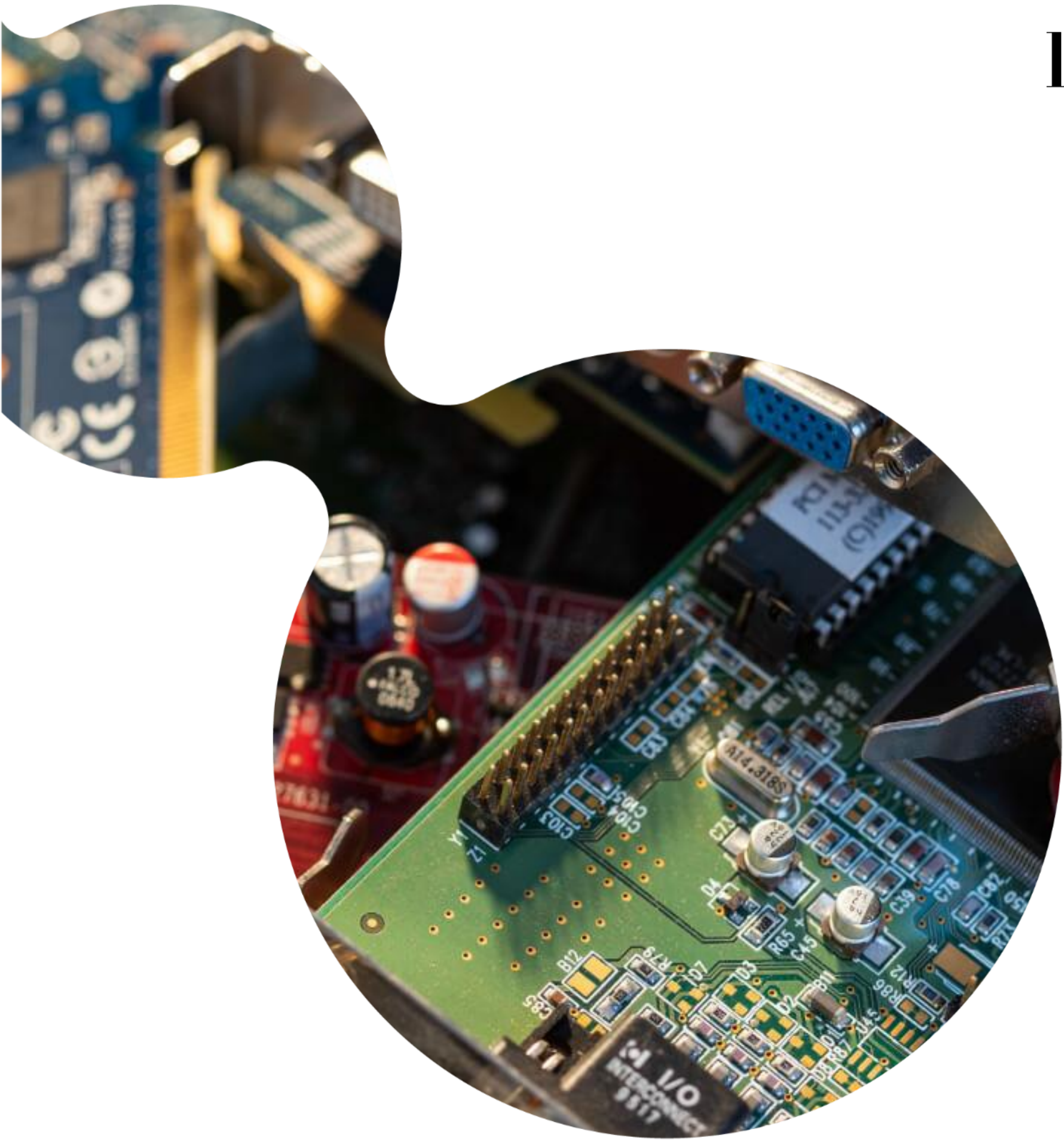


Potential environmental benefits of e-waste recycling in Australia – 2022 Canon summary report

Undertaken by Lifecycles

For Canon Australia

22 November 2022

Contents

Bontinck P.A., Grant T.F. (2022), *Potential Environmental Benefits of E-waste Recycling in Australia – 2022 Canon Summary Report*. Lifecycles, Melbourne, Australia.

Context

Canon Australia (Canon) is a founding member of the Australia and New Zealand Recycling Platform (ANZRP), a not-for-profit Co-regulatory Arrangement operating under the National Television and Computer Recycling Scheme (NTCRS).

ANZRP is tasked with collecting and recycling in-scope waste on behalf of its members, via its national e-waste recycling service TechCollect, to an amount equivalent to their liability.

