

# Stewardship Solutions for Whitegoods

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Product Stewardship Pathways for Large Household Appliances  
Final Report • June 2025



**Product  
Stewardship  
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Funded by:



# Acknowledgements

## Acknowledgement of Country

Southern Sydney Regional Organisation of Councils (SSROC) and the Product Stewardship Centre of Excellence acknowledge the Darug, Dharawal and Gadigal people of the Eora Nation, upon whose ancestral lands the SSROC stands. We would also like to pay respect to the Elders both past and present, acknowledging them as the traditional custodians of knowledge for these lands.

## About the Southern Sydney Regional Organisation of Councils

The Southern Sydney Regional Organisation of Councils (SSROC) is an association of 12 councils spanning Sydney's southern suburbs covering a third of Greater Sydney's population, over 1.8m people. Its councils manage around 655,000 tonnes of household waste each year, which is about 20 per cent of all NSW household waste. SSROC provides a forum through which member councils can interact, exchange ideas and work collaboratively to solve regional issues and contribute to the future sustainability of the region.

More information: <https://ssroc.nsw.gov.au>

## About the Product Stewardship Centre of Excellence

The Product Stewardship Centre of Excellence is an independent not-for-profit registered charity. It exists to facilitate the avoidance and reduction of waste and create positive environmental and social outcomes through sustainable design, resource conservation reuse, repair, and recycling. The Centre helps businesses, industries, associations and product stewardship organisations to adopt a strong lifecycle approach to deliver their ESG and circular economy objectives.

More information: <https://stewardshipexcellence.com.au>

## Research Team

John Gertsakis, Rose Read and Vincent Mason – Product Stewardship Centre of Excellence  
Annie Walker and David Kuhn – SSROC  
Kapil Kulkarni – RPS Consulting  
Dr Taylor Brydges – UTS Institute for Sustainable Futures

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## Disclaimer

The authors have used all due care and skill to ensure the material is accurate as at the date of this report. SSROC, the Product Stewardship Centre of Excellence, RPS Group and the UTS Institute for Sustainable Futures, and the authors do not accept any responsibility for any loss that may arise by anyone relying upon its contents.

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# Executive Summary

The Product Stewardship Centre of Excellence (the Centre), Southern Sydney Regional Organisation of Councils (SSROC) and the NSW Environment Protection Authority collaborated in 2024-2025 on a research project to investigate stewardship pathways for large household appliances.

*The purpose of the project was to progress solution-oriented action on product stewardship for large household appliances, with a focus on refrigerators, freezers, washing machines, dryers, and dishwashers.*

The project included three key stages:

1. A desktop review of international and national stewardship laws for large appliances.
2. Stakeholder interviews and roundtable discussions to capture diverse perspectives on barriers, opportunities and potential stewardship pathways.
3. High-level modelling of financial, environmental and social implications of different product stewardship scheme options.

Stewardship approaches are designed to improve product whole-of-life management by keeping products, components and valuable materials recirculating in the economy in their highest-value uses and minimising the environmental impacts throughout production, consumption, and end-of-life management.

This is especially important given Australia's circular economy ambitions and the need to design out waste and pollution and keep products and materials circulating in the economy for much longer. Effective and enduring stewardship also requires manufacturers and brands taking responsibility for funding and facilitating these outcomes.

## International policy and regulatory approaches to product stewardship and EPR

The desktop review looked at policies and regulations for large household appliances, and the manufacturing, consumption and treatment of ozone-depleting substances from the European Union (EU), Germany, France, Italy, the Republic of Ireland, Sweden, Canada, the USA, Japan, South Korea, Taiwan, China and Australia. The implementation of product stewardship policies and regulations varies across regions and countries, ranging from effective and cohesive transposition of European Union Directives throughout member state domestic law, to voluntary government-funded programs in Australia and the USA.

Of the countries that have implemented waste electrical and electronic equipment (WEEE) management regulations, a range of common themes arise. These regulations tend to identify similar priority product categories, including refrigerators, freezers, washing machines, and clothes dryers, and financial and operational penalties that can be imposed on non-compliant producers. Several countries in Asia and Europe use levies, disposal fees, penalties and legislation to ensure manufacturers are responsible for end-of-life costs.

In countries that have not enshrined WEEE management into law, such as the USA and Australia, a trend emerges where producers have no legal responsibilities for the end-of-life treatment of their products, and governments are left to ensure end-of-life products are disposed of safely.

In contrast, regulatory responses to reducing ozone-depleting substances are uniform throughout Europe, North America and Asia-Pacific. The direct influence of the Montreal Protocol to phase out chemicals that deplete the ozone layer, of which all countries are now signatories, is in part responsible for this international cohesion.

## Stakeholder views and perspectives

Interviews and roundtables were conducted with stakeholders across the appliance industry. This included manufacturers, retailers, metal recyclers, logistics providers, degassers, state and local government representatives to gain insights on existing product stewardship initiatives, barriers and opportunities related to the collection, repair, degassing, and recycling of large household appliances, and perspectives on potential future collective stewardship initiatives.

With respect to existing stewardship actions, some brands are investing in repair, but many face challenges, including service and spare parts availability, increased integration of technology into appliances, and growing labour and skills shortages. While take-back services, reuse, and refurbishment initiatives exist, they are constrained by several factors, including warranty restrictions and consumer preference for new products.

**Some key barriers** to expanding product stewardship initiatives included regulatory uncertainty, financial constraints, logistics and infrastructure. Stakeholders supported the development of a mandatory stewardship scheme and emphasised that uncertainty around future regulation and free-riders are key barriers to investing in stewardship initiatives.

Moreover, stakeholders noted that current financial models fail to incorporate recovery costs into pricing, making embedding stewardship costs in operations financially challenging, especially for budget brands.

**Important enablers** supported by stakeholders to advance product stewardship pathways in Australia included developing product design standards for durability and repairability to keep products in use longer and reduce waste, as well as industry-led collaboration, increased consumer awareness, and incentives.

Concerning governance considerations, **stakeholders strongly supported a co-regulatory approach to product stewardship**, on the basis that industry is actively engaged in scheme design and delivery while still advocating for mandatory participation to address free-rider concerns.

Eco-modulated fees<sup>1</sup> based on product recyclability were seen as relevant to encourage design for circularity features (such as using recyclable, replaceable and repairable parts and recycled materials), to extend product life and keep material out of the landfills.

**Issues related to degassing and recycling were recurring themes.** Stakeholders had varying views regarding the size of the degassing problem. Some suggested that the amount of hazardous chemicals used in refrigerators is decreasing and, therefore, less of an issue. This was a common argument for deprioritising appliance degassing. However, others maintained that while the recovery of gases from refrigerators and air conditioners was low, even small amounts of compliant degassing of some types of refrigerants can have a significant environmental benefit and, as such, should be high on the agenda.

**Stakeholders consistently emphasised the benefits of in-home collection**, which provides the necessary quality control and transparency during transport, recycling and degassing. There were also discussions on increasing enforcement to ensure compliance with degassing regulations.

<sup>1</sup> Eco-modulation is an incentives driven approach where levies, fees or taxes are variable depending on the environmental performance or impact of a product or material with a view encouraging sustainable product design.



Stakeholders commented that the financial incentives provided by the existing scheme for recovering refrigerant gases do not cover the product collection, aggregation, and storage costs, which are the biggest costs in recovering both the product and the refrigerant gases. Stakeholders also expressed significant concern about the lack of shredder floc and plastic recovery due to limited recycling pathways, with the majority of these materials ending up in landfills.

### Economic modelling

RPS Consulting was commissioned to model the high-level financial, environmental and social implications of different product stewardship scheme options (the Economic Model). The modelling estimated the net impacts of each option, to inform potential future investigations into how these scenarios could be funded and their benefits. The economic modelling showed that transferring financial responsibility to industry for the current collection and recycling costs for large house appliances would require industry to incur an estimated levy on average of \$37 per appliance (or around 2.58% of current retail price).

