waste in the proper channels if it is inconvenient or requires their time and effort;
- **Absence of suitable sites:** There may be a lack of proper locations for hazardous waste disposal where residues from e-waste recycling can be sent; and
- **Weak governance and lax enforcement:** A country with inadequate management or enforcement of e-waste legislation may result in rampant non-compliance.

2.4.3. Open burning

Open burning is a common treatment of e-waste in many countries, practiced mainly by informal recyclers when they segregate organic and inorganic compounds (e.g. burning cables to recover copper), with adverse acute and chronic effects on human health and the environment. Though less common, incineration of residues from e-waste processing and spontaneous combustion at open dumping sites are also considered open burning, with the same adverse effects. Spontaneous combustion sometimes occurs at open dumping sites when components, such as batteries, trigger fires due to short circuits.

In theory, open burning is the same as thermal treatment, either in an industrial smelter or an incinerator, but the environmental and human health impacts of these differ greatly. This is because there is no toxic emission control in open burning, and the informal sector's open-burning processes are substantially less efficient at re-gaining materials. Additionally, residues from open burning are usually disposed of in open dumping sites, leading to further adverse environmental and health effects from toxins leaching into the soil and ground water.

2.4.4. Backyard acid baths

Informal recycling, also called "backyard recycling" as it often takes place in the backyard of shops and homes, is a challenge for most developing countries in the region, with a large and burgeoning business of conducting unlicensed and often illegal recycling practices from the backyard. These recycling processes are not only hazardous for the recyclers, their communities and the environment, but they are also inefficient, as they are unable to extract the full value of the processed products. Mostly, these recyclers recover gold, silver, palladium and copper, largely from printed circuit boards (PCBs) and wires using hazardous wet chemical leaching processes commonly also known as acid baths. The e-waste goes through a series of acid or caustic leaches, which is a process whereby a soluble component is extracted from a solid by means of a solvent. Typically, informal recyclers use solvents such as sulphuric acid (for copper) or aqua regia (for gold). The leachate solutions go through a separation and purification processes in order to concentrate the valuable metals and separate impurities. This often results in the release of toxic fumes into the environment. The precious metals are then recovered following either electro-winning, chemical reduction or crystallisation processes.

End-of-life airconditioners stacked in China [Yvan Schulz]

Possible exposure by fume generated by burning waste motors [MOEJ]

2.4.5. Occupational & community health

Open burning and acid bath recycling in the informal sector have serious negative impacts on processers' occupational health. Some formal facilities also lack appropriate technologies and standards that lead to both workers and lay people becoming exposed to hazardous substances, directly or indirectly, resulting in impacts on human and environmental health and also social and economic impacts for worker families and communities. In the absence of protective materials such as gloves, glasses, masks, etc., inhalation of and exposure to hazardous chemicals and substances directly affect workers' health. Associations have been reported between exposure from improper treatment of e-waste and altered thyroid function, reduced lung function, negative birth outcomes, reduced childhood growth, negative mental health outcomes, impaired cognitive development, cytotoxicity and genotoxicity. Indirect exposure to these hazardous substances is also a cause of many health issues, particularly for families of informal recyclers who often live and work in the same location, as well as for communities living in and around the area of informal recycling sites.

To reduce occupational health hazards, workers at formal e-waste recycling facilities often have wear personal protective equipment (PPE), such as masks, gloves and glasses, to prevent inhalation of dust and other toxins that may be released in the recycling process and to prevent accidents such as cuts and bruises. Additional safety practices include helmets, particulate respirators and protective clothing and shoes to minimize and eliminate as much as possible the adverse effects of e-waste recycling on human health. However, even at formal recycling facilities, these are not always available, due to the cost and lack of information and awareness of their benefit.

2.4.6. Competition between informal and formal sectors

E-waste is a valuable commodity and the raw material for both formal and informal recyclers. To secure supplies, both informal and formal recyclers compete with each other;

especially in the absence of established e-waste take-back systems. Most informal recyclers source their e-waste from dealers of second-hand products and informal waste collectors who get their waste from households and small businesses. Formal recyclers, on the other hand, depend largely on business-to-business sources for their e-waste.

Though the recovery efficiency of the two recycling sectors differs significantly, the higher operational cost of formal recyclers often makes them uncompetitive compared to the informal recyclers who have no or very low operational costs. Additionally, the incentive for informal recycling remains high, as there is little price differentiation between their products and those of formal recyclers, as the price of the end product, such as gold or copper, is determined by commodity market prices.

2.4.7. Transboundary movements

Tracking and tracing transboundary movements of e-waste is a global issue, given that a large section of shipments seem to be illegal. E-waste smuggled across borders or shipped (intentionally or unintentionally) mislabelled is considered an illegal transboundary movement of e-waste. The huge demand for second-hand electronics, especially in developing countries, is spurring transboundary shipments of used electronic products, mainly from developed countries, both within and outside Asia. The ambiguity in the definition of between e-waste and second-hand electronics that may be nearing EoL, leads to "grey" cases of transboundary shipments. For example, a shipment that contains products that are near EoL lies outside the purview of the Basel Convention, even if the products soon become waste.

In truth, not all shipments are illegal; large quantities of second-hand electronics are traded legally under certain conditions, such as confirmation of functionality before export, confirmation of destination where second-hand electronics are sent, traceability, etc. These

Collector for secondhand electronics as a competitor of recycling business within a legal framework [Shunichi Honda]

second-hand products are genuinely helping bridge the digital divide by making digital technologies affordable. Moreover, the lifetime prolongation of some EEE through additional usage in developing countries helps to reduce the ecological footprint associated with their production. However, even well-meaning shipments of used but functioning products, though not illegal, are often the source of large volumes of e-waste, as there is no market for these out-dated products even in developing countries. Here, though the intention may have been good, short-sighted shipment caused similar challenges in the recipient country as illegally imported e-waste would have. Also, in some cases, the illegal transboundary shipment is unintentional, usually caused by a misunderstanding of e-waste's definition and the national provisions of transboundary movement of hazardous wastes. This may occur when, for example, second-hand electronics are broken during transportation, may not be recognised as reusable products at the customs at a state of import, or may be defined as e-waste under a national provision of a state of import. In these cases, the transboundary movement becomes illegal.

Yet, the majority of e-waste smuggling is undertaken by organised criminals illegally transporting e-waste by hiding it behind other goods, camouflaging it as other products

or falsely declaring as second-hand products for personal use. Smuggling mainly occurs to circumvent the Basel Convention procedure, which can be complicated; it often takes half a year to obtain the final clearances needed between the export and import states for a legal transboundary shipment.

Chapter 4 elaborates on transboundary movements of e-waste in further detail, with analysis of reported data and assessments of routes and quantities of such shipments.

2.4.8. Regulation and enforcement

While it is a challenge for many countries in the region to set specific e-waste legislation, that is only one of many the battles on the e-waste front. Simply having e-waste legislation in place cannot be mistaken for solving the problem. The greater challenge, experienced by all countries, is in the rigorous enforcement of the rules and regulations laid out in legislation, and this must build on consumers' awareness and willingness to fulfil their role in the development systems (e.g., appropriately returning obsolete equipment). Moreover, rules and regulations require significant coordination between government departments, such as the Ministry of Environment and the Ministry for Communication Technologies, where one develops and oversees the enforcement of environmental standards, while the other one is mainly there to support the development and installation of information and communication technologies, and does not necessarily have EoL aspects in its focus. Moreover, regulation and enforcement are also often hampered by corruption, as e-waste trade is a lucrative business. Therefore, collaboration with external stakeholders such as producers, importers, distributors, recyclers, retailers and consumer groups is vital to creating effective regulation and enforcement. International cooperation and coordination in regard to transboundary flows is also vital, because most countries lack the infrastructure to perform all steps involved in material recycling, thereby making international shipments necessary for appropriate treatment, especially of hazardous and fractions containing scarce resources requiring industrial processes for material recovery.

2.4.9. System financing

A sustainable take-back and recycling system is founded on a fair financial and economic model, as emphasised in the Step Green Paper authored by McCann and Wittman (2015). The absence of organised system-financing often exacerbates the problems and challenges mentioned above. It is therefore vital that policymakers work with all key stakeholders in establishing a national financial model to cover the access and collection of e-waste, logistics of storing and transport and proper treatment and recycling. Along with these obligations, there is the need to raise awareness of the proposed system and ensure that stakeholders are complying with their obligations and setting up IT systems to receive and process the data. Countries in the region have different cost and revenue dynamics, and therefore there is no single financial model that is suitable for all.

Several models of system financing are possible, with two of the most common laid out below:

- **Taxpayer-funded system:** Because e-waste can be seen as a societal problem, as it not only impacts consumers but also the entire population (both in terms of environmental and societal impacts), systems could be financed by the entire society (i.e., by taxpayers). This option would require general tax revenues to be diverted to meet the costs associated with the take-back system. At present, no national jurisdiction in East & Southeast Asia that specifically regulates e-waste finances

e-waste management through generic taxation revenues. It could be said, however, that in countries where there is no specific law, funding mechanism or organised take-back system for e-waste, municipal waste management services financed through generic taxation do bear the financial burden of e-waste management.

- **Polluter-pays system:** The charging of the consumer could be seen as an implementation of the "polluter pays principle", where the polluter is recognized as the person responsible for discarding an EoL appliance. This option mandates that the consumer either pays to discard the product or pays a fee when purchasing the new product that is collected in a fund to meet the costs associated with the take-back system. This is more commonly used for financing e-waste management systems, often through an extended producer responsibility (EPR) mechanism whereby a producer or manufacturer of the product has the legal obligation to take back its products at their end-of-life for proper disposal. It could be argued that even though a producer may bear legal responsibility, consumers eventually pay the EoL costs as part of the product price, even when no up-front external charges are specified for the same at the point of sale.

Without a system with formal financial flows, cherry picking is rampant, and only the valuable material is selected for treatment with the rest being ignored. This is a problem even if there is legislation in place, where all the formal recyclers are interested only in precious metals bearing fractions, with little or no interest in other fractions.

2.5. E-waste management system matrix and types

The Basel Convention defines the environmentally sound management of hazardous wastes or other wastes as follows: **"taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes"**. Though this is seemingly simple concept, is there a common understanding or interpretation of the environmentally sound management waste among Asian countries?

The answer is a resounding "no"; each country interprets the definition based on their situation and ground reality. For example, a country without an established a legal framework for e-waste may have diametrically opposite interpretations of the definition; it could interpret "practicable steps" as "an impossible, unachievable situation" or "a current situation that we can do achieve despite absent the lack of a legal framework". For another country with a legal framework for e-waste in place, the reaction to waste management may be "we have just started, and, we need to update our legislation to achieve the international standard that a developed country implements," or "we have already implemented this, and the others may follow our lead."

2.5.1. E-waste system matrix

Successful and environmentally sound e-waste management needs a holistic approach to waste management, taking into account many factors such as socioeconomic development, governance structures, geography and trade links, infrastructure, but also psychological considerations reflecting various consumer attitudes, in addition to a strong legal framework,

robust collection mechanisms, sound recycling and recovery facilities, high environmental awareness and developed health and safety standards. As a simplification however, four main pillars are identified within a conceptual organization of these practices in the e-waste system matrix: legal framework, collection mechanism, processing infrastructure and environmental health & safety standards. A country's e-waste management systems may be characterised along these pillars within the matrix. For each pillar, three stages of sophistication were identified, on a continuum from "basic" to "advanced". "Prevention" is considered as a common theme across all pillars, in line with that concept that prevention should be higher up in the waste hierarchy. Preventive activities can be embedded into all pillars. For example, legislation encouraging and incentivising better designed products and systems that effectively and efficiently ease reuse and repair to prevent a product from becoming waste is a preventive activity. However, preventive measures are not yet high on the political agenda in the majority of countries around the world. End-of-pipe approaches are most widely applied in typical e-waste management system development and implementation despite the existence of paradigms such as 3R, Zero Emissions, Circular Economy, Cradle to Cradle, etc. Preventive measures should, in an ideal scenario, avoid e-waste generation as such, but existing systems mainly concentrate on collection and recycling, whereas reuse and/or reduce receive less attention. In addition, transboundary movement of e-waste and used EEE, from the perspectives of both the exporting and importing country, is another common theme that influences and is influenced by the four pillars. For example, in an exporting country large-scale illegal imports may impact the efficient operation and utilisation of processing infrastructure, while for an importing country, imports may be seen as an important source of affordable equipment as well as feedstock for a nascent recycling industry.

Table 3 provides a brief description of the stages of sophistication for each pillar, from low to high. »

Stages		Legal framework	Collection mechanism
	High	Strong e-waste legislation and enforcement with efficient controls and monitoring; alternatively, strong voluntary system with governmental support and collaboration	Widespread network of formal collection channels; e-waste collection is entirely formalised, with only legally authorised e-waste collection taking place, either through legally obligated take-back systems or voluntary initiatives
	Medium	E-waste-specific draft legislation under discussion or recently enacted; in the early stages of enforcement regime development ; potentially limited scope of legislation	Informal and formal collection channels co-exist; formal collection channels operate within a legal framework, such as a licensing system; informal collectors still exist outside the legal system; voluntary take-back schemes/collection by private sector in operation
	Low	No e-waste specific legislation; e-waste management depends on *ad hoc* local actors	Only informal collection and/or disposal with municipal waste

Stages		Processing infrastructure	Environmental health & safety (EHS) standards
	High	High-efficiency, large-scale, industrial facilities for recycling and recovery of functions and materials from e-waste, including precious metals, rare earths, etc.	Legally mandated compulsory nationwide EHS standards with internationally accepted thresholds for all facilities involved in e-waste handling and processing
	Medium	Semi-mechanised formal small and medium enterprise (SME) recycling facilities for e-waste processing; dismantling and partial recovery facilities to segregate recyclable fractions; informal sector recyclers recover copper, gold and other materials using rudimentary methods	Voluntary EHS standards with basic minimum thresholds; greater individual awareness about environmental and health risks
	Low	E-waste processing on micro and small-scale often run individually by facilities in the informal sector using rudimentary and manual techniques for dismantling and repair, reuse and recycling	Limited or no awareness of EHS among e-waste processors, and therefore little protection from toxins and hazardous substances released during e-waste processing

Table 3: E-waste system matrix

2.5.2. E-waste management system types

Mapping a country's system for e-waste management on the matrix results in four types of systems:

Type 1: Advanced mechanism

In a Type 1 system, a strong legal framework for e-waste is backed by strong enforcement. In addition to legislation, there is also an established and functional collection and recycling infrastructure, with high environmental health and safety standards.

Type 2: Voluntary initiative

In a Type 2 system, the private sector (mostly international manufacturers and recyclers) take the initiative to implement a take-back and recycling programme for e-waste that may or may not be in collaboration with or bestowed with recognition by the government. As it is entirely voluntary, the system usually operates based on commercial imperatives rather than regulatory requirements, and it therefore operates even in the absence of a legal framework for e-waste.

Type 3: In transition

A system in transition is a Type 3 with a nascent legal framework that is still being tested. As the legislation is being developed and implemented, the collection and treatment mechanisms may be in the process of being established, with collection and processing infrastructure involving a mix of formal and informal actors, and EHS standards in the low to medium range of sophistication.

Type 4: Informal initiative

When the informal sector is predominant in the collection, recycling and disposal of e-waste, the system is considered a Type 4. Countries with a Type 4 system typically have no established legal frameworks for e-waste yet, and they mostly lack formal recycling facilities or high environmental health and safety safeguards.

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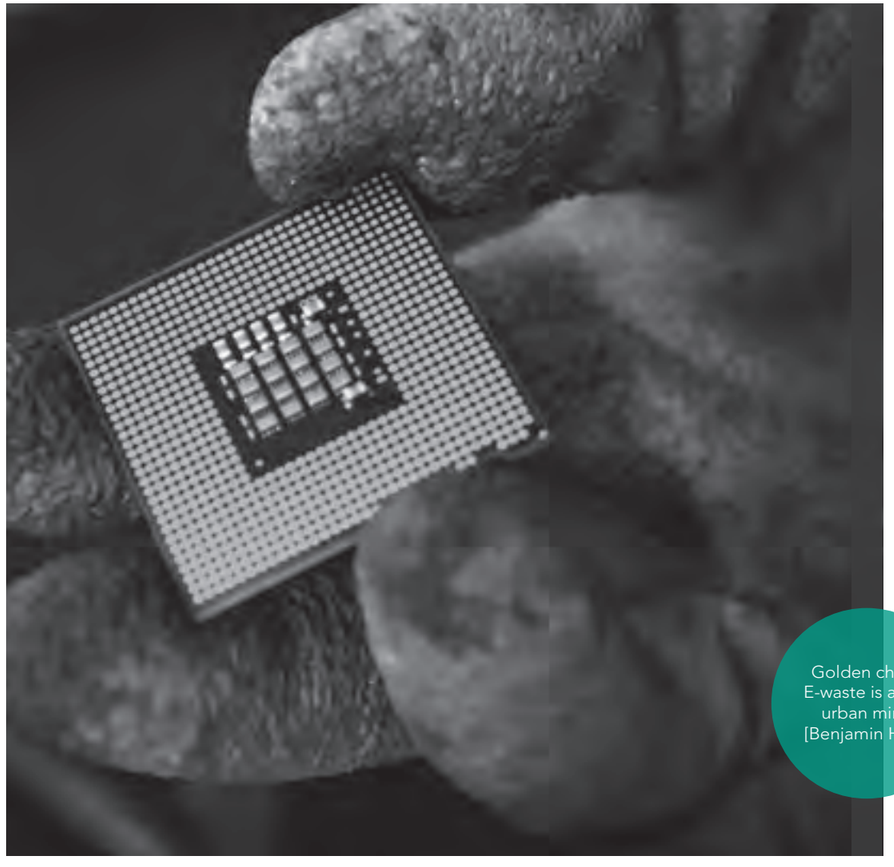
Type 1: **Advanced mechanism** – Japan, Taiwan and South Korea

Japan, South Korea and Taiwan have a head-start in establishing e-waste collection and recycling systems, having started in the late nineties to adopt and enforce e-waste specific legislations. This was built in large part on their existing experiences in and legal framework for solid waste management. Among the most advanced economies in Asia, the three are also characterised by high per capita e-waste generation, formal collection and recycling infrastructure and relatively strong enforcement.



Golden chips: E-waste is a rich urban mine [Benjamin Hale]

1. Japan

Country profile

Japan, with a population of approximately 127 million, is a highly urbanised society, with more than three quarters of the population living in sprawling cities. Residents are particularly concentrated in the major urban centres, including the Greater Tokyo Region, considered the world's most populous urban area with nearly 37.8 million inhabitants in 2014[14].

It has the fifth-largest economy in the world in terms of purchasing power parity, with a GDP per capita of US$ 38,142 in 2014[15]. An industrial powerhouse, it is home to some of the world's largest companies and most recognised brands, particularly for electronics and electrical equipment (EEE), such as Sony, Toshiba and Panasonic, among others. It also plays an international role as a major official development assistance (ODA) donor and a source of global capital and credit.

The e-waste situation in Japan

Japan, with a high per capita e-waste arising of 17.3 kg/inhabitant in 2014, is one of the largest generators of e-waste in the region, second only to China, though with a tenth of the population.

14 United Nations, Department of Economic and Social Affairs, Population Division (2014)
15 International Monetary Fund, World Economic Outlook Database, October 2014

E-waste per capita
17.3 kg

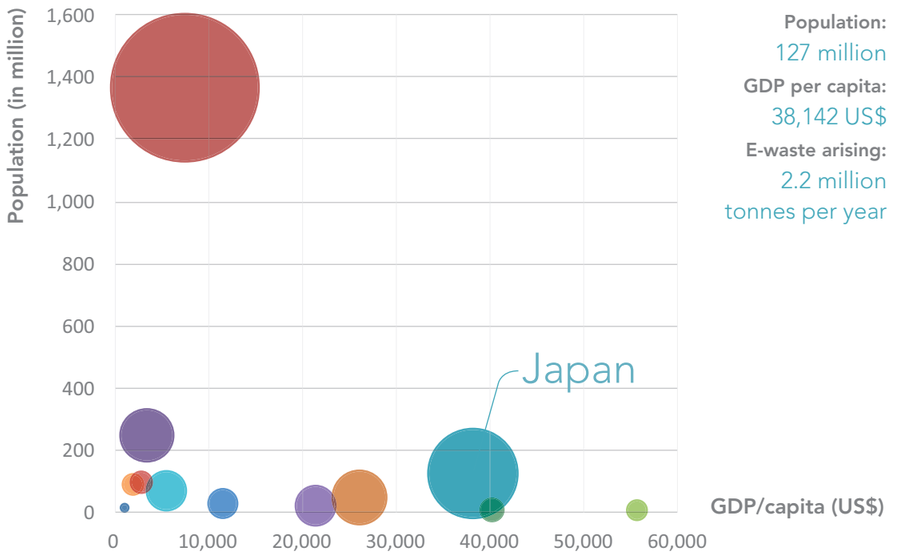


Figure 11: Population, GDP per capita and E-waste arising, Japan, 2014

There is an increasing trend in e-waste arising in Japan, going from 1.9 million tonnes in 2009 to nearly 2.3 million tonnes projected for 2016. According to the UNU, nearly 2.2 million tonnes was generated in 2014 across all EEE product categories. The Big 6 products, namely air conditioners, televisions, personal computers, washing machines, refrigerators and mobile phones, comprise nearly 40 per cent of the entire e-waste generated. Two datasets on e-waste

arising are compared in the figure below – one based on Japanese inventory data collected by the compulsory and voluntary recycling programmes for the specified products and the second based on statistical estimates using the UNU assessment model. Both estimates,

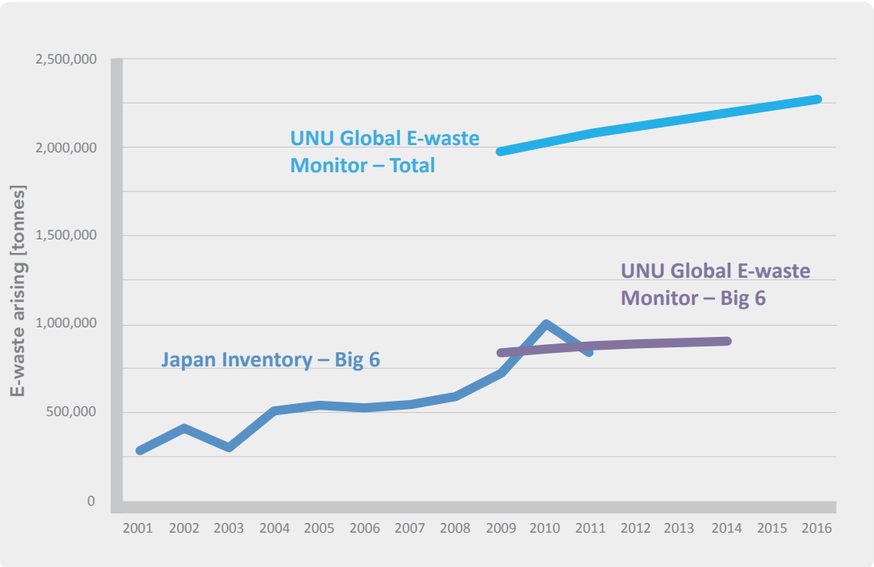


Figure 12: E-waste arising in Japan

especially for the Big 6 products, have similar estimates indicating confidence in data values. Literature such as Oguchi et al.[16] and Yoshida et al.[17] from peer-reviewed journals was also referenced to triangulate and check data estimates.

16 Oguchi, M., Kameya, T., Yagi, S., & Urano, K. (2008). Product flow analysis of various consumer durables in Japan. Resources, Conservation and Recycling, 52(3), 463-480.

17 Yoshida, A., Tasaki, T., & Terazono, A. (2009). Material flow analysis of used personal computers in Japan. Waste Management, 29(5), 1602-1614.

Japan is one of the first countries to have e-waste-specific laws. This is due to its geographical limitations as an island nation with scarce land for disposal sites and limited natural resources and also because it is home to a highly advanced EEE manufacturing sector. Additionally, Japanese consumers have a strong recycling tradition, and the country itself is resource poor. The Law for Promotion of Utilization of Recyclable Resources issued in 1991 aimed to promote recycling to industries, including design for recycling and utilization of secondary materials for production. In 2000, the law was amended to the Law for Promotion of Effective Utilization of Resources. The amended law introduced five key concepts, namely (I) the prevention of waste management by eco-design; (II) the extended life of electronics; (III) the design for recycling; (IV) the reduction of recycling cost; and (V) the creation of an information-sharing mechanism. In addition, the country has two e-waste-specific pieces of legislation: the Law for the Recycling of Specified Kinds of Home Appliances (often referred to as the "Home Appliance Recycling Law") and the Law for Recycling of Small Electronic Appliances ("Small WEEE Law").

Television sets, air conditioners, washing machines, dryers and refrigerators fall under the Home Appliance Recycling Law, which came into force in April 2001. The recycling is financed by consumers purchasing recycling tickets through the Centre for Home Appliance Recycling Tickets under the Association for Electric Home Appliances, which also runs the manifest system that controls the flow of e-waste from consumers to recyclers. The law introduces shared responsibilities for all stakeholders.