Since 2016, Lifecycles has collaborated with ANZRP in calculating the environmental benefits of operating the Co-regulatory Arrangement. Information extracted from this analysis has been communicated to stakeholder's via ANZRP's Annual Report since then.

Canon also operates its own e-waste recycling program, which is managed by ANZRP. This analysis reports on those two streams of e-waste, using the results of the ANZRP study to estimate the total environmental benefits associated with waste collected via TechCollect, and tailoring the model to estimate benefits associated with Canon's own recycling program.

The output of this analysis will provide information for Canon to engage with stakeholders, in demonstrating the environmental benefits of recycling their e-waste.

Life cycle assessment (LCA)

The environmental impacts and benefits have been calculated using life cycle assessment (LCA). This methodology is used to evaluate the full cradle to grave environmental benefits of products and processes by assessing the environmental flows at each stage of the life cycle. LCA aims to include all important environmental impacts for the product system being studied. By including all of these environmental impacts, the study results avoid the shifting of impacts from one life cycle stage to another and from one environmental impact to another.

The framework and principles of LCA are described in the international standards ISO 14040[1] and specific requirements for LCA are provided in ISO 14044[2].

The assessment follows four stages:

- **goal and scope,** describing the reasons for the LCA, and the scenarios, boundaries, indicators and other methodological approaches used.
- **inventory analysis**, where a model of the production systems involved in each of the scenarios, and how each stage in the production process interacts with the environment, is built.
- **impact assessment** relates the inventory data to impact indicators, to produce an environmental profile for each scenario.
- **interpretation**, where the results are analysed and systematic checks of the data and assumptions are undertaken to determine the robustness of the results.

Our approach

One objective of this analysis is to derive results specific to Canon from the model developed for ANZRP.

Since 2016, Lifecycles has worked with ANZRP to produce a robust model of the environmental benefits of recycling a tonne of mixed television and computer waste, for inclusion in the Co-regulatory Arrangement's annual report and communications with its stakeholders.

Every year, recyclers working with ANZRP report data on the volume collected, material breakdown and downstream reprocessing steps. This information is used to model the total recycling chain, up to the point that secondary commodities are sold on the market.

Here, we used data provided by ANZRP on the volume of waste collected on behalf of Canon and its customer, and the recycler to which it is directed. Information shared by each of these recyclers as part of the work conducted for ANZRP was used to produce a model representing more closely the management of e-waste collected by Canon.

As illustrated above, the project was divided into three phases: data review, linking to ANZRP model and reporting.

Phase	Description
Canon data review	Analysis of the data provided by Canon and ANZRP on the waste collected, the volume going to different recyclers and estimating the freight effort required in this first stage of the recycling process. Data on the collection of 490 t of e-waste was shared, and used as a representation of the 1,903 t waste liability.
Linking to ANZRP model	In the work conducted for ANZRP, data for all recyclers is collected and aggregated in one average figure. To model Canon's e-waste management, this original model is disaggregated and recompiled to be representative of the organisations towards which Canon is directing its e-waste.
Reporting	Summary report of results, including primary data, and reference to the full report completed for ANZRP.

Goal and scope

Goal

The goal of this analysis is to quantify the environmental impacts and benefits associated with recycling e-waste generated by Canon and its customers and managed by ANZRP under the National Television and Computer Recycling Scheme (NTCRS), including the transportation and reprocessing of used equipment as well as the replacement of virgin material by recovered materials in the collected e-waste.

Functional unit

The international standard on LCA describes the functional unit as defining what is being studied, and states that all analysis should be relative to the functional unit. Its definition needs to clearly articulate the functionality or service that is under investigation.

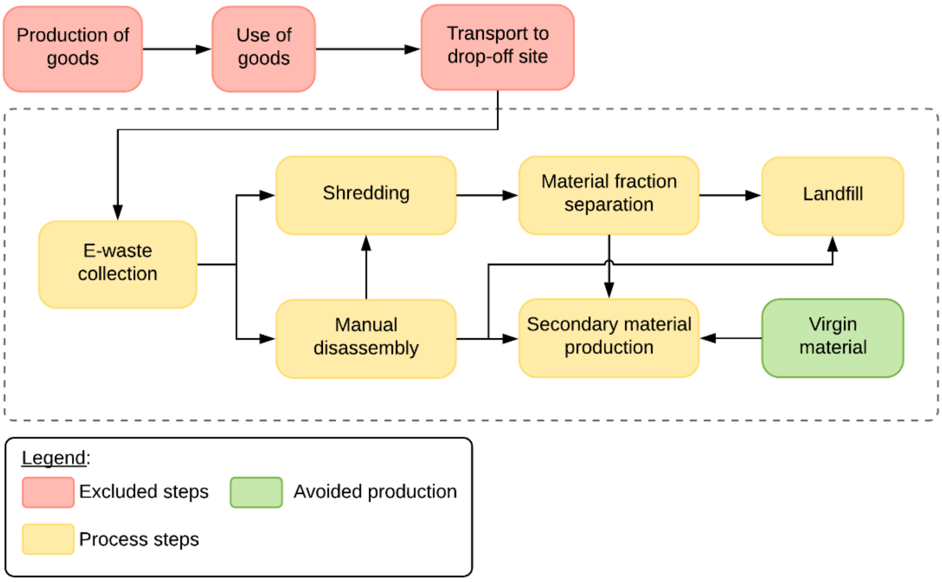
In this case, the service under investigation is the management of e-waste generated by Canon and its customers falling within the scope of the NTCRS. Thus, the functional unit is defined as:

"the recycling of 1 tonne of mixed e-waste collected through Canon's e-waste program, and managed by ANZRP in Australia, during financial year 2022".

The results are then used to estimate the annual environmental benefits associated collecting and recycling e-waste through Canon's own e-waste program and as a liable party of the NTCRS.

System boundary

The system boundary describes the life cycle stages and processes included in the LCA. In this study, the function was the management of e-waste covered by the NTCRS for Canon, as described in the Figure below.



Typically, system boundaries should include everything that is substantially affected by demand for the service provided. This includes extraction and production processes, and any additional activities required by the system being analysed.

The system boundary may exclude elements that fall below a cut-off threshold. The production and use of electronic goods, considered irrelevant to the recycling processes, is excluded from this assessment.

Inventory analysis

Inventory analysis is the stage of the LCA where the system studied is broken up into unit processes. For each unit process, the flows were defined per unit of output. These included flows to and from the environment and flows to and from the technosphere. All flows are defined relative to the functional unit. Data reported in this section, are only representative of information reported by Canon to tailor the original ANZRP model.

Foreground data represents information provided directly by or calculated from information provided by Canon and ANZRP. These include mainly transport logistics associated with the management of e-waste, from the original point of collection to the recyclers.

Downstream processes including dismantling e-waste and recovering secondary commodities from each material fractions were represented using the model developed for ANZRP.

Inbound e-waste logistics

The total freight effort of transporting e-waste between the point of collection and the recyclers was calculated using the detailed log of waste movement provided by Canon and ANZRP.

Using the information on distances for each collection trip allowed to model the logistics of each recycler individually.

Freight efforts are modelled using a tonne.km unit, which represent the requirements of moving 1 tonne of goods over 1 kilometre.

Recycler	**Road freight** *t.km*	**Average distance per tonne of waste** *km*
ACE Recycling Group	6,048	32
CDS Recycling	7,176	152
Electronic Recycling Australia	559	23
Endeavour Foundation	58	37
ERS Queensland	84	14
Scipher	3,027	20
TES-Amm, AU	369	39
Total Green Recycling	26,313	469
WeCollect	108	24
Total	**43,742**	**314**

Logistics of overseas export

Linking data collected from Canon to the model developed by ANZRP allows to create a picture of the entire recycling chain, including a representation of the volume of waste that is exported for further treatment. Our model estimates that 95% of the total mass of e-waste generated by Canon and its customers is processed domestically, up to the point that it becomes a secondary commodity sold on the global market.

Of the eight destination countries reported, Japan (61%) represented the largest fraction of export, as shown below.

Country	Proportion *%*	Mass exported *kg*	Typical materials
Japan	61%	16,280	Printed circuit board (91%) and non-ferrous metals (8.8%)
Thailand	6.0%	1,581	Plastics (100%)
Singapore	1.6%	420	PCB (94%), non ferrous metals (5.6%)
China	5.2%	1,371	Plastics (82%), and non-ferrous metals (18%)
Philippines	7.7%	2,044	Ferrous metals (85%), non ferrous metals (15%)
Malaysia	14%	3,780	Plastics (71%), ferrous metals (13%) and mixed non-ferrous metals (16%)
Pakistan	3.0%	785	Ferrous metals (85%), non ferrous metals (15%)
India	1.0%	1,000	Non-ferrous metals (100%)

Material fractions in e-waste

A critical aspect of e-waste recycling is the breakdown of materials found in a tonne of product. The most significant potential for environmental benefits resides in the recovery of individual material fractions.

When recovered, these can replace virgin materials, thus avoiding their production in the first place.