The modelling showed that to significantly increase the material recovery rate from 59% to 84% and increase gas recovery, the levy would increase by \$11 to \$48 per appliance (or around 3.37% of the current retail price). A further investment of \$1 to \$49 per appliance (or around 3.45% of the current retail price) would also uplift the number of appliances being repaired. While the levy increments in these options are modest, they are expected to provide substantial environmental and social benefits regarding material recovery, reuse, circular economy, GHG emission reduction and employment outcomes.



## Recommendations

To address the inefficient low material and gas recovery rates, greenhouse gas emissions and financial burden on local councils it is recommended that:

### **1. The Federal Government should work with manufacturers, brands, recyclers, repairers, and local government organisations to design and implement a producer responsibility regulation for large household appliances.**

The regulation would require all retailers and manufacturers to increase both the recovery of materials and gas and the repair of large household appliances, including funding the collection and delivery of their appliances from households to an approved recycler for triage, dismantling, gas and material recovery. This would include the application of a levy to adequately cover costs associated with delivering any scheme. Ideally this regulation would leverage the existing Recycling and Waste Reduction Act's (Commonwealth) rule for the National Television and Computer Recycling Scheme, as well as the Ozone Protection and Synthetic Greenhouse Gas Management Act.

### **2. Alternatively, the NSW government should create a state-based producer responsibility regulation for large household appliances under the Product Lifecycle Responsibility Act 2025.**

This ideally would be replicated by every other state and territory government over time to make seven nationally harmonised state/territory-based stewardship schemes for large household appliances.

### **3. Manufacturer and retailer-led organisations such as the Coalition for Sustainable Solutions, Refrigerant Reclaim Australia, the Consumer Electronics Suppliers' Association, and other industry peak bodies, work with recyclers, the repair industry and governments to co-design regulations and to conduct further investigations into the feasibility and implementation of the following product stewardship actions.**

- Develop and implement local collection/takeback pathways that prioritise in-house collections over hard waste kerbside collections to improve reuse, degassing, dismantling and material recovery procedures.
- Develop minimum standards for collectors and recyclers of large household appliances around responsible gas handling and material recovery.
- Investigate infrastructure and technology requirements to increase recovery of glass and plastic.
- Improve processes and rebates for degassing.
- Increase local public education and awareness on preferred repair and disposal pathways.
- Develop a product repairability/durability label based on what has been implemented in France.
- In collaboration with the Australian Competition and Consumer Commission, investigate how the current consumer law could be improved to encourage repair over replacement.
- Develop markets for spare parts.
- Rebuild industry capacity, capability and associated training in appliance repair, including dedicated apprenticeship programs.
- Undertake more detailed modelling of cost-sharing and eco-modulation arrangements between retailers, manufacturers, recyclers, repairers, and all levels of government.



# 1. Project Objectives and Problem Statement

## Project objectives

The purpose of this project was to identify barriers, opportunities, and potential pathways for increased action on stewardship for large household appliances, including appliances such as refrigerators, freezers, washing machines, dryers, and dishwashers.

Specifically, the project's objectives were to understand the perspectives, pressures, and opportunities from manufacturers, brands, suppliers and retailers to participate in stewardship initiatives, and to completing high-level economic modelling of the potential stewardship pathways.

## What is the problem

*The inefficient low material and gas recovery rates, greenhouse gas emissions and financial burden on local councils.*

It is now widely accepted by business, government and the community that we need to significantly minimise waste and ensure it does not become an environmental problem either now or for future generations. This is especially important given Australia's transition to a circular economy and the need to design out waste, reduce pollution and keep products and materials circulating in the economy for longer. This was clearly identified by the Circular Economy Ministerial Advisory Group in its final report to the Commonwealth Environment Minister in December 2024. The report included specific recommendations to transform supply chains through targeted regulation and *"a framework for product stewardship that provides an enhanced focus on mandatory participation, reporting, measurement and governance principles."*<sup>2</sup>

In 2019 an estimated 360,000 tonnes of large household appliances and temperature exchange equipment entered the Australian market. At the end-of-life stage, this translates into nearly 200,000 tonnes of e-waste generated, comprising around 68% metals, 13% plastics, 4% glass, and 15% other materials – some precious, some scarce, some hazardous and some non-renewable. While around 90% of used products are being collected it is estimated that only 57% of the material (predominately metals) is being recycled with 43% ending up in landfill (Victorian e-waste material flow analysis 2021). It is estimated that the volume of e-waste will also grow by between 63% to 83% by 2030 (E-product stewardship in Australia Evidence Report 2021).<sup>3</sup>

Most household electrical appliances and consumer electronics in Australia are not covered under an existing product stewardship scheme. Some product categories, such as televisions, computers and printers, are covered under the Recycling and Waste Reduction Act (2020) through the National Television and Computer Recycling Scheme (NTCRS). Currently, stewardship of large household appliances is limited to only a few individual brands and retailers offering take-back pathways for consumers when a replacement appliance is purchased.

Refrigerant Reclaim Australia is the scheme for refrigerant gases contained in products such as refrigerators, freezers, heat pump dryers and air conditioning units, but only for the gases, not for the whole product. In addition, consumers currently do not have convenient and accessible opportunities to repair, reuse or refurbish large household appliances.

2 Circular Economy Ministerial Advisory Group: Final report, Department of Climate Change, Energy, the Environment and Water, December 2024, p35.

3 Victorian e-waste material flow analysis. Prepare by Randell Environment Consulting in association with Blue Environment, 2021.





Previous research<sup>4</sup> led by SSROC in 2023 into the recovery of large household appliances found that:

- Refrigerators and freezers that require degassing are not well suited to mixed waste kerbside clean-up collections. Almost all other products requiring treatment before recycling, such as hazardous materials, are usually collected through business-to-business take-back solutions or dedicated drop-off recycling facilities.
- The longer refrigerators and freezers sit at the kerbside, the more likely they are to be damaged by metal scavenging, improper handling, or weather. The degassing requirements make it very difficult and expensive to deal with these products in kerbside collections. They also require experienced handlers to collect them from the household directly to reduce the risk of accidental degassing, which releases CO<sub>2</sub> and ozone-depleting gases into the atmosphere.
- Only the metal from refrigerators and freezers is being recovered and recycled, with most, if not all, plastic, rubber and insulation components ending up as shredder floc and landfilled. There is a common misconception that the commercial market for scrap metal drives effective cost recovery when it falls considerably short of covering even a fraction of the collection and degassing costs.

- The cost of current appliance disposal methods is not equitably shared with producers or consumers, with local councils bearing the cost burden of disposing of end-of-life appliances presented in kerbside collections and illegally dumped. This scenario is increasingly at odds with stated corporate commitments to circular economy and ESG (Environmental, Social, Governance) outcomes.
- Further research is required to better understand the extent to which manufacturers, brands, distributors, and retailers are currently providing take-back, collection, and recycling arrangements.

The primary recommendation from the 2023 SSROC research was for refrigerators and freezers to be included in a product stewardship or take-back scheme, and for further engagement with appliance manufacturers and brands to inform future stewardship options. This led to SSROC applying for a Sustainability Partnerships Grant from the NSW EPA for the Stewardship of Large Appliances Project.

<sup>4</sup> Summary of research findings prepared by SSROC based on a study conducted by Edge Impact in 2023.

## 2. The Importance of Product Stewardship

Product stewardship refers to producer responsibility across the entire product lifecycle, including end of life. The primary responsibility for the environmental and human health impacts of products and their materials is assigned to the producers, manufacturers, brands, importers, and retailers who place products on the market. Product stewardship also provides an obvious step-by-step pathway for businesses and governments to operationalise the circular economy.

A circular economy presents a system-wide solution to more sustainable consumption and production. It encourages us to rethink how we design, manufacture, use and manage products and materials, across the entire lifecycle, including at the end of life. Reducing resource use, increasing resource efficiency, eliminating unsafe chemicals, and enabling circular material flows are at the core of a circular economy.