Consumers should return specific kinds of e-waste to retailers or municipalities and pay costs for transportation and recycling; retailers or municipalities then collect e-waste and transport it to designated collecting stations from where manufactures or contracted recyclers pick up the e-waste and fulfil their recycling obligations, achieving compulsory targets. The

total fee paid by the consumer per large household appliance varies between US$ 27 and US$ 65, depending on the type of appliance (as per January 2015). While there had been no compulsory collection target for e-waste, there is a statutory recycling target for e-waste collected, which was revised upwards in 2009 and in 2015 for all products, except CRT TVs, as shown in the table below.

	Statutory recycling targets		
	FY2001-2008	FY2009-2015	FY2015-
Air conditioners	60%	70%	80%
TV sets (CRT)	55%	55%	55%
TV sets (flat screen)		50%	74%
Refrigerators and freezers	50%	60%	70%
Washing machines	50%	65%	82%

Table 4: Statutory recycling targets, Japan

Small household appliances, including PCs and mobile phones, come under the more recent Small WEEE Law. Previously, mobile phones were collected voluntarily through a manufacturer's initiative–the Mobile Recycle Network. However, the collection rate was rather low, as most users tend to keep unused mobile phones rather than discard them. Similarly, the PC 3R Promotion scheme was a voluntary scheme to collect waste PCs initiated by producers in 2003 pursuant to the Law for Promotion of Effective Utilization of Resources. However, both programmes suffered from low collection rates. In addition, other small WEEEs discarded by residents were basically collected, crushed and disposed by municipalities. In order to improve this situation, the Law for Recycling of Small Electronic Appliances was developed and entered into force in 2013. The Ministry of Environment (MOE) and Ministry of Trade, Economy and Industry (METI) have set a recycling target of 140,000 tonnes per year of small WEEE by fiscal 2015, based on around one kilogram per person annually.

Transboundary movements of hazardous wastes and other recyclables are regulated by the two different legal systems in Japan. The Basel Law (Law for the Control of Export, Import and Others of Specified Hazardous Wastes and Other Wastes) exists to regulate transboundary movement of hazardous wastes in terms of hazard characteristics, and the Waste Management Law (The Waste Management and Public Cleansing Law) is to regulate these based on the value of the items traded. In its efforts to prevent illegal trade of e-waste, the government conducts awareness-raising seminars, provides a consultation service to companies and works closely with the Japanese customs to inspect cargoes and ensure compliance.

On a regional level, in collaboration with the Secretariat of the Basel Convention (SBC), the government had funded the Basel Convention Partnership on the Environmentally Sound Management of E-waste for Asia-Pacific Region. Also Japan's Ministry of the Environment (MOE) initiated the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes.

E-waste flows in Japan:

An in-depth estimate of the routes and fates of e-waste flows in 2011 was conducted by assimilating available inventory data, interviews with and questionnaires sent to local stakeholders and discussions at a national committee on e-waste. The three product flows estimated are for home appliances, PCs and mobile phones.

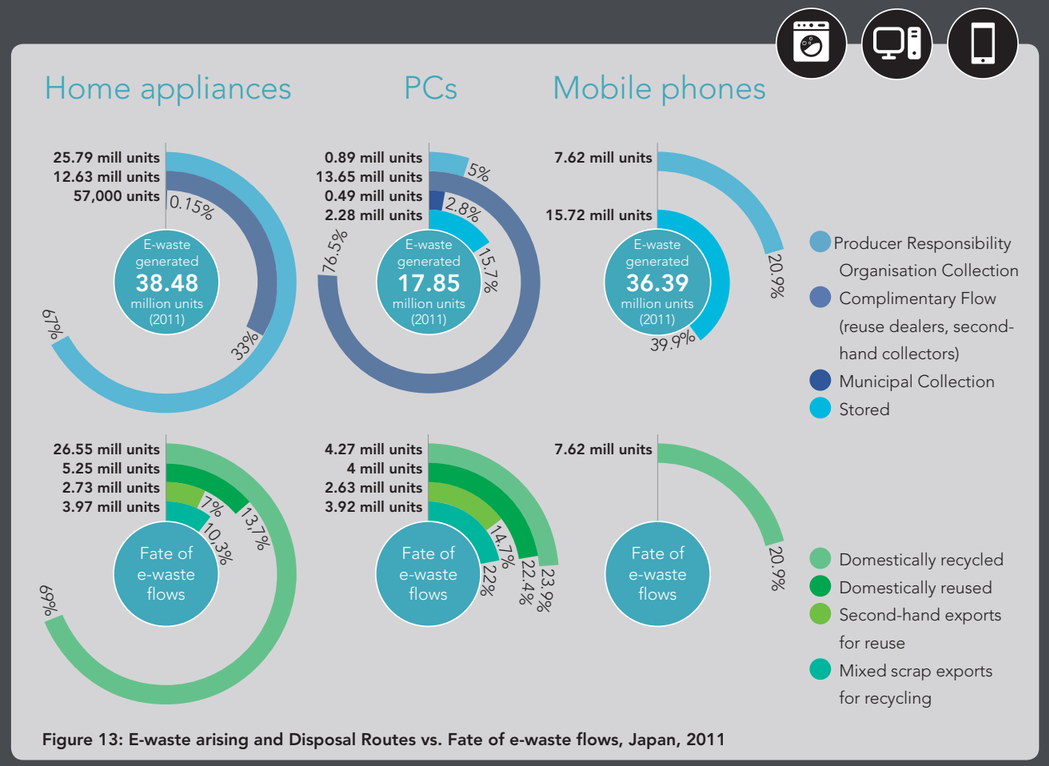


Figure 13: E-waste arising and Disposal Routes vs. Fate of e-waste flows, Japan, 2011

In 2011, 36.39 million mobile phones were generated. Of these, the large majority, some 15.72 million units (39.9%) were either stored by end users or disposed of with the normal household bin. Only 7.62 million units (20.9%) were collected under the voluntary collecting scheme, the Mobile Recycling Network (established by mobile phone service companies), and all these units were recycled in Japan. 5.72 million units (15.7%) were reused in Japan or exported for reuse or recycling. Those that were disposed of in Japan made up 6.54 million units (18.0%).

These e-waste flows indicate that there is demand among other countries to import high-quality, second-hand EEE from Japan. In other cases, metal portions removed from e-waste generated in Japan become a resource for other countries. Under the definition of wastes in Japan, a used electronic product becomes e-waste if an end user decides to dispose of it, or it becomes a second-hand product if an end user decides to sell it to the second-hand market. If an end user asks a second-hand dealer who collects any kind of second-hand goods, including electronics, for free to collect a used electronic product, such product is sent to:

1. second-hand markets in Japan, if there is still demand for this product to be reused;
2. scrap dealers who collect any kind of metal scraps for export, if there is no demand for its reuse; or
3. an exporter of second-hand electronics, if there is no demand for it to be reused in Japan, but there is demand for it to be reused in other countries.

Country type

Japan is an early adopter in the development and enforcement of a legal mechanism to control e-waste. Not only that, but it is also one of the first countries in the world to implement a system based on the extend-producer responsibility (EPR) principal for e-waste, largely building on the strong existing framework for solid waste management. As a result, there is a strong legal framework for its policies, and they are also backed up with advanced collection, take-back and processing infrastructures, putting it in the Type 1 category. Table 5 below gives an overview of the stages Japan is in for each of the pillars of the e-waste management matrix.

Pillar	Stage	Description
Legal Framework	Medium	• Different laws exist for different products – some have compulsory take-back and recycling targets, other products fall under voluntary initiatives. • The Law for Promotion of Effective Utilization of Resources (1991) sets the principles for eco-design, design for recycling, etc. • The Law for the Recycling of Specific Kinds of Home Appliances (1998) covers specific home appliances namely television sets, air conditioners, washing machines, dryers and refrigerators. • The Law for Promotion of Recycling of Small Waste Electrical and Electronic Equipment (2012) covers products like PCs, mobile phones, etc. • The country has been a Basel Convention signatory since 1993. The Japanese Basel Law (Law for the Control of Export, Import and Others of Specified Hazardous Wastes and Other Wastes) regulates transboundary movement of hazardous wastes in terms of hazard characteristics, and the Waste Management Law (The Waste Management and Public Cleansing Law) regulates waste trade.
Collection Mechanism	High	• Consumers have the responsibility to dispose of their waste appliances either at designated collection stations or at retailers or post offices. • There were 369 collecting stations as of April 2014 across Japan where retailers can also drop off e-waste collected from consumers or end users. • Consumers pay both the collection/transportation fee and the recycling fee when they dispose of their WEEE. The collection/transportation fee is set by the retailers, and the recycling fee by the manufacturers.
Processing Infrastructure	High	• 49 designated e-waste recycling facilities undertake dismantling, segregation of recyclable materials and depollution; 10 smelters and refiners recovering precious metals and rare earths from e-waste. • They achieve a recycling rate of approximate 75 per cent for products covered under legislation. • Several e-waste recycling facilities also belong to the Eco-Town which is a recycling zone composed of many waste management facilities. The Eco-Town is one of the ideal waste management strategies where each kind of waste management facility cooperates with others. For example, one Eco-Town zone is composed of the e-waste recycling facilities mainly designated for waste home appliances and personal computers, automobile recycling facility, fluorescent lamps recycling facility, paper recycling facility, plastic bottles recycling facility, etc. • Informal recycling activities have not been observed and are largely absent from Japan.
EHS Standards	High	• Emissions from recycling activities are strictly controlled. • Treatment operations subject to Labour Standards Act and Industrial Safety and Health Act. • Ministry of Health, Labour and Welfare, Japan, has the Guidance on Safety and Health Management for Cleansing Operation in order to reinforce measures on safety and health issues in waste management facilities.

Table 5: E-waste Management Matrix, Japan

Stakeholder map

Stakeholder	Website	Responsibility
Ministry of Environment Japan (MoEJ)	https://www.env.go.jp	• Set and implement environmental and waste legislation • Served as competent Authority for Basel Convention
Ministry of Economy, Trade and Industry (METI)	http://www.meti.go.jp	• Sets and implements legislation relevant to industry and trade • Involved in development and monitoring of e-waste legislation; Participates in joint advisory council with MoEJ
Ministry of Health, Labour and Welfare, Japan	http://www.mhlw.go.jp	• Set and implement health and safety regulations and guidelines
PC 3R Promotion Association Established in May 2004 under the auspices of Japan Electronics and Information Technology Industries Association (JEITA)	http://www.pc3r.jp	• Manages and operates an industry-common system related to the collection and recycling of used PCs that are discarded from households • Runs awareness programs, publicity and educational initiatives promoting the 3Rs (reduce, reuse and recycle)
Japan Electronics and Information Technology Industries Association (JEITA)	http://www.jeita.or.jp	• Promotes environmental actions and initiatives amongst and for members
Association for Electric Home Appliances	http://www.aeha.or.jp	• Operates the manifest system of control the flow of E-waste from consumers to recyclers
International and domestic producers/manufacturers such as Sony, Panasonic, Toshiba, Fujitsu, Hitachi, Sharp, Sanyo, etc.		• Implement eco-design in products • Obliged to take back and recycle their products under EPR
Producer Responsibility Organizations (PROs): Ecology Net Co; R Station Corporation		• Coordinate among manufacturers, recyclers • Manages and distributes recycling costs • Responsible for management and analysis of data on operations at the recycling plants
Recyclers such as Dowa, Mitsui, Kobe Steel, etc.		• Recycle e-waste pursuant to the legal framework • Recycle via producer consignment
Retailers such as Yamada Denki, Edion, Yodobashi Camera, K's Denki, Kojima etc.		• Explain the collection scheme, • Collect e-waste • Send to designated points for recycling
Consumers		• Have a legal responsibility to dispose of e-waste properly

Municipalities		• Collect all kinds of municipal wastes, including e-waste, if:
		  • consumers have a difficulty fulfilling their responsibility within the Law for the Recycling of Specific Kinds of Home Appliances; and
		  • municipalities designate some e-waste to be collected by the Law for Recycling of Small Home Appliances

National Institute of Advanced Industrial Science and Technology (AIST)	https://www.aist.go.jp/	• Research e-waste recycling, especially critical and rare metals
Japan International Cooperation Agency (JICA)	http://www.jica.go.jp/english/index.html	• Provides technical assistance and funding for capacity development in industrializing countries for e-waste management

Table 6: Key Stakeholders, Japan

2. Taiwan

Country profile

Taiwan has a population of 23 million[18], largely concentrated in the area around the capital Taipei. Taiwan has experienced rapid economic growth and industrialization in the past decades, boasting a GDP/capita of $22,002 in 2014[19]. Home to computer manufacturers like Acer and Asus, mobile phone producer HTC and the world's largest contract electronics manufacturing company, Foxconn, Taiwan has an export-driven economy with ICT equipment and electronics manufacturing leading the industrial sector.

The e-waste situation in Taiwan

Taiwan, a relatively high-income country, had the third-highest per capita e-waste arising in East and Southeast Asia at 18.6 kg/inhabitant in 2014, after Hong Kong and Singapore. A large domestic market for EEE has meant e-waste in Taiwan increased by over 20 per cent from 2009 to 2014. According to the UNU Global E-waste Monitor, 436,000 tonnes were generated in 2014 across all EEE product categories. The Big 6 products, namely air conditioners, televisions, personal computers, washing machines, refrigerators and mobile phones, comprise 40 per cent of the entire e-waste arising. Two datasets on e-waste arising

18 United Nations, Department of Economic and Social Affairs, Population Division (2014)

19 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

E-waste per capita

18.6 kg

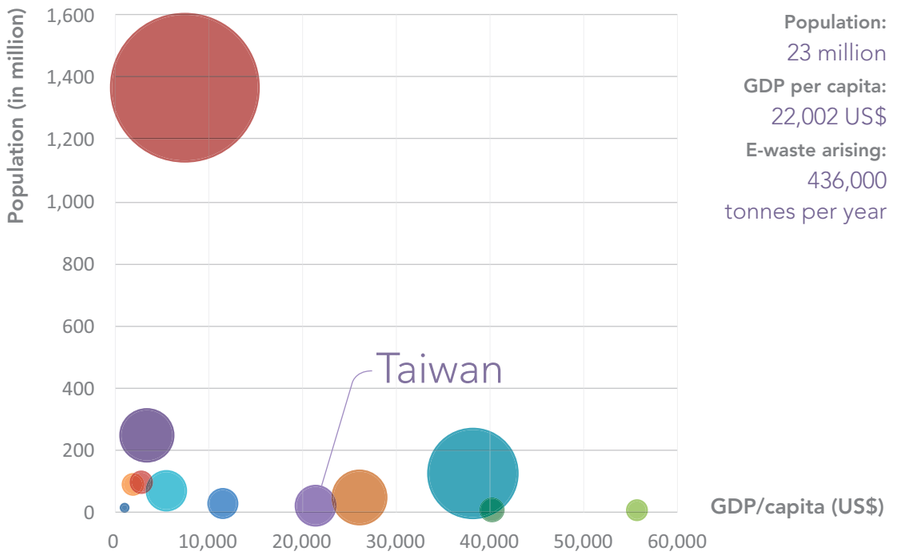


Figure 14: Population, GDP per capita and E-waste arising, Taiwan, 2014

are compared in the figure below–one based on Taiwanese inventory data from the Taiwan EPA[20], and the second based on statistical estimates using the UNU assessment model. Both estimates, especially for the Big 6 products, have similar estimates indicating confidence in data values.

20 http://recycle.epa.gov.tw/Recycle/en/index.html

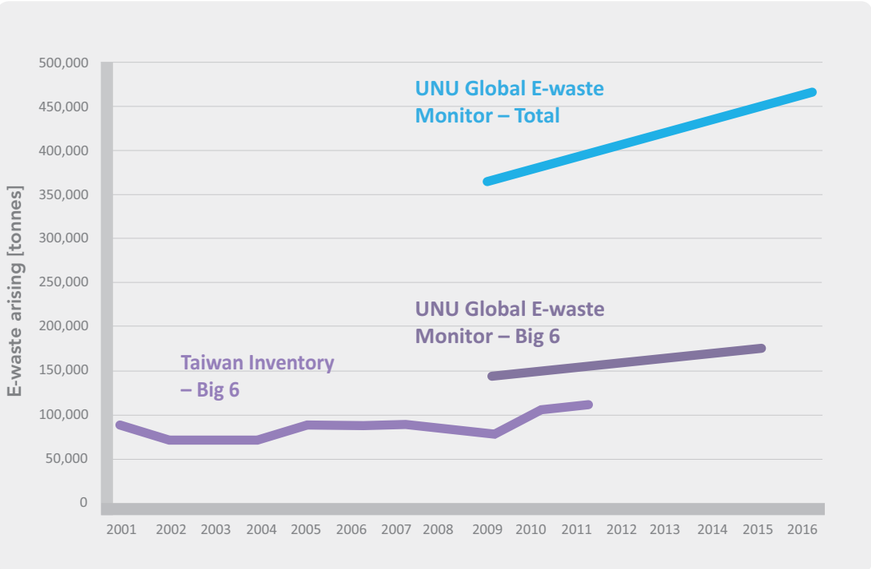


Figure 15: E-waste arising in Taiwan

Waste household appliances, IT equipment and lamps are three of 13 categories of regulated recyclable waste (RRW) under the Waste Disposal Act 1998, which introduced EPR, making manufacturers and importers physically and financial responsible for recycling. In 1997, the Environmental Protection Administration Taiwan (EPAT) introduced the "4-in-1 Recycling Program", under which it also established the Recycling Management Fund, managed by the Recycling Fund Management Board (RFMB), into which manufacturers and importers pay recycling fees. The "4-in-1 Recycling Program" integrates manufacturers and importers of new products into a complete system that also includes recyclers, municipal collection teams and community residents. The scope of the products covered under the programme has gradually increased from a handful of products, namely televisions, refrigerators, washing machines and air conditioners, to now, including IT products, printers and other peripherals, lights, fans, etc. However, EPR obligations do not yet cover all EEE products, such as small household appliances.

The four major stakeholders of the programme are community residents (waste generators), private sector recyclers/collectors (private recycling scheme), local authorities (municipal collection system) and the recycling fund (funding sources).[21] While residents and community organizations are responsible for sorting and promoting recycling activities, local authorities are responsible for the collection and channelling to private sector recycling enterprises. The overall financial responsibility of recycling lies with the manufacturers/importers, who are levied a recycling fee based on their manufacturing/import quantity. RFMB, a government-owned entity, collects the recycling fee and audits the producers. The recycling fee is stipulated by the Environmental Protection Administration Fee Rate Review Committee based on the resource recycling cost, audit costs, recycling and reuse value, etc. RFMB uses the Recycling Fund to subsidize e-waste collection by local authorities, private collectors and collectors and recyclers who meet EPAT's environmental and safety standards.

Prior to the 1997 Waste Disposal Act amendment, very few formal recycling facilities and no formal WEEE recycling facilities existed in Taiwan. All WEEE and RRW collection took place on through the informal sector. The 4-in-1 system was established as an incentive for informal collectors and recyclers of WEEE and other RRW to establish formal facilities, improve resource recovery and institute basic environmental protections.

Unique characteristics of the system are that local authorities are able to sell the collected waste to individual private recyclers or collectors. A portion of the income received is then given back to the urban local bodies for funding grants for community waste collection sites.

21 EPA, 2012, https://www.epa.gov/sites/production/files/2014-08/documents/taiwan_iemn_case_study_12.7_final.pdf

Also, the recycling fee has a differentiated structure, with the Green Differential Fee Rate providing a discount on the recycling fee rate for greener products such as Green Mark labelled products or energy/water efficient products, or premium to the recycling fee rate to discourage less environmental friendly products.

Recycling facility in Taiwan [MOEJ]

Recycling fees incentivising eco-design

To encourage green design and promote green products, there is a differentiated fee for products that have green attributes such as energy efficiency labels. The recycling fee for various products, including the discounted fee for greener products is given in the table below.

Item	Description	Regular (NT$/unit) [US$/unit]	Green Products (NT$/unit) [US$/unit]	Green Product Discount (%)
TV sets (1998)	> 27 inches, Non-LCD	371	260	30%
	< 27 inches, Non-LCD	247	173	30%
	> 27 inches, LCD	233	163	30%
	< 27 inches, LCD	127	89	30%
Refrigerators (1998)	> 250 litres	588	412	30%
	< 250 litres	392	274	30%
Washing machines (1998)		307	215	30%
Air conditioners (1998)		241	169	30%
Electric fans (2007)	> 12 inches	34	24	29%
	< 12 inches	19	13	32%
Monitors (1998)	Non-LCD	127	89	30%
	> 25 inches, LCD	233	163	30%
	< 25 inches, LCD	127	89	30%
Printers (2001)	Inkjet	101	96	5%
	LaserJet	144	137	5%
	Dot-matrix	152	144	5%
PCs (1998)		114.8	78	32%
Notebooks (1998)		39	27	31%
Keyboards (2007)		14	10	29%

Table 7: Recycling tariffs in Taiwan in 2014; the first year of regulation is indicated in parentheses for each waste item

Country type

Like Japan, Taiwan has had e-waste-specific legislation in place for many years, and it has developed an efficient collection and processing infrastructure, resulting in high recycling rates. Table 8 below gives an overview of Taiwan's stage progression for each of the pillars of the e-waste management matrix.

Pillar	Stage	Description
Legal framework	Medium	• E-waste is specifically categorised as regulated recyclable waste (RRW); Only specific products included; There is not yet a comprehensive list covering all EEE products/categories. • E-waste management falls under the Waste Disposal Act 1998 Article 15 to Article 23.[22] The Recycling Fund Management Board (RFMB) was established to initiate the "4-in-1 Recycling program" under the Act. • Regulated Recyclable Waste Auditing and Certification Regulations[23] also come under the Waste Disposal Act, setting the standard for the auditing and control of waste management enterprises. • Taiwan is not Party to the Basel Convention; therefore, no official data or implementing legislation under Basel Convention is available.
Collection mechanism	High	• E-waste is collected both by municipalities at specific municipal collection points, as well as by private collection firms that buy e-waste from consumers and the sell it to authorized recyclers. • Retailer take-back is mandatory for waste home appliances, requiring free collection of waste when new items are purchased.[24] • For regulated WEEE items, recycling is subsidized, but collection is not. • In 2014, there were over 200 waste EEE appliance collection enterprises.[25]
Processing infrastructure	High	• Recyclers are authorised by the EPAT with only compliant recyclers that meet EPAT's environmental and safety standards eligible for subsidies through the Recycling Fund. • Waste appliances recycling volumes, waste IT equipment recycling volumes and waste fluorescent recycling volumes have increased by 5.9, 24.4 and 13.7 times respectively in 2012 as compared to 1998.[26] • There are 12 waste appliances recycling plants, 17 IT equipment-recycling plants and six waste fluorescent lamp recycling plants. WEEE recyclers in Taiwan focus on dismantling; their primary techniques include manual product disassembly, mechanized CRT separation, manual phosphor powder removal, mechanized refrigerator shredding and separation, mechanized coolant removal from refrigerators and air conditioners and mechanized circuit board shredding. • As only two enterprises in Taiwan are capable of recovering gold, silver and palladium from WEEE components, shredded circuit board scrap is sent to Japan, Korea and Mainland China. • The informal recycling sector, which was dominant prior to 1997, is marginally present, with only few recyclers operating outside the scheme.
EHS standards	High	• Methods and Facilities Standards for Recycling, Storage, Clearance, Treatment and Disposal of Waste Information Technology Products and Waste Electrical and Electronic Equipment, Order No. 0960013423, 2007 ensure environmental and health standards of e-waste processing. • Subsidies are granted to compliant recyclers who are a part of the RFM Scheme. Auditing and certification procedural regulations are included in Article 18 of Waste Disposal Act, which makes it necessary for participating recyclers to be compliant.

Table 8: E-waste Management Matrix, Taiwan

22 http://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCode=O0050001

23 http://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCode=O0050058

24 Taiwan EPA, http://www2.epa.gov/sites/production/files/2014-08/documents/taiwan_iemn_case_study_12.7_final.pdf

25 Lillian Li, "Update on e-waste management in Taiwan," Resource Recycling Fund Management Board, http://www2.epa.gov/sites/production/files/2014-05/documents/taiwan.pdf

26 See Lillian Li, https://www.epa.gov/sites/production/files/2014-08/documents/taiwan_iemn_case_study_12.7_final.pdf

Stakeholder map

Stakeholder	Website	Responsibility
Environmental Protection Administration	http://web.epa.gov.tw/en/	• Issue and implement regulation regarding safe management of waste, provide areas for storage of e-waste • Monitor recycling facilities for compliance • Audit and authorize recycling centres to operate and registers them under the RFMB programme
Local government		• Manage waste collection centres and recycling consignments • Organize collection teams Sale to intermediate sellers/collectors • Manage recyclers and used goods • Authorize recyclers to participate in the recycling scheme
International and domestic producers/manufacturers such as Acer, Asus…		• Carry financial obligation and payment of fees to RFMB for appropriate collection and recycling of e-waste
Recyclers		• Comply with requirements set by the ministry • Ensure safe management of e-waste and recovering precious metals
Private collectors, retailers		• Offer take-back schemes and collection services from consumers and municipal points • Sell the collected e-waste to appropriate formal recyclers
Producer Responsibility Organisation - RFMB	http://recycle.epa.gov.tw/Recycle/	• Collects money and organizes the 4-in-1 Recycling Program
Consumers/Community residents		• Separate their recyclable, non-recyclable and organic wastes and bring to municipal collection points

Table 9: Key Stakeholders, Taiwan

Cathode Ray Tube recycling worker in Taiwan [MOEJ]

3. South Korea

Country profile

The Republic of Korea, also known as South Korea, has a population of around 49 million[27], half of which resides in the metropolitan area surrounding the capital, Seoul. The other populous urban regions include Busan, Incheon, Daegu, Daejon and Gwangju. Almost 83.2 per cent of the country's population is urbanized. With a GDP/capita of US$28,739,[28] South Korea's economy is highly developed and ranks 15th globally. The Korean economy has grown rapidly over the past half century with the development of an export-oriented manufacturing sector. Currently, the largest manufacturing industry in Korea is EEE in terms of value added, with Samsung, LG and Daewoo established as global giants.