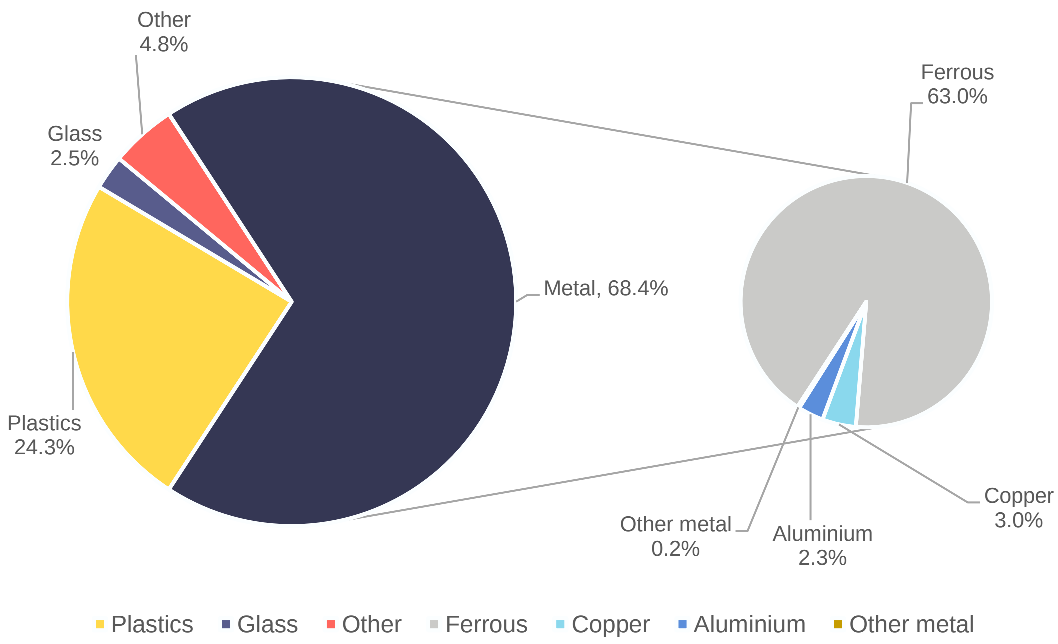
The broad range of materials in e-waste, includes various metals, plastics and glass. Metals are often a focus for recovery, as they represent a high proportion of the waste, can sometime be easily separated, and have a high resale value.

Information reported by recyclers to ANZRP was used to identify the material fractions found in e-waste. Information reported by ANZRP on the volume of waste directed to the various recyclers was used to tailor this estimate of the material fractions found in e-waste.

Material fraction	Mass kg / t	Ratio %
Metal	**676**	**68%**
- Aluminium	22	2.26%
- Brass	1.6	0.16%
- Copper	29	2.97%
- Gold	0.0007	0.000073%
- Iron	623	63%
- Nickel	0.10	0.010%
- Palladium	0.00023	0.000023%
- Silver	0.010	0.0010%
Glass	**24**	**2%**
- Clean glass	3	0.34%
- Lead glass	21	2.12%

Material fraction	Mass kg / t	Ratio %
Plastics	**209**	**21%**
- ABS / PC / HIPS	0.4	0.041%
- PP / LDPE	0.03	0.0025%
- Mixed plastics	240	24.3%
Other	**47**	**5%**
- Batteries	2.1	0.22%
- Toner	5.5	0.56%
- Other	39	3.99%

The material breakdown is summarised in the diagram below.



Background model and literature

This report builds on the work conducted for ANZRP in the context of their annual report. Additional detail on the background models and literature used throughout the modelling process is reported in the ANZRP LCA report and does not form part of this report.

Impact Assessment

The impact assessment stage relates the inventory flows to the indicators chosen for the LCA.

The indicators chosen for this analysis are expected to be the most relevant to recycling industries, at the exception of human and ecotoxicity indicators which are not included due to large uncertainties in the models and background data used in the study.

The table below describes each of the indicators chosen for the LCA and the source of the characterisation factors.

Indicator	Description	Characterisation model
Climate change	Measured in kg CO_2 eq. This is governed by the increased concentrations of gases in the atmosphere that trap heat and lead to higher global temperatures. Gases are principally carbon dioxide, methane and nitrous oxide.	IPCC model based on 100-year timeframe[3].
Fossil energy use	Measured in MJ lower heating value. It includes all energy resources extracted and used in any way. It does not include renewable energy, energy from waste or nuclear energy.	All fossil energy carriers based on lower heating values.
Particulate matter	Measured in g $PM_{2.5}$. This impact category looks at the health impacts from particulate matter for PM_{10} and $PM_{2.5}$. This is one of the most dominant immediate risks to human health as identified in the global burden of disease.	World impact plus method [4].
Water scarcity	Measured in m^3 of water equivalent. Water extracted directly from the environment, thereby competing with environmental and other human requirements for water.	The impacts of water use based on water scarcity factors developed by Pfister[5].