Systemic change across the product lifecycle is essential for the circular economy transition.

**Figure 1** on the next page, outlines the product stewardship actions businesses and governments can implement to deliver circular economy outcomes across the three product lifecycle stages: design and production, consumption and post-consumption. These actions can drive significant positive environmental and social benefits.<sup>5</sup>

Product stewardship not only shifts the economic burden of products' environmental and human health impacts away from governments and the broader community to the producer and user, but it also significantly increases the private sector's investment in driving systemic changes to prevent and reduce waste efficiently and cost-effectively, as illustrated by the National Television and Computer Recycling Scheme, the Used Oil Product Stewardship Scheme and the Container Deposit/Return Schemes.

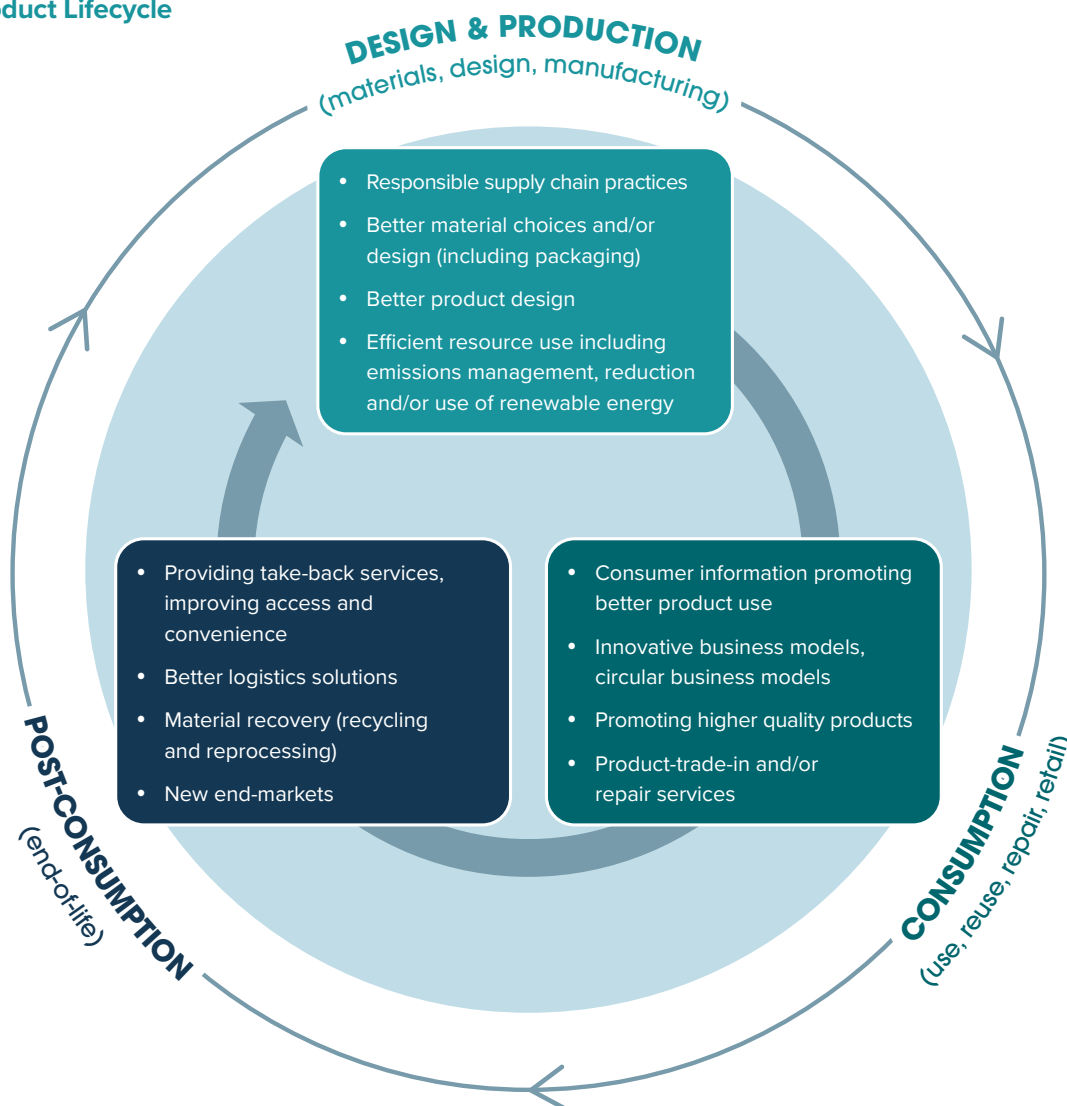
However, product stewardship and the circular economy are much more than recycling. Producer action at the end of a product's life does not avoid and design out waste or optimise the circulation of products and materials in the economy or restore the environment. Action, investment and innovation in the first two phases of the product lifecycle – Design and Production (materials, design, manufacturing) and Consumption (use, reuse, repair, retail) is also necessary to achieve a circular economy, and deliver the objectives of the Australian Government's Recycling and Waste Reduction Act 2020 (RAWR Act).

For example, waste prevention-related decisions made at the design stage can significantly inform and reduce a product's environmental impact during its consumption and post-consumption phases.

When executed well, product stewardship delivers a wide variety of benefits and positive impacts, including:

- **Environmental** – eliminating hazardous materials, conserving resources and materials, preventing and reducing waste, and reducing greenhouse gas emissions.
- **Social** – improving workers' health and safety across the supply chain and increasing accessibility to repair services and collection points for recycling.
- **Economic** – job creation, upskilling, reskilling, and creating new markets for recovered materials.

Figure 1: Product Lifecycle



## Characteristics of effective product stewardship that enable greater circularity

Research by UTS Institute for Sustainable Futures and the Product Stewardship Centre of Excellence, on the effectiveness and benefits of product stewardship<sup>6</sup> identified the following five essential characteristics to effective stewardship.

- 1** High levels of industry or business investment and participation where regulation is the best solution for ensuring high levels of industry investment and participation.
- 2** Clearly defined objectives – measurable environmental, social, and economic performance indicators demonstrate benefits and allow for continual assessment of the effectiveness.
- 3** Good governance – this includes well-defined roles and responsibilities and ensures transparency through public reporting.
- 4** Use of financial incentives – to drive behaviour change of businesses, consumers, repairers, collectors, sorters, and recyclers.
- 5** Effective marketing and communications – leading to high awareness and increased user participation.

6 <https://stewardshipexcellence.com.au/resources/#benefits>

### 3. Approach and Methodology

The project approach and method consisted of four elements aimed at addressing the objectives and are outlined below.

**Desktop review:** A review of literature, studies and reports on policies, directives and regulatory approaches to large household appliances in other jurisdictions.

**Stakeholder engagement:** Interviews and roundtables were conducted with stakeholders across the appliance industry, including manufacturers, retailers, recyclers, and government representatives, to gain insights on existing product stewardship initiatives, barriers and opportunities related to the collection, repair, degassing, and recycling of appliances, and perspectives on potential future collective stewardship initiatives.

**High-level modelling:** High-level financial, environmental, social and economic cost-benefit analysis of participating in a stronger stewardship approach. Modelling included costs of collection and aggregation models, increased repair and material recovery scenarios, and benefits such as emissions capture, jobs and training.

**Reporting:** Findings from the above activities documented and shared with relevant stakeholders, including presentations to government officials, interested manufacturers, brands, retailers, and other relevant parties.

The project was limited to capturing insights from key stakeholders on how to further progress stewardship for appliances. It did not include designing a new scheme or the mechanics of how to expand an existing scheme to include large appliances.

These activities were conducted collaboratively with specific roles and responsibilities shared between SSROC and the Centre. The research acknowledges that further stewardship thinking, and action needs to be co-designed by government and industry, including manufacturers, brands and importers; retailers and buying groups; reconditioning, repair, recycling, degassing; transport/logistics businesses/operators; all levels of government; and relevant associations and social enterprises.