The e-waste situation in South Korea

South Korea is a gadget-mad country. It had, for example, worldwide the highest overall mobile ownership of 99 per cent, with 67 per cent owning smartphones.[29] Increasing disposable income has meant that e-waste has become one of the fastest growing solid

27 United Nations, Department of Economic and Social Affairs, Population Division (2014)

28 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

29 http://www.nielsen.com/content/dam/corporate/uk/en/documents/Mobile-Consumer-Report-2013.pdf

E-waste per capita

15.9 kg

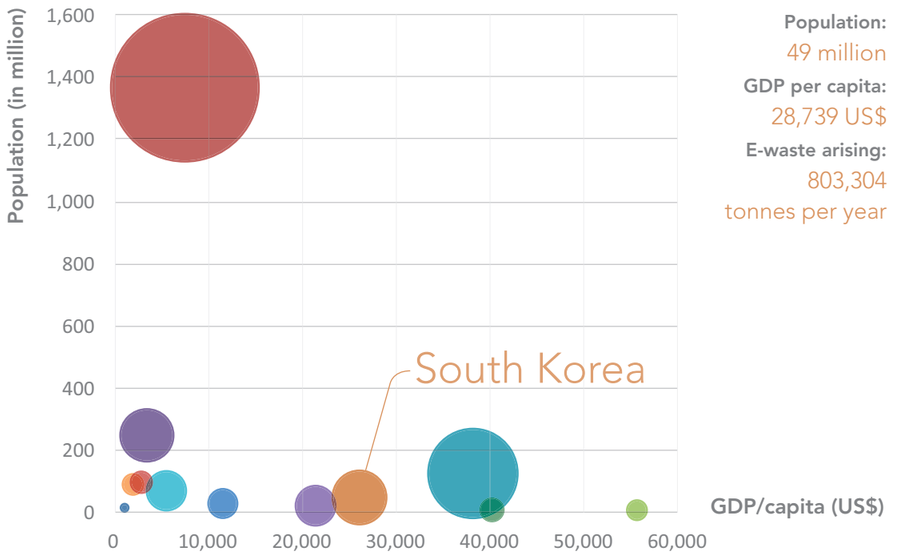


Figure 16: Population, GDP per capita and E-waste arising, South Korea, 2014

waste streams in Korea, with e-waste arising growing from 13 kg/capita in 2009 to nearly 16 kg/capita in 2014, and it is forecasted to be nearly 18 kg/capita by 2018, according the UNU estimates.

As seen in Figure 16, South Korea is the third-largest generator of e-waste in East and Southeast Asia, behind only China and Japan, generating slightly over 800,000 tonnes of

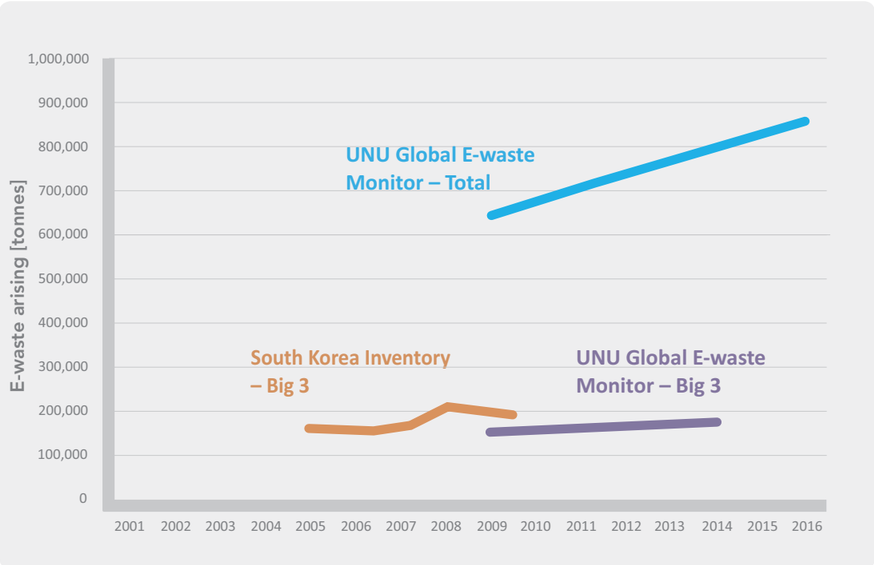


Figure 17: E-waste arising in South Korea (Big 3 products above are: PCs, TVs and Washing Machines)

e-waste across all EEE product categories. Korean inventory data, available for three products – namely PCs, TVs and washing machines – for the years 2005 to 2009 is shown in Figure 17.

E-waste management started in Korea in 1992, with the inclusion of TVs and washing machines under the Producer Deposit-Refund scheme. Air-conditioners and refrigerators were also included in later years of the programme, which regulated other types of wastes as well such as packaging. The deposit, paid by manufacturers to a fund regulated by the Korean Recycling Corporation (KORECO), was paid back to the manufacturer on proof of proper recycling of e-waste. In practice however, the refund rate was less than 10 per cent as the deposit was hardly claimed by manufacturers, as it was cheaper than the cost of recycling. An overhaul of the system took place in 2003, not only expanding the scope of products, but also making EPR the central principle of the revised legislation. In a further update, since January 2008, Korea has implemented the Act on the Resource Circulation of Electrical and Electronic Equipment and Vehicles from the Ministry of Environment, with inputs from the Ministry of Knowledge Economy (now Ministry of Trade, Industry and Energy), and the Ministry of Land, Transport and Maritime Affairs. The legislation covers most large and small household appliances and some IT and consumer electronics product, namely TVs, computers, refrigerators, air conditioners, washing machines, mobile phones, audio products, printers, copiers, facsimile machines, batteries, fluorescent bulbs and small household EEE.

The new legislation not only aims to improve the Korean e-waste management situation, which currently has a relatively low recycling rate, setting a target of 3.9kg/capita in 2014, increasing to 6kg/capita by 2018. It also extends its scope, from 10 to 27 items, and also includes design for the environment and restriction of hazardous substances, and appropriate treatment of e-waste.[30] The collection and recycling costs are borne by the producers, who are responsible for providing collection points throughout the country and obligated to meet annually revised volume based recycling targets for each item. Obligated producers or importers can pay a recycling fee to a PRO, so that the organization can collect and recycle the used products.

The allotments are distributed among the member producers of the PRO according to the mandatory recycling quantity assigned to each producer, and the PRO collects and manages the recycling fee. The intention of the legislation is to also incentivise producers to design products and use materials that are easily dismantled and recycled. Consumers are required to sort their waste and cooperate in the collection process. This has ensured the decline of informal and illegal e-waste activities. Producers and importers of EEE may collect and recycle

30 Lee, S.-C.; Na, S.-I. E-Waste Recycling Systems and Sound Circulative Economies in East Asia: A Comparative Analysis of Systems in Japan, South Korea, China and Taiwan. Sustainability 2010, 2, 1632-1644. doi:10.3390/su2061632

their waste individually or join a Recycling Mutual Aid Association. The law also provides the Ministry of the Environment with powers to impose penalties on defaulters who do not meet recycling obligations, with a penal cost of an additional 30 per cent of the recycling cost incurred for the recycling of non-compliant waste.[31]

Korea has been party to the Basel Convention since 1994, but it is not yet party to the Ban Amendment. Although difficult to conclusively confirm, there have been no reports of illegal e-waste exports from Korea to developing countries. There has, in fact in the past been an inflow of e-waste into South Korea for processing, for example 7,103 tonnes of e-waste from the United States (including CRT glass) to three facilities in South Korea.

Evolution of the e-waste management system

South Korea has continuously evolved its e-waste management system to keep pace with international best practices following the greater diffusion of products, improvement in technology and the demand for scarce resources for its manufacturing industries.

1991
- Introduction of deposit system for EEE through the Waste Deposit-Refund System under the Law for Promotion of Resources Saving and Reutilization. Limited scope going from 2 to 4 EEE products.

2000
- Voluntary agreements on EPR (government - three major consumer electronics makers).

2003
- Mandatory EPR based-system, under the Producer Recycling System programme under the revised Law for Promotion of Resources Saving and Reutilization legislation. Scope expanded.

2008
- New Act on the Resource Circulation of Electrical and Electronic Equipment and Vehicles (eco-assurance system) enforced. Scope includes Large and small household products. Recycling targets for manufacturers, revised annually.

31 RSJ Technical Consulting, "What is Korea RoHS," http://rsjtechnical.com/WhatisKoreaRoHS.htm

Mandatory recycling rates have been increasing slowly. Recycling targets were announced five years in advance to help manufacturers establish recycling plans from a long-term perspective. From 2014, instead of product-wise target, an annual recycling target of 3.9kg/capita will be implemented.

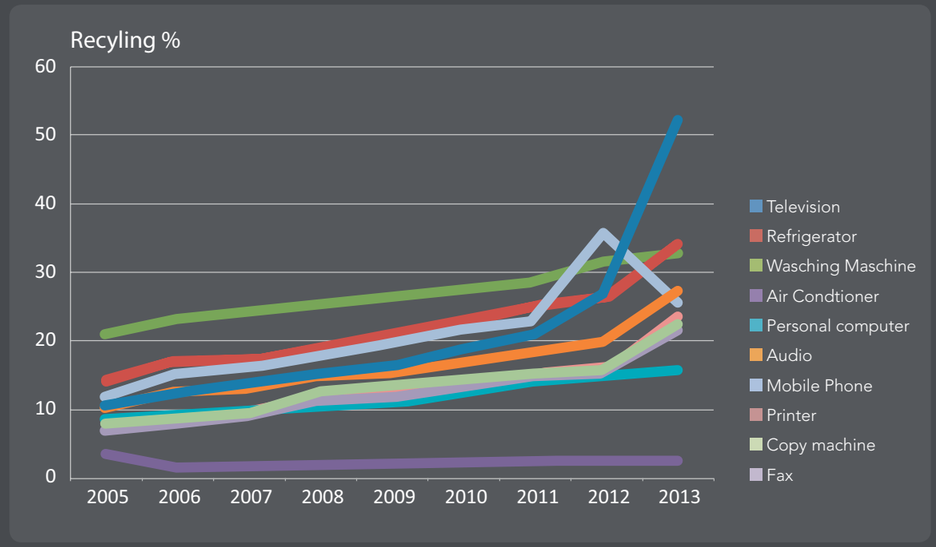


Figure 18: Gradually increasing recycling targets in South Korea

There has been a substantial increase in the recycling rate, which has steadily gone up in the last few years, with TV recycling almost doubling from 27 to 51 per cent of TVs put on market (PoM) by mass. This is also because heavier CRT TVs are being disposed of, while flatter

and lighter LED TVs are being sold. However, not all products are achieving their recycling targets as highlighted in red in the table below. Nevertheless, total mass of e-waste recycling has increased from nearly 122 kilotonnes in 2011 to nearly 150 kilotonnes in 2013.

	PoM (tonne)			Recycled (tonne)			Recycling %		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Televisions	73,821	82,866	63,918	19,585	35,380	32,402	27%	43%	51%
Refrigerators	231,793	214,500	223,466	62,567	65,329	75,027	27%	30%	34%
Washing machines	97,884	95,689	99,061	27,885	26,371	30,941	28%	28%	31%
Air conditioners	146,862	126,600	139,278	4,060	3,072	2,338	3%	2%	2%
Personal computers	55,507	46,959	42,053	7,141	4,526	8,183	13%	10%	19%
Mobile phones	3,302	3,204	2,854	619	633	461	19%	20%	16%
	609,167	569,819	570,630	121,858	135,312	149,35	20%	24%	26%

Table 10: Big 6 products put on market and recycled, South Korea

Country type

South Korea has had in place e-waste-specific legislation for several years, having adapted it based over time to better achieve environmental objectives, in the process also supporting the development of a collection and processing infrastructure. Table 10 below gives an overview of the stages South Korea is in for each of the pillars of the e-waste management matrix.

Pillar	Stage	Description
Legal Framework	Medium	• E-waste take-back falls under the law Act on the Resource Circulation of Electrical and Electronic Equipment and Vehicles (2008), also known as the 'Eco-Assurance Act' specifically for e-waste and end-of-life vehicles. • 27 specific products, classified into five groups: large-scale equipment, telecommunication devices, medium-size equipment, small-size equipment and cellular phones, are covered. • The Promotion of Installation of Waste Disposal Facilities and Assistance is to promote domestic recycling industry through long-term, low-interest rate loans for facility installation, technology development and commercialization of recycling businesses. • The Act on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal exists for the management of hazardous wastes transposes Basel Convention.
Collection mechanism	Medium	• E-waste is collected from consumers via various collection points provided by producers, take-back system at retailers and a government collection system. Over 100 logistics centres nationwide with 3,300 distributing agencies (in 2014). • Retailers must provide free take-back of customers' old products and pack-aging materials for new products, and they are responsible for transporting collected wastes to a collection depot/recycler (or they can reuse it themselves). • Free pick up service for large household appliances started as a pilot project in 2012 by the Ministry of Environment and expanded nationwide in 2014.
Processing Infrastructure	High	• Seven Metropolitan Recycling Centres (MRCs) with total capacity of 117,000 tonnes/year. • They achieve a recycling rate of 68.8 per cent for refrigerators to 93.44% for washing machines. • Main Materials recovered include iron, synthetic resin, copper, aluminium CFC (R12) and urethane. • Large smelters for final material recovery include LS-Nikko Copper Inc Korea Zinc Co., the word's largest producer of refined zinc.
EHS Standards	High	• Illegal dumping, dismantling and open burning of e-waste is not allowed. • Recyclers are authorized by the government on the basis of the technology used and other compliance requirements. • KEA CE-3500: Standards for the Recycling Rate of Parts and Materials to Calculate Recyclability Rate of electrical and electronic equipment", Standard of Korea Electronics Association (in Korean)

Table 11: E-waste Management Matrix, South Korea

Stakeholder map

Stakeholder		Responsibility
Ministry of Environment (MoE)	http://eng.me.go.kr/eng/web/main.do	• Enact and amend environmental laws and regulations • Set frameworks for waste reduction, recycling and recovery of energy through its policy branch, the Resource Recirculation Bureau • Publish a per capita recycling target on an annual basis
Ministry of Trade, Industry and Energy (MoTIE)	http://english.motie.go.kr/	• Involved in the consultation of e-waste legislation • Host the Korea Urban Mining Association, that also has several e-waste recyclers as members
Ministry of Land, Transport and Maritime Affairs (MoLIT)	http://english.molit.go.kr/intro.do	• Involved in the consultation of e-waste legislation • Mandates land planning, which includes waste treatment and processing facilities
Local Government (232 local autonomous authorities)		• Provides curbside collection and WEEE recycling in accordance with the national policies • Carries out public awareness programmes for local residents
International and domestic producers/manufacturers (Samsung, LG, etc.)		• Pay advance disposal fees for the take-back and recycling of their products • Achieve mandatory collection/recycling targets
Producer Responsibility Organization (PRO) - Korea Association of Electronics Environment (KAEE)		• Sets and collects advance disposal fees from producers • Reports recycling implementation plans and results to KECO • Compensates local government for collection costs • Compensates recyclers for treatment costs
Recyclers		• Recycles via producer consignment
Consumers		• Cooperate on collection by channelling the e-waste to appropriate stakeholders (retailers, local governments, collection companies)
Collection companies		• Offer voluntary collection, • Distribute as used goods • Process residues
EcoAS	http://www.ecoas.or.kr	• Report and guide operational management information system
Korea Environment Corporation (KECO)		• Oversees the EPR system • Acts as a clearing house and checks and monitors producer compliance to ensure targets are met • Provides financial assistance in the form of low-interest rate loans to small and medium sized recycling businesses seeking technical consulting to improve technological capacity
Korea Environment and Resources Corporation (KORECO)		• Operates waste treatment facilities • Provide necessary support to the green industry
Korea Federation for Environment (KFEM)		• Serves as environmental NGO and the Korean member of Friends of the Earth
Korea Environmental Industry and Technology Institute	http://www.keiti.re.kr/en/index.do	• Supports entrepreneurs attempting to establish new recycling businesses to treat wastes or produce products using secondary resources
KOICA	http://www.koica.go.kr/english/main.html	• Under Korean ODA, supports projects on improving e-waste management in developing countries in Asia (e.g., Cambodia)

Table 12: Key Stakeholders, South Korea

Type 2: **Voluntary Initiative** – Singapore, Hong Kong

Hong Kong and Singapore do not have specific e-waste legislation. Instead, the governments collaborate with producers to manage e-waste through a public-private partnership. As small island nations with large shipping and trade networks, both countries have significant transboundary movements of e-waste generated domestically, as well as in transit from other countries.

E--waste dismantling in China [Benjamin Hale]

4. Singapore

Country profile

Singapore, situated in Southeast Asia between Malaysia and Indonesia, is an island nation with a population of 5.4 million[32], making it the third-most densely populated country in the world. As a highly urbanized country, it is a hub for trade, commerce and finance. The rapidly-developing nation's gross domestic product per capita was US$ 55,568 in 2014, the highest in East and Southeast Asia.[33] The electronics industry forms a major portion of the manufacturing industry in Singapore, contributing 25 per cent of the total manufacturing value-added.

The e-waste situation in Singapore

Singapore's high per capita income correlates with a high per capita generation of e-waste. The country's e-waste production has grown from 17.5 kg per inhabitant in 2009 to nearly 19.5 kg per inhabitant in 2014, and it is expected to grow to nearly 21 kg per inhabitant by 2018. According to UNU estimates, as shown in Figure 19, approximately 109,000 tonnes of e-waste

32 United Nations, Department of Economic and Social Affairs, Population Division (2014)

33 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

E-waste per capita

19.5 kg

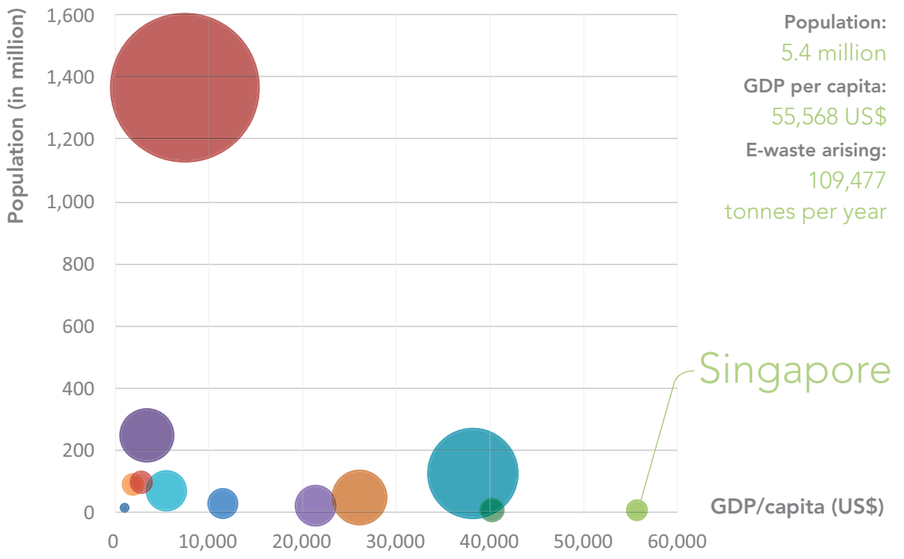


Figure 19: Population, GDP per capita and E-Waste Growth, Singapore, 2014

were generated in 2014 across all electrical and electronic product categories in Singapore[34]. According to the National Environment Agency (NEA), Singapore generates about

34 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

60,000 tonnes of e-waste every year.[35] However, there is no information available regarding the scope of products included in this estimate. According to UNU Global Monitor, e-waste from the "Big 6" products –namely TVs, PCs, washing machines, refrigerators, air-conditioners and mobile phones, which account for nearly 40 per cent of the e-waste – was estimated at approximately 40,000 tonnes in 2014.

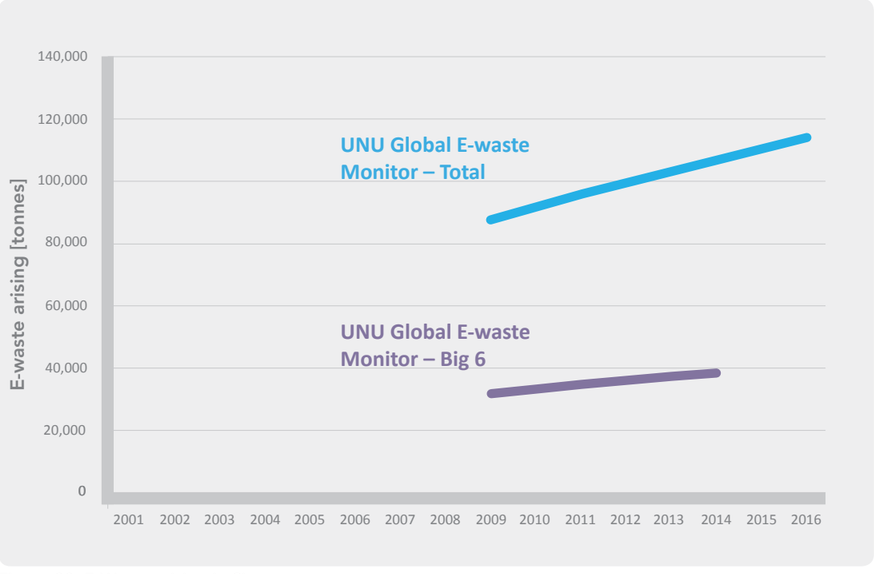


Figure 20: E-Waste arising in Singapore

35 Ministry of the Environment and Water Resources & National Environmental Agency. Factsheet on National Voluntary E-Waste Recycling Partnership (2015). Available from http://www.mewr.gov.sg/docs/default-source/default-document-library/cos-2015-media-factsheet---national-voluntary-e-waste-recycling-partnership.pdf

Currently, Singapore does not have specific legislation for e-waste management, and e-waste is classified as non-hazardous solid waste for local regulatory purposes. However, Singapore is studying various options for implementing a regulated e-waste management framework in the near future. Meanwhile, NEA has formed a national voluntary partnership with interested stakeholders[36] for e-waste, lamp and battery recycling (see info box). Existing voluntary measures by industry for e-waste collection, take-back and recycling include:

- REcycling Nations Electronic Waste (RENEW), a joint initiative by telecommunications company StarHub, e-waste recycler Tes-AMM and courier firm DHL; Panasonic's Heartland E-Waste Recycling Programme and SingTel-Nokia Recycling Program; recycling partner Cimelia Resource Recovery; and several large take-back programs by Original Equipment Manufacturers (OEMs) of their own products.[37]

- Project Homecoming, which is a joint multi-brand ink and toner cartridge recycling initiative led by Brother, Canon, Dell and Epson, and supported by recycler Tes-AMM, the National Library Board (NLB) and NEA.

- Fuji Xerox collects used printers and cartridges from customers' offices for recycling and also recycles its own printing equipment.

36 http://www.nea.gov.sg/energy-waste/3rs/e-waste-lamp-battery-recycling/national-voluntary-partnership
37 http://www.nea.gov.sg/energy-waste/3rs/e-waste-lamp-battery-recycling/e-waste-recycling

National Voluntary Partnership

The objectives of the programme include

- Building public awareness of e-waste, lamp and battery recycling
- Providing consumers with convenient drop-off points;
  Raising collection and recycling standards; and
- Getting feedback and data to support the development of formal regulation

Stakeholders involved:

1. **Consumers** (e.g., general public, companies) of electrical and electronic equipment are encouraged to proactively recycle their e-waste. Companies and organizations are encouraged to implement corporate policies to manage e-waste properly (e.g., adoption of SS 587) and to engage recycling service providers that are members of the partnership.

2. **Producers** (e.g., manufacturers, retailers) of electrical and electronic equipment are encouraged to collect back the products that they have sold when consumers discard them. For example, retailers of home appliances could provide home pick-up services for bulky e-waste and send the bulky e-waste to registered recycling service providers. Producers will also be encouraged to spearhead e-waste recycling programmes.

3. **Venue partners** (e.g., schools, shopping malls, community centres) can support e-waste recycling by providing space for recycling bins or organizing community recycling drives.

4. **Recycling service providers** (e.g., collectors, recyclers, logistics providers) are encouraged to raise the standards of their processes.