Results

COMPARING RESULTS FOR ANZRP AND CANON

Lifecycles has been conducting this analysis annually for ANZRP since 2016, resulting in a robust analysis of Australian e-waste management. This report builds on the work done for ANZRP, tailoring the analysis to the recyclers which process the waste collected from Canon and its customers. The results of this assessment are reported alongside ANZRP's results, representing Canon's remaining liability, in the table below.

	Unit	Canon program	Canon's remaining liability *(ANZRP TechCollect program)*	Total
Total e-waste managed	tonnes	490	1,413	1,903
Climate change	kg CO_2e / t	-1,423	-1,358	
	kg CO_2e / year	-296,756	-1,918,560	-2,615,317
Cumulative energy demand	MJ NCV / t	-18,184	-16,669	
	MJ NCV / year	-8,902,976	-23,553,671	-32,456,648
Particulate matter	g $PM_{2.5}$ / t	-2,549	-2,374	
	g $PM_{2.5}$ / year	-1,247,981	-3,354,20	-4,602,187
Water scarcity	m^3 / t	-3.9	-4.1	
	m^3 / year	-1,897	-5,726	-7,624

The results are well aligned with those of the entire scheme, with small variations suggesting that the benefits of recycling e-waste from Canon's perspective are slightly higher than the average e-waste flow managed via ANZRP.

Here, it is worth highlighting that the data collected for this analysis did not include detailed downstream recycling data representative of the e-waste collected from Canon and its customers. However, the model was tailored to be representative of the recyclers which reprocess this waste. As such the breakdown of material recovered, as well as the downstream recycling processes, differs slightly from the average of all recyclers with whom ANZRP is working. This explains the variation in estimated environmental benefits.

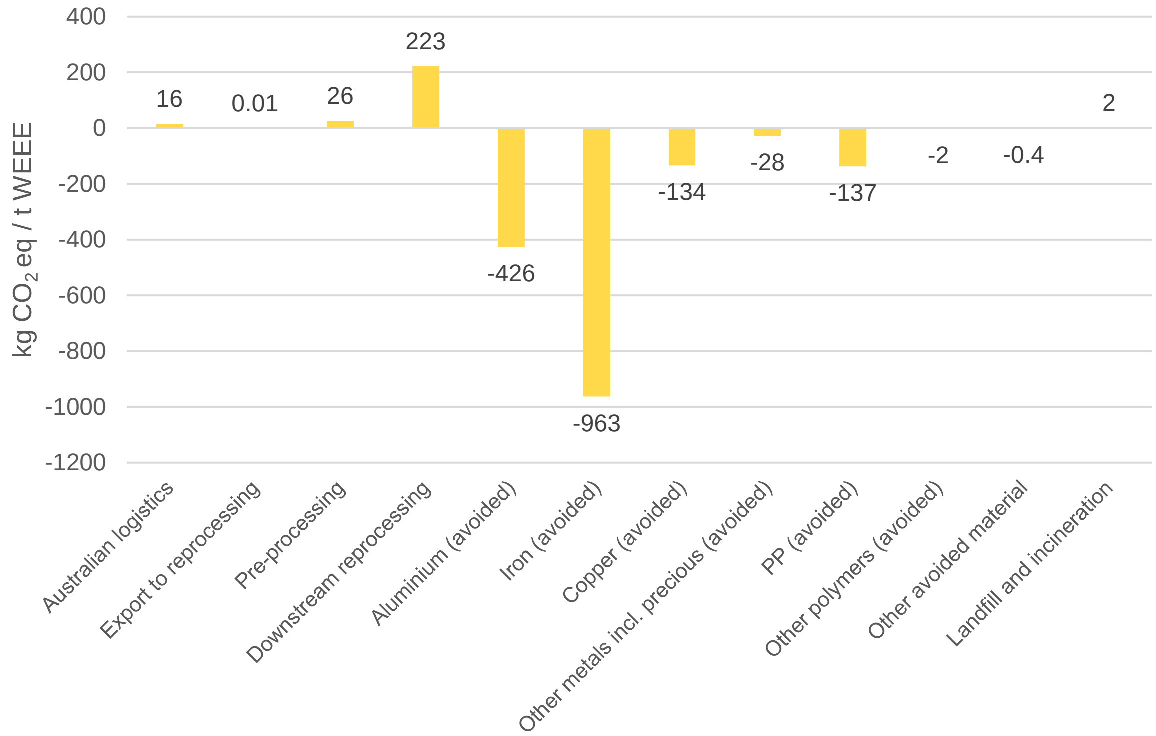
A further improvement of the model would be to collect detailed data specific to the e-waste collected from Canon and its customers.