## 4. International Stewardship Approaches

The desktop review looked at policies and regulations for large household appliances and the manufacturing and consumption of ozone-depleting substances in the European Union (EU), Germany, France, Italy, the Republic of Ireland, Sweden, Canada, the USA, Japan, South Korea, Taiwan, China, and Australia.

The implementation of product stewardship policies and regulations varies across regions and countries, ranging from an effective and cohesive transposition of European Union Directives throughout member state domestic law, to voluntary state-funded programs in Australia and the USA.

Of the countries that have implemented waste electrical and electronic equipment (WEEE) management regulations, a range of common themes arise. These regulations tend to identify similar priority product categories, including refrigerators, freezers, washing machines and clothes dryers, and outlining financial and operational penalties that can be imposed on non-compliant producers. While these broad similarities strengthen the international response to WEEE management, there is deviation across borders regarding the scope of producer responsibility and the role of government programs in funding and enabling the safe collection, treatment and disposal of large household appliances.

Several countries in Asia and Europe use levies, disposal fees, penalties and legislation to ensure manufacturers are responsible for end-of-life costs. Examples include:

- In France, manufacturers/importers are obliged to contribute towards collection and treatment costs, with financial penalties for non-compliance.
- Ireland's legislation assigns financial responsibility for collection and the full cost of recovery on manufacturers, importers and retailers.
- Taiwan requires manufacturers and importers to pay a fixed fee per unit sold domestically, which is allocated to collecting and recycling post-consumer products<sup>7</sup> with penalties for non-compliance.
- South Korea's Product Recycling System has retailers and suppliers financially responsible for collecting goods, and consumers are also responsible for paying a disposal fee.
- Japan requires "retailers to facilitate the collection of goods from consumers, while manufacturers and importers are responsible for product recycling and financially accountable for costs associated with collection".
- China's approach includes holding manufacturers and importers financially responsible for the end-of-life treatment of their products<sup>8</sup> and having a state-administered Disposal Fund.

In countries that have not enshrined WEEE management into law, such as the USA and Australia, a trend has emerged where producers have no legal responsibilities for the end-of-life treatment, and governments are left to ensure end-of-life products are disposed of safely. While voluntary programs in these countries encourage the extension of producer responsibility, there is a need to assign and regulate increased accountability for producers throughout the supply chain.

In contrast, regulatory responses to reducing ozone-depleting substances are uniform throughout Europe, North America and Asia-Pacific. The influence of the Montreal Protocol is in part responsible for this international cohesion, with many of the legislative instruments that have been analysed referring to its contribution to the regulation's formulation.

Regulatory responses in Australia should prioritise the assignment of responsibility throughout the supply chain, incentivise compliance with these policies, increase local capabilities to process appliances, and establish succinct and clear methods of knowledge sharing and communications to ensure industry stakeholders are aware of their responsibilities.

A summary of the key features of each country's policies and regulatory approaches relevant to large household appliances are provided in **Tables 2** and **3**.

<sup>7</sup> *ibid.*

<sup>8</sup> China WEEE (2020) Envilliance Asia

**Table 2: Key features of selected international policies and regulatory approaches for waste electrical and electronic products, including large household appliances**

| Region & Country /<br>Law or Government Program                                                 | Key Features                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>European Union</b><br>Waste from Electrical and Electronic Equipment (WEEE) Directive (2003) | Provides a cohesive framework for European countries to align e-waste management strategies, to address environmental and economic challenges. Aims to prevent the creation of electronic waste, encourages efficient use of resources, retrieval of secondary raw materials through re-use, recycling, improving the environmental performance of everyone in the EEE life cycle and establishing regulatory guidance on how stakeholders can incorporate EPR principles into their supply chain strategies. <sup>9</sup>                                               |
| <b>Germany</b><br>Electrical and Electronic Equipment Act (Elektrogesetz) (2005)                | Aims to protect human and environmental health from the harmful substances used in WEEE, ensure the proper collection and return of waste materials, prevent waste and reduce the amount of waste through reuse, preparation for reuse or recycling and recovery, <sup>10</sup> placing the responsibility on organisations who profit from the distribution and sale of WEEE. Includes language that discourages producers from intentionally preventing products' re-use. Targets include a minimum of 80 per cent [rate of recovery] by average weight per appliance. |
| <b>France</b><br>Title IV, Environmental Code (2003)                                            | Any person who professionally manufactures, imports or introduces onto the national market electric or electronic household appliances... is obliged to provide for or contribute to the collection, removal and treatment of electric or electronic household appliance waste, irrespective of the date on which they were put on the market. <sup>11</sup> Financial penalties to producers who do not comply.                                                                                                                                                         |
| <b>Italy</b><br>Legislative Decree 49/2014                                                      | WEEE made into domestic law, updated 2018 with open scope approach that any electrical equipment that meets definition needs to follow requirements including that large household appliances achieve 80% recovery rate based on product weights.                                                                                                                                                                                                                                                                                                                        |
| <b>Rep. of Ireland</b><br>Statutory Instrument No. 149 (2014)                                   | Clear direction on responsibilities of manufacturers, importers and retailers in managing collection and financial guarantee for full cost of recovery when discarded by the final user.                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Sweden</b><br>Ordinance 2022:1276                                                            | WEEE plus Ordinance outlines requirements for producers including 85% recyclability and that they design for reuse and recycling.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Canada</b><br>Canada-wide Action Plan for EPR (2009)                                         | 9 out of 10 Canadian provinces introduced EPR policies and programs, with exceptions made for remote northern territories due to logistical difficulties, no minimum recycling target. However, KPIs are identified for EPR programs, including kgs of waste/capita captured, dollars/kg recovered and avoided GHG emissions.                                                                                                                                                                                                                                            |
| <b>USA</b><br>Responsible Appliance Disposal Program (2006)                                     | No federal regulation, 25 states regulate e-waste management. Responsible Appliance Disposal (RAD) program for voluntarily participate in EPR practices but no enforcement.                                                                                                                                                                                                                                                                                                                                                                                              |

<sup>9</sup> WEEE (2024) European Commission

<sup>10</sup> Meunier, C. (2013) Umweltbundesamt

<sup>11</sup> ibid

| Region & Country /<br>Law or Government Program                                                                     | Key Features                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Japan</b><br>Home Appliance Recycling Law (2001)                                                                 | Regulated EPR with required recycling rate of 55-82% (depending on product category) and assigns clear responsibilities e.g. retailers required to facilitate the collection of goods from consumers, while manufacturers and importers are responsible for product recycling and financially accountable for costs associated with collection. Also regulates the recovery and treatment of products containing CFCs, HCFCs and HFCs. <sup>12</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>South Korea</b><br>Product Recycling System (2003)                                                               | Retailers and suppliers are financially responsible for the collection and transport of goods and have the choice of fulfilling their obligations by recycling the products themselves or engaging third party recyclers and Producer Responsibility Organisations. <sup>13</sup> Consumers also have a responsibility to pay a disposal fee. Includes recycling rate targets and penalties where producers fail to meet the mandatory recycling rates, a fee equivalent to the amount of the recycling shortage multiplied by 115 to 130% of the standard recycling cost will be payable by the infringing producer. <sup>14</sup>                                                                                                                                                                                                                                                     |
| <b>Taiwan</b><br>4-in-1 Recycling Program under the Waste Disposal Act (1988)                                       | Manufacturers and importers are required to pay a fixed fee per unit sold domestically, which is allocated to the collection and recycling of post-consumer products. <sup>15</sup> Guidelines are also provided on collection strategies, determining that collection points for Regulated Recyclable Waste (including large household appliances) are required at certain retail locations, including supermarkets and convenience stores. <sup>16</sup> Manufacturers can be penalised for non-compliance. No mandatory recycling rates. Exported appliances are exempt from the fixed-fee-per-unit pricing mechanism. <sup>17</sup>                                                                                                                                                                                                                                                 |
| <b>China</b><br>Management of Collection and Disposal of Waste Electrical and Electronic Products Regulation (2011) | Manufacturers and importers are held financially responsible for the end-of-life treatment of their products. <sup>18</sup> China's approach to managing WEEE hinges on a state administered Disposal Fund, that collects fees from manufacturers and importers that are allocated to the collection and disposal of waste electrical and electronic products. <sup>19</sup> Collection and disposal service providers are licensed to ensure they are meeting regulatory expectations, with severe penalties administered to non-complying service providers. <sup>20</sup><br><br>Stakeholders suggest that the legislation has not materially influenced the product design processes <sup>21</sup> due to insufficient awareness among stakeholders, the perception of insignificant impact and limited understanding of the practical changes the regulation incurs. <sup>22</sup> |
| <b>Australia</b><br>Fridge Buyback Scheme (2006-2017)<br>ACT Fridge Buyback                                         | No national, state or territory regulations exist. State and territory government funded programs. NSW Fridge Buyback Schemes offered residents across 51 Councils the opportunity to responsibly dispose of their fridges between from 2006 – 2017. The program created significant economic benefits, saving a total of ~\$18 million/yr on residential bills. <sup>23</sup><br><br>ACT's Fridge Buyback scheme available to ACT residents who are also ActewAGL customers, offers in home collection of one and two door refrigerators with two door refrigerators receiving a \$30 credit.                                                                                                                                                                                                                                                                                          |