Funding Scheme for Partners

To encourage partners to implement or expand programmes to increase e-waste recycling awareness and provide convenient recycling services for the public, NEA is offer-ing a funding scheme. New recycling programmes, expansions of existing recycling programmes, and existing programmes that have lapsed for three months or more are eligible for funding. Only members of the partnership can apply to the funding scheme.

The funding scheme provides up to 80 per cent support for qualifying costs, which may include collection, recycling, edu-cation and other costs. Qualifying costs are evaluated on a case-by-case basis.

Support & recognition from NEA

NEA appreciates the voluntary efforts of partners and aims to support partners by:

- Providing funding to support recycling programmes; and
- Providing recognition for the efforts of partners through added publicity for partner programmes and their achievements

More information on the program: http://www.nea.gov.sg/energy-waste/3rs/e-waste-lamp-battery-recycling/national-voluntary-partnership

In November 2014, Singapore Standard SS587:2013 was launched by NEA and the Singapore Standards Council.[38] SS587 provides companies and organizations with guidelines to manage their information and communication technology equipment in environmentally responsible ways when they reach their end-of-life.

Singapore has been party to the Basel Convention since 1996, and enacted the Hazardous Waste (Control of Export, Import and Transit) Act (1998) and its regulations to regulate the control of export, import and transit of hazardous waste in accordance with the principles and provisions of the Basel Convention. Although Singapore has not signed the Basel Ban Amendment and does not ban the import or export of e-waste, it has strict regulations for transboundary movements, restricting the import and export of hazardous waste and other waste for final recovery and final disposal under the Hazardous Waste Act (1998). Under the Act, permission from the Pollution Control Department prior to any export, import or transit of hazardous waste is required. While in general Singapore does not allow export of waste for disposal, the export of hazardous waste can be allowed for recovery purposes if there is no waste treatment facility available domestically. The import of hazardous waste for recovery is granted on a case-by-case basis.[39] Import of used tele-communication equipment is also subject to approval by the Infocomm Development Authority of Singapore (IDA). Importers are required to obtain a relevant Telecommunication Dealer's Licence from IDA for sale, offer for sale or rental of repaired or refurbished tele-communication equipment in local markets, or for re-export purposes[40]. The specific codes and quantity units for e-waste and used electronic equipment are strictly applied.[41]

38 http://www.zerowastesg.com/tag/e-waste/#sthash.9hYW8VDa.dpuf
39 http://www.seas.at/aseas/5_1/ASEAS_5_1_A3.pdf
40 http://app.nea.gov.sg/cms/htdocs/article.asp?pid=1545
41 http://www.nea.gov.sg/docs/default-source/anti-pollution-radiation-protection/chemical-pollution/hange-of-product-code-quantity-unit-for-used-electronic-equipment-nbsp-.pdf?sfvrsn=0

Country type

Despite of the absence of specific e-waste legislation, Singapore has a fairly developed e-waste management system. It is largely based on the voluntary initiative of private industry, both from manufacturers as well as recyclers, with the government playing only a supporting role.

Pillar	Stage	Description
Legal Framework	Low	• No specific e-waste management law exists in Singapore and it is considered to be non-hazardous solid waste for legal purposes. • The Singapore Standard SS587:2013 is an industry implementation of national standards on the management of end-of-life ICT equipment. • The Hazardous Waste (Control of Export, Import and Transit) Act (1998) regulates export, import and transit of hazardous waste in accordance with the principles and provisions of the Basel Convention.
Collection Mechanism	Medium	• Waste collectors are private/public entities and need a license from the government to operate. There are nine licensed public waste collectors of solid waste and over 300 licensed general waste collectors. Residents are provided recycling bags/bins and door-to-door collection takes place every two weeks[42]. • Cash-for-trash locations are provided by Public Waste Collectors (not valid for lamps and batteries). • At voluntary collection programs (e.g., RENEW[43]), recyclers work with several brand owners to recycle the waste collected by the take-back mechanisms. • A total of 2,700 kg were collected in 2012, 6,500 kg in 2013, and 8,700 kg in 2014[44].
Processing Infrastructure	Medium	• Several privately owned companies have their recycling facilities in Singapore, particularly for the recovery and refining of precious metals. Other e-waste fractions that cannot be processed domestically are exported.
EHS Standards	High	• Environmental Public Health (Toxic Industrial Waste) Regulations (1988) regulates the collection, treatment and disposal of toxic industrial waste. • Recycling plants are strictly monitored for environmental and health safety standards and must have latest recycling technology to be certified and allowed to operate.

Table 13: E-waste Management Matrix, Singapore

Footnotes see page 126 above

Stakeholder map:

Stakeholder		Responsibility
Ministry of Environment and Water Resources	https://www.mewr.gov.sg/	Formulation and implementation of environmental policies.
Pollution Control Department, National Environment Agency	http://www.nea.gov.sg/energy-waste/3rs/e-waste-lamp-battery-recycling/e-waste-recycling	Statutory body under the Ministry of the Environment and Water Resources. Overall responsibility for the planning, development and management of solid waste disposal facilities and operations, including the licensing and regulation of solid waste collection and enforcement of illegal dumping
Singapore Customs	https://www.customs.gov.sg/	Monitoring compliance of import and export of e-waste and used electronics to and from Singapore.
Infocomm Development Authority	http://www.ida.gov.sg	Approve the import of used telecommunication equipment for import or re-export.
Private and Public Collectors		Collect the solid waste from designated points in the city and bring it to recyclers.
International producers (e.g., HP, Dell, Apple, Panasonic, Sony, Toshiba, Canon, Samsung, LG)		Organising and financing voluntary take-back programs; joining the National Voluntary Partnership; implementation of the SS587 standard.
Private recyclers (e.g., Tes-AMM, Cimelia Resources)		Safely sort and recycle e-waste to achieve maximum material recovery.
National Library Board	http://www.nlb.gov.sg/sure/what-happens-to-e-waste/	In partnership with the NEA and printer manufacturers, implement collection and awareness programs (e.g., Project Homecoming)

Footnotes page 125

42 Gua Eng Hock, http://www.epa.gov.tw/FileLink/FileHandler.ashx?file=16768

43 http://www.eco-business.com/news/e-waste-recycling-goes-big-in-singapore/

44 http://www.virogreen.net/e-waste-recycling-singapore

Consumers		Put e-waste in designated collection bins or utilize free collection offered by producers

Table 14: Key Stakeholders, Singapore

TVs and washing machines for testing for reuse, Hong Kong [Yvan Schulz]

5. Hong Kong

Country profile

Hong Kong is a Special Administrative Region of the People's Republic of China bordering the South China Sea and China. Although the region is a part of the People's Republic of China, it has a different political system from mainland China. With a population of approximately 7.1 million in 2014[45], it is the fourth-most densely populated territory in the world. An important economic hub and long considered a gateway to the East, Hong Kong has a highly developed economy, and its urban population enjoys one of the highest per capita incomes in the region.[46] However, the land-scarce territory faces huge waste disposal challenges; its three existing landfills estimated to be exhausted by 2019.[47]

The e-waste situation in Hong Kong

According to the UNU's estimates, as shown in Figure 18, approximately 156,000 tonnes of e-waste was generated in 2014 across all electrical and electronic product categories in Hong Kong. The Big 6 products, namely TVs, PCs, washing machines, refrigerators,

45 United Nations, Department of Economic and Social Affairs, Population Division (2014)

46 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

47 Ir Dr Alain Lam, "Hong Kong's Comprehensive Waste Management Strategy for coming 10 years," Environmental Protection Department, February 21, 2014

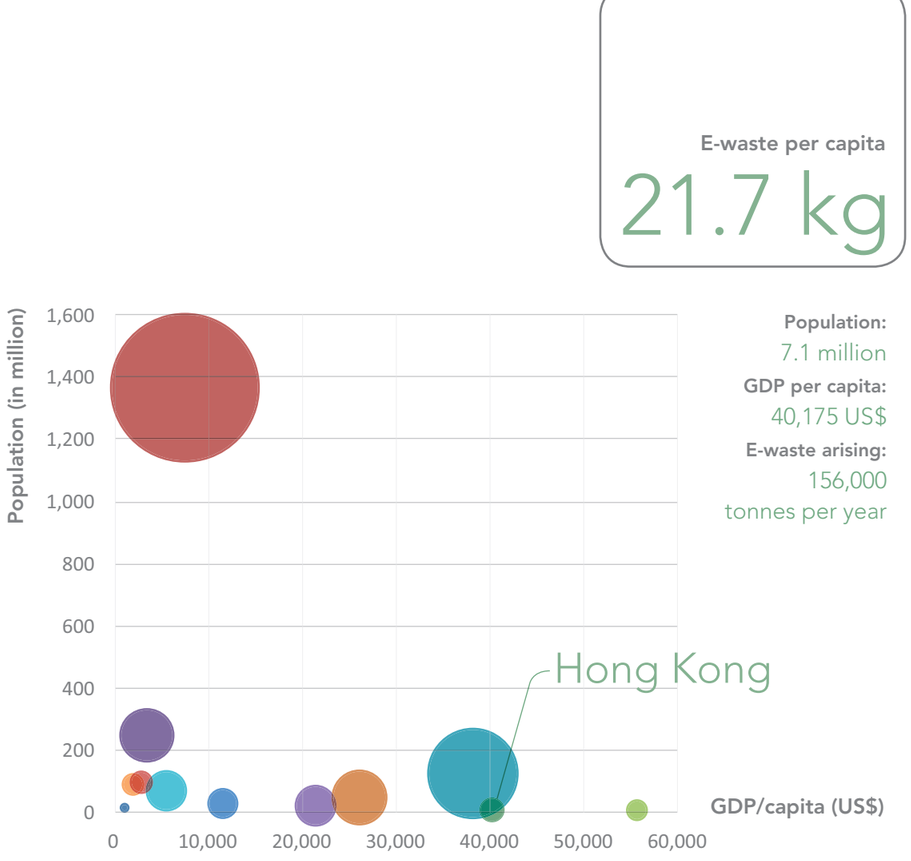


Figure 21: Population, GDP per capita and E-waste arising, Hong Kong, 2014

air-conditioners and mobile phones, which account for nearly 40 per cent of the e-waste, are estimated to have made up approximately 60,000 tonnes in 2014[48] (Balde et. al, 2015). The Environment Protection Department (EPD) reports annual waste recycling statistics, and the

48 Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. Access online: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

data from 2005 to 2013 show that approximately 80 per cent of e-waste is recovered, and volumes have remained in the range between 53,000 to 66,000 tonnes per year[49] as shown in Figure 22. According to a background brief for the Legislative Council Panel on Environmental Affairs, most e-waste generated on the island is exported for reuse or recovery of valuable materials.[50]

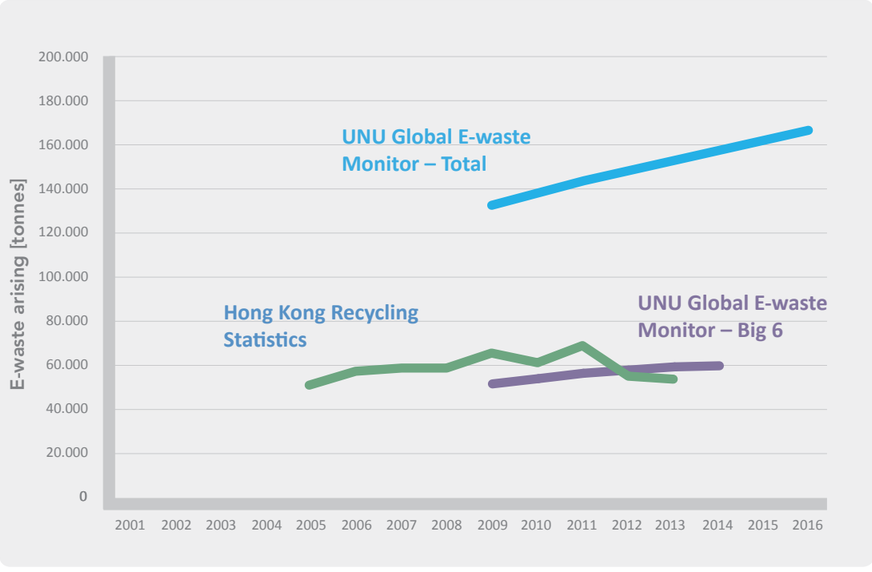


Figure 22: E-waste arising in Hong Kong

49 https://www.wastereduction.gov.hk/en/quickaccess/stat_recycle.htm
50 http://www.legco.gov.hk/yr14-15/english/panels/ea/papers/ea20150126cb1-454-4-e.pdf

At the time of this writing, there is no specific e-waste legislation in Hong Kong, although there have been discussions over the last several years regarding its implementation. Draft legislation for management of WEEE as part of a producer responsibility scheme (PRS) has been prepared for implementation by 2016 (see page 133). It is expected to cover five main products: TV sets, refrigerators, washing machines, air-conditioners and computer products, with a recycling fee paid by producers to finance the scheme. Under this scheme, retailers and distributors would be obligated to provide free take-back services. The existing policy framework for the management of municipal solid waste in Hong Kong (2005-2014) already outlines initiatives for enshrining the "polluter pays" principle and producer responsibility in the management of all types of waste. In 2008, the Product Eco-responsibility Ordinance was enacted, providing the necessary legal framework for the introduction of PRSs to minimize the environmental impact of various types of products.

Meanwhile, the EPD has launched voluntary programs such as the WEEE Recycling Program and the Computer Recycling Program to promote reuse and recycling.[51,52] The CRP was launched in 2008 as a territory-wide recycling initiative jointly funded and organized by 20 major computer manufacturers and suppliers. Members of the trade have formed the Hong Kong Waste Electrical and Electronic Equipment Recycling Association ("the Association") to manage and promote the CRP.

In addition to local e-waste, Hong Kong is a trading hub; it handles international trading of regulated e-waste either as second-hand goods or waste. Hong Kong implements the Basel Convention through the Waste Disposal Ordinance (WDO). In November 2004, the EPD issued a set of guidelines on the control of the import and export of second-hand electrical and electronic equipment and hazardous e-waste, introducing a permit control for

51 Environmental Protection Department, "Recycling of Computer Equipment," https://www.wastereduction.gov.hk/en/workplace/crp_intro.htm , 2014
52 Environmental Protection Department, "Recovery of Waste Electrical and Electronic Equipment," https://www.wastereduction.gov.hk/en/workplace/weee_intro.htm , 2014

import and export of waste under the 1980 WDO. Under the ordinance, it is illegal to import such commodities into Hong Kong without a written permit from the local authority. The offender, including the carrier, is liable for a possible fine of HKD 200,000.00 and six months' imprisonment. However, there are still cases of Hong Kong being used for e-waste shipments, and the EPD, together with the Immigration Department and the police conduct operations to investigate e-waste recycling workshops and other suspect activities.

Electrical components that are not classified as e-waste under the WDO are largely exported to other countries for recycling, with Hong Kong acting as a point for storage and subsequent re-export of e-waste from countries like the United States.[53] However, as part of the discussion under the regulatory framework of the PRS, the legislative council has proposed to include enhanced export control, so that no regulated e-waste can be exported unless, among other things, the competent authority of the import destination and of each transit destination have consented to the import or transit of such regulated e-waste. Further, e-waste must be demonstrated as either genuinely reusable second-hand products or products that require treatment overseas through sophisticated processes unavailable in Hong Kong. The enhanced import control will guard against international dumping and prevent regulated e-waste intended for re-export ending up in Hong Kong.

53 Environmental Protection Department, 2011

Hong Kong's proposed e-waste Legislation

The Promotion of Recycling and Proper Disposal (Electrical Equipment and Electronic Equipment) (Amendment) Bill 2015 was introduced into the Legislative Council in March 2015 and sent to the bills committee for scrutiny. The bill proposes to include air-conditioners, refrigerators, washing machines and TV sets as well as computers and certain associated devices including printers, scanners and monitors (collectively referred to as regulated electrical equipment) in the legislation. Manufacturers and importers of regulated electrical equipment will be required to register as registered suppliers and pay a recycling fee for regulated electrical equipment that is distributed in Hong Kong. The bill strengthens existing measures and proposes some additional measures in relation to the collection, recycling and disposal of regulated e-waste:

- a seller must arrange, after distribution of regulated electrical equipment, a removal service for consumers free of charge, so that the old equipment can be delivered to a competent recycler;
- any person who is engaged in the storage, treatment, reprocessing and recycling of regulated e-waste must obtain a waste disposal license;
- a permit is required for the import and export of regulated e-waste; and
- regulated e-waste will no longer be accepted at landfills for disposal.

In order to build processing infrastructure on the island, the government contracted a private recycler under a Design-Build-Operate model to establish a facility with capacity to process 30,000 tonnes annually. The government has earmarked about $550 million for the building of the WEEETRF at the EcoPark in Tuen Mun. Its operating cost, which is payable in accordance with the volume of e-waste collected and treated in the facility, is estimated to be about $200 million a year. The new facility is expected to be completed for commissioning in 2017.

Source: http://www.info.gov.hk/gia/general/201505/08/P201505080745.htm

Country type

Hong Kong often regarded as the world-wide hub of mobile-phone recycling/refurbishment, and a transit point for e-waste flows between countries, has a domestic e-waste system that is currently more reliant on voluntary initiatives rather than legislation.

Pillar	Stage	Description
Legal Framework	Medium	• No specific e-waste law exists in Hong Kong, however the Promotion of Recycling and Proper Disposal (Electrical Equipment and Electronic Equipment) (Amendment) Bill, 2015 (PRS Scheme) was under discussion at the time of writing. • The Waste Disposal Ordinance (WDO) (1980), commonly known as the WDO controls and regulates storage, collection and disposal including the treatment, reprocessing and recycling of waste. • Under the WDO, import and export of hazardous wastes, including e-waste is subject to permit control.
Collection Mechanism	Medium	• Under the WEEE Recycling Program and Computer Recycling Program, 16 public collection points and mobile collection vehicles have been designated by the EPD to collect WEEE from different districts.[54] • EPD's mobile collection vehicle collects electrical appliances, as well as computers, rechargeable batteries, compact fluorescent lamps and fluorescent tubes. The vehicle visits a different district each week. • The Computer Recycling Programme Free collection service is provided to public, on special request, for bulk pick-up (five or more pieces of main computer equipment – i.e., desktop, notebook, printer, scanner, CRT & LCD monitor) • Under the new contract signed by the government, the recycling contractor will set up eight collection points and three recycling centres across the city.
Processing Infrastructure	Medium	• According to the EPD, almost 80 per cent of e-waste is exported to mainland China and other countries for recycling. The rest is either dumped in one of the three operating strategic landfills or temporarily stored in open storage sites in rural New Territories[55] or sent to local recycling facilities. Only 10 per cent of e-waste generated is currently recycled locally.[56] • Alba Integrated Waste Solutions Hong Kong, a joint-venture subsidiary of the Alba Group, signed a 12-year contract with the Hong Kong government in May 2015. It will spend two years building the plant and then operate the collection and recycling system in the city for the next 10 years. The plant would be capable of processing 30,000 tonnes of waste a year, but the capability could be extended to a maximum of 56,000 tonnes by arranging additional shifts as needed.
EHS Standards	Medium	• Local collectors, refurbishers and recyclers are subject to compliance of environmental standards, random audits/patrolling by EPD and are required to submit reports in accordance with licensing conditions. • Pollutants produced in workshops are subject to control under Air Pollution Control, Noise Pollution, Water Pollution Control and Waste Disposal Ordinances.

Table 15: E-waste Management Matrix, Hong Kong

54 See EPD, 2011, https://www.wastereduction.gov.hk/en/source-separation-e-waste.html

55 Environment Bureau, "Safe and sustainable: a new producer responsibility scheme for waste electrical and electronic equipment," Consultation Document. http://www.epd.gov.hk/epd/english/resources_pub/policy/files/weee_consultation_eng.pdf , 2010

56 See EPD, 2011, https://www.wastereduction.gov.hk/en/source-separation-e-waste.html

Stakeholder map

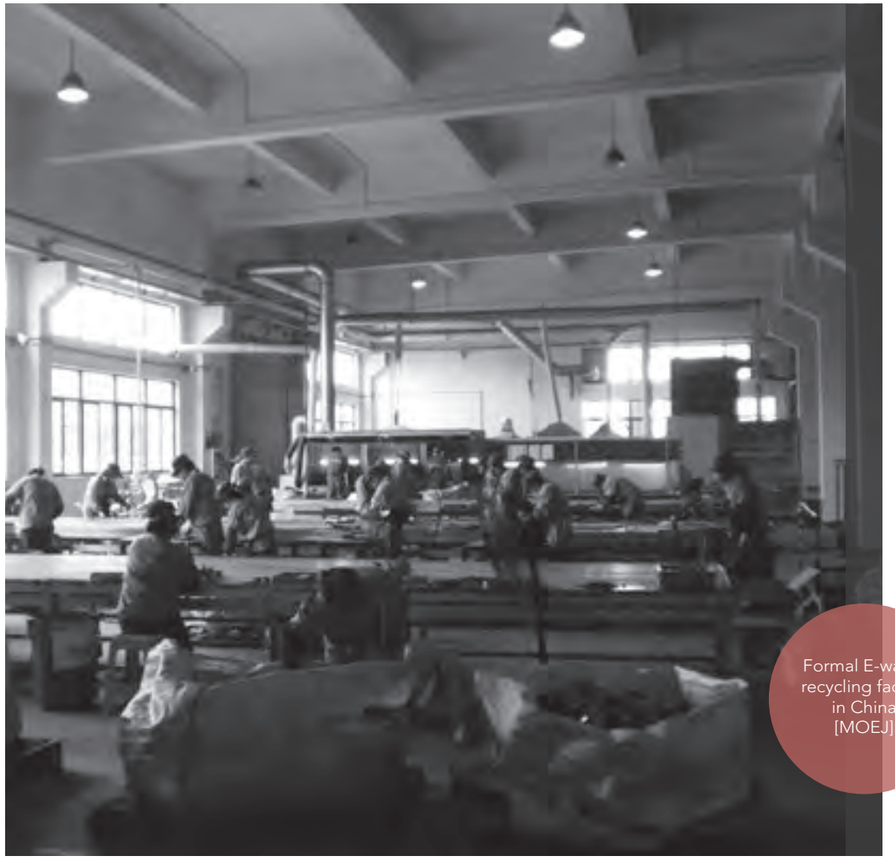
Stakeholder		Responsibility
Legislative Council	http://www.legco.gov.hk/database/english/data_ea/ea-municipal-solid-waste.htm	Lawmaking body for the Special Administrative Region that scrutinizes and passes legislation
Environment Bureau / Environmental Protection Department (EPD)	http://www.epd.gov.hk/epd/english/environmentinhk/waste/waste_maincontent.html	To issue and implement regulation regarding safe management of waste, provide areas for storage of e-waste and monitor recycling facilities for compliance
International producers such as HP, Dell, Apple, Panasonic, Sony, Toshiba, Canon, Samsung, LG etc.		Financing and organizing voluntary programmes to collect and take-back end-of-life electronics
Private recyclers (eg. Alba; Vannex International)		Safely sort and recycle e-waste to achieve maximum material recovery
NGOs – St. James Settlement, Caritas Hong Kong	https://www.wastereduction.gov.hk/en/workplace/weee_collection_points.htm http://www.ccw.org.hk/index.html	Provide collection and refurbishment services; raise awareness
Hong Kong WEEE Recycling Association	http://www.hkwra.org.hk/index.html	Voluntary association for the supervision and promotion of the CRP and other related programs for batteries and fluorescent tubes
Consumers		To dispose of e-waste at designated collection points only

Table 16: Key Stakeholders, Hong Kong

E-waste stored for dismantling and recycling [Benjamin Hale]

Type 3: **In transition** – China, Malaysia, the Philippines and Vietnam

China, the Philippines, Malaysia and Vietnam all have recent e-waste legislation. The four countries are therefore in a transitionary phase, with a mix of formal and informal elements in an evolving eco-system in terms of collection and recycling infrastructure. The countries face similar challenges in enforcing regulations with limited resources and capacity and low public awareness regarding the hazards of improper disposal of e-waste.