CLIMATE CHANGE

Recycling 1 tonne of mixed e-waste collected by Canon in Australia avoided 1,423 kg CO_2e from being emitted to the atmosphere.

Most impacts are linked to downstream reprocessing, which is far more significant than the logistics associated with running the waste management system.

Ferrous metals (iron) and aluminium provide substantial benefits. Both fractions can easily be segregated using current technology, such as magnetic separators or eddy current separators, and represent a significant proportion of the waste. They also have good resale value and well-established recovery routes and replace a material that requires significant amount of energy to be produced from raw ore.



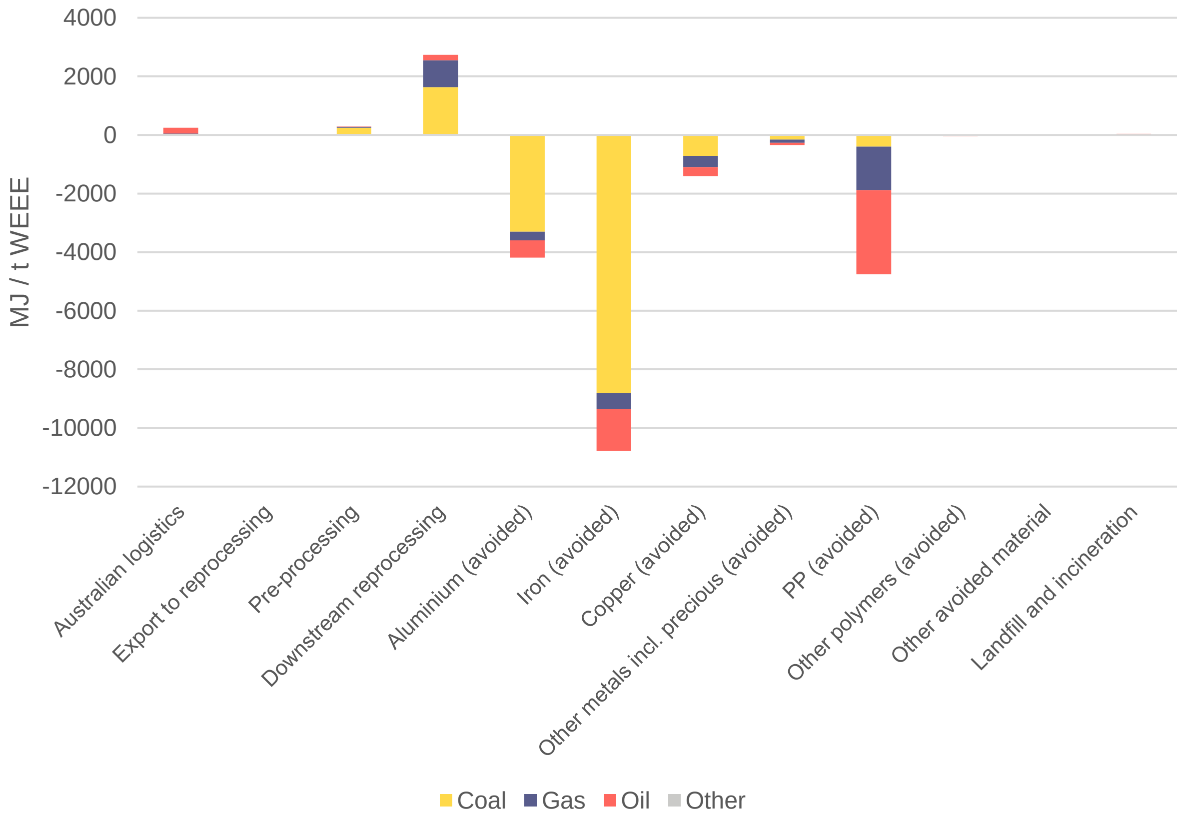
ENERGY

Recycling 1 tonne of mixed e-waste collected by Canon in Australia avoided the consumption of 18,184 MJ of fossil fuel.

As for climate change, most of the energy use lie in the downstream reprocessing of the various fractions – this includes the recycling processes associated with the various metals, plastics, and glass fractions.

Iron and aluminium provide significant benefits in terms of energy savings. Both materials are present in substantial amounts in the waste, and their production from raw material requires large amounts of energy.

The recovery of plastics as mixed pellets used for manufacturing also has significant benefit. As this stream displace the use of virgin plastics, it avoids the need for oil and gas extraction required to produce plastics.