12 ibid

13 ibid

14 ibid

15 ibid

16 WEEE Management in Taiwan (2012) USEPA, p. 2

17 ibid, p. 21

18 China WEEE (2020) Enviance Asia

19 ibid

20 ibid

21 ibid, p. 12

22 ibid

23 ibid

**Table 3: Key features of selected international policies and regulatory approaches for ozone depleting gases for large household appliances**

| Region & Country /<br>Law or Government Program                                                                                   | Key Features                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>European Union</b><br>Regulation (EU) 2024/590 on<br>Substances that Deplete the Ozone<br>Layer (2024)                         | Focuses on producers' management of the recovery, destruction, recycling and reclamation of ozone-depleting substances.                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Canada</b><br>Ozone-depleting Substances and<br>Halocarbon Alternatives Regulation<br>(OSHAR, 2016)                            | Ensures responsible reclamation, recovery and recycling of hazardous chemicals found in heating, plumbing or refrigeration systems. <sup>24</sup> These regulations transpose guidelines from the Vienna and Montreal Protocol. <sup>25</sup> However, OSHAR has not yet been amended to restrict the incidental production of harmful substances, <sup>26</sup> limiting its regulatory oversight in comparison to European leaders in the space.                                                                      |
| <b>USA</b><br>American Innovation and<br>Manufacturing Act (2020)                                                                 | American Innovation and Manufacturing Act (2020) regulates HFCs in refrigeration, air conditioning, heat pump and fire suppression equipment, ensuring that those who own, operate, service, repair, recycle, dispose, or install equipment containing HFCs are held responsible for the proper treatment of hazardous chemicals.                                                                                                                                                                                       |
| <b>Japan</b><br>Ozone Layer through the Control<br>of Specified Substances and Other<br>Measures (1988)                           | This law refers to the Vienna and Montreal Protocol, outlining strict controls on the production of 'specified substances', requiring comprehensive reporting, research and independent oversight of the substances' production.                                                                                                                                                                                                                                                                                        |
| <b>South Korea</b><br>Act on the Control of Manufacture<br>of Specific Substances for the<br>Protection of the Ozone Layer (2008) | Integrating the Montreal Protocol into domestic law, the regulation defines the responsibilities of producers, the entities eligible for exemption and penalties incurred because of non-compliance. <sup>27</sup>                                                                                                                                                                                                                                                                                                      |
| <b>Taiwan</b><br>Air Pollution Control Act                                                                                        | Regulation to phase out the use of ozone-depleting substances, guided by the Montreal Protocol. <sup>28</sup> Taiwan has phased out the majority of ozone-depleting substances since 2006, with a target of eliminating the consumption of HCFCs by 2030. <sup>29</sup> A suite of regulations under the Air Pollution Control Act provide guidelines for producers' responsibility in reducing their use of HCFCs, specifically targeting manufacturers of refrigeration and air conditioning equipment. <sup>30</sup> |
| <b>China</b><br>Regulations on Administration of<br>Ozone Depleting Substances (2010)                                             | Oversight of refrigeration and air conditioning equipment, while expanding state control of HFC reporting and elimination. <sup>31</sup>                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Australia</b><br>Ozone Protection and Synthetic<br>Greenhouse Gas Management<br>Legislation (1989)                             | Controls ozone-depleting substances throughout the product lifecycle from production to disposal. <sup>32</sup> The regulation specifically acknowledges refrigerators and air conditioners as priority product categories given their reliance on CFCs and HCFCs. <sup>33</sup>                                                                                                                                                                                                                                        |

24 OSHAR (2016)

25 ibid

26 ibid

27 Act No. 19002

28 Ozone Layer Protection (2024) Ministry of Environment

29 ibid

30 ibid

31 ibid

32 The Ozone Acts (2021) DCCEEW

33 ibid



# 5. Stakeholder Engagement

Interviews and roundtables were conducted with stakeholders across the appliance industry. This included manufacturers, retailers, metal recyclers, state and local government representatives to gain insights on existing product stewardship initiatives, barriers and opportunities related to the collection, repair, degassing, and recycling of appliances, and perspectives on potential future collective stewardship initiatives.

Refer to the supporting report: *Industry Views, Opinions and Appetite* for a more detailed summary of the findings.

## Key findings from stakeholder interviews and roundtables

### 1. Existing product stewardship initiatives:

- **Repair:** Some brands are investing in repair but many face challenges including service and spare parts availability, as well as increased integration of technology into appliances and growing labour shortages.
- **Reuse:** Take-back programs and refurbishment initiatives exist but are constrained by several factors, including warranty restrictions and consumer preference for new products.
- **Recycling and degassing:** Australia has strong refrigerant management regulations, but a limited in-home collection of appliances creates challenges for effective and transparent degassing and material recovery see point five in this chapter for more specific issues on this stage of the process.

*“Before we even talk about recycling, it really starts at the source – with the materials we use and the way we design our products. Our mandate is for appliances to last the equivalent of 20 years of regular use. Longevity depends on use, maintenance, and above all, quality materials. If you use poor-quality components – whether it’s steel or electronics – the product won’t last. That’s why we’re meticulous about who we work with and what we use.” – Manufacturer*

### 2. Barriers to the expansion of product stewardship initiatives:

- **Regulatory uncertainty:** Despite supporting the development of a mandatory stewardship scheme, stakeholders emphasised that uncertainty around future regulation and free-riders are key barriers to investing in voluntary stewardship initiatives.
- **Financial constraints:** Moreover, stakeholders noted that current financial models fail to incorporate recovery costs into pricing, making embedding stewardship costs in operations financially challenging, especially for budget brands.
- **Logistics and infrastructure:** Collecting and transporting large appliances requires investment in and expansion of dedicated infrastructure. Servicing regional areas also increases complexity and cost.
- **Labour shortages:** Alongside high labour costs, a shrinking skilled workforce risks limiting the growth of repair and reuse initiatives, particularly in regional areas.
- **Consumer engagement:** There is an opportunity to increase the general public’s awareness and support for product stewardship initiatives (both at the level of individual businesses and a collective scheme).

*“As an individual business, we don’t always have a strong voice with government officials. Sometimes laws and regulations are introduced without fully understanding their impact on manufacturers, retailers, or consumers. It’s important for us to have a seat at the table to work with the government before new rules are implemented.” – Manufacturer*

### 3. Enablers for effective product stewardship:

- **Policy support:** Stakeholders were largely in favour of a mandatory stewardship approach. They also supported exploring product design standards for durability and repairability to keep products in use longer and reduce waste.
- **Industry-led collaboration:** Existing industry collaboration (working groups and sharing of data/knowledge) can be leveraged to increase participation in stewardship initiatives.
- **Consumer awareness and incentives:** Public education campaigns and financial incentives, such as buy-back programs, can promote responsible disposal and repair behaviour.