Formal E-waste recycling facility in China [MOEJ]

6. China

Country profile

China, with over 1.3 billion people[57], is world's most populous country as well as its second-largest economy. With rapid urbanization in the past decades, with just over 50 per cent of the population lives in urban areas, many in urban agglomerations such as Shanghai, Beijing, Chongqing, Shenzhen and Guangzhou. It is the world's largest exporter of goods and, since 2010, it has also been the largest manufacturing nation, accounting for 22.4 per cent of the world's manufacturing output in 2010.[58]

The e-waste situation in China

In 2011, China overtook the United States as the world's largest market for personal computers,[59] and the country is the world's largest market for mobile phones and televisions (TVs) by volume. The sales of TVs, refrigerators, washing machines, air conditioners and computers have increased manifold. According to the Chinese National Bureau of Statistics, the total ownership of home appliances and electronic in China increased substantially,

57 United Nations, Department of Economic and Social Affairs, Population Division (2014)
58 https://www.mapi.net/china-has-dominant-share-world-manufacturing
59 http://online.wsj.com/article/SB10001424053111903461304576525852486131230.html?mod=googlenews_wsj

E-waste per capita
4.4 kg

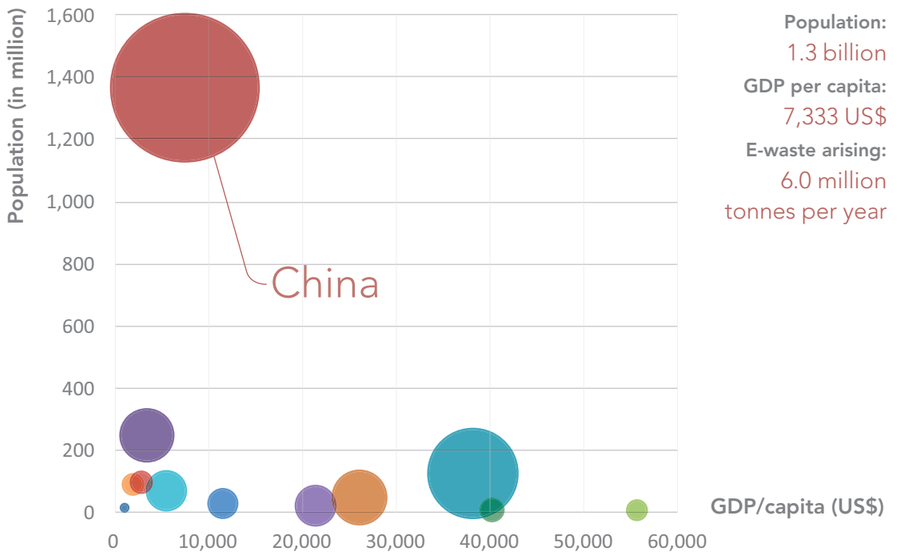


Figure 23: Population, GDP per capita and E-waste arising, China, 2014

particularly ownership of mobile phones, computers and air conditioners, both in rural and urban households as shown in the table 17[60]

60 CNBS, Statistical Yearbook of China 1996-2012, Beijing: China National Bureau of Statistics.

Appliance	Items/100 Urban Households				Items/100 Rural Households				National Average
	2000	2005	2010	2012	2000	2005	2010	2012	2013
Mobile Phones	19.5	137.00	188.86	212.64	4.32	50.24	136.54	197.80	203.2
Colour TVs	116.6	134.80	137.43	136.07	48.74	84.08	111.79	116.90	116.1
Washing Machines	90.50	95.51	96.92	98.02	28.58	40.20	57.32	67.22	80.8
Refrigerators	80.10	90.72	96.61	98.48	12.31	20.10	45.19	67.32	82.0
Air Conditioners	30.80	80.67	112.07	126.81	1.32	6.4	16.00	25.36	70.4
Computers	9.70	41.52	71.16	87.03	0.47	2.10	10.37	21.36	48.9

Table 17: Ownership of Household Durable Goods in China

With growth in ownership and greater replacement of obsolete equipment, there has been a dramatic increase in the quantities of e-waste being disposed of domestically in China, from 9.91 million units in 2001 to 109.80 million units in 2013 (CHEARI, 2013).[61] The amount of WEEE generation was 75.85 million units in 2012, 109.8 million units in 2013 and 113.77 million units in 2014, and the amount of WEEE that was treated was 25.84 million units in 2012, 47.56 million units in 2013 and 70 million units in 2014.[62]

A report by the United Nations Environment Programme (UN Environment) indicated that in 2010, more than 2.3 million tonnes of e-waste were annually generated in China.[63] However, according to more recent estimates in the UNU Global E-waste Monitor, China is estimated to have generated nearly six million tonnes of e-waste domestically in 2014. In addition, China is also a recipient of e-waste from other countries, with an estimated 1.5–3.3 million tonnes of WEEE exported to China via various legal and illegal routes each year.

61 CHEARI (China Household Electric Appliance Research Institute), 2013. White paper on WEEE recycling industry in China http://www.cheari.org/recycling/index.html

62 Tian Hui, Improve the EPR System in WEEE recycling in China, the 10th International Conference on Waste Management and Technology, Mianyang, China, October 2015

63 Feng Wang, Ruediger Kuehr, Daniel Alquist, Jinhui Li,"E-waste in China: A country report," StEP Green Paper Series, 5 April 2013

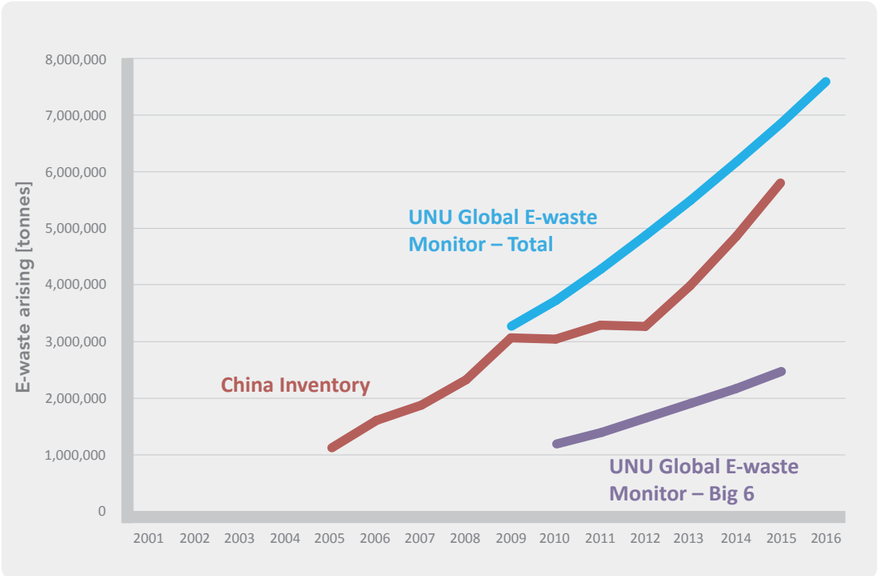


Figure 24: E-waste arising in China

Most collection activities are carried out in urban areas due to high population density and the availability of large volumes of e-waste. Informal workers perform door-to-door collection and serve as an interface between consumers and medium level scrap dealers, refurbishers and recyclers. Currently, around 440,000 people are involved in informal e-waste collection.[64,65] After collection, this e-waste is sorted and usable appliances and valuable components are sold to the second-hand market. Items with little or no value are sold to scrap dealers from

64 Duan, H. and M. Eugster, Employment analysis of WEEE recycling and disposal in China, 2007, Internal working paper of EMPA: St. Gallen, Switzerland.

65 Yu, J., et al., Managing e-waste in China: Policies, pilot projects and alternative approaches. Resources, Conservation and Recycling, 2010. 54(11): p. 991-999.

where they go to informal recycling hubs which are concentrated close to waterways and ports of entry. The most prominent of these areas include Guiyu, Longtang, and Dalion the Pearl River Delta; Taizhou on the Ynagtze River Delta; Hebei Province; Hunan Province and Jianxi Province.[66,67] Guiyu, which is the largest e-waste recycling site in China and the world, has a population of 150,000 people, nearly 100,000 of whom are migrant labourers engaged in recycling operations. In these informal recycling hubs, the treatment of WEEE is mainly carried out via primary methods, such as hammering, manual sorting, open burning and acid leaching.

Apart from domestic generation of e-waste, China remains one of the largest recipients of e-waste from other countries. This is in spite of the Chinese government having banned the import of e-waste (for both domestic reuse and recycling) in 2000 and having ratified both the Basel Convention in 1991 and Ban Amendment in 2001. Scrap dealers and smugglers now use less direct and visible means to import e-waste into China. Unscrupulous traders in high-income countries like Japan and Korea, often combine e-waste components into mixed metal scrap imported into China for recycling. Since the import of mixed metal scrap for recycling is legal in China, it is difficult to monitor shipments that have e-waste mixed within them. Also, under the "One Country, Two Systems" policy, legislation of mainland China is not applicable in Hong Kong, which is then able to export huge quantities of e-waste to China. Hong Kong also acts as a base for re-export of e-waste from other countries to China.[68]

66 Fraunhofer IZM. Sector review of Waste of Electronic and Electrical Equipment (WEEE), Country Report: China (confidential report). International Finance Corporation, 2008.

67 Wang, F., et al. Economic conditions for formal and informal recycling of e-waste in China. in Electronics Goes Green, 2008. Berlin, Germany.

68 Yoshida, A., China: the World's Largest Recyclable Waste Importer, in International Trade of Recyclable Resources in Asia 2005, IDE-JETRO (Institute of Developing Economies Japan External Trade Organization): Chiba Japan.

A unique scheme

China has trialed a unique scheme to improve its e-waste recycling system. Given the widespread existence of informal e-waste collectors and recyclers, formal recyclers have difficulty accessing e-waste products, as they are unable to compete on price given higher treatment costs in the formal sector. Consequently, to promote more environmentally sound recycling system, the Chinese government has several policies that incentivize the channelization of e-waste into the formal sector. As a result, many facilities have cropped up in recent years with additional help from investments by foreign recycling companies, often with state-of-the-art equipment for processing e-waste. The map in figure 25 shows the number and locations of the e-waste treatment facilities in China. Predictably, they are concentrated in the industrial and more urbanised eastern part, especially around big urban centres.

> Until July 2014, 106 facilities have been authorized for funding under the incentive scheme.

From June 2009 to December 2011, the government initiated a programme to encourage formal collection by authorized collectors who were then able to pay consumers higher prices to purchase old appliances, putting them at an advantage over the informal sector. The annual formal collection rate under this program reached up to 64 per cent.[69] However, since the scheme ended, informal collection has become more common, with lesser volumes reaching the formal sector. According to the most recent data available from the Ministry of Environment Protection data, in 2013, over 800,000 tonnes of e-waste from 39.87 million units of WEEE was

69 Feng Wang, Ruediger Kuehr, Daniel Alquist, Jinhui Li,"E-waste in China: A country report," StEP Green Paper Series, 5 April 2013

dismantled in the formal sector, the large majority from TVs, with over 50 per cent of the mass from CRT TV glass. The subvention incentive provided by the Chinese government to the formal recyclers for this volume was to the tune of 3.306 billion Yuan (or US$ 542 million at 2013 exchange rates).

Formal Recyclers per Province

Figure 25: Formal Recyclers per Province

Fractions from Formal Dismantling of WEEE in China 2013

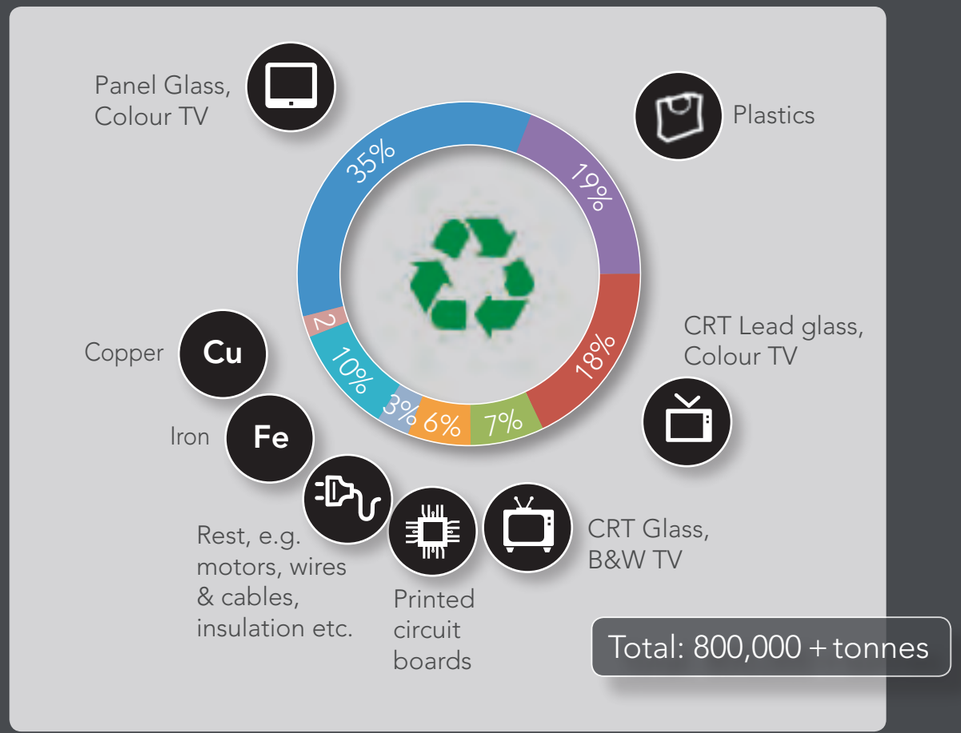


Figure 26: Fractions from Formal Dismantling of WEEE in China in 2013

Country type

Over the last decade, the Chinese government issued a variety of environmental laws, legislation and standards related to WEEE management, making a commitment to establishing a formal recycling system.

Pillar	Stage	Description
Legal Framework	Medium	• China has ratified both the Basel Convention and the Ban Amendment, however, it struggles with huge quantities of e-waste imports. Important laws related to e-waste management in China are: • The Law on the Prevention and Control of Environmental Pollution by Solid Wastes was passed in 1995 and amended in 2005 • The Catalogue for managing the import of wastes (MOC, MEP, NDRC, GAC, AQSIQ, 2009, No. 36) has banned the import of e-waste since 2000. • The Technical Policy on Pollution Prevention and Control of WEEE (SEPA No. 115) came into force in 2006 and sets othe"3R" and "Polluter Pays" principles, stipulates eco-design and makes provisions for environmentally sound collection, reuse, recycling and disposal of WEEE. • The Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products, commonly known as China RoHS (MIIT No.39), has been in force since 2007. It sets requirements for eco-design, restrictions on use of hazardous substances and requirements for producers to provide information about their products. • Since 2008, the Administrative measures on pollution prevention of WEEE (SEPA No. 40) has focused on preventing pollution during disassembly, recycling and disposal of e-waste and has provided a licensing scheme for e-waste recycling companies. • Regulations on the Management of the Recovery and Treatment of Waste Electronic and Electrical Products, commonly known as China WEEE Regulation, was passed in 2009 and came into force in 2011. It makes e-waste recycling mandatory, implements EPR and establishes a fund to subsidize e-waste recycling. The first batch of products covered under this law was limited to TVs, refrigerators, washing machines, air conditioners and computers. In the second batch, this catalogue will be expanded to printers, copiers, mobile phones, water heaters and monitors, among others.

Pillar	Stage	Description
Legal Framework	Medium	• The administrative measures for levy and use of treatment fund for WEEE includes a levy on EEE is used to fund the collection and treatment of WEEE. Other related legislations are: • Cleaner Production Promotion Law, passed in 2002 and amended in 2012 • Circular Economy Promotion Law, passed in 2008
Collection Mechanism	Low	• Most of the e-waste is collected by the informal sector collectors who offer door-to-door collection services and make cash payments to purchase e-waste from households and businesses.
Processing Infrastructure	Medium	• Formal treatment infrastructure: Currently, 130 e-waste recycling enterprises are registered on the e-waste Dismantling Enterprise list, and as of 2012, 53 e-waste treatment facilities in 15 provinces and cities had received the necessary treatment licenses, with a total of 122 planned to be built by 2015 (MEP). However, formal treatment is still in early stages and most of the e-waste is recycled informally.[70]
EHS Standards	Low	• Municipal environmental protection departments are responsible for approving the qualifications of enterprises engaged in WEEE treatment, based on the requirements set down under the WEEE Treatment Facility Qualification. • The informal dismantling and recycling sector does not ensure safe e-waste practices, and it has caused extreme environmental degradation and increased health risks to those involved in such recycling activities. Studies have shown that residents of places that are recipients of e-waste in China that are also hubs of informal waste activities are exposed to dioxins 15-20 times higher than the WTO recommended level.

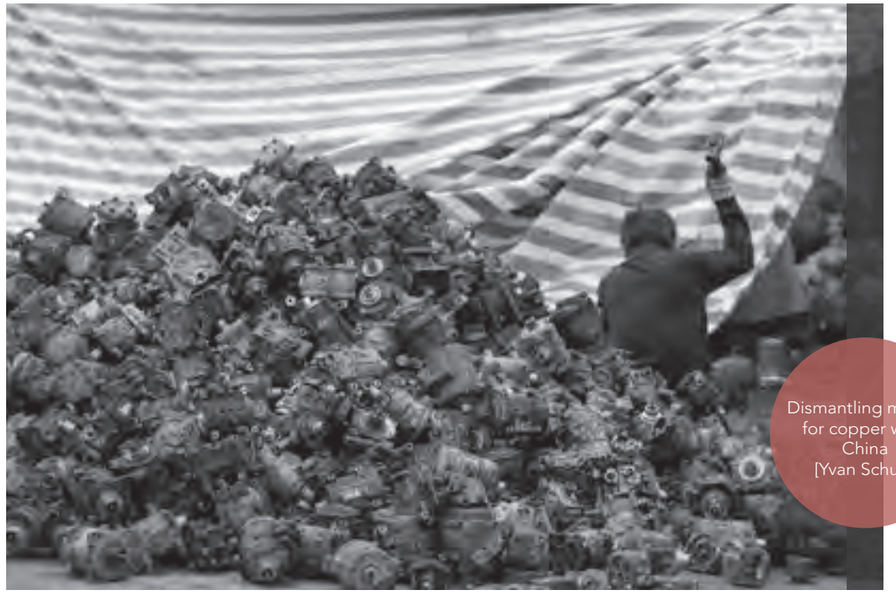
Table 18: E-waste Management Matrix, China

70 Feng Wang, Ruediger Kuehr, Daniel Alquist, Jinhui Li,"E-waste in China: A country report," StEP Green Paper Series, 5 April 2013.

Stakeholder map

Stakeholder		Responsibility
National Development and Reform Commission	http://en.ndrc.gov.cn/	Formulate general framework for e-waste management in the country
Ministry of Environmental Protection (MEP)	http://english.mep.gov.cn/	Monitor the treatment, standards, toxic control and shipment control of e-waste
Ministry of Industry and Information Technology (MIIT)	http://www.miit.gov.cn/	Manage electrical and electronic equipment manufacturing industry and their product designs (eco-design); Responsible for China RoHS
Ministry of Commerce, Ministry of Finance	http://english.mofcom.gov.cn/	Management of e-waste collection channels and financing and taxation of collection and recycling facilities
Customs/General Administration of Customs		Monitor illegal imports and register shipments; implementation of levy
Municipal Environmental Protection Departments		Approve and license e-waste recycling and treatment facilities
Basel Convention Regional Centre for Asia and the Pacific (BCRC China)	http://www.bcrc.cn/	Research, capacity building, technology transfer and awareness-raising
Civil Society Organisations (eg. Greenpeace, BAN)		Non-governmental organizations monitoring the effects of e-waste recycling and status of e-waste management framework
China Household Electric Appliance Research Institute (CHEARI)	http://www.cheari.org/AboutUs/english.html	National institution for scientific innovations and technical services focusing on services of HEA research, testing, certification, standardization, metering and calibration of household equipment
National Electronic Waste Recycling Engineering Research Center (EWR-ERC) – inaugurated November 2014		Promote the development of Chinese E-waste recycling in harmless and resource recovery through e-waste recycling technology
China Household Electrical Appliances Association (CHEEA), China National Resources Recycling Association (CRRA)	http://en.cheaa.org/; http://www.crra.com.cn/English/	Industrial associations helping and advising the ministry to bring in effect the recycling law
National (eg. Haier, Huawei, Lenovo) and international producers (eg. Sony, Dell etc) and importers		Pay levy to finance formalization of collection and recycling
Collectors and recyclers - Formal and informal		Collect e-waste from households and businesses; Sort and recycle e-waste

Table 19: Key Stakeholders, China



Dismantling motors for copper wire, China [Yvan Schulz]

7. Malaysia

Country profile

Malaysia, separated by the South China Sea into peninsular Malaysia and East Malaysia on the island of Borneo, shares borders with Thailand, Singapore, Indonesia and Brunei. The total population of Malaysia in 2013 was estimated at 29.62 million[71] (IMF, WEO database), more than 70 per cent of whom live in cities and urban areas. The Greater Kuala Lumpur area, which includes the national capital and surrounding districts is home to more than one fifth of the population. Malaysia has progressed from the 1970s, when it was primarily a producer of raw materials, such as tin and rubber, to becoming a leading exporter of electrical appliances, electronic parts and components, palm oil and natural gas with an open economy that welcomes trade and investments. With industrial development, Malaysia's GDP has also risen steadily to over US$300 billion, with a GDP per capita of US$10,000 in 2013[72], making it an upper-middle income country.

The e-waste situation in Malaysia

As per estimates by the United Nations University, Malaysia is estimated to generate approximately 250,000 tonnes of e-waste per year, at a rate of 7.8 kgs/inhabitant. Consumption

71 United Nations, Department of Economic and Social Affairs, Population Division (2014)

72 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

E-waste per capita

7.8 kg

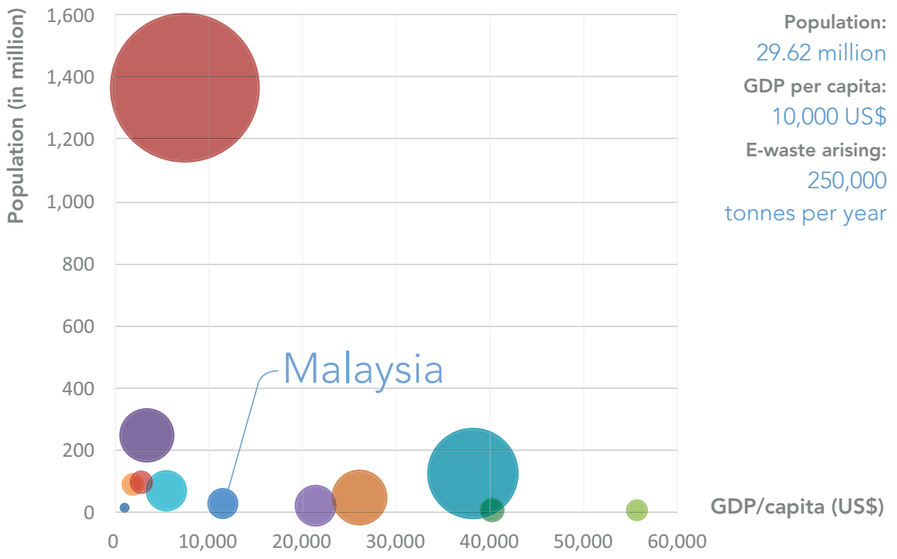


Figure 27: Population, GDP per capita and E-waste arising,, Malaysia, 2014

of electronic and electrical products has risen steadily in Malaysia. This has been especially prevalent in the exponential growth of mobile phone adoption. To better understand the e-waste situation in Malaysia, the first ever e-waste inventory was carried out from 2007 to 2009, under the aegis of the Asia E-waste Project.[73]

73 Perunding Good Earth Sdn Bhd. The E-waste Inventory Project in Malaysia.

The inventory provided rough estimates on e-waste volumes generated, which were estimated to reach over 900,000 tonnes in 2015 from the Big 6 products (namely TVs, washing machines, refrigerators, air conditioners, PCs and mobile phones). However, these figures suggest a per capita waste generation of more than 30kg/inhabitant, which is unrealistically high – the highest per capita e-waste generation in Asia is Hong Kong at 22 kg/inhabitant. A more recent estimate by UNU provided an e-waste arising estimate of approximately 90,000 tonnes per year from the Big 6 products.

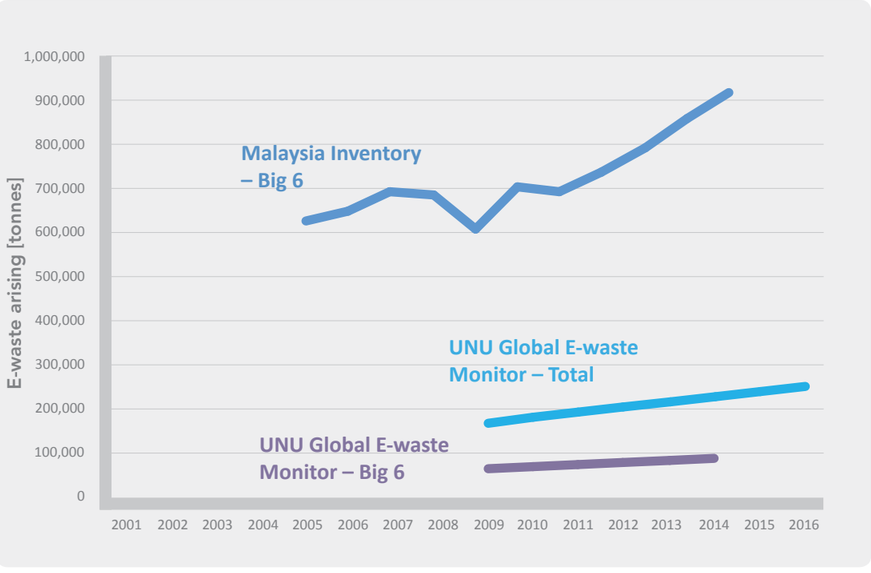


Figure 28: E-Waste arising in Malaysia

The inventory survey also found that a sizeable chunk of old electronics remain unused in households. The reasons for keeping unwanted WEEE at home ranged from reluctance to dispose of a gadget bought at a high price, potential for cannibalisation of parts, and most commonly, because consumers were waiting for scrap collectors to buy their e-waste, rather than having to pay someone to collect it. The majority of the e-waste is still sold to scrap collectors who purchase e-waste from consumers and households at scrap rates. Door-to-door scrap buyers are commonly known as "old newspaper men" (orang surat khabar lama), as they normally go around the neighbourhood making their presence felt by chanting "old newspapers". In spite of the numerous licenced facilities for e-waste processing, informal collection and recycling networks are still widespread in Malaysia.