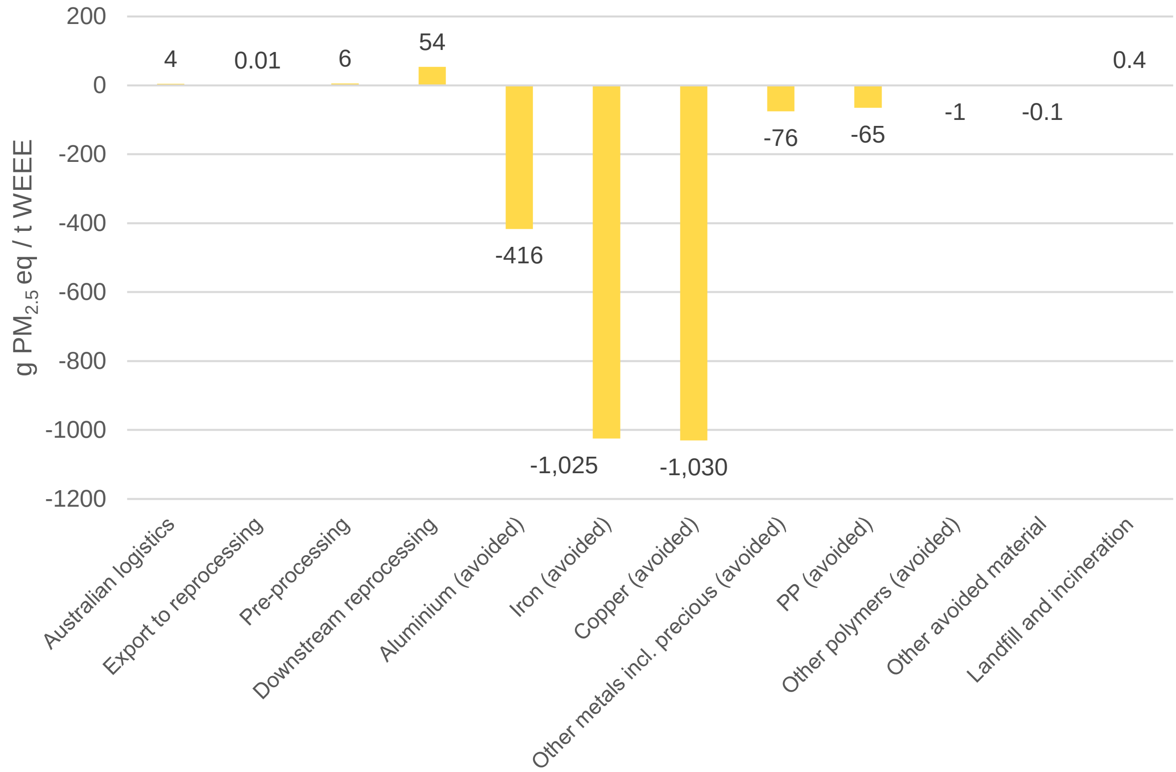


PARTICULATE MATTER

Recycling 1 tonne of mixed e-waste collected by Canon in Australia saved 2,549 grams of particulate matter.

The emission of particulate matter globally has significant health consequences, particularly in densely populated areas, and countries with lower emission controls.