*“Most consumers don’t realise that disposing of old refrigerant equipment isn’t just about keeping it out of landfill – it’s about ensuring harmful gases are properly captured. Without awareness, refrigerants can be released into the atmosphere, causing serious environmental harm.” – Retailer*

### 4. Governance considerations:

- Strong stakeholder support was also found for a co-regulatory approach to product stewardship, ensuring that industry is actively engaged in scheme design and delivery while still ensuring a mandatory approach to address free-rider concerns.
- Eco-modulated fees based on product recyclability could encourage design for circularity features (such as using recyclable, replaceable and repairable parts and recycled materials), so product life can be extended and keep material out of the landfills. Plastic floc going to landfills were identified as a persistent and growing concern.
- Transparent financial contribution guidelines are needed to determine cost-sharing responsibilities amongst stakeholders across the product lifecycle.

*“We favour a co-regulatory approach where there is significant stakeholder engagement and industry involvement while also preventing free-riders.”  
We see this as a hallmark of a successful scheme” – Industry association*

### 5. Degassing and recycling

Issues related to degassing and recycling were a recurring theme. Large household appliances, including fridges and air conditioners, pose several important issues related to degassing. To ensure degassing takes place, stakeholders consistently emphasised the benefits of in-home collection, which provides the necessary quality control and transparency during transport, recycling and degassing. However, several challenges were identified, including:

- In-home collection services are limited, typically found in premium industry segments, and are often only initiated when a customer purchases a new product.
- Many appliances are collected for recycling during kerbside pick-up. Once on the street, however, they are vulnerable to metal scavenging and weather exposure, which contribute to declining material recovery. Interviews consistently noted that one of the most valuable scrap components in refrigerators and freezers is the compressor, which is often removed by metal scavengers. The removal of the compressor releases harmful gases and decreases the value of appliances for recyclers.

*“When white goods are left on the footpath, scrap collectors immediately cut out the compressors. About 95% of fridges we receive from third parties come without compressors because they’re worth more than the fridge itself. It’s a simple process for them – just two cuts – and it earns them a bigger rebate.”*

– Recycler

- When appliances arrive already degassed at the next processing stage, this negatively impacts organisations that have invested in degassing systems and related training, which is then underutilised.
- Stakeholders commented that the financial incentives provided by Refrigerant Reclaim Australia’s scheme for recovering refrigerant gases do not cover the costs of product collection, aggregation, and storage, which are the biggest costs in recovering both the product and the refrigerant gases.

- Stakeholders also expressed significant concern about plastic floc and plastic recovery. Sorting and separating plastics in appliances at end-of-life is labour-intensive, and the resulting material has low recovery value. There are also limited recycling pathways for shredder floc, most of which end up in landfills. This led many stakeholders to call for better product design to reduce the amount of plastic utilised and prioritise recyclable materials.

*“Whitegoods aren’t great recyclable products because increasingly, they contain a lot of non-metallic materials. They’re basically consumables now that people just throw in bins. Even dryers and washing machines with big metal drums don’t yield much value, especially front loaders that have heavy concrete blocks inside. Given Australia’s 25 million people spread across a huge continent, the only real solution is to consolidate and recycle them as best as possible.” – Recycler*

- Packaging was also identified as a priority area for future stewardship action. Packaging waste, such as expanded polystyrene, remains a notable issue. Some stakeholders described engaging with other industry stakeholders to improve data collection on packaging use and explore more sustainable alternatives.

*“There’s a lack of governance when it comes to refrigerant disposal and this creates a major environmental risk. While we’re vocal about our take-back and recycling program, there needs to be action from the wider industry to have a greater impact.” – Retailer*

Stakeholders also had varying views regarding the size of the degassing problem. Some suggested that the amount of hazardous chemicals used in refrigerators is decreasing and, therefore, less of an issue. (This was a common argument for deprioritising appliance degassing, particularly as other priority products such as lithium-ion batteries, are a growing issue).



Others maintained that recovery of gases from household refrigerators and air conditioners was low and that even small amounts of degassing of some types of refrigerants can have a significant environmental benefit and, as such, should be high on the agenda. There were also discussions on how to increase education and awareness on the importance of degassing and increasing enforcement to ensure compliance with degassing regulations.

*“A domestic refrigerator containing approximately 300g of HFC-134a refrigerant gas, if not degassed properly and released into the atmosphere releases 429kg of carbon dioxide, this is equivalent to amount of CO<sub>2</sub> released from driving nearly 1,500kms<sup>34</sup>” – Industry association*

34 \*Based on a standard petrol car using the USA EPA Greenhouse gas equivalencies calculator <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>

# 6. Economic Modelling

## Background and purpose

RPS Consulting was commissioned to model the high-level financial, environmental and social implications of different product stewardship scheme options (the Economic Model). The modelling estimated the net impacts of each option, to inform potential future investigations into how these scenarios could be funded and what their benefits might be.

## Approach and scheme options

The modelling considered three options to address one or more product stewardship scheme objectives relative to the current problems in the Base Case as outlined in **Table 4** below.

The options assumed that the product stewardship scheme achieves improved stewardship outcomes through a regulatory product stewardship approach. A regulatory approach involves the government

introducing regulations and regulatory oversight to ensure the achievement of stewardship outcomes. Based on stakeholder interviews in this project, such an approach should be co-designed in consultation with industry.

The practical implication of assuming a regulatory approach is that the modelling assumes full industry participation. Effectively, every brand that imports products into Australia contributes to funding through a levy and that their funding is proportional to the mass of appliances they sell.

In contrast, a voluntary approach is highly likely to lead to free riding and less than full participation, and stakeholder interviews showed universal support for a regulatory approach due to the issue of free riders.

The modelling considered three product stewardship scheme options as outlined in **Table 5**.

Table 4: Options for product stewardship scheme objectives

| Problems in Base Case                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Scheme objectives for Options                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>Inconsistent handling of refrigerant gas which, if not managed responsibly, results in harmful gasses being released into the atmosphere, including greenhouse gas (GHG) emissions, chlorofluorocarbons and hydrochlorofluorocarbons</li><li>Council and ratepayers bearing the cost of end-of-life management without being able to directly influence the factors that drive this cost</li><li>Limited material recovery, which is focused primarily on metals, with the glass and plastic being sent to landfill</li><li>Limited opportunities for repair, reuse and refurbishment.</li></ul> | <ol style="list-style-type: none"><li>Transfer the collection and recycling costs and responsibility to producers, importers and retailers</li><li>Increasing recycling</li><li>Increasing material and gas recovery</li><li>Providing accessibility/convenience of collection</li><li>Increasing repair/reuse/refurbishment</li><li>Educating and informing consumers</li><li>Investing in research &amp; development</li><li>Providing data transparency and robust governance.</li></ol> |



**Table 5: Product stewardship scheme options**

| Option 1                                                                                                                                                                                                                                                                                  | Option 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Option 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Transfer costs to producers</b>                                                                                                                                                                                                                                                        | <b>Uplift material &amp; gas</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Uplift including repair</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>Move to a common industry program and transfer the costs of end-of-life management of large household appliances to producers</li> <li>No explicit initiatives to improve recycling, recovery, repair, reuse or refurbishment outcomes.</li> </ul> | <ul style="list-style-type: none"> <li>Producers directly invest in and/or provide incentives to uplift recycling, gas and material recovery outcomes, through on or more of the following:               <ul style="list-style-type: none"> <li>» A mandated target to achieve these outcomes or incur a penalty cost</li> <li>» Rebates to Scheme approved collectors and recyclers</li> <li>» Direct investment in recycling capacity owned by the industry to improve pathways for more costly or difficult to recycle materials, such as problematic plastics</li> <li>» Buyback of materials or gas reclaimed.</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>Same measures as Option 2 to address recycling, gas and material recovery outcomes</li> <li>Address key barriers related to repair/reuse/refurbishment, including:               <ul style="list-style-type: none"> <li>» Introducing mandates to right of repair, providing a legal right for product owners to freely modify and repair large household appliances</li> <li>» Better labelling about repairability/durability</li> <li>» Stimulating the development of markets for spare parts</li> <li>» Apprenticeship programs in collaboration with government.</li> </ul> </li> </ul> |

## Results

**Table 6** on the following page summarises the results of the modelling. The results show that:

- The cost to the industry to assume financial responsibility for the end-of-life management of large households applies is an estimated \$37 per appliance, which is expected to be:**
  - » Banded according to category/size (e.g. large fridge, small fridge, large washing machine).
  - » Approximately 3% of the retail price.
- For an additional \$11.14 per appliance levy, Option 2 is estimated to:**
  - » Significantly lift net material and gas recovery.
  - » Significantly reduce illegal dumping.
  - » Provide significant environmental and social benefits in terms of avoided landfill, employment associated with the circular economy and GHG emission reductions.