The Department of Environment (DOE) under the Ministry of Natural Resources and Environment is responsible for e-waste legislation and has been taking steps in promoting a strong e-waste recycling sector, particularly because of the country's large EEE manufacturing industry.

In Malaysia, e-waste is categorized as a scheduled waste under the code SW 110. E-waste was first legally recognized as a type of hazardous waste in Malaysia August 2005, when a provision on the control of pollution caused by e-waste generation, storage, treatment and disposal came into effect. However, there is still neither any e-waste-specific legislation nor a legally obligatory take-back system. The 2005 regulation aimed to adequately control the management of hazardous wastes generated in Malaysia and prohibit the import of hazardous waste, including e-waste, for either for refurbishment or recovery. Recognising the Basel Convention's importance for the country's economic and environmental well-being, Malaysia became party to the convention in October 1993. One of the steps associated with the Basel Convention has been to restrict the export of e-waste from Malaysia if this e-waste can be recycled domestically. As a result, several multinational e-waste recyclers and local firms have entered the market.

The EEE sector is an important contributor to Malaysia's economy, which in 2009 accounted for 6 per cent of Malaysia's gross national income, and 41 per cent of the country's total exports. As the large and economically important EEE manufacturing sector is dominated by multinationals, awareness-raising efforts have been launched on the safe disposal of e-waste with campaigns and pilot voluntary recycling programmes among domestic manufacturers as well as retailers and consumers.

E-waste Alam Alliance

The E-waste Alam (or "environment" in English) Alliance Program was officially launched on December 11, 2013 by the Deputy Minister of Natural Resources and Environment. The Alliance was created as a follow-up to a pilot project entitled The Development Model for E-Waste Collection, Segregation & Transportation from Household For Recycling, which was carried out in Penang under the sponsorship of the Japan International Cooperation Agency (JICA) with the cooperation between DOE Penang and Penang Municipal Council.

The objectives of the programme are to implement a sustainable system of collection, segregation and transport of e-waste while creating awareness and cooperation among stakeholders, including manufactures, retailer and consumers. It was launched in six states, namely Perak, Selangor, Federal Territory (Kuala Lumpur and Putrajaya), Melaka and Johor, with the Big 6 products being the main items targeted for collection and disposal.[74] In the first three months following the launch, Senheng Electric, one of the retailers participating in the program, collected seven tonnes of e-waste across its various retail locations.

74 http://www.doe.gov.my/household-ewaste/wp-content/uploads/2015/10/Information-for-inclusion-in-the-DOE-Portal.pdf

Country type

Malaysia is in transition from an unregulated informal e-waste management system to a more formalised system within a legal mechanism.

Pillar	Stage	Description
Legal Framework	Medium	Malaysia does not have specific e-waste legislation; however, there are other rules and guidelines under the hazardous waste framework that are applicable for e-waste handling and processing. • Environmental Quality (Scheduled Wastes) Regulation in 2005 under the Environmental Quality Act. The amended regulation categorises E-waste as a scheduled waste SW110. • Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia in 2008 (the first edition) and 2010 (the second edition) from the Department of Environment, Malaysia that provide guidance on determining whether used electrical and electronic equipment is E-waste or second-hands goods.
Collection Mechanism	Low	The collection and take-back system in Malaysia is still largely done by itinerant informal collectors and small agents/buyers. Retail drop-off at Senheng occurs under the E-waste Alam Alliance Program. Consumers can request free pick-up of bulky EEE products, such as refrigerators or washing machines.
Processing Infrastructure	Medium	There are two types of formal e-waste facilities: a full recovery facility and a partial recovery facility. Although there is no clear definition to distinguish between the two, a full recovery facility is capable of dismantling of e-waste, crushing and segregating recyclable materials and recovering precious metals by hydrometallurgy. A partial recovery facility is capable of one or some of those operations. There are 138 e-waste recovery facilities with a total capacity to handle 288,000 tonnes/year. Of these, 39 are full recovery facilities, and 98 are the partial recovery facilities as of November 2015.[75] Informal recyclers are also engaged in dismantling and metal recovery operations.
EHS Standards	Low	The Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment Disposal Facilities) Regulation issued in 1989 prescribes the control measures on collection, treatment, recycling and disposal of as well as inventory of the scheduled wastes, including e-waste.

Table 20: E-waste Management Matrix, Malaysia

75 http://www2.epa.gov/sites/production/files/2014-08/documents/malaysia_country_presentation.pdf

Stakeholder map

Stakeholder		Responsibility
Department of Environment	http://apims.doe.gov.my/	To formulate legislation on safe environmentally safe management of e-waste, guiding on application of environmental standards, approving impact assessment reports related to treatment of e-waste
National Solid Waste Management Department, Ministry of Local Government and Housing	http://jpspn.kpkt.gov.my/	To enact the Solid Waste Management and Public Cleansing Act 2007
E-waste Alam Alliance Programme	http://www.doe.gov.my/household-ewaste/wp-content/uploads/2015/10/Information-for-inclusion-in-the-DOE-Portal.pdf	To provide a sustainable collection and recycling system for e-waste
Informal e-waste Collectors		To participate in door-to-door collection services, scavenging for e-waste from municipal waste
Formal & Informal Recyclers		To recycle e-waste in an environmentally safe manner (formal facilities); to ensure safe and environmentally activities such as dismantling and depollution (Informal recyclers)
Ministry of Environment, Japan		To support capacity-building efforts and studies on transboundary movements of e-waste
Japan International Cooperation Agency (JICA)	http://www.jica.go.jp/malaysia/english/office/others/c8h0vm000001u4at-att/newsletter201302.pdf	To support capacity building, technical cooperation and assistance on waste management and material recycling technologies
Civil Society Organisations		To create awareness and advocacy for environmentally sound disposal practices and policies
Multinational Companies and Retailers		To offer voluntary take-back of e-waste and conduct e-waste awareness programmes (eg. Toshiba Malaysia, Senheng Electrical)

Table 21: Key Stakeholders, Malaysia

Printed Circuit Boards awaiting recycling stored in an open-space storage [Ruediger Kuehr]

8. Philippines

Country profile

The Republic of the Philippines, which consists of more than 7,000 islands, has a total population of about 107 million,[76] 48.8 per cent of whom live in urban areas. The most populated and urbanised cities include Manila, Quezon City, Davao, Cebu City and Zamboanga, with Metro Manila, the country's capital, being the most metropolitan region. The Philippines has been transitioning from an agrarian-based economy to one based on services and manufacturing. In particular, the semiconductor devices and other electronic components industry contributes nearly 50 per cent of all manufacturing value, with electronic products serving as the country's leading export and import commodities.[77]

The e-waste situation in Philippines

As per estimates by the United Nations University,[78] the Philippines is estimated to generate approximately 125,000 tonnes of e-waste per year, at a rate of 1.35kg/inhabitant. The consumption of electronics in the Philippines has grown exponentially in the last

76 United Nations, Department of Economic and Social Affairs, Population Division (2014)

77 National Statistics Office, Philippine Statistics Authority, Republic of the Philippines, 2010 http://web0.psa.gov.ph/content/2010-annual-survey-philippine-business-and-industry-aspbi-manufacturing-sector-final-results

78 UNU Global E-waste Monitor, 2015

E-waste per capita

1.3 kg

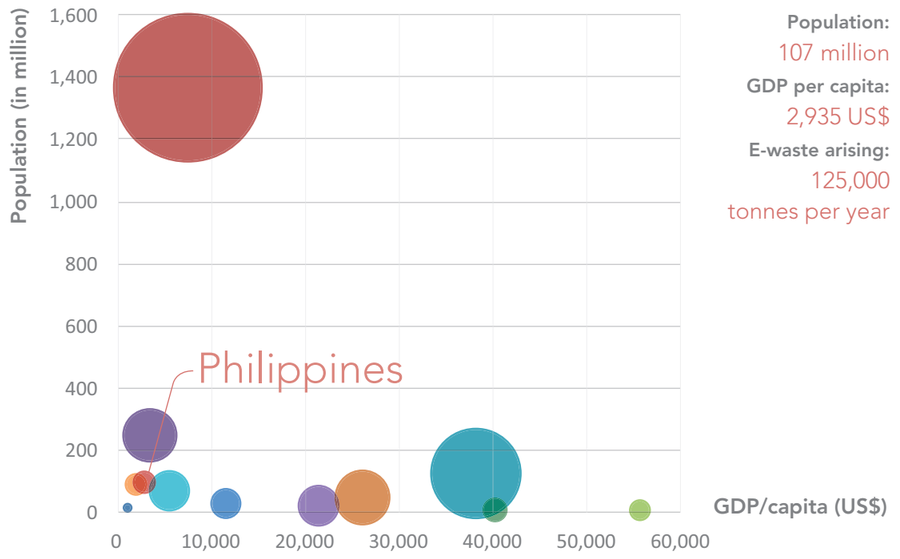


Figure 29: Population, GDP per capita and E-waste arising, Philippines, 2014

15 years. According to the International Telecommunications Union (ITU), mobile phone ownership has increased from 34,000 units in 1991 to almost 79 million units in 2010. However, this increase in electronics usage has been accompanied by increasing amounts of e-waste.[79]

79 Brian Carisma, "Drivers of and barriers to e-waste management in the Philippines," IIIEE Thesis 2009:03 http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=1511085&fileOId=1511091

As a result, groups such as the Eco-waste Coalition have been calling for government attention as early as 2010 to the problem of e-waste. Driving the availability and affordability of EEE products is the import of near-end-of-life EEE products, which are sold in surplus stores.

The Department of Environment and Natural Resources (DENR) Administrative Order No. 28, Series of 1994[80] allows the import of electronic assemblies and scraps, provided there is a notification and consent between parties, and the receiving facilities have essential environmental permits and clearance. The Philippines has not yet ratified the Basel Ban Amendment, which amends the Convention, and bans all exports of hazardous wastes from developed countries to all other countries for any reason. The senate has, however, ratified the controversial Japan-Philippines Economic Partnership Agreement (JPEPA) in 2008 that allows the import of Japanese chemical, hospital and municipal wastes into the Philippines without a tariff.

However, illegal imports of e-waste, through incorrect declaration or classification, do occur, mainly from industrialised countries like the United States, Korea, Thailand and Japan.

A study by Peralta (2006) on the current and future quantity of e-waste in the Philippines estimates that approximately 2.7 million units of televisions, refrigerators, air conditioners, washing machines and radios became obsolete by the end of 2005.[81] A later study, by Villavert[82] et. al in 2009 applied a similar methodology to estimate obsolete personal computers. Using an average weight as mentioned in Table 1, e-waste arising from the big 5 products, namely TVs, washing machines, refrigerators and air conditioners and personal computers, is

80 DENR Administrative Order (DAO No. 28) 1994: http://www.env.go.jp/en/recycle/asian_net/Country_Information/Imp_ctrl_on_2ndhand/Philippines/dao94-28.pdf

81 Peralta, G. and Fontanos, P. 2006. E-waste issues and measures in the Philippines, Journal of Material Cycles and Waste Management

82 Villavert, R., Peralta, G. L. and Ramos, S. (2009) Estimation of Obsolete Computers in the Philippines, presentation at the 2009 Workshop of the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Waste, Kuala Lumpur, Malaysia, 20-22 January

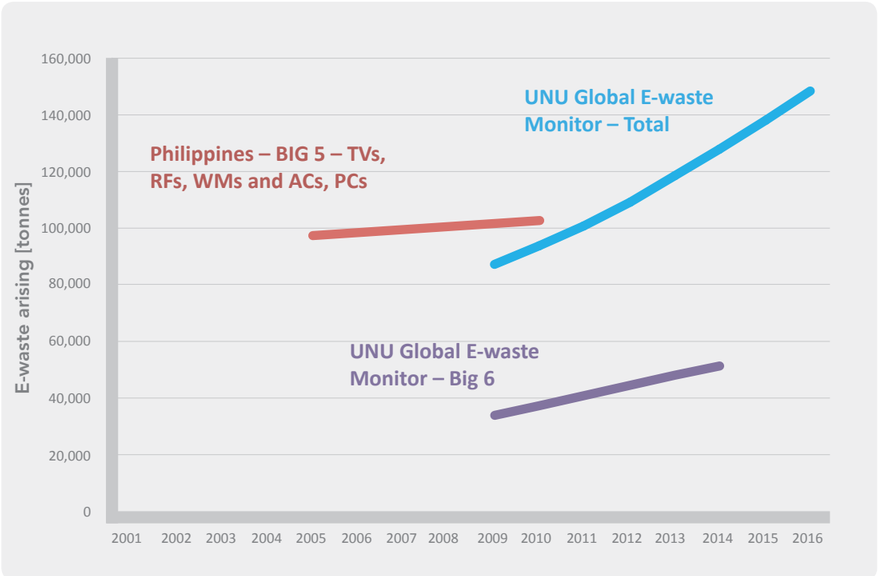


Figure 30: E-waste arising in Philippines

estimated at nearly 100,000 tonnes annually in 2010. Another, more recent estimate by UNU suggests total e-waste volumes, including all other EEE products is estimated also around 100,000 tonnes annually, with the volume of Big 6 products, also including mobile phones, in the same year was estimated at approximately 40,000 tonnes. The big difference between the two estimates indicates the need for a more rigorous inventory process of e-waste to arrive at more accurate figures.

The majority of e-waste, specifically from households and commercial establishments, is generally sold to the informal sector, with a significant portion also being landfilled along with

other solid waste.[83] The informal collection sector includes itinerant waste pickers, garbage collectors and junkshop owners who sell onwards to informal recyclers who use rudimentary methods of recycling to extract precious metals, such as gold. This sector uses artisanal processes, including environmentally unsound hydrometallurgical and/or pyrometallurgical processes. Most of these activities take place in crowded neighbourhoods and in impoverished areas of Metro Manila.[84] Lacking proper disposal facilities, large quantities of e-waste, such as discarded linear and compact fluorescent lamps and computer circuit boards (PCBs) are dumped in open pits.

E-waste generated from large-scale manufacturers is usually sent to either waste treatment facilities located in the nearby export processing zones or to licensed waste treatment units for proper waste treatment and disposal, typically a Treatment, Storage and Disposal facility accredited by the Department of Environment and Natural Resources (DENR). Formal recyclers in the Philippines are mainly transporters of metal scraps and crushed electronic components for exports and further material recovery in other countries. Due to limited waste disposal infrastructure, a great quantity of processed waste is exported to other countries from the Philippines for further metal recovery.

83 Greenpeace, 2005, http://www.greenpeace.org/seasia/ph/News/news-stories/toxic_threat_in_th_rp/
84 See Brian Carisma, note 78 above.

'Surplus Stores'

Originating as shops selling export surplus clothing, "surplus stores" have grown to include all sorts of household products including furniture and electronic and electrical appliances. These stores are mainly involved in refurbishing and reselling defective electronic equipment, mainly imported from Japan and South Korea. Often, components from imported second-hand products are scavenged to repair and refurbish used and non-functioning equipment. An analysis of data from the National Statistics Office showed that over 100,000 tonnes of used televisions, refrigerators, air conditioners, washing machines and personal computers were imported into the Philippines from 2001 to 2005. The price difference between a new and a used product is quite significant–as seen in the table below (data from Foreign Trade Statistics Section, National Statistics Office for March and May 2007).[85]

EEE Type	Brand New		Second-hand	
	Price/Unit (US$)	Price/kg (US$)	Price/Unit (US$)	Price/kg (US$)
TVs	$25-800+	$3-11	$2-7	$0.11-2.90
Refrigerators	$100+	$2+	$10-85	$0.2-1.90
Personal Computers	$300-7,500	$2 – 820	$26-200	<$2
Washing Machines	$61.90-144	$8-10+	$2-6	$0.3-2+
Air Conditioners	$88-425	$8-12	$4-12	$0.20 – 3+

Table 22: Price difference between new and used EEE

85 http://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/2012_PDF/D1S1-3[PHILIPPINES]rev.pdf

Country type

Pillar	Stage	Description
Legal Framework	Medium	• Philippines ratified the Basel Convention in 1993, but it is not party to the Ban Amendment. There is no specific law to address e-waste management in the Philippines. However, e-waste is categorized as a hazardous waste in the legal framework for hazardous waste management and the overall framework for e-waste management falls under two legislations: • The Ecological Solid Waste Management Act of 2000 (RA 9003) and its implementing rules and regulations, DAO1992-29 classifies consumer electronics and white goods as special wastes that must be handled separately from other residential and commercial wastes. However, there are no guidelines that specify how to handle them. • The Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990 (RA 6969) regulates the handling, storage, and disposal of hazardous materials that are found in electronic products. Although the law recognizes the hazardous components of EEE, it does not have any specific provision for the management of e-waste. • DAO No.28 Series 1994, Department Administrative Order No. 28, Series of 1997, Department Administrative Order No. 27, Series of 2004, and Department Administrative Order No. 66, Series of 2004, allows import and export of recyclable materials containing hazardous substances under limiting conditions. It requires importers to first register with DENR and obtain import clearance for each shipment. The Environment Management Bureau under the DENR has implemented an online application system for permitting and monitoring, including applications for import of used EEE. • A proposal on E-waste and Cellular Phones Recycling, Senate Bill 911, 2013 is under discussion. It would ensure environmentally sound management of e-waste under specific guidelines. However, this is as yet not in force at the time of publication.
Collection Mechanism	Low	The municipality is responsible for e-waste collection under RA 9003-waste. However, there is no functional system initiated by the government for e-waste collection, which is, as a result, either disposed together with the municipal waste or scavenged by the informal sector.
Processing Infrastructure	Low	• There are limited formal processing facilities for dismantling, sorting, segregating and compacting e-waste, though many are being developed. They export the fractions to other countries for final smelting and material recovery. • Backyard practices include dismantling and metal recycling/recovery using manual techniques and rudimentary processes. • Treatment, Storage and Disposal (TSD) facilities for hazardous wastes also accept e-waste for final disposal. As of December 2014, there were 20 TSDFs in the Philippines.
EHS Standards	Low	• Licensed recyclers/formal recyclers are required to follow a minimum set of environmental and safety standards for operation. Most of TSD facilities in the Philippines are partly invested by international recycling companies, and they introduce international standards on ESM for hazardous wastes. However, the informal sector involved in recycling takes few precautions while involving itself in e-waste activities. They dismantle e-waste with bare hands or using simple tools and recover metal by burning wires or integrated circuit boards, which exposes workers to toxic fumes.

Table 23: E-waste Management Matrix, Philippines

Stakeholder map

Stakeholder		Responsibility
Department of Environment and Natural Resources; Environmental Management Bureau	http://www.denr.gov.ph	To formulate legislation on the environmentally sound management of e-waste, guiding on application of environmental standards, approving impact assessment reports related to treatment of e-waste. Also includes inspection of recycling facilities, granting authorisation to operate, planning of landfills, raising public awareness campaigns.
Informal E-waste Collectors		To participate in door-to-door collection services, scavenging for e-waste from municipal waste
Surplus Stores		To repair and refurbish broken/ unused EEE and sell second-hand EEE
Formal & Informal Recyclers		To recycle e-waste in an environmentally safe manner (Formal facilities); to ensure safe and environmentally activities, such as dismantling and depollution (Informal recyclers)
Ministry of Environment, Japan	https://www.env.go.jp/en/	To support capacity-building efforts and studies on transboundary movements of e-waste
World Bank, Japan International Cooperation Agency (JICA), NIES, BCRC		To support capacity building, technical cooperation and assistance on waste management and material recycling technologies
Civil Society Organisations (eg., Eco-Waste Coalition; Foundation for Media Alternatives)	http://ecowastecoalition.blogspot.de/	To create awareness and advocacy for environmentally sound disposal practices and policies
Multinational companies		To offer voluntary take-back of e-waste (eg., Fuji-Xerox Philippines has a take-back programmes for discarded toner, printers and photocopying machines; Nokia takes back mobile phones)

Table 24: Key Stakeholders, Philippines

Readying wires for open burning to recover copper in an informal settlement [Florencio Jr Ballesteros]

9. Vietnam

Country profile

Vietnam, located in Southeast Asia, shares borders with China, Laos and Cambodia. Once considered to be one of the poorest nations in the world, Vietnam has rapidly grown following the political and economic reforms of 1986. Consequently, its per capita income has grown from less than US$ 100 in 1990 to US$ 1,895 in 2013.[86] Though still a largely rural, agricultural society, there has been rapid urbanization, with 32 per cent of Vietnam's 92.5 million people living in urban areas.[87] The major urban areas are Ho Chi Minh City, Haiphong, Na Dang, Can Tho and Hanoi, the capital.[88],[89] Economic growth and government incentives have prompted many manufacturers to set up sites in Vietnam. Alongside growing demand for EEE, the nation's information and communication technology sector has seen a rapid increase in recent years.

The e-waste situation in Vietnam

According to estimates by the United Nations University, Vietnam is estimated to generate approximately 115,000 tonnes of e-waste each year, at a rate of 1.34 kgs per inhabitant. This

86 "UNDP: About Vietnam," http://www.vn.undp.org/content/vietnam/en/home/countryinfo/
87 "World Economic Outlook: Vietnam". International Monetary Fund. October 2013. Retrieved 16 February 2014.
88 "General Statistics Office, Vietnam," http://www.gso.gov.vn/default.aspx?tabid=387&idmid=3&ItemID=14632
89 "The World Factbook", Retrieved 20 June 2014

E-waste per capita
1.3 kg

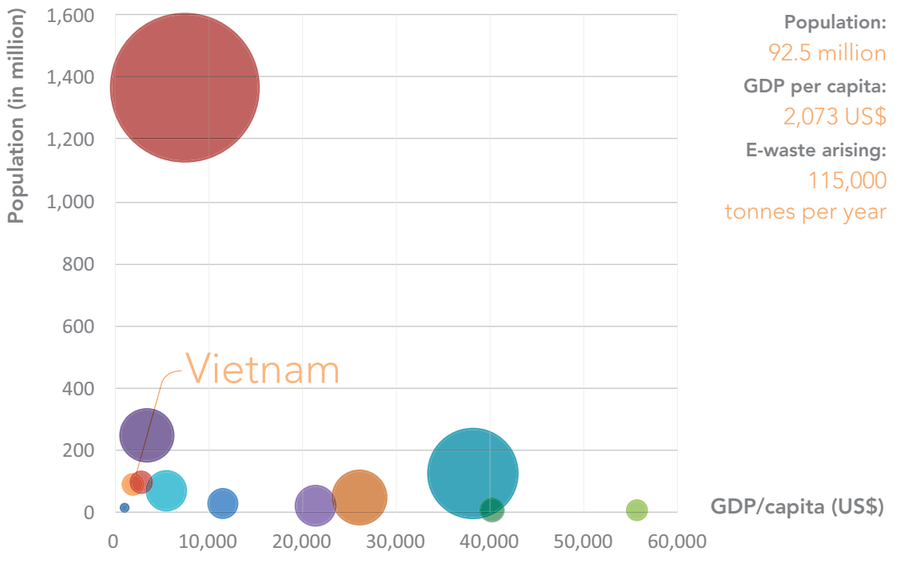


Figure 31: Population, GDP per capita and E-waste arising, Vietnam, 2014

is one of the lowest per capita e-waste generation rates in the region, with only neighbouring Cambodia being lower.

With political stability, Vietnam has seen rapid growth and development, including an increase in the consumption of durable goods. Though volumes are still low, e-waste is a growing

waste stream, as ownership of EEE has increased while use time has decreased. Under the aegis of the Basel Convention's Asian E-waste Project, funded by Ministry of the Environment, Japan (MoEJ), Japan, the first inventory study was carried out in 2006. The study showed that around 8,803 tonnes of electronic waste were generated in 2006; whereas, according to the Vietnam Environment Administration (VEA), around 12,000 tonnes of e-waste are produced per year. This includes illegal imports of e-waste shipped from other countries. The discrepancy in the actual volumes of waste shows the result of a lack of official records, ineffective monitoring of imported and locally generated waste, and unaccounted potential sources of waste.