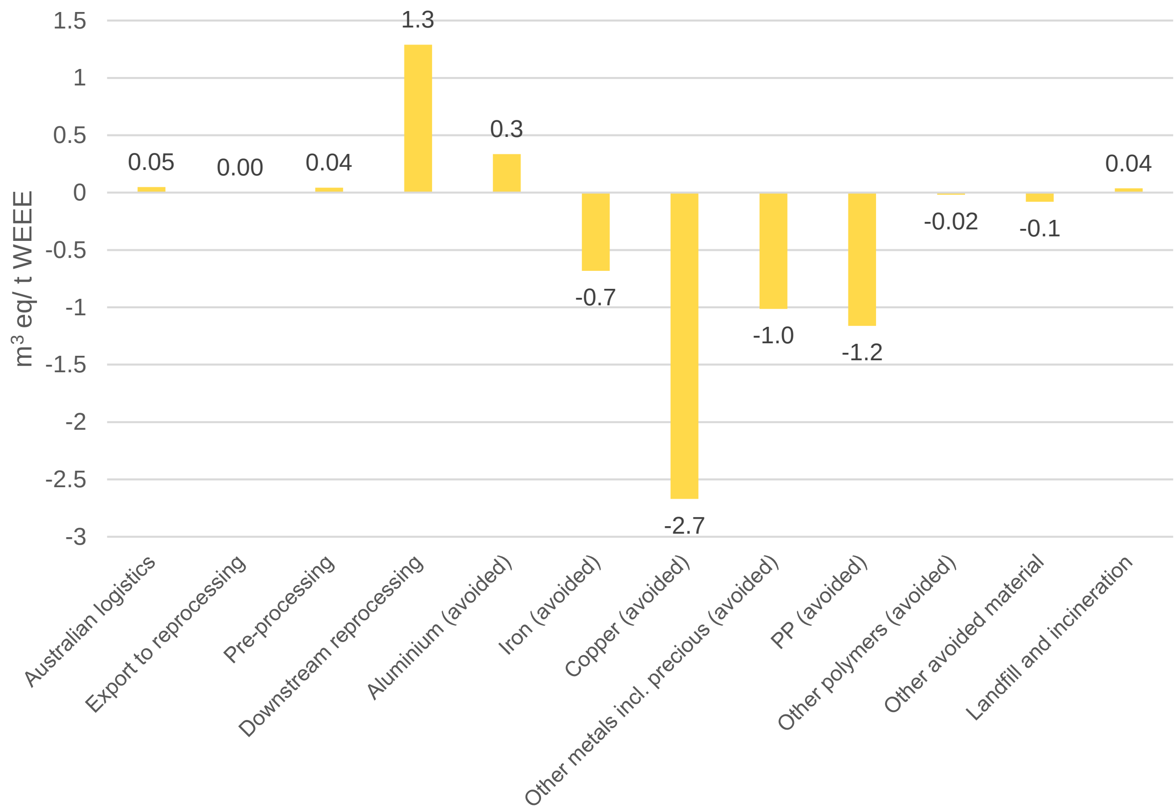
The energy input from downstream processing generates the most particulate matter in the system. As with other impact categories, these burdens are more than offset by avoided materials, particularly iron, copper, and aluminium (in that order).



WATER FOOTPRINT

Overall, recycling 1 tonne of mixed e-waste collected by Canon in Australia saved 3.9 m³ eq. of water.

The water footprint takes account of the relative water stress in catchments where water is extracted. The water usage and savings are similar to the other indicators, with downstream processing being the major user, and metal and plastic recovery being the main areas of saving. Here, the recovery of copper, plastics and iron drive the benefits.



ANALYSING TOTAL ANNUAL BENEFITS

The total volume of e-waste collected by or on behalf of Canon throughout financial year 2022 is as follow:

- Canon's own e-waste program resulted in the collection and recycling of 490 tonnes of e-waste;
- Canon funded ANZRP to collect an amount of e-waste equivalent to the rest of its total liability for the year, which was 1,903 tonnes in financial year 2022.

Overall, 1,903 tonnes of waste have been collected and recycled throughout the year.

The values reported on page 8 of this report represent the total volume of avoided emissions throughout the year, thanks to collection and recycling of e-waste.

The waste collected by Canon, or on its behalf, represent a significant volume of waste. To put things in perspective, it is equivalent to the weight of over three Airbus A380 planes.

The emissions avoided thanks to the recycling program are equivalent to the annual greenhouse gas emissions of almost 190 Australians[1].

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[1] Based on a per capita consumption-based emission of 13.8 tonnes CO_2e per year (https://ourworldindata.org/grapher/consumption-co2-per-capita?tab=chart&country=~AUS)

Conclusions and recommendations

This analysis shows the value of Canon's participation in Australian e-waste management, by demonstrating the environmental benefits associated with reprocessing e-waste collected by or on behalf of Canon in Australia.

The outputs are calculated from a robust model which has been developed in collaboration with ANZRP since 2016, providing a high level of confidence in the results.

The model could be further improved by a better representation of the downstream recycling of the actual e-waste managed by Canon. Currently, it represents the average recycling of mixed e-waste by the recyclers which reprocess e-waste collected from Canon's and its customers'.

The e-waste industry continues to be a focus in Australia, as work at the Federal level investigating the potential for a wider product stewardship scheme. At the state level, work is also underway or has recently been conducted to better understand the current flow of e-waste, as well as the likely increase over time. This work will likely inform policy decision on the most appropriate management of this significant waste stream.

Meanwhile, strict rules on waste exports have recently been implemented, meaning that a larger fraction of waste has to be managed domestically. This is a particularly significant move for the plastic stream, which was historically managed overseas, and for which durable solutions have so far proven difficult to put in place in Australia.

Having scientifically grounded information about the benefits of e-waste recycling is very helpful to inform stakeholders, and further expand the reach of the e-waste collection system. This analysis shows that even though a fraction of the e-waste stream can be difficult to recover for high-quality applications, the overall environmental benefits of recycling e-waste are extremely clear. This is a message which may help further expand the reach of the e-waste collection system.

Sources

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