- For a further \$1.18 per appliance levy, Option 3 is estimated to:**
  - » Stimulate a repair/reuse/refurbishment economy.
  - » Further substantially improve employment within the circular economy.





Table 6: Results of modelling of three product stewardship scheme options

|                                                             | Unit                      | Option 1                    | Option 2              | Option 3            |
|-------------------------------------------------------------|---------------------------|-----------------------------|-----------------------|---------------------|
|                                                             |                           | Transfer costs to producers | Uplift material & gas | Uplift incl. repair |
| <b>Diversion and material recovery (by Year 5)</b>          |                           |                             |                       |                     |
| Collection for recycling/repair                             | %                         | 90%                         | 95%                   | 95%                 |
| Net material recovery rate from recycling                   | %                         | 59%                         | 84%                   | 80%                 |
| Illegal dumping                                             | Tonnes/yr                 | 802                         | 402                   | 402                 |
| <b>Environmental and social benefits (by Year 5)</b>        |                           |                             |                       |                     |
| Repaired/reused/refurbished                                 | Tonnes/yr                 | minimal                     | minimal               | 4,958               |
| Landfill reduced                                            | Tonnes/yr                 | 0                           | 5,317                 | 5,317 <sup>3</sup>  |
| Landfill airspace depletion avoided <sup>2</sup>            | m <sup>3</sup> /yr        | 0                           | 40,677                | 40,677 <sup>3</sup> |
| Incremental employment within circular economy <sup>4</sup> | FTE/yr                    | 0                           | 149                   | 496                 |
| GHG emissions reduced <sup>1</sup>                          | tCO <sub>2</sub> -e/yr    | 0                           | 3,872                 | 3,901               |
| <b>Financial implications</b>                               |                           |                             |                       |                     |
| Scheme levy (per average household appliance)               | \$/appliance <sup>2</sup> | \$36.60                     | \$47.84               | \$49.02             |
| Percentage of retail price                                  | % <sup>2</sup>            | 2.58%                       | 3.37%                 | 3.45%               |

1 Including through recycling, avoiding the emissions embedded in materials recovery, as well as repair/reuse/refurbishment, avoiding the embodied emissions in new product manufacture

2 The modelling is based on an 'average large appliance', with an average weight of 65kg and costing \$1,256 ex GST

3 Although the results show the same estimated landfill diversion outcomes for Option 2 and Option 3, the latter is expected to deliver greater long-term diversion outcomes. The current modelling does not capture these long-term effects and focuses on the first 5 years of the Scheme.

4 These jobs would be distributed across Australia. Jobs would be predominantly concentrated in manufacturing regions, including in NSW and Victoria.

While these results relate to a NSW scheme, a national scheme would be expected to achieve proportionately higher environmental and social outcomes but with a similar levy, because the additional costs are spread over a larger base of sales, with potentially greater economies of scale and scope. A national scheme approach would also signal uniformity for brands and retailers, so that there is consistency across states and territories in terms of commercial rules, logistics and procurement of services.



## Findings

The economic modelling assessed the implications of three regulatory options to address the current problems associated with the stewardship of large household appliances. Overall, the results show that transferring financial responsibility to the industry would require industry to incur an estimated levy of \$36.60 per appliance. However, it is expected to be banded according to appliance category and size.

The size of the levy reflects the cost already incurred to collect large household appliances at end-of-life. Councils are primarily responsible for incurring this existing cost burden.

Options 2 and 3 involve additional investment to uplift material recovery, GHG emission reduction and repair outcomes. However, the costs to achieve this uplift are relatively low compared to the existing costs of collection and recycling. As such, the estimated levies for Option 2 and Option 3 are only modestly higher than Option 1.

The current barriers and opportunities to achieving these outcomes appear to be that:

- Only the metal materials are being recovered commercially from large household appliances with plastic and glass going to landfill.
- Despite a large proportion of appliances being collected for recycling, the refrigerant gas reclamation rate is very low.
  - » This means that harmful gases are being leaked at the kerbside or further downstream in the collection and recycling pathway.
- High labour costs in Australia are a likely impediment to repair/reuse/refurbishment.

Potential actions that are likely to be effective in addressing these barriers and opportunities include:

- Requiring stewards to collectively provide improved collection/take-back pathways.
- Enforceable minimum standards for collectors and recyclers of large household appliances around responsible gas handling and material recovery.
- Investment in capacity to process the recovered glass and plastic.
- Rebates for degassing that cover collection, aggregation and storage in addition to the current rebate for the recovered refrigerant gas.

- Delivering education and awareness to consumers.
- Introducing mandates for the right of repair, providing a legal right for product owners to freely modify and repair large household appliances.
- Better labelling about repairability/durability.
- Stimulating the development of markets for spare parts.
- Apprenticeship programs in collaboration with government.

These potential actions can be implemented either by an industry-funded stewardship scheme or by government agencies or regulators who can refine policy and funding settings in the absence of a scheme. In practice, the most effective approach will likely be a model combining a regulated industry stewardship scheme with appropriate government policy and funding.

Without a regulatory framework, producers are likely to be reluctant to participate in a voluntary industry-led scheme due to concerns about free riding and competitive disadvantage, as well as the substantial investment required to facilitate collection and take-back pathways. Lack of regulation is therefore a fundamental obstacle to the establishment of an effective product stewardship scheme. As such, the modelling assumes a regulatory approach.

The effects, costs and benefits of these mechanisms should be investigated further through future, more detailed and targeted analyses.

Refer to the supporting report prepared by RPS Consulting: *Improving Stewardship for Large Household Appliances – Economic Modelling*, for more details about the modelling, assumptions and analysis.

# 7. Conclusions

**From the international desktop review,** there is a diversity of approaches that can help inform Australia's future policy and regulatory approaches to improving stewardship of large household appliances and ozone-depleting gases. As a minimum, future Australian policies and regulations need to clearly address the following requirements:

- Manufacturer, brand and retailer responsibilities.
- Levies or equivalent financial contributions to fund collection, repair, treatment and recovery costs.
- Consequences and penalties for non-compliance.
- Environmental targets.
- Design, durability, reuse, repairability and recycling standards.
- Data collection and reporting requirements are needed to effectively address the waste and human health issues created by large household appliances.

**It is clear from the stakeholder interviews and roundtable discussions** that some individual manufacturers, brands and retailers are slowly but increasingly investing in repair networks and/or running individual take-back, refurbishment and recycling initiatives. However, this is not taking place industry-wide, which presents a barrier to the systematic change required. Manufacturers, brands and retailers cited several challenges to greater recovery and repair, including service availability, increased integration of complex electronics into large household appliances, growing labour shortages, warranty restrictions and a general consumer preference for new products.