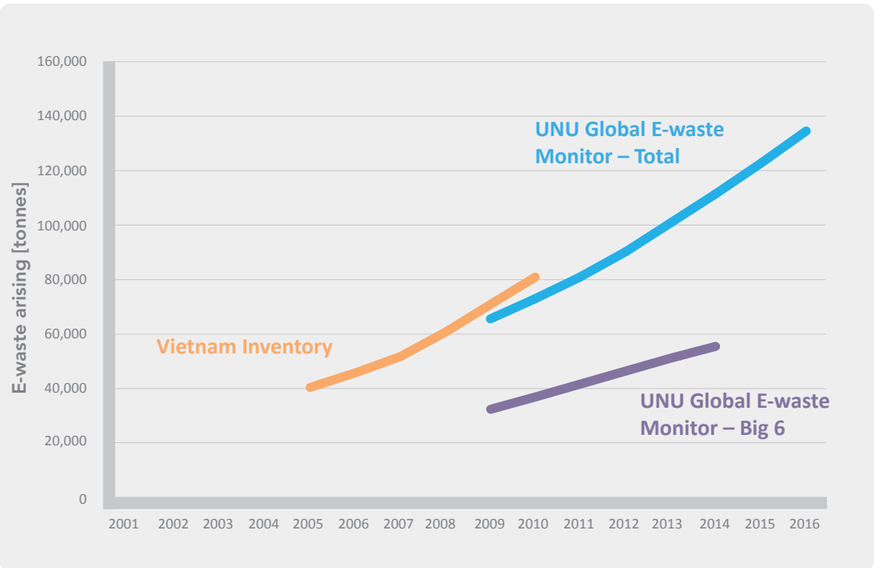


Figure 32: E-waste arising in Vietnam

The Basel Convention was ratified by Vietnam in 1995; however, the country has yet to adopt the Ban Amendment, which would prevent it from accepting hazardous waste from and exporting it to other countries. Passed in May 2015, Decision No.16 stipulates that from July 2016 EOL products such as personal computers, laptops, mobile phones and major home appliances including TVs, fridges, air conditioners and washing machines must be taken back and recycled. Based on EPR, it makes producers responsible for setting up collection, take-back and sound recycling. Yet, both illegal imports of e-waste and informal recycling activities that are hazardous to the environment and human health continue.

Second-hand markets for electronics are important for many Vietnamese citizens, who cannot afford to buy the latest electronics but who would like to maintain a lifestyle that heavily relies on information technology. Because of this demand, second-hand markets including refurbishment, repair and production of discarded electronics are more established than waste industries, including e-waste recycling.

There is extensive informal business and trade going on without much control and consideration for the environment. Awareness about both the environmental damage caused by the current practices, and the value contained in the EEE is generally very low. The current recycling system is a cherry-picking practice by which only those materials that are of known value are recycled and/or traded, with limited disassembly. This process frequently takes place in the black market. It is said that much of the valuable material is going to China, while material of little or no value is dumped into the environment.

While around 150 facilities in Vietnam have been licensed by the VEA to collect and treat hazardous waste of all kinds, only 15 of them are equipped with the proper technology to dismantle and recycle e-waste.[90] Bulk generators, such as hotels, factories and offices,

90 "Current Status of E-Waste in Vietnam and Future Goals," Vietnam Environment Administration, Hanoi July 2014

sell most of their e-waste to these formal facilities, while households and small generators usually sell their e-waste to informal collectors. Most of this e-waste is then dismantled, and the operational parts are resold in the refurbished or repair markets. The residual unusable components are then disposed into neighbouring landfills. Around 80 to 90 per cent of used EEE are sent for repair and refurbishing, while the leftover 10 to 20 per cent of the products are dismantled and recycled manually in craft villages of Vietnam.[91]

Such activities not only cause pollution, but they also harm the economy of the country by stimulating a large black market where the recycled material is sold or traded. While most of the recycled material is sent to China, the residues are dumped in nature[92]. E-waste residue from the recycling process ranges from 5 to 30 per cent of the volume of the actual electronic product depending on the type. E-waste recycling practices occur in approximately 90 of a total of 1,450 rural craft villages.[93]

As Vietnam experiences an increase in electronics manufacturing industries, there is a pressing need for a dedicated e-waste management law requiring manufacturers to apply global policies on producer responsibility principles.

91 "Final Report on Service Contract: On Provision of Consulting Services for the Development of e-waste inventory in Vietnam," URENCO Environment, Vietnam, July 2007

92 "E-waste management in Vietnam. SIDA PDC Grant," Progress Report 1, http://www.georange.se/upl/files/83953.pdf

93 See URENCO Environment, note 90 above

The top five producers represent 80 to 90 per cent of the market share for each product. The only exception is PCs; where assembled, no-brand PCs are dominant with a 35 per cent market share.

Product	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
TVs	Samsung	Sony	LG	Panasonic	Sharp
PCs	Assembled	Acer	HP	Mekong	Toshiba
Mobile Phones	Nokia	Motorola	Sony Ericsson	Samsung	
Refrigerators	Samsung	LG	National	Panasonic	Sanyo
Air-Conditioning	LG	Samsung	National	Panasonic	Funikin
Washing Machines	Samsung	LG	Panasonic	National	Electrolux

Table 25: Ranking of producers by market share

Vietnam's unique craft villages

During the off season, agricultural workers engage in activities other than farming, such as the production of textiles, handicrafts and porcelain and ceramic work, as well as silk reeling and waste recycling. Additionally, around 13 per cent of other rural households rely on these activities to make a living throughout the year.

These craft villages support around 10 million workers and have become a significant source of income for agricultural households. They are spread across Vietnam, where approximately 90 such villages are engaged in waste recycling activities, primarily in northern Vietnam, with 61 villages; central Vietnam, with 25 villages; and southern Vietnam, with 5 villages.

Most of these craft villages are small and they have fragmented operations, use manual and obsolete technologies, and lack the understanding of health and environmental impacts caused by their activities.

Country type

Pillar	Stage	Description
Legal Framework	Medium	• Although the Basel Convention has been ratified, Vietnam is not yet party to the Ban Amendment. • Regulations on the Recovery, Processing and Disposal of Waste Products, Decision No. 50/2013/QD-TTg, that aim at environmentally safe management of e-waste preceded the Regulations on the recovery, processing waste products that came in force from July 2015. • Though e-waste imports are prohibited under Decision No. 20/2006/QD-BBCVT, national waste trade agreements Decision No. 12/2006/QD-BTNMT and Decree no. 12/2006/ND-CP allow scrap materials to be imported as secondary materials for industrial production. They also provide guidelines on implementation of trade laws on temporary importation and re-exportation of commodities (including e-waste). The guiding articles for the Decree No.187/2013/ND-CP regarding the import and export of used information technology products provides the list of banned information technology products. • Regulations on Hazardous Waste Management in force since September 2015 Other relevant legislation and regulations • Chapter VIII of Law on Environmental Protection (1994) stipulates waste management and introduces producer responsibility to recover discarded products including electronic and electric equipment. • Supplemental regulation: List of Hazardous Waste (2006) lists e-waste as a hazardous waste. • Supplemental regulation: Regulation on Companies Engaging in Hazardous Waste Generation, Transportation and Disposal requires a hazardous waste generator to register with a local Office for Natural Resources and Environment, and a hazardous transporter and disposer to apply for a professional license. • National Technical Regulation on Hazardous Waste Thresholds (2009) • The Prime Minister's Decision for the Regulation on Management of Hazardous Waste (1995) prescribes the environmentally sound management of hazardous waste.
Collection Mechanism	Low	Domestic and small businesses sell their e-waste to informal collectors, whereas formal recyclers are able to intercept e-waste only from big organizations.
Processing Infrastructure	Low	Vietnam has an active repair and refurbishment market; however, the country currently does not have the technical capacity to treat e-waste on a large scale. Only 15 companies are authorized to recycle e-waste, and the quantity of waste input received (around 2.5 tonnes per day) is significantly below the capacity for plants to operate profitably[94]. Most of the e-waste is manually recycled in approximately 90 craft villages, which use manual techniques to sort, pre-process, melt and cast the metals from e-waste. The Urban Environment Company (URENCO) is a state-owned company in each province/city that is responsible for collecting and treating waste in Vietnam. URENCO in Hanoi has treated e-waste on an experimental basis since 2009.
EHS Standards	Low	There is an absence of EHS standards in craft villages and no use of masks or safety gear while treating e-waste with chemicals. Wastewater and effluents are discharged into nearby rivers, causing extreme pollution. Residues such as CRT glass and PCBs are then either disposed in open, unmonitored dumps or landfills, or incinerated. Part of e-waste used for energy recovery is incinerated at private facilities that do not comply with national standards.[95] Only two authorized incineration facilities exist in Vietnam.

Table 26: E-waste Management Matrix, Vietnam

94 See Vietnam Environment Administration, https://www.epa.gov/sites/production/files/2014-08/documents/vietnam_country_presentation_1.pdf

95 See URENCO Environment, note 90, at p.174, https://www.epa.gov/sites/production/files/2014-08/documents/vietnam_country_presentation_2-_prof._hai.pdf

Stakeholder map

Various stakeholders in e-waste management in Vietnam are:

Stakeholder		Responsibility
VEA – Ministry of Natural Resources and Environment (MoNRE)	www.monre.gov.vn/wps/portal/english	Formulates legislation on environmentally safe management of e-waste, guiding the application of environmental standards, approving impact assessment reports related to treatment of e-waste. Also includes inspection of recycling facilities, planning of landfills, raising public awareness campaigns.
Ministry of Health	http://www.moh.gov.vn/homebyt/en/portal/index.jsp	Assesses human health impacts of e-waste recycling.
Ministry of Industry and Trade		Supervises and assists industries with managing e-waste, and regulating illegal imports of e-waste and other scrap material sent for recycling.
Ministry of Police, Local Authorities		Regulates transboundary movement of e-waste.
Ministry of Environment, Japan		Funds inventory studies, seminars on public awareness, pilot schemes on collection, evaluation and segregation of e-waste, national workshops, and research on technologies and practices for repair and recycling of end-of-life EEE in Vietnam.
Swedish International Development Agency (SIDA)		Provides assistance to MoNRE on e-waste management issues regarding legislation, recycling techniques and strengthening collection systems.
Formal recyclers (eg. Tes AMM and MRT Recyclers)		Work in association with international agencies to support projects on improving e-waste management system in Vietnam. Provide environmentally sound recycling and disposal.
Informal e-waste collectors and recyclers		Participate in door-to-door collection services, scavenging for e-waste from municipal waste and informal dismantling, recycling and disposal activities
Multinational OEMs (eg. Nokia, Ericsson, Samsung)		Support producer partners and provide technical assistance, for example, the SIDA project.

Table 27: Key Stakeholders, Vietnam

E-waste worker in Vietnam [MOEJ]

Type 4: **Informal Initiative** – Cambodia, Indonesia and Thailand with Type 2

Cambodia, Indonesia and Thailand have yet to establish legal frameworks for e-waste management. However, there is an active informal sector in these countries with an established network for collection and import of end-of-life products and their recycling, particularly repair, refurbishment and parts harvesting.

Informal recycler in Phonon Penh, Cambodia [MOEJ]

10. Cambodia

Country profile

The Kingdom of Cambodia borders Thailand, Vietnam and Laos and has a population of 15.2 million people.[96] The country's economy has been growing strongly for the past decade, and its GDP per capita has increased from US$ 200 in 1992 to US$ 1,108 in 2014.[97] Phnom Penh, the capital, is the most populated city, with 1.55 million residents. Approximately 55.8 per cent of Cambodia's total population is involved in agricultural activities.

The e-waste situation in Cambodia

As in other developing countries, there is a burgeoning demand for gadgets and appliances in Cambodia, driven by a more affluent and growing middle class. In the absence of domestic manufacturing, most electronics, both new and used, are imported into Cambodia. In addition to domestically circulated second-hand products, which are sold through the informal sector, a major source of used EEE is the Guangzhou region of China, which has an active repair and refurbished products industry.

Currently, Cambodia has no specific laws mandating environmentally safe management

96 United Nations, Department of Economic and Social Affairs, Population Division (2014)

97 International Monetary Fund, World Economic Outlook Database, October 2014. Available from https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

E-waste per capita

1.1 kg

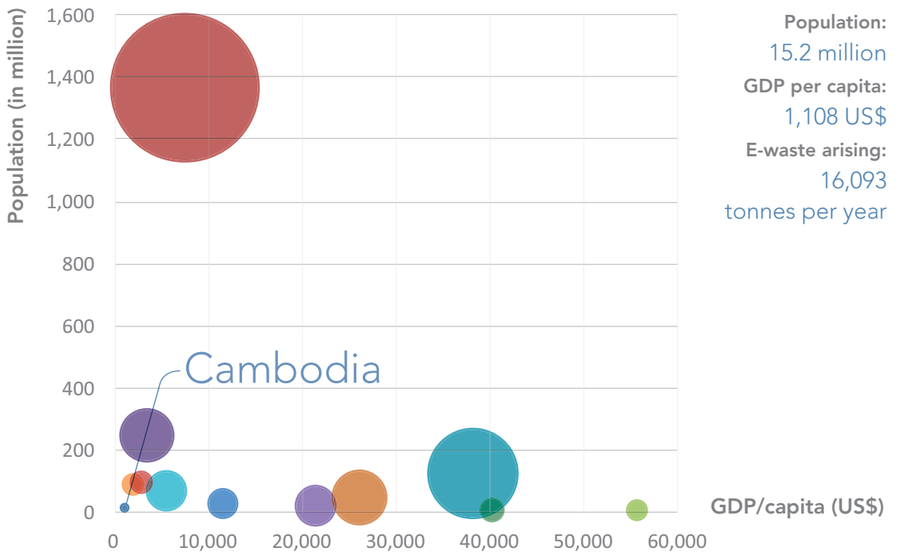


Figure 33: Population, GDP per capita and E-waste arising, Cambodia, 2014

of e-waste. Although it ratified the Basel Convention in 2001, it is not yet party to the Ban Amendment. However, it does have an import ban, with Article 21 of the Sub-Decree on Solid Waste Management prohibiting the import of hazardous waste from other countries into the Kingdom. Nevertheless, although e-waste imports are banned, illegal imports continue.

E-waste is individually retrieved by informal sector collectors who sell it either to repair

shops for dismantling or to waste traders. The reusable parts are kept for sale, and the recyclable materials are then sold to local scrap yard owners for export. The residues left after the extraction of reusable components, and recyclable materials are then disposed of through municipal waste systems, burned by owners or discarded in dumpsites or landfills.[98] In recent years, through various projects and pilots, the Ministry of Environment, Cambodia (MOEC) has worked with the informal sectors to upgrade their methods and techniques for

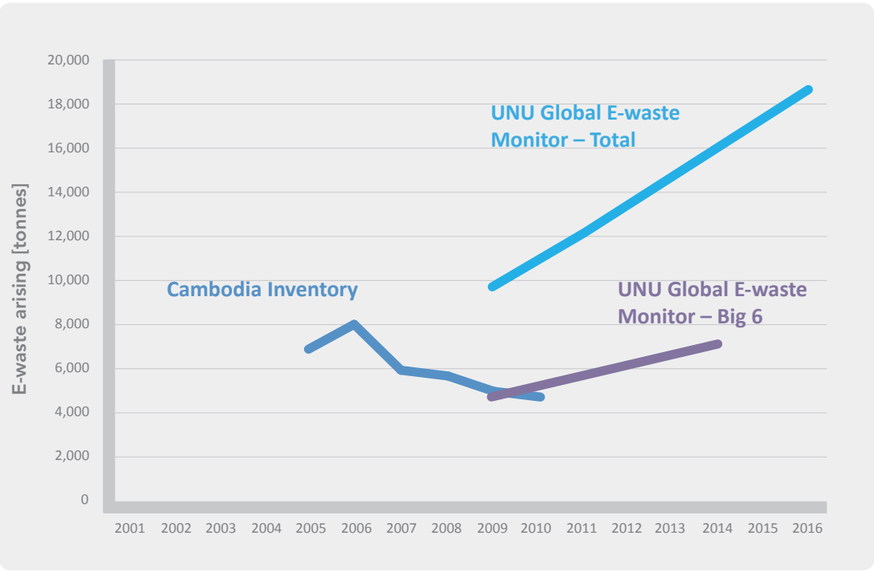


Figure 34: E-waste arising in Cambodia

98 "Technical Report on National Inventory of used of EEE in Cambodia," CEA, http://www.env.go.jp/en/recycle/asian_net/Project_N_Research/E-wasteProject/01.pdf

environmentally sound management of e-waste and has developed a strategy for developing a national e-waste management system, taking into account the informal e-waste sector.

Country type

Pillar	Stage	Description
Legal Framework	Low	Although Cambodia has not issued any laws or regulations for e-waste management (including recycling), the Ministry of Environment, Cambodia, plans to develop a new sub-decree on e-waste management under Law on Environmental Protection and Natural Resource Management. The relevant laws for ESM management of e-waste currently in place are: • Law on Environmental Protection and National Resource Management (December 1996) stipulates the "prevention, reduction, control of airspace, water and land pollution, noise and vibration disturbances as well as waste, toxic substances and hazardous substances". • Sub-decree on Solid Waste Management (April 1999) covers all activities related to disposal, storage, collection, transport, recycling and dumping of garbage and hazardous waste. In this annex of the sub-decree, hazardous waste includes metal waste and the compounds found in e-waste; waste from used or discarded electric lamps; and PCBs from microwave ovens, air conditioners and TVs. In particular, Articles 15, 20 and 21 are the most relevant for e-waste. • Article 8 of Sub-decree on Water Pollution Control stipulates that the disposal of solid waste, garbage and hazardous substances into public water areas or drainage systems shall be strictly prohibited. The storage or disposal of solid waste, garbage and hazardous substances that lead to water pollution shall be strictly prohibited. • Sub-decree on Air Pollution and Noise Disturbance stipulates the strict monitoring of emissions from used electrical and electronic equipment and/or electrical and electronic waste burning. Lack of awareness and knowledge of these laws among implementing officials renders their enforcement ineffective.
Collection Mechanism	Low	E-waste is individually collected by waste-pickers, who transport it by handcart, bicycle, motorcycle or small trucks to either repair shops for dismantling or to waste traders.

Processing Infrastructure	Low	Dismantling and recycling take place largely in the informal sector, mostly manually. Few repair shops and recyclers in Phnom Penh use pumping machines to extract gases from air conditioners and refrigerators. No formal e-waste recycling facilities exist. A “repair and recycling shop” is a kind of a second-hand shop; they buy used equipment for repair and resale, including components and parts that can be used as spares. However, they do not engage in material recovery activities.
EHS Standards	Low	There is a lack of awareness regarding safety and environment during e-waste management. There is no mandate on wearing safety gear during dismantling processes, which has led to several accidents. Free discharge of toxic gases into the atmosphere from equipment results in health and environmental hazards. Residues are burned in dumpsites or disposed of in public places, causing extreme ground, water and air pollution.

Table 28: E-waste Management Matrix, Cambodia

Stakeholder map:

Stakeholder		Responsibility/Activities
Ministry of Environment; Department of Pollution Control	http://www.moe.gov.kh/	Involved in the assessment of e-waste inventory, formulation of e-waste legislation, guidance on environmental standards and impact assessment for e-waste treatment. Also includes inspection of recycling facilities, planning of landfills and raising public awareness campaigns.
Department of Customs and Excises	http://www.customs.gov.kh/	Responsible for checking and monitoring flows of new and used electronics and e-waste.
Waste importers, exporters		Informal sector that is involved in receiving or sending used electronic equipment from and to other countries for further use, repair or recycling.
Informal e-waste collectors		Provide door-to-door collection services to households and businesses.
Repair shops		Small and micro-scale enterprises, often in the informal sector, who repair, refurbish and dismantle electronic products.
Informal e-waste recyclers		Often backyard businesses applying crude methods for harvesting some precious from e-waste
International development cooperation (Ministry of Environment, Japan; JICA, Korea International Cooperation Agency (KOICA))		Fund capacity building programs, inventory programs and pilot projects.
UN Environment, International Environmental Technology Centre (IETC)		Support capacity building and pilot projects on environmentally sound management (ESM) of e-waste.
UNIDO		Leading KOICA/Samsung-funded project on capacity building and green economy through ESM of e-waste.
Multinational OEMs (e.g. Samsung)		Provide funding and OEM activities in Cambodia. Collaborate on a project with UNIDO on e-waste management.

Table 29: Key Stakeholders, Cambodia

International Development Cooperation Projects on e-waste in Cambodia

Ministry of Environment, Japan supported projects in collaboration with the Ministry of Environment, Cambodia (MOEC) including:

- Development of national e-waste inventory including identifying imports, consumption and disposal patterns, and current e-waste treatment practices (Cambodia Environmental Association, 2007).
- Development of a draft Sub-decree on E-waste Management in order to achieve the goal of effective, environmentally sound e-waste management in Cambodia. Project duration: December 2012-2014.

UN Environment, International Environmental Technology Centre (IETC) supported projects in collaboration with MOEC and local partners including:

- Comprehensive pilot project for e-waste management in the Phnom Penh Municipality (Ministry of Environment, Cambodia, 2009).
- Training courses on the environmentally sound management of electrical and electronic waste in Cambodia (Ministry of Environment, Cambodia, 2008).
- Training programme on e-waste and demonstration of environmentally sound management of e-waste at the recyclable waste collecting site (Ministry of Environment, Cambodia, 2011).

Korea International Cooperation Agency (KOICA) supported a project in collaboration with UNIDO and Samsung Electronics to build capacity through skill development for repair and refurbishment activities, and support the local economy by creating opportunities for green businesses.[99]

99 "UNIDO-Samsung: Transforming e-waste into job and business opportunities," http://www.unido.org/fileadmin/user_media/Services/PSD/UNIDO_business_partnerships/Samsung_2013.pdf

Informal recycler in Phonon Penh [MOEJ]

11. Indonesia

Country profile

The Indonesian islands lie between the Indian Ocean and the Pacific Ocean in Southeast Asia. With a population of around 251 million, Indonesia is the fifth-most populated country in the world, and the population continues to grow at a rate of annually 1.04 per cent.[100] The nation consists of 17,508 islands, about 6,000 of which are inhabited.[101] Jakarta, its capital and largest city, lies on the island of Java. The other major urban areas are Surabaya, Bandung, Medan, Semarang and Palembang.[102] Around 50.7 per cent of the total population live inurban areas, and 58 per cent of the total country's population live onthe island of Java. Indonesia's GDP per capita is about US$ 3,404[103] with the industry sector accounting for 46.4 per cent of the country's total GDP.[104]

The e-waste situation in Indonesia

The production of electrical appliances is one of Indonesia's major industries, and these appliances form a large portion of the country's export commodities. Two-hundred and fifty

100 http://worldpopulationreview.com/countries/indonesia-population/
101 Indonesia", CIA Retrieved 10 April 2011
102 See World Factbook, note 1 above
103 "International Monetory Fund", November 2014
104 "Indonesia Economy Profile 2011", indexmundi.com Retrieved 10 April 2011

E-waste per capita
2.9 kg

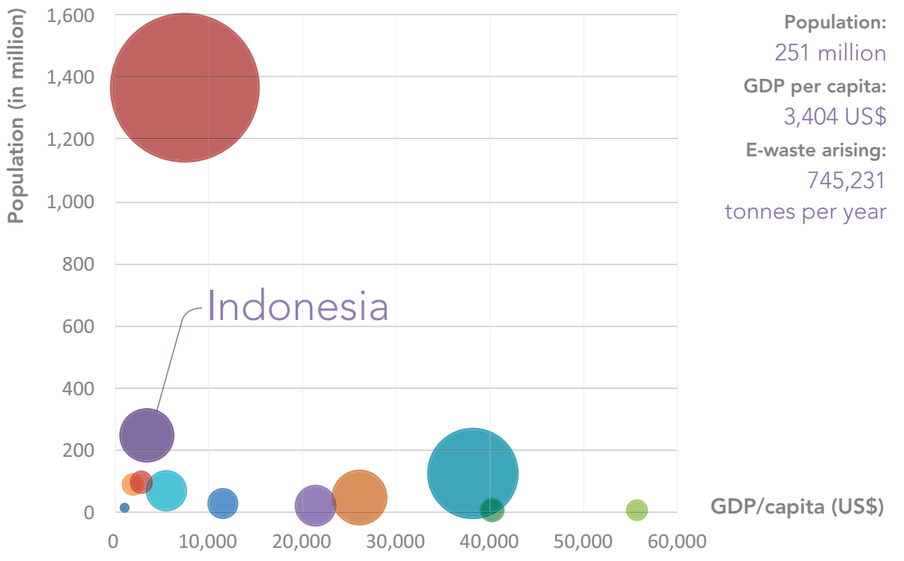


Figure 35: Population, GDP per capita and E-waste arising, Indonesia, 2014

electronics and components producers are located in the country. International electronics brands dominate the higher-end digital electronics sector, but Indonesian brands are highly competitive in the domestic market within the low- to middle-end technology sector for goods that suit the purchasing power of the mass market. In order to take advantage of the country's consumer market and use it to serve as an entry point for the Association of Southeast

Asian Nations (ASEAN) region, international electronics manufacturers are beginning to bolster their presence in the Indonesian market by setting up new factories and production plants there. The Indonesian Electronics Association forecasted a 20 per cent rate of growth in domestic electronics sales for 2012 (excluding cell phones and computer hardware).[105]

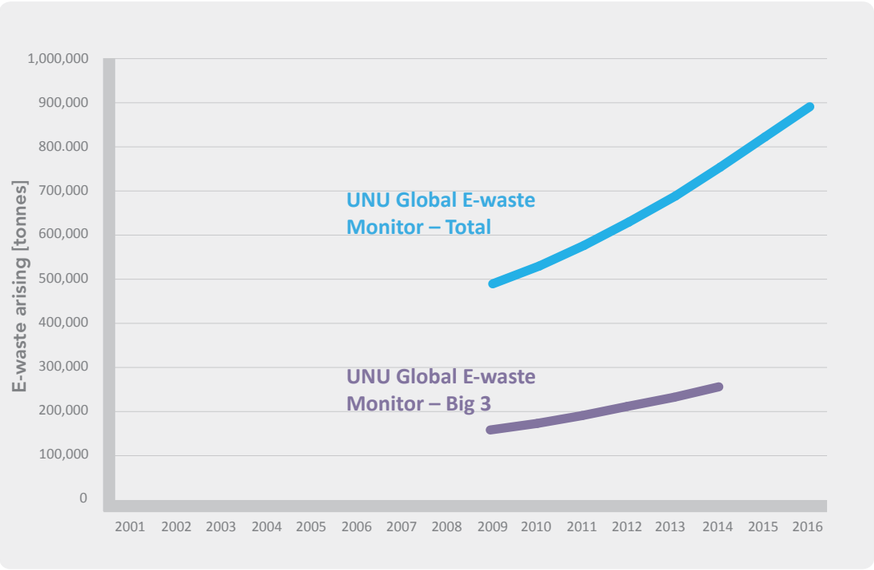


Figure 36: E-waste arising in Indonesia

Indonesia has a large and growing electronics sector, driven by greater consumer demand, especially for mobile phones and computers, also partly due to lower priced used EEE imports. By some estimates, around 40 per cent of electronic devices sold in Indonesia are illegal imports. In addition to the absence of effective control of illegal imports, there is no regulation for managing the e-waste generated locally.