Regarding recycling and degassing, stakeholders considered that while Australia has strong refrigerant management regulations, limited in-home appliance collection creates challenges for effective and transparent degassing. They also identified shredder residues or floc going to landfills, currently at 43% of collections, as a persistent and growing concern. A recent report – *Tackling the Invisible Climate Risk* – published by Civic Futures Lab examines the environmental risks of refrigerant leakage from end-of-life refrigeration and air conditioning equipment in Australia and how it contributes to greenhouse gas emissions and ozone depletion, worsening climate change.

Stakeholders were largely in favour of developing a mandatory (i.e. government-regulated) stewardship scheme where industry is actively engaged in scheme design and implementation. While they acknowledged the challenge of a comparatively small market in Australia, they were also supportive of:

- Investigating product design standards for durability and repairability to keep products in use longer and reduce waste.
- Levers such as eco-modulated levies based on product recyclability to encourage design for circularity features, such as using recyclable, replaceable and repairable parts and recycled materials.
- The development of transparent financial contribution guidelines to determine cost-sharing responsibilities amongst stakeholders across the product lifecycle.

In terms of implementing stewardship for large household appliances, the stakeholders identified the following challenges:

- Current business models fail to incorporate recovery costs into product pricing, making embedding stewardship costs in operations financially challenging, especially for budget brands.
- Collecting and transporting large appliances requires investment in and expansion of dedicated infrastructure.
- Servicing regional areas increases complexity and cost.
- High labour costs and a diminishing skilled workforce risks limiting the growth of repair and reuse initiatives, particularly in regional areas.

Stakeholders also identified a range of opportunities:

- To increase public awareness and support for product stewardship initiatives (both at the level of individual business and a collective scheme).
- To increase industry participation by leveraging existing industry collaboration (working groups and sharing of data/knowledge).
- To improve responsible disposal and repair behaviour by public education campaigns and offering financial incentives, such as buy-back programs.
- To increase gas recovery by working closely with Refrigerant Reclaim Australia.

**The economic modelling** showed that transferring financial responsibility to industry for the current collection and recycling costs for large house appliances would require industry to incur an estimated levy on average of \$37 per appliance (or around 2.58% of current retail price). Noting that the levy would vary according to appliance category and size.

The modelling also showed that to significantly increase the material recovery rate from 59% to 84% and increase gas recovery, the levy would only increase by \$11 to \$48 per appliance (or around 3.37% of the current retail price). A further investment of \$1 to \$49 per appliance (or around 3.45% of the current retail price) would also uplift the number of appliances being repaired.

While the levy increments in these options are modest, they are expected to provide substantial environmental and social benefits in terms of material recovery, reuse, circular economy, GHG emission reduction and employment outcomes.

The primary barriers identified to achieving improved stewardship outcomes include:

- Manufacturers are likely to be reluctant to participate in a voluntary program due to concerns about free-riders and the risk of competitive disadvantage.
- Only the metal materials are being recovered commercially from large household appliances with plastic and glass going to landfill.
- Despite a large proportion of appliances being collected for recycling, the refrigerant gas reclamation rate is very low. This means that harmful gases are being leaked at the kerbside or further downstream in the collection and recycling pathway.
- High labour costs in Australia are a likely impediment to repair/reuse/refurbishment.

To address these barriers, the following potential actions were identified:

- Regulation is fundamental to addressing the free-rider issue. Ideally this would be a national regulation, but the NSW Product Lifecycle Responsibility Act 2025 does provide an opportunity to start with a state led approach with the aim of a set of nationally harmonised state and territory-based regulations.
- Require stewards to provide improved collection/ take-back pathways collectively.
- Enforce minimum standards for collectors and recyclers of large household appliances around responsible gas handling and material recovery.
- Invest in capacity to process the recovered glass and plastic.
- Provide rebates for degassing.
- Deliver effective education and awareness to consumers.
- Introduce mandates to right of repair, providing a legal right for product owners to more easily repair their large household appliances.
- Develop product labelling to inform consumers about reparability and durability performance.
- Stimulate the development of markets for spare parts.
- Apprenticeship programs in collaboration with government eg. through TAFEs.



## 8. Recommendations

To address the inefficient low material and gas recovery rates, greenhouse gas emissions and financial burden on local councils it is recommended that:

**1. The Federal Government should work with manufacturers, brands, recyclers, repairers, and local government organisations to design and implement a producer responsibility regulation for large household appliances.**

The regulation would require all retailers and manufacturers to increase both the recovery of materials and gas and the repair of large household appliances, including funding the collection and delivery of their appliances from households to an approved recycler for triage, dismantling, gas and material recovery.

This would include the application of a levy to adequately cover costs associated with delivering any scheme. Ideally this regulation would leverage the existing Recycling and Waste Reduction Act's (Commonwealth) rule for the National Television and Computer Recycling Scheme, as well as the Ozone Protection and Synthetic Greenhouse Gas Management Act. A series of related recommendations are outlined in a recent report – *Tackling the Invisible Climate Risk* – published by Civic Futures Lab (March 2025).

**2. Alternatively, the NSW government should create a state-based producer responsibility regulation for large household appliances under the Product Lifecycle Responsibility Act 2025.**

This ideally would be replicated by every other state and territory government over time to make seven nationally harmonised state/territory-based stewardship schemes for large household appliances.

**3. Manufacturer, brand and retailer-led organisations such as the Coalition for Sustainable Solutions, Refrigerant Reclaim Australia, the Consumer Electronics Suppliers' Association, and other industry peak bodies, work with recyclers, the repair industry and governments to co-design regulations and to conduct further investigations into the feasibility and implementation of the following product stewardship actions.**

- Develop and implement local collection/takeback pathways that prioritise in-house collections over hard waste kerbside collections to improve reuse, repair, degassing, dismantling and material recovery procedures.
- Develop minimum standards for collectors and recyclers of large household appliances around responsible gas handling and material recovery.
- Investigate infrastructure and technology requirements to increase recovery of glass and plastic.
- Improve processes and rebates for degassing.
- Increase local public education and awareness on preferred repair and disposal pathways.
- Develop a product repairability/durability label based on what has been implemented in France.
- In collaboration with the Australian Competition and Consumer Commission, investigate how consumer law could be improved to encourage repair over replacement.
- Develop markets for spare parts.
- Rebuild industry capacity, capability and associated training and skills development in appliance repair, including dedicated apprenticeship programs.
- Undertake more detailed modelling of cost-sharing and eco-modulation arrangements between retailers, manufacturers, recyclers, repairers, and all levels of government.



## Further information

The following supporting documents can be downloaded from the SSROC or Centre websites:

- *Summary of Stakeholder Views. June 2025*
- *Desktop Review of Product Stewardship and EPR Laws for Large Appliances. June 2025*
- *Improving Stewardship for Large Household Appliances – Economic Modelling. April 2025*

## Organisations that contributed to the project

We would like to acknowledge and thank the following organisations for participating in interviews, roundtables and providing data to assist with the economic modelling. Their constructive and solution-oriented approach provided an important first phase of engagement towards improving the state of product stewardship for large household appliances.

- |                                               |                                                 |                                                        |
|-----------------------------------------------|-------------------------------------------------|--------------------------------------------------------|
| • BSH Home Appliances                         | • Retravision                                   | • Whirl Recycling<br>(formerly Arnies Recon)           |
| • Electrolux ANZ                              | • Samsung                                       | • Local Government NSW                                 |
| • Fisher & Paykel                             | • Winning Group                                 | • Southern Sydney Regional<br>Organisation of Councils |
| • JB Hi-Fi Group<br>(including The Good Guys) | • Coalition for Sustainable<br>Solutions        | • City of Sydney                                       |
| • KKTS                                        | • Consumer Electronics<br>Suppliers Association | • City of Canterbury<br>Bankstown Council              |
| • Miele                                       | • Refrigerant Reclaim Australia                 | • Inner West Council                                   |
| • NARTA                                       | • Ecocycle / EcoBatt                            | • Northern Beaches Council                             |
| • Next Energy Lighting                        | • Sell and Parker                               | • NSW EPA                                              |
| • Panasonic                                   | • Sircel                                        |                                                        |





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