105 "Manufacturing | Indonesia's Electronics and Home Appliances Sector", Global Business Guide Indonesia. 2013

Indonesia has been party to the Basel Convention since 1993, and the country ratified the Ban Amendment in 2005. However, illegal imports of e-waste continues using various methods, including falsely declaring e-waste as raw materials, materials for reconditioning and/or reuse or materials for charity. Batam Island, which has 65 sea ports, is a key point of e-waste import. This is largely due to the fact that it is exempt from many of Indonesia's import and export laws, making it an ideal destination for e-waste specially from Singapore and Malaysia.[106] Imports of used and waste electronics have also been reported via Pare-Pare and Wakatobi Islands on the eastern seaboard.[107,108] There is also an active trade in e-waste from Indonesia to China and Hong Kong, largely for recycling. Residues that do not have value and cannot be exported or processed are either burned in open areas or dumped in landfills for disposal.

There are a few limited collection centres provided by some international producers, however these are limited to voluntary initiatives. Without any options for proper disposal and recycling coupled with low consumer awareness of proper e-waste treatment, had led to very minimal collection through formal collection and channels. As in many other developing countries, the collection and recycling of e-waste takes place in the informal sector. Within the informal sector, there is a clear hierarchy, of five main types of actors: scavengers, aggregators, classifiers, processors and recyclers. Households sell their e-waste to scavengers through informal transactions, while institutions (such as universities and government organizations) sell their waste to classifiers. Classifiers maintain networks with institutions and auction

106 Leslie Young, "The global trade in electronic waste" http://www.pbs.org/frontlineworld/stories/ghana804/map/map.html

107 Agustina H, "The challenges of E-waste management (Indonesian experience). In: E-waste management workshop on take-back system", Osaka, Japan: UN Environment-DTIE-IETC. 2011

108 Ministry of Environment, "Project report: electronic waste in Indonesia", Basel Convention, UNEP. 2009

houses in the city. Aggregators collect e-waste from scavengers, sort it and then sell it to classifiers. E-waste is then dismantled and reused in repair and refurbishment markets while its non-functional components are discarded in public dumpsters. Those components are either picked up by scavengers or end up in landfills. Classified items are then sold to various processing industries and onward to recyclers that recover and/or recycle raw materials for industry supplies.[109] None of these informal recycling facilities completes any special treatment process in order to isolate precious content from e-waste. Workers in the classifying business are exposed to harmful impacts of improper manual dismantling techniques. Further, only limited facilities in East Java have conducted thermal or melting processes, but the processes are not sufficiently specialized to refine the precious content of e-waste such as gold or silver, which are present in a small quantity of parts or components. Thermal processes employed in these facilities are only performed in order to form ingot or metal bars from scraps upon buyers' requests. In fact, recycling facilities visited generally only conduct metal separation and packing, and no chemical or thermal process are employed.

As Indonesia is increasingly attracting electronics manufacturers to set up plants in the country, there is a dire need to address the e-waste issue with specific e-waste legislation that clearly defines the term "e-waste", the scope of its collection and recycling, and the stakeholders involved. Given the quantity of international manufacturers in Indonesia, the Ministry of Environment is looking to base the law on the EPR principle, assigning the responsibility of taking care of the product at end-of-life to the manufacturers. Ministry of Environment Indonesia has plans to implement further project activities based on the outcomes of the project on preliminary inventory.

109 Fauziah Rochman, "E-waste in Indonesia: The case of personal computers", Tropical Resources 29(2010), 71-77.

Country type

Pillar	Stage	Description
Legal Framework	Low	No specific e-waste management law exists in Indonesia. Although the country has acceded to the Basel Convention and ratified the Ban Amendment, illegal e-waste imports continue. • E-waste is not defined by law and falls under hazardous waste regulation, Government Regulation No. 18/1999 and No. 85/1999, concerning Hazardous Waste Management. The Hazardous Waste Management Regulation Act No. 32/2009 defines hazardous waste management as an activity covering the reduction, storage, collection, transportation and/or its piling. According to Article 59 of this Act, the producer of hazardous waste is legally bound to treat it. Treatment of hazardous waste needs to be a done by a licensed entity. • According to Act No. 32/2009, Article 69 point 1, import of hazardous waste is prohibited into the country. • Under the Ministry of Trade Decree No. 48/2011 concerning the import of second-hand computers and monitors, Article 12 states the conditions under which the imports of the above items are allowed. On the 30 May 2016 the Indonesian Ministry of Trade approved Regulation 41/2016 on the amendment of Regulation No. 82/2012 on import requirements for cellular phones, handheld computers, and tablet computers[110]. A draft on Ministerial Decree for Indonesia National E-waste Management which is based on the EPR principle is being developed.
Collection Mechanism	Low	Most of the country's e-waste is collected by informal collectors or scavengers and classifiers.[111] Households sell e-waste to scavengers, and institutions sell it to classifiers. Scavengers sell the e-waste to aggregators who sort the waste and sell it to classifiers for further processing. Six formal collection facilities in Java and one in Tangerang collect e-waste from household communities and institutions, segregate it, pack and send it out for export or domestic sale.[112]
Processing Infrastructure	Low	Informal classifiers are involved in manual dismantling and reusing components, which is hazardous to health. Unusable parts are dumped into landfills or incinerated. The classified and sorted items are then recycled for material recovery by processors and recyclers. Three formal recyclers are reported to have reconditioning and smelting facilities in Java, and there is one dismantling facility and a few smelting facilities in Batam Island.

Table 30: E-waste Management Matrix, Indonesia

footnotes 110, 111, 112, see on page 196

EHS Standards	Low	There is currently a lack of environmental and safety compliance in the informal sector. Classifiers do not take any safety precautions while manually dismantling electronic products. Residues generated post dismantling and recycling processes are either dumped in landfills or burned in open areas, causing extreme soil, water and air pollution.

Stakeholder map

Stakeholder		Responsibility
Ministry of Environment	http://www.menlh.go.id	To issue policies and regulations of e-waste management. Currently, government bodies are considered as a separate entity andare not involved in any stage of e-waste management in Indonesia. The Ministry is the competent authority for the Basel Convention in Indonesia.
Department of Cleaning and Gardening, Manado		To manage of all kinds of waste in the region of Manado, Indonesia.
Ministry of Trade	http://www.kemendag.go.id/en	To issue policies regarding the imports and export of electronics and e-waste and monitor these activities.
Customs Department	http://www.beacukai.go.id/websitenew/index.html	To inspect and enforce legislation on import and export of goods, including illegal imports of e-waste.
Chamber of Commerce and Industry	http://www.bsd-kadin.org	To promote sustainable trade and industry.
National and international original equipment manufacturers and importers/distributers		Offer voluntary take back of their products to channelize them for proper recycling, although they are not legally bound to do so in the absence of EPR-based legislation.

Table 31: Key Stakeholders, Indonesia

110 Compliance and Risks (page 195)

111 Haruki Agustina, "The challenges of e-waste management (Indonesian Experience)", Ministry of Environment, Indonesia, E-waste Management Workshop, 13-15 July, 2011, Osaka , Japan (page 195)

112 "Ministry of Environment", Indonesia, http://www2.epa.gov/sites/production/files/2014-05/documents/indonesia.pdf

Wires for recycling, China
[Yvan Schulz]

12. Thailand

Country profile

The Kingdom of Thailand lies at the centre of the Indochina peninsula in Southeast Asia. The country of 68.5 million[113] borders Myanmar and Laos to the north, Cambodia to the east, Gulf of Thailand and Malaysia to the south and the Andaman Sea to the west. Over 30 per cent of the country is urbanized, and the major urban areas include the capital Bangkok and the city of Samut Prakan. Thailand has a high Human Development Index and ranks second in quality of life among the 10 ASEAN countries.[114] Thailand has shown robust economic growth in the past two decades, with an economy that is highly reliant on exports, particularly of electric appliances and components. The EEE manufacturing industry forms 8 per cent of all industry in Thailand, with Thailand seen as a export hub for many multinationals, making it for example rank second in world-wide production of hard disk drives.[115]

The rapidly growing economy is not only a large manufacturer, but also an expanding market for EEE, with national and international manufacturers vying for market share. Unsurprisingly, there is a large and increasing volume of e-waste being generated. The first

113 United Nations, Department of Economic and Social Affairs, Population Division (2014)

114 Orapa Chueyprasit; Chaite Naasiri (27 March 2014). "Thailand ranks 2nd in ASEAN for the best quality of life". National News Bureau of Thailand. Retrieved 28 March 2014.

115 Industry Week: Advancing the Business of Manufacturing "Thailand's manufacturing growth," http://www.industryweek.com/thailand

E-waste per capita
6.1 kg

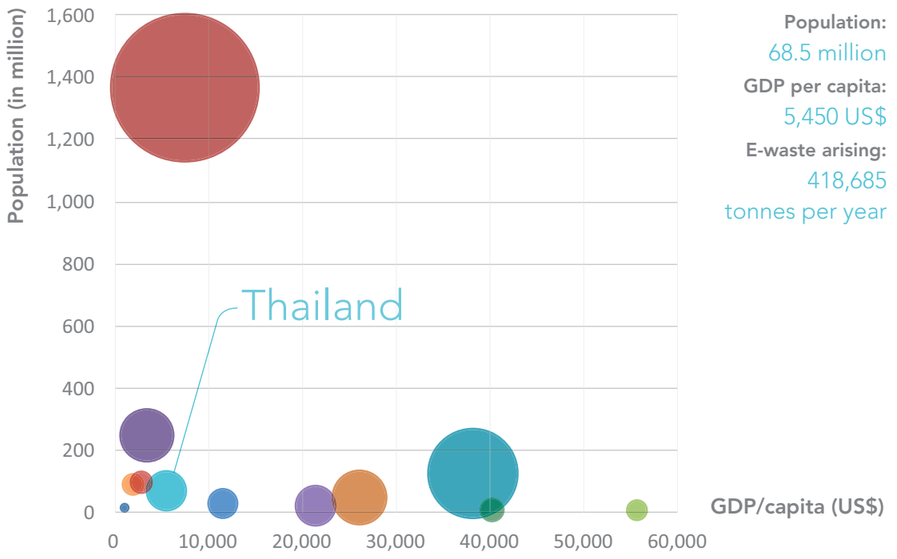


Figure 37: Population, GDP per capita and E-waste arising, Thailand, 2014

national inventory, conducted by the Thai Electrical and Electronics Institute in 2006-2007, under the aegis of the Japanese funded Asia E-waste Project, estimated around 1 million TVs, 3 million PCs and over 400,000 refrigerators alone being generated as e-waste in 2015.[116] Another estimate by the Department of Industrial Works (DIW) estimated 20,000 tonnes from

116 Electrical and Electronics Institute, Thailand, "Development of e-waste inventory in Thailand," 2007.

EEE manufacturers alone in 2009.[117] The most recent estimates, by the PCD in 2010 estimated more than 300,000 tonnes of e-waste from 15 million units across 10 product categories being generated annually in Thailand.[118] According to the PCD study, almost 51.3 per cent of the country's total e-waste is sold to informal sector or junk shops, 25.3 per cent is stored by consumers, 15.6 per cent is disposed of along with other wastes and 7.8 per cent is donated to given to relatives for further use.

Most of the e-waste generated is collected and processed by waste collectors and pickers,

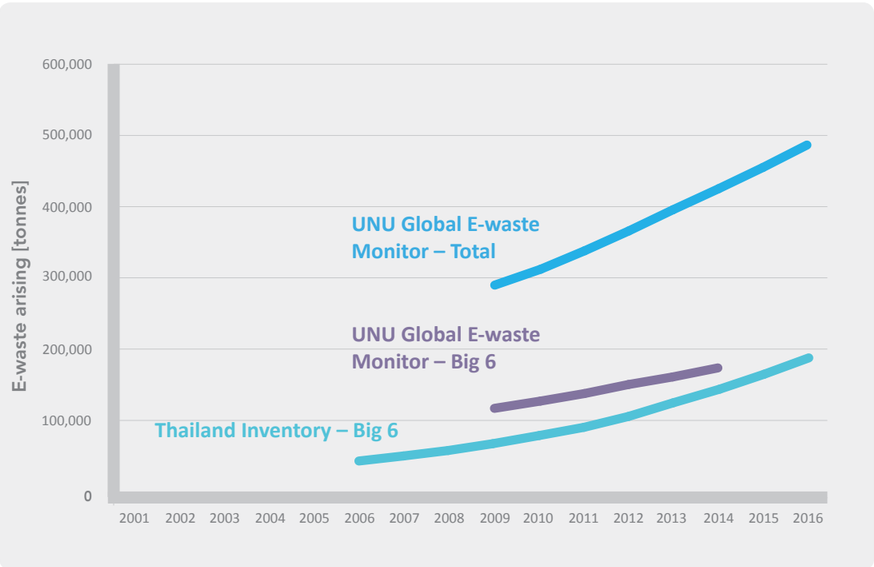


Figure 38: E-waste arising in Thailand

117 Taweechai Jiaranaikhajorn, "WEEE Management Policy update from Thailand," PCD, July 17, 2013
118 ibid

traders, junk shops, recyclers and re-processors in the informal sector – who use hazardous techniques to dismantle and recycle the e-waste collected from households and offices. The residues are either disposed of in the municipal waste stream or burned in the open.

Occasionally, e-waste is donated to charity organizations such as the Suan Keaw Temple, where the products are refurbished and resold to the public. The purpose of such an organization is to generate work for those living in nearby communities.[119]

Collection services are also offered by the Local Administration Office, however the collected quantities are extremely low and usually end up being disposed in landfills. Apart from the informal sector and small formal recycling firms, bigger companies like Uni Copper Trade, Wongpanit Co. Ltd. and the General Environmental Conservation Public Co., Ltd. (Genco), offer recycling services in the country.[120]

Tricyclers: One of the oldest traditional methods to discard obsolete products was to give it to "tricyclers". Tri-cyclers are private individuals who go from door to door collecting various wastes. They perform a basic sorting service, separating recyclables such paper, glass, plastic, and metal. Products that may be in reasonably good condition may be sold to repair shops or second-hand shops. The recyclables are sold to various traders and junk shops. By some estimates, there are around 9,000 junk shops in Thailand. Non-valuable parts are discarded into municipal waste[121].

A few take-back initiatives have been launched by international companies, such as Toshiba and Nokia, that take back e-waste from certain organizations.

119 See Electrical and Electronics Institute, note 116 above
120 See Electrical and Electronics Institute, note 118 above
121 See Electrical and Electronics Institute, note 116 above

Country type

Pillar	Stage	Description
Legal Framework	Low	No specific law for e-waste management exists in Thailand. A draft of legislation, known as the Thai Draft WEEE Bill proposed in November 2014, was based on EPR principles. However, until 2016 at the time of publication, this Bill was not passed. The country is party to the Basel Convention but not to the Ban Amendment. E-waste management falls under the Hazardous Substance Act B.E 2535 (1992) and its amendment B.E 2556 (2013). E-waste falls under the following categories under the act: • No. 5.2 category: Chemical Wastes, type 3 must obtain a permit from Department of Industrial Works. • No. 5.3 category: Used EE Appliance, type 3 is exempted from getting a permit and registration but it is required for importing used EEE.
Collection Mechanism	Low	Limited collection services for e-waste are offered by municipalities and local administration offices. However, most of the household e-waste is collected by the informal sector. Some international e-waste recyclers offer collection services to businesses and industrial users,
Processing Infrastructure	Low	Between 2010 and 2011, formal e-waste recycling/dismantling facilities permitted to recycle e-waste in Thailand went from 22 to 41[122, 123]. Factories use manual techniques and simple tools to dismantle e-waste, as they lack formal dismantling technology. Only limited metal recovery is achieved in Thailand, mainly iron, copper and aluminum.
EHS Standards	Low	According to the Factory Act B.E. 2535, e-waste management facilities are classified as: • Factory type 105: sorting or landfilling facility of wastes • Factory type 106: recycling facility in which unusable industrial products or industrial wastes are utilized to produce raw material or new product. The there is little monitoring or control of environment, safety or health standards in either the formal or the informal sector. There are no measures to protect informal recyclers from inhaling toxic dust and fumes while dismantling and burning electronic waste in order to recover precious metals.

Table 32: E-waste Management Matrix, Thailand

122 ibid
123 Pornpimon Chaeronsong, "E-waste Management in Thailand", PCD, July 2014

Stakeholder map

Stakeholder	Responsibility	
Department of Industrial Works, Ministry of Industry	http://www4.diw.go.th:8080	To issue regulation and permits for the import control of used electronic equipment and its parts
Department of Health, Ministry of Punblic Health	http://eng.moph.go.th	To study and report impacts of e-waste management on human health
Department of Local Administration, Ministry of Interior	http://www.dla.go.th/en/index.jsp	To provide collection services from individual households
Pollution Control Department, Ministry of Natural Resources and Environment	http://webeng.mnre.go.th/main.php?filename=index	To formulate the framework for electronic equipment recycling, and monitor and regulate air, water and soil pollution caused by e-waste recycling
Electrical and Electronics Institute, Thailand	http://www.thaieei.com/2013/th/	To provide technical assistance for ESM of e-waste in Thailand, developing e-waste inventory, identifying collection to disposal channels of e-waste and offering recommendations on the current implementation of the legal framework
Ministry of Environment, Japan; Ministry of Economy, Trade and Industry, Japan		To provide technical assistance to the Thai government and other stakeholders for inventorization, policy development, infrastructure development etc.
UN Organisations (eg. UNESCAP, UNCTAD, UN Environment, UNIDO, BCRC etc.)		To support and facilitate dialogue amongst stakeholders, build national capacity on policy, regulation and enforcement; support the development of sustainable e-waste business models
Thailand Environment Institute Foundation	http://www.tei.or.th	Works in association with international agencies for promotion of advanced waste management based on the 3R concepts
Charitable Organizations/Temples		Charity organizations such as Suan Keaw Temple accept end-of-life equipment that they can refurbish and sell at very low prices, mainly as a social service.
Recyclers (eg. GENCO, Wongpanit, etc.)	http://www.genco.co.th/	To provide sound dismantling, recycling and disposal of e-waste

Table 33: Key Stakeholders, Thailand

CHAPTER FOUR

Transboundary movements 206

Trransport
of e-waste
[Benjamin Hale]

Transboundary movements

International frameworks

Just as the supply chains of EEE are global in nature, so also are the reverse chains at end-of-life, with ever-increasing international trade in waste. The exponential growth and international controversies of these transboundary trades have led to the development of regulations at the national, regional and international levels.

The most prominent among these regulations, in the context of transboundary movements of e-waste, is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (commonly known as the Basel Convention). This regime was developed as a multilateral response to a series of toxic trade scandals in which various developed-world industries were caught dumping hazardous wastes in developing countries and Eastern Europe. Under international environmental justice concerns, nation states entered into the negotiations aimed at suppressing environmentally and socially detrimental hazardous waste trading patterns. Enshrined under the auspices of the United Nations Environment Programme (UN Environment), the Basel Convention was adopted in 1989, and it entered into force in May 1992. There are some declarations under the Basel Convention, such as the Nairobi Declaration in 2006 and the Cartagena Declaration in 2011, which promote the environmentally sound management of hazardous wastes, including e-waste. Though the Basel Convention does not deal with e-waste as such, but rather hazardous components also being part of e-waste, technical guidelines on reuse, recycling and transboundary movement of e-waste currently are being devised under its auspices.

What is controlled under the Basel Convention and what is not?

The Basel Convention defines "hazardousness" in terms of the substances in the waste materials, and it classifies wastes as either hazardous or non-hazardous depending on the waste's chemical properties. At the crux of the Basel Convention is the principal of prior informed consent.
Transboundary movement of e-waste containing hazardousness is controlled when an importing Party and/or an exporting Party identify hazardousness in e-waste under the provisions of the national law. Article 1-1 of the Convention stipulates hazardous wastes are subject to transboundary movement under the Basel Convention as follows:

a. Wastes that belong to any category contained in **Annex I**, unless they do not possess any of the characteristics contained in **Annex III**; and
b. Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.

Annex VIII of the Convention provides list of hazardous wastes (List A), and Annex IX provides a list of non-hazardous wastes (List B), unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic.

In addition to the Convention's provisions, some Parties set national threshold values to distinguish between hazardous and non-hazardous waste, including e-waste.

Similar to the Basel Convention, the OECD Waste Agreement established a framework for member countries of the Organization for Economic Cooperation and Development (OECD) to supervise and control the transboundary movement of wastes within the OECD area. However, it focuses on wastes exported for the purpose of material recovery only. Thus, when compared to the Basel Convention, which aims to minimise hazardous waste shipment, regardless of intent, the OECD Council Decision seeks to control the trade of potential resources secured from waste. The OECD's regulation offers more specific guidelines than the Basel Convention regarding waste destined for recovery, and it allows countries that are not signatories of the Basel Convention, such as the United States, to continue to trade waste with OECD countries. In 2006, the European Union transposed the Basel Convention and the OECD Council Decision into European regulation with the European Waste Shipment Regulation (WSR). The WSR implements the international obligations of the two multilateral environmental regimes of the Basel Convention and the OECD Waste Agreement and includes the internationally agreed-upon objective that wastes shall be disposed of in an environmentally sound manner.

National frameworks

The Parties to the Basel Convention have one option to prohibit the import of hazardous waste or other wastes that Article 4-1 stipulates. If any Party lacks a facility for environmentally sound hazardous waste treatment, they take this option to prohibit the import of those wastes in order to avoid any adverse effect in human health and the environment. This is one of the advanced measures to prevent the negative effect of the transboundary movement of e-waste.

In addition, countries, states or any entity that governs legal frameworks for the environment, including wastes, at a national level can take another measure to prohibit the import of second-hand electrical and electronic equipment. Some Asian countries enforce laws and/or regulations to prohibit the import of second-hand electronics or set the standard or criteria to distinguish between second-hand electronics that allowed to be imported and those not allowed to be imported. These provisions serve as the wall blocking those kinds of products into the countries.

- **Flows Data**
  - **1998-2000**
  - **2001-2003**
  - **2004-2006**
  - **2007-2009**

The main reasons for the transboundary movement of EEE are (i) to make used equipment available at lower prices in the destination countries and thus help close the digital divide, (ii) to repair or refurbish components or entire machines in use or (ii) to recycle materials and substances contained in end-of-life EEE and treat these in an environmentally sound way. Since e-waste contains various kinds of recyclable materials and substances, such as plastics, glasses, non-ferrous metals, precious metals and rare metals, the transboundary movement of e-waste enables sufficient collection to operate a recycling businesses. E-waste is also shipped internationally, but some of those trades are illegal under international law.

China (including Hong Kong), Indonesia and Malaysia ratified the Ban Amendment which prohibits all transboundary movement of hazardous wastes from Annex VII countries (Parties and other States which are members of OECD, EC and Liechtenstein) to non-Annex VII countries. In addition, China prohibits the import of e-waste and second-hand electronics and Indonesia prohibits the import of e-waste and some items of second-hand electronics. Hong Kong prohibits the import of e-waste, and it controls the import of second-hand electronics. On the other hand, Malaysia controls the import of e-waste only from non-Annex VII countries and second-hand electronics.

Cambodia, Japan, the Philippines, Singapore, Thailand and Vietnam have not ratified the Ban Amendment, and of these countries, only Cambodia prohibits the import of e-waste and only Vietnam prohibits the import of second-hand electronics.

Taiwan (which does not apply to the Basel Convention) controls the import of e-waste through its national legal framework, which is the equivalent of the Basel Convention.

All the countries in the region control e-waste either via the Basel Convention or their national legal frameworks. However, measures to control the import of second-hand electronics are different among the countries and regions. There are two groups on control measures to import of e-waste and second-hand electronics: 1) do control the import of e-waste but do not restrict of second-hand electronics (Taiwan, Japan, the Philippines, Republic of Korea, Singapore and Vietnam); and 2) prohibit the import of e-waste and prohibit or restrict the import of second-hand electronics (Cambodia, China, Hong Kong, Malaysia and Vietnam).

Despite these formal steps, enforcement of these measures remains a significant challenge in these countries and many others around the globe.

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